STORMWATER MANAGEMENT AND DRAINAGE PLAN

FOR THE

MATTAMY RICHMOND LANDS

CITY OF OTTAWA

PROJECT NO. 07-303

MARCH 2010

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EXECUTIVE SUMMARY

David Schaeffer Engineering Ltd., in collaboration with the offices of JFSA, Kilgour and Associates with Parish Geomorphic and AECOM, were commissioned by Mattamy Homes to prepare the following Stormwater Management and Drainage Plan in support of their Official Plan Amendment application to develop a 131.5ha residential subdivision in the Village of Richmond.

The intent of this stormwater management and drainage study is to establish existing stormwater conditions for the development area and to select a stormwater management scheme. The presented stormwater management scheme will be conceptual in nature and will serve as the foundation for the detailed design stage of this project.

Three stormwater management options were identified and brought forward for evaluation through a pair-wise evaluation matrix process. The evaluation matrix was developed as part of the Village of Richmond Master Servicing Study considering the environmental, social and economic impacts of each alternative. Based on the evaluation decision matrix, Option 3 was selected as the preferred stormwater management solution for the development of Mattamy's Land.

- Option 3 involves the construction of three Stormwater Management Ponds (SWMPs) where SWMPs 1 and 2 are "Wet Ponds" with MOE 'Enhanced' TSS removal and SWMP 3 is conceived to be a dry pond for quantity control only, while TSS removal will take place within a oil/grit separator. In this stormwater management option, the Moore Tributary for its entire length will be left open and JED-1 will be enclosed within the development area. The existing channel will need to be redesigned to ensure that the channel contains the 100yr event. The corridor width for the re-engineered Section 8 of VG-R3-2 (north-south hedgerow) will be 17.5m and Section 6&7 of VG-R3-2 will be 18.8m.

SWMP 1 is situated south of Perth Street in the 100-year regulatory floodplain, outside the meander belt and 100-year summer flood elevation of the Van Gaal/Arbuckle Drain. AECOM prepared an analysis to establish the 100-year summer flood limit. It was determined that 100-year summer flood elevations can be greatly reduced upstream if Fortune Street by increasing the Fortune Street culvert. SWMP 1 will outlet to the Arbuckle Drain and be designed to demonstrate no impact on flood levels for storm events up to and including the 100-year storm event, while flows up to and including the 2-year event will be attenuated to the critical erosion threshold discharge rate established by Parish Geomorphic. SWMP 2 is situated at the southeast corner of the parcel of development between Perth and Ottawa Streets. This facility will be designed to receive runoff from 21 ha north of Ottawa Street and the developable land south of Ottawa Street. SWMP 2 has one outlet directing post-development runoff rates to the Jock River via a proposed storm sewer along Ottawa Street. The 100-year release rate from SWMP 2 will be restricted to the free flowing capacity of the outlet sewer. SWMP 3 will be designed to collect and retain runoff from approximately 3 ha north of Perth Street, east of the Van Gaal Drain.

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AECOM provided a phosphorus reduction assessment in addition to evaluating the anticipated post-development impact on Jock River flood levels. The Jock River, based on phosphorus concentrations, has been classified as a Policy 2 watercourse by the Ontario Ministry of Environment (MOE); as such, post-development phosphorus loadings must be equivalent or less than pre-development loadings. The post-development phosphorus loadings are 58% lower than pre-development levels, achieving the objectives for a Policy 2 watercourse. Based on hydrologic modeling and resulting hydrographs at the confluence of the Van Gaal Drain and the Jock River, it can be concluded that the proposed development and its potential SWM options will not have an impact on flood levels of the Jock River for either the 100-year rainfall or spring melt flood levels.

Kilgour & Associates were retained to assess the existing natural environment conditions (***Environmental Study***) and evaluate the potential impact that the three SWMP alternatives would have on fish habitat. This analysis concluded that Option 3, the preferred alternative, has the least potential impact on the existing fish habitat and that the preliminary design results in a net increase in direct fish habitat in approximately 3,385m^2.

As established through the presented documentation and decision making process, Option 3 provides the greatest benefit to the subject land and the existing Village from natural, social, cultural, and economic environment perspectives.

STORMWATER MANAGEMENT AND DRAINAGE PLAN FOR MATTAMY RICHMOND LANDS

MARCH 2010

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PRELIMINARY
STORMWATER MANAGEMENT ANALYSIS
FOR
MATTAMY VILLAGE OF RICHMOND

CITY OF OTTAWA

MARCH 2010
OUR FILE.: 07-303

1.0 INTRODUCTION

1.1 Scope of Work

David Schaeffer Engineering Ltd., in collaboration with the offices of JFSA, AECOM, and Kilgour and Associates Ltd, were commissioned by Mattamy to prepare a Stormwater Management and Drainage Plan in support of their Official Plan Amendment application to develop a 131.5ha residential subdivision in the Village of Richmond. A work plan outlining the scope of work was submitted to the City of Ottawa and Rideau Valley Conservation Authority in November 2008 (***Appendix A***). The general approach is summarized as follows:

- Establish existing drainage patterns within the site including as well as external lands draining through the site.
- Calculate existing flows by developing a computer models using SWMHYMO with 25mm 4 hour Chicago storm, 2, 5,and 100 year 24 hour SCS Type II, and 2, 5 and 100 year 10day rain on snow events.
- Prepare an existing condition Water Budget.
- Confirm stormwater management criteria for the Van Gaal Drain and Jock River.
- Integrate geotechnical, natural environment and geomorphic information.
- Develop stormwater management and drainage options to service the development.
- Undertake a phosphorous loading analysis.
- Prepare cost estimates for each option.

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- Evaluate options using the pair wise comparison and weighting criteria established by the development team.
- Prepare a preliminary grade control plan for the preferred option.
- Review the class EA process to ensure conformity with the proposed SWM plan.
- Develop an Implementation Plan.

The results of hydrologic modeling simulations for the existing and proposed development areas are presented in this study. Kilgour & Associates with Parish Geomorphic provided the baseline natural environment and fluvial geomorphology information as well as input into the development of the stormwater management options. Parish Geomorphic provided erosion threshold limits for the existing in stream conditions. Kilgour & Associates carried out an assessment of the potential impact on existing fish habitat for each of the three stormwater management scenarios. AECOM was also retained to provide phosphorus reduction assessment of the proposed development compared to existing conditions and undertake the river hydraulic analysis applying the Jock River hydraulic model developed by Totten Sims Hubicki (now AECOM). AECOM also prepared a detailed analysis of channel and culvert improvements along the Van Gaal Drain to establish a 100-year summer limit. JFSA was commissioned to prepare a water budget analysis , a hydraulic grade line analysis of the preferred solution including an analysis of downstream water levels in the Van Gaal Drain, as well as a hydraulic analysis of external areas to be conveyed through the subdivision.

The intent of this stormwater management study is to identify existing stormwater conditions for the development area and to select a stormwater management scheme. The presented stormwater management scheme will be conceptual in nature and will serve as the foundation for the detailed design stage of this project.

The Stormwater Management and Drainage Report represents one of many planning and technical studies required to support the Official Plan Amendment for the Mattamy Richmond lands. The following studies have been submitted as part of the OPA application that was deemed complete on May 26, 2009 by the City. Revised documents have subsequently been submitted addressing comments received from the technical circulation of the application:

- Mattamy Homes Richmond Lands, Planning Rationale and Official Plan Amendment. FoTenn Consultants, February 2009 (to be revised)
- Richmond Village – Analysis of Future Employment Potential on Vacant Lands. FoTenn Consultants, February 2009
- Richmond Village – Analysis of Future Residential Growth Potential on Vacant Lands. FoTenn Consultants, February 2009
- Mattamy Homes Richmond Lands, Concept Plan Report, Looney Ricks Kiss, February 2010

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- Village of Richmond Water and Sanitary Master Servicing Study. Stantec with Golder and Associates, March 2009 (draft)
- Village of Richmond Community Transportation Study. Genivar, March 2010
- Mattamy Homes Richmond Lands, Natural Environment and Impact Assessment Report. Kilgour & Associates with Parish Geomorphic, February 2010
- Mattamy Homes Richmond Lands, Stormwater Management and Drainage Plan. David Schaeffer Engineering Limited, March 2010
- Mattamy Homes Limited Richmond Lands, Agricultural Assessment. EnviroPlan Consulting Services, February 2009
- Mattamy Homes Limited Richmond Lands, Preliminary Geotechnical Investigation. Jacques Whitford Limited, June 2007.

1.2 Study Process

The Municipal Class Environmental Assessment is an approved provincial planning and design procedure developed to ensure that the potential social, economic, and natural environmental effects are considered in undertaking certain projects. The approach is provided in the Municipal Engineers Association Municipal Class Environmental Assessment document prepared in October 2000 and amended in 2007. The Class EA planning process is a self-directed process (by the proponent), which represents an acceptable procedure for municipalities to carry out individual assessments for most municipal water and wastewater projects in Ontario. The Class EA deals with various aspects of municipal servicing projects (water and wastewater), including:

- Maintenance and operational activities
- Reconstruction and modification of existing supply sources/treatment facilities and distribution/collection systems
- Construction of facilities

Since water and wastewater projects undertaken by municipalities vary in their environmental impact, projects are further classified in terms of schedules:

> Schedule A (Pre-Approved Activities) projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects are pre-approved and may proceed to implementation without following the Class EA planning process. Schedule A projects generally include normal or emergency operational and maintenance activities.
>
> Schedule A+ (Pre-Approved Activities with Public Advisory) projects are similar to Schedule A projects but include projects where it is appropriate to inform the public of the municipal infrastructure project(s) being constructed or implemented in their area.

Schedule B projects have the potential for some adverse environmental effects. The proponent is required to undertake a screening process, involving mandatory contact with directly affected public and relevant review agencies, to ensure that they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation. Schedule B projects generally include improvements and minor expansions to existing facilities.

Schedule C projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Class EA document. Schedule C projects require that an Environmental Study Report be prepared and filed for review by the public and review agencies. Schedule C projects generally include the construction of new facilities and major expansions to existing facilities.

Note: There is an appeal mechanism for Schedule B and Schedule C projects – members of the public, interest groups and/or review agencies may request the Minister or delegate to require a proponent to comply with Part II of the EA Act before proceeding with the undertaking (the Minister or delegate will determine if this is necessary). Schedule A and Schedule A+ projects are pre-approved and there is no ability for the public to request a Part II Order (public comments on these projects should be directed to local municipal councils).

The selection of the applicable schedule is determined for certain projects by the environmental impact and other projects are determined to fall within a schedule based on cost.

Figure 1 presents a flow chart of the Municipal Class EA Planning and Design Process with the requirements of the various Schedules.

Mattamy Homes is the proponent and lead of the Stormwater Management and Drainage Plan report. As such, the lead proponent shall be subject to the terms and conditions of this Class EA.

There are a number of stormwater project types identified as wastewater projects under Schedule “A’, “A+” and “B” projects, including those that are intended to:

Schedule A

1. Construction of stormwater management facilities which are required as a condition of approval on a consent, site plan, plan of subdivision or condominium which will come into effect under the Planning Act prior to the construction of the facility.

2. Any project which would otherwise be subject to this Class EA and has fulfilled the requirements outlined in Section A.2.9 of this Class EA and for which the relevant Planning Act documents have been approved or have come into effect

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under the Planning Act, R.S.O. 1990, Chapter P.13, as amended.

Schedule A+

1. Establish, extend, or enlarge a sewage collection system and all necessary works to connect the system to an existing sewage or natural drainage outlet, provided all such facilities are in either an existing road allowances or an existing utility corridor, including the use of Trenchless Technology for water crossings.

Schedule B

1. Establish new stormwater retention/detention ponds and appurtenances or infiltration systems including outfalls to receiving water body.

2. Enclose a watercourse in a storm sewer.

Section A.1.3 of the Class EA document discusses the application of the EA Act for private sector development. Projects undertaken by the private sector developers which are designated as an undertaking to which the Ontario EA Act applies (i.e. Schedule C project that are servicing residential developments – see Ontario Regulation 345/93) are subject to all requirements of this Class EA document.

The potential stormwater management projects to support Mattamy Homes development are Schedule A, A+ and B projects. As this is a private sector lead exercise, subject to Planning Approval with no identified Schedule C undertakings, the projects fall under Schedule A undertaking. However, the Class EA document encourages municipalities to consider requiring developers to fully consider appropriate alternatives even if the project is exempt under Ontario Regulation 345/93.

In this regard, Mattamy's Stormwater Management and Drainage Plan will consider alternatives and follow Phases 1 and 2 of the Class EA process in order to determine the preferred stormwater scheme for Mattamy's lands. There will be no formal filing of the document under the Class EA provisions. However, this document will go through a public process as it is a supporting study of Mattamy's Official Plan Amendment application.

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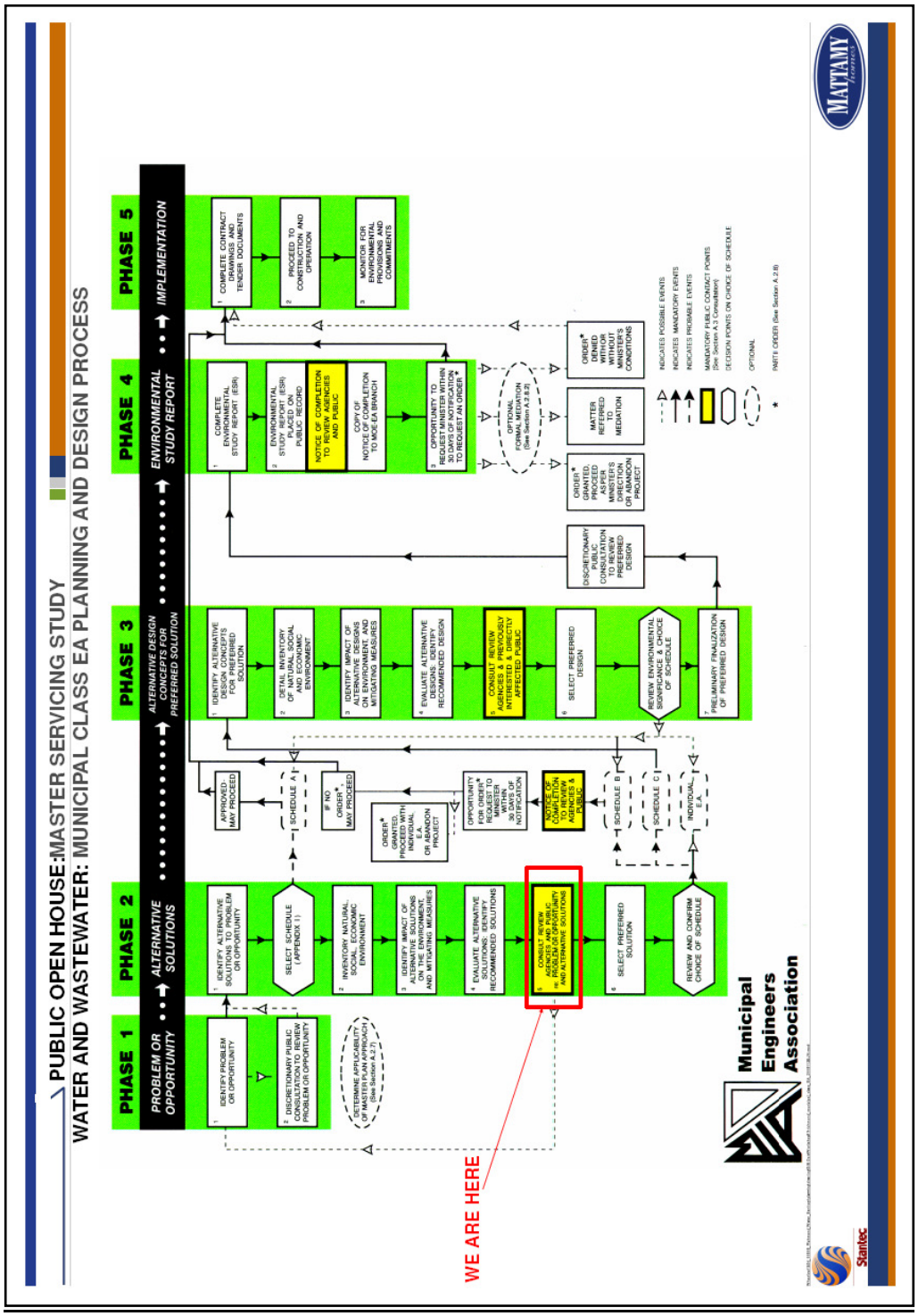

Figure 1: Municipal Class EA Planning and Design Process

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1.3 Public and Agency Consultation

Public consultation is an integral part of the preparation of Mattamy Homes Official Plan Amendment and supporting studies including the Stormwater Management and Drainage Plan exercise. A transparent process in which members of the public, community groups, residents, City of Ottawa, public agencies and other stakeholders can express their issues and concerns and obtain timely information on the study as it progresses are key components of this study. Regulatory public meetings are also a requirement of the Class Environmental Assessment Process which is being followed, in spirit, for the Stormwater Management and Drainage Plan exercise. The following consultation points are outlined under the Class EA Process for Phases 1 and 2:

Phase 1 – Problem or Opportunity

- Discretionary public consultation to review problem or opportunity

Phase 2 – Alternative Solutions

- Mandatory public and agency consultation on the identified problem or opportunity and identified and evaluated alternative solutions to the problem

The City of Ottawa initiated the Richmond Village Community Design Plan (CDP) process in March of 2008. Through the Ward Councillor, a Steering Committee made up of representatives from the Village was established to facilitate a community based approach to prepare and develop the Community Design Plan for the Village of Richmond. The Steering Committee is comprised of residents, farmers, the Richmond Village Association, business people, and individuals/companies with a development interest. The community based Steering Committee allows the Richmond Village Community Design Plan to be developed by the community, for the community. Mattamy Homes is a member of the Richmond Village Steering Committee.

A collaborative public consultation approach has been undertaken that informs both Mattamy Homes Official Plan Amendment process and the Richmond Village CDP. A number of public events have taken place either lead by the City, the Richmond Village Steering Committee or Mattamy Homes that have assisted with the preparation of the technical documents supporting Mattamy's OPA as well as the preparation of the Village CDP. These public consultation events are briefly described below with supporting documentation in ***Appendix B***.

April 12th Public Open House

The City of Ottawa held a public open house at the Richmond Public School from 9:00 a.m. to Noon on Saturday, April 12, 2008. The purpose of the open house was to introduce the commencement of the Richmond Village Community Design Plan process. As well, a number of information stations were displayed with City staff on hand to answer questions and share information related to: the existing village plan, heritage buildings, natural environment, groundwater and servicing. Participants were

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asked to identify "Places We Like Most" and "Places We Like Least" in the Village of Richmond through red (least) and green (most) dots placed on a mounted aerial photo of the Village. Participants were also asked to place yellow dots on the aerial photo to identify traffic problems and pedestrian safety "hot spots" in Richmond. This event was well attended with approximately 125 people participating in the event.

April 19th Visioning Workshop

The City of Ottawa and Richmond Village Steering Committee hosted a visioning workshop to bring together the residents and stakeholders in Richmond to see what they wanted the Village to be in 20 years. Participants were also asked to identify "greatest opportunities" and "greatest challenges" to meet the vision for the Village. The workshop was held at the Richmond Public School from 9:00 a.m. to Noon. The "Dot-mocracy" map was on display and those who had not attended the April 12th session were asked to place their red, green and yellow dots on the aerial photo of the Village. The workshop had discussion tables set up for the following topic areas: Village/Heritage Character; Future Development; Transportation and Pathways; Environment, Drainage and Floodplains; Servicing and Groundwater; Building Richmond as a sustainable community; and Recreation, Community Facilities and Open Space. Each participant could participate in 5 topic areas within the time period established for the break out sessions. City staff and Richmond Village Steering Committee facilitated the discussions at each of the topic area tables. Approximately 75 people attended and participated in the visioning workshop.

Community Visioning Principles

Based on the feedback from the April community visioning exercise, City staff and the Richmond Village Steering Committee drafted a primarily community vision for the Richmond Village which comprised of six main community principles:

- Create a Livable and Sustainable Community
- Protect and Enhance Richmond's Historic Village Character
- Protect the Natural Environment and Incorporate Constraints in the Plan
- Expand and Maintain Transportation Infrastructure
- Create and Protect Open Space, Recreation and Community Services
- Ensure Sustainability of Servicing (Groundwater, Wastewater and Stormwater Systems)

On June 4, 2008, the Richmond Village Steering Committee hosted a Strategic Direction Workshop at the Richmond Library from 7:00 p.m. to 9:00 p.m. The public was invited to participate in a small working group session to provide input on the draft community visioning principles on: Village Character and Development; Environment,

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Recreation and Sustainability; Transportation and Facilities; and Servicing and Groundwater. Based on the input received, the Village of Richmond Community Vision Workbook was prepared and circulated for comment to all residents in the Village in July 2008. A total of 2461 booklet were distributed directly to residents in the Village and additional copies were available at the Richmond Library and the Valu-Mart. A total of 246 booklet responses were returned to the City. More than two-thirds of respondents agreed with the community visioning principles. The response suggests that the principles are in line with the areas that Richmond residents feel important in the planning process. The Richmond Community Visioning Principles are contained in ***Appendix B***.

September 2008 Design Workshop

The Richmond Village Steering Committee endorsed Looney Ricks Kiss (LRK), architects and community planners, to undertake a four-day design workshop in the community to define the Village Core based on the established visioning principles. The Councillor along with the Richmond Village Steering Committee invited residents to attend the four-day workshop held from September 22 to September 25 at the vacant storefront situated at 3480 McBean Street. The workshop was set up as a drop-in centre – day or night – to participate in defining and designing the village core plan.

In preparation for this workshop, LRK conducted site visit investigations to 16 villages in Eastern Ontario called benchmarking. This exercise involved measuring and documenting local built precedents and historic and contemporary examples that could be used as the base line for defining architectural character as well as urban design and landscape patterns. This process documented landscape/streetscape treatments and patterns and architectural buildings that could provide examples to draw from when preparing the Richmond Village plan.

As well, Mattamy Homes consultant team set up and manned display boards in the store on the existing conditions information related to planning, design, natural environment, stormwater management, transportation, water, groundwater and sanitary servicing. The public visiting the workshop could view the display information and asked questions to the consultant on existing information and the overall process being undertaken to support Mattamy Homes Official Plan Amendment.

