MATTAMY RICHMOND LANDS

Natural Environment & Impact Assessment Study

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EXECUTIVE SUMMARY

Mattamy Homes is proposing a mixed-residential development on its land holdings within the Village of Richmond. This document is produced in support of that development, and fulfills a number of objectives of Sections 2.4.3 of the City's Official Plan related to subwatershed and environmental management plans that address:

- Document the existing conditions of the natural environment;
- Identify the significant natural features and linkages within the study area;
- Assess the potential impacts of existing and future land-use activities;
- Delineation of creek corridor widths;
- Specific mitigation measures to protect significant features;
- Conceptual design of stormwater management scheme and creek corridor restoration and enhancement.

This report first reviews the Municipal, Provincial and Federal Policies and Regulations that are relevant to the project (Section 2). The report then describes the existing natural-environmental conditions, based on both review of existing documents, and field programs carried out in 2008 and 2009 (Section 3). A draft report on the existing conditions and impact assessment was provided to the city and local regulatory agencies in March 2009 (Kilgour and Parish, 2009). Subsequent review and consultation with the agencies led to the development of Environmental Management Guidelines that are meant to provide instruction for development within Mattamy's land holding, and which are presented in Section 4. The development concept plan which respects the Environmental Management Guidelines is presented in Section 5. The environmental impact assessment (terrestrial and aquatic; Section 6) assesses the anticipated impact on ecological resources by the proposed development concept, including the proposed stormwater management option. Section 7 describes the future study requirements that will be required as Mattamy's Richmond land holding proceed through subsequent planning approval processes. The Village of Richmond is surrounded by high quality natural features including the Richmond Fen (a Provincially Significant Wetland) to the west, and the Marlborough Forest (NESS Area 422) to the southwest. The Village core contains patches of natural vegetation including meadow, old field and woodlands. The Jock River is a high-quality riverine feature into which drains the Van Gaal/Arbuckle Drain (with headwaters in the Richmond Fen) and Marlborough Creek (with headwaters in Marlborough Forest). 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.

There are no provincially significant wetlands or ANSIs on or adjacent to the property, which is mostly rural. The wooded areas north and south of the Jock River would likely be considered as Significant Woodland under proposed changes to Ottawa's Official Plan, requiring an Environmental Impact

Statement (EIS) for development within 120 m. Significant Wildlife Habitat has not been formally identified on the property; however, two woodland pools (probably permanent) were observed which are considered significant for wildlife. There was one nationally and provincially endangered species (Butternut, *Juglans cinerea*) located in two separate locations. Of 295 vascular plant species recorded, there were four regionally significant species observed. Of 51 bird species observed or heard, all are considered provincially secure as breeders in Ontario. Nine of these species are considered to be area-sensitive and require areas of interior forest to breed. Of 12 other vertebrate species observed (amphibians, reptiles, mammals), all are considered provincially secure in Ontario. Nineteen vegetation community polygons were identified on the Mattamy lands, of which 15 are considered natural vegetation communities. These are considered provincially secure in Ontario. Areas of Communities 11, 12, 15 and/or 16 are likely 50 to 100 years old.

The majority of the headwater streams in the study area have been channelized, or ditched. This modification of channel planform has interfered with processes of water and sediment transport through the drainage network. The future management of the streams within this study area needs to account for the straightening of these channels in order for the improvement of fish habitat, water quality and geomorphic processes. The 100-year flood line covers a large portion of Mattamy's land holding southeast of Perth Street, and southeast of Ottawa Street. The meander belt for the Jock River in the vicinity of the Mattamy land holding is 180 m. The meander belt for the mainstem Van Gaal/Arbuckle Drain is 42 m, while it is 18 to 19 m for the Moore Branch, and 25 m for the Jock River Estates storm drain outlet.

The Van Gaal/Arbuckle Drain, and the Jock River Estates Drain have high total phosphorus concentrations reflecting inputs from agricultural activities. Those high concentrations have led to relatively heavy growths of aquatic plants.

The Van Gaal/Arbuckle Drain contained a relatively diverse assemblage of fish, including up to 16 species, with many considered coolwater species. Mottled sculpin were present in the Van Gaal/Arbuckle Drain, indicating coldwater, but not the Moore Branch nor the Jock River Estates Drain. The Van Gaal/Arbuckle Drain is a marginal "cool"-water stream, while the Moore Branch provides "cool" water to the Arbuckle Drain. A single young-of-year northern pike was observed in the Arbuckle Drain downstream of Perth Street, suggesting the local presence of pike spawning habitat. The confluence of the Moore Branch with the Arbuckle Drain may provide suitable pike spawning habitat. The Moore Branch is used by several species of forage fish for spring spawning. The upper reaches of the Moore Branch are ephemeral, and thus probably do not contribute significantly to the productive potential of the Van Gaal/Arbuckle Drain. The Jock River Estates Drain is used by five species of fish for spring spawning. The upper reaches of that tributary are also ephemeral, with only the most downstream ~ 200 m being fully aquatic (through to until August), and thus do not contribute significantly to the productive potential of the Jock River.

Mattamy's proposed development for the Richmond Land holding respects both Regulatory Requirements and the City of Ottawa's "Design-With-Nature" objectives. Mattamy's "Design-with-Nature" or Environmental Management Guidelines recognize regulatory constraints, as well as opportunities for utilizing or enhancing the existing natural and green-spaces that are found on the lands. Specific Environmental Management Guidelines were developed to guide the development for

Mattamy's Richmond Lands that include: the Jock River and other Watercourses, Fisheries Enhancements, Pathways and Trails, Significant Woodlands and Jock River Corridor, Local Woodlands and Hedgerows, Grading, Stormwater Management Ponds and Outlets, Water Crossings, Owner Awareness Brochures, and Tree Planting and Conservation.

A concept plan for the proposed development of the land holding respects the environmental management guidelines. The ecological function of terrestrial features will remain because the concept is protecting and integrating most of the existing small woodlands and hedgerows into the development concept. The significant woodland to the south of the property (i.e., NESS 422) and the Jock River corridor will be protected. Re-grading of the Mattamy land holdings, and the subsequent construction and operation of the SWM ponds is anticipated to have minimal impact on fish habitat within the Mattamy land holding. The proposed SWM option should produce a net increase in direct fish habitat of some ~3,386 m^2. Outlet channels from Pond 1 under this option could be designed as fish spawning habitats. A low-flow outlet channel from this pond is proposed to outlet through a cooling trench so that cool base flows are provided to the Moore Branch as per existing conditions.

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1.0 INTRODUCTION

1.1 Report Objective

Mattamy Homes is proposing a mixed-residential development on its land holdings within the Village of Richmond. This document is produced in support of that development, and fulfills a number of objectives of Sections 2.4.3 of the City's Official Plan related to subwatershed and environmental management plans that address:

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1.2 Study Area

The Village of Richmond is approximately 25 km southwest of the downtown core of the City of Ottawa. Mattamy's land holding consists of ~325 acres of land along the west side of the Village of Richmond (Figure 1). The Mattamy land holding is adjacent to the Jock River which flows in a north-easterly direction south east of the property. Mattamy's land holding is drained primarily by agricultural drains that flow into the Van Gaal Drain (known as the Arbuckle Drain from Perth Street to the Jock River) and the Jock River. The Van Gaal/Arbuckle Drain has been modified in many segments both on the Mattamy lands and in the Village of Richmond. The Jock River bisects the Village of

Richmond. The village east of the Jock River is drained primarily by the Hamilton Drain which has also been modified and straightened through some of the reaches. Flowing Creek drains into the Jock River at the northern edge of the Village of Richmond. Likewise, Flowing Creek appears to have been modified and straightened in several locations. Marlborough Creek flows through eastern portions of the Village of Richmond, connecting with the Jock River outside the Village boundary (Figure 2).

Most of the study area is actively farmed, although two large fields have been fallow recently and are reverting to meadows. Several hedgerows are found along the edges and dividing agricultural fields on the property. There is some riparian vegetation along the Van Gaal Drain and also in the central drain (Arbuckle) south of Ottawa Street. The largest natural areas on the property are found at the south end of the Mattamy lands, mainly in the floodplain to the north and south of the Jock River. The Mattamy property has the designation of "Village" on Schedule A of Ottawa's Official Plan.

There are small natural terrestrial features both on the Mattamy land holding, as well as elsewhere within the Village of Richmond. The Richmond Fen, a provincially significant wetland lies to the west of the Village, while the Marlborough Forest (NESS 422) generally lies further to the southwest of the Village with a piece falling within the Mattamy land holding.

2.0 POLICY REVIEW

2.1 Introduction

Several pieces of municipal, provincial and federal environmental policies and legislation exist to protect against natural hazards to property, and to protect wildlife in the terrestrial and aquatic environments. The major pieces of legislation and policy are reviewed in the sections below.

2.2 Provincial Legislation and Policy

The Provincial Policy Statement for *Understanding Natural Hazards* describes several constraints related to watercourses and developments. Flooding hazards include the 100-year flood limit. This is the elevation to which the 100-year flood would reach. This is to say the flood level that has the probability of occurring once every 100 years. Construction must occur outside of this flood limit to ensure the integrity of structures.

An erosion hazard refers to the loss of land that could threaten life or property. This is usually defined using the 100-year erosion rate, or the extent of bank erosion that can occur over a 100-year period. Historic aerial photographs are usually used for this purpose. There are several components considered when establishing erosion setbacks for rivers, depending on the geographic setting of the river. A toe erosion allowance is often established where the eroding bank is less than 15 m from a valley wall. The extent of the erosion setback allowance is determined based on the native soil structure as well as the severity of the bank erosion observed in the river at this location. The stable slope allowance in confined systems is defined as the setback at the top of the slope to ensure that infrastructure and developments are not affected by any slope failures. A stable slope allowance three times the height of the slope is considered the minimum setback. These setbacks are usually set through a geotechnical study. In unconfined systems, the meander belt width is of particular importance when considering appropriate setbacks for development. The meander belt width is defined as the corridor the river could potentially occupy through meander growth and migration and is usually established using the largest amplitude meander in a given reach. The meander belt width therefore defines a hazard zone of the area that could be susceptible to erosion as the river naturally meanders through the floodplain.

The Provincial Policy Statement (2005), issued under Section 3 of the *Planning Act*, promotes the long-term maintenance and enhancement of ecological functions. It prohibits development with Provincially Significant Wetlands (PSWs) and the significant habitat of Endangered and Threatened species. Development within areas such as significant woodlands, significant valleylands, significant wildlife habitat and Areas of Natural and Scientific Interest (ANSIs) is not permitted unless it has been demonstrated that no negative impact will occur on these features.

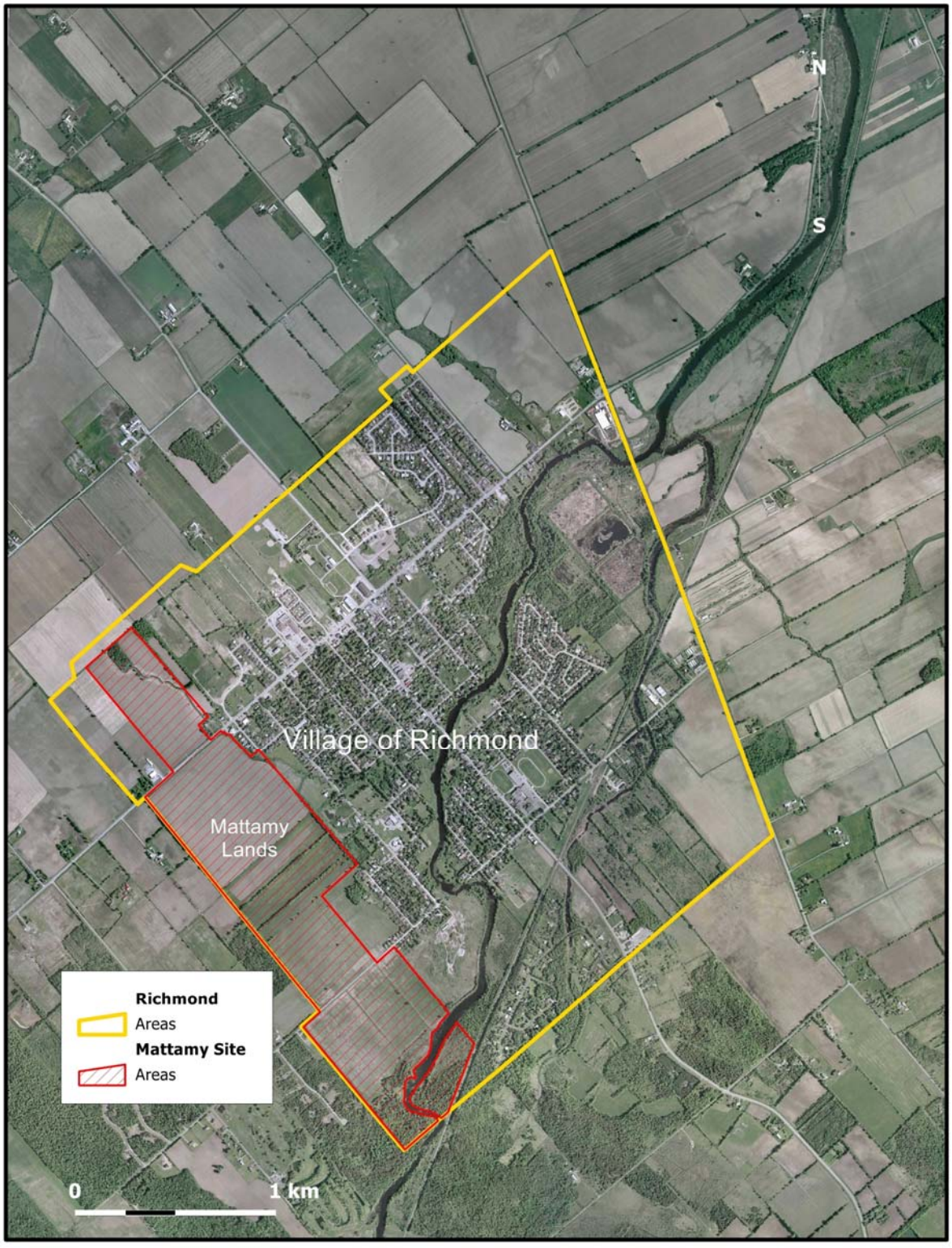


Figure 1. Village of Richmond showing the Mattamy land holding.

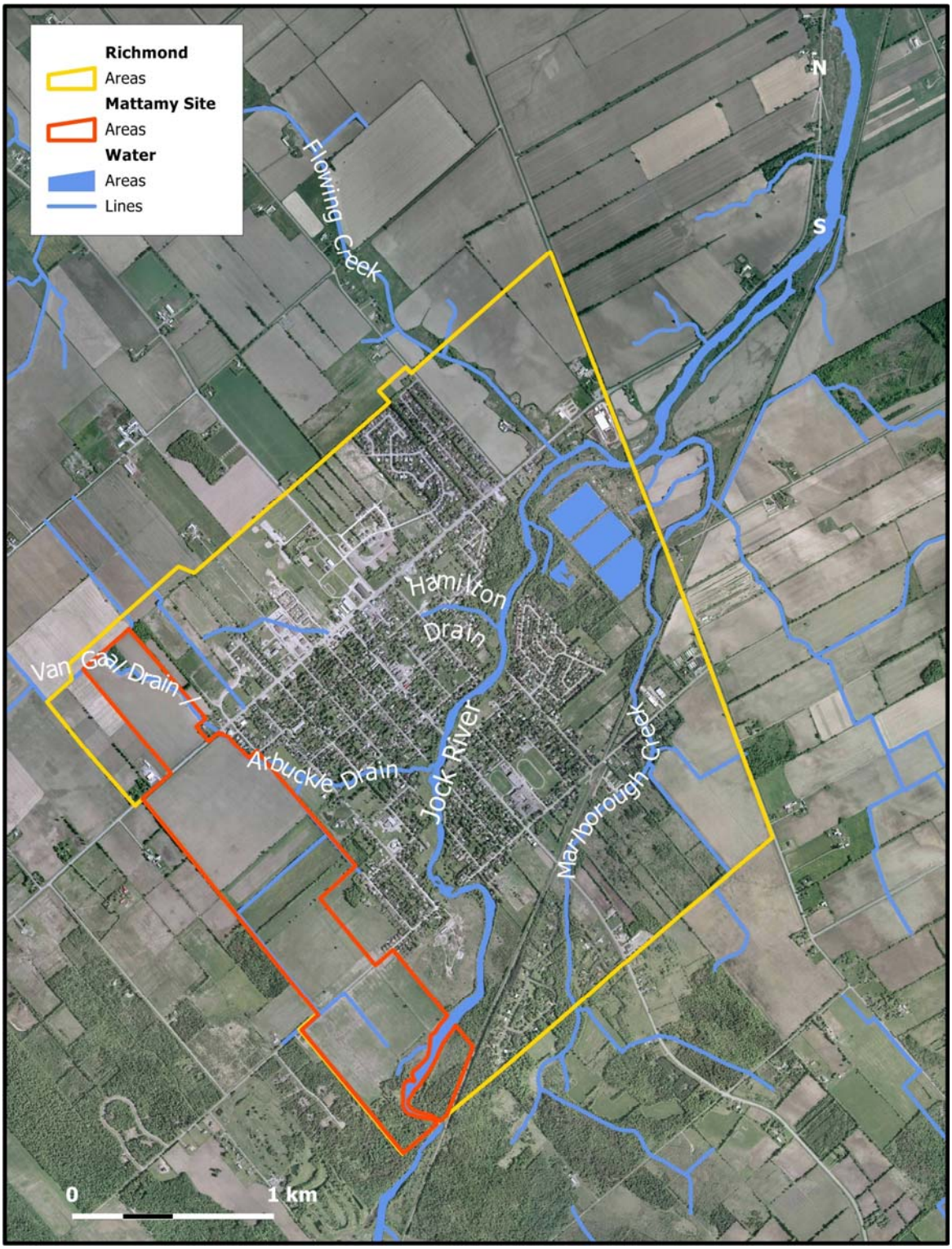


Figure 2. Map of the Village of Richmond showing regional watercourses.

The provincial *Endangered Species Act* (1971) prohibits destruction of individuals or habitats of regulated Endangered species in Ontario. However, a new Ontario Endangered Species Act was passed in 2007, which broadens protection provisions to Endangered and Threatened species as well as their habitats. Many policies surrounding this new Act are still in development and under consultation.

2.3 Municipal Legislation and Policy

Ottawa's *Official Plan* (2003) provides further specific policy related to the Natural Environment (Section 3.2). Policies regarding Significant Wetlands and Natural Environment Areas (NEAs), or areas that have been found to have a high environmental value through federal, provincial or municipal studies are outlined. These areas are mapped in Schedules A and B of the Official Plan. The City of Ottawa has also developed a *Greenspace Master Plan (*2007), which expresses the City's vision for maintaining greenspace within the urban areas and works toward developing policies to achieve them.

City Council also establishes minimum setbacks from rivers, lakes and streams through watershed, subwatershed and environmental management plans. Policy 4.7.3 – Erosion Prevention and Protection of Surface Water establishes the policies for setbacks from rivers, lakes and other watercourses such that:

> 1. Except as otherwise provided for in this section, Council will establish minimum setbacks from rivers, lakes, streams, and other watercourses in watershed, subwatershed, and environmental management plans and in these plans identify any additional studies needed to refine the setback through the development review process as well as any site-specific measures needed to protect the setback.

This report satisfies the objectives of an environmental management plan and thus will establish the setback limits for all watercourses within Mattamy land holdings through the site-specific work carried out by the consultant team in this report.

2.4 Federal Legislation and Policy

Ontario's signatory status to the federal Accord for the Protection of Species at Risk provides policy support to the federal *Species at Risk Act* (2003), which describes prohibitions that apply mainly to federally governed species (e.g., migratory birds, fish), and all species found on federal lands. Most migratory birds in Canada, including many waterfowl and songbirds, are also protected under the federal *Migratory Birds Convention Act* (1917), which provides the ability to regulate activities that may affect migratory birds while in Canada.

The *Federal Fisheries Act* (FA) provides three significant constraints that need to be respected by the Richmond development. First, Section 35 of the FA prohibits the destruction, disruption or alteration of direct or indirect fish habitat (i.e., a HADD). Direct fish habitats include watercourses directly supporting fish, while indirect fish habitats included watercourses that do not contain fish, but that

contribute water and nutrients (food) to downstream watercourses. Alterations to drains on the Mattamy land holding may be considered to be HADD's of fish habitat requiring Authorization.

Other Sections of the *Fisheries Act* may provide additional constraints to the development of the Mattamy land holdings. Section 32 of the FA prohibits the killing of fish, though a permit to kill fish can be obtained. Section 36 of the FA prohibits the deposit of a deleterious substance. Construction activities must be mitigated to prevent eroded soils from entering waterways.

3.0 EXISTING CONDITIONS ANALYSIS

3.1 Terrestrial Environment

This analysis of the terrestrial environment existing conditions utilized both literature review and field investigations, as described below.

3.1.1 Approach

3.1.1.1 Literature Review

A review of the background literature was conducted in April 2008, in order to describe the site and identify any previously documented significant features. Main literature sources included:

- Jock River Reach 2 Subwatershed Study (MMM and WESA, 2007)
- Natural Environment System Study (NESS), (Brownell et al., 1997)
- Natural Heritage Information Centre (NHIC) database (NHIC, 2008).

3.1.1.2 Field Studies

Between April and August 2008, nine field visits were made to the site by ecologists for the purpose of terrestrial study, representing over 60 person hours (Table 1). Studies focused on vegetation, breeding birds, and amphibians. All site visits were conducted by Holly Bickerton, with Tony Francis and Chris Delage also present for some visits. Observations of some terrestrial fauna were made by Chris Delage during fisheries surveys at other times.

Table 1. Field visit schedule for terrestrial-environment investigations

Date	Time	Surveyor(s)	Purpose
10-Apr	13:30-15:45	H. Bickerton, C. Delage, B. Kilgour	Site orientation; tracks, birds
22-Apr	19:15 -22:00	H. Bickerton, C. Delage	Evening survey for early breeding birds & amphibians
20-May	7:15-14:00	H. Bickerton	Early spring plants; some breeding birds
03-Jun	8:00 - 13:00	H. Bickerton, T. Francis	Early spring plants; breeding birds south of Jock River; ELC
17-Jun	7:00 - 10:00	H. Bickerton	Breeding birds, woodland sedges and late spring flora; ELC
25-Jun	7:15 - 14:00	H. Bickerton	ELC south of Ottawa St., breeding birds, flora inventory
10-Jul	7:15 - 13:45	H. Bickerton	ELC south of Ottawa St., breeding birds, flora inventory
15-Jul	7:30 - 13:00	H. Bickerton, T. Francis	ELC south of Jock River, breeding birds, flora inventory
06-Aug	10:00 - 2:00	H. Bickerton	Inventory of all hedgerows and adjacent woodlands; summer flora

3.1.1.2.1 Ecological Land Classification and Detailed Vegetation Inventory

All natural vegetation communities on the property were visited on at least two occasions through the season, with many communities visited four or more times. These areas were identified and mapped in the field to vegetation type (to the extent possible) using the methods described in Ecological Land Classification for Southern Ontario (Lee et al., 1998). This method results in a standardized description of vegetation communities, with a minimum polygon size of 0.5 ha, that gives information on dominant vegetation type and soils. Several data control points were taken for each community, and basal prism sweeps were conducted throughout each forested community to confirm species composition. Mapping of the communities within GIS was completed by Tony Francis and confirmed by Holly Bickerton. Photographs of each vegetation community were taken.

Areas adjacent to the property and those too small to be identified as a vegetation community (i.e., hedgerows, adjacent wooded areas not on Mattamy property) were also visited. This gave a general idea of their species composition, including any rare species.

During several site visits to each community throughout the season (May 20 – Aug 6), a detailed vegetation inventory of all vascular plants observed was conducted, with specimens taken for later identification where field identification was uncertain.

Species and communities of national, provincial and regional significance were determined by consulting accepted status lists and publications such as the federal Species at Risk (SARA) Registry, the Species at Risk in Ontario (SARO) List, the online database of the MNR's Natural Heritage Information Centre (NHIC), and the Vascular Plants of the City of Ottawa (Brunton, 2005), including the identification of species regarded significant within the City of Ottawa.

3.1.1.2.2 Birds

Breeding bird observations were made during eight site visits throughout the breeding season (between April 10 and July 15). Levels of breeding probability were recorded using the methods described in the Ontario Breeding Bird Atlas (Federation of Ontario Naturalists, 2001). One evening survey in early spring (April 22) was conducted to identify early breeders such as owls, American Woodcock, Common Snipe, as well as breeding amphibians. Taped recordings of songs of Saw-whet, Screech, Barred, Great Horned Owls were played in two wooded locations on the property.

Most on-site fieldwork during the breeding season was initiated in the early morning (6:30 am) in suitable weather conditions to ensure that vocalizations could be heard. Birds were identified by song and observation.

Based on the number of observations and individuals observed over the five-month field season, the relative abundance of each species recorded on the property was estimated following the end of fieldwork.

3.1.1.2.3 Amphibians and Reptiles

Surveys were made for amphibians between April 22 and July 15. One evening survey was made at dusk on April 22 to detect the calls of early spring breeding amphibians. Additional observations of amphibians were made throughout the season. In most vegetation communities, rocks were turned over to locate salamanders and smaller snakes. Wetland habitats along the shoreline of the Jock River were routinely checked for turtles during field visits.

3.1.1.2.4 Mammals

Mammal observations were limited to incidental sightings of tracks, scat, and in some cases, animals themselves. Observations were recorded from early spring (e.g., from tracks in snow and mud), through to mid-summer.

3.1.1.2.5 Significant Features

Natural areas on the property were also surveyed for features regarded as components of either significant woodland (City of London, 2000) or significant wildlife habitat (OMNR, 2000). Such additional features include: presence of old growth forest, nesting cavities, presence of woodland pools, stick nests, interior forest bird species, snake hibernacula, evidence of deer yards, and the presence of colonial breeding birds.

3.1.2 Results

3.1.2.1 Geology and Soils

The surficial geology of the site shows predominantly fine, offshore sediments of the Champlain Sea: clay, silty clay and silt (Figure 3. A small area of till plain is documented on either side of Ottawa Street at approximately the western property boundary, and an area of muck and peat lies just to its north. Near the Jock River, the older bedrock is more exposed in outcrops of limestone, dolomite, and/or sandstone (Richard, 1982).

Soil mapping shows the entire property to be poorly drained clay loam (North Gower Clay Loam) and loam (Osgoode Loam), generally level topography with slightly alkaline to neutral soils (Hills et al., 1944). Bottomland soils are found along the Jock River floodplain.

The 2003 Well Head Protection Study prepared by Golder identifies much of the City of Ottawa area as a groundwater "recharge" area, in the sense that precipitation moves downward through the ground as opposed to moving upward (discharge). The amount of discharge in a given area is a function of precipitation and the permeability of the geological materials that infiltrating precipitation must pass through.

Figure 2.17 of the 2003 report illustrates the amount of recharge that was applied to the groundwater flow model. Recharge was applied to the entire model, based on soil types. The majority of the model domain was underlain by clay, and was assigned a low recharge value of 5 mm/year. Areas underlain by till were assigned a somewhat greater recharge value of 15mm/year. The granular deposit located to the northeast of Richmond was assigned a recharge value of 200 mm/year.

The southern portion of Mattamy' lands are not a significant source of recharge to the local aquifers.

3.1.2.2 Provincially Significant Wetlands and ANSIs

No Provincially Significant Wetlands (PSWs) occur within the study area. The Rideau Valley Conservation Authority's online Wetland Information System (which uses NRVIS data) and the Jock River Reach 2 study both confirm this.

To the south and west of the study area is the Richmond Fen Provincially Significant Wetland (Figure 4). At its closest point, it is about 0.5 km upstream from the study area along the Jock River, well beyond the 120m environmental impact study trigger for development near a PSW . The Richmond Fen is a diverse wetland of fen, mixed swamp, and emergent marsh with areas of mixed and deciduous forest.

Field studies identified six wetland vegetation community types on Mattamy lands, (see below) along the shoreline of the Jock River, totalling approximately 5 ha. These are approximately 1 km from the Richmond Fen PSW and have not been identified as significant.

No Areas of Natural and Scientific Interest are found within the study area. ANSI reports for MNR Site Districts 6 to 11 and 6 to 12, the Jock River Reach 2 Study (MMM and WESA, 2007), and the NHIC website were consulted. Approximately 3 km to the northeast of the village of Richmond lays the Richmond Forest ANSI – a regionally significant upland deciduous forest.

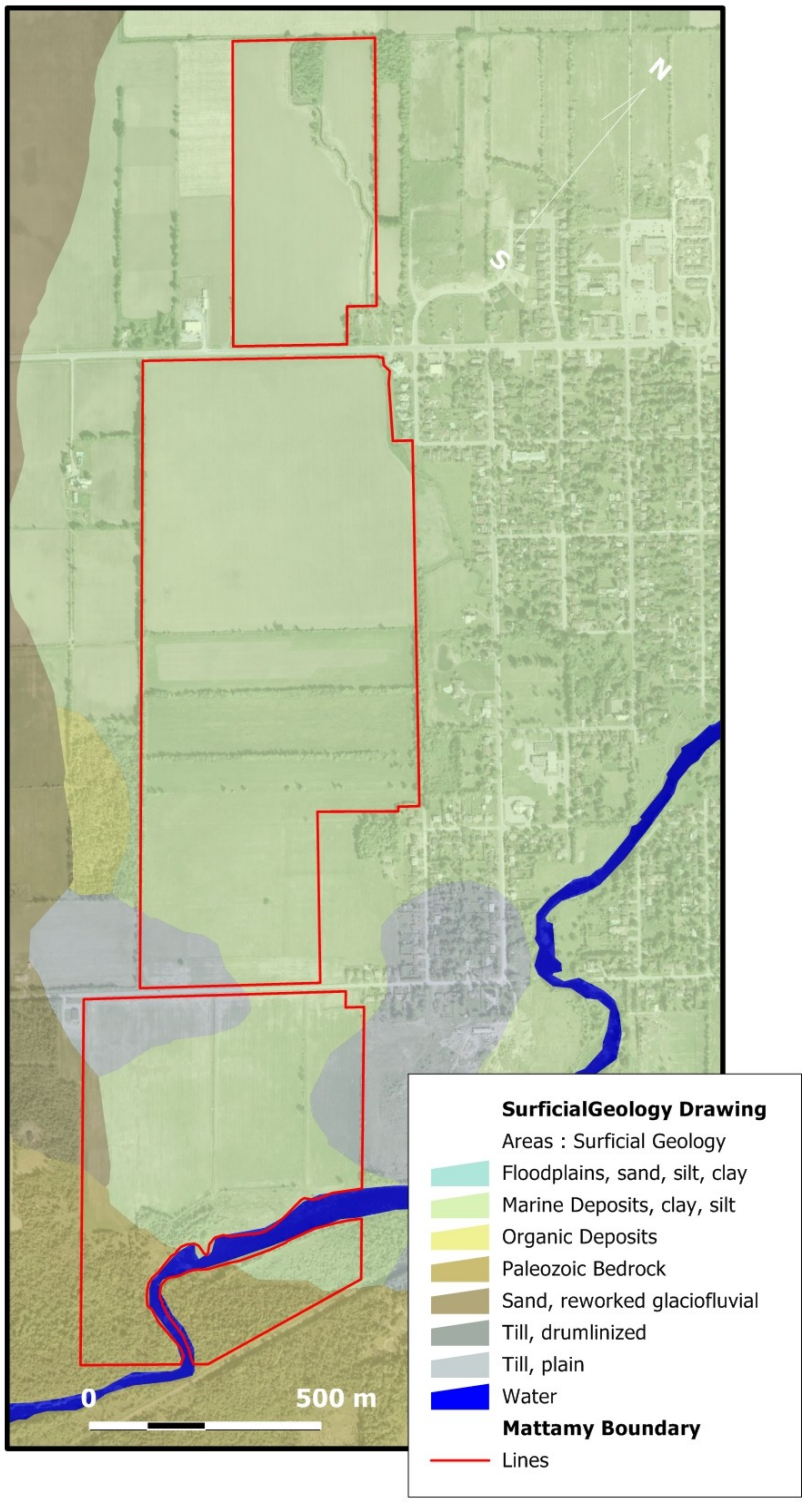


Figure 3. Map of the study area showing surficial geology.