This workshop was very well attended with over 250 individuals attending at least one of the four days, with many persons making repeated visits. A summary of the four day design workshop is provided below:

Monday, September 22
Focus groups were set up for the morning inviting representatives from the businesses, real estate agents, recreational groups, residents along McBean and Perth, community groups, schools, churches, and farmers. The public was invited to participate in a benchmarking tour of other Eastern Ontario villages in the afternoon to investigate comparable communities and the design examples that may be applicable to Richmond. In the evening, the Councillor sponsored a barbeque which attracted around 100

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residents. Participants were asked to participate in a community design survey developed by LRK. Participants were asked through a PowerPoint presentation to vote for the image that best represents their vision for Richmond associated with: residential building design, commercial building design, parks and open space, Perth Street, McBean Street, river corridor, local streetscape. The survey was available during all four days so that all attendees could participate. A total of 120 surveys were completed.

Tuesday, September 23

On Tuesday morning, residents and stakeholders were invited to take part in a walking tour of the village core. Participants were encouraged to talk about McBean Street, Perth Street, the Jock River and the surrounding area and how these spaces can be improved.

Roundtable discussions took place in the afternoon where City staff, agencies and the public participated in several topic areas hosted by Mattamy Homes and the consultant team including: transportation, servicing, natural environment and open space, as well as the design of McBean Street. The Master Servicing Study presented the preliminary list of alternatives being considered for water and sanitary servicing for the Village.

On Tuesday evening, LRK presented the results of the visioning survey which would serve as the foundation to create the design for the Village Core. Through public input, the Village Core was defined the Perth Street and McBean t-intersection extending along McBean Street to the Jock River bridge.

Wednesday, September 24 and Thursday, September 25

The last two days of the workshop focused on the design of the Village Plan. Participants could view the progress being made on the plan and the street and building designs. The technical information was also on display for the public to review, ask questions and provide comments. On Thursday evening, LRK presented the Village Core Plan at the South March High School. Over a hundred people attended the presentation.

Mattamy's December 2008 Design Workshop

Following the September workshop, Mattamy Homes conducted a similar workshop in December to prepare a conceptual land use plan for Mattamy's lands in Richmond based on the vision developed for the Village. Looney Ricks Kiss facilitated this three-day workshop that took place at the same storefront on McBean Street from December 8-10, 2008. As well, the findings of the technical studies was available through a series of display boards related to planning, design, transportation, stormwater management, natural environment, hydrogeology, water and sanitary servicing. Mattamy Homes consultant team attended the three day event to allow the opportunity for the public to ask questions, provide input and comments on the technical findings and preliminary recommendations.

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A total of 52 persons attended the event on one of the three days. This workshop was conducted to assist Mattamy Homes in preparing an Official Plan Amendment application for our future development lands in the Village of Richmond. The workshop was also advertised as a formal meeting (Phase 1) under the Municipal Engineers Association Class Environmental Assessment Process as the Master Servicing Study being prepared by Mattamy Homes is being planned as a Schedule C undertaking.

The storefront opened on Monday, December 8th at 4:00 p.m. There were two open house sessions held from 4:00 p.m. to 6:00 p.m. and again from 6:00 p.m. to 8:00 p.m. to present three different land use options for public review, input and comment. These sessions were conducted as an open house/workshop format to understand the public preferences related to the amount, distribution and type of land use for Mattamy Homes lands. On Tuesday, December 9th the doors opened at 1:00 p.m. to present to the public the consolidated land use plan based on the input heard from the public the previous evening. Mattamy's planning, design and technical studies were also presented through a series of display boards related to planning, design, transportation, stormwater management, natural environment, hydrogeology, water and sanitary servicing. Roundtable discussions took place with the public, city staff and stakeholders on various technical aspects including water and sanitary servicing. The Master Servicing study evaluation criteria were displayed and a roundtable discussion took place on the evaluation process, criteria and weighting. As well the alternatives for water and sanitary servicing were also presented and discussed.

On Tuesday evening, LRK presented the preferred concept plan for Mattamy lands based on the input received on Monday and earlier in the day. Based on the public response, LRK then finalized the concept plan. On Wednesday, December 10th, the open house started at 10:00 a.m. where the public could drop in and visit the design, planning and technical displays as well as see the land use plan that had resulted over the two day workshop. On Wednesday evening, the evolution of the concept plan for Mattamy's land was presented by LRK with design examples associated with different aspects of the plan. The plan was well received by the participants in attendance.

February 12, 2009 Open House

Mattamy Homes held a Public Open House on Thursday, February 12th from 5:00 p.m. to 8:00 p.m. at St. Phillips Catholic Church in the Village of Richmond. A total of 80 persons attended the public open house. The purpose of the open house was to present the land use concept plan for Mattamy's lands, the results of Phase 1 and 2 of the water and sanitary Master Servicing Class EA Study and the findings to date on the planning, natural environment, stormwater and transportation studies supporting Mattamy's Official Plan Amendment. The workshop was also advertised as a formal meeting (Phase 2) under the Municipal Engineers Association Class Environmental Assessment Process as the Master Servicing Study being prepared by Mattamy Homes is being planned as a Schedule C undertaking. The preferred solutions for water and sanitary were presented to the public along with the natural environment constraints, the

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preliminary stormwater management options and the recommended transportation solutions for the Village.

This meeting provided stormwater management and drainage information associated with the problem, existing conditions, and identification of alternatives satisfying Phase 1, discretionary consultation point of contact.

September 12, 2009 Open House

The City of Ottawa hosted a public open house on Saturday, September 12, 2009 for Mattamy's Official Plan Amendment application. The meeting was held at the Richmond Memorial Community Centre situated at 6095 Perth Street from 9:00 a.m. to Noon. The meeting was well attended with 103 signed-in attendees. The purpose of the meeting was to present the recommendations of the planning and technical studies supporting Mattamy's Official Plan Amendment application. The meeting started with a presentation on the concept plan. An "Ask the Experts" session was then available for participants to visit each of the display stations and ask questions to the consultants. Display materials were exhibited for the concept plan, transportation, stormwater management, natural environment, land use planning, water and wastewater servicing. An open "Question and Answer" period followed to allow additional questions to be asked to Mattamy, the consultant team and City staff. A list of the questions asked by attendees is contained in Appendix B.

Village of Richmond Planning Project Steering Committee

Ward Councillor Glenn Brooks established a Steering Committee to guide the development of the Community Design Plan for the Village of Richmond in concert with City Planning Staff. The Steering Committee was established in April of 2008 and meets once a month at the Richmond Library. These meetings are open to the public and all documentation is filed at the library. Mattamy Homes is a non-voting member of the Steering Committee. Updates on Mattamy's planning and technical studies are provided at these meetings.

Technical Advisory Committee

Mattamy Homes is the proponent of the Village of Richmond Water and Sanitary Master Servicing Study. The Master Servicing Study will identify preferred infrastructure projects that will ultimately be owned and operated by the City of Ottawa. As such, City input along with approval agencies and the public is required throughout the process. At the request of Mattamy Homes, a Technical Advisory Committee was established by the City of Ottawa to provide technical input and advice throughout the preparation of the MSS. As a Stormwater Management and Drainage Plan was also being prepared for Mattamy Homes lands, the TAC was broaden to include stormwater as well. Infrastructure Planning in the City's Infrastructure Services and Community Sustainability Department has been assigned the lead at the City. The Technical Advisory Committee (TAC) is comprised of City staff from various sectors of the City

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related to water, wastewater and stormwater in areas of policy, planning, approvals, operating and maintenance. As well representatives from the Ministry of Environment and Rideau Valley Conservation Authority participate as members of the TAC. Members of the Richmond Village Steering Committee and interested public were extended an invitation to attend the TAC meetings following the first TAC meeting.

Two meetings have taken place with the TAC through Phases 1 and 2 of the EA process. The first meeting took place on September 28, 2008 with City and agency staff that focused on the existing servicing setting in the Village of Richmond, the workplan for the MSS as well as to introduce the stormwater management and drainage plan study. The evaluation criteria were presented and distributed to the TAC for input and comments. Comments were later received by the TAC requesting that the Operation and Maintenance criterion weight be increased and equal to the capital cost weighting to make sure the maintenance of the system is sustainable in order to protect the City's infrastructure.

As per the MEA Class EA process, it is urged that the proponent contact the Regional Coordinator of the Environmental Assessment and Approvals Branch to discuss the approach being considered for the Master Plan. As well, it is recommended that First Nations and Aboriginal Peoples be recognized as a stakeholder and notified of the Class EA process being undertaken, early in the process. Mattamy Homes wrote to both of these parties in December 2008 notifying them of the Village of Richmond Master Servicing Study and stormwater management and drainage plan being undertaken by Mattamy Homes. The Regional Coordinator responded indicating no concerns with the Master Plan or stormwater management approach. The representative for the First Nations indicated an interest in the Master Servicing Study and Archeological information. This information was sent to the First Nation representative on October 5, 2009. At this time of writing this report, a reply has not been received.

A meeting was held on January 28, 2009 with the RVCA and City staff from Infrastructure Planning to discuss the Stormwater Management and Drainage Plan study as well as the floodplain mapping update being conducted for the Van Gaal Drain by the RVCA. The minutes of this meeting are contained in **Appendix B**.

The second Technical Advisory Committee Meeting was held on February 4, 2009 at City Hall. The focus of this meeting was to present the results of the evaluation of water and sanitary alternatives applying the evaluation criteria developed for the study. As well, the three preliminary stormwater management options were presented by David Schaeffer Engineering Limited. The advertisement for the February 12, 2008 open house was distributed to attendees encouraging their attendance at the meeting. The TAC minutes are contained in **Appendix B**.

January 22, 2009 Agriculture and Rural Affairs Committee

At the January 22, 2009 meeting of the Agriculture and Rural Affairs Committee, City staff presented a report on the status of the Richmond Village Community Design Plan

and the processes associated with the future development lands. The report acknowledges the technical studies Mattamy Homes is leading and funding including the Village-wide Master Servicing Study. It states that the City will be using these studies to assist with completing the Richmond Village Community Design Plan that will be provided through Mattamy Homes Official Plan Amendment submission.

Technical Circulation Comments

Mattamy Homes Official Plan Amendment application was circulated for technical and public review and comment in June 2009. The various studies were posted on the City of Ottawa website, Mattamy Homes Richmond website as well hard copies of the reports were made available at the Richmond library. A number of comments were received on the various reports submitted as part of this application. Time has been spent on resolving the relevant issues with City staff, agencies and the public. Revised reports addressing the comments were submitted back to the City beginning in February 2010 for review and concurrence.

The comments received on the DSEL Stormwater Management and Drainage Plan report (March 2009) are contained in ***Appendix B***. This report now replaces the 2009 report originally submitted with the application. Subsequent meeting(s) maybe required with City and RVCA staff following their review of this report.

2.0 RELEVANT STUDIES, GUIDELINES AND POLICIES

2.1 Policies and Guidelines

The following provides a brief summary of the policy, standards and guidelines that are applicable to stormwater management, drainage and sewers that need to be considered when preparing this Stormwater Management and Drainage Plan.

Ottawa 20/20 Official Plan (OP) (Consolidated, 2007)
The Official Plan (OP) provides a framework for future growth in the City of Ottawa. The OP also serves as a basis for a wide range of municipal services, including water and sewage servicing requirements, as well as surface drainage.

Of particular relevance to the Richmond Village project are the determinations of water and sanitary service areas:

Drainage and Stormwater Management:
The Official Plan states that planning to be done on the basis of natural systems to protect and enhance natural processes and ecological functions (e.g. watershed planning, groundwater and surface water protection and green space policies).

Ottawa 20/20 Infrastructure Master Plan (IMP) (June 2003)
The IMP focuses on many aspects related to the planning of infrastructure systems. It is intended to direct the management and extension of public works systems related to

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water supply and treatment, wastewater collection and treatment and stormwater collection and release.

More specifically, and with respect to stormwater management, the IMP states that; "*the main impetus for municipalities to implement stormwater management has derived from regulatory requirements, stemming particularly from the Fisheries Act at the federal level (protection of fish habitat), and The Lakes and Rivers Improvement Act (in-stream works), and the Ontario Water Resources Act (water quality and hydrologic performance) at the provincial level. Conservation Authorities provide input to stormwater management requirements as commenting agencies under the Planning Act and also apply Regulations under the Conservation Authorities Act to works within watercourses. Municipalities are also bound to consider impacts to downstream users by the riparian rights doctrine of common law.*"

The IMP further states that; "*Regulatory compliance will always remain a critical element in stormwater management planning. However, as the ultimate owner and operator of the infrastructure, it behooves the City to 'take ownership' of stormwater management by better understanding the costs and benefits of current approaches and by developing alternative, integrated approaches that continue to satisfy regulatory agencies and which keep pace with the growing understanding of river systems - all the while striving to minimize the cost of stormwater infrastructure.*"

Stormwater Management Policies (June 2007)
This document outlines the requirements to best integrate SWM planning into the land use planning process; will clarify various SWM design issues at the planning level to provide a consistent approach City-wide, and will further detail how the new directions promoted by the SWM policies are to be achieved.

Sewer Use By-Law
The Sewer Use By-law defines what is permitted to be discharged into a sewer, whether sanitary, combined or storm sewers. Some substances and materials are completely prohibited; others are restricted to defined safe limits.

Development Charges Act (1997)
This Act allows municipalities to impose development charges to pay for the capital cost associated with an increased need for services.

Ontario Water Resources Act (MOE)
This Act is used for issuing approvals and to create a framework for the establishment and operation of water supply, stormwater and wastewater collection systems, and treatment systems. The MOE Certificate of Approval (C of A) is issued for water distribution, sewerage and treatment works under this Act.

Ontario Environmental Assessment Act (MOE)
The Municipal Class EA process has evolved into a self-regulating process (by the municipality or proponent) to provide a process to ensure environmental impacts are considered prior to final approval of a project.

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Other Applicable MOE Statutes

Other statutes administered by the MOE that are applicable to municipal works include the Clean Water Act, the Nutrient Management Act, Environmental Protection Act, the Environmental Bill of Rights, and the Services Improvement Act.

Ontario Municipal Act

This Act generally describes the organization, powers and services of the municipalities in Ontario and primarily affects water and sewer servicing with respect to financing issues.

Ontario Planning Act

This Act regulates development and land use and covers the protection of public health and safety through the provision of resources and infrastructure.

Ontario Municipal Board Act

The Ontario Municipal Board is an independent tribunal that hears appeals from landowners, the public and others on land use planning matters. It hears appeals of municipal decisions, and appeals where no decision has been made on planning applications within timelines set out in the Planning Act.

Drainage Act

The Drainage Act provides landowners with a tool for resolving drainage problems by petitioning their municipality for a communal drainage scheme, commonly known as a "municipal drain". Typically an engineer retained by the municipality prepares a report with a proposed solution to the problem. Landowners have an opportunity to appeal various aspects of the report. After all appeals have been resolved, the report is adopted by municipal by-law, the drain is built and the cost of the work is assessed to the landowners in the watershed. The local municipality, through their drainage superintendent, is also responsible for the management of the network of municipal drains. There are over 700 municipal drains totaling 1,200 km in length in the City of Ottawa, the most open drains of any municipality in Ontario.

Most municipal drains are located on private property in rural agricultural areas and are either ditches or closed systems such as pipes or tiles buried in the ground. Most municipal drains were constructed to improve the drainage of agricultural land by serving as the discharge point for private agricultural tile drainage systems. However, they also remove excess water collected by roadside ditches, residential lots, commercial lands and any other properties in rural areas.

Municipal drains are created under the authority of the Drainage Act (provincial legislation) and municipalities in Ontario are required to administer the Act on behalf of the Province.

Federal Fisheries Act

The harmful alteration, disruption or destruction of fish habitat is prohibited by the Fisheries Act unless it is authorized by the Minister of Fisheries and Oceans. Persons

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having Fisheries Act authorization for their project may proceed with their work without violating the Fisheries Act, provided they comply with the conditions of the authorization.

Fish habitat is any component of an aquatic system that provides any one of the following: Cover, Food, Reproduction (location), Water quality (including temperature), and Migration routes.

The Lakes and Rivers Improvement Act
The purposes of this Act are to provide for; the management, protection, preservation and use of the waters of the lakes and rivers of Ontario and the land under them; the protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario; iii) the protection of the interests of riparian owners; iv) the management, perpetuation and use of the fish, wildlife and other natural resources dependent on the lakes and rivers; and v) the protection of the natural amenities of the lakes and rivers and their shores and banks.

Conservation Authority Act
20. (1) The objects of an authority are to establish and undertake, in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals. R.S.O. 1990, c. C.27, s. 20.

2.2 Background Studies and Guidelines

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

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

- **Engineer's Report – Van Gaal Municipal Drain,**
  Robinson Consultants, July 2003.
  (Municipal Drain Report)

- **Jock River Flood Risk Mapping (Within the City of Ottawa),**
  PSR Group Ltd., November 2004.
  (Jock River Flood Mapping)

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

- **Jock River Reach 2 and Mud Creek Subwatershed Study, Existing Conditions Report (Draft),**
  Marshall Macklin Monaghan Ltd. and
  Water and Earth Sciences Assoc., May 2005.
  (Draft Subwatershed Study)

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- **Stormwater Management Strategy Stage 2: Policies**
  City of Ottawa, June 2007.

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

- **Jock River Reach 1 Subwatershed Study**
  Stantec Consulting Ltd., June 2007.

- **Preliminary Existing Conditions Report,**
  FoTenn Urban Planners and Designers, May 2008.

- **Servicing, Water, Sanitary, and Stormwater – Preliminary Existing Conditions Analysis,**
  Stantec Consulting Ltd., May 2008.
  (Existing Conditions Report)

- **Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond.**
  J.F. Sabourin & Associates. November 2009
  (Van Gaal Floodplain Mapping)

- **Mattamy Homes – Richmond, Jock River Phosphorus Reduction Assessment**
  AECOM, February 2009
  (Phosphorus Reduction Assessment)

- **Mattamy Homes – Richmond, Infill Impact on Jock River**
  AECOM, February 2009

- **Mattamy Homes – Richmond, Post-development Impact on Jock River**
  AECOM, March 2009

- **Natural Environment & Impact Assessment Report, Mattamy Richmond Lands**
  Kilgour and Associates Ltd., February 2010.
  (Environmental Study)

- **Potential Impacts of Three Storm Water Management Options to Fish Habitat on Mattamy's Richmond Holdings,**
  Kilgour and Associates, February 2010.
  (Environmental Impact Assessment)

- **Cumulative Impact Assessment – Jock River Development**
  AECOM, March 2010

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3.0 EXISTING CONDITIONS

The Village of Richmond is located within the City of Ottawa city boundaries and is approximately 10km south of Stittsville and 12km west of Manotick, as illustrated on ***Figure 2***. The subject lands lie along the western perimeter within the Village boundary. The subject land extends north of Perth Street and south of Perth Street to the Jock River, as illustrated on ***Figure 3***. The existing property is primarily active farmland and is relatively flat with slopes ranging from 0.1% to 0.5%.

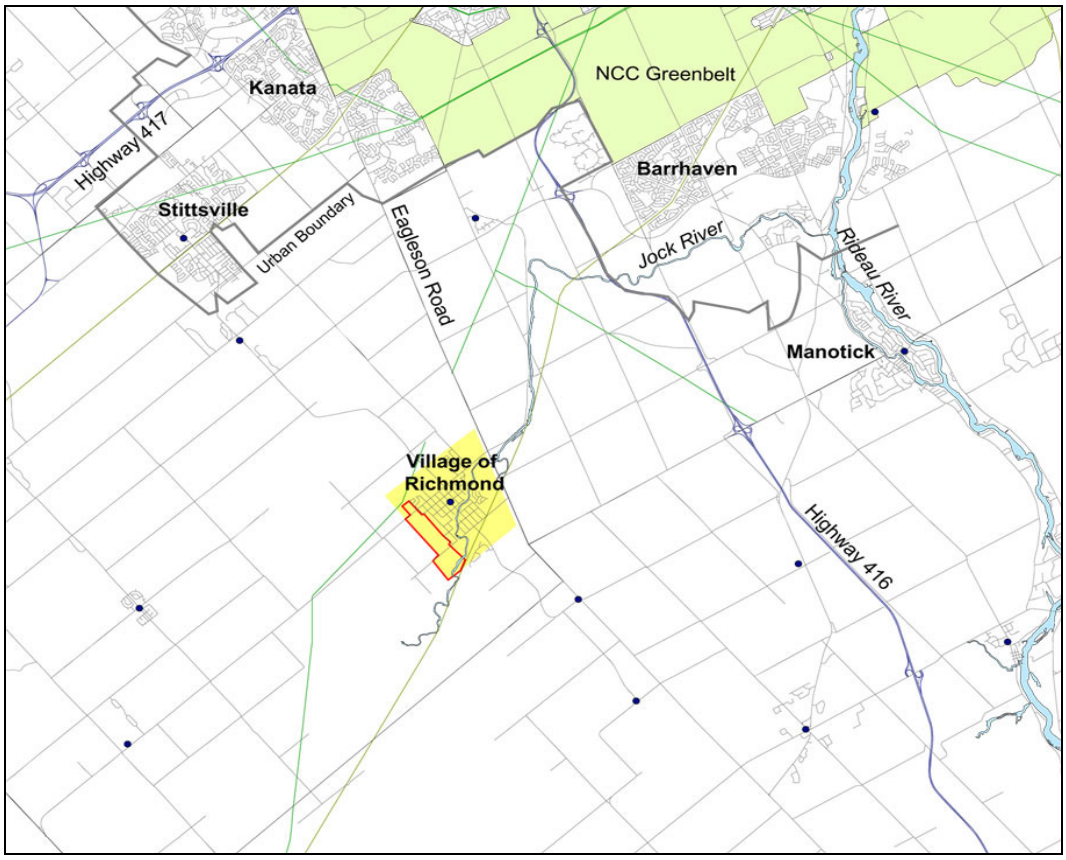

Figure 2: Location of the Village of Richmond

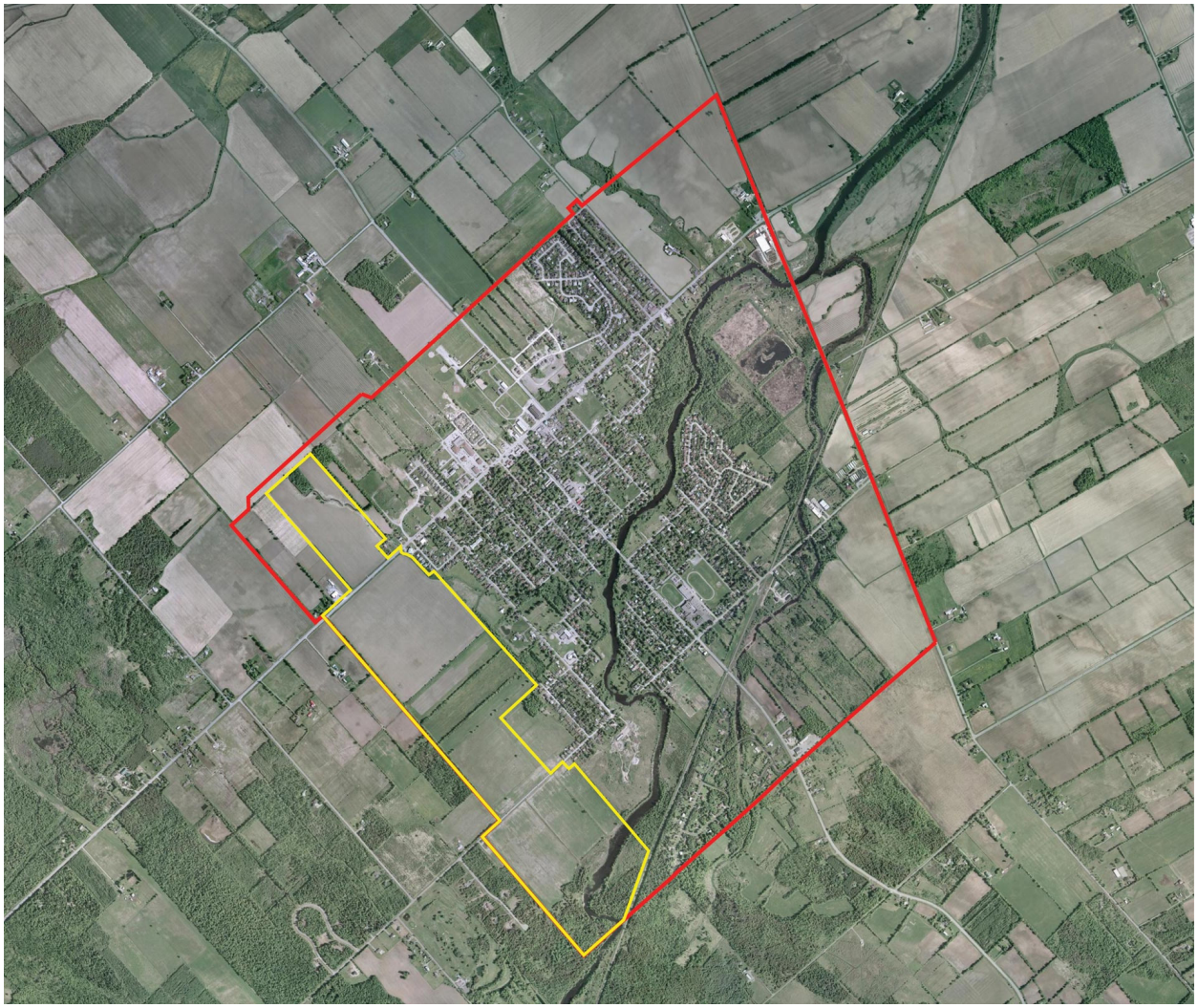

Figure 3: Mattamy Lands in Relation to Village of Richmond

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. An estimated drainage area of approximately 800 ha drains into the Van Gaal Drain north of Perth Street. Within the subject property, and starting at the upstream north limit, the Van Gaal municipal drain crosses Garvin Road, Perth Street, and then Queen Street. From Queen Street, the Drain meanders through the Village of Richmond and crosses three culverts before it reaches the Jock River. ***Preliminary Drawing 1 Existing Drainage*** illustrates the subwatershed boundary with drainage catchment areas.

The portion of the Drain that is generally located between Garvin Road and Perth Street was studied by Robinson Consultants in 2003. The purpose of the study was to permit the owners of Cedarstone Subdivision the right to realign a portion of the existing East

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Main Drain of the Van Gaal Municipal Drain and connect it to the West Main Drain at the north limit of the subdivision.

South of Perth Street, the watercourse is referred to as the Arbuckle Drain which is an Award Drain. A petition was launched in 2005 by the owners of the affected lands to designate the Arbuckle Award Drain and the Moore tributary as a Municipal Drain. Robinson Consultants were retained as the Drainage Engineer and have prepared a Drainage Report (October 2008) which has been approved by the Rideau Valley Conservation Authority. The Drainage Engineering Report proposes some spot lowering (0.5-1.0m) and erosion remediation along the watercourse.

The following sections provide an overview of the existing conditions relevant to this stormwater report. The source of the information is indicated and can be consulted for further details.

3.1 Drainage Fabric

Source: Environmental Report
The major watercourses in the Village of Richmond are illustrated in ***Figure 4***. The drainage fabric for Mattamy Richmond Land is illustrated in ***Figure 5.*** The Van Gaal/Arbuckle Drain is the primary drainage feature (VG-R2) on the northwest portion of Mattamy's property. There are two principal branches:

- VG-R2-2 located along the northern property limit that conveys flows from the upper watershed and the northeastern branches (VG-R2-1 and VG-R2-3).

- The Moore Tributary which is situated in the southwest portion of the site (VG-R3, VG-R3-2 & VG-R3-1).

Drainage from the north side of Ottawa Street currently flows north through a hedgerow (VG-R3-2), then north-east through a second hedge row to the Moore Branch (VG-R3). The Moore tributary drains into the Arbuckle Drain, the lower portion of the Van Gaal Drain system (south of Perth Street). Additional drainage features were identified from the Ontario Base Map (shown as narrow pink lines in ***Figure 5***), but were confirmed as being absent upon field reconnaissance and investigation. Those previously-mapped drainage features south of Ottawa Street historically conveyed surface drainage north, under Ottawa Street via culvert, and north to the Moore Branch. The construction of the Jock River Estates Drain (JED-1) has re-routed drainage such that flow is now conveyed south through the berm adjacent to the Jock River.

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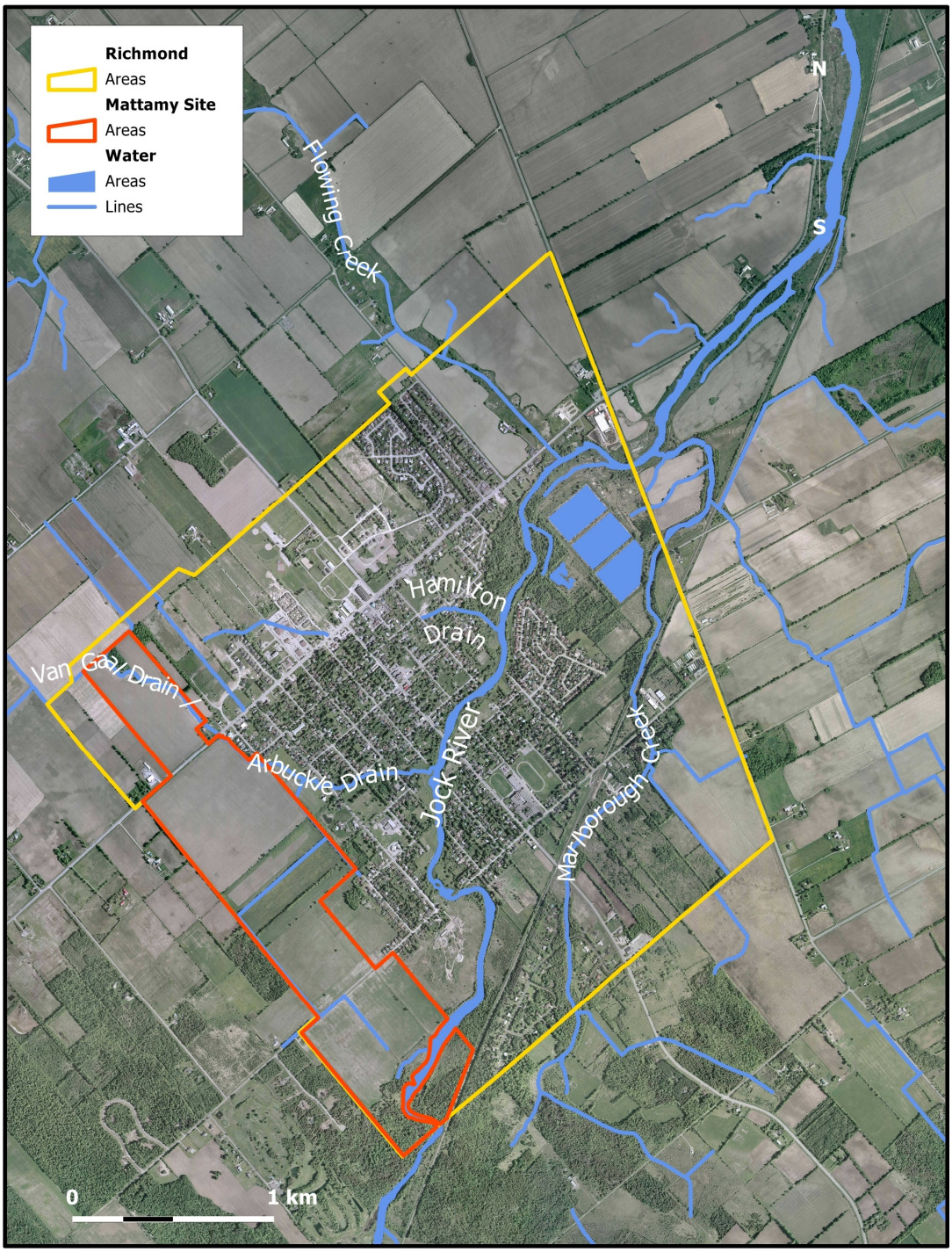

Figure 4: Map of the Village of Richmond Major Watercourses.

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Figure 5: Map of the Mattamy Richmond Land showing watercourses.

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3.2 Regulatory Floodplain

The Rideau Valley Conservation Authority completed and approved updated floodplain mapping for the Jock River in 2005 (Jock River Flood Risk Mapping, PSR Group, 2004). The floodplain mapping applies to the Jock River and the Arbuckle Drain, south of Perth Street within Mattamy's land holdings. The City of Ottawa, jointly with the Rideau Valley Conservation Authority, retained J.F. Sabourin & Associates in October 2008 to complete the floodplain mapping of the Van Gaal Municipal Drain as no regulatory floodplain existed for the Van Gaal Drain, north of Perth Street. The floodplain mapping of the Van Gaal Municipal Drain will be necessary to identify developable area, filling requirements, storm sewer outlet elevations, stormwater management pond outlet elevations, and flood protection requirements within the Mattamy lands.

The report entitled "*Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drain in the Village of Richmond (November 2009)"* was prepared by J.F. Sabourin & Associated. This report 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 met 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 and grade raises, RVCA will amend its flood hazard and regulation limits mapping based on the completed works. The 2009 Floodplain Mapping for the Van Gaal and Arbuckle Drain is contained in ***Appendix C***.

AECOM undertook a preliminary assessment of the Van Gaal Drain channelization works as recommended at the January 14th meeting. This report was submitted to the RVCA and is contained in ***Appendix C.*** The analysis concluded that the proposed terracing/channelization to the Van Gaal Drain would maintain flood levels at or below the estimated in the JFSA November 2009 report. The channelization/berm modifications would result in a new floodplain shown conceptually shown in ***Figure 6.***

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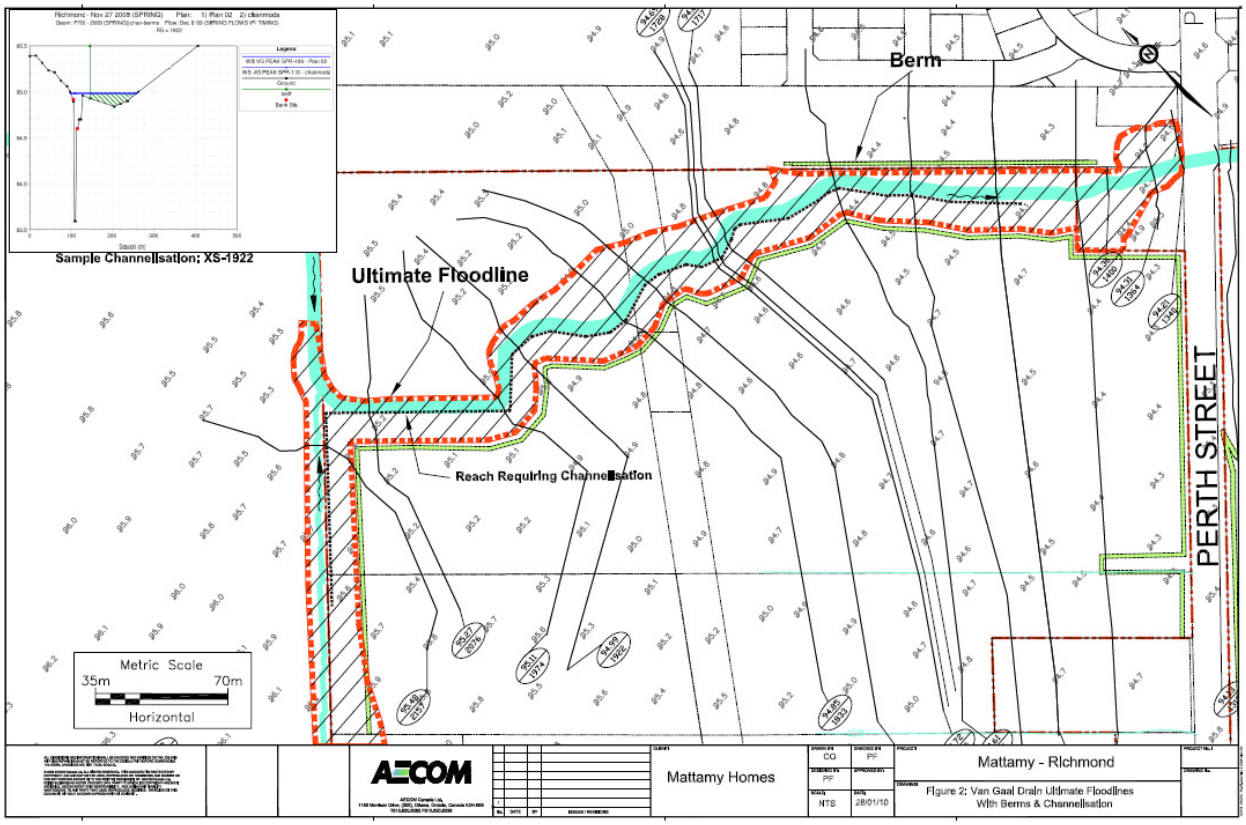

Figure 6. Van Gaal Drain Ultimate Floodlines with Berms and Channelization (AECOM January 27, 2010)

For the portion of the Mattamy lands that currently drain or may, in the future, drain directly to the Jock River, the recently updated floodplain mapping indicates that the 100 year flood elevations are respectively 96.80 m and 96.16 m at the approximate western and eastern limits of the subject property (see ***Figure 7***).

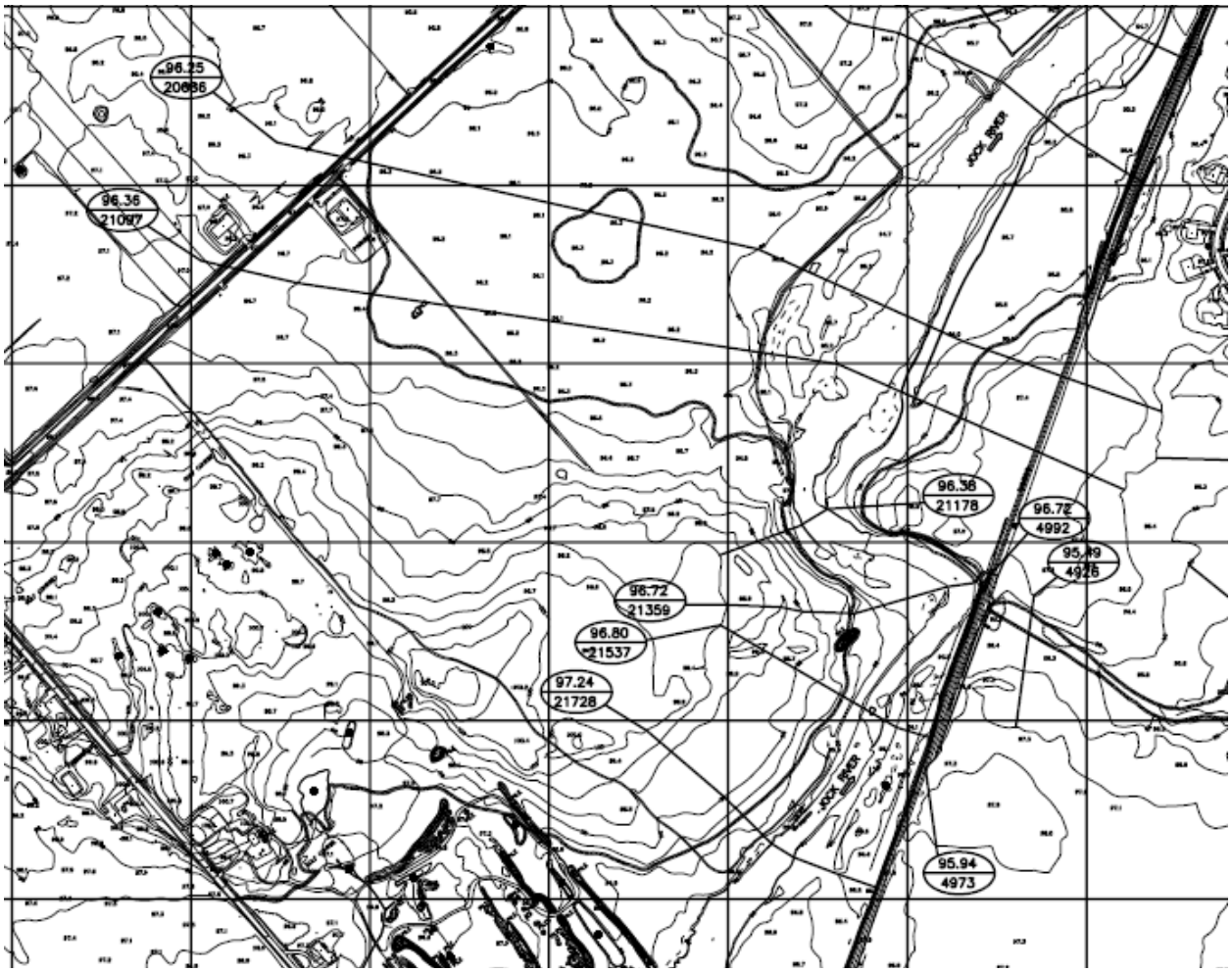

Figure 7. Floodplain Elevations on Jock River adjacent to Subject Lands (RVCA Jock River Floodplain Mapping 2004)

Past and recent approvals from the RVCA, have allowed for a future amendment to the 100-year floodplain limit for the lands south of Ottawa Street within Mattamy's landholdings. 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 authorizing works to be conducted based on past approvals granted on the property (***Appendix C***). The authorized works involve removal of the existing berm and relocate it to the approved 2005 location (as shown in ***Figure 8***). The existing flapgate 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**.** The infill is in an area of the Jock River that experiences less than 0.3m of flooding during the 100-year event.

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On ***Figure 8*** and subsequent drawings, the floodplain south of Ottawa Street has been changed on the assumption that the work contemplated in the RVCA letter of Permission (March 3, 2009) will be completed.

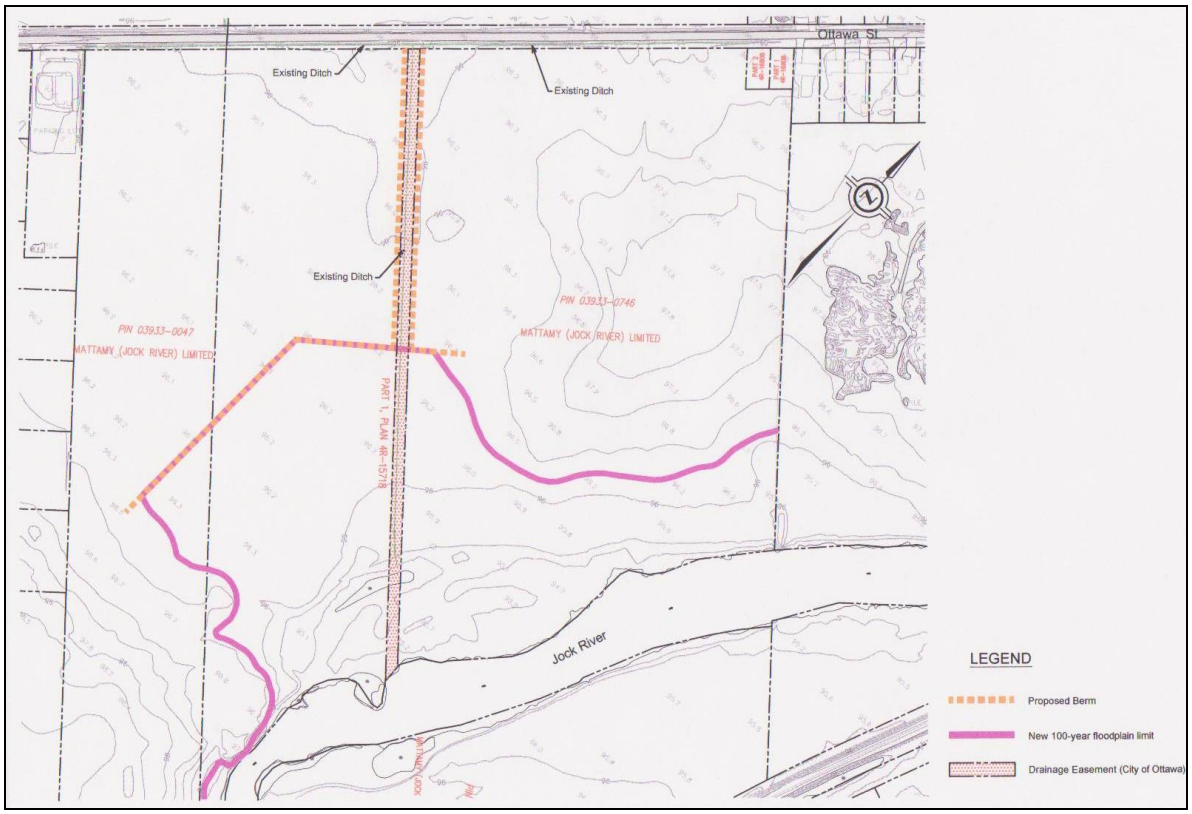

Figure 8. Revised Floodplain Limit on Jock River

The RVC permission letter states that the 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. In support, AECOM has undertaken an analysis that confirms no cumulative impact on flood level in the Jock River associated with the approved filling on Mattamy's lands. The completed analysis is included as ***Appendix C***.