Figure note: map data provided by the City of Ottawa (Brad Wright).

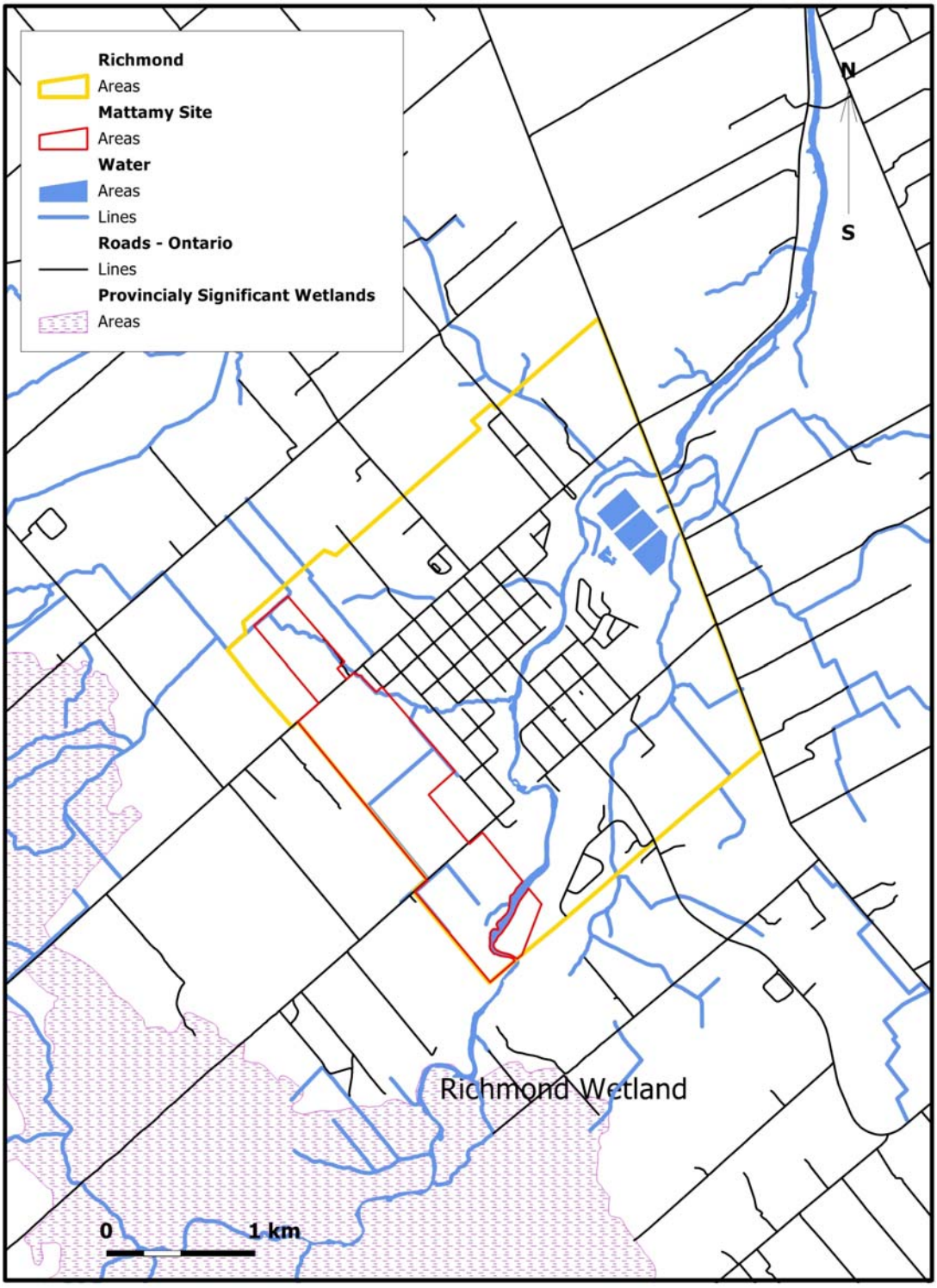


Figure 4. Map of the Village of Richmond (and surrounding area) showing the proximity of the Richmond Wetland.

Figure Note: map information obtained from MMM and WESA (2007).

3.1.2.3 Significant Woodlands

The City of Ottawa has completed their 5 year comprehensive review of the Official Plan that resulted in OPA 76 being approved by Council on June 24, 2009. A new definition of "Significant Woodlands" for the City of Ottawa was approved which is defined as contiguous woodland patches that:

- Contain mature stands 80 years of age or older, and
- Contain interior forest habitat of at least 2 ha located more than 100 m inside the edge of a forest patch, and
- Are within 5 m of a surface water feature such as a river, creek, drain, pond, or wetland.

Based on this definition, it is likely that the wooded areas north and south of the Jock River (see Communities 11, 12, 13, 15, 16 and 17) would be considered as Significant Woodlands. According to NESS data provided by the City of Ottawa (based on Forest Resource Information – FRI - mapping), this contiguous area contains mature forest between 50 and 100 years old, substantial interior forest (>100 m from the edge), while the edges of both contiguous patches are within 5 m of the Jock River.

The woodlands along the Jock River have also been identified as having ecological significance in two studies. These wooded areas (NESS Area 422, Marlborough Forest) are identified as High Value in the NESS study of 1997 (Brownell et al., 1997). The Marlborough Forest area as a whole (NESS 422) is described by author David White as one of the most significant natural areas in the former RMOC for maintaining biodiversity and ecological function, with a high representation of diverse vegetation communities, rare species, wildlife concentrations, and hydrological features. Although the remainder of NESS 422 is identified as a Rural Natural Feature on Schedule A of Ottawa's Official Plan, the study area is identified as "Village" on Schedule A.

The small wooded area north of Perth Street (Community 1; Figure 5) was not described during NESS or other studies. This area does not possess features typically used to identify areas of ecological significance (e.g.. large area, presence of interior forest, close proximity to other wooded areas, proximity to riparian areas) and does not fulfill the proposed criteria for Significant Woodlands (City of Ottawa, 2008).

Background studies showed that regional tree cover is low for the subwatershed. At present, the Subwatershed Study calculated that forests, treed swamps, and plantations occupy 17.3% of the land cover of the intensively agricultural Jock River Subwatershed (MMM and WESA, 2007). The City has a target of 30% tree cover throughout the City, and Section 4.7.2 of the Official Plan provides for protection of vegetative cover.

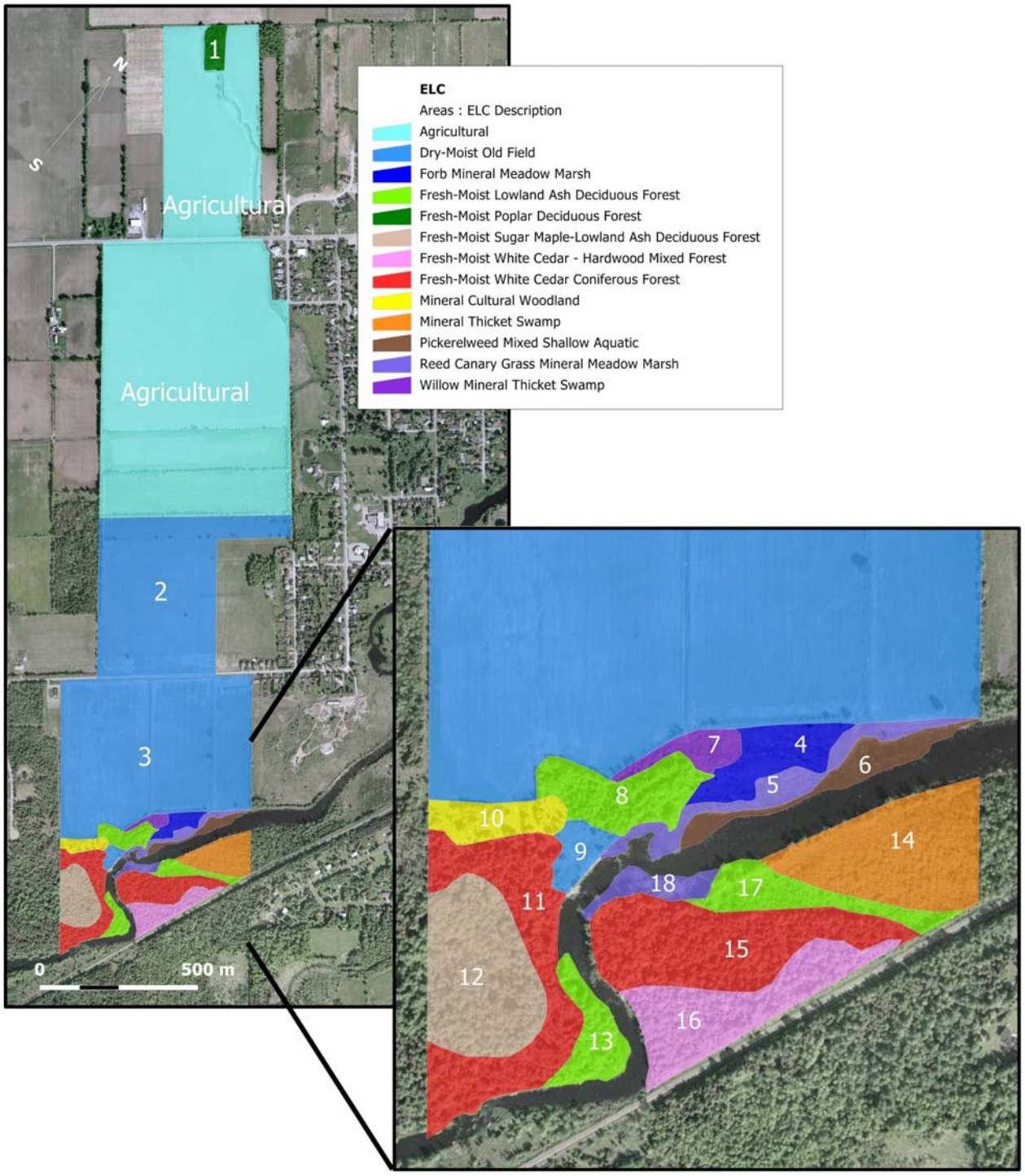


Figure 5. Ecological Land Classification, Mattamy land holding, Richmond.

3.1.2.4 Significant Wildlife Habitat

Significant Wildlife Habitat as described under the Provincial Policy Statement has not been identified or mapped by the City of Ottawa to date. No descriptions of significant wildlife habitat were found during the background literature review. However, the area was examined during field studies and results are described below.

3.1.2.5 Species at Risk

No previous site-specific field investigations for species at risk or regionally significant species were located. A broad background search for previously documented records of species at risk and rare species was completed for the general area surrounding the study site (approximately 5 km x 5 km), using the database of the Natural Heritage Information Centre (NHIC) of the Ministry of Natural Resources. Within this broad area, there were records for seven species, although none of these appear from the mapping to occur directly on the site. These are: Least Bittern (*Ixobrychus exilis*, THR[*]), Yellow Rail (*Coturnicops noveboracensis*, SC), Loggerhead Shrike (*Lanius ludovicianus*, END), Halloween Pennant (*Celithemis eponina*, a dragonfly, S3), Eastern Prairie Fringed-orchid (*Platanthera leucophaea*, END), Blanding's Turtle (THR), and Milk Snake (SC).

3.1.2.6 Vegetation Communities

Nineteen vegetation community polygons (greater than 0.5 ha) were identified on the Mattamy lands (Table 2). Of these, 15 are considered to be "natural" vegetation communities. There were nine different types of natural vegetation communities. Most natural vegetation on the property is found in the areas along the shoreline of the Jock River. All of the natural vegetation communities on the property have been identified as common and secure (S4 or S5) in Ontario (NHIC 2008; W. Bakowsky, personal communication).

Vegetation on the Mattamy lands is described below in three main sections for this large property: for the area north of Perth Street, the area between Perth Street and Ottawa Street, and finally, for the area south of Ottawa St. where most of the natural vegetation is found. Vegetation communities larger than 0.5 ha are listed approximately as they occur from north to south on the Mattamy lands, and are each assigned a community number (Figure 5). Additional information is provided on hedgerows and adjacent communities, as observed from Mattamy property.

[*] The designations given to Species at Risk are listed here in order of severity: END: Endangered; THR: Threatened; SC: Special Concern.

Table 2. Vegetation communities and provincial ranks

Community No.	Name	ELC Code	Provincial Status
1	Fresh-Moist Poplar Deciduous Forest	FOD 8-1	S5
2	Moist Old Field	CUM 1-1	not ranked
3	Dry-Fresh Old Field	CUM 1-1	not ranked
4	Forb Mineral Meadow Marsh	MAM 2-10	S4S5
5	Reed Canary Grass Mineral Meadow Marsh	MAM 2-2	S4
6	Pickerelweed Mixed Shallow Aquatic	SAM 1-1	S5
7	Willow Mineral Thicket Swamp	SWT 2-2	S5
8	Fresh-Moist Lowland Ash Deciduous Forest	FOD 7-2	S4
9	Dry-Moist Old Field	CUM 1-1	not ranked
10	Mineral Cultural Woodland	CUW	not ranked
11	Fresh-Moist White Cedar Coniferous Forest	FOC 4-1	S4
12	Fresh-Moist Sugar Maple-Lowland Ash Deciduous Forest	FOD 6-1	S5
13	Fresh-Moist Lowland Ash Deciduous Forest	FOD 7-2	S4
14	Mineral Thicket Swamp	SWT 2	not ranked
15	Fresh-Moist White Cedar Coniferous Forest	FOC 4-1	S4
16	Fresh-Moist White Cedar - Hardwood Mixed Forest	FOM 7-2	S4
17	Fresh-Moist Lowland Ash Deciduous Forest	FOD 7-2	S4
18	Reed Canary Grass Mineral Meadow Marsh	MAM 2-2	S4

3.1.2.6.1 North of Perth Street

Community 1: Fresh-Moist Poplar Deciduous Forest Type (FOD 8-1)

This small mid-successional woodland of approximately one hectare lies at the northern boundary of the Mattamy lands, north of Perth Street and just to the east of the Van Gaal Drain. This forest is almost entirely deciduous and its overstorey is dominated by a mixture of Poplar species, especially Balsam Poplar (*Populus balsamifera*) and Trembling Aspen (*Populus tremuloides*) (Appendix 1). Other common overstorey species are also characteristic of moist forests and include Green Ash (*Fraxinus pennsylvanica*), White Elm (*Ulmus americana*) and Manitoba Maple (*Acer negundo*), especially along the edges. The shrub layer includes species such as Wild Black Currant (*Ribes americanum*), Beaked Hazel (*Corylus cornuta*) and Tartarian Honeysuckle (*Lonicera tatarica*). There is a good diversity of understorey species for a woodland of such small size. Common ground flora includes Enchanter's Nightshade (*Circaea quadrisulcata*), Ostrich Fern (*Matteucia strutheriopteris* – forming a large monoculture in the centre of the community), Stellate Sedge (*Carex radiata*), White Avens (*Geum*

canadense), Dwarf Raspberry (*Rubus pubescens*). This woodland has a few regionally uncommon species such as Highbush Cranberry (*Viburnum trilobum*), Spikenard (*Aralia racemosa*) and a large area of Nodding Trillium (*Trillium cernuum*).

This community has been moderately disturbed in the past. Although vegetation is thick in places, and there are no pathways through it, there is a large area at the south end that has until recently been used as a garbage dump. A discarded pile of sheet metal was providing a den site for a coyote in May 2008. Some invasive species are present here, especially around the margins of the woodland (e.g., Tartarian Honeysuckle, European Buckthorn, and Manitoba Maple).

Hedgerow 1 (H1)

This hedgerow provides a very narrow link between Community 1 (above) with an adjacent woodland to the east, off Mattamy property. It is about 3 to 5 m wide, and provides only limited and intermittent cover for wildlife, consisting of scattered shrubs (e.g., Hawthorn, *Crataegus punctata* and Nannyberry, *Viburnum lentago*), as well as vines like Virginia Creeper (*Parthenocissus inserta*) and Riverbank Grape (*Vitis riparia*). At the east end, trees such as Green Ash (*Fraxinus pensylanica*) and White Elm (*Ulmus americana*) dominate (Appendix 1). Frequent forbs and grasses are largely non-native field species, including Smooth Brome (*Bromus inermis*), Cow Parsnip (*Pastinaca sativa*), Lamb's Quarters (*Chenopodium album*), and Orchard Grass (*Dactylis glomerata*).

Hedgerow 2 (H2)

This hedgerow links W2 (off Mattamy lands) with the Van Gaal drain. Again, it is made up of larger trees such as Green Ash (*Fraxinus pensylanica*) and White Elm (*Ulmus americana*) (Appendix 1), with an understorey composition similar to H1. This hedgerow is a maximum of about 5 m wide.

Woodland 1 (W1)

From Mattamy property, this woodland appears to be dominated by Green Ash, with some Trembling Aspen (*Populus tremuloides*), Manitoba Maple (*Acer negundo*) and scattered European Mountain Ash (*Sorbus aucuparia*) (Appendix 1). The shrub layer and understorey are dense and along the western edge, are dominated by species such as Canada Plum (*Prunus nigra*), Virginia Creeper (*Parthenocissus inserta*) and Riverbank Grape (*Vitis riparia*). This woodland is approximately 1 ha in size.

Van Gaal Drain

The Van Gaal Drain north of Perth Street consists of a thin band of mostly native riparian (wetland) vegetation, which is best characterized as a Mineral Meadow Marsh, but it is not large enough to map as such. Wetland vegetation is varied along the length of the drain but is dominated by common native wetland species, including Reed Canary Grass (*Phalaris arundinacea*), Broad-leaved Cattail (*Typha latifolia*), Burreed (*Sparganium emersum*), Fowl Manna Grass (*Glyceria striata*), Black Bulrush (*Scirpus atrovirens*), Porcupine Sedge (*Carex hystericina*), Retrorse Sedge (*Carex retrorsa*), Fox Sedge (*Carex vulpinoidea*), Jewelweed (*Impatiens capensis*), and Blue Vervain (*Verbena hastata*), with many other species present (Appendix 1). The regionally significant Water Speedwell (*Veronica anagallis-*

aquatica) occurs frequently along this section of the drain, although there is some disagreement regarding whether this species is native to Ontario (see below).

South of Perth Street, the Drain contains riparian vegetation but is much thicker and less diverse than the northern section. For example, this area is dominated by large stands of Reed Canary Grass (*Phalaris arundinacea*) and Purple Loosestrife (Lythrum salicaria), with many non-native pasture weeds (e.g., Wild Parsnip, *Pastinaca sativa*; Smooth Brome, *Bromus inermis*; Sow-thistles, *Sonchus* spp.) and some native forbs (Spotted Joe-pye Weed, *Eupatorium maculatum*; Blue Vervain (*Verbena hastata*), Jewelweed, *Impatiens capensis*; Meadowsweet, *Spiraea latifolia* ssp. *latifolia*).

3.1.2.6.2 Between Perth Street and Ottawa Street

Hedgerows and adjacent wooded areas in this predominantly agricultural area are described below, and mapped in Figure 6.

Hedgerow 3

This hedgerow is about 10 m in width and is dominated by trees >10 m in height (Appendix 1). In spring, a drain runs through the centre. Dominant trees are Bur Oak and Trembling Aspen with some Green Ash, White Elm, Largetooth Aspen, and Basswood. Common species in the shrub layer are Wild Black Currant (*Ribes americanum*), Prickly Gooseberry (*Ribes cynosbati*), European Buckthorn (*Rhamnus cathartica*), Red Raspberry (*Rubus ideaus* ssp. *strigosus*), Pussy Willow (*Salix discolor*), Manitoba Maple (*Acer negundo*), Dogwoods (*Cornus sp*.) and Hawthorns (*Crataegus sp*.). Common understorey species are mix of native and non-native species, including Field Horsetail (*Equisetum arvense*), Poison Ivy (*Toxicodendron radicans*), Cow Parsnip (*Pastinaca sativa*), Wild strawberry (*Fragaria virginiana*), (*Viola sororia* ssp. *affinis*), Small-flowered Buttercup (*Ranunuculus abortivus*), and Ground Ivy (*Glechoma hederacea*). This hedgerow is linked with other hedgerows, but not with any large natural areas, and likely functions minimally as a wildlife corridor, probably for human-tolerant species such as squirrels, raccoons, deer and coyotes.

Hedgerow 4

Just to the south of Hedgerow 3 is a similar hedgerow that is approximately the same width (10 m) but does not have a drain running through it (Appendix 1). It is also dominated by larger trees (>10 m in height) such as White Elm, Green Ash, and Manitoba Maple, and some White Birch and Balsam Poplar are also present. Common shrubs include saplings of the above, as well as young Black Cherry (*Prunus serotina*), Nannyberry (*Viburnum lentago*), Wild Black Currant (*Ribes americanum*), Red Raspberry (*Rubus ideaus ssp. strigosus*), and Hawthorn (*Crataegus chrysocarpa*). Understorey species are typical of disturbed sites and include Burdock (*Arctium minus*), Virginia Creeper (*Parthenocissus inserta*), Cow Parsnip (*Pastinaca sativa*), Field Horsetail (*Equisetum arvense*), and Corn Speedwell (*Veronica arvensis*).

Figure 6. Hedge rows and woodlands on or adjacent to the Mattamy land holding, Richmond.

Hedgerow 5

This hedgerow also consists mainly of mature trees, especially at its northern end (Appendix 1). Common species are Green Ash, some Black Ash, and Bur Oak, with some Basswood and White Birch. Shrub and ground flora species are Nannyberry (*Viburnum lentago*), Hawthorns (*Crataegus* sp.), Riverbank Grape (*Vitis riparia*), Virginia Creeper (*Parthenocissus inserta*), as well as pasture grasses and weeds.

Hedgerow 6

This is a treed hedgerow, quite wide in places (approximately 8 to 10 m) with drainage through the centre of it, mostly stagnant shallow standing water by mid-August (Appendix 1). Trees are mature, especially towards the southern end of this hedegrow, including Green Ash, Manitoba Maple, and White Elm, and a shrub layer of Hop Hornbeam, Prickly Ash (*Zanthoxylum americanum*), Hawthorns (*Crataegus sp*.), Wild Red Currant (*Ribes triste*) and Canada Plum (*Prunus nigra*). Along the edges of the hedgerow, the ground flora include field species such as Burdock (*Arctium minus*), Deadly Nightshade (*Solanum dulcamara*), Common Milkweed (*Asclepias syriaca*), Calico Aster (*Symphyotrichum lateriflorus*) and some wetland vegetation along the drainage line (e.g., Reed Canary Grass (*Phalaris arundinacea*), Narrow-leaved Cattail (*Typha angustifolia*)). Under the canopy there are shade-tolerant understorey species such as Snowberry (*Symphoricarpos albus*) Pennsylvania Sedge (*Carex pensylvanica*), Common Speedwell (*Veronica officinalis*), Enchanter's Nightshade (*Circaea quadrisulcata*) and two large patches of non-native Lily-of-the-Valley (*Convallaria majalis*). The drainage line shows signs of beaver activity and human disturbance (i.e., garbage dumping), and the alien invasive shrub, Glossy Buckthorn (*Rhamnus frangula*), is present in low numbers throughout. This hedgerow likely provides some wildlife habitat, although it does not connect any large natural areas.

Woodland 2 (W2)

The woodland was visited on 1 Sept 2009 from 15:00 to 16:00 hrs by H. Bickerton, with the following description. The woodland is just north of Ottawa St and several homes on Queen Charlotte St back onto it. It's about 1ha in area, (i.e., not very large). From one side of it, you can just see through to the backyards on the other side. Three sides of the woodland are surrounded by farm fields, currently planted in soybeans.

The woodland was a fresh-moist mixed deciduous forest community. The dominant species in the overstorey were Ash (likely White Ash), but there were also some White Elm, Bur Oak (mostly along the edges), Eastern White Cedar (a few in the northeast corner), and Trembling Aspen. The woodland contained several large trees, mostly White Ash and Bur Oaks with DBH ~18 to 24 inches. This observation matched a comment from the City of Ottawa that the woodland appeared on aerial photos from the 1940s. The shrub layer and understorey of the woodland was grown up in Manitoba Maple (*Acer negundo*[*]). Additional shrub layer species included Prickly Gooseberry (*Ribes cynosbati*), and Canada Blackberry (*Rubus canadensis*), with some European Buckthorn (*Rhamnus cathartica*[*]) seedlings and small shrubs apparent.

[*] Denotes non-native species

Ground layer plants in the woodland included: Virginia Creeper (*Parthenocissus inserta*), Lopseed (*Phryma leptostachya*), Spinulose Woodfern (*Dryopteris carthusiana*), Ebony sedge (*Carex eburnea*), Canada Wood-nettle (*Laportea canadensis*), Panicled Aster (*Symphyotrichum lanceolatum*), Frost Grape (*Vitis riparia*), Bur cucumber (*Echinocystis lobata*), Enchanter's Nightshade (*Circaea lutetiana*), Sensitive fern (*Onoclea sensibilis*), Virginia waterleaf, Fowl Manna-grass (*Glyceria striata*), Motherwort (*Leonurus cardiaca*[*]), Poison Ivy (*Rhus radicans*), Nightshade (*Solanum dulcamara*[*]), Wild strawberry (*Fragaria virginiana*), Helleborine (*Epipactis helleborine*[*]), Lady fern (*Athyrium felix-femina*), Calico Aster (*Symphyotrichum lateriflorus*), Sedges (*Carex* spp.), Avens (*Geum* sp.), Willow-herb (*Epilobium* sp.), and Violets (*Viola* sp.). From the mosses at the base of the trees, it looks as though this woodland may be quite wet during the early spring snowmelt.

Towards the southern edge of the woodland, the trees were younger (almost exclusively Manitoba Maple with some Balsam poplar, and a Hawthorn (*Crataegus* sp.). In the more open areas there were field species such as Red raspberry (*Rubus idaeus*), Wild parsnip (*Pastinaca sativa*[*]), Staghorn sumac (*Rhus typhina*), White Sweet Clover (*Melilotus alba*[*]), Yellow Goatsbeard (*Tragopogon pratensis*[*]), Canada Goldenrod (*Solidago canadensis*), Burdock (*Arctium minus**), and Tall Goldenrod (*Solidago altissima*). At the southernmost edge, the woodland graded into a dense, young thicket of Ash and Manitoba Maple, with Stinging Nettle (*Urtica dioica*[*]) in the understorey.

This area had been used for many years as a dumpsite for garbage from the agricultural field and the residential development, with old furniture, sheet metal, rolls of wire, carpets, buckets, and yard waste observed. One effect of this dumping was the dominance of an unidentified garden escape, which was common in the groundcover throughout the woodland. There were some informal footpaths through the woodland, and the southwest corner appeared to have an old foundation in it, and a small paved area, with trees now growing up through it.

The large trees and understorey still had surprisingly reasonable ecological value (mainly due to the large trees), considering the anthropogenic effects on this natural area over the years. However, this woodland feature did not meet the criteria necessary to be classified a significant woodland.

Woodland 3 (W3)

This woodland is not contained on Mattamy's property and as such was observed only from the eastern edge and is separated from the Mattamy property by a drain. It appears to have large patches of poplars, especially Large-tooth Aspen, as well as White Elm, White Birch, Bur Oak and Green Ash. Along the margin, there are shrubs and vines such as Nannyberry and Virginia Creeper.

Community 2: Moist Old Field (CUM 1-1)

Old fields or "cultural meadows" are the result of past disturbance, and often indicate farming activity or recent clearing. The large field immediately north of Ottawa Street has not been plowed in a few years, and the native vegetation characteristic of moist open areas is re-establishing. Furrows are still evident, and given the wet 2008 season, a patchy mixture of upland and wetland species (many of which are non-native) is present. For example, common species include: saplings of Manitoba maple (*Acer negundo*), Red-osier dogwood (*Cornus stolonifera*), Slender Willow (*Salix petiolaris*), Panicled Aster

(*Symphyotrichum lanceolatum*), Hairy Willow-herb (*Epilobium hirsutum*), Canada Goldenrod (*Solidago canadensis*), Narrow-leaved Goldenrod (*Euthamia graminifolia*), Common Milkweed (*Asclepias syriaca*), Purple Loosestrife (*Lythrum salicaria*), and Fox Sedge (*Carex vulpinoidea*).

3.1.2.7 Between Ottawa Street and the Jock River

The area south of Ottawa Street contains the largest area and variety of natural vegetation on the Mattamy Lands (see Figure 5).

Community 3: Dry-Fresh Old Field (CUM 1-1)

The field immediately south of Ottawa Street is also fallow, but is dominated by upland pasture weeds, such as Smooth Brome (*Bromus inermis*), Timothy (*Phleum pratense*), Sow-thistle (*Sonchus arvensis*), Ragweed (*Artemisia ambrosiifolia*), Shepherd's Purse (*Capsella bursa-pastoris*), Red clover (*Trifolium hybridum*), Small Bindweed (*Convolvulus arvensis*). There is a narrow central drain through the middle of this field, with some riparian vegetation present.

Community 4: Forb Mineral Meadow Marsh (MAM 2-10)

A meadow marsh is an area which floods seasonally, where the standing water depth is less than 2 m, and which often becomes moist or even dry by mid-summer. A large (0.78 ha) area along the northern shoreline of the Jock River consists of meadow marsh dominated by a variety of forb (herbaceous plant) species (Appendix 1). The dominant forbs here are Spotted Joe Pye-weed (*Eupatorium maculatum*), Jewelweed (*Impatiens capensis*), Tall Meadow-rue (*Thalictrum pubescens*), Purple Loosestrife (*Lythrum salicaria*), and Stinging Nettle (*Urtica dioica spp. gracilis*). Graminoids include a large patch of Sweet-flag (*Acorus americanus*), as well as Reed Canary Grass (*Phalaris arundinacea*) and Canada Bluejoint (*Calamagrostis canadensis*). Shrubs such as Slender Willow (*Salix petiolaris*), Meadowsweet (*Spiraea alba var. alba*), Gray Dogwood (*Cornus racemosa*) and Red-osier Dogwood (*Cornus stolonifera*) are also present in smaller patches throughout the community. The regionally significant Beaked Sedge (*Carex utriculata*) was found in this community.

A lightly used walking path runs through this community and small (<0.5 ha) patches can be found where the vegetation shows characteristics of drier soils, where old-field species such as Timothy (*Phleum pratense*), Cow Vetch (*Vicia cracca*) and Milkweed (*Asclepias syriaca*) dominate.

Community 5: Reed Canary-grass Mineral Meadow Marsh (MAM 2-2)

This community extends runs along the northern shoreline of the Jock River. It is dominated by Reed-canary Grass (*Phalaris arundincea),* a wetland grass (Appendix 1). The soils are mainly mineral soils, with some organic soils right along the Jock River where flooding is more frequent. Forbs (herbaceous plants) are widespread throughout most of this community. Other common species here are Spotted Joe Pye-weed (*Eupatorium maculatum*), Jewelweed (*Impatiens capensis*), Tall Meadow-rue (*Thalictrum pubescens*), Stinging Nettle (*Urtica dioica spp. gracilis*). Meadowsweet (*Spiraea alba var. alba*), and Canada Bluejoint (*Calamagrostis canadensis*). There is no visible human disturbance in this community. The regionally significant Beaked Sedge (*Carex utriculata*) was collected from this community.

Community 6: Pickerelweed Mixed Shallow Aquatic Vegetation Type (SAM 1-1)

Shallow aquatic vegetation communities occur in areas where the water depth is up to 2 m, and there is standing water present throughout the year. Along the northern shore of the Jock River is shallow aquatic vegetation with a mixture of both submerged and floating plants (Appendix 1). It is dominated by Pickerelweed (*Pontederia cordata*). Other floating and emergent plants are Bur-reed (*Sparganium eurycarpum*.), Arrowhead (*Sagittaria latifolia*), Spikerush (*Eleocharis* sp.) and Soft-stem Bulrush (*Scirpus validus*). Common floating plants include Yellow Pond-lily (*Nuphar variegatum*), European Frog's-bit (*Hydrocharis morsus-ranae*), Lesser Duckweed (*Lemna minor*) and the regionally significant Greater Duckweed (*Spirodela polyrhiza*). Common submerged plants are Coontail (*Ceratophyllum demersum*) and Common Waterweed (*Elodea canadensis*). There is little or no human disturbance in this community, although the aggressive invasive European Frog's-bit is dominant in places.