The regulatory mapping for Ontario Regulation 174/06 is reviewed as required when new and / or more accurate defensible information becomes available and amendments introduced as required. The RVCA's regulatory limits and underlying flood hazard mapping will not be revised until such time as the finished grade plan has been submitted and confirmed as being in compliance with the letter of permission, and an alternate route for flows conveyed by the Jock River Estate Storm Easement has been implemented.

The 100-year ultimate flood line is illustrated on ***Preliminary Drawing 2 – Site Constraints.***

It is also noted that the maximum 100-year flood elevations along the Jock River are in response to Spring snowmelt+rain events. The maximum 100 year flood elevations along the Van Gaal Drain, downstream of Perth Street, are the backwater from the Springmelt levels experienced in the Jock River and are assumed not to be influenced by flows in the Van Gaal Drain (due to a 12 hour lag in the Jock River peak). The 100 year flood levels in response to summer rainfall events are significantly less (by 1 metre) than those occurring as a result of the Spring melt. (*Jock River Flood Risk Mapping Study – 2004 – PSR Group*)"

3.3 Geomorphology

For ease of reference, the fluvial geomorphology section of the ***Environmental Study*** is contained in ***Appendix D*** of this report and summarized below.

Source: Environment Report
The reach delineation and meander belt width are illustrated on ***Figure 9*** for the Jock River, Van Gaal/Arbuckle Drains, the Moore tributary and Jockvale Estate Drain.

A description of each watercourse is summarized below.

Van Gaal/Arbuckle Drain (VG-R1, VG-R2)

The mainstem reach VG-R2 is slightly sinuous with several straightened areas. The dominant geomorphic process observed in the watercourse was degradation with significant evidence of planform adjustment and channel widening. A rapid geomorphic assessment suggested the reach has low stability, associated with agricultural drains and the poor evidence of scour and deposition features observed. Bankfull widths were between 4 and 10 m with associated depths of 0.6 to 1.5 m. Wetted widths in early June varied between 3.5 and 7 m with associated depths of between 0.2 and 1 m. Wetted widths in August varied up to 4 m, with maximum depths of ~ 0.4 m. The gradient through the reach was low to moderate with a low sinuosity. Sediment in the pools was characterized by sands. A corrugated steel culvert is situated in this reach near fishing location VG-R2f. Spring flows through that culvert approached 1 m/s during the spring melt event (August 16, 2008), posing a potential barrier to upstream migrations by most cyprinids, and potentially pike.

Reach VG-R2-1 had been straightened for agricultural purposes prior to the historical aerial photographs. This subreach is aggrading and is considered to have low stability due in large part to the poor scour and deposition features. Bankfull widths were estimated to be between 4 and 4.5 m with associated depths of 0.6 to 1.0 m. Wetted widths at the time of the walks in early June were observed to vary from 2.0 to 4.0 m with associated depths of 0.15 to 0.4 m.

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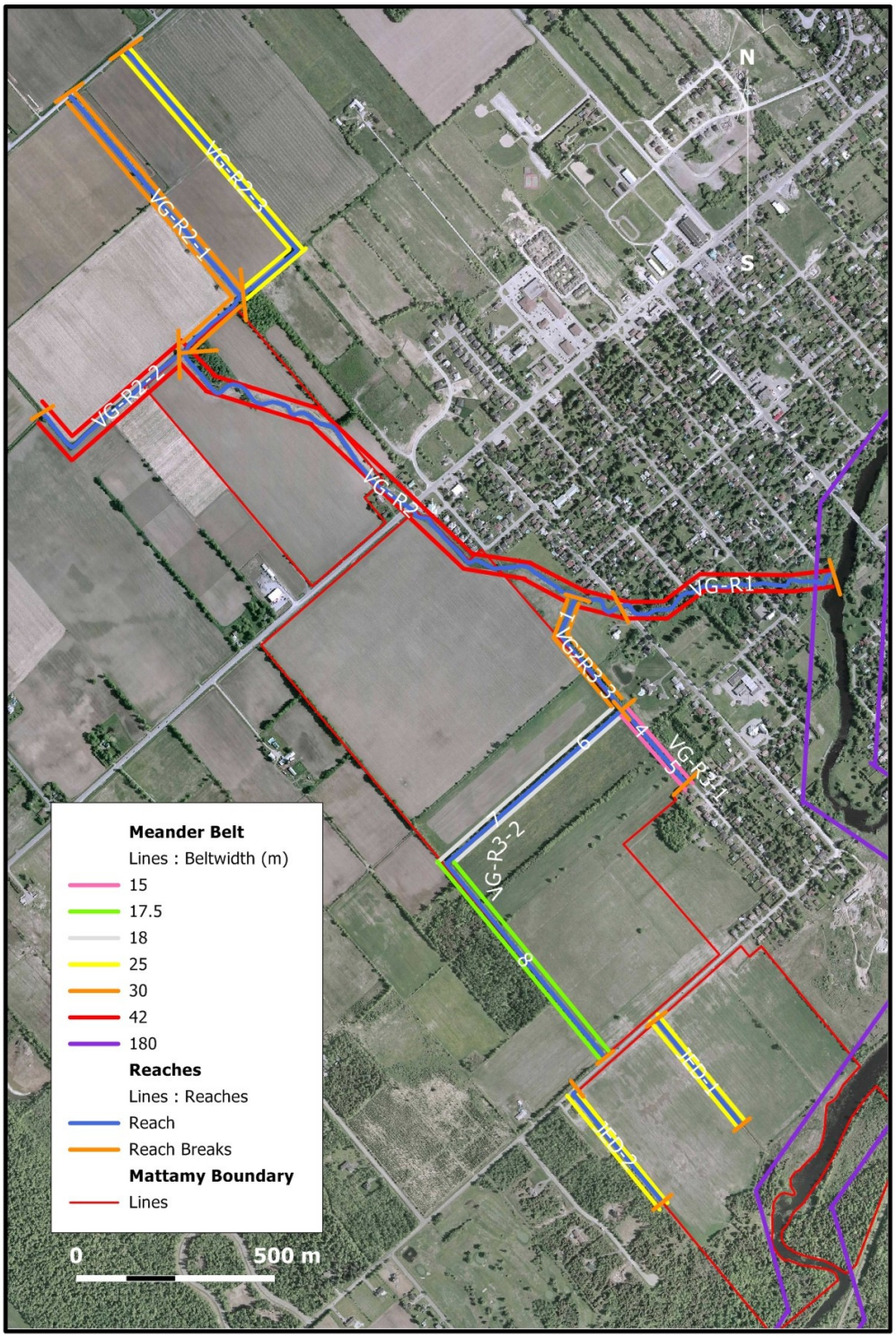

Figure 9. Reach and Meander belt width delineations

Reach VG-R2-2 had also been straightened prior to the historical aerial photographs. This reach was also aggrading, and was considered to have low stability because of

poor scour and deposition features. Bankfull widths were estimated to be between 2 and 4 m with associated depths of 0.7 to 1.2 m. Wetted widths at the time of the walks in early June were observed to vary from 1.5 to 2.5 m with associated depths of 0.5 to 0.6 m. Wetted widths in August were between 1.5 and3 m, with wetted depths ranging between 0.3 and 1 m. The channel was shallowest at its most western end, and deeper (1 m) prior to its confluence with VG-R1. The gradient through the reach was observed to be low with no sinuosity.

Moore Tributary (VG-R3)

Reach VG-R3-1 began at its confluence with VG-R3 and extended upstream to Burke Street. The reach had been straightened prior to the historical aerial photographs. The RGA assessment determined the reach to be stressed with a score of 0.33. The dominant geomorphic process observed in the watercourse was channel widening and planform adjustment. Vegetation through this reach consisted primarily of grasses and herbs with more shrubs and trees further upstream in the reach. Bankside vegetation provided nearly 100% canopy cover during summer. Minor woody debris was observed at several locations in the reach. The RSAT assessment determined the creek to have a moderate stability. Bankfull widths were estimated to be between 4 and 7 m with associated depths of 0.6 to 1.0 m. Wetted widths in August were ~0.1m, with associated maximum depths of ~0.05 m. The gradient through the reach was low with a very low sinuosity. Sediment in the reach was silt, sands and pebbles. Bank material consisted of clay and silt. Channel disturbances in the reach included a crushed corrugated steel culvert (used historically as a farm crossing).

Jock River Estate Storm Easement (JED-1)

This reach was constructed for the purposes of providing an adequate outlet for runoff from the Jockvale Estates subdivision, an estate subdivision to the west of the subject lands. The reach is considered to be aggrading, and to have low stability due to poor in-stream habitat features. Bankfull widths were estimated to be between 2 and 3 m with associated depths of 0.4 to 0.7 m. Wetted widths in early June varied from 1 to 1.5 m with associated depths of 0.1 to 0.3 m. The reach had low gradient and was straight (no sinuosity). Sediment in the reach consisted of silt, clay and fine sands. Bank material consisted of clay and silt."

Since a channel naturally erodes and meanders across its floodplain, the extent of this movement can be defined by the meander belt width. A meander belt width defines a potential hazard area; or a zone within which the stream can potentially occupy, or has occupied in the past, and which usually coincides with the flood plain. Meander belt widths were delineated for each of the reaches on the Mattamy land holding including the adjacent reach of the Jock River which are shown in the table below.

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Table 1
Summary of Meander Belt Widths

Watercourse Name	Reach Identification Name	Meander Belt Width (m)
Jock River	JR-6	180
Van Gaal/Arbuckle Drain	VG-R2	42
Van Gaal Drain	VG-R2-1	30
Van Gaal Drain	VG-R2-2	42
Moore Tributary	VG-R3	30
Moore Tributary	VG-R3-1	25
Moore Tributary	VG-R3-2	30
Jock River Estates Drain	JED-1	25
Jock River Estates Drain	JED-2	25
Source: Parish Geomorphic for Kilgour and Associates, Natural Environment & Impact Assessment Report, February 2010		

3.4 Geology/Geotechnical

For ease of reference, the preliminary geotechnical recommendations of the ***Geotechnical Report*** are reproduced in this section. Refer to the complete document prepared by Jacques Whitford (2007) for the findings of the preliminary geotechnical investigation.

Source: Geotechnical Report

North of Perth Street
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.

Between Perth and Ottawa Street
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.

South of Ottawa Street
Within these parcels of land 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.

Based on the soil conditions encountered in the test holes and our understanding of the project the following geotechnical constraints should be considered:

- 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 following Table summarizes the preliminary grade raise restrictions for the site.

Table 2
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

3.5 Aquatic Resources

For ease of reference, a brief overview of the ***Environmental Study*** is reproduced in this section and is also contained in ***Appendix C*** of this report.

Source: Environment Study

Jock River

The Jock River has basic pH (~ 8), with elevated concentrations of nutrients, particularly total phosphorus (> 0.03 mg/L). Summer water temperatures of the Jock River in the vicinity of the Village of Richmond indicate the river is a generally warm-water system. There is evidence, however, of groundwater influences through the village since water temperatures generally decrease by about 2°C from upstream to downstream of the village.

Fisheries work conducted by the RVC and City of Ottawa on the Jock River resulted in 35 fish species captured. The fish communities in the Jock River have included warmwater, coolwater and coldwater fish species, including one sensitive species, the greater redhorse sucker (Moxostoma valenciennesi), captured in the Jock River. Pearl dace (Margariscus margarita) and mottled sculpin (Cottus bairdi) are the primary cool/coldwater species found in the Jock River. The presence of pearl dace and mottled sculpin in the Jock River reflects apparent inputs of cold water, potentially groundwater. The fish community of the main channel, however, is generally dominated by warmwater and coolwater species such as blacknose shiner (Notropis heterolepis), blacknose dace (Rhinichthys atratuluss), brook stickleback (Culea inconstans), common shiner (Luxilus cornutus) and golden shiner (Notemigonus crysoleucas).

Van Gaal/Arbuckle Drain

The Van Gaal Drain including the mainstem VG-R2, and the two major tributaries VG-R2-1 and VG-R2-2 are permanent watercourses. The mainstem Van Gaal Drain has reasonable water quality with basic pH (~8), high hardness (> 300 mg/L), but with somewhat elevated nutrient concentrations (total phosphorus ~ 0.05 mg/L). Summer water temperatures indicate generally cool conditions, with periods of warm-water.

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Mottled sculpin were found throughout the Van Gaal/Arbuckle Drain (except the north-east tributary) from the Moore Branch upstream to and including the north-westerly tributary (VG-R2-2). The presence of mottled sculpin implied that the drain is a cool-water system. A relatively large number of fish species collected from the Van Gaal Drain/Arbuckle Drain were also cool-water species including northern pike, central mudminnow, white sucker, northern redbelly dace, Johnny darter and rock bass among others. Water temperatures at the Perth Street culvert indicated that the Van Gaal/Arbuckle Drain provides is a marginal cool-water stream, with temperatures classifying as both cool and warm.

The presence of the single young-of-year pike in the Van Gaal/Arbuckle Drain is significant. A young-of-year pike was previously found in the drain near the Perth Street culvert according to records provided by the RVCA. Pike spawning may also occur near or upstream of the point of capture of the single pike in this study (i.e., in the vicinity of the Moore Branch confluence). Riparian habitat in the vicinity of the confluence of the Moore Branch and the Arbuckle Drain appeared to be relatively suitable for spawning pike with the caveat that water levels were not high for a very long period of time.

The potential for pike to spawn in habitats downstream of the Fortune Street culvert are limited according to Muncaster Environmental who conducted studies on that part of the drain during 2008. There are potentially suitable spawning habitats downstream of the Fortune Street culvert, but like the Moore Branch confluence, water levels did not remain high enough long enough to be fully suitable.

The potential for pike to spawn upstream of the “spawning shelf” is also considered low. The upper Van Gaal Drain was walked on both April 10 and 17. There were no suitable spawning habitats identified during those investigations, while water levels, like at the Moore Branch confluence dropped significantly over that one-week period. The culvert situated 350 m upstream of Perth Street presents a potential velocity barrier during periods of high spring flows. Velocities at that point were estimated at slightly greater than 1 m/s on April 17 (see photographs for VG-R2f; Appendix 7), which is marginally passable by pike during spring runoff events. The most likely pike spawning habitat in the Van Gaal Drain, as per the information to date, is in the Moore Branch.

Moore Branch

Flows in the Moore Branch are maintained by cool groundwater seeping from a tile drain at a hedgerow separating Sections 2 and 3. Water quality is good with basic pH (~ 7.5), high hardness (> 300 mg/L), non-detectable total phosphorus concentrations and low solids (TSS ~ 4 mg/L). Bankfull widths of the Moore Branch were variable (4 to 10 m) with bankfull depths of between 0.6 and 1.5 m. Bank materials consist of clay and silt. Vegetation in the branch consisted of grasses and herbs with more shrubs and trees in the riparian zone further upstream in the reach. Bank-side vegetation provided nearly 100% canopy cover in summer. Minor woody debris was observed at several locations.

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The Moore Branch was utilized by 15 fish species during the spring high-flow event in 2008. White sucker, northern redbelly dace and pearl dace were found upstream as far as Ottawa Street along VG-R3-2. The fish community in the lower part of the Moore Branch also included high relative numbers of creek chub and common shiner. Of the 15 species found in the spring, only four were found in the Moore Branch in early August: central mudminnow, creek chub, pearl dace, and brook stickleback. A single central mudminnow was found in the branch near VG-R3-2(2) on August 9, 2008. Downstream of that point, the drain was dry, resulting in the mudminnow (and any other fish that were in the upstream reach) being stranded. On August 9, 2008, the drain contained water to depths of approximately 4 to 8 cm, and 1 to 1.5 m wide. There were, however, no other fish observed in the upstream reach on that day. The absence of fish would appear to reflect that the upper drain periodically goes dry or anoxic. The Moore Branch was flowing through to August 9, 2008, the last time the site was visited in 2008, with flows provided by a tile drain.

The Moore Branch was flowing through to August 9, 2008, the last time the site was visited, with flows provided by a tile drain. Based on these findings, the lower part of VG-R3 appears to be permanent aquatic habitat. It is unknown whether this drain would remain wet during drier years. The upper sections of the drain provide spawning habitat for 15 species of fish, but it is likely that many of those fish become stranded and perish. A high point in VG-R3-2 (the split between Sections 6 and 7, ***Figure 10***) causes that tributary to dry from the most downstream sections first, effectively stranding fish in the upper reach. Adult cyprinids clearly access this tributary during the spring to spawn. As waters recede, adult fish may move downstream prior to becoming stranded. Young (fry) would be less likely to move downstream because they tend to have greater site fidelity and move passively with currents. Fry stranded by the high point would perish as waters heat up or evaporate. Although the Moore Branch has water temperatures indicating cool-water, it did not produce mottled sculpin, probably because the water was generally too shallow.

To identify any use by Northern Pike of potential of spawning habitat along the eastern edge along the Arbuckle and Moore drains during the spring of 2009, weekly site visits to these reaches began March 19, 2009 and continued until April 26, 2009, with one final site visit on May 28 (Appendix 10). Adult pike were not observed in the Arbuckle Drain or Moore Branch on any site visit nor were fish eggs found in submerged vegetation. There was, thus, no evidence of pike spawning in the vicinity of the Arbuckle Drain and Moore Branch, and the confluence of those two watercourses that spring. Pike may not have used this area for spawning because of particularly low water levels that year causing reduced spawning habitat.

Jock River Estate Storm Easement

The Jockvale Estates Drain flows along Ottawa Street, then south-east through a field where it goes through the manmade berm at the Jock River. Water in the drain is basic (pH~8) with high hardness (> 400 mg/L), but has relatively high nutrient concentrations (0.04 mg/L total phosphorus) based on a single sample.

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During the spring of 2008, the drain contained five species of fish in relatively low abundances. Central mudminnow and fathead minnow were the most dominant fishes in the spring collection. There were no pike or other esocids. The same set of species, but minus the bluntnose minnow, was also collected in the early August inventory. The drain was dry upstream of a rock/rubble check dam that was situated approximately 150 m upstream of the constructed berm. Only the lower ~150 m was permanent aquatic habitat in 2008, and it may go completely dry during drier years. The check dam can also be considered to pose a potential downstream barrier to fish movement post spawning/hatching from upstream habitats: some fish will become stranded behind the check dam and perish upon the water evaporating. This drain would not provide good winter habitat because it is too shallow: fish would likely freeze because of the lack of apparent groundwater flow to the tributary. It is believed that fish gain access to the drain through the berm via the culvert at times of high flow, and assuming that the valve at the downstream end of the culvert stays open during those periods of high flow. There is no other apparent access point for fish to this tributary. As a result of these findings, this tributary is considered to provide artificial fish habitat that did not occur prior to its construction.

Figure 10 illustrates the fish habitat classification based on the field work and assessment conducted by Kilgour & Associates for the watercourses on Mattamy lands. Further definition of the classification system can be found in ***Appendix H.***

Figure 10. Map of the study area showing classifications of fish habitats

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3.6 Terrestrial Habitat

For ease of reference, a brief overview of the ***Environmental Study*** is reproduced in this section and is also contained in ***Appendix C*** of this report.

Source: Environmental Study

There are no Areas of Natural or Scientific Interest (ANSI's) within the Village Boundaries. NESS Area 422 does extend into the southwest corner of the Village and onto the Mattamy site. Flora and fauna investigations were conducted by Kilgour and Associated for the Mattamy Lands. There are no provincially significant wetlands or Areas of Natural and Scientific Interest (ANSIs) on or adjacent to the property, which is mostly rural. There was one nationally and provincially endangered species (Butternut, Juglans cinerea) located in two separate locations on Mattamy. The wooded areas north and south of the Jock River meets the City's definition of Significant Woodland. The most valuable ecological linkage areas on the Mattamy lands are the natural areas to the north and south of the Jock River. These are relatively large areas, mostly in a natural state, with the potential to provide wildlife movement corridors along the Jock River into the much larger Marlborough Forest and Richmond Fen natural area complex (NESS 422), and are thereby a component of a Natural Heritage System. All of these characteristics and functions support the designation of significant woodlands and significant wildlife habitat within the context of the PPS and the City's new Official Plan (OPA 76). Development within 120 m of the Natural Heritage System would require an Environmental Impact Statement (EIS) at the time of draft plan submission.

3.7 Site Constraints

The review of relevant background studies has revealed the following site development constraints and is illustrated on ***Preliminary Drawing 2***.

Geotechnical

- The Geotechnical Study identified grade raise constraints ranging from 1.0m to 4.0m maximum grade raise from north of Perth Street to the Jock River.
- Rock was encountered near the surface south of Ottawa Street.

Geomorphology

- A 'Meander Belt' was established for the Jock River, the Van Gaal/Arbuckle Drain and Moore Tributary. The meander belt width is 180 m along the Jock River, 42 m along the Van Gaal/Arbuckle Drain and ranges from 17 to 30m along sections of the Moore tributary.
- The Van Gaal/Arbuckle Drain was determined to be "in transition." Therefore a 'Critical Discharge Rate' of 0.33m^3/s was established for low flows directed to the drain.

Natural Environment

- The Van Gaal/Arbuckle drain was identified as being direct fish habitat, containing a relative diverse assemblage of fish and a marginal cool water fishery.
- Thermal regime in the Van Gaal/Arbuckle drain needs to be considered.
- A portion of the Moore tributary and the Jock River Estate stormwater easement (JED-1) were identified as being intermittent direct habitat.
- The Jock River is a high quality watercourse.
- Significant Woodlands are presently situated along the Jock River corridor.
- The Jock River corridor serves a significant ecological linkage function.

Hydrology

- Based on the 2005 Rideau Valley Conservation Authority Jock River floodplain mapping, the floodplain occupies a large portion of Mattamy's Land Holdings.
- The floodplain limit south of Ottawa Street has been modified as shown in the drawings contained in the report on the assumption that the works contemplated in the RVCA letter of permission, March 3, 2009, will be completed and approved.
- The Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drain in the Village of Richmond (JFSA, November 2009) establishes the 100 year regulatory floodplain limit.
- The 100 year floodplain limit for the Van Gaal Drain north of Perth Street can be amended in the future based on channelization works subject to RVCA approval.
- The JFSA floodplain model will be incorporated into the detailed hydrologic and hydraulic modeling of the proposed subdivision.
- External drainage as identified on ***Preliminary Drawings 1 and 2*** must be accommodated for and conveyed through the site in post-development conditions.

Existing Features

- Shallow sanitary sewers exist within the existing Village of Richmond.
- Final site grading design must tie into existing grades.
- Site grading will be managed to protect significant woodland, retained hedgerows, treed areas and individual trees identified for protection.

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4.0 EXISTING CONDITIONS MODEL

The hydraulic and hydrologic model employed in the 2010 Van Gaal Floodplain model was utilized to establish existing conditions for the proposed development. Additionally, it was utilized to determine flow to be conveyed through the development from external areas. The SWMHYMO input file is included in ***Appendix C***. The hydrologic model originally prepared for the March 2009 submission of this study was City and RVCA and was updated as part of the RVCA floodplain analysis prepared by JFSA.

The floodplain mapping model utilized SWMHYMO to develop the existing hydrology and HEC-RAS to calculate the water levels along the Van Gaal Drain.

The following design storm events were modeled to develop existing peak flow and water levels along the Van Gaal Drain.

- 24 Hour SCS Type II, with a 100-yr rainfall distribution.
- 10 Day rain on snow event with a 100-yr rainfall distribution.

A separate hydrologic and hydraulic undertaking was completed by AECOM for areas currently draining to or may drain to the Jock River in the future. Their analysis is included in ***Appendix G*** and is discussed in ***Section 7.1.2., Water Quantity Criteria***.

4.1 Summary of Results

4.1.1 Summary of Flow to the Van Gaal Drain

Table 3 summarizes the estimated existing peak flows to the Van Gaal Drain during the 100-year Spring and Summer Events. The storm conditions analyzed were the 100-year summer, 100-year spring, and the 100-year spring at the point in time where the Jock River peak reaches the outlet of the Van Gaal Drain. The importance of reviewing the third condition is exemplified at cross-section 666, where although the flow is substantially lower than condition 1 and 2, the elevation is the highest. This phenomenon is described in detail in ***Section 10.4, Technical Justification***.

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Table 3
Existing Peak Flow Rates and at Discharge locations along Van Gaal Drain

Location	X-Sec ID	24 Hour SCS Storm[1]		10 Day Rain on Snow[2]		10 Day Rain on Snow[3]	
		Flow (m^3/s)	Elev. (m)	Flow (m^3/s)	Elev. (m)	Flow (m^3/s)	Elev. (m)
Upstream of Perth Street	1340	11.434	94.21	11.619	94.19	3.426	93.13
Downstream of Perth Street	1312	12.200	94.14	12.204	94.12	3.439	94.12
Upstream of Fortune Street	666	16.377	93.32	15.739	93.68	4.056	94.10

1. The Van Gaal Drain 100-year summer peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring flow reaches the Jock River.
3. The Jock River 100-year spring peak flow reaches the outlet of the Van Gaal Drain.

4.1.2 Summary of Flow to be conveyed through Proposed Development

Table 4 summarizes the existing peak flows to be conveyed through the proposed development as estimated by the hydrologic model prepared by JFSA. ***Section 9.3*** describes how the external areas will be conveyed through the proposed development. ***Appendix E*** contains the SWMYMO model input file utilized to estimate the peak flow and is consistent with the 2010 RVCA Van Gaal Drain Flood Plain mapping study.

Table 4
Summary of Peak Flows to be conveyed through Subdivision

Location	24 Hour SCS Storm	4 Hour Chicago	10 Day Rain on Snow Event
	(m^3/s)	(m^3/s)	(m^3/s)
Mat – A	2.381	1.992	1.225
Mat – B	0.861	0.701	0.633
Mat – C	3.736	3.053	2.852
Mat – D	2.002	1.646	1.277
Mat – E	1.253	1.046	0.650

Please refer to ***Drawing 1***, ***Preliminary Drawings***, for locations of external areas to be conveyed through the proposed development.

5.0 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 I.*** 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

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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)

Table 5 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 I.*** Table 6 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.

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Table 5
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 6***, maximizing opportunity for directing roof leaders to grassed areas significantly improves post-development annual infiltration volume.

Table 6
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

6.0 PHOSPHOROUS ANALYSIS

The Jock River, based on phosphorus concentrations, has been classified as a Policy 2 watercourse by the Ontario Ministry of Environment (MOE); as such, post-development phosphorus loadings must be equivalent or less than pre-development loadings. The following section summarizes the results of a phosphorus loading study (see ***Appendix***

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F) completed by AECOM, that demonstrates the Mattamy development will meet MOE requirements.

Typically, the urbanization of agricultural land reduces phosphorus loadings to the receiving watercourse; where this does not occur, a storm water management (SWM) facility, designed in accordance the Ontario Ministry of Environment guidelines, can be used for quality control. The phosphorus removal efficiency of SWM facilities in Ottawa has been found to be approximately 70% as indicated in Appendix H of the Jock River Reach 1 Subwatershed Study, Stantec Consulting Ltd.

The rate of phosphorus loading (kg/ha/yr) from non-point sources varies with land usage; typically, forested areas have the lowest phosphorus export coefficients, while corn fields have some of the highest. ***Table 7*** below outlines the phosphorus export coefficients used in the analysis.

The pre-development landuse conditions are primarily agricultural; post-development are urban residential. Ten (10) years of historical crop plantings were analyzed to determine an average pre-development phosphorus export coefficient for various parcels of land to be urbanized. Details can be found in ***Appendix F*** and the results are summarized in ***Table 7***. No historical data was available for the remaining 15.7ha of properties where landuse was assumed to be general agricultural with a coefficient of 0.6 kg/ha/yr. Post development landuse is entirely urban residential and an export coefficient of 1.0kg/ha/yr is used.

Table 7 estimates the total pre and post-development phosphorus loadings based on existing and proposed landuse and the appropriate phosphorus export coefficients.

Table 7
Total Pre and Post Development Phosphorus Loadings

Parcel	Pre-development				Post-development				
	Land Use	Area (ha)	P. Export Coef. (kg/ha/yr)	P. Total Loading (kg/yr)	Land USe	P. Export Coef. (kg/ha/yr)	P. Total Loading (kg/yr)	Removal Efficiency (%)	Net P. Loading (kg/yr)
Arbuckle	Arg.	53.0	2.2	117	Urb.	1.0	53	70	37
1634049 On Inc.	Arg.	20.5	1.5	31	Urb.	1.0	20	70	14
Laffin	Arg.	23.2	1.6	37	Urb.	1.0	23	70	16
Moore S. of Ottawa	Arg. (Gen)	42.1	1.2	51	Urb.	1.0	42	70	29
Other	Arg. (Gen)	16.7	0.6	10	Urb.	1.0	17	70	12
Total		**155.5**		**245**			**155**		**109**

Pre-development loadings were found to be 245kg/yr. Post-development loadings were found to be 155kg/yr without the use of a SWM facility and 109kg/yr with a SWM facility.

The post-development phosphorus loadings are 58% lower than pre-development levels, achieving the objectives for a Policy 2 watercourse. A SWM facility is not required for phosphorus removal, but may be required for other water quality/quantity control measures.

7.0 PROPOSED STORMWATER MANAGEMENT SYSTEM

7.1 Stormwater Management Criteria

7.1.1 Water Quality Criteria

The MOE ***SWMP Design Manual*** provides assistance to the consultant on the selection of the required level of quality treatment.

The ***Environmental Study*** identified significant fish habitat in the Jock River, the Van Gaal/Arbuckle drain and a portion of the Moore tributary (at the confluence of the Arbuckle Drain). Therefore stormwater discharged to these receiving watercourses will require Enhanced total suspended solids removal (80% TSS removal) per the ***SWMP Design Manual***.

7.1.2 Water Quantity Criteria

The subject property is located in the Jock River Reach 2 sub-watershed. The sub-watershed is approximately 148km^2 and includes the area draining into the Jock River between Highway 416 to the outlet of the Richmond Fen. The Jock River Reach 2 Sub-watershed Study is not complete with the water quantity criteria for the Van Gaal and Jock River still outstanding.

The existing development currently drains to the Jock River and the Van Gaal Drain.

AECOM was retained to prepare a cumulative effects analysis to assess the impact of the urbanization on the Jock River. Ten (10) development areas identified by the RVCA for Richmond in addition to the anticipated development elsewhere within the Jock River watershed was assumed a reasonable estimate of potential urbanization within the watershed. The hydrologic model for summer flow estimates, prepared for the Jock River Flood Risk Mapping Study (PSR Group/JFSA 2004), was used to assess both existing and future (developed) flows. A simplistic approach has been used to identify the cumulative impact of development on peak flows in the Jock River watershed. A comparison of existing and developed flows was achieved by modifying the Curve Numbers (CN) utilized in the hydrologic model for those catchments that contained proposed development. There was no stormwater management (SWM) component considered: the intent was to gain understanding of the magnitude and timing of development flows and their potential to impact downstream areas. The addition of SWM would reduce flow magnitude but potentially increase the duration of the reduced peak flow. Given the size of the watershed and the relatively small amount of development in the foreseeable future, it is apparent that there is no impact from

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anticipated development on Jock River flows. The complete "Cumulative Effects" report prepared by AECOM is located in ***Appendix G.***

Based on the cumulative effects analysis and the recently completed Van Gaal Drain floodplain analysis, the following stormwater management criteria is recommended:

Jock River

- No quantity control storage required for flood control purposes as the hydrograph from the watershed will peak before the upstream peak in the Jock River.
- No erosion control storage required to maintain the predevelopment in-stream erosion condition.
- Quality control volume per the Ministry of Environment Enhanced Treatment (80% TSS removal)

Van Gaal/Arbuckle Drain

- Quantity controls required to demonstrate no impact on flood levels for storm events up to and including the 100-year storm event.
- Erosion control storage required to maintain the predevelopment in-stream erosion condition per ***Geomorphology Study***.
- Quality control volume per the Ministry of Environment Enhanced Treatment (80% TSS removal)

The ***Geomorphology Study*** (***Appendix D***) indicates that the Van Gaal/Arbuckle Drain is 'In Transition.' The observed in stream erosion processes triggered an 'Erosion Threshold Assessment.' The results of the erosion threshold analysis for the Van Gaal/Arbuckle Drain in the area of Mattamy's Land holds were extracted from Table 6 of the ***Geomorphology Study*** and are reproduced in ***Table 8.***

Table 8
Erosion Threshold Analysis per *Geomorphology Study*

Parameter	VG-R2
Average Bankfull Width (m)	4.99
Average Bankfull Depth (m)	0.39
Energy Gradient (%)	0.15
Bed Material D_{50} (mm)	0.002
Bed Material D_{84} (mm)	0.08
Average Bankfull Velocity (ms^{-1})	0.59
Average Bankfull Discharge (m^3s^{-1})	1.35
Stream Power (Wm^{-1})	19.93
Stream Power per Unit Width (Wm^{-2})	3.98
Critical Discharge (m^3s^{-1})	0.33
Method	Chow, 1959

Note: Extracted from ***Geomorphology Study -*** Table 6

All flows up to and including the 2-year storm event released from the proposed stormwater management facility directed to the Van Gaal/Arbuckle Drain (VG-R2) will be attenuated to the critical discharge rate noted in ***Table 8***.

7.2 SWM Servicing Alternatives

In December 2008, Mattamy Homes held a three-day design workshop in Richmond to develop a land use concept plan for their lands. Looney Ricks Kiss (LRK) facilitated the design workshop with input from Mattamy's consultant team, City staff, residents and other stakeholders. Building upon the visioning principles established through the Village of Richmond Community Design Plan process, a preliminary land use concept plan was developed (***Figure 11***). In order to finalize and support the development land use concept plan, the stormwater management requirements need to be established.

Figure 11. Preliminary Land Use Concept Plan

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7.2.1 End of Pipe Stormwater Alternatives

There are several suitable end-of-pipe options for the treatment of stormwater runoff from urban areas including – Infiltration Basins, Wetlands, Dry Ponds, Wet Ponds, and Hydrodynamic Separation Units. ***Table 9*** presents the four options and their suitability as described in the Stormwater Management Planning and Design Manual (MOE, March 2005).

Table 9
End of Pipe Treatment Systems Considered

Stormwater Management Practice	Description
Infiltration Basins	Infiltration basins are above-ground pond systems which are constructed in highly pervious soils. Water infiltrates into the basin and either recharges the groundwater system or is collected by an underground perforated pipe network and is discharged to a downstream outlet.
Wet Ponds	Wet ponds are the most common end-of-pie stormwater facilities in Ontario. The performance does not depend on soil characteristics, permanent pool minimizes re-suspension of captured solids and minimizes blockages at the outlet. Furthermore, the biological removal of pollutants occurs. Wet ponds are suited to drainage areas 5ha and greater
Wetlands	Wetlands are normally more land-intensive than wet ponds because of their shallower permanent pool depth. They provide similar quality benefits as wet ponds, although the biological processes are enhanced.
Dry Ponds	Dry ponds have no permanent pool of water. As such the removal of containments is purely a function of the detention time in the pond.
Hydrodynamic Separation Units	Hydrodynamic Separation Units or Oil / Grit separator are manufactured concrete units for the expressed purpose of trapping sediment and oil. The processes are patented and sizing is dependent on the manufactures specifications and tends to work well with small (less than 5.0ha) catchments. These units tend to occupy less land area.

In developing the various end of pipe stormwater management alternatives, two additional considerations were given priority. First, sitting a SWMP at the lowest elevations of the site was considered over higher elevations. Second, the ponds should be situated nearest to their respective outlet locations.

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Jock River Outlet Options

One of the SWMP options conceived was to locate a facility at the southern most extent of the site to outlet directly to the Jock River within the subject lands. However, as illustrated on ***Preliminary Drawing 2*** the 100-year flood elevation at this location is 96.40, which is higher than the northern portion of the development. An alternate outlet location was considered at the end of Ottawa Street where the 100-year level in the Jock River lowers dramatically, by approximately 2.0m, 1200m downstream at Ottawa Street which could facilitate drainage of the majority of the subject lands.

Outlet routes from the subject area to Jock River at Ottawa Street were considered along Queen Charlotte, Royal York Street, Burke Street, and Ottawa Street. Based on 'as-built' information received from the City of Ottawa Information Centre, it was found that an existing sanitary sewer would be in conflict with a proposed sewer routing along Royal York and Burke Streets at Fortune Street. An outlet route to the Jock River via Martin, Hamilton and Perth is not possible as the storm sewer is unable to cross under the existing Van Gaal Drain. As such, routing along Queen Charlotte Street and Ottawa Street are the storm sewer route most feasible from the subject lands should flows be directed to the Jock River at the end of Ottawa Street.

Van Gaal/Arbuckle Outlet Options

An outlet directly to the Van Gaal/Arbuckle Drain was considered for the development area north and south of Perth Street. It will be required to demonstrate that there would be no increase in flood levels along the Van Gaal Drain as well as providing erosion impulse control in accordance with the ***Geomorphology Study***.

Preliminary Screening of End of Pipe Stormwater Management Alternatives

Infiltration basins require low ground water tables and permeable soils. The ***Geotechnical Study*** illustrated that ground water elevations are within 0.60m to 1.2m of the existing ground surface. Furthermore, the soils are predominately clays with low percolation rates. Therefore, infiltration basins are not suitable in this application.

According to the ***SWMPDM*** wetlands tend to raise the temperature more than wet ponds. The ***Environmental Study*** indicated that the downstream watercourse has thermal sensitive species. Therefore, and end of pipe facility that minimizes temperature increase was given priority.

Based on the site characteristics, constraints, and requirements; stormwater management solutions incorporating wet ponds, dry ponds, and oil/grit separators will be investigated in additional detail.

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7.2.2 Lot Level Stormwater Management Alternatives

Table 10 summarizes investigated lot level stormwater management practices.

Table 10
Lot Let Treatment Systems Considered

Stormwater Management Practice	Description
Rain Barrel	Harvesting rainwater by capturing rooftop runoff by connecting roof leaders to 'barrels' for watering during periods of dry weather.
Cistern	Harvesting rainwater by capturing rooftop runoff and directing stormwater to an underground storage tank. Water is pumped for watering during dry periods.
Green Roof	Consist of a thin layer of vegetation and growing medium installed on top of a convention flat or sloped roof. Reduces the 'heat' island effect and reduces runoff volume.
Roof downspout disconnection	Roof downspouts are disconnected from the weeping tile and are directed to grassed areas.
Soakaway, infiltration trench or chamber	Rectangular or circular excavations lined with geotextile filter cloth and filled with clear stone designed to promote groundwater infiltration.
Bioretention / Biofilter	Consists of a filter bed consisting of a mixture of sand, soil, and organic material. Bioretention facilities are designed to capture small storm events to retain and filter stormwater runoff. Plantings promote evapotranspiration.
Permeable pavement	An alternative to traditional impervious pavement to allow stormwater to drain through into an aggregate reservoir and infiltrate into the ground water.
Enhanced grass swale	Vegetated open channels designed to convey, treat, and attenuate stormwater runoff. Check dams and vegetation in the swale promote attenuation and infiltration.
Dry Swale	A dry swale incorporates an engineered soil medium and a perforated pipe under drain.
Perforated pipe system	Underground stormwater conveyance systems usually incorporated into the right-of-way drainage system.

Mattamy Home subdivisions typically consist of urban right-of-way cross-sections and residential homes with peaked roofs. It is anticipated that similar streetscaping will be applied in the proposed subdivision.

As such the following measures were not considered:

- Cisterns – Would increase the cost of each home.
- Green Roofs – Not standard practice in residential homes.

- Soakaway, infiltration trenches or chambers – requires permeable soils and low ground water table.
- Biorentention / Biofilter – not part of a standard City of Ottawa cross-section. Would increase right of way maintenance.
- Permeable Pavement – not standard practice in the City of Ottawa.
- Enhanced Grass Swale – Would have to take place in rear yards. It is anticipated that home owners will remove check dams.
- Perforated pipe system – not typical sewer design practice in the City of Ottawa. Would increase maintenance cost.

The proposed subdivision will consist of the following:

- Roof Leaders to Grassed Areas. As identified in ***Section 5.0 – Water Budget***, Roof leaders disconnected from weeping tile and directed to grassed areas significantly increases post-development annual infiltration volume.
- Dry Swales.
- An education program to promote rain barrels.

7.2.3 Screening of Options

Based on the discussion presented in the previous section and ***Section 3.7 Site Constraints***, three stormwater management servicing alternatives, illustrated on ***Preliminary Drawings 3 to 5***, were developed for evaluation:

Option 1 (Preliminary Drawing 3)

- Four Stormwater Management Ponds (SWMPs)
- Three facility are "Wet Ponds" with MOE 'Enhanced' TSS removal. While Pond 3 is a dry pond for quantity control and a hydrodynamic separator to provide quality control.
- External drainage tributary to the subject lands will be conveyed through proposed storm sewers and drainage ditches. The existing channels identified as VG-R3-2, VG-R3-1 and JED-1 will be enclosed.
- External drainage west of the development currently being conveyed along the Perth Street roadside ditches (MAT-A and MAT-B) will continue to outlet to the Van Gaal Drain. Once the road is widened to an urban cross-section the external drainage from west of Perth Street will be conveyed to the Van Gaal Drain via storm sewers.
- External drainage currently being conveyed through the Moore Tributary (MAT-C and D) will be conveyed to Pond 1 via new storm sewers.
- Jock River Estates drainage will be conveyed north of Ottawa Street through the new storm sewer system to Pond 1.

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- Pond 1 will be designed to receive flow from the majority of the area between Perth Street and Ottawa Street, approximately 58 ha.
- This wet pond will be designed to attenuate post-development runoff rates to predevelopment levels, while flows up to and including the 2-year event will be attenuated to 330L/s in accordance with the ***Geomorphic Study***.
- Pond 2 will be designed to receive runoff from approximately 8 ha north of Ottawa and the developable land south of Ottawa Street.
- Pond 2 is a wet pond and has one outlet directing post-development runoff rates to the Jock River via a proposed storm sewer along Ottawa Street. The 100-year release rate from Pond 2 will be restricted to the free flowing capacity of the outlet sewer.
- Pond 3 will be designed as a dry pond with a hydrodynamic separator to collect and retain runoff from approximately 3 ha north of Perth Street east of the Van Gaal Drain.
- This pond will be designed to attenuate flows to 330L/s in accordance with the ***Geomorphic Study***.
- The proposed facility will incorporate a hydrodynamic separator to provide 80% TSS removal per ***SWMPDM***.
- Pond 4 will be designed to collect and retain runoff from approximately 28 ha north of Perth Street east of the Van Gaal Drain and will outlet to the Van Gaal Drain.
- This pond will be designed to attenuate post-development runoff rates to predevelopment levels, while flows up to and including the 2-year event will be attenuated to 330L/s in accordance with the ***Geomorphic Study***.

Option 2 (Preliminary Drawing 4)

- Three Stormwater Management Ponds (SWMPs)
- Ponds 1 and 2 are “Wet Ponds” with MOE ‘Enhanced’ TSS removal. Pond 3 is a dry pond for quantity control and a hydrodynamic separator to provide quality control.
- External drainage tributary to the subject lands will be conveyed through proposed storm sewers and therefore the existing tributaries identified as VG-R3-2 and JED-1 will be enclosed. VG-R3-1 will remain open.
- External drainage west of the development currently being conveyed along the Perth Street roadside ditches (MAT-A and MAT-B) will continue to outlet to the Van Gaal Drain. Once the road is widened to an urban cross-section the external drainage from west of Perth Street will be conveyed to the Van Gaal Drain via storm sewers.
- External drainage currently being conveyed through the Moore Tributary (MAT-C) will be conveyed to Pond 1 via new storm sewers.