Community 7: Willow Mineral Thicket Swamp (SWT 2-2)

This thicket swamp stretches along the edge of the recently constructed berm at the south end of the agricultural fields (Appendix 1). This area is a low depression, with standing water (>0.5 m) in several locations, even in late June 2008. It is dominated by large stands of shrubby Slender Willow (*Salix petiolaris*) but also contains Gray Dogwood (*Cornus racemosa*), Meadowsweet (*Spiraea alba var. alba*) and saplings of White Elm (*Ulmus americana*). Widespread herbaceous species include: Canada Bluejoint (*Calamagrostis canadensis*), Bur-reed (*Sparganium eurycarpum*), Fowl Manna Grass (*Glyceria striata*), Reed Canary-grass (*Phalaris arundinacea*), Arrowhead (*Sagittaria latifolia*), Water Parsnip (*Sium suave*), and Bulb-bearing Water Hemlock (*Cicuta bulbifera*). This community has upland species at its northern edge, on the top of the berm ridge.

Community 8: Fresh- Moist Ash Lowland Deciduous Forest (FOD 7-2B)

This area of deciduous forest lies in moist floodplain mineral soils (Appendix 1). The dominant species present are Green Ash (*Fraxinus pennsylvanica*) with some Black Ash (*Fraxinus nigra*), White Cedar (*Thuja occidentalis*) White Elm (*Ulmus americana*) and Manitoba Maple (*Acer negundo*). The understory is similar to that in Community 12, and shows some signs of seasonal disturbance due to flooding (e.g., waterlines and scattered debris). There are signs of beaver activity (e.g., chewed stumps).

Community 9: Dry-Moist Old Field (CUM 1-1)

Along the Jock River, this old field appears to be used for recreational activities (e.g., river access for swimming, camping). Several trails converge here, and there is a large firepit and some minor dumping of garbage. The bank to a small limestone ledge along Jock River is fairly steep (~1.5 m) and the water is fast-moving with little vegetation. Non-native species dominate in this old field, including White Sweet Clover (*Melilotus alba*), Smooth Brome (*Bromus inermis*), Cow Parsnip (*Pastinaca sativa*), Timothy grass (*Phleum pratense*), Cow Vetch (*Vicia cracca*), Tall buttercup (*Ranunculus acris*), Red clover (*Trifolium pratense*) and Ox-eye Daisy (*Chrysanthemum leucanthemum*) (Appendix 1). Native species include Common Milkweed (*Asclepias syriaca*), Goldenrod (*Solidago* sp.), Philadelphia Fleabane (*Erigeron philadelphicus*) and a small patch of Fox-glove Beardtongue (*Penstemon digitalis*).

Community 10: Mineral Cultural Woodland (CUW 1)

A "cultural woodland" is a community that results from past human disturbance, such as clearing. This semi-wooded area contains relatively open (35 to 65%) tree cover, mainly of Eastern White Cedar (*Thuja occidentalis*), which occurs in patches (Appendix 1). However, many of these patches consist of dense cedars, many of them mature. The understorey in these patches is very sparse or absent, but may includes Poison Ivy (*Toxicodendron radicans*), Common Speedwell (*Veronica officinalis*) and Enchanter's Nightshade (*Circaea quadrisulcata*). In the openings between cedar patches, there are species common in old fields: Timothy (*Phleum pratense*), Smooth Brome (*Bromus inermis*), Wild Basil (*Clinopodium vulgaris*), Wild Marjoram (*Origanum vulgare*), Goldenrod (*Solidago* sp.), Meadowsweet (*Spiraea alba* var. *alba*), Staghorn Sumac (*Rhus typhina*), Ox-eye Daisy (*Chrysanthemum leucanthemum*), Graceful Sedge (*Carex gracillima*), Pale Sedge (*Carex pallescens*), and Compressed Sedge (*Carex arctata*). A large number of young White Cedar saplings suggests that this area will fill in with White Cedar over time. There is a trail that passes through clearings to the river.

Community 11: Fresh-Moist White Cedar Coniferous Forest (FOC 4-1)

A band of mature White Cedar forest extends through the western part of the study area (Appendix 1). Although large Eastern White Cedar trees (*Thuja occidentalis*) make up the predominant overstorey species, other mature tree species, mainly deciduous, are present throughout the community. These include Sugar Maple (*Acer saccharum*), Basswood (*Tilia americana*), Balsam Poplar (*Populus balsamifera*) and White Elm (*Ulmus americana*). Common in the shrub layer, which in places is quite sparse, are saplings of Red Maple (*Acer rubrum*), Sugar Maple (*Acer saccharum*), Beaked Hazel (*Corylus cornuta*), Red Elderberry (*Sambucus pubens*) and European Buckthorn (*Rhamnus cathartica*). The ground flora is varied and characteristic of rich soils. Typical of the many herbaceous species in this large area are Stellate Sedge (*Carex radiata*), Blue Cohosh (*Caulophyllum thalictroides*), Enchanter's Nightshade (*Circaea quadrisulcata*), Oak Fern (*Gymnocarpium dryopteris*), and Spinulose Woodfern (*Dryopteris carthusiana*).

A lightly used trail network passes through much of this community, causing very little disturbance. At the northern end of the community (nearest the fields), there is a small dump site with an old car and other garbage (Appendix 1). Overall, there are few non-native invasive species in this community. The invasive species of greatest concern is European Buckthorn (*Rhamnus cathartica*), but it remains at relatively low levels at this time. One provincially endangered Butternut tree (*Juglans cinerea*) occurs within this community.

Community 12: Fresh-Moist Sugar Maple – Lowland Ash Deciduous Forest (FOD 6-1)

Along the southwestern boundary of the Mattamy lands, there is a large patch of moist deciduous forest on floodplain soils (Appendix 1). Throughout most of this area, Sugar Maple (*Acer saccharum*) is the dominant overstorey species. However, smaller low-lying areas, for example at least two areas with permanent woodland pools, throughout the community are dominated by large Black Ash (*Fraxinus nigra*) trees (Appendix 1). Other common overstorey species are Basswood (*Tilia americana*) and White Elm (*Ulmus americana*). This is a mature forest, with many Sugar Maple trees throughout the area exceeding 18 inches DBH (Diameter at Breast Height). In the forest understorey were many

saplings, including Hop Hornbeam (*Ostryra virginiana*), Basswood (*Tilia americana*), Bur Oak (*Quercus macrocarpa*), Bitternut Hickory (*Carya ovata*), young Sugar Maple (*Acer saccharum*) and Ash (*Fraxinus* sp.), as well as shrubs such as Alternate-leaved Dogwood (*Cornus alternifolia*), Beaked Hazel (*Corylus cornuta*), and Red Elderberry (*Sambucus pubens*). Common ground flora were Peduncled Sedge (*Carex pedunculata*), Stellate Sedge (*Carex radiata*), Blue Cohosh (*Caulophyllum thalictroides*), Jack-in-the-Pulpit (*Arisaema triphylla*), Enchanter's Nightshade (*Circaea quadrisulcata*), Toothwort (*Cardamine diphylla*), and White Trillium (*Trillium grandiflorum*). However, wetter areas with permanent woodland pools were dominated by wetland vegetation such as Sensitive Fern (*Onoclea sensibilis*), Ostrich Fern (*Matteucia strutheriopteris*), Jewelweed (*Impatiens capensis*), Hop Sedge (*Carex lupulina*), and Bladder Sedge (*Carex intumescens*).

There is almost no human disturbance in this community. Part of the trail network extends along the western property boundary but is very lightly used. There has been some use by mountain bikes in the past, but paths and structures do not appear to have been used recently. There were very few invasive species observed within this community, and none are aggressive invaders. Songs of forest interior breeding birds such as Ovenbirds, Wood Thrushes, and Veerys were heard throughout this community, confirming that it does provide forest interior habitat for these sensitive species.

Community 13: Fresh- Moist Ash Lowland Deciduous Forest (FOD 7-2A)

A second area of low deciduous forest dominated by ash occurs along the northern shoreline of the Jock River (Appendix 1). The main species here are Green Ash (*Fraxinus pensylvanica*) with some White Elm (*Ulmus americana*), and Black Ash (*Fraxinus nigra*). Common species in the sometimes-dense understorey are Enchanter's Nightshade (*Circaea quadrisulcata*), White avens (*Geum canadense*), Stellate Sedge (*Carex radiata*), and Virginia creeper (*Parthenocissus inserta*). One provincially endangered Butternut tree (*Juglans cinerea*) occurs within this community.

3.1.2.7.1 South of the Jock River

The area south of the Jock River is almost entirely natural vegetation and because it is not easily accessible, there are few signs of disturbance. This area is considered part of the Marlborough Forest NESS area (NESS #422).

Community 14: Mineral Thicket Swamp (SWT2)

This young wetland area on mineral soils (sandy clay) is in the intermediate stages of regeneration, likely from being used as pasture. It is identified only to the broader ecosite type because its dominants are mixed throughout the community. Slender Willow (*Salix petiolaris*) and Bebb's Willow (*Salix bebbiana*) are found almost throughout, but other dominants include young saplings (<5 m in height, and often >25% cover) of Green Ash (*Fraxinus pensylvanica*), Silver Maple (*Acer saccharinum*), White Elm (*Ulmus americanus*), Balsam Poplar (*Populus balsamifera*) and Trembling Aspen (*Populus tremuloides*) (Appendix 1). Typical shrubs in this community include Speckled Alder (Alnus rugosa), Silky Dogwood (*Cornus*), Meadowsweet (*Spiraea alba* ssp. *alba*) and the non-native Glossy Buckthorn (*Rhamnus frangula*). The understorey is this community is diverse and includes mainly wetland species such as Spotted Joe Pye-weed (*Eupatorium maculatum*), Cut-leaved Bugleweed (*Lycopus americanus*), Boneset (*Eupatorium perforatum*), Turtlehead (*Chelone glabra*), Fringed Loosestrife (*Lysimachia ciliata*)

and Pink Pyrola (*Pyrola asarifolia*). Toward the railway line, some facultative and upland species enter the understorey, including Wild Strawberry (*Fragaria virginiana*), Hog Peanut (*Amphicarpa bracteata*), Narrow-leaved Goldenrod (*Euthamia graminifolia*), Tall Goldenrod (*Solidago altissima*) and Milkweed (*Asclepias syriaca*). The regionally significant Broom Sedge (*Carex scoparia*) was found in this community.

This area has had virtually no human disturbance as it regenerates. A seldom-used trail runs along the shoreline and, aside from the presence of Glossy Buckthorn, invasive species are few. In time, it will likely regenerate rapidly into an early successional deciduous swamp or possibly moist deciduous forest.

Community 15: Fresh – Moist White Cedar Coniferous Forest (FOC 4-1a)

The largest forested area south of the Jock River mainly consists of greater than 75% stand composition of mature White Cedar (*Thuja occidentalis*). In some patches, White Cedar forms dense patches almost to the exclusion of all other species, and with a very dark and sparse understorey (Appendix 1). However, most of this community is best characterized as mature White Cedar, with some large deciduous trees in the canopy and supercanopy, and a relatively diverse understorey. At low levels (<25% overall) throughout the overstorey and sapling layers are deciduous species such as Sugar Maple, Basswood, White Elm and Ironwood, and in very small pockets (much less than 0.5 ha), these may even dominate. The sparse shrub layer consists of deciduous saplings of the above species, and also species such as Red Elderberry (*Sambucus pubens*) and Alternate-leaved Dogwood (*Cornus alternifolia*). Species common in the groundcover layer include Poison Ivy (*Toxicodendron radicans*), Enchanter's Nightshade (*Circaea quadrisulcata*), Sweet Cicely (*Osmorhiza claytonii*), Bulblet Fern (*Cystopteris bulbifera*) and Common Speedwell (*Veronica officinalis*).

Community 16: Fresh – Moist White Cedar – Hardwood Mixed Forest (FOM 7-2)

This forest polygon is separated from the adjacent conifer forest polygon because it has greater than 25% stand composition of deciduous tree species, and is therefore considered to be a mixed forest (Appendix 1). The main deciduous species in the canopy here is Sugar Maple (*Acer saccharum*), but also common are Ironwood, Basswood, and some Black Cherry (*Prunus serotina*). This area is drier overall than the White Cedar Coniferous Forest described above. The shrub layer and understorey contain species including the ones described for the coniferous forest, but in areas some species more characteristic of upland deciduous forests appear, such as White Trillium (*Trillium grandiflorum*), Red Baneberry (*Actaea rubra*), Rolled-up Sedge (*Carex rosea*), Peduncled Sedge (*Carex pedunculata*), Canada Mayflower (*Maianthemum canadense*) and Blue Cohosh (*Caulophyllum thalictroides*).

Community 17: Fresh – Moist Ash Lowland Deciduous Forest (FOD 7-2)

This very moist forest borders directly on the thicket swamp and demonstrates gradational change between upland and wetland. The dominant overstorey species in this community is Green Ash (*Fraxinus pennsylvanica*), but poplars (Balsam Poplar and Trembling Aspen) and White Birch are also common (Appendix 1). Understorey species include Black Currant (*Ribes americanum*), Common Speedwell (*Veronica officinalis*), Tall Goldenrod (*Solidago altissima*), Virginia Creeper (*Parthenocissus*

inserta), Ox-eye Daisy (*Chrysanthemum leucanthemum*) and Wild Grape (*Vitis riparia*). The community is similar to, although younger than, those shown in Appendix 1.

Community 18: Reed Canary-grass Mineral Meadow Marsh (MAM 2-2)

The shoreline meadow marsh dominated by Reed Canary Grass (*Phalaris arundinacea*) is also present in a narrow band along the south shore of the Jock River (Appendix 1). The community composition is very similar to the community on the opposite (north) shore, with commonly occurring species including Broad-leaved Cattail (*Typha latifolia*), Canada Bluejoint (*Calamagrostis canadensis*) and Spotted Joe-Pye Weed (*Eupatorium maculatum*), Swamp Meadow Grass (*Poa palustris*), Black Bulrush (*Scirpus atrovirens*), Woolgrass (*Scirpus cyperinus*), Marsh Vetchling (*Lathyrus palustris*), Hog Peanut (*Amphicarpa bracteata*), and Cow Vetch (*Vicia cracca*).

3.1.2.8 Vegetation inventory

A total of 295 vascular plant species were identified on the Mattamy lands between May and August of 2008. Of these, four were regionally significant and one was provincially significant and endangered (Appendix 2). These will be discussed below. Approximately 77% of the plant species recorded on Mattamy lands are native species, which is relatively high considering the large area with past agricultural use. The high diversity reflects the variety of natural communities on the site (woodland, marsh, swamp), and the relatively undisturbed nature of the southern wooded areas.

3.1.2.9 Breeding Birds

During surveys between March and August 2008, 51 bird species were identified on the Mattamy lands, and another three species were identified just off the property (i.e., less than 100 m) and likely also use the area (Appendix 3). Twenty-four of these species were identified as probable breeders, mainly by the presence of singing males in suitable habitat. Another twenty species probably breed on Mattamy lands, i.e., breeding pairs, courtship displays, or frequent territorial singing were observed. The remaining seven species were observed on the property but were not necessarily displaying breeding behaviours. At a minimum, these species probably use the property for feeding or shelter.

All fifty-one bird species observed on Mattamy lands are regarded as common breeders in Ontario (NHIC, 2008).

3.1.2.10 Amphibians and Reptiles

Six amphibian species were observed or heard on the site (Appendix 4). Of these, five species were widespread and/or abundant on the property (American Toad, Bullfrog, Green Frog, Northern Leopard Frog, Spring Peeper). Only Wood Frogs were infrequently heard along the northern shoreline of the Jock River in early spring. One reptile species, an Eastern Garter Snake, was observed on two separate field visits. All species are common in Ontario (NHIC, 2008).

3.1.2.11 Mammals

Five mammal species (or their signs) were observed on the site during field visits between March and August (Appendix 4). White-tailed deer were observed on three separate occasions and likely breed

on or near the property, as one observation was a young fawn. A coyote was startled, possibly from its den, on the edge of the woodland north of Perth Street in early spring, and coyote scat was found nearby on a separate occasion. Beavers likely use the area near the Jock River, where characteristic chewed tree stumps were found. One Eastern Cottontail Rabbit was observed on the property, and Raccoon tracks were found in two locations. Both of these species likely use, and may even breed on the property. All species observed are common in Ontario.

3.1.2.12 Species at Risk and Regionally Significant Species

One provincial species at risk was located on the Mattamy property. Two **Butternut** (*Juglans cinerea*) trees were found in two separate locations (Figure 7). Butternut is a formerly widespread tree that has been affected by Butternut Canker, which has greatly reduced its population throughout eastern North America. Two older trees in two separate locations were in fair condition (>50% of crown remaining) but with many dead branches and some canker at the base of the tree.

Four regionally significant plant species (having fewer than 10 records) for the City of Ottawa (Brunton 2005) were located in the study area (Appendix 2). These are:

- **Large Duckweed** (*Spirodela polyrhiza*) is a floating plant that occurs along the shoreline of the Jock River within Community 6.
- **Water Speedwell** (*Veronica anagallis-aquatica*) is a purple-flowered wetland plant in the Figwort or Snapdragon family, and it grows in the channel of the Van Gaal Drain north of Perth Street. This species is taxonomically problematic and there is some disagreement whether it is native to Ontario or not (Brunton 2005; Newmaster *et al.*, 1998)
- **Beaked Sedge** (*Carex utriculata*) is a wetland sedge that was found in the marsh communities (4 and 5) along the north shore of the Jock River.
- **Broom Sedge** (*Carex scoparia*) is another wetland sedge found on the south side of the Jock River in Community 14, a willow thicket swamp.

None of the fauna species recorded at the site are nationally, provincially or regionally rare or at-risk.

Field studies confirmed that there is no suitable habitat on the property for at least four of the seven species at risk identified in the area from the area by the Natural Heritage Information Centre. Least Bittern and Yellow Rail require extensive areas of interior wetland habitat, with very specific structural requirements. The riparian wetland habitat along the Jock River is too small for these area-sensitive species. Loggerhead Shrikes require open, short grass pasture (i.e., not cropped fields) with scattered shrubs and small trees (e.g., red cedar or hawthorn), and this highly specific habitat is not present on the site. The endangered Eastern Prairie Fringed-orchid requires open calcareous fen habitat that is not present along the Jock River.

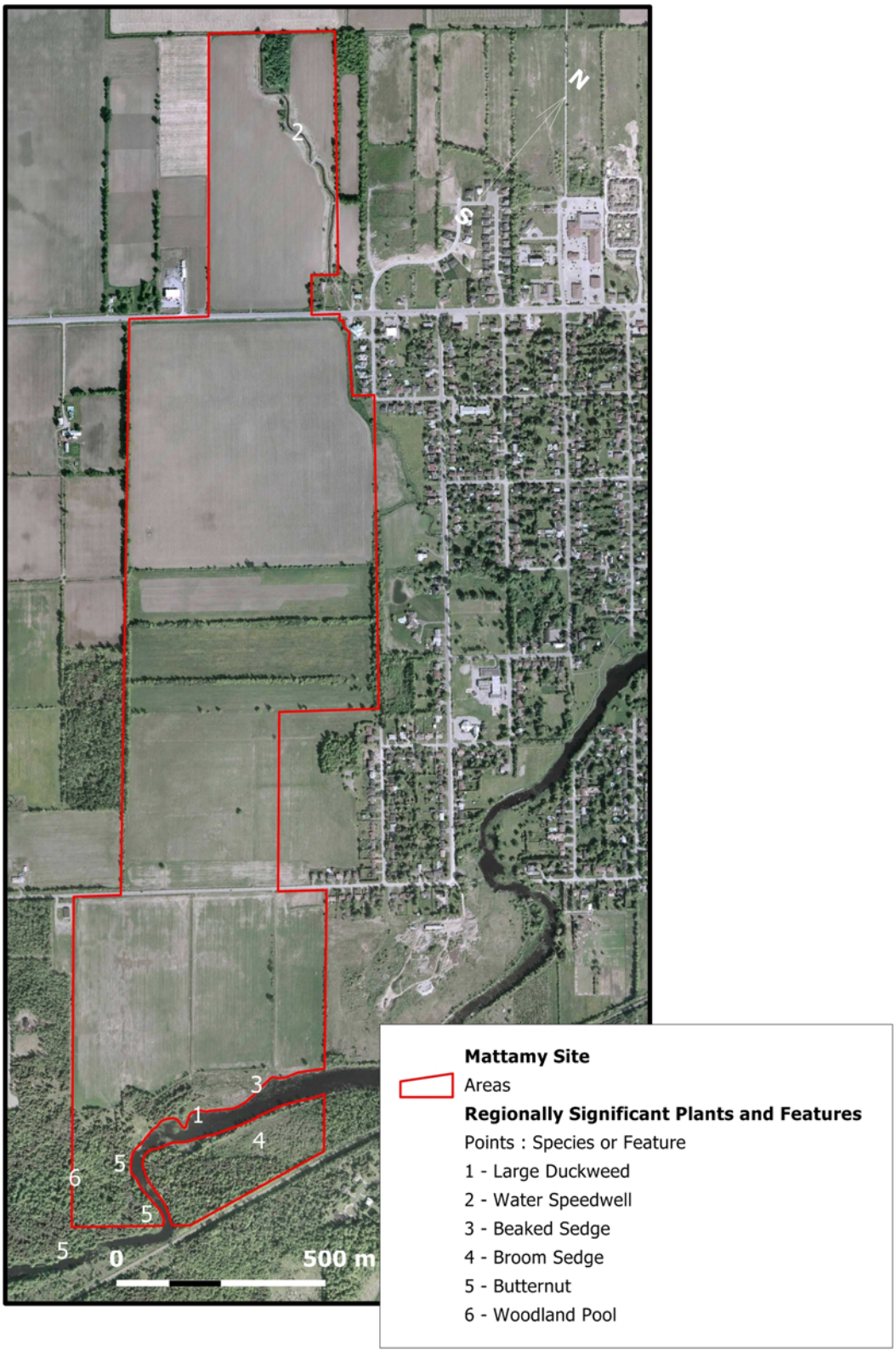


Figure 7. Regionally significant plants and features, Mattamy land holding, Richmond.

The three other species were not observed, but suitable habitat may exist on the site. It is possible that Blanding's Turtles may be present in the Jock River system, although none were observed. Similarly, no Milksnakes were observed, although habitat may be suitable. The Halloween Pennant (an orange and black dragonfly) was recorded about 2km northeast of the study site and requires meadow and pond habitat, but none were observed during field studies.

3.1.2.13 Significant Features

3.1.2.13.1 Interior forest birds

The presence of interior forest is regarded as a component of significant woodlands and significant wildlife habitat. Nine bird species that have been characterized by Bird Studies Canada as area-sensitive (i.e., requiring interior forest habitat) were observed on the property (Couturier, 1999). Five of these species (Black-and-white Warbler, Black-throated Green Warbler, Ovenbird, Veery, Woodthrush) were relatively common in the forested areas on the north side of the Jock River (Communities 11, 12 and 13). In addition to these species, White-throated Sparrows and Alder Flycatchers were also on the south side of the Jock River (Communities 14 to 18).

The Subwatershed Study (MMM and WESA, 2007) identified an area of interior forest habitat for area-sensitive breeding birds, roughly aligning with Communities 11 and 12 (Figure 8), just to the south of Mattamy lands. However, because of the size, low level of human disturbance, and probable or possible breeding presence of several interior bird species, all areas of Communities 11 to 18 that are greater than 100 m from a forest edge should be considered as *functional* interior forest habitat.

The small 1 ha poplar woodland (Community 1) at the north end of the property had a very low diversity of breeding birds. Only one species that requires interior forest (Least Flycatcher) was present and probably breeding here. Red-tailed hawks were observed twice on the property, possibly roosting on the edge of Community 1.

3.1.2.13.2 Woodland pools

Woodland pools provide important breeding habitat for woodland amphibians, including many species of salamander and woodland frogs such as spring peepers, woodfrogs, and gray treefrogs. They are regarded as one component of significant wildlife habitat (OMNR 2000). Two woodland pools were found within Community 12 (Figure 7), although it is possible that other small pools exist. Both were filled with water in mid-June, although the spring and summer of 2008 were unusually wet.

No other components of significant wildlife habitat were observed. Nesting cavities were not observed, although they may be present in the older forested areas on the property. No stick nests, deer yards, snake hibernacula, or breeding bird colonies were observed during fieldwork.

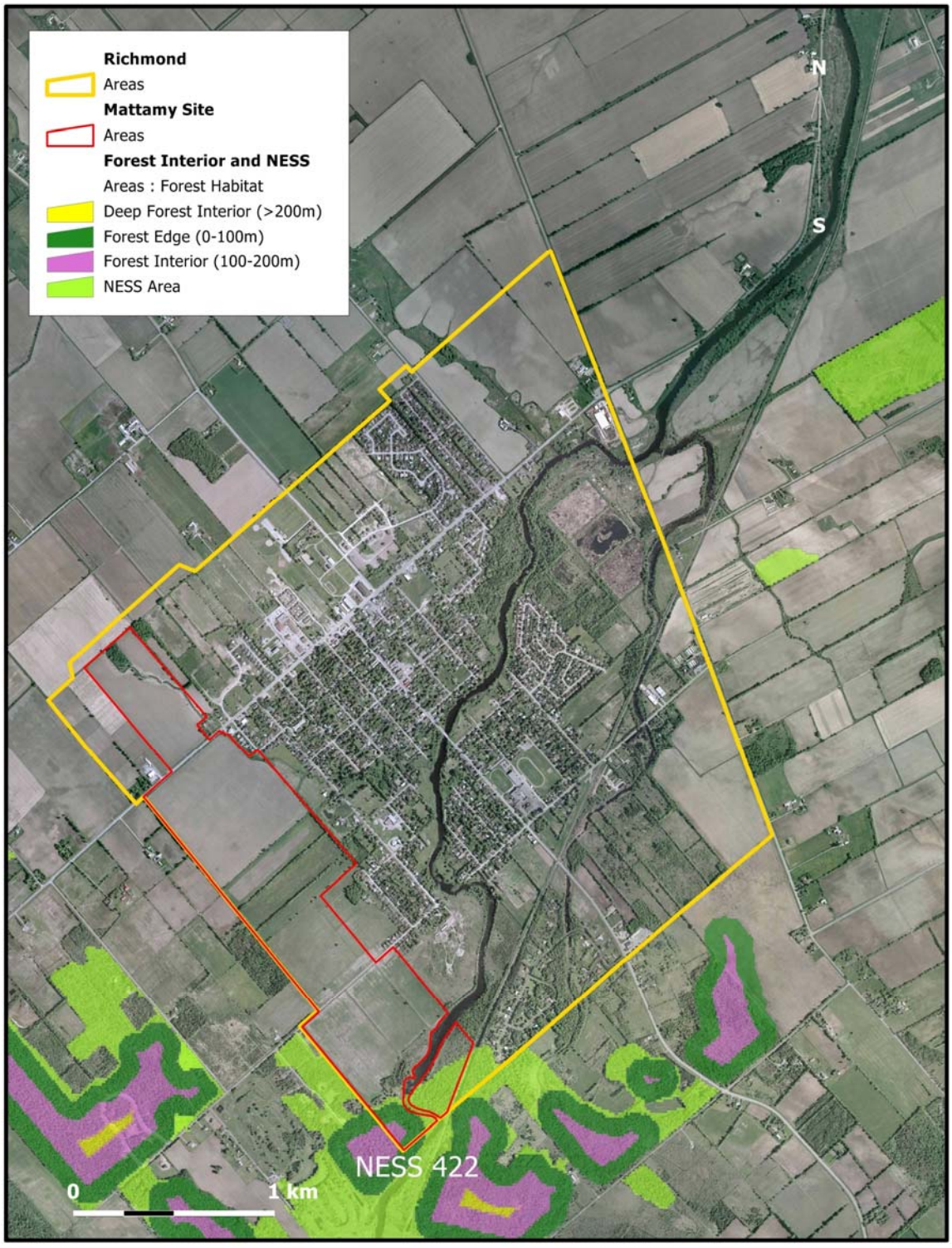


Figure 8. Map of the Village of Richmond (and surrounding area) showing areas of Interior Forest and Ness Areas.

3.1.2.13.3 Other significant features

Portions of the wooded areas to the north and south of the Jock River are believed to be woodland between 50 and 100 years (MMM and WESA 2005). Fieldwork confirmed that there are large trees, including cedars and some hardwoods, in this area and also in Community 11 and 12. Given that the original FRI (Forest Resources Inventory) data that supplied these dates is now at least 30 years old, it is likely that these mature forests are over 80 years in age. This satisfies one of the criteria of Significant Woodlands identified in the City's new Official Plan (Official Plan Amendment (OPA 76, 2009).

3.1.2.14 Ecological Linkages

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 also then require an Environmental Impact Statement (EIS).

The Van Gaal Drain north of Perth Street, and Hedgerows 1 and 2 provide some connection between the small wooded areas, probably limited to wildlife more tolerant of humans (e.g., coyotes, raccoons, squirrels). The presence of permanent water may also attract terrestrial wildlife.

The potential of the other agricultural hedgerows on the property to provide terrestrial wildlife linkages is low. This is because they are narrow (~5 m or less), are not connected to larger natural areas, are dominated by non-native plant species, and are currently surrounded by intensive agriculture.

3.1.3 Terrestrial Environment Summary

- There are no provincially significant wetlands or ANSIs on or adjacent to the property, which is mostly agricultural.

- The wooded areas north and south of the Jock River meet the definition of Significant Woodland under OPA 76. The vegetated riparian corridor of the Jock River forms part of the City's Natural Heritage System. Development within 120 m of the significant woodland and Jock River corridor require the preparation of an Environmental Impact Statement.

- Significant Wildlife Habitat has not been formally identified on the property; however, two woodland pools (probably permanent) were observed which are considered significant for wildlife.

- There was one nationally and provincially endangered species (Butternut, *Juglans cinerea*) located in two separate locations.

- Of 295 vascular plant species recorded, there were four regionally significant species observed.
- Of 51 bird species observed or heard, all are considered provincially secure as breeders in Ontario. Nine of these species are considered to be area-sensitive and require areas of interior forest to breed.
- Of 12 other vertebrate species observed (amphibians, reptiles, mammals), all are considered provincially secure in Ontario.
- Nineteen vegetation community polygons were identified on the Mattamy lands, of which 15 are considered natural vegetation communities. These are considered provincially secure in Ontario.
- Areas of Communities 11, 12, 15 and/or 16 are likely 50 to 100 years old.

3.2 Aquatic Environment

3.2.1 Approach

The analysis of the aquatic environment incorporated an assessment of physical geomorphic character and processes, water quality, water temperature, and inventories of fish and invertebrates. This analysis incorporated the review of existing information with data collected through field investigations as described below.

Existing information from prior agency studies (e.g., Jock River Subwatershed Study) and consultant reports for the study area were reviewed. Water quality and stream water temperature data were provided by the City of Ottawa. Fish catch records were obtained from review of the Subwatershed Study, as well as from the Rideau Valley Conservation Authority (Jennifer Lamoureaux).

The geomorphic assessment of the study area was used as the basis on which to stratify site-level investigations of physical processes, water quality, water temperature and fisheries studies of watercourses within Mattamy's land holding.

3.2.2 Drainage Fabric

The drainage fabric for the Mattamy Richmond Land is illustrated in Figure 9. The Van Gaal Drain is the primary drainage feature on the northwest portion of Mattamy's property, with two principal branches (one from the southwest, the other from the northeast). Drainage from the north side of Ottawa Street currently flows north through a hedge row, then north-east through a second hedge row to the Moore Branch and the Arbuckle Drain, entering the Arbuckle Drain ~ 150 m upstream of Fortune Street. Additional drainage features were identified from the Ontario Base Map (shown as narrow pink lines in Figure 9), 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 (Figure 9) has re-routed drainage such that flow is now conveyed south through the berm adjacent to the Jock River.