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- Jock River Estates drainage will be conveyed north of Ottawa Street through the new storm sewer system to Pond 1.
- Pond 1 will be designed to receive runoff from 45 ha between Ottawa and Perth Streets in addition to 28 ha north of Perth Street on the west side of the Van Gaal Drain. Pond 1 will have two outlets:
- The first channel will be designed to convey low flows up to and including the 2-year event attenuated to 330L/s in accordance with the ***Geomorphic Study***. The channel will provide both surface and subsurface conveyance. The channel will be bordered by strategic planting to promote shaded cover, while the subsurface component will enhance cooling opportunities.
- The second channel will be designed to convey the treated stormwater runoff from the less frequent storm events generated during the 5 to 100 year return periods.
- Pond 2 will be designed to receive runoff from 21 ha north of Ottawa and the developable land south of Ottawa Street.
- Pond 2 has one outlet directing post-development runoff rates to the Jock River via a proposed storm sewer along Ottawa Street. The 100-year release rate from pond 2 will be restricted to the free flowing capacity of the outlet sewer.
- Pond 3 will be designed as a dry pond for quantity control / hydrodynamic separator to collect and retain runoff from approximately 3 ha north of Perth Street east of the Van Gaal Drain.
- This pond will be designed to attenuate flows to 330L/s in accordance with the ***Geomorphic Study***.
- The pond outlet structure will be designed to mitigate increases in water levels in the Van Gaal Drain
- The proposed facility will incorporate an oil / grit sedimentation chamber to provide 80% TSS removal per ***SWMPDM***.

Option 3 (Preliminary Drawing 5)

- Three Stormwater Management Ponds (SWMPs)
- Ponds 1 and 2 are “Wet Ponds” with MOE ‘Enhanced’ TSS removal, while Pond 3 is conceived to be a dry pond for quantity control and a hydrodynamic separator to provide quality control.
- In this stormwater management option, the Moore Tributary for its entire length will be left open and JED-1 will be enclosed within the development area. The existing channel will need to be redesigned to ensure that the channel contains the 100yr event. JFSA prepared a hydrologic and hydraulic model to confirm the proposed cross-sections, see ***Appendix I*** for the detailed analysis. The corridor width for the re-engineered Section 8 of VG-R3-2 (north-south hedgerow) will be 17.5m and Section 6&7 of VG-R3-2 will be 18.8m. ***Figures 12 and 13*** illustrate the proposed cross-sections. The proposed cross-sections will be reviewed by a

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Fluvial consultant (Geomorphology) and their recommendations will be incorporated at the detailed design stage.

- External drainage west of the development currently being conveyed along the Perth Street roadside ditches (MAT-A and MAT-B) will continue to outlet to the Van Gaal Drain. Once the road is widened to an urban cross-section, the external drainage from west of Perth Street will be conveyed to Pond 1 via storm sewers.
- External drainage currently being conveyed through the Moore Tributary (MAT-C, MAT-D) will be conveyed to the Van Gaal/Arbuckle Drain via the redesigned Moore Tributary channel.
- Jock River Estates drainage will be conveyed north of Ottawa Street through a new culvert to the redesigned Moore Tributary channel to Van Gaal/Arbuckle Drain.
- The Fortune Street Culvert will be modified to lower 100-year summer water levels upstream of Fortune Street. AECOM produced the resulting 100-year summer elevations by increasing the culvert by 50% in the RVCA floodplain mapping model. Detailed results are included in ***Appendix I***.
- Pond 1 will be designed to receive runoff from 45 ha between Ottawa and Perth Streets in addition to 28 ha north of Perth Street on the west side of the Van Gaal Drain. Pond 1 will have two outlets:
- The first outlet will be designed to convey low flows up to and including the 2-year event attenuated to 330L/s in accordance with the ***Geomorphic Study***. The will be designed enhance cooling opportunities.
- The second outlet will be designed to convey the treated stormwater runoff from the less frequent storm events generated during the 5 to 100 year return periods.
- Pond 1 is situated in the 100-year regulatory floodplain, outside the 100-year erosion limit and 100-year summer flood elevation of the Van Gaal/Arbuckle Drain.
- Pond 2 will be designed to receive runoff from 21 ha north of Ottawa and the developable land south of Ottawa Street.
- Pond 2 has one outlet directing post-development runoff rates to the Jock River via a proposed storm sewer along Ottawa Street. The 100-year release rate from pond 2 will be restricted to the free flowing capacity of the outlet sewer.
- Pond 3 will be designed to collect and retain runoff from approximately 3 ha north of Perth Street east of the Van Gaal Drain.
- This pond will be designed to attenuate flows to 330L/s in accordance with the ***Geomorphic Study***.
- The proposed facility will incorporate an oil / grit sedimentation chamber to provide 80% TSS removal per ***SWMPDM***.

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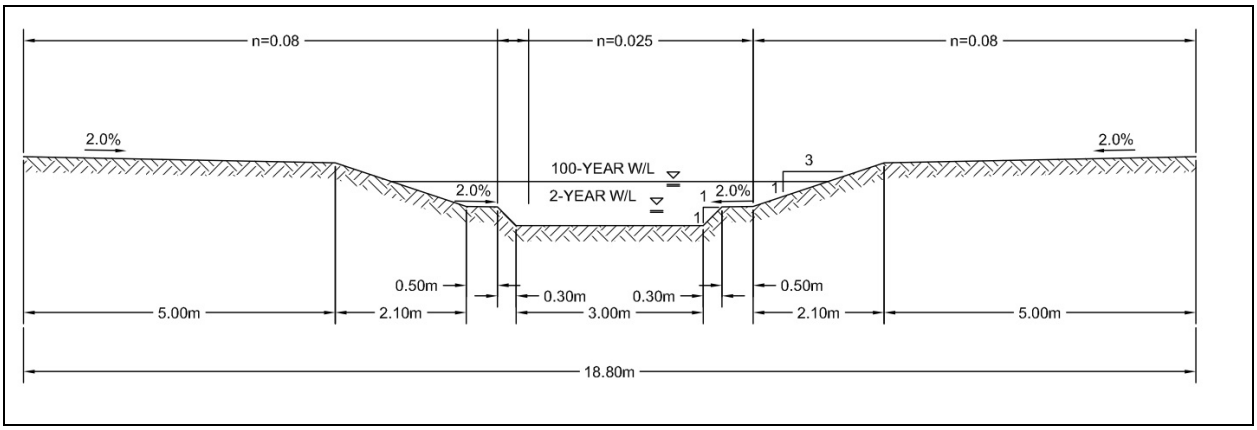

Figure 12 – X-Section of North / South Corridor

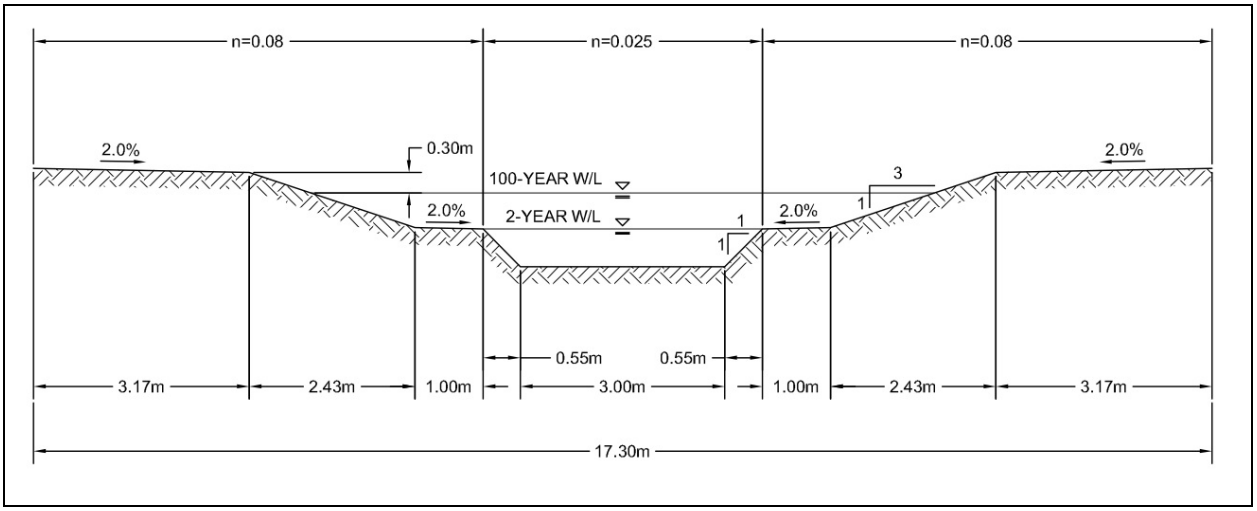

Figure 13 – X-Section of Re-Engineered VG-R3-2

7.3 Selection of Preferred SWMP

7.3.1 Evaluation Process

The three stormwater management options presented in ***Section 6.2.2*** were brought forward for evaluation through a pair-wise comparison matrix. The evaluation matrix was developed as part of the Village of Richmond Master Servicing Study (***Servicing Study***). These evaluation criteria were presented and reviewed by the Technical Advisory Committee and the public.

The evaluation criteria consist of criterion in four major categories: Natural Environment, Caring and Healthy Communities, Constructability and Functionality, and Cost. Each of these major categories has been assigned a weighting which is summarized in ***Table 11***.

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Table 11
Summary of Decision Matrix Categories

Parameter	Indicators	Weighting
Natural Environment		**21%**
N1 Impact on significant natural features	Loss, displacement, disruption fragmentation of natural areas (wetlands, woodlands, terrestrial ecology, ANSI's and associated corridors).	3%
N2 Impact on ecological processes	Fragmentation of natural areas, interruption of natural linkages.	3%
N3 Impact on aquatic systems	Number of stream crossings, impact on significant fish habitat	7%
N6 Effects on green space and open space	Interference with linear green way systems.	7%
Caring and Healthy Communities		**25%**
C3 Impact on level of service	Maintains or improves level of service to the existing and future village residents.	13%
C4 Disruption to community	Compatibility with existing community character.	6%
C9 Consistency with infrastructure planning policies	Compatibility with infrastructure servicing corridors and flexibility for enhancements to land use.	6%
Constructability and Functionality		**29%**
CO2 Schedule / Staging Opportunities	Ability to phase infrastructure to facilitate development phasing	6%
CO3 Construction Risk	Conforms to geotechnical, geomorphology, hydrological	6%
CO4 Impact on existing infrastructure	Relocation of existing services (i.e. sanitary sewers, wells) and other utilities	6%
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	6%
Cost		**25%**
E9 Total 25 year life cycle cost	Cost effective life cycle costs	6%
E11 Total Capital Cost	Cost effective capital costs.	19%

Each alternative is ranked based on the criteria presented previously. The ranking values assigned to the alternatives based on the various criteria are given over a relative range from 1 to 5. The description of these rankings is presented in **Table 12**:

Table 12
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

Under this ranking system, each individual criteria is ranked relatively for each alternative. For example, for Criteria N1 (Impact on Natural Features), the 1 to 5 ranking for an individual alternative is determined based on the relative impact on the environment compared to all the other alternatives being evaluated.

7.3.2 Discussion of Preferred Option

The results of the evaluation of the three stormwater management options are contained in ***Table 13.*** Kilgour & Associates were retained to complete the evaluation of the three options for the Natural Environment criteria. A detailed evaluation of fisheries impacts for the three options is contained in ***Appendix G***.

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Table 13
Stormwater Management Evaluation

Parameter	Weighting	Option 1			Option 2			Option 3		
		Description	Score	Weighting	Description	Score	Weighting	Description	Score	Weighting
Natural Environment	**21%**									
N1 – Impact on Significant Natural Features	3%	There is no footprint of the SWM facilities on significant natural features (NESS Area 422, Significant Woodlands, Jock River corridor).	5	0.15	There is no footprint of the SWM facilities on significant natural features (NESS Area 422, Significant Woodlands, Jock River corridor).	5	0.15	There is no footprint of the SWM facilities on significant natural features (NESS Area 422, Significant Woodlands, Jock River corridor).	5	0.15
N2 – Impact on Ecological Processes	3%	There are no terrestrial corridors impacted by this option. New outlets being introduced into watercourses.	4	0.12	There are no terrestrial corridors impacted by this option. New outlets being introduced into watercourses.	4	0.12	There are no terrestrial corridors impacted by this option. New outlets being introduced into watercourses. Riparian corridors being enhanced.	5	0.15
N3 – Impact on Aquatic Systems	7%	Loss of some 3660 m^2 of indirect fish habitat; loss of some 2510 m^2 of direct fish habitat	2	0.14	Loss of some 3285 m^2 of indirect fish habitat; loss of some 177 m^2 of direct fish habitat	2	0.14	Conversion of existing indirect fish habitat to direct fish habitat, for a total gain of direct fish habitat of some 3386 m^2. Creation of new potential fish spawning habitats in outlet channel.	5	0.35
N6 – Effects on Greenspace and Open Space	7%	Less greenspace as hedgerows removed and entire lengh of Moore Tributary enclosed.	2	0.14	Less greenspace as portion of Moore Tributary (VG-R2-2) enclosed and hedgerows removed. VG-R3-1 remains open retaining existing vegetation.	3	0.21	Entire length of Moore Tributary open and hedgerow reestablished along VG-R3-2. Enhancement of tributary and SWM Pond integrared with Martin Street Pedestrian Extension	4	0.28

Caring and Healthy Communities	**25%**									
C3 – Impact on Level of Service	13%	New facilities. All options meet swm criteria and flood protection for downstream recipents.	4	0.52	New facilities. All options meet swm criteria and flood protection for downstream recipents.	4	0.14	New facilities. All options meet swm criteria and flood protection for downstream recipents.	4	0.52
C4 – Disruption to Community	6%	Village currently does not have wet pond SWM facilities. Ponds situated in development lands.	3	0.18	Village currently does not have wet pond SWM facilities. Ponds situated in development lands.	3	0.21	Village currently does not have wet pond SWM facilities. Ponds situated in development lands.	3	0.18
C9 – Consistency with Infrastructure Planning Policies	6%	Pond technology and design consistent with the City and Ministry Guidelines. Grading north of Perth Street exceeds Geotechnical recommendations.	2	0.12	Pond technology and design consistent with the City and Ministry Guidelines.	4	0.24	Pond technology and design consistent with the City and Ministry Guidelines. Location of ponds in floodplain not common but permitted under the Provincial Policy Statement based on certain criteria being met	3	0.18

Constructability and Functionality	**29%**									
CO2 – Schedule /Staging Opportunities	6%	Four ponds equally distributed to allow for ease in project phasing	4	0.24	One large centrally located facility does not provide the ease of construction phasing	3	0.18	One large centrally located facility does not provide the ease of construction phasing	3	0.18
CO3 – Construction Risk	6%	Exceeds geotechnical recommendations.	1	0.06	Exceeds geotechnical recommendations.	1	0.06	Conforms to geotechnical recommendations	5	0.30
CO4 – Impact on Existing Utilities	6%	Stormsewer outfall along Queen Charlotte and Ottawa street	2	0.12	Stormsewer outfall along Ottawa Street	3	0.18	Stormsewer outfall along Ottawa Street	3	0.18
CO5 – Disruption during Construction	6%	4 Ponds – additional pond construction over other options	2	0.12	3 Ponds with Pond 1 setback farther from existing residents	3	0.18	3 Ponds with Pond 1 situated closer to existing residents	2	0.12
CO6 – Operation and Maintenance	6%	Use of proven technology – additional pond to maintain	3	0.18	Use of proven technology	4	0.24	Use of proven technology	4	0.24
Economy	**25%**									
E9 – Total 25 year Life Cycle Costs	8%	Highest O&M costs.	2	0.12	Lower O&M than option 3	4	0.24	Lower O&M than option 1	3	0.18
E11 – Total Capital Costs	13%	Highest total capital cost	1	0.19	Lower capital cost than 1.	3	0.57	Lower capital cost than 2.	5	0.95
Total				**2.4**			**3.2**			**4.0**
Ranking				**3**			**2**			**1**

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The recommended alternative based on the criteria matrix described in ***Section 6.2.2*** was found to be Option 3, where it scored ***4.0***.

For Natural Environment Criteria, all three options received the same rating for N1 – Impact on Significant Natural Features as all ponds have been situated outside of significant woodlands and the Jock River Corridor. For the remaining criterion, the Fish Habitat Risk Assessment was relied on to assess each option. This assessment identified re-grading of the Mattamy land holdings, and the subsequent construction and operation of the SWM ponds will cause some moderate changes under Options 1 and 2, and a net gain in direct fish habitat in Option 3. Fish habitats that would be altered are generally indirect intermittent habitats or are man-made. SWM Option 3 is anticipated to provide a significant and net benefit to direct fish habitat, in association with the following aspects of the proposed design. Sections 6 and 7 of the Moore Branch will be regraded to enhance the conveyance function of the feature. That will result in a change in the status of Sections 7 and 8, which are currently classified as indirect intermittent fish habitat, to direct intermittent fish habitat. Fish will continue to be able to access Section 7 for spawning, while the improved grading is anticipated to allow larvae/fry to migrate out of the system as water levels recede over the course of the spring/summer. A French drain will be incorporated in the SWM pond design to provide cool baseflow to the lower Moore Branch, and maintain the cool-water function of that feature. The outlet channel for SWM Pond 1 will be designed to provide spring fish spawning habitat. Additional riparian plantings along the Moore Branch will enhance its ability to cool surface waters and to provide a naturalized corridor. Riparian plantings along the mainstem of the Arbuckle Drain will provide additional shade and course woody material to that feature. Option 3, with a large SWM pond in the 100-year floodplain of the Arbuckle Drain, would provide net benefits to fish habitat with up to at additional 3,386 m^2 of fish habitat created as a result of the undertaking. As such, Option 3 ranked highest for criterion N2, N3, N6.

For Caring and Healthy Communities criteria, the three options have similar ranking for the three criteria except for C9 – Consistency with Infrastructure Planning Policies. All options will meet the swm criteria established for the receiving watercourses. C4 – Disruption to Community is defined as compatibility with existing Village character. The Village does not have stormwater management so this is new infrastructure being introduced, however, all ponds are contained on future development lands. Option 2 ranked highest for C9 as it is most consistent with applicable policies.

For Constructability and Functionality, Option1 ranks the highest for CO2 – Schedule/Staging opportunities as the additional pond provides greater staging flexibility. CO3 – Construction Risk was based meeting JWL grade raise limits. Option 3 ranked highest as it conforms to the grade raise limits with Option 1 and 2 exceeding geotechnical recommendations. CO4 – Impact on Existing Utilities was defined as any new storm sewers required within existing right-of-ways. Option 1 ranked the lowest as it proposes a storm sewer along Queen Charlotte Street. Option 2 ranked highest for CO5 – Disruption during Construction as it has 3 ponds with Pond 1 situated farther away from existing residents. All options were equal for CO6 – Operations and

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Maintenance as the technology is consistent among the options and has a proven track record.

Economy represents 25% of the score. Based on a relative comparison of costs, Option 2 ranks highest for E9, Total 25 year Life Cycle Costs as it had the lowest life cycle costs. For E11, Total Capital Costs, Option 3 had the lowest costs and therefore ranked first.

Mattamy's land use concept plan produced at the December 2008 workshop was refined based on the findings and recommendations of the technical studies. The final concept plan was developed by Looney Ricks Kiss and is contained in the Richmond Concept Plan Report (February 2010). This concept plan is shown on ***Figure 14*** and reflects the preferred stormwater management option.

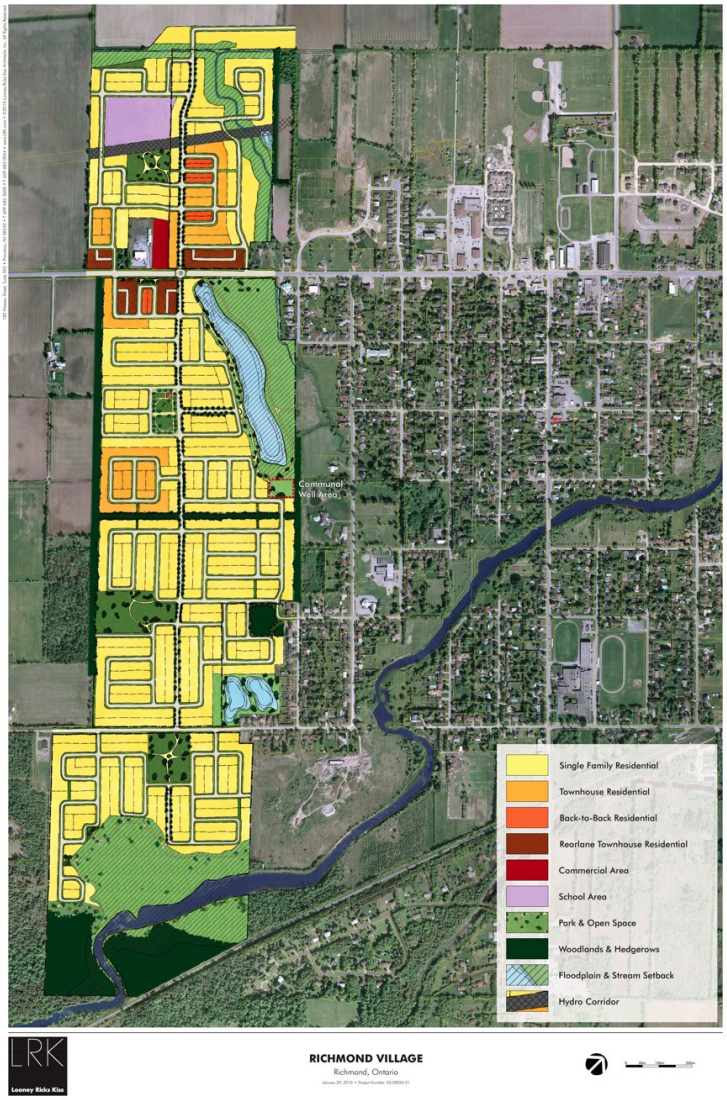

Figure 14 – Concept Plan

8.0 PRELIMINARY GRADE CONTROL PLAN

With consideration given to the volume of fill required and the geotechnical grade raise constraints as noted in ***Section 3.4,*** three grading strategies were developed were developed for the preferred stormwater management option.