The Regulatory 100-yr flood line for the Jock River and Van Gaal/Arbuckle Drains are illustrated on Figure 10 (grey and blue area). For the lands south of Ottawa Street along the Jock River, the current regulatory floodplain limit is shown as the outer blue area. However, past and recent approvals from the RVCA, have changed the 100-yr floodplain limit for these lands. In December 2005, a letter of permission was issued by the RVCA for the construction of a berm to maintain flood risk mapping land levels as per (the 1980 Acres Floodplain) Mapping Study (96.0 m) 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. The authorized works re-establish the 100-yr floodplain limit to an approved berm location east and southwest of the high point as shown on Figure 10 as the solid blue area. The regulatory mapping for Ontario Regulation 174/06 is reviewed once a year and amendments introduced as required. Once the authorized permit works are complete satisfactory to the RVCA along with an approved alternative drainage scheme for the lands north of the berm, an amendment to the regulatory mapping will be processed to reflect the changes to the 1:100 floodplain contemplated in the approval.

For the Van Gaal Drain, north of Perth Street, the regulatory floodplain (blue and grey area) as shown on Figure 10 was approved by the RVCA Executive Board on January 28, 2010. However, the RVCA Board approved a future solution and process to allow an amendment to the regulatory floodplain limit. Additional channel modifications will be done 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 which will result in a new floodplain limit shown conceptually in blue on Figure 10.

3.2.3 Geomorphology

The Subwatershed Study (MMM and WESA, 2007) delineated reaches for all the streams and drains flowing into the Jock River in the subwatershed. Reach delineation was initially completed using stream order and was then further refined into sub-reaches based on geology, land use, and gradient. Rapid Geomorphic Assessments were completed in June and September 2004 during low-flow conditions. A rapid assessment is a synoptic survey meant to quickly and qualitatively assess stream reaches in order to identify any specific problems, assess overall channel stability and sensitivity, and validate mapping and aerial photography (i.e., the desktop analysis). Flowing Creek was found to have a dominant geomorphic process of aggradation. The lower-order streams were found to be relatively stable, however, the mainstem was found to be in poor condition. The Van Gaal/Arbuckle Drain was found to be in similar condition to Flowing Creek although the Van Gaal/Arbuckle Drain is a smaller system with many of the tributaries being dry for most of the year. The dominant process observed through much of the subwatershed was aggradation with channel widening also important in the lower portion of the Van Gaal Drain (i.e., Arbuckle Drain). Meander belt widths were also delineated for the subwatershed following the Toronto and Region Conservation Authority's guidelines. Due to the altered nature of many portions of the channels in Flowing Creek and Van Gaal/Arbuckle Drain,

surrogate belt widths had to be used in some areas. The meander belt width for Flowing Creek was determined to be 40 m for the main channel. The main branch of Van Gaal/Arbuckle Drain was determined to have a meander belt width of 30 m with meander belt widths of the tributaries ranging in widths from 15 to 20 m (see Figure 3.5.5.6 in MMM and WESA, 2007).

Robinson Consultants (2003) produced its *Engineer's Report for Van Gaal Municipal Drain*. This report outlined the procedure for relocating the East Main Drain (VG-R2-1 in this report) to accommodate a new development north of Perth Street. The downstream portion of the East Main Drain between Garvin Road and Perth Road was to be redirected along the northern boundary of the new development to join with the West Main Drain (VG-R2-2 in this report). From the new confluence down to Perth Road, the prior confluence of the two drains, the West Main Drain was to be deepened to accommodate the increase in flows as a result of the relocation of the East Main Drain. OTTHYMO modeling of both drains indicated that current road crossing structures were sufficient to accommodate any change in flow regime as a result of the new configuration. Proposed erosion control included seeding, buffer strips, and rip rap protection at key areas (i.e., culvert outlets, channel bends). The work outlined in the 2003 report was completed in 2006 by Capital Engineering (personal communication Andy Neon, Capital Engineering). No report or design brief was produced at this time as the 2003 design was implemented as is.

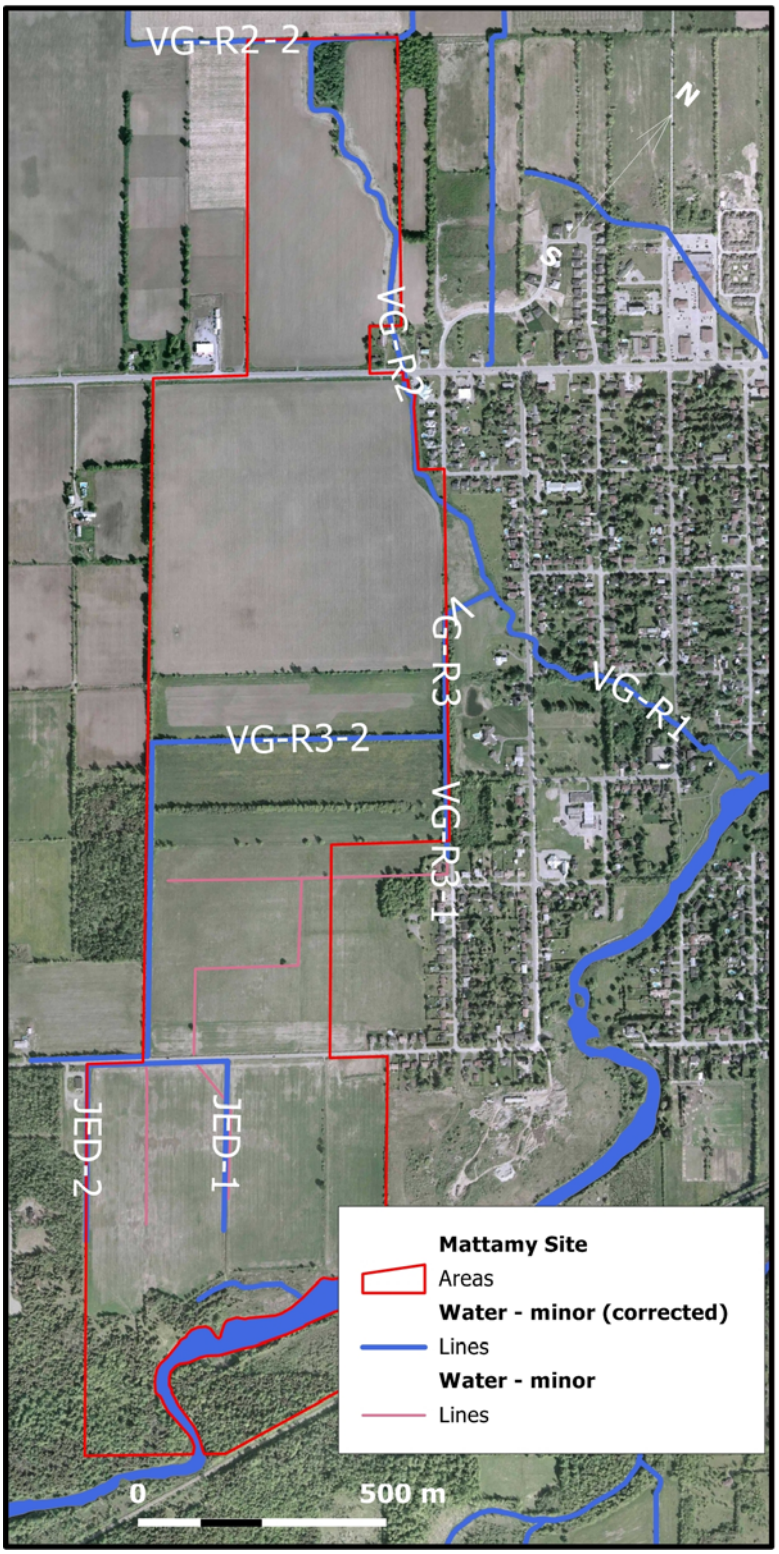


Figure 9. Map of the Mattamy Richmond Land showing watercourses.

Figure Note: Lines in heavy blue denote confirmed drainage. Narrow pink lines denote drainage

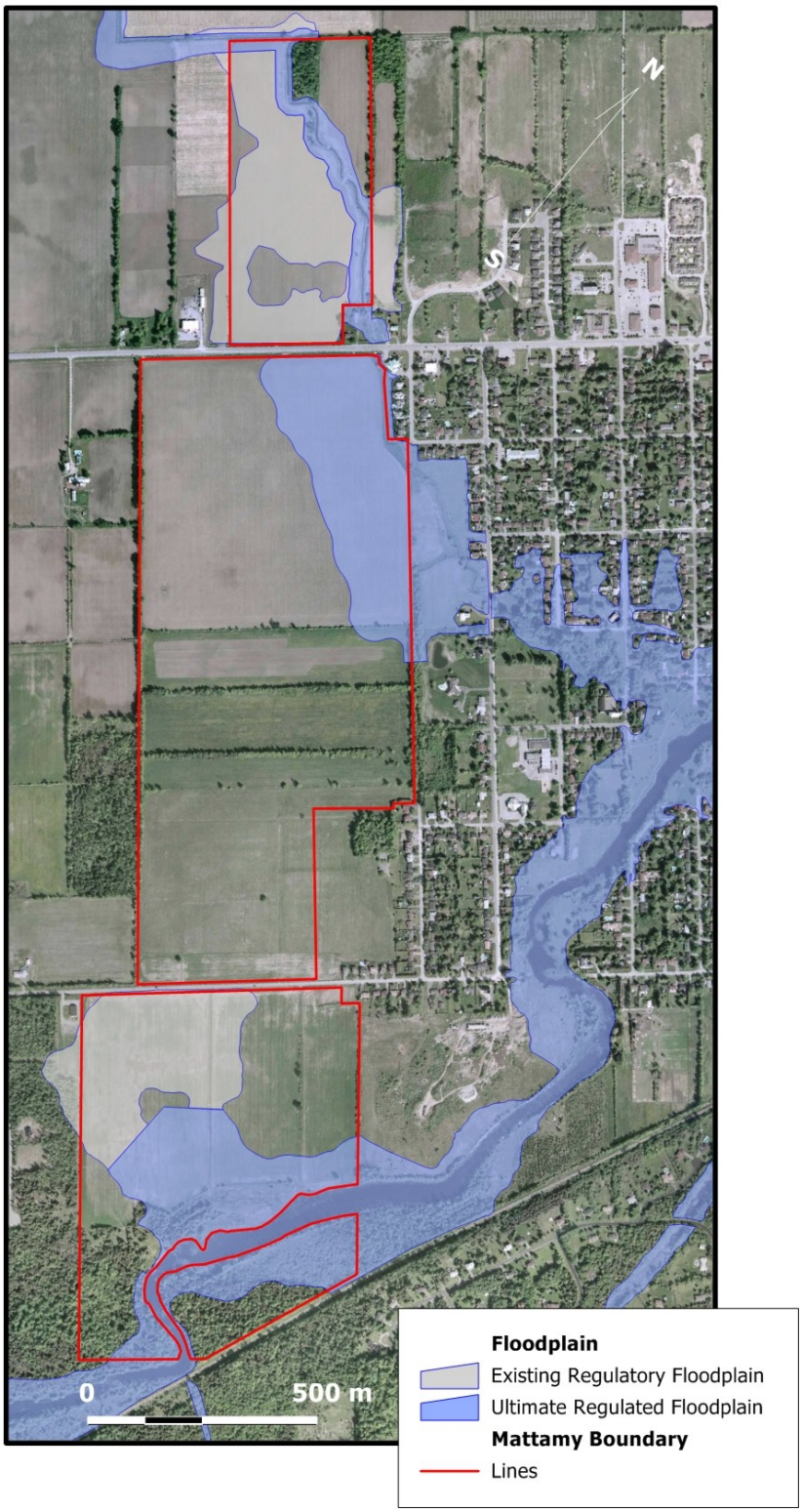


Figure 10. Map of Mattamy Richmond Lands showing 100-year flood line.

Figure Note: data layer from RVCA.

3.2.3.1 Historical Analysis

The 1946 aerial photographs show that the study area was primarily agricultural with a small woodland in the south east corner. The Village of Richmond at that time was mainly confined to McBean Street with most of the surrounding roads being on farmland. The Arbuckle Drain appears to have been straightened northwest of Fortune Street prior to 1946. The planform of the Van Gaal/Arbuckle Drain could not clearly be identified in these photographs.

The 1975 aerial photographs show that there was substantial residential growth after 1946 with residences extending from Fortune Street to King Street which had previously been occupied by agricultural lands. By 1975 there was also significant residential development south of the Jock River where there had previously only been agricultural lands. Due to the quality of the 1946 photographs, changes to planform could not be interpreted.

The 2005 digital images show increased development north of Perth Street. There did not appear to be any significant increase in residential development south of the Jock River. The number of trees in the Village of Richmond appears to have increased since 1975, particularly in the corridor surrounding the Arbuckle Drain downstream of Fortune Street. No changes in planform could be detected since the 1975 photographs although the channel downstream of Fortune Street was partially obscured by vegetation in the available air photo imagery (Google Earth).

3.2.3.2 Reach Delineation

The characteristics of the flow or channel materials can change along a creek or stream. In order to account for these changes, channels are separated into reaches – normally several hundred metres to several kilometres in length. A reach displays similarity with respect to its physical characteristics, such as channel form, function, and valley setting. Delineation of a reach considers sinuosity, gradient, hydrology, local geology, degree of valley confinement, and vegetative control using methods outlined in PARISH Geomorphic Ltd. (2001). Reaches were delineated for the watercourses within the study area (Figure 11; Appendix 5). Table 3 summarizes the reach characteristics for the reaches on Mattamy Lands.

3.2.3.3 Geology

The geology of a particular region controls the physical characteristics and functions of the drainage system. These aspects shape the physiography of a landscape and control the volume of water and sediment supplied to the drainage network. Understanding the geology that characterizes a subwatershed or catchment area guides the interpretation of the geomorphic analyses. The surficial geology of most of the reaches consisted of offshore marine sediments with the exception of Reach JED-2 which consisted of till at the downstream end and offshore marine sediments at the upstream end of the reach (Geological Survey of Canada, 2003).

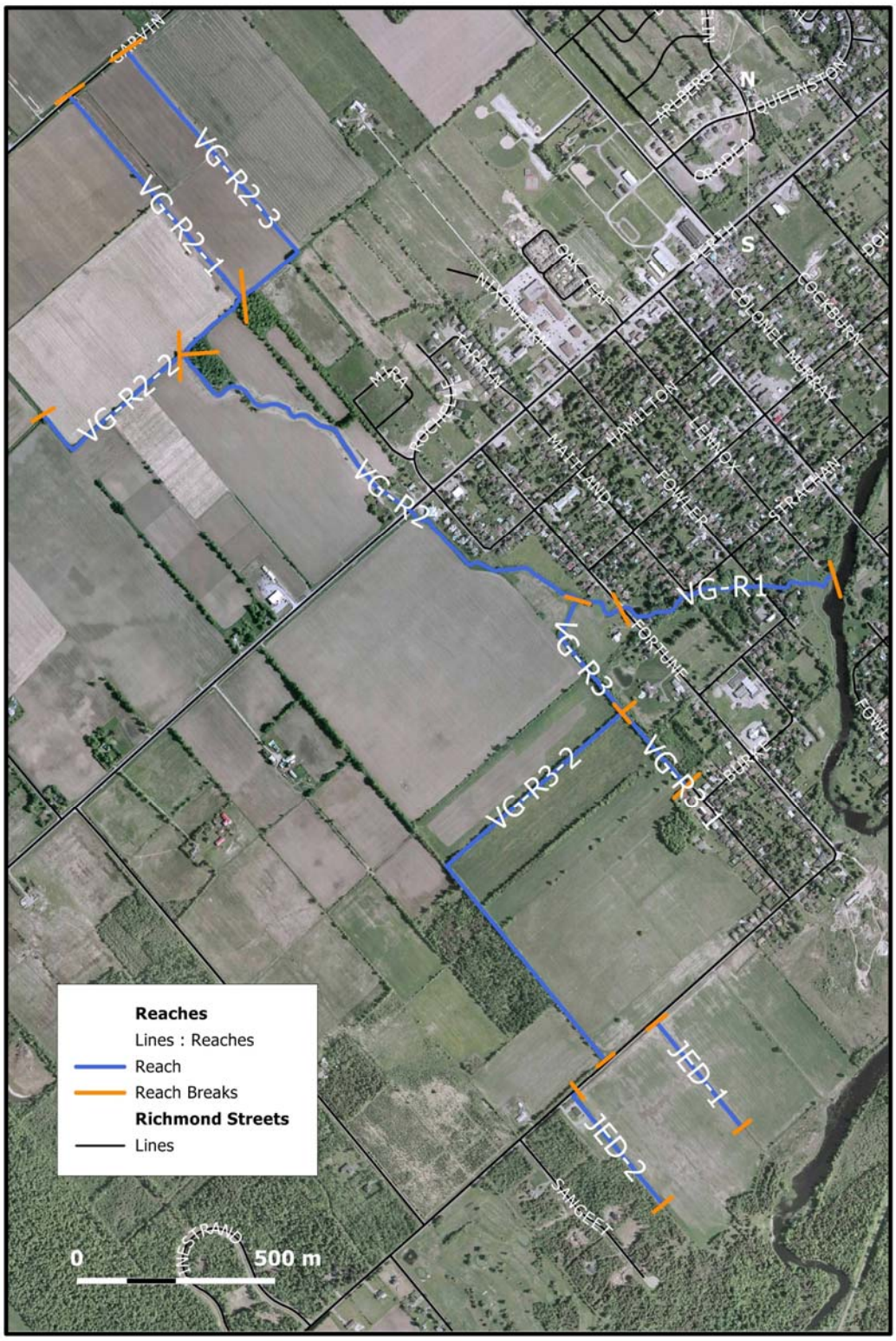


Figure 11. Watercourse reach delineation on Mattamy Lands.

Table 3. Watercourse reach characteristics for the tributaries on Mattamy Lands.

Reach Name	Valley Length (m)	Reach Length (m)	Sinuosity
VG-R2	1326	1434	1.08
VG-R2-1	856	856	1.00
VG-R2-2	490	490	1.00
VG-R3	346	346	1.00
VG-R3-1	249	249	1.00
VG-R3-2	1230	1230	1.00
JED-1	338	338	1.00
JED-2	351	351	1.00

3.2.3.4 Meander Belt Width

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.

Two reaches, the mainstem of the Jock River, Reach JR-6, and Reach VG-R2, were delineated in the habitual manner outlined in *Belt Width Delineation Procedures* (Parish Geomorphic, 2004). The meander axis was first determined by following the general down-valley orientation of the meander pattern. Following the identification of the meander axis, the belt width was determined by drawing parallel lines tangential to the outside meanders of a planform. The resulting belt width for JR-6 was 180 m and for VG-R2 it was 42 m. The other reaches in the study area had been straightened prior to the historic record provided by aerial photographs. Detailed site investigation was carried out on VG-R3-1 and VG-R3-2, with meander belt calculations based on existing channel form and computed bankfull discharge. For both channels, conveying 0.5 m^3/s, the meander belts were computed (see Technical Memo from B. Wilkes and J. Parish, January 20, 2010 in Appendix 5) as 19 m in VG-R3-1 and 18 m in VG-R3-2. The 2nd order portions of VG-R3, i.e., Sections 1, 2 and 3 were assigned meander belts of 30 m.

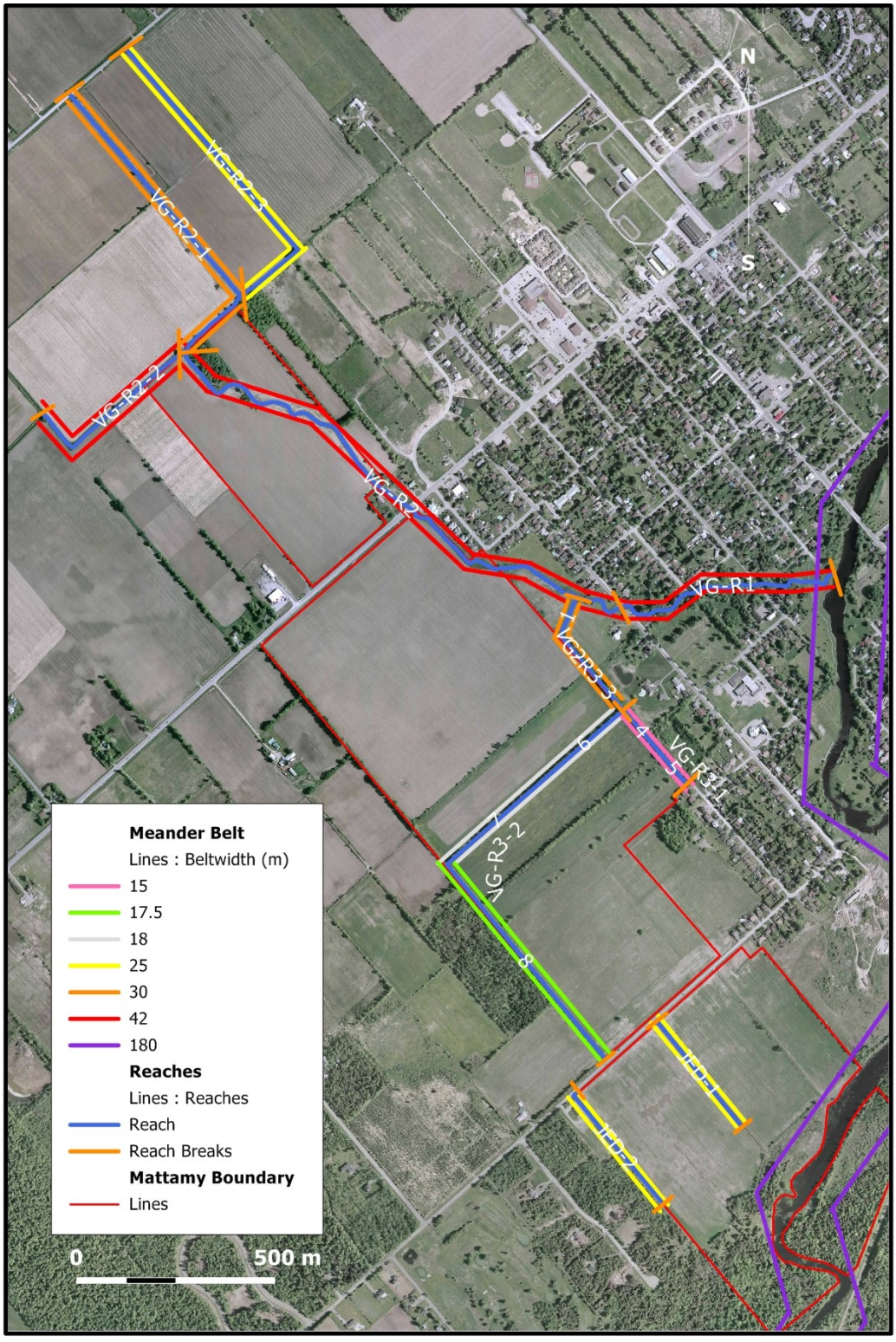


Figure 12. Meander belt width delineations for the watercourses on or adjacent to Mattamy's Richmond Lands.

Table 4. Meander belt width values for the reaches on or adjacent to Mattamy's Richmond Lands.

Reach Name	Meander Belt Width (m)
JR-6	180
VG-R2	42
VG-R2-1	30
VG-R2-2	42
VG-R3	30
VG-R3-1	19
VG-R3-2 S6-7	18
VG-R3-2 S8	18
JED-1	25
JED-2	25

3.2.3.5 Field Reconnaissance

A key component of any fluvial geomorphological assessment is a synoptic-level survey of the system. The purpose of the rapid stream assessment is to document areas of active erosion, refine reach breaks, collect basic channel dimensions and gain an understanding of the active channel processes along each reach. In other words, a rapid assessment is a synoptic survey meant to quickly and qualitatively assess stream reaches in order to identify any specific problems, assess overall channel stability and sensitivity, and validate mapping and aerial photography work (i.e., the desktop analysis). A Rapid Geomorphic Assessment (RGA) documents observed indicators of channel instability (MOE, 1999). Observations are quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, channel widening, and planimetric adjustment. The RGA index indicates whether the channel is stable/in regime (score <0.20), stressed/transitional (score 0.21 to 0.40) or adjusting (score >0.41).

The Rapid Stream Assessment Technique (RSAT) provides a broader view of the system by also considering the ecological functioning of the stream (Galli, 1996). Observations include in-stream habitat, water quality, riparian conditions, and biological indicators. Additionally, the RSAT approach includes semi-quantitative measures of bankfull channel dimensions, type of substrate, vegetative cover, and channel disturbance. RSAT scores rank the channel as maintaining a low (<20), moderate (20 to 35) or high (>35) degree of stream health. Table 5 provides a summary of the RGA and RSAT scores for all reaches while Figure 13 shows the results of the RGA assessment.

Additional physical-habitat data were collected during field inventories of fish, water quality, and water temperature. Field inventories were conducted during mid summer (early August), and again in early October. Wetted channel depths and widths were noted during these additional site visits, augmenting the data collected during the rapid geomorphic assessment.

3.2.3.5.1 Reach VG-R2

Reach VG-R2 (mainstem of the Van Gaal/Arbuckle Drain) extended from Fortune Street at the downstream end to the north end of the Mattamy land holding (i.e., confluence of VG-R2-1 and VG-R2-2). The reach is slightly sinuous with several straightened areas. The RGA assessment determined the reach to be stressed with a score of 0.34. The dominant geomorphic process observed in the watercourse was degradation with significant evidence of planform adjustment and channel widening. The RSAT assessment suggested the reach has low stability. This low score was largely due to poor water quality 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. Riffles in the lower part of the reach (downstream of Perth Street) were dominated by a sand/pebble mix, while riffles in the upper section of the reach (upstream of Perth Street) had developed as a result of rip rap falling into the channel. . Bank material consisted of clay and silt with some clay exposed at the bank toe. Vegetation through the reach consisted primarily of grasses and herbs with trees in some areas. Minor woody debris was observed at several locations in the reach. Channel disturbances in the reach included culverts at Perth Street as well as farm crossings (see sub-reach VG-R2f in Appendix 7) in addition to some rip rap on some of the banks, particularly in bends (see habitat maps in Appendix 7). The culvert in sub-reach VG-R2f had high flows approaching 1 m/s during the spring melt event (April 16, 2008), posing a potential barrier to upstream migrations by most cyprinids, and potentially pike.

Although this reach contained water for the duration of the study period (April through to October, 2008), this reach had been dry in places upstream of Perth Street in October of 2007 as determined by a field investigation by B. Muncaster (see Kilgour & Associates Ltd. and Parish Geomorphic Ltd., 2008). The Robinson Consultants (2003) report provided the design for the rip rap re-enforcements found in VG-R2, as well as the background documentation for a spawning shelf situated just upstream (right upstream bank) of the Perth Street culvert.

Table 5. Summary of RGA and RSAT scores for the watercourses on or adjacent to Mattamy's Richmond Lands.

Reach Name	RGA Score	Condition	RSAT Score	Condition
VG-R2	0.34	In Transition	17	Low Stability
VG-R2-1	0.14	In Regime	15	Low Stability
VG-R2-2	0.14	In Regime	17	Low Stability
VG-R3	0.33	In Transition	20	Moderate Stability
VG-R3-1	0.18	In Regime	18	Low Stability
VG-R3-2	0.18	In Regime	19	Low Stability
JED-1	0.18	In Regime	17	Low Stability
JED-2	0.11	In Regime	15	Low Stability

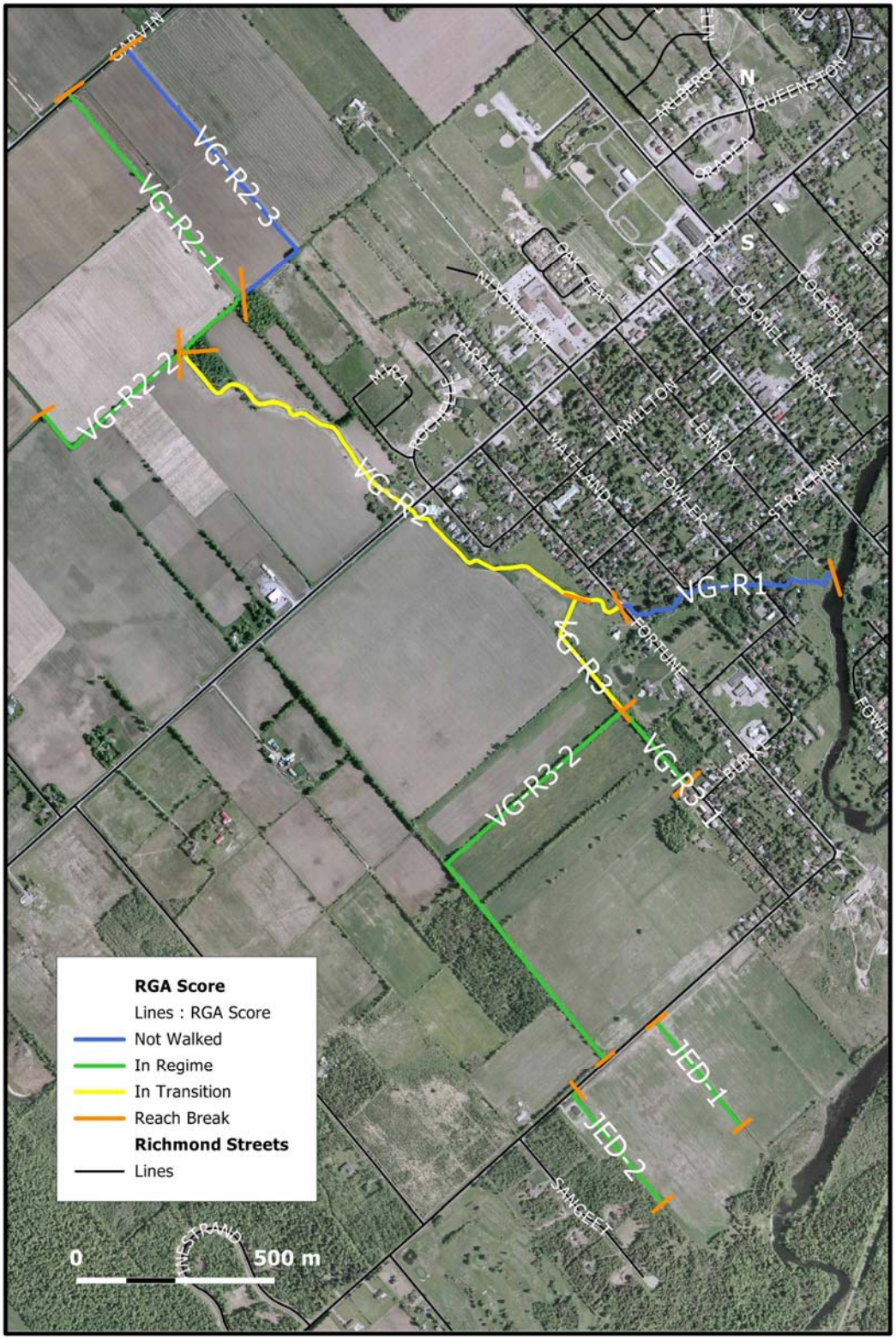


Figure 13. Rapid Geomorphic Assessment (RGA) scores for the Van Gaal Drain.

3.2.3.5.2 Reach VG-R2-1

Reach VG-R2-1 extended from Garvin Road to the confluence with VG-R2-2. The reach had been straightened for agricultural purposes prior to the historical aerial photographs. The RGA assessment determined the reach to be in regime with a score of 0.14. The dominant geomorphic process observed in the watercourse was aggradation. The RSAT assessment indicated that the creek had a low stability due in large part to the poor habitat and water quality and 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. The gradient through the reach was observed to be low with no sinuosity. Sediment in the channel was characterized by sands, silt and clay. Bank material consisted of clay and silt. Vegetation through the reach consisted primarily of grasses and herbs. Some in-stream vegetation was observed in the reach.

3.2.3.5.3 Reach VG-R2-2

Reach VG-R2-2 extended from the confluence of two smaller drains to the confluence with VG-R2-1. The reach had been straightened prior to the historical aerial photographs. The RGA assessment determined the reach to be in regime with a score of 0.14. The dominant geomorphic process observed in the watercourse was aggradation. The RSAT assessment indicated that the creek had a low stability due in large part to the poor habitat and water quality and the 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. Sediment in the reach was characterized by silt and clay. Rip rap at the end of the channel created a minor riffle. Bank material consisted of clay and silt. Vegetation through the reach consisted primarily of grasses and herbs with some shrubs on the south side of the reach. The top of the channel was slightly wider with a more open canopy, while the bottom of the reach was narrower, and the overhanging grasses provided for nearly 100% cover. Minimal woody debris was observed at a few locations in the reach.

3.2.3.5.4 Reach VG-R3

Reach VG-R3 began at its confluence with VG-R2 and extended upstream to the confluence of reaches VG-R3-1 and VG-R3-2. 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 processes observed in the reach were channel widening and planform adjustment. The RSAT assessment determined the creek to have a moderate stability. The score was 20 which is on the threshold of low/moderate stability. The low score was associated with the presence of agricultural drains and little evidence of scour and deposition features or in-stream habitat. Bankfull widths were estimated to be between 4 and 7 m with associated depths of 0.6 to 1.0 m. Wetted widths in early June were observed to vary from 2 to 4.0 m with associated depths of 0.15 to 0.6 m. Wetted widths in August were ~ 0.1 m, 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. Vegetation through the reach consisted primarily of grasses and herbs with

more shrubs and trees further upstream in the reach. Bankside vegetation provided nearly 100% canopy cover in summer. Minor woody debris was observed at several locations in the reach. Channel disturbances in the reach included a crushed corrugated steel culvert (used historically as a farm-crossing; see photos in Appendix 7) and PVC piping. This reach contained water during every site visit including those in August. Flows appeared to be provided by a single tile drain at the head of this sub-reach (see photos in Appendix 7).

3.2.3.5.5 Reach VG-R3-1

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 and is surrounded by a wooded corridor. The RGA assessment resulted in a score of 0.18 which indicates that the reach is in regime. The dominant geomorphic process observed in the watercourse was channel widening. Tree canopy provided nearly 100% canopy cover during summer. There was an abundance of fallen and leaning trees in the reach in addition to large woody debris and exposed tree roots. The RSAT assessment suggested the creek had a low stability which was primarily due to poor water quality associated with tile drains and little evidence of scour and deposition features. Bankfull widths were estimated to be between 2.5 and 4 m with associated depths of 0.2 to 0.35 m. Wetted widths in early June were observed to vary from 1.5 to 3.5 m with associated depths of 0.05 to 0.15 m. The gradient through the reach was low with a very low sinuosity. Sediment in the reach was silt and sand. Bank material consisted of clay, silt and some sand. Major woody debris was observed throughout the reach. Channel disturbances consisted of a small farm culvert.

3.2.3.5.6 Reach VG-R3-2

Reach VG-R3-2 began at its confluence with VG-R3-1 and extended upstream to Ottawa Street. The reach had been straightened for agricultural purposes prior to the historical aerial photographs and is surrounded by a wooded corridor. The RGA assessment yielded a score of 0.18 indicating that the reach is in regime. The dominant geomorphic process observed in the watercourse was channel widening. There was an abundance of fallen and leaning trees in the reach in addition to large woody debris and exposed tree roots. The RSAT assessment determined the creek to have a low stability which was primarily due to poor water quality associated with agricultural drains. Bankfull widths were estimated to be between 2.3 and 3.3 m wide with associated depths of 0.2 to 0.25 m. Wetted widths in early June were varied from 0 to 1.5 m with associated depths of 0 to 0.10 m. The gradient through the reach was low with a very low sinuosity. Sediment in the reach consisted primarily of clay with some silt. Bank material consisted of clay, silt and fine sand. Vegetation through the reach consisted primarily of trees and shrubs (providing nearly 100% canopy cover in summer) within a narrow corridor with agricultural fields on either side. Large woody debris was present throughout the reach. The single channel disturbance consisted of a small farm culvert at the point where the channel turned from its east-west branch to its north-south branch (Appendix 7). Flows in this reach were intermittent. In early August, the lower half of this reach (sub-reach VG-R3-2a) was dry while the upper half (VG-R3-2b) contained standing water (Appendix 7).

3.2.3.5.7 Reach JED-1

Reach JED-1 began at the culvert leading to the Jock River under the berm and extended upstream to Ottawa Street. The reach had been constructed for the purposes of stormwater management for the

adjacent Jock River Estates. The RGA assessment yielded a score of 0.18 indicating that the reach is in regime. The dominant geomorphic process observed in the watercourse was aggradation. The RSAT assessment determined the creek to have a low stability which was primarily due to poor water quality associated with agricultural drains and 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. Vegetation through the reach consisted primarily of tall grasses with fields on either side, with overhanging grasses (in summer) providing little canopy cover. In-stream vegetation was observed throughout the reach, dominated by cattails and bluegreen algae. Channel disturbances consisted of a small, damaged wooden crossing near Ottawa Street, in addition to a rock check dam about half way between Ottawa street and the constructed berm.

3.2.3.5.8 Reach JED-2

Reach JED-2 began in the field south east of Ottawa Street and extended upstream to Ottawa Street. The reach had been straightened for agricultural purposes prior to the historical aerial photographs. The RGA assessment resulted in a score of 0.14 which indicated that the reach was in regime . The dominant geomorphic process observed in the watercourse was aggradation. The RSAT assessment determined the creek to have a low stability. Bankfull widths were estimated to be between 2.0 and 3.0 m with associated depths of 0.3 to 0.5 m. Wetted widths in early June were observed to vary from 1.0 to 2.0 m with associated depths of 0.1-0.3 m. The gradient through the reach was observed to be low with no sinuosity. Sediment in the reach consisted of silt and fine sands with organic material. Bank material consisted of primarily of silt with some clay. Vegetation through the reach consisted primarily of tall grasses and herbs. In-stream vegetation was abundant throughout the reach. Minor woody debris was observed at a few locations along the reach.

3.2.3.6 Erosion Threshold Assessment

Following the field reconnaissance, four sites (VG-R2, VG-R3, VG-R3-2, and JED-1) were selected for detailed field work with the goal of completing erosion threshold assessments (Figure 14). The sites were selected to be representative of conditions of the majority of watercourses on Mattamy's land holding. Statistics generated for the four reaches can be applied to generally long sections of watercourse. VG-R2 applies to all portions of the Van Gaal and "Arbuckle" Drains that are adjacent to Mattamy land. VG-R3-2 is the Moore Branch, and all sections of it. JED-1 is the Jock River Estates Drain, and so those statistics apply to all portions of that drainage feature. Two of the sites selected had RGA scores suggesting that they were 'In Transition' while two had scores suggesting that they were 'In Regime'. Moreover, drains of different sizes were chosen as part of the erosion threshold assessment. Detailed geomorphic information was collected for the four reaches in order to perform analyses based on critical shear stress and permissible velocities to identify erosion thresholds. Erosion thresholds indicate the point at which sustained flows entrain and transport sediment downstream. Table 6 provides a summary of both bankfull characteristics and erosion threshold parameters. Five cross-sections were measured at each of the sites, including one top of bank cross-section at each location. The cross-sections measured both bankfull dimensions and wetted dimensions. Sediment data were also collected for each of the sites through a modified Wolman sampling method. At each cross-section information on bank conditions and vegetation was also collected. At the location of

each detailed site, one monitoring station was established to allow for the annual monitoring of each site. The monitoring stations consisted of permanent cross-section and erosion pins in at least two locations.

Table 6. Summary of erosion threshold analysis for Van Gaal Drain.

Parameter	VG-R2	VG-R3	VG-R3-2	JED-1
Average Bankfull Width (m)	4.99	4.28	2.80	2.45
Average Bankfull Depth (m)	0.39	0.27	0.22	0.24
Energy Gradient (%)	0.15	0.83	0.46	0.13
Bed Material D_{50} (mm)	0.002	0.0009	0.0001	0.002
Bed Material D_{84} (mm)	0.08	3.11	0.02	0.04
Average Bankfull Velocity (ms^{-1})	0.59	1.00	0.70	0.32
Average Bankfull Discharge (m^3s^{-1})	1.35	1.41	0.50	0.23
Stream Power (Wm^{-1})	19.93	114.61	22.78	2.93
Stream Power per Unit Width (Wm^{-2})	3.98	26.66	8.16	1.21
Critical Discharge (m^3s^{-1})	0.33	0.55	0.06	0.11
Method	Chow, 1959	Dunn, 1959	Dunn, 1959	Dunn, 1959

In all cases, the critical discharge and bankfull flow were compared to determine whether the bed is fully mobilized around bankfull flows. The erosion thresholds calculated for the four reaches were determined to be discharges below bankfull, as is normally the case. This implies that sediment can be entrained below bankfull flows and that any increase in discharge within these systems will lead to increased sediment transport and would likely exacerbate channel erosion. The resultant threshold values represent performance targets that must be considered when developing a stormwater management plan for the study area.

It should be noted that erosion is a natural process that must occur within a channel in order to maintain a state of equilibrium. As such, the threshold is meant to be exceeded. The overall goal is to ensure that post-development conditions do not see a substantial increase in the frequency or duration of flow events which are in excess of the established thresholds from pre-development conditions. This will ensure that the receiving channels do not experience higher-than-normal rates of erosion. Erosion thresholds can also be used to inform any rehabilitation measures being undertaken as part of the development process by providing insight into the design of enhancement features and the ultimate channel configuration.

Two of the monitoring locations are on tributaries that may be filled or entombed depending on the outcome of the analysis of preferred options for development of the property. The station within JED-1, in particular is unlikely to remain as a monitoring location because the site is man-made and is likely to be filled. The locations for further monitoring will take into consideration the anticipated development activities (Figure 14), which were unknown at the time of these existing conditions studies.

3.2.3.7 Summary

The majority of the headwater streams in the study area have been channelized, or ditched. This modification of channel planform has interfered with processes of water and sediment transport

through the drainage network. Generally, low order tributary channels serve an important function within any drainage network. During precipitation events, water from surrounding land area begins to fill these channels until there is sufficient volume to cause the water to flow. The lag time between the onset of precipitation and the downstream flow of water in the low order streams lengthens the duration of the storm hydrograph and attenuates peak flows. However, when the channels are straightened, the lag time decreases and the downstream reaches receive the flow at a faster rate. Furthermore, when the planform of a watercourse is changed, then adjustments will be made by the channel, over a period of time, to regain a natural planform configuration. Excessive erosion of channel banks often accompanies this re-adjustment process since the stream power has been temporarily increased in the reach and the development of meanders requires changes to the channel banks, the result is decreased bank stability and in substantial sediment being contributed to the channel. The future management of the streams within this study area needs to account for the straightening of these channels in order for the improvement of fish habitat, water quality and geomorphic processes.

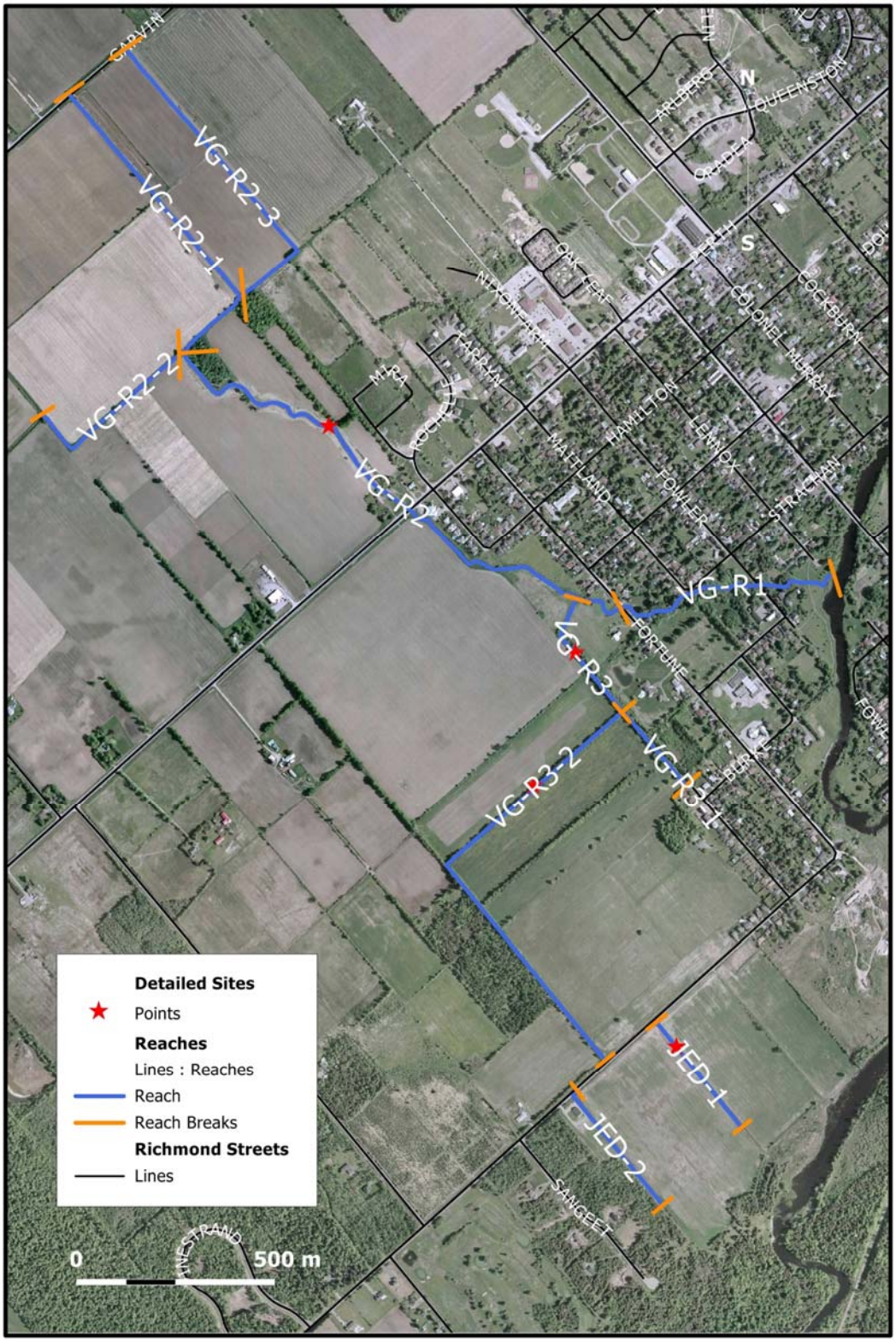


Figure 14. Locations of detailed field work for erosion threshold assessments.

3.2.4 Water Quality

City of Ottawa water quality monitoring data were summarized in the Subwatershed Study by MMM and WESA (2007). The Jock River in the vicinity of the Village of Richmond, as well as Flowing Creek were both considered to have "Marginal" water quality. Water quality data have been obtained from the City of Ottawa for the Van Gaal Drain and Jock River in the vicinity of the Village of Richmond (Figure 15). Concentrations of conventional pollutants such as metals and nutrients, as well as more general indicators of water quality parameters (e.g., pH, suspended solids) and water temperature (Jock River only) were described by MMM and WESA (2007).

In addition to the data available for the Jock River and mainstem Van Gaal Drain, single water samples for the Van Gaal Drain at Perth Street, as well as for the Moore Branch (VG-R3) and Jock River Estates Drain (JED-1) were collected in early August 2008. Those samples were analyzed for general water quality parameters (i.e., suspended solids, pH, hardness), a suite of metals, as well nitrogen and phosphorus compounds. The sample collected from the Moore Branch was collected from a pool below a tile drain. That sample should reflect the quality of groundwater contributions to the Moore Branch.

The Jock River and Van Gaal Drain are hard-water systems, with relatively high concentrations of base cations (i.e., Ca, Mg, Na, K), basic pH (i.e., > 7), and relatively high alkalinity. Water hardness exceeds 180 mg/L in all watercourses, offering high buffering capacity and protection against metals, some of which are at high concentrations. Aluminum concentrations have been high at all locations monitored by the City of Ottawa (Table 7) with the exception of the Jock River at Ottawa Street. Aluminum concentrations were also in excess of the CCME (0.1 mg/L) and provincial (0.075 mg/L) guidelines in the Van Gaal Drain at Perth Street and in the Moore Branch (both in August 2008). High aluminum concentrations are probably associated with suspended materials (i.e., silt), and probably do not reflect high concentrations of dissolved concentrations (i.e., the metal fraction more likely to pose an ecological risk). High concentrations of aluminum in the Moore Branch indicates the source of aluminum is likely natural and in the groundwater.

In addition to aluminum, concentrations of iron have also been high, exceeding its CCME (2002) water quality guideline. Further, copper concentrations have been high in an unnamed tributary (at King Street in the Village of Richmond) to the Jock River. Total phosphorus concentrations at all locations monitored within the vicinity of the Village of Richmond have exceeded the Provincial Water Quality Guideline of 0.03 mg/L to prevent nuisance growths of algae in riverine systems. Concentrations were very high (> 0.1 mg/L) in the unnamed tributary inside the Village of Richmond, as well as in Upper Van Gaal Drain (>0.3 mg/L). Total suspended solids loads have generally been low (i.e., < 25 mg/L), with the exception of the Upper Van Gaal Drain (almost 80 mg/L). High solids concentrations at that location seem unusual considering the site is a point of drainage for a woodland.

Canada's Code of Practice for Road Salts recommends chloride concentrations below 35 mg/L for long-term exposures and below 140 mg/L for short-term exposures in fresh surface waters to protect aquatic organisms. Concentrations of chlorides in the unnamed tributary have been upwards of 180 mg/L, indicating some potential risk of effects due to chlorides. Chlorides concentrations at all other locations have been well below that proposed guideline.

With the exception of the sample from the Moore Branch (tile drainage), total phosphorus concentrations at all locations within the study area have exceeded the provincial guideline of 0.03 mg/L. That guideline is set for riverine systems to prevent nuisance growths of algae and other aquatic plants. Nuisance growths of in-stream plants were not evident in areas with shading provided by grasses (many parts of the Van Gaal Drain), but were evident in areas without shading. Further, reaches of the Van Gaal Drain and of the tributary to the Jock River (JED-1) that lacked shade had surface growths of blue-green algae, suggesting that phosphorus concentrations were high enough to result in nitrogen being the limiting nutrient.

Table 7. Averages for conventional water quality parameters for several locations on the Jock River system within the vicinity of the Village of Richmond.

Sample Point		Parameter									
		Al	**Cu**	**Fe**	**pH**	**Alk**	**Hard**	**TP**	**TSS**	**Cl**	**Cond**
JR-09[1]	Jock River @ Eagleson Road	**0.275**	**0.005**	**0.413**	8.11	182	189	**0.056**	9	23	465
JR-11	Jock River @ McBean Street							**0.054**	9		
JR-12	Jock River @ Ottawa Street	0.074	0.002	0.172	8.26	173	191	**0.034**	4	18	394
JR-42	Unnamed Tributary @ King Street	**0.550**	**0.008**	**0.841**	7.93	277	354	**0.108**	23	**181**	1144
JR-43	Lower Van Gaal Drain @ Fowler Street	**0.194**	0.003	**0.403**	8.01	219	279	**0.052**	8	49	614
JR-44	Upper Van Gaal Drain @ Joy's Road	**0.372**	0.004	**5.436**	7.78	183	212	**0.332**	78	6	362
VG-R2[2]	Van Gaal @ Perth Street	**0.14**	0.001	**0.48**	8.04		277	**0.05**	2		707
JED-1[2]	Jock River Estates Drain	0.020	**0.006**	0.050	7.95		410	**0.04**	<2		999
VG-R3[2]	Moore Branch	**0.200**	0.002	0.210	7.59		331	<0.01	4		880
CCME Guideline[3]		0.100	0.004	0.300	6.5-9.0						
MOE, PWQO[4]		0.075	0.005	0.300	6.5-8.5			0.03			
Code of Practice[5]										140	

Table Notes: [1] Data from City of Ottawa, with data covering 1991 to 2007, and provided by the City of Ottawa (Adam Bishow). Codes: Al = aluminum, Cu = copper, Fe = iron, Alk = alkalinity, Hard = hardness, TP = total phosphorus, TSS = total suspended solids, Cl = chloride, Cond =-conductivity. [2] Data from this study. Full dataset presented in Appendix 6. [3] Canadian Council of Ministers of the Environment (2002). [4] Ontario Ministry of the Environment Provincial Water Quality Objectives. [5] Environment Canada's Code of Practice for Road Salts.

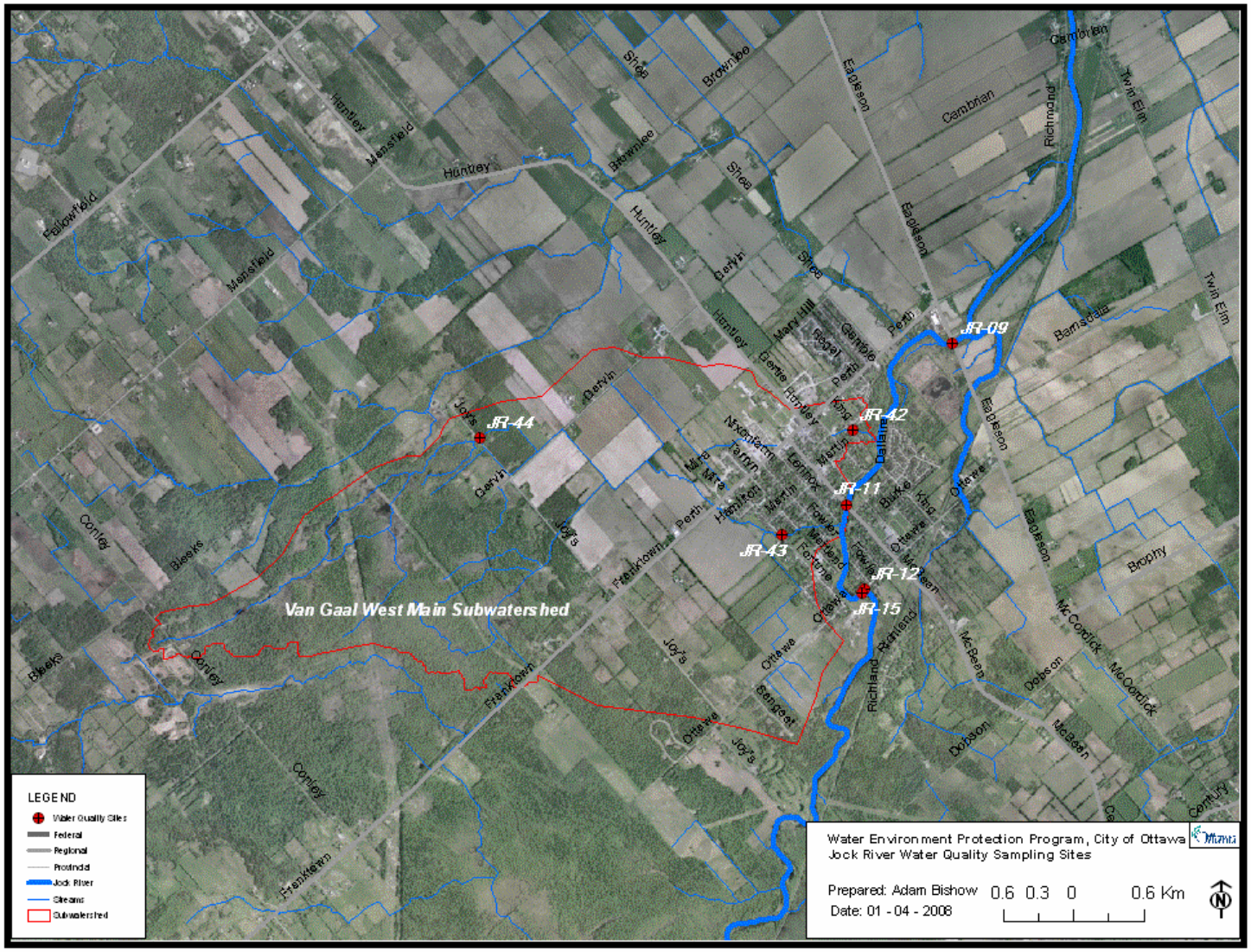


Figure 15. Water quality sample locations.

Figure Note. Map provided by the City of Ottawa (Adam Bishow).

3.2.5 Water Temperature

Historical stream water temperature data were available for this review for six monitoring stations in the Jock River main channel for the period from May to September 2004, including locations at Moodie Drive, Steeplehill Road, Cambrian Road, Eagleson Road, Ottawa Street and in Leamy Creek at Cambrian Road. Data for two locations, one downstream of the Village of Richmond (Jock River at Eagleson Road, and one upstream (Jock River at Ottawa Street) were utilized for this assessment. Additional stream temperature data for the Van Gaal Drain at Perth Street, and for the Moore Branch ~ 100 m upstream of the confluence with the Van Gaal Drain were collected using stream temperature loggers (Hobo tidbits). Temperatures were recorded hourly. A third temperature logger was used to monitor air temperatures in a shaded location, again logging temperatures hourly over the monitoring period (July 18 to August 28, 2008).

The relationship between air and water temperatures can be used to classify the thermal regime of a surface-water system (Stoneman and Jones, 1996). The data from both locations in the Jock River suggested that the mainstem of the Jock River is a warmwater system (Figure 16). Further, temperature of the river decreased significantly (2 to 4°C) from upstream to downstream through the summer of 2004, reflecting apparent inputs of cool surface water and/or groundwater. The presence of sculpin and pearl dace in the vicinity of the Village of Richmond (MMM and WESA, 2007; Figure 17) confirm inputs of "cold" water. Inputs of groundwater would be consistent with the shallow depth to bedrock within the Village of Richmond in the vicinity of the Jock River.

The Van Gaal Drain had water temperatures that varied between 17 and 24°C, resulting in a stream classification of generally cool- to warm-water (Figure 18). Mottled sculpin were present in the Van Gaal Drain from the Moore Branch upstream to the northern limit of Mattamy's land holding (see Section 3.5), suggesting inputs of cool water. The Moore Branch was somewhat cooler, reflecting the inputs from tile drainage, with water temperatures of between 16 and 22°C, and a thermal classification of cool-water (Figure 19). In the case of the Moore Branch, despite generally being a groundwater input and having ~100% canopy cover (either grasses or mature trees), the data suggest that the groundwater contribution is from shallow groundwater that has not been fully cooled to a more typical groundwater temperature of 8 to 10°C.

The thermal condition of the Tributary to the Jock River (i.e., JED-1) was not fully assessed. A single spot measurement of water temperature was made on August 3, 2008 when the fish community was also sampled. Water temperature was 17°C at 15:45 while air temperature was ~ 28°C, producing a thermal classification of cool water. That tributary, however, has not produced mottled sculpin during two electrofishing visits (Section 3.5).

The general conclusions from the assessment of thermal conditions of the surface waters in the study area is that the Van Gaal Drain is a cool- to warm-water system, the Moore Branch is cool-water, the Jock River Estates stormwater outlet is cool-water, and the Jock River itself is warm-water. The Van Gaal Drain appears to be one of the sources of cooler water to the Jock River.

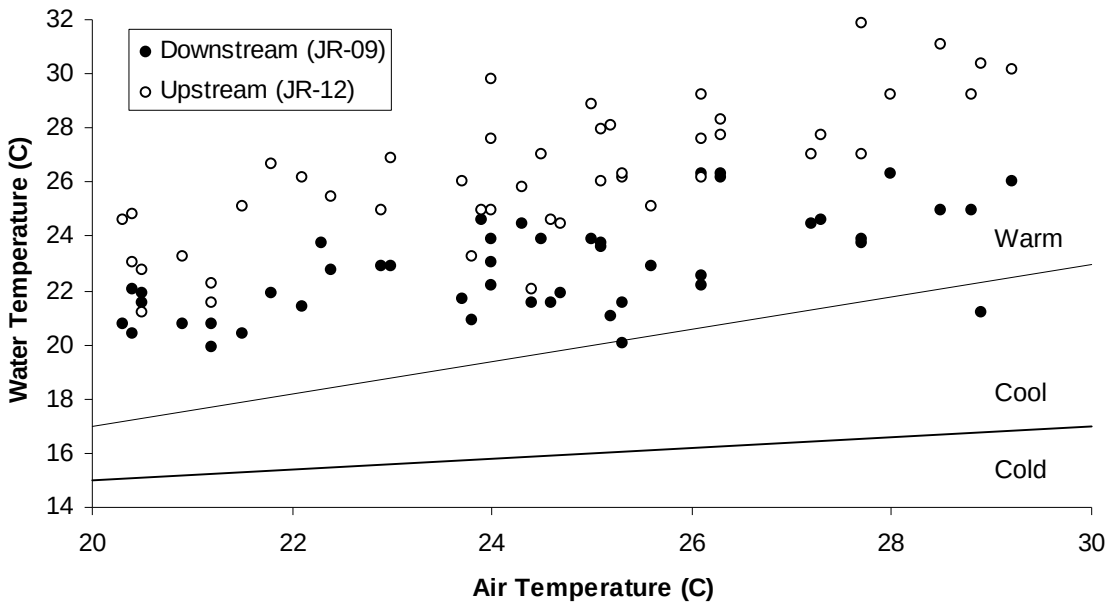


Figure 16. Relationship between air and water temperature in the mainstem Jock River in the vicinity of the Village of Richmond.

Figure Note: Data for the summer of 2004, and provided by the City of Ottawa (Adam Bishow).

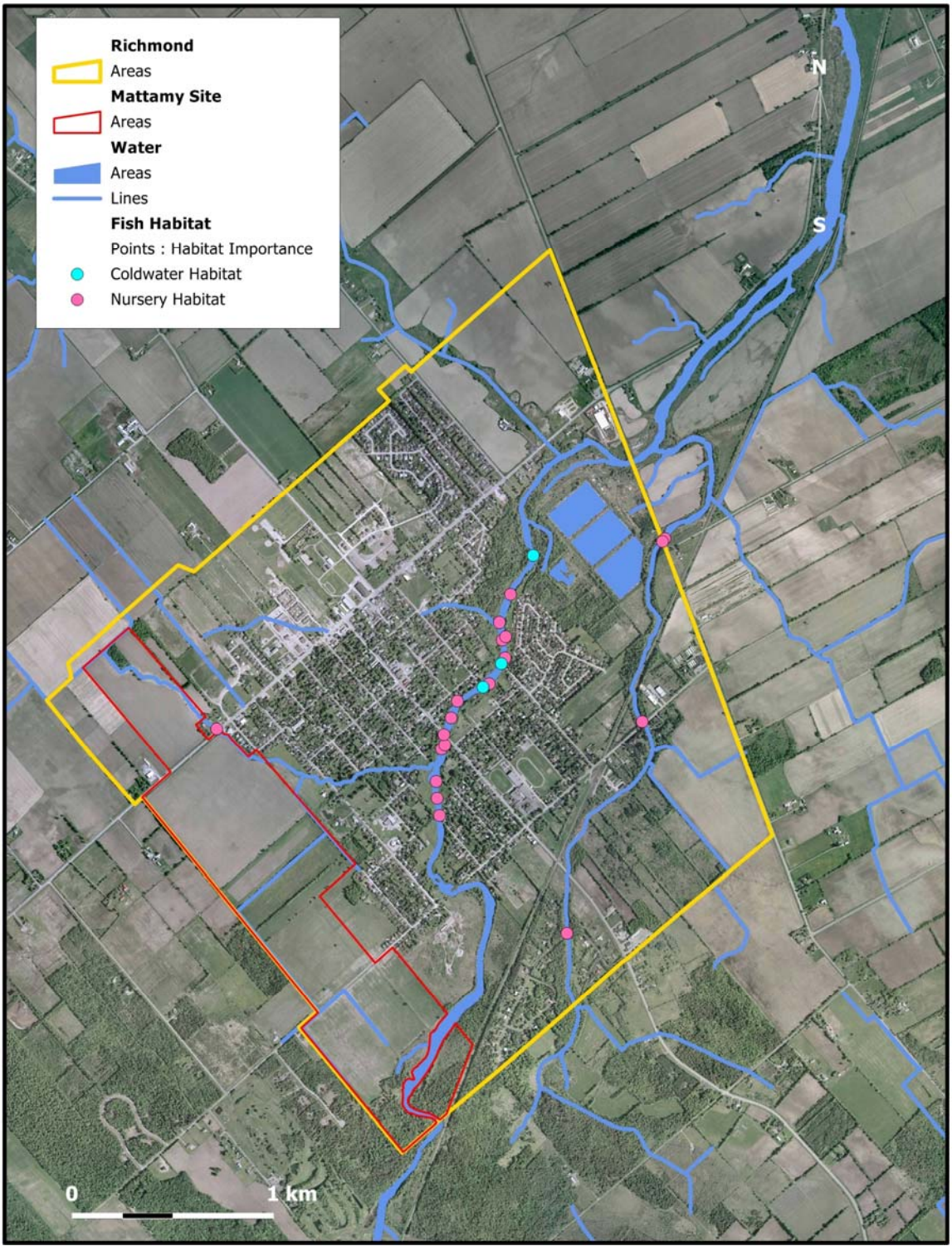


Figure 17. Map of the Study Area Showing Areas of Coldwater Fisheries Habitat and Nursery Habitat.