- ***Option 3A*** - Design site grading with typical servicing connections per ***City Guidelines***.
- ***Option 3B*** - Design site grading to minimize cut / fill requirements through submerged pond inlets.
- ***Option 3C*** - Design site grading to minimize fill requirements through the use of sump pumps in the proposed residential units.

Option 3A, 3B, and 3C are shown on ***Preliminary Drawings 4, 5, and 6***. The results of each grading strategy are summarized in ***Table 14***.

Table 14
Grading Strategy Results

	Option 3A	Option 3B	Option 3C
Sump Pump Coverage	0	0	100%
Cut / Fill	FILL 2,492,000m^3	FILL 1,718,000m^3	CUT 81,500
Max Grade Raise	2.8m	2.5m	1.2m
Area Exceeding Geotechnical Grade Raise Recommendations	720,000m^2	580,000m^2	10,000m^2
% Total Area Exceeding Geotechnical Grade Raise Recommendations	50%	40%	0.5%
Boundary Implications	Will lose all existing hedrows. Required to Raise Perth and Ottawa Streets	Loose majority of the existing hedgerow.	Maintains all existing hedgerows. Closely matches existing surrounding Grades.

Based on the fill requirements, the Stormwater Management and Drainage Report recommended the utilization of sump pumps (Option 3c).

Drawings 5 and 7 and ***Drawings 10 and 12*** illustrate the preliminary grading plans and anticipated earthwork requirements based on separate grading strategies.

Drawing 5 and 10 illustrate the preliminary finished grades and associated earthworks quantities based on typical servicing connections per the City design guidelines.

Grades range from 97.20m to 98.87m, whereas the existing surrounding grades are between 94.50m to 96.00. Therefore, under this grading scenario (Option 3A) the finished grades are approximately 2.70m (9 feet) higher than the existing grades. Furthermore, the site requires approximately 2,500,000m^3 of earth to raise the grade to the proposed elevations. The fill requirement is not available from existing pit and quarry sources that service the Richmond area and therefore the fill would need to be imported at a premium.

Preliminary Drawings 7 and 12 illustrate a preliminary grading plan based on employing sump pumps (Option 3C) to drain the weeping tile surrounding the house. The proposed grades range from 95.00 to 96.80 which match the existing surround grades. Furthermore, as demonstrated on ***Preliminary Drawing 12***, this preliminary grading strategy produces approximately 81,500m^3 of fill. Based on this arrangement it is anticipated that at the detail design stage the site can be balanced, meaning that it will not be required to import or export fill to and from the site.

Therefore, employing sump pumps will maintain surrounding grades and enable the development to transition with the existing Village. Minimizing grading requirements will enable the integration of the hedgerows, woodlots and good specimen trees as desired by the community, Rideau Valley Conservation Authority and City staff. A 2.7m (9ft) grade raise is not compatible with maintaining Village character as set out by the Community Vision. The feasibility of obtaining the require fill requirements is questionable and the associated costs would be significant and prohibitive.

Equipping homes with sump pumps to drain the weeping tile is a common strategy employed in the City's rural area including the Village of Richmond as well as the Greater Toronto Area in the municipalities of Richmond Hill, Town of Milton, and, Oakville. The City of Ottawa Sewer Design Guidelines, Section 5.7.1, list three types of storm sewer service connection systems that are available:

- Connection to the storm sewer;
- Sump pumps;
- And/or third-pipe system with a dedicated foundation drain sewer

Figure 15 illustrates the standard detail drawing for sump pumps in the Town of Milton with two discharge options. The first shows a connection to a storm sewer and the second illustrates a discharge to the surface. A common practice employed by home owners is to connect a sump pump that discharges to the surface to the sanitary service in order to avoid water ponding outside the home. Investigations conducted by the City have found that a high number of sump pumps in Richmond are connected to the sanitary system. The high rate of extraneous flow in the sanitary system has a significant impact on the capacity and operation of the system. Any new development must prevent any opportunity for connecting to the sanitary system. Therefore, we are recommending that the sump pump be connected to a storm service.

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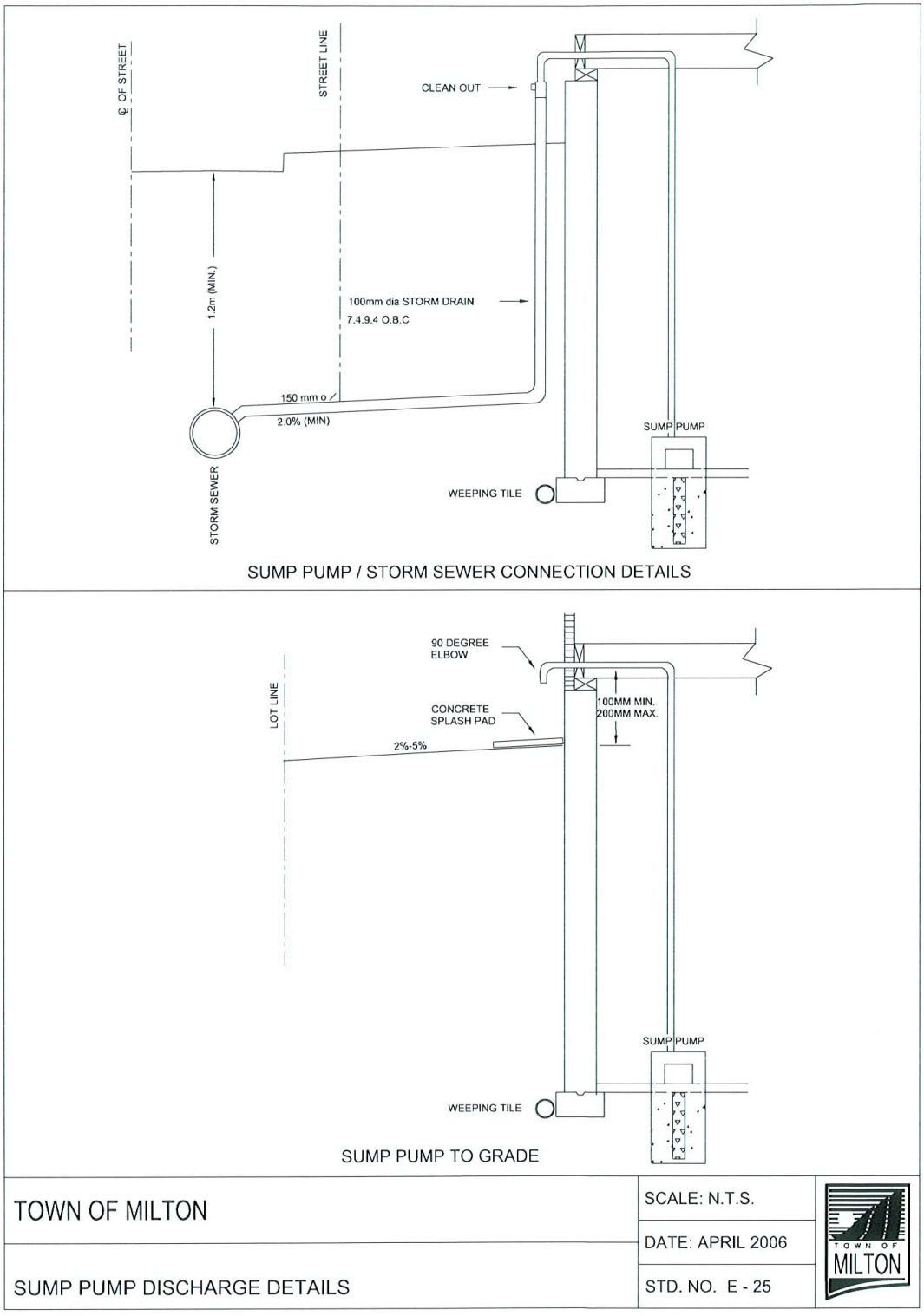

Figure 15 – Town of Milton Sump Pump

Figure 16 illustrates the proposed sump pump configuration. In this system the sump pump will be equipped with a swan neck whose elevation will be set a minimum of 0.3m

above the 100-year HGL in the storm sewer. Furthermore, backwater prevention valves are proposed at the storm service outlet and weeping tile. The elevation of the swan neck and the backwater prevention valves will provide protection to the homes during significant storm events. The water and sanitary services will be provided per City guidelines.

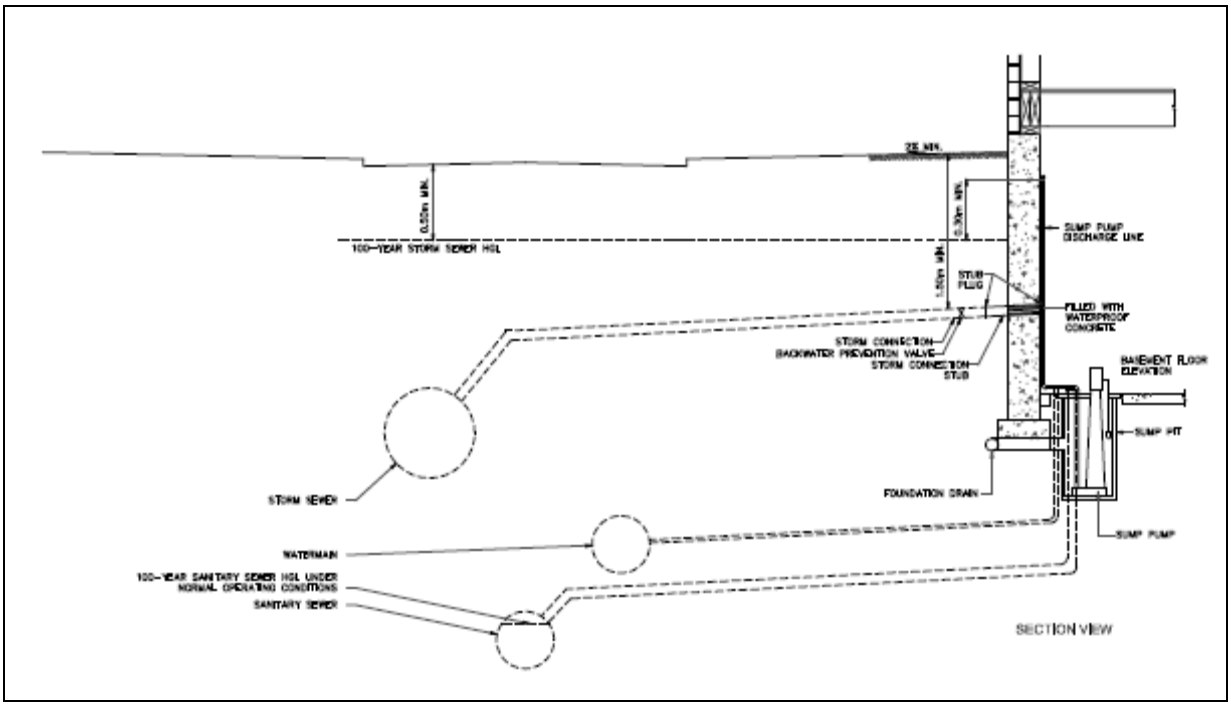

Figure 16 – Proposed Sump Pump Configuration

Additional grading detail has been investigated for Option 3C. A full sized plan has been appended to this report in ***Detail Drawings***.

The use and application of sump pumps as it relates to groundwater is being reviewed by Golder Associated Ltd., and their investigation will be submitted under separate cover as part of Mattamy's Official Plan Amendment application requirements.

Stantec Consulting Ltd. is undertaking a review of the Sanitary Sewer Hydraulic Grade Line under normal operating conditions and failure. The resulting worse case hydraulic grade line will be incorporated into the final grading design. The proposed sanitary sewer network illustrated in ***Detailed Drawing*** has been designed to ensure that the hydraulic grade line remains within the sewer.

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9.0 POST-DEVELOPMENT CONDITIONS

The following subsections describe the stormwater management plan and summarize the hydrologic and hydraulic modeling results. Complete results are contained in ***Appendix I*** along with a CD of relevant input and outlet files.

9.1 Conveyance of Minor System Flows

The Mattamy development will be serviced by a conventional storm sewer system designed in accordance with the City Standards.

The storm sewers will be sized employing the City of Ottawa IDF curves.

- Size sewers on local and collector roads to convey 5-year storm
- Size sewers on arterial roads to convey 10-year storm
- Minimum sewer size of 250mm diameter.
- Minimum full flowing velocity of 0.8m/s
- Maximum full flowing velocity of 3.0m/s
- Service laterals to be 100mm dia PVC SDR 28 with a minimum slope of 1.0%

All storm flows will be directed to a stormwater management facility, where the runoff will be treated for water quality and quantity control as noted in the SWMP Manual.

Storm drainage area drawings as well as profiles have been appended to this report. Storm sewer calculation sheets are located in ***Appendix I***.

9.2 Hydraulic Grade Line Analysis

The office of JFSA was retained to prepare a hydraulic grade line analysis based on the preliminary grade control plan and storm sewer network. The resulting hydraulic grade line is illustrated on the attached plan and profiles. A table summarizing the flow and hydraulic grade line results is included in ***Appendix I***. The analysis was completed under the following conditions:

- 100-year 4-hour Chicago Storm – Free outfall
- 100-year 24-hour SCS Storm – Free outfall
- 100-year 24-hour SCS Storm – Restrictive Downstream Conditions (Pond 1 only)

It was determined that the storm event producing the highest elevation in the storm sewer system is the 100-year 24 hour SCS design storm. Pond 2 was evaluated under free outfall conditions since the Jock River peaks well after the peak flow exits the proposed development.

The resulting 100-year 24hour SCS HGL is illustrated on the attached plan and profiles.

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9.3 Conveyance of Major System Flows

Major system runoff in excess of the minor system and up to the 100 year event will be conveyed within the road allowances via a continuous overland flow route, ultimately directed to the Pond. The major system flow will not exceed the width of the road allowance, and in no case will the depth of flow exceed 0.30 meters above the edge of pavement during a 100 year event, in accordance with the City of Ottawa. Should the major system flow exceed the conveyance capacity of any given road, the storm sewer will be sized to accommodate the flows in excess of the road capacity. The major system flow routes are illustrated on ***Detailed Drawing 1***. Major System flow North of Perth Street will be conveyed to Pond 1 through the proposed box sewer.

9.4 External Drainage

External areas that currently drain through the subject property will need to be considered in the detailed design. As illustrated on ***Preliminary Drawing 1,*** there are five locations where the external drainage that current drains through the subject property. The following outlines how each area will be conveyed under future build-out.

MAT-A and MAT-B: These areas are currently being conveyed along the existing road side ditches north and south of Perth Street. The drainage pattern will be maintained while the road cross-section remains rural. Should the right-of-way become urbanized, storm sewers will be provided to convey the external areas to the Van Gaal Drain.

MAT-C and MAT-D: The underdeveloped area currently supplies water to the existing channel referred to as the "Moore Tributary." The proposed subdivision will enhance the existing Moore Tributary to ensure that the 100-year peak flows are contained within the tributary.

MAT-E: The external area includes the existing Estate Lot subdivision that is currently serviced by the existing drainage easement outleting to the Jock River will be redirected to the enhanced Moore tributary.

9.5 SWMP Operating Characteristics

The stormwater management ponds have been designed in accordance with the requirements of the City of Ottawa and the ***SWMP Design Manual***, and include the following features:

Sediment Forebay ➢ to improve sediment removal prior to entering the pond

Permanent Pool ➢ to buffer storm flows and trap pollutants

Extended Detention Storage ➢ to provide water quality and erosion control

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Quantity Control Storage
- Demonstrate no increase in flood levels for flow directed to Van Gaal Drain (as stated in ***Section 6.2.1***), or as in the case of SWMP 2, to the free flowing capacity of the outlet sewer.

Thermal Mitigation
- Ponds discharging to the Van Gaal Drain will incorporate a low flow drain that will draw stormwater from the bottom of the main cell. The low flow drain will consist of a "French Drain" to promote contact with the cooler ground temperate.

Operation and maintenance design requirements will be addressed at the plan of subdivision stage.

9.5.1 Sediment Forebay

All wet stormwater management ponds include a sediment forebay in order to improve the pollutant removal by trapping larger particles near the inlet of the pond. The forebay should be designed with a length to width ratio of approximately 2:1 and should not exceed one third of the permanent pool surface area for wet ponds, as required in the ***SWMP Design Manual***. Furthermore, the forebay should have a minimum depth of 1.0 metre (1.5 metres preferred) to minimize the potential for re-suspension.

9.5.2 Permanent Pool

The permanent pool is approximately 1.5 metres deep, which is within the one to two metre deep range recommended in the ***SWMPDM.***

The permanent pools have been sized to provide Enhanced level of protection in accordance with the ***SWMP Design Manual***.

Table 15
Criteria for Required Storage Volumes

Pond I.D.	Drainage Area (ha)	Imp. Coverage (%)	Permanent Pool Volume [1] (m^3/ha)
1	84.67	55	190
2	45.53	53	185
3	3.28	55	190

1) Protection level for wet pond: Enhanced 80% long-term S.S. removal. ***SWMDPM*** Table 3.2 (March 2003)

The slopes in the permanent pool will be graded with side slopes of 5:1, with minor localized variations.

9.5.3 Active/Extended Detention Storage

The active detention storage has been sized based on 330L/s for erosion control for pond directing flow to the Van Gaal Drain, in accordance with the ***Geomorphology Study***. For flow directed to the Jock River active detention storage was based on the 24 hour release of runoff volume generated during the 2-year storm event. As stated in the ***SWMPDM*** (pg 3-15) the two year storm is frequently adopted as the design event for determining active storage volume because it has been found to correspond to the bankfull flow stage. Meanwhile, extended detention is provided to attenuate peak flow generated during storm events up to and including the 100-year storm event to the free flowing capacity of the outlet sewer.

Table 16
Required Storage Volumes for SWM Facilities

Pond Component	Required Volume (m^3)	Volume Provided (m^3)	Volume Ratio	Provided Elevation (m)
Pond 1 Permanent Pool(1)	12,701	48,922	3.85	92.65
Pond 1 Quality Control(2)	3,387	3,758	1.11	92.74
Pond 2 Permanent Pool(1)	6,602	17,019	2.58	93.20
Pond 2 Quality Control(2)	1,821	1,852	1.02	93.31

1) Required PP volume based on Table 15.
2) Require quality control volume based on 40 m^3/ha.

The extended detention storage should not exceed 2.0 metre depth in accordance with ***SWMPDM***.

The extended detention component has been provided with side slopes of 5:1 with minor localized variations. Side slopes of 5:1 have been applied to the pond area three metres on either side of the permanent pool water levels.

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9.5.4 SWMP Post-Development Modeling Analysis

Table 17
Summary of SWMP 1 Storage Characteristics

Pond Component	Target Outflow[(1)] (m^3/s)	Pond Inflow[(2)] (m^3/s)	Lower Elevation (m)	Upper Elevation (m)	Pond Outflow[(2)] (m^3/s)	Volume Used[(2)] (m^3)
Permanent Pool	N/A	N/A	91.15	91.65	N/A	48,922
Quality Control	0.029	N/A	92.65	92.74	0.029	3,758
2yr/24hr SCS	0.330	9.271	92.74	93.30	0.261	27,728
5yr/24hr SCS	2.133	14.811	93.30	93.36	0.644	30,738
10yr/24hr SCS	2.629	18.053	93.36	93.42	1.248	33,430
25hr/24hr SCS	3.253	21.335	93.42	93.50	2.267	36,896
50yr/24hr SCS	3.737	23.826	93.50	93.55	3.162	39,644
100yr/24hr SCS	4.258	26.599	93.55	93.61	4.174	42,448

1) Refer to Tables 15 and 16 for required permanent pool and quality control volumes. 24 hour detention time assumed for quality control volume. 2 to 100 year release rates based on pre-development flows.
2) Pond inflow taken as a direct summation of major and minor system inflows.
3) Assuming a $0.100m^2$ circular vertical quality control orifice at an invert of 92.65, a $0.074m^2$ circular vertical erosion control orifice at an invert of 92.74m and a 12.0m long quantity control weir at an invert of 93.296m.
4) Volumes used are active storage only for all pond components except the permanent pool.

Table 18
Summary of SWMP 2 Storage Characteristics

Pond Component	Target Outflow[(1)] (m^3/s)	Pond Inflow[(2)] (m^3/s)	Lower Elevation (m)	Upper Elevation (m)	Pond Outflow[(2)] (m^3/s)	Volume Used[(2)] (m^3)
Permanent Pool	N/A	N/A	91.20	93.20	N/A	17,019
Quality Control	0.018	N/A	93.20	93.31	0.018	1,852
2yr/24hr SCS	N/A	3.407	93.31	93.67	0.707	8,439
5yr/24hr SCS	N/A	5.204	93.67	93.79	1.069	11,007
10yr/24hr SCS	N/A	6.715	93.79	93.87	1.328	12,655
25hr/24hr SCS	N/A	8.684	93.87	93.96	1.661	14,709
50yr/24hr SCS	N/A	10.239	93.96	94.02	1.913	16,218
100yr/24hr SCS	2.235	12.076	94.02	94.09	2.193	17,819

1) Refer to Tables 15 and 16 for required permanent pool and quality control volumes. 24 hour detention time assumed for quality control volume. 100-year release rate based on capacity of 1500 mm outlet pipe at 0.10% slope.
2) Pond inflow taken as a direct summation of major and minor system inflows.
3) Assuming a $0.039m^2$ circular vertical quality control orifice at an invert of 93.20 m and a 1.7m long quantity control weir.
4) Volumes used are active storage only for all pond components except the permanent pool.

The impervious coverage has been estimated based on the various land uses and their respective sizes in the current plan. Please note that the final impervious coverage will up-dated at the detailed design stage based on the characteristics of the actual plan, and the pond sizing adjusted accordingly.

Preliminary pond designs including plan and cross-sections are provided in ***Detailed Drawing***.

9.5.5 Evaluation of Post-development Impact on Downstream Systems

The existing conditions model as described in ***Section 4.0*** was modified to include the proposed development, stormwater management facilities, and the proposed routing of external areas as described in ***Section 9.4***. ***Table 19*** illustrates the post-development flow rates and estimated maximum elevations in the Van Gaal Drain at key locations. Refer to ***Appendix I*** for a complete printout of flow and elevations along the Van Gaal Drain to the Jock River.

The stormwater management pond outlet rate was established in accordance with the geomorphology recommendations. Therefore, the design should not cause undue erosion in the Van Gaal Drain downstream of the development area.