Figure Note: data from MMM and WESA (2007)

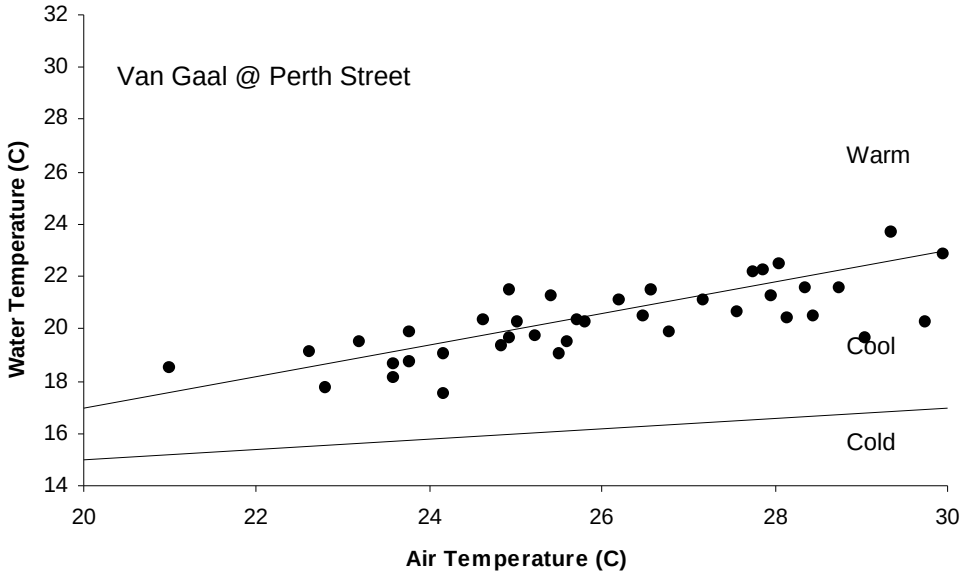


Figure 18. Relationship between air and water temperature in the Van Gaal Drain at Perth Street, summer 2008.

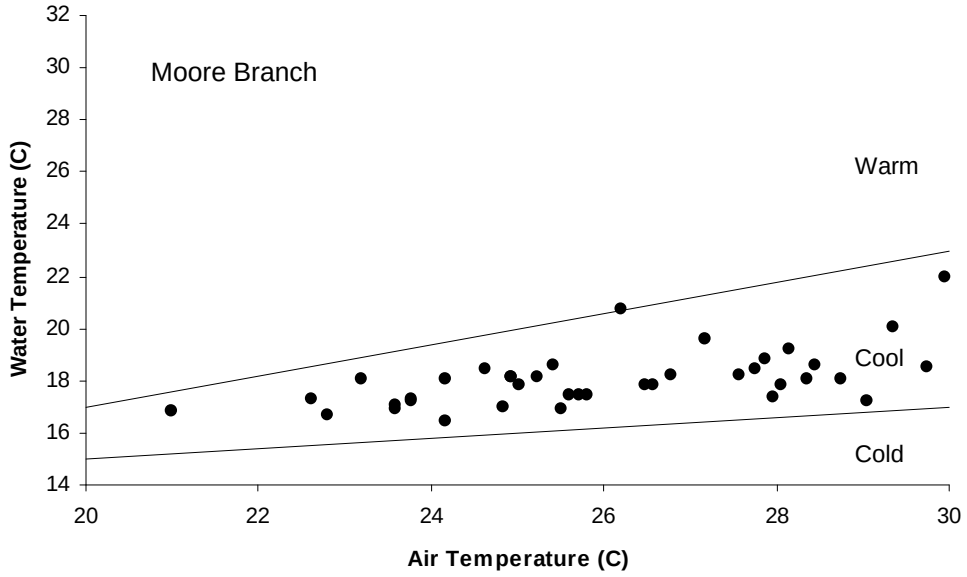


Figure 19. Relationship between air and water temperature in the lower Moore Branch, summer 2008.

3.2.6 Fisheries

This assessment relied largely upon existing information to document the fishery of the Jock River in the vicinity of the Village of Richmond, and of field investigation to document the fishery of watercourses associated with the Mattamy land holding. Existing information was obtained from Jennifer Lamoureaux of the Rideau Valley Conservation Authority, as well as from Adam Bishow of the City of Ottawa. Muncaster Environmental Planning in association with Robinson Consultants completed a fisheries study of the Arbuckle Municipal Drain (Van Gaal Drain from Perth Street to the confluence with the Jock River), but those data were not available at the time of printing this document. Other sources of reviewed fisheries information included the Subwatershed Study (MMM and WESA, 2005), as well as academic publications (McAllister and Coad, 1974; Mandrak and Crossman, 1992).

Site visits were conducted in early spring (early through mid April) to investigate possible spawning habitats for large species (especially pike), to document the upstream migrations of forage species (Table 8), and to document areas that would provide spawning habitat potential with an emphasis on habitat for spawning pike. The mainstem Van Gaal Drain was not electrofished in the spring because there was an expectation that adult pike might be using the drain for spawning, and electrofishing was considered to pose a potential threat to spawning adult pike. The Moore Branch (VG-R3) and Jock River Estates Drain (JED-1) were electrofished in the spring to document the use of those tributaries during anticipated maximum water levels (Figure 20). The Van Gaal Drain (VG-R2, VG-R2-1, VG-R2-2), as well as the Moore Branch and Jock River Estates Drain (JED-1) were also electrofished in early August (3rd and 9th) to document the use of those habitats during anticipated low-flow periods, following the recommended time period in the Ontario Stream Assessment Protocol (Stanfield et al., 2000). Wetted widths and depths, presence and approximate cover by macrophytes, obstructions to upstream fish migration were noted during site visits in August and October. Habitat maps (Appendix 7) illustrate key fish habitat features in each of the reaches and sub-reaches. A summary of the physical dimensions of the reaches is also provided in Appendix 7.

Table 8. Field visit schedule for fisheries-related investigations.

Date	Surveyor(s)	Purpose
5- Apr	B. Kilgour	Site orientation, documentation of spring thaw.
10-Apr	H. Bickerton, C. Delage, B. Kilgour	Site orientation
16-Apr	C. Delage	Fish habitat documentation (photo record) of the Van Gaal Drain and Moore Branch
17-Apr	C. Delage	Fish habitat documentation (photo record) of the Van Gaal Drain and Moore Branch
19-Apr	C. Delage, A. Francis	Electrofishing of Moore Branch and Jock River Estates Drain (JED-1)
18-Jun	B. Kilgour	Install temperature loggers
3-Aug	B. Kilgour, A. Francis	Electrofishing of Van Gaal Drain, Moore Branch, Jock River Estates Drain
6-Aug	B. Kilgour, J.P. Faubert	Document fish habitat in Van Gaal mainstem and Moore Branch
9-Aug	B. Kilgour, J.P. Faubert	Electrofishing Moore Branch, Van Gaal Drain
9-Oct	A. Francis	Document fish habitat in Van Gaal mainstem and Moore Branch

3.2.6.1 Jock River

The RVCA and the City of Ottawa carried out fish community investigations in 1995, 2002, 2003 and 2004. These investigations resulted in the capture of 35 fish species in the Jock River subwatershed (Figure 20; Table 9). 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 (MMM and WESA, 2005). Mottled sculpin have been captured at four locations in the mainstem of the Jock River, including three locations in the Village of Richmond. The fourth was located at the confluence of the Jock River and Monahan Drain. The preferred habitat for mottled sculpin consists of well shaded cobble and gravel riffles, and to a lesser extent sand (Scott and Crossman, 1973). The mottled sculpin captured in the Village of Richmond were collected from an area of limited shade with a substrate consisting of a combination of coarse materials (i.e., gravel, cobble) and fine material (i.e., silt, sand) (MMM and WESA, 2005). The presence of this species in areas of open canopy suggested that groundwater upwelling was occurring in these reaches.

Pearl dace have been captured at two locations within and near the Village of Richmond. In one site, Pearl dace dominated while in the second, it was outnumbered by pumpkinseed (*Lepomis gibbosus*)

and rock bass (*Ambloplites rupestris*). Pearl dace is considered a coldwater species due to its preference for a water temperature of ~16°C, although it has a high upper temperature tolerance limit of ~31°C that enables it to inhabit warmwater habitats (Scott and Crossman, 1973).

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*). The warmwater fish species captured in the main channel in the greatest abundance have included bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), common carp (*Cyprinus carpio*), emerald shiner (*Notropis atherinoides*) and pumpkinseed.

The Rideau Valley Conservation Authority and the City of Ottawa established nineteen fish-community sampling locations in the Jock River at known nursery habitat locations. Fourteen of these nursery habitat locations are located within the boundaries of the Town of Richmond between Fowler Street and Eagleson Road while the remaining stations were located at the confluence of the Jock River and Leamy Creek and immediately upstream and downstream of Moodie Drive (Figure 17). The determination of whether a species was using nursery habitat was based on the presence of young-of-year. Species observed to be using these known nursery habitat areas included bluegill, brown bullhead, muskellunge, pumpkinseed, smallmouth bass, northern pike and rock bass.

The fish species found to be using the Jock River main channel as nursery habitat at the greatest frequency included rock bass and pumpkinseed with young-of-year captured at 15 and 16 of the 19 stations, respectively. The young-of-year of both these species were found to occur with each other at 13 sites. The association of these two species is likely a result of the similarity between their preferred nursery habitats consisting of shallow water areas in or adjacent to aquatic vegetation. Young-of-year muskellunge were captured at 6 of the 19 stations in association with rock bass and pumpkinseed. The remaining species were captured at two or fewer stations. As above, the RVCA found northern pike young-of-year have been observed in the Van Gaal Drain (in 1999) suggesting that habitats in the drain upstream of Perth Street have in the past been suitable spawning and nursery habitat for pike.

Table 9. List of species reported from Jock River and their ecological sensitivities.

Common Name	Scientific Name	Socio-economic Importance			Status	Trophic Guild[6]	Repro-ductive Guild[7]	Thermal Class	Pref. Temp.	Sensitivity to Sediment/Turbidity[8] (High, Moderate, Low)		
		Rec.	Comm.	Bait						Repro.	Feeding	Resp.
northern pike	*Esox lucius*	x				P	A.1.5	cool	22.5	M	H	L
muskellunge	*Esox masquinongy*	x				P	A.1.5	warm	25.6	M	H	L
central mudminnow	*Umbra limi*			x		I/O	A.1.5	cool/warm		M	M	L
white sucker	*Catostomus commersoni*					I/O	A.1.3	cool	22.4	M	L	H
silver redhorse	*Moxostoma anisurum*					I	A.1.3	cool		M	L	H
greater redhorse	*Moxostoma valenciennesi*					I	A.1.3	cool/warm		M	L	H
northern redbelly dace	*Phoxinus eos*			x		H	A.1.5	cool/warm	25.3	M	L	L
carp	*Cyprinus carpio*	x				O		warm		M	L	
brassy minnow	*Hybognathus hankinsoni*			x	NAR	O/H	A.1.4	cool		M	L	
golden shiner	*Notemigonus crysoleucas*			x		O	A.1.5	cool	23.8	M	M	L
emerald shiner	*Notropis atherinoides*			x		I	A.1.1	cool	22-25	M	L	H
common shiner	*Luxilus cornutus**			x		I	B.2.1	cool	21.9	M	M	
blacknose shiner	*Notropis heterolepis*			x		I	A.1.6	cool/warm		M	M	H
spottail shiner	*Notropis hudsonius*			x		I	A.1.6	cold/cool	14.3	M	M	H
bluntnose minnow	*Pimephales notatus*			x		O	B.2.3	warm	29	M	L	
fathead minnow	*Pimephales promelas*			x		O	B.2.3	warm	29	L	L	
blacknose dace	*Rhinichthys atratulus*			x		I/Ge	A.1.3	cool	24.6	M	M	H
longnose dace	*Rhinichthys cataractae*			x		I	A.1.3	cool	20.6	M	M	H
creek chub	*Semotilus atromaculatus*	x		x		I/Ge	A.2.1	cool	20.8	M	H	H
fallfish	*Semotilus corporalis*	x		x		I	A.2.1	cool		M	H	H
pearl dace	*Margariscus margarita**			x		I	A.1.3	cold/cool	16.2	M	M	H
yellow bullhead	*Ameirus natalis**	x				I	B.2.5	warm	28.3	M	L	
brown bullhead	*Ameirus nebulosus**	x	limited			I	B.2.3	warm	25-27	M	L	L
banded killifish	*Fundulus diaphanus*			x		I	A.1.5	cool	21	M	M	L
brook stickleback	*Culaea inconstans*			x		I	B.2.5	cool	21.3	L	M	
rock bass	*Ambloplites rupestris*					I/P	B.2.1	cool	20.5	L	H	
pumpkinseed	*Lepomis gibbosus*	x				I	B.2.4	warm	26	L	M	
bluegill	*Lepomis macrochirus*	x				I	B.2.1	warm	30.9	L	M	
smallmouth bass	*Micropterus dolomieu **	x	past			I/P	B.2.1	warm	30.3	M	H	
largemouth bass	*Micropterus salmoides*	x	past			I/P	B.2.2	warm	30.2	L	H	H
black crappie	*Pomoxi*	x				I/P	B.2.2	cool	21.7	L	H	

Common Name	Scientific Name	Socio-economic Importance			Status	Trophic Guild[6]	Repro-ductive Guild[7]	Thermal Class	Pref. Temp.	Sensitivity to Sediment/Turbidity[8] (High, Moderate, Low)		
		Rec.	Comm.	Bait						Repro.	Feeding	Resp.
	nigromaculatus											
walleye (yellow pickerel)	*Stizostedion vitreum vitreum*	x				P	A.1.3	cool	22	M	H	H
Johnny darter	*Etheostoma nigrum*			x		I	B.2.3	cool	22.8	M	M	
logperch	*Percina caprodes*			x		I	A.1.6	cool/warm		M	M	H
mottled sculpin	*Cottus bairdi*			x		I	B.2.3	cold	16.6	M	M	

Table Note: Ecological attributes are from MTO (2006) and Coker et al. (2001). See Appendix 9 for definition of reproductive guilds. Species list is from Table Note: classification provided in MMM and WESA (2005).

3.2.6.2 Van Gaal/Arbuckle Drain (VG-R2)

The fish community of the Van Gaal/Arbuckle Drain has not been well characterized, and was not described in the Subwatershed Study (MMM and WESA, 2005). The Rideau Valley Conservation Authority (Jennifer Lamoureux) has a record of young-of-year northern pike having been collected at Perth Street in 1999. RVCA also has a record of white sucker having been caught in the drain upstream of Perth Street in 2000.

The early-August inventory of the Van Gaal/Arbuckle Drain produced a variety of cool-water species including central mudminnow, brook stickleback, brassy minnow, common shiner, and Johnny darter (Table 10). The various ecological tolerances and preferences of species found in the Moore Branch are provided in Table 11. A single 15-cm young-of-year northern pike was collected ~250 m downstream of Perth Street at Station VG-R2(2), upstream of the Moore Branch, reflecting successful spawning by adult pike within the Van Gaal/Arbuckle drainage potentially in the vicinity of that same station. Creek chub were about the most dominant species in the drain from the lowest station surveyed to the most upstream station surveyed within VG-R2. Central mudminnow was, however, the most abundant species in the two tributaries to VG-R2 (i.e., VG-R2-1 and VG-R2-2).

The more easterly branch of the Van Gaal Drain (i.e., VG-R2-2) was essentially standing water, with negligible flow in August. The lack of diversity of fish in that tributary suggested degraded conditions, particularly considering the two species present were brook stickleback and central mudminnow.

Mottled sculpin were found throughout the Van Gaal 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 (Table 10). Water temperatures at the Perth Street culvert indicated that the Van Gaal 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 (Jennifer Lamoureaux), which is the precise location where a spawning shelf was constructed. The channel is slightly wider there, and is well vegetated with emergent macrophytes (see photos for sub-reach VG-R2f in Appendix 7). That location provides potential, though limited in terms of area, habitat for pike spawning.

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; Figure 21). 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. Pike spawn in flooded grasses and sedges when water temperatures are between 4 and 11°C (Scott and Crossman, 1973). Adhesive eggs require between 12 and 14 days to hatch. Water levels, therefore, need to remain high and flooding vegetation for a period of 2 to 3 weeks. Photographs of the lower reach of the Van Gaal/Arbuckle Drain (VG-R2a) and of the Moore Branch (VG-R3) (Appendix 7) show the appropriate water elevations in the Moore Branch on April 10, 2008, but less appropriate

elevations on April 17 (i.e., one week later). However, grasses and sedges that line the channel of the lower Moore Branch were flooded on April 17, and may have provided suitable spawning habitat for pike.

The potential for pike to spawn in habitats downstream of the Fortune Street culvert are limited according to Bernie Muncaster (personal communication), 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 (according to Bernie Muncaster, personal communication, August 29, 2008).

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.

Table 10. Fish collection records for the Van Gaal/Arbuckle Drain, August 3 and 6, 2008.

Species (MNR Code)	Location						
	VG-R2(1)	VG-R2(2)	VG-R2(3)	VG-R2(4)	VG-R2(5)	VG-R2-1(1)	VG-R2-2(1)
northern pike (131)		1					
central mudminnow (141)	3	5	5	3	18	9	20
white sucker (163)		6	3	1	1		
northern redbelly dace (182)			1				
brassy minnow (189)		4	2	3			
common shiner (198)		25	45	105	41		12
spottail shiner (201)			4				
bluntnose minnow (208)		11	14	19	2		
fathead minnow (209)			1	3			
blacknose dace (210)		28	8	74	15		3
creek chub (212)	2	56	50	70	25		2
brook stickleback (281)			26	1		1	1
rock bass (311)		1			2		
pumpkinseed (313)	3						
Johnny darter (341)		5	14	2	1		1
mottled sculpin (381)	1	5	3	5	2		4
Distance Shocked (m)							
Number of Species	4	11	13	11	9	2	7
Total Fish	9	147	176	286	107	10	43

Table Note: see detailed catch records in Appendix 8. Site locations are provided in Figure 20.

Table 11. List of species reported from the Van Gaal/Arbuckle Drain and their ecological sensitivities.

Common Name	Scientific Name	Socio-economic Importance			Status	Trophic Guild[6]	Repr. Guild	Thermal Class	Preferred Temp.	Sensitivity to Sediment/Turbidity[8] (High, Moderate, Low)		
		Recr.	Comm.	Bait						Repr.	Feed	Resp.
northern pike	*Esox lucius*	x				P	A.1.5	cool	22.5	M	H	L
central mudminnow	*Umbra limi*			x		I/O	A.1.5	cool/warm		M	M	L
white sucker	*Catostomus commersoni*					I/O	A.1.3	cool	22.4	M	L	H
northern redbelly dace	*Phoxinus eos*			x		H	A.1.5	cool/warm	25.3	M	L	L
brassy minnow	*Hybognathus hankinsoni*			x	NAR	O/H	A.1.4	cool		M	L	
common shiner	*Luxilus cornutus**			x		I	B.2.1	cool	21.9	M	M	
spottail shiner	*Notropis hudsonius*			x		I	A.1.6	cold/cool	14.3	M	M	H
bluntnose minnow	*Pimephales notatus*			x		O	B.2.3	warm	29	M	L	
fathead minnow	*Pimephales promelas*			x		O	B.2.3	warm	29	L	L	
blacknose dace	*Rhinichthys atratulus*			x		I/Ge	A.1.3	cool	24.6	M	M	H
creek chub	*Semotilus atromaculatus*	x		x		I/Ge	A.2.1	cool	20.8	M	H	H
brook stickleback	*Culaea inconstans*			x		I	B.2.5	cool	21.3	L	M	
rock bass	*Ambloplites rupestris*					I/P	B.2.1	cool	20.5	L	H	
pumpkinseed	*Lepomis gibbosus*	x				I	B.2.4	warm	26	L	M	
Johnny darter	*Etheostoma nigrum*			x		I	B.2.3	cool	22.8	M	M	
mottled sculpin	*Cottus bairdi*			x		I	B.2.3	cold	16.6	M	M	

Table Note: Ecological attributes are from MTO (2006) and Coker et al. (2001). See Appendix 1 for definition of reproductive guilds

Figure 20. Fish collection sampling locations for April and August inventories.

Figure 21. Air photo of the Arbuckle/Moore confluence showing area considered to be sensitive and potential pike spawning/rearing habitat.

Figure Note: Figure provided by Bernie Muncaster.

3.2.6.3 Moore Branch

The Moore Branch was utilized by 15 fish species during the spring high-flow event (Table 12). 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 (Table 13). The ecological tolerances and preferences of these species are provided in Table 14.

A single central mudminnow was found in the branch near VG-R3-2(2) (Figure 20) 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, however, were no other fish observed or electrofished in the upstream reach. 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, with flows provided by a tile drain (Appendix 7). 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 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.

Table 12. Fish collection records for the Moore Branch, April 17, 2008

Species (MNR Code)	Location				
	VG-R3 (1)	VG-R3 (2)	VG-R3 (3)	VG-R3-2 (1)	VG-R3-2 (2&3)
central mudminnow (141)	2	2	10		
white sucker (163)	11	5	4	8	2
northern redbelly dace (182)	2	1	3	12	3
brassy minnow (189)			1	3	
silvery minnow (190)	1	1	2		
golden shiner (194)	2				
common shiner (198)	41	20	3	1	
blacknose shiner (200)	4				
bluntnose minnow (208)	14	1			
fathead minnow (209)	4		2	1	
blacknose dace (210)	1				
longnose dace (211)			2	1	
creek chub (212)	7	23	17	11	
pearl dace (214)	1		5	30	5
brook stickleback (281)	12	5	17		
Distance Shocked (m)	70	100	400	525	620
Number of Species	13	8	11	8	3
Total Fish	102	58	66	67	10

Table Note: see detailed catch records in Appendix 8. Site locations are provided in Figure 20.

Table 13. Fish collection records for the Moore Branch, August 3 and 6, 2008

Species (MNR Code)	Location			
	VG-R3(2)	VG-R3(3)	VG-R3-2(2)	VG-R3-2(3)
central mudminnow (141)	1		1	
common shiner (198)	21			
creek chub (212)	11	1		
pearl dace (214)		29		
brook stickleback (281)	11	2		
Distance Shocked (m)				
Number of Species	4	3	1	0
Total Fish	44	32	1	0

Table Note: see detailed catch records in Appendix 8. Site locations are provided in Figure 20.

Table 14. List of species reported from the Moore Branch and their ecological sensitivities.

Common Name	Scientific Name	Socio-economic Importance			Status	Trophic Guild[6]	Repr. Guild[7]	Thermal Class	Preferred Temp.	Sensitivity to Sediment/Turbidity[8] (High, Moderate, Low)		
		Rec	Comm.	Bait						Repr	Feed	Resp
central mudminnow	*Umbra limi*			x		I/O	A.1.5	cool/warm		M	M	L
white sucker	*Catostomus commersoni*					I/O	A.1.3	cool	22.4	M	L	H
northern redbelly dace	*Phoxinus eos*			x		H	A.1.5	cool/warm	25.3	M	L	L
brassy minnow	*Hybognathus hankinsoni*			x	NAR	O/H	A.1.4	cool		M	L	
silvery minnow	*Hybognathus nuchalis*			x		H	A.1.4	cool/warm		M	L	
golden shiner	*Notemigonus crysoleucas*			x		O	A.1.5	cool	23.8	M	M	L
common shiner	*Luxilus cornutus**			x		I	B.2.1	cool	21.9	M	M	
blacknose shiner	*Notropis heterolepis*			x		I	A.1.6	cool/warm		M	M	H
bluntnose minnow	*Pimephales notatus*			x		O	B.2.3	warm	29	M	L	
fathead minnow	*Pimephales promelas*			x		O	B.2.3	warm	29	L	L	
blacknose dace	*Rhinichthys atratulus*			x		I/Ge	A.1.3	cool	24.6	M	M	H
longnose dace	*Rhinichthys cataractae*			x		I	A.1.3	cool	20.6	M	M	H
creek chub	*Semotilus atromaculatus*	x		x		I/Ge	A.2.1	cool	20.8	M	H	H
pearl dace	*Margariscus margarita**			x		I	A.1.3	cold/cool	16.2	M	M	H
brook stickleback	*Culaea inconstans*			x		I	B.2.5	cool	21.3	L	M	

Table Note: Ecological attributes are from MTO (2006) and Coker et al. (2001). See Appendix 9 for definition of reproductive guilds

3.2.6.4 Jock River Estates Drain

The Jock River Estates Drain flows along Ottawa Street, then south-east through a field (JED-1) where it goes through the manmade berm at the Jock River (see Photo Set 5; Appendix 7). During the spring of 2008, the drain contained five species of fish in relatively low abundances (Table 15). The environmental tolerances and preferences of these species are provided in Table 16. 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 constructed fish habitat that did not occur prior to its construction.

The outlet of this drain provides some water to the wetland feature adjacent to the Jock River. That feature was described in the terrestrial section as containing meadow marsh, thicket swamp and pickerel weed, much of which would provide potential spawning habitat for pike and other fish species. Water levels in that wetland feature appear to be largely controlled by water levels in the Jock River. Water levels in the marsh were about 30 cm deep, a level determined by the level of the Jock River, since there were negligible flows discharging from the Jock River Estates Drain.

Table 15. Fish collection records for the Jock River Estates drain, April 17 and August 3, 2008

Species (MNR Code)	Location	
	April	August
central mudminnow (141)	15	3
bluntnose minnow (208)	3	
fathead minnow (209)	10	1
creek chub (212)	1	3
brook stickleback (281)	7	16
Distance Shocked (m)	500	23
Number of Species	5	4
Total Fish	36	23

Table Note: see detailed catch records in Appendix 8. Site location is provided in Figure 20.

Table 16. List of species reported from the Jock River Estates Drain and their ecological attributes.

Common Name	Scientific Name	Socio-economic Importance			Status	Trophic Guild[6]	Repr. Guild	Thermal Class	Preferred Temp.	Sensitivity to Sediment/Turbidity[8] (High, Moderate, Low)		
		Recr	Comm.	Bait						Repr	Feed	Resp
central mudminnow	*Umbra limi*			x		I/O	A.1.5	cool/warm		M	M	L
bluntnose minnow	*Pimephales notatus*			x		O	B.2.3	warm	29	M	L	
fathead minnow	*Pimephales promelas*			x		O	B.2.3	warm	29	L	L	
creek chub	*Semotilus atromaculatus*	x		x		I/Ge	A.2.1	cool	20.8	M	H	H
brook stickleback	*Culaea inconstans*			x		I	B.2.5	cool	21.3	L	M	

Table Note: Ecological attributes are from MTO (2006) and Coker et al. (2001). See Appendix 9 for definition of reproductive guilds

3.2.6.5 Other Biota

Anecdotal inventories of additional biota such as aquatic plants and invertebrates of the Van Gaal Drain were conducted as part of the habitat inventories and electrofishing conducted in August. The Van Gaal Drain contained a number of submerged and emergent aquatic plants. The macro-alga *Cladophora* was often present in areas with exposure to direct sunlight, and often to excessive levels. Substrate within the channel was often sub-optimal for *Cladophora* because it was predominantly sand on clay, or silt/clay. *Cladophora*, however, was often attached to the bases of other plants including arrowhead (*Sagittaria*) that was also dominant in the channel. In addition to arrowhead, the mainstem of the Van Gaal Drain also contained cattail (*Typha*), bulrush (*Scirpus*), and giant bur-reed (*Sparganium*) in relatively high abundance, as well as various species of pondweed (*Potamogeton* sp.) in less abundance. Duckweed (*Lemna*) covered much of the surface of the eastern tributary to the Van Gaal Drain (i.e., VG-R2-1) where there was exposure to sunlight.

The benthic community of the Van Gaal Drain is not diverse, owing largely to the predominantly sand/silt/clay bottom. Crayfish (*Orconectes* sp.) were sporadically present throughout the drain, with burrows in the clay bottom, as well as in areas with rip-rap reinforcing. A single sweep sample for benthic invertebrates ~ 100 m upstream of the Perth Street culvert produced chironomids, snails of several kinds including *Helisoma*, *Gyraulus*, *Physa* and *Stagnicola*, water boatmen (Corixidae), damselfly larvae (*Odonata*), tubificid worms and water mites (Acarina). A second sweep sample of cobble/boulder material in the vicinity of the VG-R2(5) failed to produce stoneflies or mayflies, but did produce net-spinning caddisflies (Hydropsychidae). The general absence of larger cobble and gravel in all of the channels is a limiting factor for many of the larger insects such as caddisflies and mayflies. Water temperatures are generally too high for stoneflies (Plecoptera).

Shells of fingernail clams were present throughout the channel, with the most dominant species of shell being *Sphaerium simile*. The freshwater mussel *Anodontoides ferruscianus* was also present in the drain, with both living (one live specimen found at VG-R2(2) and empty (dead) shells found sporadically throughout the drain.

3.2.6.6 Species at Risk

A review of Royal Ontario Museum (ROM) and the OMNR listings of aquatic (fish) species at risk in Ontario indicated only three fish species have ranges potentially intersecting the Jock River watershed: Lake Sturgeon (*Acipenser fulvescens*), American Eel (*Anguilla rostrata*) and River Redhorse (*Moxostoma carinatum*). There are, however, no records of any of these species anywhere in the entire Rideau River watershed.

3.2.7 Aquatic Environment Summary

- The ultimate regulatory 100-year flood line for the Jock River and the Van Gaal/Arbuckle Drain covers a large portion of Mattamy's land holding.

- The meander belt for the Jock River in the vicinity of the Mattamy land holding is 180 m. The meander belt for the mainstem Van Gaal Drain is 42 m, while it ranges from 18 to 30 m for the various sections of the Moore Branch, and 25 m for the Jock River Estates storm drain outlet.

- The Van Gaal/Arbuckle Drain, and the Jock River Estates Drain have high total phosphorus concentrations reflecting inputs from agricultural activities. Those high concentrations have led to relatively heavy growths of aquatic plants.

- The Van Gaal/Arbuckle Drain contained a relatively diverse assemblage of fish, including up to 16 species, with many considered cool-water species.

- Mottled sculpin were present in the Van Gaal/Arbuckle Drain, indicating coldwater, but not the Moore Branch nor the Jock River Estates Drain.

- The Van Gaal Drain/Arbuckle Drain is a marginal "cool"-water system, while the Moore Branch provides "cool" water to the Van Gaal/Arbuckle Drain.

- A single young-of-year northern pike was observed in the Van Gaal/Arbuckle Drain downstream of Perth Street, suggesting the local presence of pike spawning habitat. The confluence of the Moore Branch with the Arbuckle Drain may provide suitable pike spawning habitat. However flows were lower in 2009 than 2008, making the confluence area less suitable as pike spawning habitat. Very little riparian vegetation was flooded, contrasting with conditions in 2008. Thus the confluence area is currently less than likely to support viable pike spawning.