Table 19
Post-development Peak Flow Rates
at Discharge locations along the Van Gaal Drain

Location	X-Sec ID	24 Hour SCS Storm[1]		10 Day Rain on Snow[2]		10 Day Rain on Snow[3]	
		Flow (m^3/s)	Elev. (m)	Flow (m^3/s)	Elev. (m)	Flow (m^3/s)	Elev. (m)
Upstream of Perth Street	1340	10.712	94.17	11.087	94.15	3.426	94.12
Downstream of Perth Street	1312	11.470	94.10	11.680	94.07	3.438	94.12
Upstream of Fortune Street	666	15.576	93.11	15.203	93.63	4.185	94.10

1. The Van Gaal Drain 100-year summer peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring flow reaches the Jock River.
3. The Jock River 100-year spring peak flow reaches the outlet of the Van Gaal Drain.

Post-development water levels at all locations along the Van Gaal Drain are either equal to or lower than pre-development elevations.

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10.0 RECOMMENDED STORMWATER MANAGEMENT SOLUTION

Option 3 is the recommended stormwater management solution to service Mattamy development. The Rideau Valley Conservation Authority has indicated that placement of the stormwater management pond in the regulatory floodplain is not encouraged and would require the proponent to demonstrate that this option is consistent with provincial policy and supported by technical, environmental and economic justification in order for this option to be considered. A rationale is provided below.

10.1 Policy Rationale

Provincial Policy Statement

Policy 3.1 Natural Hazards

Policy 3.1.1 of the Natural Hazards of the Provincial Policy Statement (PPS) states that:

Development shall generally be directed to areas outside of:

a) *Hazardous lands adjacent to the shorelines of the Great Lakes – St. Lawrence River System and large inland lakes which are impacted by flooding hazards, erosion hazards and/or dynamic beach hazards;*
b) *Hazardous lands adjacent to river, stream, and small inland lake systems which are impacted by flooding hazards and/or erosion hazards; and*
c) *Are impacted by flooding hazards and/or erosion hazards; and*
d) *Hazardous sites*

The Provincial Policy Statement defines development as:

Development: *means the creation of a new lot, a change in land use, or the construction of buildings and structures, requiring approval under the Planning Act, but does not include:*

a) Activities that create or maintain infrastructure authorized under an environmental assessment process;
b) Works subject to the Drainage Act; or,
c) For the purposes of policy 2.1.3(b), underground or surface mining of minerals or advanced exploration on mining lands in significant areas of mineral potential in Ecoregion 5E, where advanced exploration has the same meaning as under the Mining Act. Instead, those matters shall be subject to policy 2.1.4(a).

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Provincial Policy Statement

Policy 3.1 Natural Hazards

Policy 3.1.1 of the Natural Hazards of the Provincial Policy Statement (PPS) states that:

Development shall generally be directed to areas outside of:

e) Hazardous lands adjacent to the shorelines of the Great Lakes – St. Lawrence River System and large inland lakes which are impacted by flooding hazards, erosion hazards and/or dynamic beach hazards;
f) Hazardous lands adjacent to river, stream, and small inland lake systems which are impacted by flooding hazards and/or erosion hazards; and
g) Are impacted by flooding hazards and/or erosion hazards; and
h) Hazardous sites

The Provincial Policy Statement defines development as:

Development: *means the creation of a new lot, a change in land use, or the construction of buildings and structures, requiring approval under the Planning Act, but does not include:*

a) Activities that create or maintain infrastructure authorized under an environmental assessment process;
b) Works subject to the Drainage Act; or,
c) For the purposes of policy 2.1.3(b), underground or surface mining of minerals or advanced exploration on mining lands in significant areas of mineral potential in Ecoregion 5E, where advanced exploration has the same meaning as under the Mining Act. Instead, those matters shall be subject to policy 2.1.4(a).

The Provincial Policy Statement defines Infrastructure as:

Infrastructure: *means physical structures (facilities and corridors) that form the foundation for development. Infrastructure includes: sewage and water systems, septage treatment systems, waste management systems, electric power generation and transmission, communications/telecommunications, transit and transportation corridors and facilities, oil and gas pipelines and associated facilities.*

In terms of stormwater, the PPS defines stormwater as Municipal sewage services: means a sewage works within the meaning of Section 1 of the Ontario Water Resources Act that is owned and operated by a municipality.

Stormwater works (municipal sewage services) are defined as “infrastructure” under the PPS. As such infrastructure is not considered development. Activities that create infrastructure are permitted in hazard lands if authorized under an environmental assessment process.

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As per ***Section 1.2*** of this report, the preparation of this stormwater management and drainage plan are following Phases 1 and 2 of the Class Environmental Assessment Process.

The PPS also defines site alteration as:

Site Alteration: *means activities such as grading, excavation and the placement of fill that would change the landform and natural vegetative characteristics of a site.*

The definition does not include the same exemption for infrastructure that is authorized under an EA process as does the definition of development. Since the PPS specifically excludes infrastructure that has been subject to an EA process from the more general prohibition of development on hazard lands, it is implicit that the policy providing for the exemption would also apply to activities or works resulting in site alteration. As the construction of infrastructure involves site alteration, it would not be consistent to permit infrastructure authorized under an EA process but prohibit such infrastructure because it results in a site alteration.

City of Ottawa Official Plan

Section 4.8.1 of the City of Ottawa Official Plan provides policies related to floodplains. The policies distinguish between "development" and "infrastructure". Policy 3 states that the City will not permit any buildings, structures or septic systems in the floodplain regardless of the underlying designation with 3 exceptions. Policy 7 states: *All new development and infrastructure in the flood plain will be subject to the approval of the appropriate Conservation Authority, in accordance with the applicable provincial legislation.* Again, stormwater management facilities would be considered infrastructure. Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (Ontario Regulation 174/06 under Section 28 of the Conservation Authorities Act) would apply to the stormwater management pond being situated in a regulated area.

Section 4.7.3 Erosion and Prevention of Surface Water of the Official Plan states:

4. *No site alteration or development is permitted within the minimum setback, except as otherwise provided for in this section. Site alteration is defined as activities, such as fill, grading and excavation would change the landform and natural vegetative characteristics of a site. Development is defined as the creation of a new lot or the construction of buildings and structures requiring approval under the Planning Act or the issuance of a Building Permit under the Building Code Act. Exceptions to this policy are:*

   a. Activities that create or maintain infrastructure within the requirements of the environmental assessment process or works subject to the Drainage Act;

   b. Alterations necessary for recreation, environmental restoration, or slope stability works that are approved by the City and the Conservation

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Authority.

This policy is consistent with the PPS. Development is defined based on the Planning Act and Building Code Act which do not apply to stormwater management facilities. Activities that create or maintain infrastructure within the requirements of the environmental assessment process are permitted within setbacks from watercourses.

Section 3.1, Generally Permitted Uses, provides policies related to public utilities states:

9. *Public utility facilities, Ontario Power Generation Inc. facilities and Hydro One Networks Inc. facilitates that are subject to the requirements of the Environmental Assessment Act, may be permitted in all land-sue designations of this plan.*
10. *Other public utilities and municipal services and facilities are permitted in all land-use designations on Schedules A and B, except in Natural Environment Areas, Significant Wetlands South and East of the Canadian Shield, Sand and Gravel and Limestone Resource Areas, or in Flood Plains and Unstable Slopes shown on Schedule K....*
A stormwater management facility is a municipal service and so is not permitted to be located within the floodplain according to the governing OP policy. (Note: OPA 76 remains consistent with existing policy 10.)

"Public Utility" is defined in the City OP Glossary as "a public body or private corporation providing infrastructure services to the public, such as hydro, natural gas, telephone, cable, and sewer and water".

Clearly, the permitted "public utility facilities" in Policy 9 would include a stormwater management pond given the definition of "public utility". Accordingly, where such facilities are subject to the *Environmental Assessment Act* process, they are permitted as of right on all land use designations.

Policy 10 addresses "other public utilities and municipal services and facilities not subject to an *Environmental Assessment* process as outlined in Policy 9. Stormwater management facilities are subject to the MEA Class Environmental Assessment process.

The PPS and City of Ottawa Official Plan do not preclude infrastructure in the floodplain. The PPS states that the creation of infrastructure such as a stormwater management facility in the floodplain is permitted if authorized under an environmental assessment process.

Ministry of Environment SWMP Design Manual

The SWMP Design Manual states on page 4-5:

End-of-pipe SWMPs should normally be located outside of the floodplain (above the 100 year elevation). If the facility is multi-purpose in nature (e.g., providing quantity

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control in addition to quality and erosion control) it must be located above the highest design flood level. In some site-specific instances, SWMPs may be allowed in the floodplain if there is sufficient technical or economic justification and if they meet certain requirements.

A provision is made within the MOE's Stormwater Management Planning and Design Manual (SWMPDM) for the placement of SWM facilities with floodplain. It is stated under Section 4.2, Sitting of Stormwater Management Facilities that SWMPs may be allowed in the floodplain if there is sufficient technical or economic justification and if they meet certain requirements:

- The cumulative effects resulting from changes in floodplain storage and balancing cut and fill do not adversely impact existing or future development;
- Effects on corridor requirements and functional valleyland values must be assessed. SWMPs would not be allowed in the floodplain if detrimental impacts could occur to the valleyland values or corridor processes;
- The SWMPs must not affect the fluvial processes in the floodplain; and
- 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.

10.2 Technical Justification

The Arbuckle Drain floodplain presents a unique opportunity to consider locating a stormwater management pond in the regulatory floodplain.

There are three elements that make the area in question unique in the City of Ottawa. The first is how the floodplain is defined. Second, is a matter of timing; and the third is the nature the Van Gaal Drain itself.

The 2005 floodplain mapping along the Van Gaal Drain was recently revisited. The RVCA retained the office of J.F. Sabourin and Associates Ltd (JFSA) to further examine the floodplain along the Van Gaal Drain extending the regulatory mapping north of Perth Street. Floodplain mapping for the Van Gaal and Arbuckle Drain (JFSA, November 2009) was approved the RVCA Board of Directors on January 28, 2010. Both the 2004 and 2009 studies have defined the floodplain in the subject area as being a result of a 'backwater' effect from the Jock River during a spring melt event that has a probability of occurring once every 100 years.

The spring melt event producing the 'backwater' effect is an event that occurs under a condition where the ground is covered with snow and it rains intermittently over a period of ten days. The term 'backwater' refers to a scenario where the water level increases at the Jock River and begins to fill the Van Gaal Drain. Therefore, under this condition the floodplain defined along the Van Gaal Drain is not a result of water being conveyed down the drain, but rather water that is traveling up the drain from the Jock River.

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During the spring melt event the peak flow conveyed by the Van Gaal Drain occurs approximately 8.5 hours prior to encountering the peak flow in the Jock River (refer to ***Appendix G Cumulative Impact Analysis*** for details). When the Jock River peak reaches the Van Gaal Drain, the drain is flowing at a 'normal' rate. Therefore, under post-development conditions, the stormwater from the development is 'gone' by the time the area in question floods. Thus, under peak conditions, the Van Gaal Drain operates independent of the Jock River.

The high water mark along the Van Gaal Drain needs to be established during the period of time where the flow in the Jock River is not influencing the drain. It was determined that the summer event, and not the spring event, results in the highest water elevation along the Van Gaal Drain under peak conditions. It was determined that with modest improvements to the Fortune Street culvert will result in 100-year summer water elevations lower than the predicted 100-year spring elevations. See AECOM Fortune Street Culvert Analysis ***Appendix I*** for additional details. ***Detailed Drawing 6*** illustrates the resulting 100-year summer flood line.

During a 100-year 10 day rain on snow event it is anticipated that re-suspension of sediment trapped in the forebay would be minimal. Expected velocities in the forebay are anticipated to be lower than 0.15m/s since the 100-year Spring Melt event flood plain limit was established as a result of back water effects of the Jock River. Modeling will be prepared at the detailed design stage to confirm the above assumptions. Therefore, it is anticipated that the facility will continue to mitigate the effects of urbanization on the downstream receiving watercourses during winter months.

As a result of the timing of peak flow between the two watercourses, it is conceived that a pond inside the regulatory floodplain but outside the 100-year summer limit established for the Van Gaal Drain will not negatively affect the floodplain. To ensure no impact during the 100-year spring condition, the pond located between the regulatory floodplain limit and the 100-year summer limit must have a maximum water level at or below the existing ground elevations. In other words, the water in the pond cannot 'fill' the floodplain. As shown on ***Detailed Drawing 6***, the 100-year summer elevation remains below the existing ground. Thus, the floodplain storage volume is not reduced.

In summary, while the Van Gaal drain is flowing under spring conditions the high water mark in the Jock River has not been reached. The 100-year summer rain storm produces a higher flow along the Van Gaal Drain than the 100-year spring melt event, and therefore the elevations produced during this event need to be respected. Sitting a stormwater management pond between the 100-year summer limit and the regulatory flood line that has a maximum water elevation at or below the existing ground level will not negatively impact the floodplain storage volume required during the 'backwater' scenario.

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10.3 Environmental Considerations

The existing floodplain has been cleared and modified from its natural state to allow for agricultural practices. The proposed 4.97 ha SWM Pond 1 is situated south of Perth Street in the 100-year regulatory floodplain, outside the 100-year erosion limit and 100-year summer flood elevation of the Van Gaal/Arbuckle Drain. This pond will outlet to the Arbuckle Drain and be designed to attenuate post-development runoff rates to pre-development levels, while flows up to and including the 2-year event will be attenuated to the critical erosion threshold discharge rate established by Parish Geomorphic. The pond will be oriented from north-west to south-east.

The following environmental and ecological enhancement features are being proposed that will create an ecological gain in terms of aquatic habitat and function while improving the ecological corridor function of the Arbuckle Drain:

- French Drain to Convey Baseflow to Section 3 of the Moore Branch;
- Extension of riparian zone along Section 2 of the Moore Branch
- SWM Pond outlet channel and construction of fish habitat feature; and,
- Vegetating the Arbuckle Drain

A concept plan has been prepared by MMM with Kilgour & Associates which is illustrated in ***Figure 17.*** The environmental aspects of the Pond are discussed below.

Figure 17 – SWMP 1 Concept Plan

French Drain

The upper end of the Moore Branch receives cool baseflow from a tile drain, under existing conditions. It is important, from an ecological perspective, to maintain those cool baseflows to the top of Section 2 (Figure 10), maintaining cool-water habitat for fish. The proposed pond design includes a French Drain that will convey a continuous and cool "baseflow" from the south-east end of the pond to the top of Section 2 of the Moore Branch. The final design of the French Drain will be based on the notion of maintaining the existing condition.

Extension of riparian zone along Sections 2 & 3 of the Moore Branch

Section 3 of the Moore Branch has a well-developed riparian zone with mature Green Ash, Manitoba Maple, and White Elm providing canopy. Section 2 is vegetated along its lower half, but not the upper half. The riparian zone of the upper half of Section 2 will be planted with a mixture of native woody plants through the road allowance to enhance stream shading and add to the leaf litter entering the watercourse. The extended canopy will provide shade where the stream was once fully exposed to sun. The extended riparian corridor will increase the natural corridor/linkage function of the Moore Branch, connecting upper Sections of the Moore Branch to SWM Pond 1 and the Arbuckle Drain.

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SWM Pond outlet channel and construction of fish habitat feature

The proposed outlet channel will be aligned to convey storm flows directly to the Arbuckle Drain, upstream of the proposed pedestrian bridge. This feature will be designed to provide a unique marsh-wetland habitat that could be used by pike and other species for spawning in the spring.

The channel will be ~50 m long with a ~ 1-m wide low-flow channel, graded at a slope of ~0.1 to 0.3% to the Arbuckle Drain. The channel will be sinuous, based on natural channel design principles and respecting the topography, soils and flow volumes that the channel will convey. The channel bottom will be constructed with a variety of habitat features including riffles and pools, with varying substrate, and water depth, to maximize habitat diversity. Pools will be designed with boulders and root wads for cover for fish. Willow will be planted to provide a canopy to the low-flow channel. Side slopes will be graded to between 10:1 and 20:1, with 30 to 40-cm hummocks. Side slopes and hummocks will be planted with sedges *Carex* sp. and meadow grass (*Calamagrostis canadensis*) to the top of the high-flow channel (i.e., the 2-year spring event). Side slopes and hummocks will ensure a variable flooding depth of grasses and sedges, a critical component of design for the provision of fish spawning habitat. Plantings in the side slopes will also contain red osier dogwood and other shrubs to provide local diversity of vegetation and shade for the low-flow channel. In total, the side slopes will provide over 4500 m^2 of spawning fish habitat in the spring.

Pike currently use the Arbuckle Drain for spawning with spawning likely occurring in low-lying areas adjacent to the Van Gaal/Arbuckle Drain. It is anticipated that the outflow channel including the side slopes will provide additional potential spawning habitat for pike and other fishes during spring.

Vegetating the Arbuckle Drain

Mattamy proposes to provide riparian plantings along the east side of the Arbuckle Drain to provide a natural-environment enhancement as part of the overall SWM Pond design. The plantings will include native shrubs (red osier dogwood) and caliper trees (willow, maple, cedar) planted in a 5-m buffer. The trees and shrubs will provide shading to the channel, reducing channel warming that presently occurs in the reach from Perth Street to the confluence with the Moore Branch. Caliper trees and shrubs will provide additional allochthonous (woody) materials that will become food for invertebrates and fish. This riparian zone will provide a natural corridor/linkage function between the SWM pond and the upper reaches of the Van Gaal Drain (i.e., VG-R2).

Vegetating the SWM Pond

SWM Pond 1 will be 4.77 ha in size (total area inundated by 100-year event) and will include two forebays. The north and south end of the pond, as well as the east side of the pond will have elevations set such that those areas become wetland/marsh areas. The marshy areas will be ideal habitat for shorebirds, and may also be used by a variety of amphibians (frogs) and reptiles (turtles).

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Mattamy proposes to provide riparian plantings along the margin of the proposed SWM Pond including native shrubs and caliper trees. The density of the plantings will minimize access to the pond by people. A trail system is envisioned for the pond margin, with that system connected to the Martin-Street access.

The combination of marsh, open water, and riparian zone with large woody trees will provide habitat diversity that can be utilized by a variety of birds and mammals. SWM Pond 1 and associated plantings will provide an additional natural corridor/linkage function between the Moore Branch and upper Van Gaal Drain, and woodlands further to the north-west.

10.4 Economic Considerations

Policy 1.1.3, Settlement Areas, of the Provincial Policy Statement applies to the Village of Richmond and the Mattamy lands. Policy 1.1.3.1 states that Settlement Areas shall be the focus of growth and their vitality and regeneration shall be promoted. Policy 1.1.3.2 states that land use patterns within Settlement Areas shall be based on:

a) Densities and a mix of land uses which:
   1) efficiently use land and resources;
   2) are appropriate for, and efficiently use, the infrastructure and public service facilities which are planned or available, and avoid the need for their unjustified and/or uneconomical expansion; and …….

Policy 1.6.1, that *Infrastructure and Public Service Facilities* shall be provided in a coordinated, efficient and cost-effective manner to accommodate projected needs.

The City of Ottawa's Official Plan has a number of strategic principles to guide the development of the Official Plan as well as to guide day-to-day decision making.

A Creative City Rich in Heritage, Unique in Identity

- Rural development is focused on Villages, and agricultural lands and environmental features are preserved.

A City of Distinct, Livable Communities

- Livability is addressed by accommodating new growth and development in a more sustainable manner utilizing compact, mixed-use built form principles, including a moderate increase in density.

A Responsible and Responsive City

- Growth and development is accommodated in a more sustainable manner, utilizing compact, mixed-used form in appropriate locations.

Both the PPS and the City's Official Plan support the efficient use of development land in a cost-effect manner. The preferred concept plan for the future development lands along the western limit of the Village is shown on Figure 13. The current concept plan

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has approximately 30% of its land base represented by floodplains, natural features (woodlots, hedgerows) infrastructure (not including roads), parks and schools. Roadways represent 30% of the residential land area which increasing the undevelopable area of the plan to 60%.

The Arbuckle floodplain is approximately 11.3ha (28 acres). Utilization of the floodplain lands for stormwater management purposes provides a more efficient and cost effective use of the lands for residential purposes. This in turn provides the means to incorporate additional natural features and provide other community amenities into the concept plan that fulfills the community visioning principles established for the Village of Richmond.

Other Examples in the Province of Ontario

The Credit Valley Conservation Authority has approved stormwater management facilities in the floodplain. The CVCA will allow SWM Ponds between the 25 year and 100 year floodlines, on a site by site basis if can be demonstrated that there is no negative hydraulic or natural environment impacts. Environmental enhancements are welcomed under this scenario.

The Central Lake Ontario Conservation Authority (CLOCA) has also permitted stormwater management ponds in the floodplain. They would consider SWM ponds in the floodplain where it could be demonstrated that there is no impact to hydraulics and the natural environment. There are many examples in their watersheds, one being the “Gates of Whitby” subdivision on Lynde Creek in Whitby.

11.0 CONCLUSIONS AND RECOMMENDATIONS

Through the thorough review of appropriate background material, hydrologic and hydraulic analysis and evaluation of stormwater management options, it was determined that the preferred stormwater management solution for the development of Mattamy's Land is Option 3.

The preferred stormwater management scheme provides MOE Enhanced Level of TSS removal and the post-development phosphorus loading is lower than existing conditions. The ***Environmental Impact Assessment*** concluded that the selected alternative has the least potential impact on the existing fish habitat and that the preliminary design results in a net increase in direct fish habitat in approximately 3,386m^2. It has been established that the post-development peak flow does not negatively impact the downstream receiving watercourses in the storm events analyzed. Post-development infiltration enhancements are required to achieve existing conditions.

As established through the presented documentation and decision making process, Option 3 provides the greatest benefit to the subject land and the existing Village from natural, social, cultural, and economic environment perspectives.

Based on the fill requirements it is proposed to utilize sump pumps; otherwise traditional storm sewer servicing will be provided where it is economically feasible.

In addition to the above conclusions the report provides the following recommendations:

- An implementation plan will be prepared in collaboration with the Master Servicing Study for Mattamy's lands
- Additional site reconnaissance to confirm dry weather flow component of sections being modeled.
- In order to prepare a detailed design, commission an Ontario Land Surveyor to complete a detailed topography of subject lands.
- It is recommended to compare and collaborate modeling results with other consultants to ensure consistency

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This report satisfies the scope of work described in the workplan prepared by DSEL.

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