- The Moore Branch is used by several species of forage fish for spring spawning. The upper reaches of the Moore Branch are ephemeral, and cannot contribute significantly to the productive potential of the Arbuckle Drain because of a high point in the drainage that isolates the fish community during periods of low flow.

- The Jock River Estates Drain is used by five species of fish for spring spawning. The upper reaches of that tributary are ephemeral, with only the most downstream ~ 150 m being fully aquatic (through to until August), and thus do not contribute significantly to the productive potential of the Jock River.

4.0 ENVIRONMENTAL MANAGEMENT GUIDELINES

Mattamy's proposed development for the Richmond Land holding respects both Regulatory Requirements and the City of Ottawa's "Design-With-Nature" objectives. This chapter provides a summary of Mattamy's "Design-with-Nature" guidelines that recognize regulatory constraints, as well as opportunities for utilizing or enhancing the existing natural and green-spaces that are found on the lands.

4.1 General

General Environmental Management Guidelines include the following:

- Promote openness and visibility of the natural elements to promote accessibility and open space opportunities.
- Floodplains will be incorporated into the greenspace system and used as passive public amenity areas.
- Parks to be located adjacent to watercourse corridors or hazard lands and woodlands; hazards lands are not considered parkland.
- Existing natural features, such as significant woodlands and hedgerows, should be incorporated into the new development through such means as street design and individual lotting patterns, grading patterns and on institutional, civic and parkland areas. Building setbacks can be adjusted to accommodate tree preservation.
- Aerial mapping should be used in preliminary design of subdivisions, to locate existing features such as good quality trees, hedgerows, and determine the potential for their integration into plans.

4.2 Jock River and Watercourses

The Jock River corridor is an important environmental and community asset that will be preserved as public greenspace.

The Van Gaal/Arbuckle Drain is a tributary to the Jock River which supports a high diversity of fish species. This watercourse will be conserved with a development setback that is the greater of: the 100-year floodplain, meander belt allowance, 30 m from normal high watermark; and geotechnical hazard (Figure 23).

For those tributaries that are classified as a Municipal Drain under the Drainage Act, the setback and maintenance access requirements will be respected.

For the Moore Branch, the development setback will be set to:

- The 100-year floodplain for Sections 1 and 2;

- The 100-year floodplain for the lower portion of Section 3, and the 30 m meander-belt for the upper portion of Section 3.

- The edge of the meander belt for Sections 4 through 8 (15 to 18 m, Table 4), to protect property, allow the channel an opportunity to develop a natural meander, and more than adequately protect and maintain the ecological function of the aquatic habitat (6.2.4 - Risks to Fish Habitat on page 117).

Tributaries should be restored and enhanced using natural channel principles, where required. Their corridors should be planted with native species along both sides to enhance aquatic habitat.

4.3 Fisheries Enhancements

Fisheries enhancement opportunities are available in the middle sections of the Moore Drain, as well as the mainstem Van Gaal and Arbuckle Drains in areas that Mattamy owns access. Potential works could include:

- Riparian plantings along the mainstem Van Gaal and Arbuckle drains within the corridor setbacks.

- Upgrade of tractor crossing over Van Gaal (increase culvert to 1.2 X bankfull width to reduce constriction and velocities during high-flow events) as a future road crossing

- Enhancement of baseflows to Section 2 of Moore Branch from the adjacent SWM pond.

- Re-grading of Sections 7 and 6 of the Moore Branch to provide proper conveyance during periods of low flow ensuring that fish do not continue to be stranded in the upper Section 7.

Pike spawning area has been identified (Figure 21) on the Arbuckle Drain upstream of Fortune Street to just past Martin Street and along the Moore tributary at the confluence. However, upstream of Fortune Street the water is moving out too quickly when temperatures are optimal for spawning. As part of the construction of the outlet channel for the proposed stormwater management pond, there is an opportunity to create additional low-lying habitat that would potentially stay flooded longer during the spring and provide more optimal pike spawning habitat. This has been considered in the design of the outlet channel.

4.4 Pathways and Trails

Trails will be situated at the edge of one side of the Jock River and Van Gaal/Arbuckle hazard land as extensions of the Village greenway system.

Trails within or adjacent to natural features will be designed for pedestrian use based on each site's sensitivities to minimize environmental impacts. Trails in natural areas should have the following features:

- The location and layout of the trail system should be respectful to sensitive features and functions that should not be exposed or disturbed; proposed trail locations will be identified in the Environmental Impact Statement and Tree Conservation Plan.

- Footpaths (width and materials) should be low impact encourage;

- Pathway materials and widths should consider both upland and wetland conditions and minimize the likelihood of establishment of invasive species;

- Pedestrian-friendly barriers (e.g., dead logs, rocks, etc.,) should be strategically placed to discourage public access to areas of ecological sensitivity;

- Existing trails that do not form part of the recommended trail system should be decommissioned; and,

- Interpretative signs should be included to feature local ecological highlights.

Pathways for pedestrians and cyclists are preferred to be 3.0 m wide; trails for pedestrians are preferred to be 2 m wide. In both cases, the minimum width of the block will not be less than 6 m.

Where green streets are proposed, an alternate street ROW should be encouraged to provide for a greenway pathway or trail. In this way, "green" streets may be created as a key means to create continuity in the Greenspace Network.

The pedestrian bridge at Martin Street is to be designed to respect the identified fish habitats in that area (potential pike spawning); with a structure that does not alter spring flows and water levels of the Arbuckle Drain. The design for the pedestrian bridge will consider maintenance costs in determining design specifications. The footprint of the bridge is to be outside of the 2-year event, or to have a width not less than ~ 1.2x bankfull.

Pathway locations, width, materials, etc., will be determined at the Plan of Subdivision process through the Tree Conservation Report, Landscape Plan and Environmental Impact Statement. The Plan of Subdivision will clearly locate the location of the pathway within the hazard setback, where required.

4.5 Significant Woodland and the Jock River Corridor

The woodland feature along the Jock River corridor meets the definition of "significant woodland" (Figure 23). The riparian corridor of natural areas along the Jock River also provides a corridor for potential wildlife movement between the Marlborough Forest and Richmond Fen. The significant woodland classification deems that the woods should be protected based on the policy provisions of the City of Ottawa's Official Plan. The significance classification of the woods on Mattamy's land holdings is contingent on the retention of the woodland on adjacent properties.

Development near or adjacent to the significant woodland and the Jock River corridor should be sensitive to the features and functions of this natural area and corridor. The subdivision layout should

ensure that the orientation of the roadways and residential lots, park areas and roadway configuration (e.g. single-loaded roads) provide:

- views to, and along the Jock River and the significant woodland,
- community access at key points to the open space network along the Jock River.

No works will be conducted within 120 m of the significant woodland and Jock River corridor (Figure 24) until an Environmental Impact Statement (EIS) has determined an appropriate site-specific setback. The EIS will need to conform with the Provincial Policy Statement, OPA 76 and any other guidelines in place at the time of submission.

An EIS will be required for any development application within 120 m of the significant woodland and vegetation communities 4-9 and 11 along the Jock River corridor (refer to Figure 5). A Table of Contents will be submitted to the City and RVCA for input prior to submitting the EIS.

The analysis of the impact of the proposed development on interior forest birds will be carried out within the EIS. The analysis will consider the "area" requirements of interior forest birds observed in the woodland, the area available to them, and the mitigations that will minimize/avoid risks to these species. The EIS will also consider the influence of the local significant woodlands adjacent and near the Mattamy land holding, as they are generally larger, and are also important to the local avian ecology.

The development setback will be determined through the EIS and in addition to the policies in Section 4.7.8 of the Official Plan and any other guidelines in place at the time of subdivision application will consider:

- Ecological function of the significant woodland in relation to other local environmental features,
- Potential for adjacent residential property damage due to windthrow and wildlife;
- Potential damage to the woodland vegetation and wildlife as a result of increased access by persons and their pets;
- Potential for designing a natural buffer that creates a transition to the woodland to residential areas, and that minimizes access by persons and their pets;
- Potential for posting or distribution of educational materials targeting local residents, and communicating ways to minimize ecological damage;
- Developments adjacent to the significant woodland and its buffer to be consistent with the "design-with-nature" approach; and,

- Development near or adjacent to the significant woodland along the Jock River should be sensitive to the features and functions of the woods when designing the orientation and layout of roadways and residential lots.

4.6 Local Woodlands and Hedgerows

The local woodland north of Perth Street (W1) is not considered ecologically significant, but a portion of the woods will be retained within the watercourse setback providing riparian cover along a portion of the Van Gaal Drain. Efforts will be made to retain as many specimens of the regionally uncommon species as possible.

The small woodland north of Ottawa Street (W2) is not considered ecologically significant but is valued locally and shown on 1946 aerial photographs. The majority of this woodland will be preserved as a public open space. The following mitigation measures are recommended to improve and maintain the integrity of this small woodland area:

- Fencing of new lots situated adjacent to the woodland
- Single loaded road adjacent to the woodland
- Clean up of current site prior to dedicating to the City
- Education/stewardship brochure provided to existing adjacent residents
- Limit access/ formalize trail system

The north-south hedgerow (H1) along the village boundary provides a green buffer between the farmland and the residential neighbourhood. The hedgerow will be maintained within the back and side yards of the development as private property.

The east-west hedgerow (H3) that contains the Moore Tributary will be maintained as a green/blue feature within the neighbourhood plan. The feature will be regraded and designed for stormwater management, then re-instated with vegetation along its length. The redesign of the channel will follow natural channel principles with native species planted along both sides of the creek to enhance aquatic habitat.

Where feasible, good quality trees will be transplanted when removed in order to retain trees in the area.

The retention of the hedgerows is dependent on acceptance of the preferred stormwater drainage and grading plan which minimizes fill requirements.

Hedgerows and woodlands on adjacent lands will be unaffected as grading will respect elevations on adjacent properties.

4.7 Grading

Grading and fill required for stormwater management and other servicing infrastructure will be minimized and where required, will be managed to protect the significant woodland, retained hedgerows, treed areas and significant trees on and adjacent to the site (see Figure 22 for a conceptual illustration of the grading requirement).

Grading plans, in support of development applications, must ensure that existing grades are matched around trees noted for preservation; and road grades and elevations of the proposed road network must also ensure that existing grades are maintained around trees noted for preservation.

The EIS and Tree Conservation Report will identify specific impacts to terrestrial features on and adjacent to the property associated with grading requirements and recommend appropriate mitigation measures, where required.

4.8 Stormwater Ponds & Outlets

Where possible, stormwater ponds should be located to provide green gateways to the community.

Street frontage will be provided along sections of ponds and tributaries through such means as single-loaded roads to promote public access to these natural areas.

Generally, ponds shall not be fenced. However, when the City requires fencing (i.e., between the pond and a sidewalk, abutting an arterial road), it shall be decorative in nature and in keeping with the theme of the streetscape.

Ponds should be designed to be naturally shaped and vegetated to provide aesthetic and ecological (e.g., maintain thermal regime) benefits.

The outlets from the ponds should be designed applying natural channel design principles that provide aquatic benefits.

4.9 Water Crossings

The tractor crossing of the Arbuckle Drain should be upgraded with a larger structure more capable of properly conveying high flow events. There is no critical spawning habitat for fish in that area, so no concerns with regard to potential impacts to sensitive habitat. The structure would be designed according to current and best practices.

The Martin Street crossing of the Arbuckle Drain will be designed to respect the identified fish habitats in that area (potential pike spawning), with a structure that does not alter spring flows to that area. The footprint of the structure should be minimized. The sanitary crossing at Martin Street will involve laying the pipe beneath waterways which will have to comply with permits, timing, required environmental safeguards and mitigating construction impacts per the Ontario Ministry of Transportation's Environmental Standards and Practices and the RVCA.

A village collector roadway is proposed to cross a section of the Moore Branch. The crossing will be designed to convey spring flows as per the existing condition. There is no critical fish habitat spawning in the area, while spawning by cyprinids and other species can be expected to be carried out as usual with the crossing in place. The culvert structure can be anticipated to provide a refuge during periods of low water.

4.10 Owner Environmental Awareness Brochure

The developer will prepare an owner awareness package with information on environmental issues to promote an understanding of the importance of woodlands, importance and care of trees on private property and foster stewardship initiatives for new residents.

4.11 Tree Planting and Conservation

Where there is insufficient room on a site plan application or plan of subdivision to plant the required number of trees as specified in the draft conditions , the 'owed' trees will contribute to a "tree bank" and will be planted within the community (e.g. on school sites, in parks, in creek buffer, used to rehabilitate natural areas etc.).

Through the Tree Conservation Report, good quality specimen trees will be identified and where possible retained and incorporated in the subdivision plan.

4.12 Overall Environment-Related Development Constraints

The various environmental development constraints to the proposed development are illustrated in Figure 24 through Figure 26, and were developed as a direct result of the policy considerations discussed in Section 1.3. Significant constraints on development include: the meander belts associated with the Moore Branch, Van Gaal Drain, Arbuckle Drain (Figure 23), significant woodland and Jock River corridor (Figure 24), and the regulatory 100-year flood plain (Figure 25). The sum of those constraints is further illustrated in Figure 26, and detailed in table below.

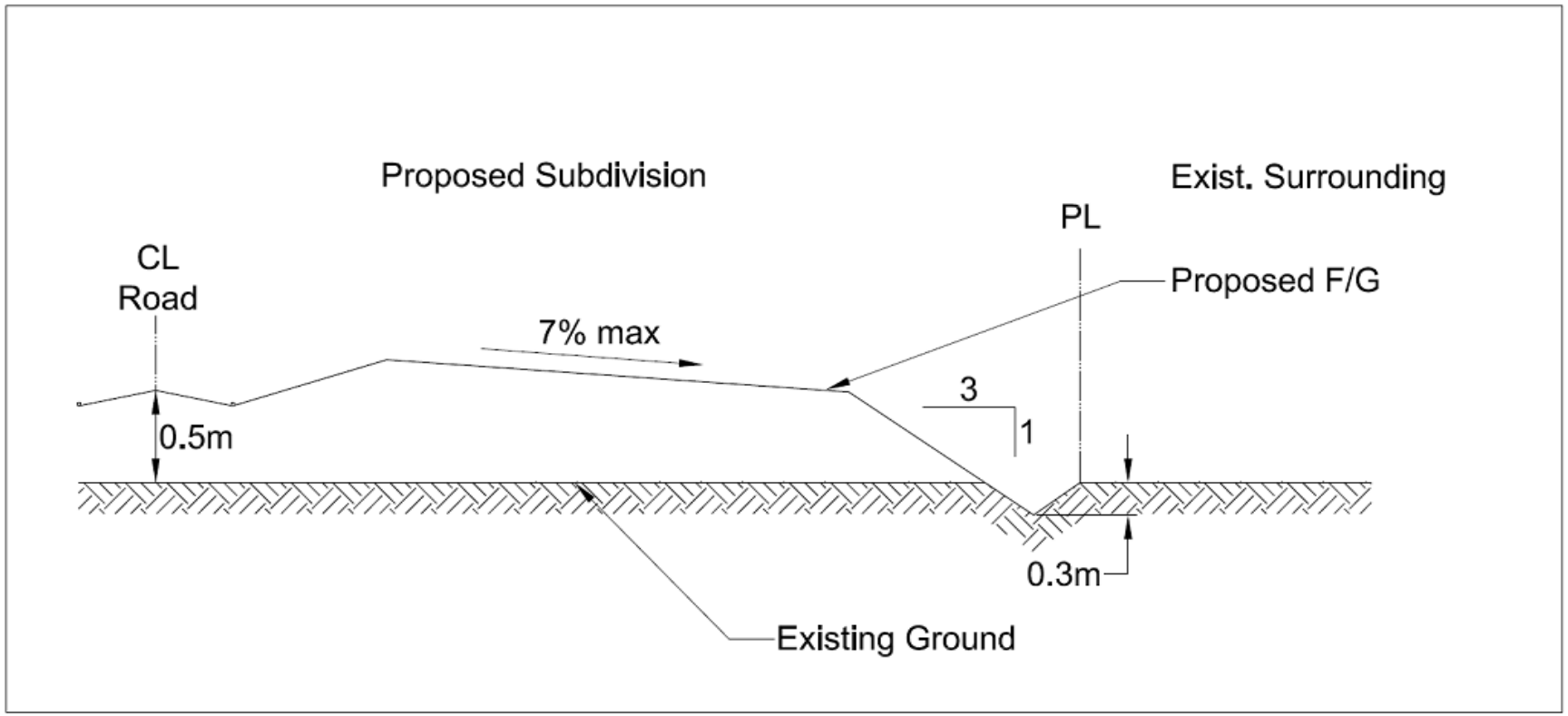


Figure 22. Conceptual drawing of tapered grading.

Table 17. Proposed watercourse setbacks

Watercourse	Reach	Regulatory Constraints	Proposed Minimum Setback (m) Distance from Watercourse	Justification
Van Gaal / Arbuckle	VG-R2-1	-30 m setback from high water mark to protect direct sensitive fish habitat	30 m from normal high water mark	The 30 m setback from the high-water mark respects the City of Ottawa Official Plan for watercourses containing fish.
	VG-R2-2	-100-yr ultimate floodplain -30 m setback from high water mark to protect direct sensitive fish habitat	30 m from normal high water mark.	Ultimate floodplain is within the 30 m setback for the protection of aquatic habitat.
	VG-R2 (upstream of Perth Street)	-100-yr ultimate floodplain -30 m setback from high water mark to protect direct sensitive fish habitat	30 m from normal high water mark, or floodplain where it is greater.	Floodplain extends to ~ 50 m in some places along the reach.
	VG-R2 (downstream of Perth Street)	-100-year floodplain -30 m setback from high water mark to protect direct sensitive fish habitat	~200+ m from normal high water mark associated with floodplain	Regulatory floodplain forces the setback, and will provide protection to ecological functions of the Arbuckle Drain.
Moore Branch	VG-R3 (Section 1, Section 2 lower portion)	-100-year floodplain -Meander belt	~125+ m from normal high water mark associated with floodplain	Regulatory floodplain forces the setback, and will provide protection to ecological functions of the lower portions of the Moore Branch.
	VG-R3 (Section 2 upper portion)	-Meander belt	30 m corridor from centre line of the channel. Bankfull width is 5 m, so setback from normal high water mark would be ~ 12.5 m.	Fluvial geomorphological studies have demonstrated that the 30 m corridor would permit natural conveyance and ecological function. Proposed corridor would be greater than existing corridor, ensuring ecological function and integrity.
	VG-R3 (Section 3)	-Meander belt	30 m corridor from centre line of the channel. Bankfull width is 3.7 m, so setback from normal high water mark would be ~ 13 m.	
	VG-R3-1 (Sections 4, 5)	-Meander belt	19 m corridor from centre line of drain	Fluvial geomorphological studies have demonstrated that the 19 m corridor would

Watercourse	Reach	Regulatory Constraints	Proposed Minimum Setback (m) Distance from Watercourse	Justification
				permit natural conveyance and ecological function. Proposed corridor would be greater than existing corridor, ensuring ecological function and integrity.
	VG-R3-2 (Sections 6, 7)	-Meander belt	17.3 m corridor from centre line of drain. With a 4.1 m bankfull width, the setback would be 6.6 m from the normal high water mark.	Detailed hydraulic and fluvial geomorphological studies have demonstrated that the 18 m corridor would permit natural conveyance and ecological function. Proposed corridor would be greater than existing corridor, ensuring ecological function and integrity.
	VG-R3-2 (Section 8)	-Meander belt	17.2 m corridor from centre line of drain. With a 3.6 m bankfull width, the setback would be 7.6 m from the normal high water mark.	Detailed hydraulic and fluvial geomorphological studies have demonstrated that the 18 m corridor would permit natural conveyance and ecological function. Proposed corridor would be greater than existing corridor, ensuring ecological function and integrity.
Jock River	Southeast corner of Mattamy land holding	-100-year floodplain -15 m setback from top of bank to protect direct fish habitat -Meander belt	60 m (minimum) from normal high water mark associated with floodplain	Ultimate floodplain is the greatest setback, and will provide protection to ecological functions of the Jock River.
	Southwest corner of Mattamy land holding	-100-year floodplain -15 m setback from top of bank to protect direct fish habitat -Meander belt -Significant woodland	Setback to be determined through completion of an EIS. At a minimum the setback will be 15 m from top of bank. Potentially much greater to respect boundary of significant woodland and meander belt.	EIS is to be completed, at which point the minimum setback protecting the Jock River and associated riparian areas will be determined.

Table Notes: see Figure 22 for reach locations, Figure 24 for the floodplain map, and Figure 25 for an overall constraint map.

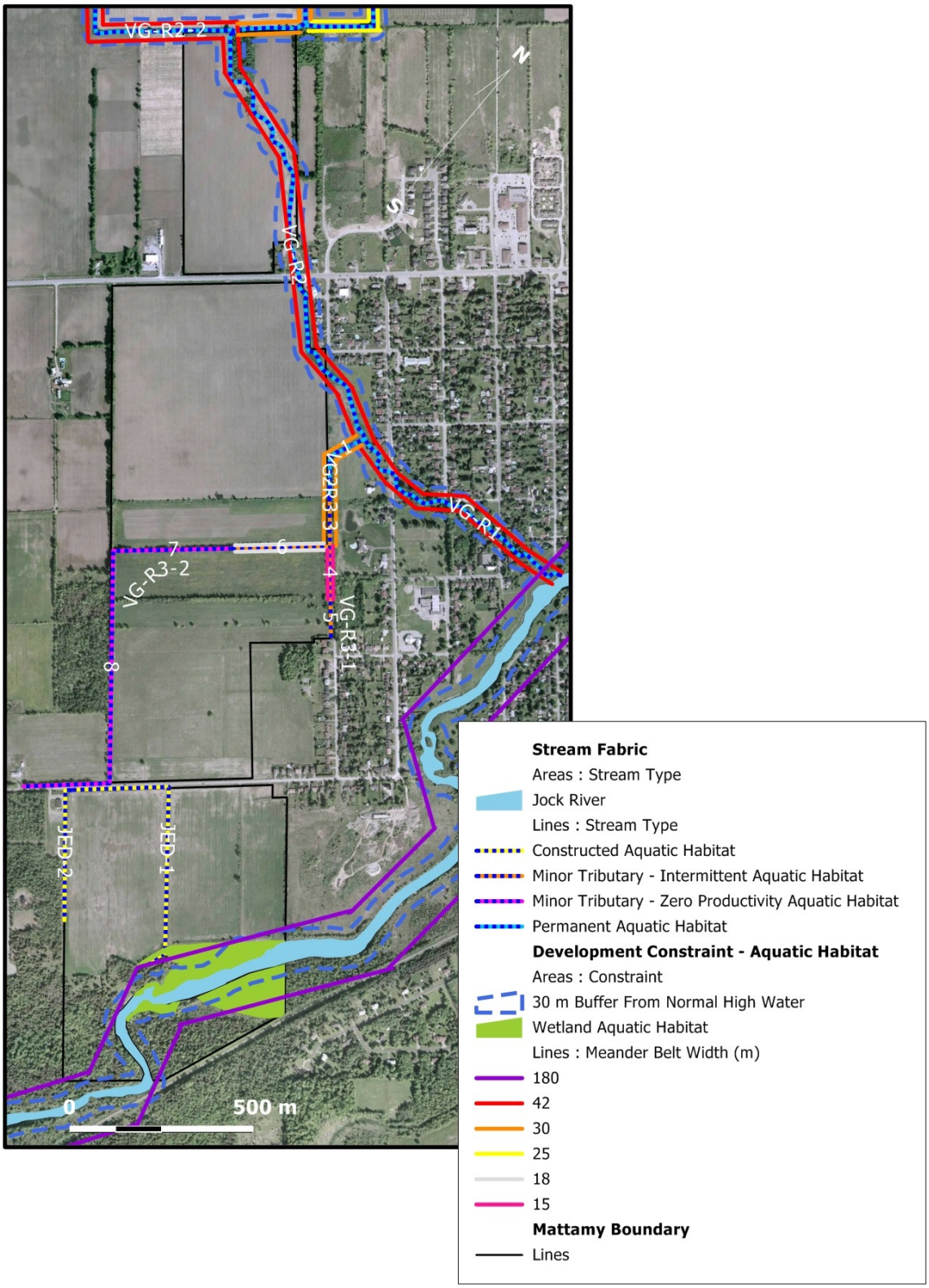


Figure 23. Map of the Mattamy Richmond land holding showing the stream fabric and associated watercourse constraints.

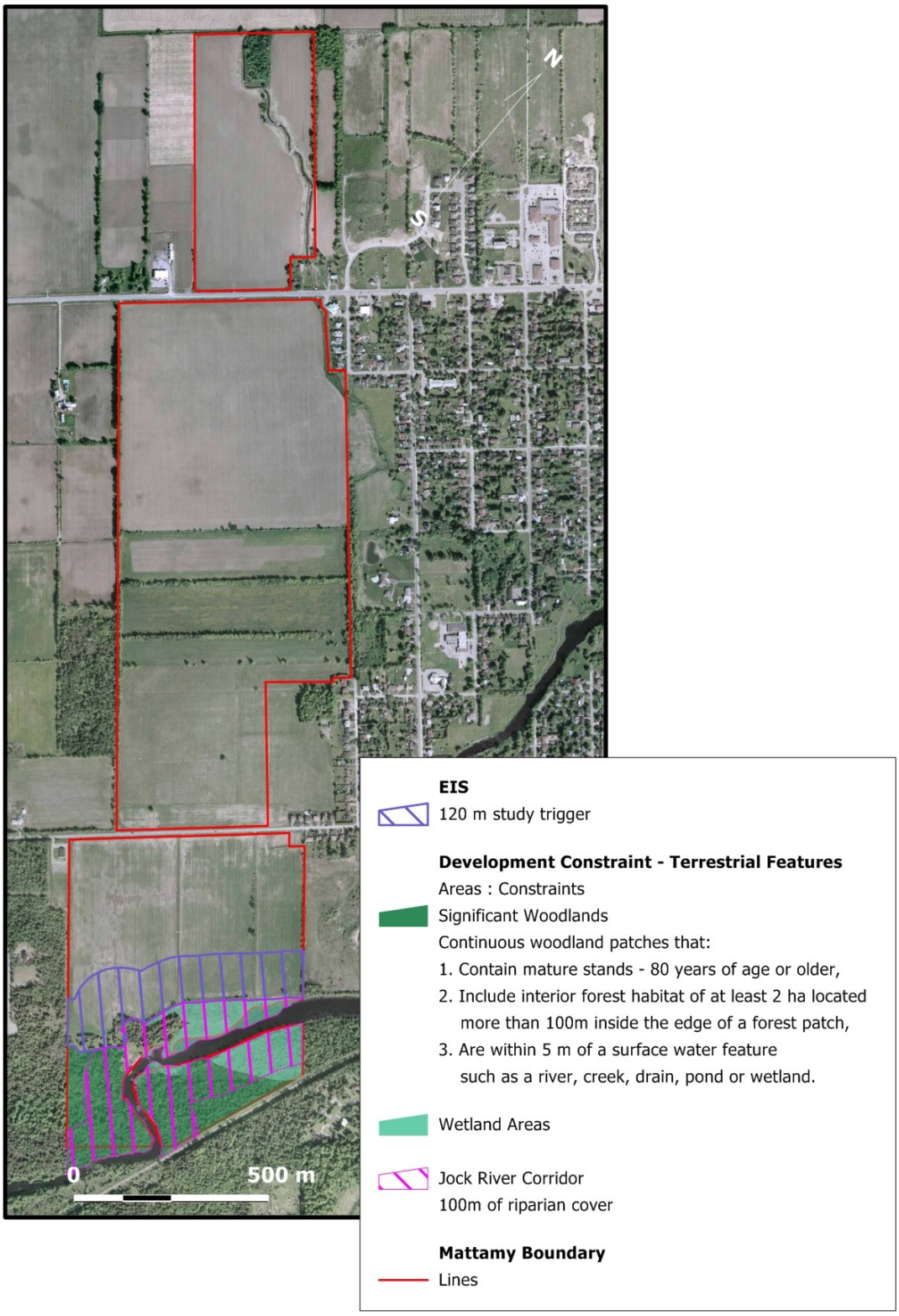


Figure 24. Map of the Mattamy Richmond land holding showing terrestrial constraints to development.

Figure 25. Map of the Mattamy Richmond land holding showing the ultimate100-year floodplain.

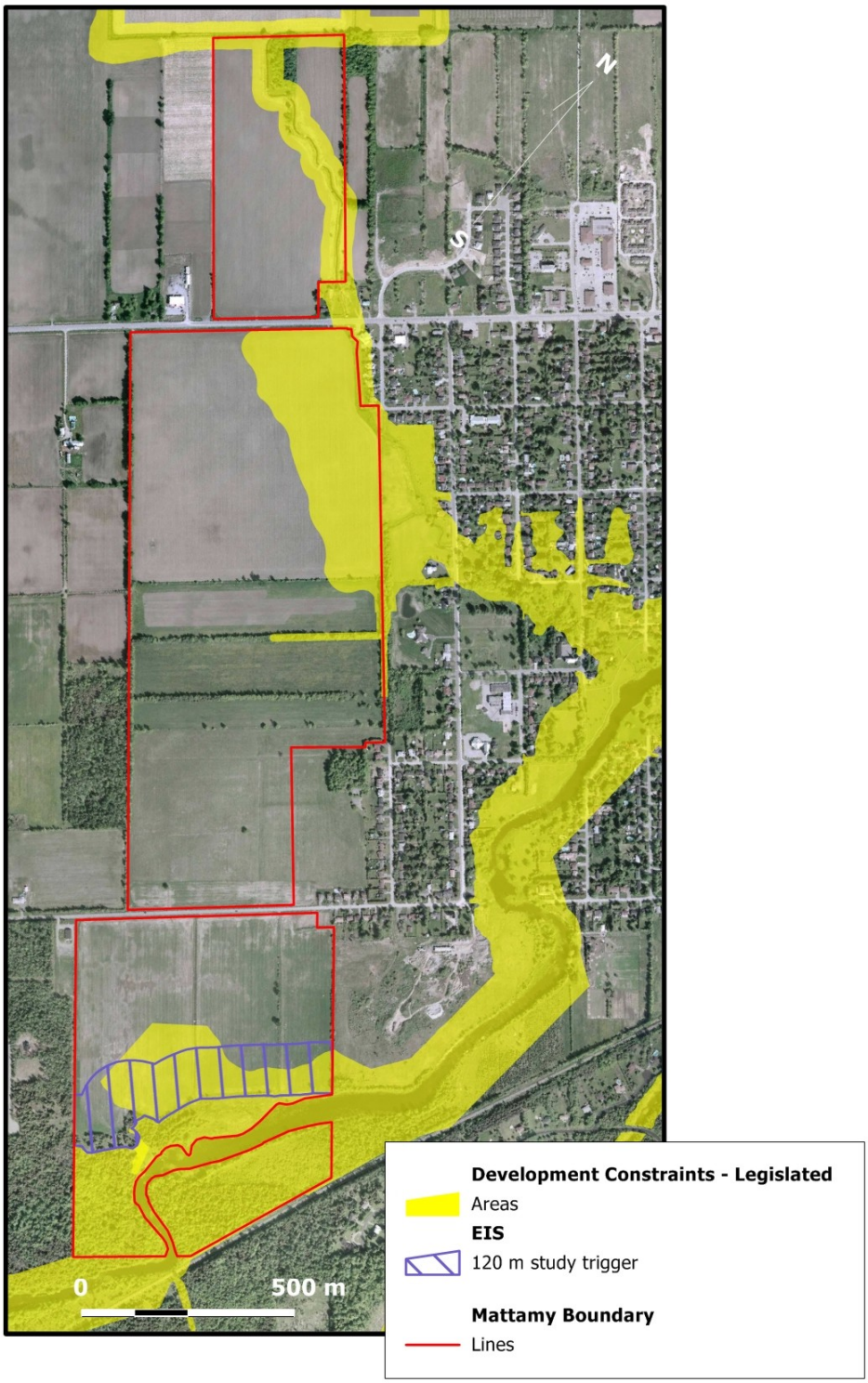


Figure 26. Map of the Mattamy Richmond land holding showing the overall legislated development constraint areas.

5.0 DEVELOPMENT CONCEPT

5.1 Concept Plan

Mattamy Homes is proposing a mixed residential development as conceptually illustrated in Figure 27 below. The plan was designed respecting and incorporating the overall constraint areas defined by this report (Figure 25). A Village "spine" road will connect the properties north and south of Perth Street with local road connections to the property south of Ottawa Street. The woodland and corridor along the Jock River will be undeveloped with an appropriate setback determined through the preparation of an Environmental Impact Statement. The preferred stormwater management scheme for the development includes a hybrid wet pond and wetland within the 100-year regulatory floodplain limit, but outside the 100-year summer event. A new channel outlet is proposed that will be designed to provide a unique marsh-wetland habitat that could be used by pike and other species for spawning in the spring. Modifications to the Moore Tributary are required for stormwater management, which will result in an increase in total direct fish habitat.

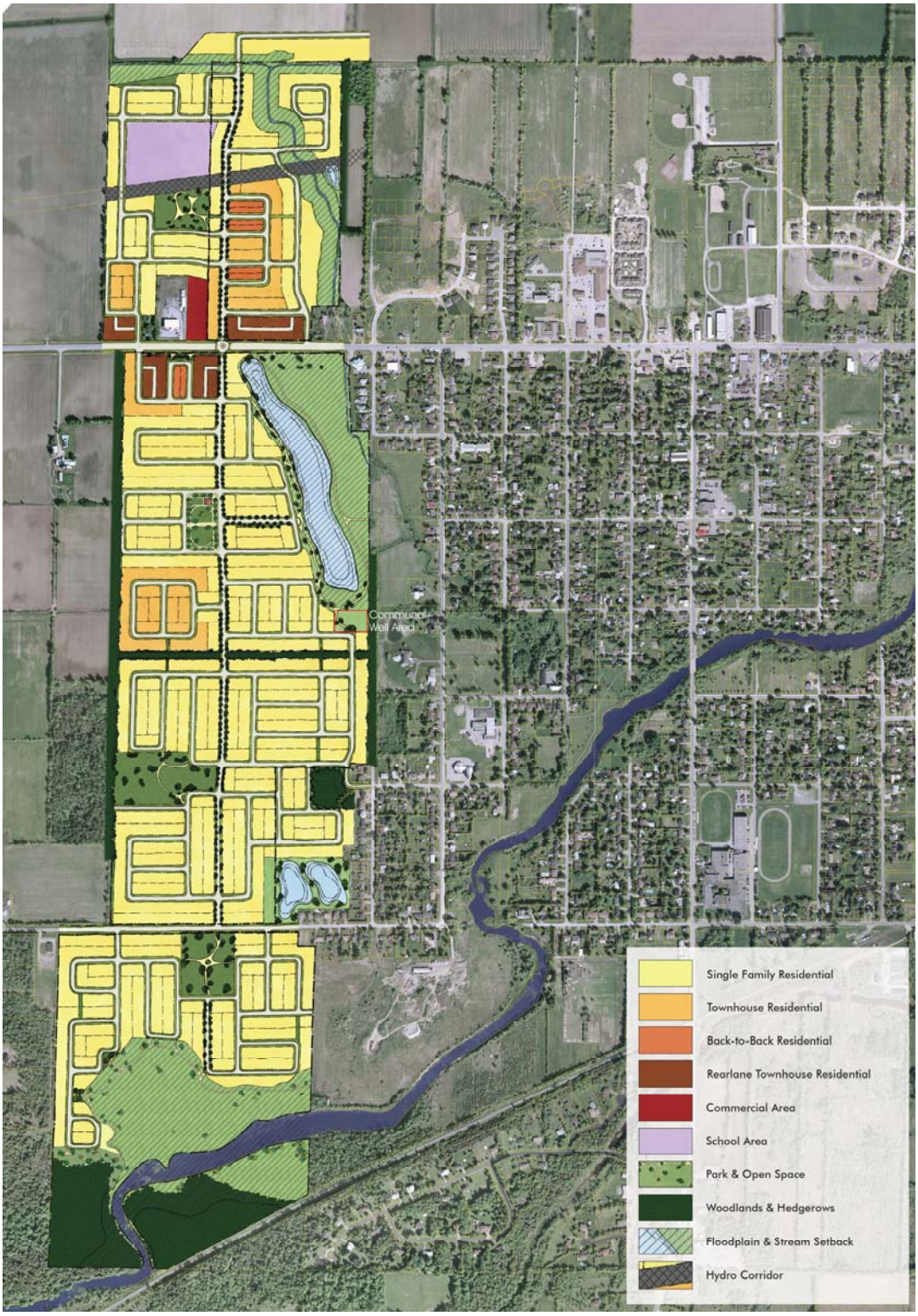


Figure 27 - Mattamy Richmond Lands Concept Plan

5.2 Stormwater Management

Three potential stormwater management options were assessed in DSEL et al. (2010). The preferred option from that analysis (Option 3) is described here. That option involves the construction of three storm ponds as illustrated in Figure 28. Pond 1 (Figure 29) would be a single-cell pond, situated within the 100-year flood-plain limit adjacent to the Arbuckle Drain, and outside the zone of potential influence of the proposed community well (Figure 27). The community well is, further, outside the 100-year flood plain (Figure 32).

The proposed 4.77 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 main features of SWM Pond 1 design are:

- 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

These aspects are discussed below.

5.2.1 French Drain

The upper end of Section 2 of the Moore Branch receives cool baseflow from a tile drain (Figure 30), under existing conditions. It is important, from an ecological perspective, to maintain those cool baseflows to the top of Section 2, 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.

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

Section 3 (Figure 29) 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.

5.2.3 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 (Figure 29). 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.

5.2.4 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).

5.2.5 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).

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 (Figure 29), 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.

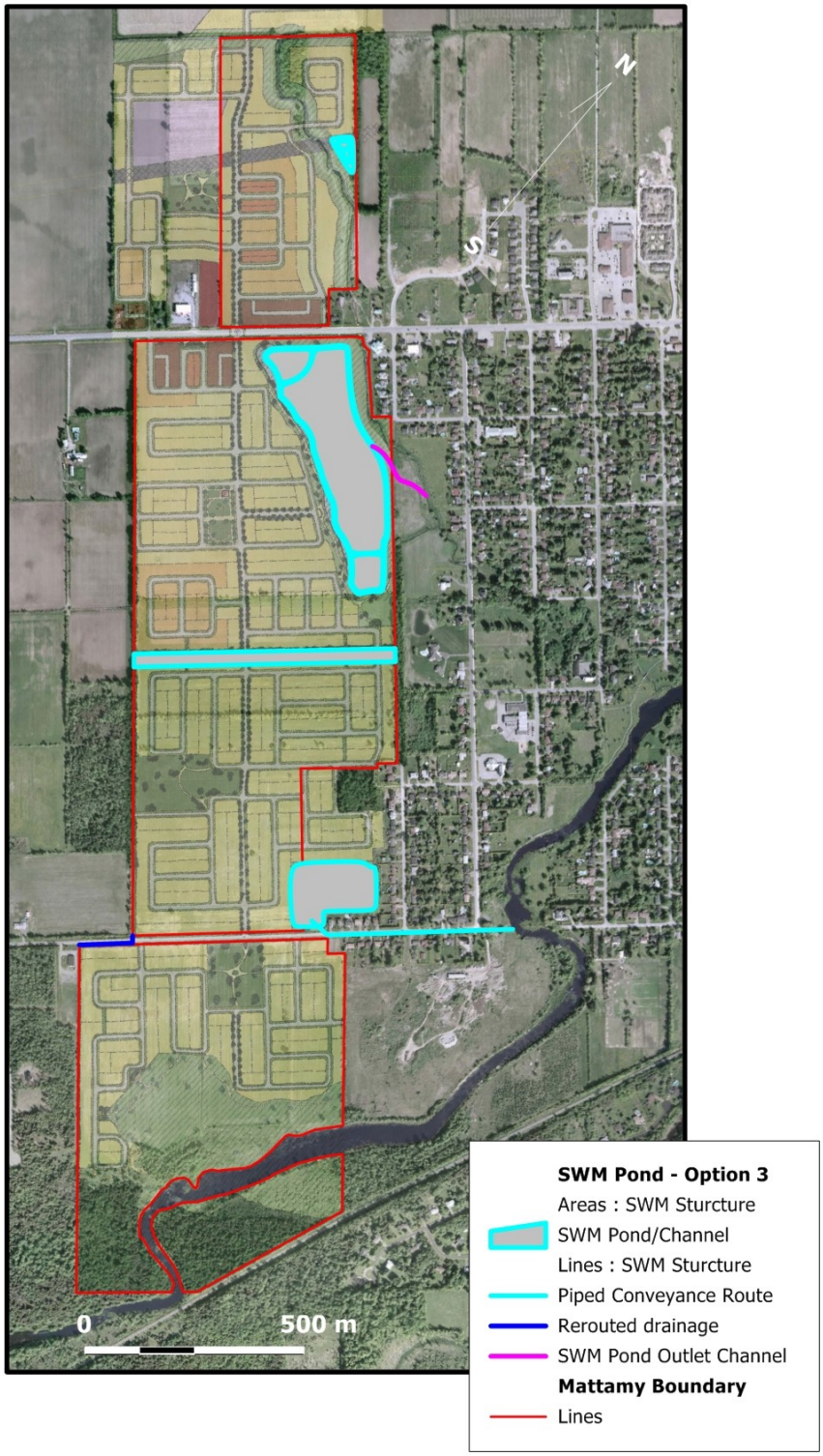


Figure 28. Map of the Mattamy Richmond Lands showing the preferred stormwater management option.

Figure 29. Concept drawing for SWM Pond 1.

Figure 30. Photo of the Moore Branch at the top of Section 3 showing the tile drain that provides cool baseflow.

Figure Note: photo taken August 19, 2008, facing downstream. The creek was dry upstream of this point at the time of the photo.

6.0 IMPACT ASSESSMENT

6.1 Terrestrial Environment Impacts

Impacts to the terrestrial ecology of the Mattamy lands and surrounding area will be fully assessed in an Environmental Impact Statement (EIS) and Tree Conservation Report, to be submitted with the Plan of Subdivision and Zoning applications. The high level assessment below is provided as an initial review of the likely impacts of development as it is currently proposed.

Apart from current agricultural lands, there are three main sets of terrestrial features that could potentially be impacted by the Mattamy development: (1) small woodlands on or near the north and central properties; (2) hedge rows in these same areas; and (3) woodland and wetland areas on the southern property along the Jock River (Figure 6). A summary of the woodlands and hedgerows that are anticipated to be kept is illustrated in Figure 31 and Figure 32.

Community 1 and the three woodlands adjacent to the Mattamy properties (W1, W2 and W3 – Figure 6) are not considered to be significant woodlands, following City criteria. These woodlands will be only indirectly impacted, maintaining their limited existing ecological functions.. The western edge of Woodlot 1 (W1) that is not in the Van Gaal setback may be disrupted, especially during construction, depending on grading and the proximity of adjacent housing. Woodland W2 is currently isolated with housing along one side and ploughed fields on the other three sides. It has no wooded or aquatic corridor connections to other natural areas. Several large bur oak and ash trees are present, although the area has been heavily impacted over the years. This woodland is not considered to be ecologically significant. The current concept plan maintains this woodland. Single loaded roads are adjacent to the woodland on three sides. Impacts to this woodland may be indirect, due to the increase in residential population surrounding the natural area. By minimizing rear lot access to this woodland, garden and refuse dumping will be mitigated. The area adjacent to residential development will be fenced to reduce encroachments, dumping and access that may occur. Further mitigation measures could include:

- establishing limited access points
- a more formal trail
- a cleanup of the current site, and
- education for future and adjacent landowners.

As part of the Tree Conservation Report and EIS, the plan of subdivision, grading, roadway alignments can be further examined to minimize impacts on the canopy and especially on the large trees.

Woodland 3 (W3), the largest of the three off-site wooded areas, will have a park and new housing backing on to its eastern edge, replacing current farmland. Indirect impacts (increased noise, light, etc.,) may occur as the population in this area increases. Surficial drainage flows in an approximately

easterly direction, meaning that the water regime of the woodlot should remain unchanged by development to the west.

A fourth woodland (Community 1 – Figure 6), located on the very north end of the Mattamy property adjacent to the Van Gaal Drain, will be reduced in size. This one hectare woodland is not considered to be ecologically significant, according to the City's criteria. The eastern side of this area will likely be cleared as the existing agricultural space in the northeast corner is converted to residential space. However, all portions of the woodland extending into the aquatic buffer zone of the Van Gaal Drain along the north and east sites will be retained and it will retain its functional capacity as a buffer to the Van Gaal Drain.

Section 3.1.2.6 – Vegetation Communities, and as shown on Figure 6, documents the findings of the ecological inventories conducted of the 7 hedgerows adjacent or on Mattamy's lands. In summary, all hedgerows on the property are narrow and of minor ecological value. To serve as an effective connection between wilderness areas, MMM and WESA (2007) recommended that wildlife corridors be a minimum of 50 m in width. These hedgerows are mostly only ~5 m in width to a maximum of 10 m in some locations. Currently these corridors likely provide minimal connectivity for common to abundant wildlife, such as squirrels, raccoons, foxes, and deer, and may also provide nesting areas for common bird species. In short, the hedgerows within and along Mattamy's lands are not regarded as ecologically significant.

Nonetheless, the current concept plan proposes to retain the majority of the hedgerows except hedgerow H4 situated north of Ottawa Street that crosses the property in an east-west direction. Hedgerow H3 will be removed and then re-established as part of the stormwater drainage scheme for the development. For all retained hedgerows, grading and fill required for stormwater management and other servicing infrastructure will be minimized and where required, will be managed to protect the retained hedgerows, treed areas, and significant trees on and adjacent to the site.

A description is provided below on the retention status and mitigation measures for each of the hedgerows identified in Figure 6.

H1 –This hedgerow is situated north of Perth Street at the northern limit of Mattamy's lands between Community 1 woodland and W1 woodland. This hedgerow is protected within the development setback for the Van Gaal Drain (VG-R2-2). This watercourse constraint area including the hedgerow on Mattamy's land will be dedicated to the City as open space. The 30 metre setback from normal high watermark will protect and reduce any potential impacts from adjacent development. Grading will be tapered down to match existing grades at the edge of the setback.

H2 – This hedgerow is along the eastern boundary of Mattamy's land, north of Perth Street. This hedgerow straddles both Mattamy lands and the adjacent property. The hedgerow contained on Mattamy's lands will be maintained as proposed in the February 2010 Concept Plan. A portion of the hedgerow will be dedicated to the City as part of the Van Gaal Drain setback area. The remaining portion of the hedgerow will be in private ownership as it will form part of private lots within the

backyards. Grading will be tapered down to match existing grades at edge of setback. Mitigation measures will be proposed to ensure protection of the hedgerow in the Tree Conservation Report required as part of the Plan of Subdivision process.

H3 – This hedgerow is situated in the centre of the site between Perth Street and Ottawa Street. This hedgerow forms part of the Moore tributary (VG-R3-2) that conveys drainage from the rural area adjacent to Mattamy's lands to the Arbuckle drain. This feature is retained in the Concept Plan. However, it is anticipated that drainage improvements and grading requirements will require the removal of the trees within this corridor. Inventories of H3 have indicated that there are no butternuts, and no individual trees performing a significant ecological function or otherwise high quality specimen trees. This hedgerow does not provide a viable terrestrial corridor but a portion of the drain supports fish habitat. The vegetation will be re-established along the channel banks. A landscaping plan will be prepared at Plan of Subdivision stage that will provide a species mixture that will result in an aesthetically pleasing natural corridor, and is sustainable considering alterations to the grading and drainage pattern. H3, after full re-instatement, will retain its function as a watercourse. Its main function in the concept design is as a green corridor and aesthetic buffer.

H4 – This hedgerow is not proposed for retention in the Concept Plan. It was proposed for retention in the preliminary concept plan generated at the December 2008 workshop. However, it was not feasible to retain this hedgerow based on the modified grid roadway layout. In addition, 30% of the concept plan is already represented by open space, parks, floodplain and stormwater management ponds. These areas will be "reclaimed" from agricultural practices and will have landscaping component that will increase the vegetation cover on site over existing conditions.

At this time, this hedgerow does not provide a viable terrestrial corridor. Loss of the natural area provided by the hedgerow will be compensated for by the retention of other environmental areas proposed in the concept plan. The Tree Conservation Report required at the Plan of Subdivision stage will identify good quality tree species within the hedgerow and if feasible, these will be incorporated into the subdivision plan. New trees will be planted in the subdivision as required, and will be outlined in the landscaping plan for the development.

H5 – This hedgerow is situated along the western edge of the property, running in a north-south direction, and terminates at the adjacent woodland (W3). H5 straddles Mattamy and the adjacent landowner's property. The Concept Plan proposes to retain the hedgerow assuming that the preferred preliminary grading plan is accepted by the City. This hedgerow would be primarily in private ownership as it would form part of the backyards of homes along this edge. However the portion of the hedgerow adjacent to parks, H3, and the West Martin Street would be dedicated to the City for public ownership. Grading will be tapered down to match existing grades at edge of setback. Mitigation measures will be proposed to ensure protection of the hedgerow in the forthcoming Tree Conservation Plan.

H6 – This hedgerow is situated along a portion of the western edge of Mattamy's lands, primarily situated in the City's unopened road allowance. The Moore Tributary (VG-R3) is situated

adjacent/within the hedgerow. The detailed grading will be designed to tie into existing grades surrounding the property. Since hedgerow H6 lies on or very near to the property line it is likely that this row of tree will be preserved. Through the Tree Conservation Report, any impacts will be identified/confirmed and mitigation measures recommended.

Van Gaal Hedgerow – The vegetation along the Van Gaal/Arbuckle drain has been identified as a hedgerow. This feature will be retained through the watercourse setback for this watercourse. The watercourse setback will help to mitigate any potential impacts from adjacent development.

Finally, the trees along the western side of the property (i.e. the edge of W3 and scattered south to Ottawa St.) are present as part of the drainage ditches and are proposed to be retained in the Concept Plan. Some grading of the ditches may be required in order to convey surface flows, particularly through Section 8 of the Moore Branch. Some trees may need to be removed to assist with re-grading.

The woodland communities near the southwest corner of the property (Communities 11, 12 and 13– Figure 5) are the only ecologically significant wooded areas on the Mattamy properties north of the Jock River. This wooded area is part of NESS 422, and satisfies the City's criteria to be considered as a Significant Woodland. However, depending upon the outcome of a current development proposal on the adjacent (south-west) property adjacent (McIntosh Perry, 2009), this area may no longer meet the City's criteria as a significant woodland, since the interior forest area may be lost.

For the moment, the significance of this area will remain assumed and a development setback to protect the ecological functions of the feature will be established through an Environmental Impact Study. Any setback will account for potential damage to homes from wind-throw, and to provide a buffer that limits the likelihood of the introduction of invasive species from garden dumping, and cutting into the interior bird habitat. The cul-de-sac will occur in an area where there are currently scrubby open cedars and old field, with an old cart track and an informal trail leading to the river. These features have the potential to be enhanced to provide public access to the river.

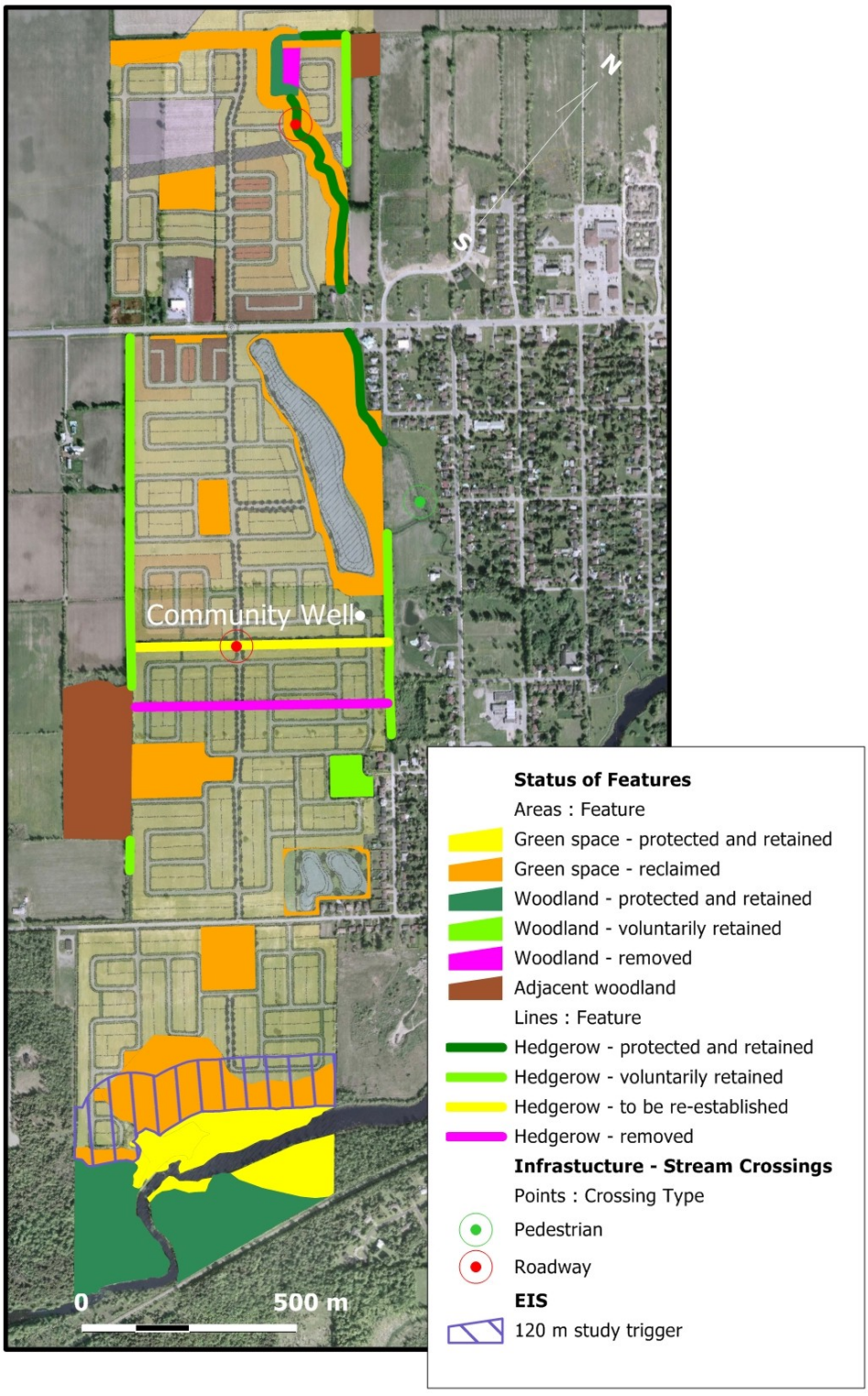


Figure 31 - Natural features removed, re-established, retained, or reclaimed under the proposed development of Mattamy Richmond lands.

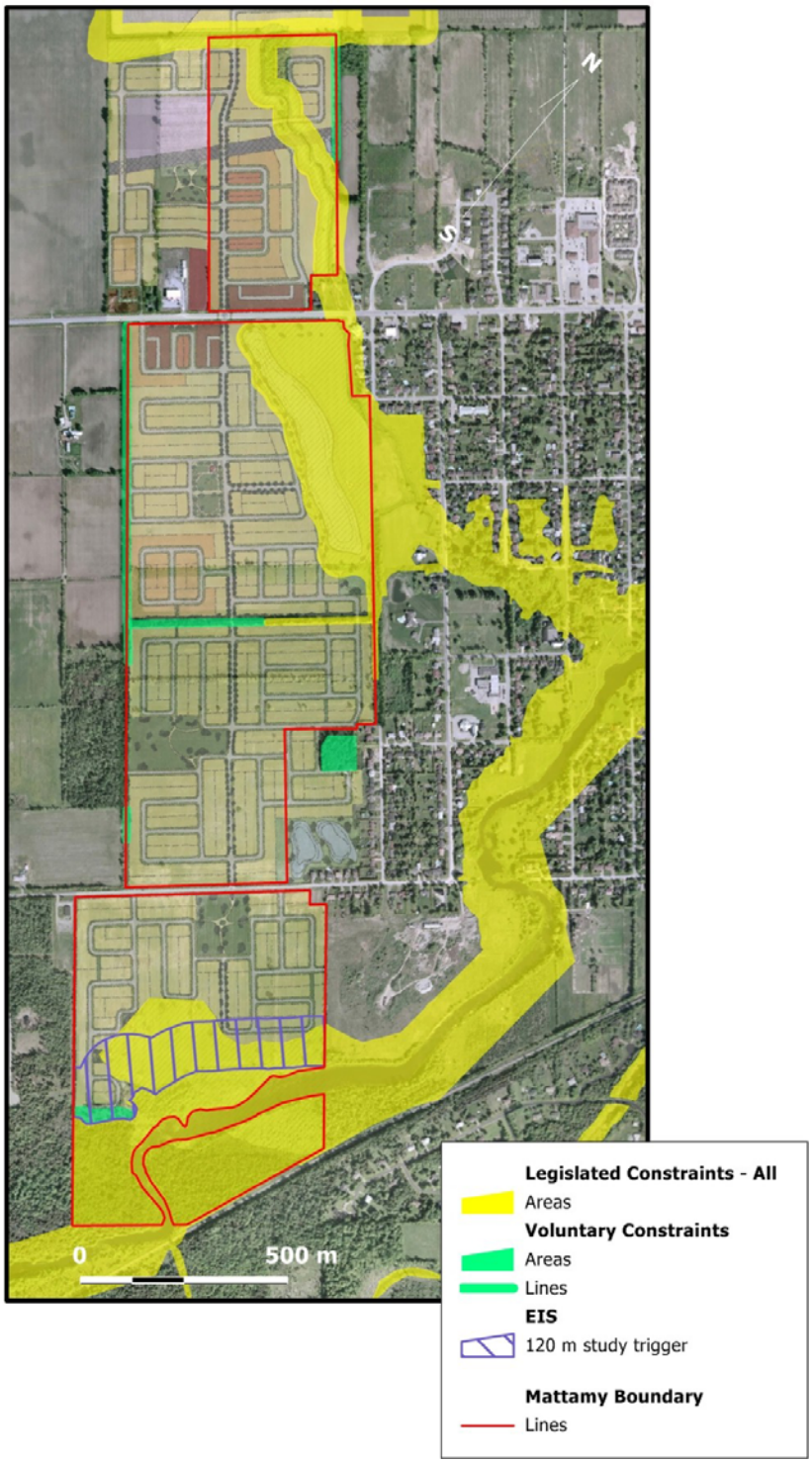


Figure 32. Areas of developed natural features relative to areas of environmental constraint.

6.2 Aquatic Environment (Fisheries) Impacts

Section 35(1) of the federal *Fisheries Act* prohibits the harmful alteration, disruption or destruction (or HADD) of fish habitat. Fisheries and Oceans Canada (DFO) recently developed its *Risk Management Framework for DFO Habitat Management Staff* that outlines a methodology for practitioners to evaluate the risks posed to aquatic habitat by development proposals. The Risk Management Framework is intended to provide a structured approach to decision-making that takes into account the concepts of risk, uncertainty and precaution. Practitioners are encouraged to use this approach to:

- analyze development proposals and apply mitigation to minimize residual effects;
- assess residual effects and characterize the risk they pose to fish and fish habitat;
- use the risk characterization process to support management decisions; and,
- communicate the rationale for their decisions.

This section assesses the potential for risk of loss of productive potential to fish habitat resulting from the proposed development of the Mattamy Lands and associated stormwater management (Option 3 from DSEL et al., 2009). This assessment follows the recommended methodology provided by the Ontario Ministry of Transportation and Department of Fisheries and Oceans (MTO, 2006). The fisheries associated with each of the watercourses were described in previous sections. Sensitivity of each watercourse (Section 4.3.1) to land development is assessed on the basis of: (1) the species known to occur, and their sensitivities to suspended particulate matter and water temperature; (2) rarity of habitats locally and regionally; (3) species' dependence on these watercourses; and (4) habitat resilience. Published pathways of effects diagrams were used to identify likely stressors to watercourses on the developing Mattamy lands. We further identify mitigation measures for these activities, and qualitatively assess the likelihood of significant risk to fish and fish habitat on these lands.

6.2.1 Classification of Fish Habitat Sensitivity

6.2.1.1 Overview of Classifications

A summary of the existing conditions fisheries habitats is provided in Figure 33, showing the various features and their classification as Direct and Indirect Fish Habitat. Sensitivities are summarized in the table below. The amount (area) of fish habitat potentially influenced in the vicinity of the Mattamy project is also summarized in the table for the Van Gaal/Arbuckle system, the Moore Branch, and for the Jock River Estates Drain. There is ~ 16,526 m^2 of permanent direct fish habitat within the vicinity of the Mattamy lands, as well as an additional ~3,052 m^2 of direct intermittent habitat, and 3,660 m^2 of indirect intermittent fish habitat (Table 18).

6.2.1.2 Jock River

The Jock River is **permanent, direct fish habitat** (Figure 33). The Jock River is considered to be **moderately sensitive** on the basis of the following (from Table 9):

- **Species Sensitivity**: The Jock River contains a highly diverse assemblage of fish including species that are potentially sensitive to land development activities.
- **Species Dependence**: The Jock River within the Village of Richmond can be considered to provide habitats for all of the various life stages of fish including spawning habitats, rearing, feeding and over-wintering.
- **Rarity:** None of the shoreline or mid-channel sections of the Jock River have been demonstrated to be unique or unusual habitats. Species within the Jock River can find and use other locales for life processes.
- **Habitat Resilience:** The Jock River is a permanent flowing, large water course. The system is generally warmwater, but does have local areas of coolwater habitat. Groundwater inputs are locally evident from the cooling of the watercourse that apparently occurs as water travels through the Village of Richmond.

There are no species at risk in the Jock River in the vicinity of the Village of Richmond.

6.2.1.3 Van Gaal Drain/Arbuckle Drain

The Van Gaal/Arbuckle Drain (all sub-reaches) is considered to be **Permanent Direct Fish Habitat (**Figure 33**)**. The Van Gaal and Arbuckle Drains are considered to be **moderately sensitive** on the basis of the following:

- **Species Sensitivity**: This drain contains a highly diverse assemblage of fish including species that are potentially sensitive to land development activities (Figure 33).
- **Species Dependence**: The Van Gaal/Arbuckle Drain through Mattamy's land holding and adjacent areas can be considered to provide habitats for many of various life stages of fish including spawning habitats, rearing, feeding and over-wintering.
- **Rarity:** None of the sections of the Van Gaal/Arbuckle reaches has been demonstrated to be unique or unusual habitats. Species within the Jock River can find and use other locales for life processes.
- **Habitat Resilience:** The Van Gaal/Arbuckle Drain is a permanent flowing, medium-sized watercourse. The system can be classified as a transition from cool to warmwater: it contains sculpin implying a coolwater classification is appropriate but has water temperatures that classify as warm/cool.

There are no species at risk in the Van Gaal Drain or Arbuckle Drain.

6.2.1.4 Moore Branch

Aquatic habitat upstream of the high point in VG-R3-2 (i.e., Sections 7 and 8) was classified as **Intermittent Indirect Fish Habitat** after discussions with RVCA (Lamoureaux, 2009; Figure 33). Section 5 is classified as Intermittent Indirect Fish Habitat as a result of a blockage. Sections 1, 2, 3, 4, 6 are classified as Direct Fish Habitat as a result of direct connections to the Arbuckle Drain.

Sections 2 through 8 of the Moore Branch are classified as supporting **low sensitivity** habitats on the basis of the following:

- **Species Sensitivity**: This drain system has a relatively low diversity of fish species that use the drain during the spring, and only one or two species that use the drain during low-flow periods. During low-flow periods, much of the drainage system stagnates and dries. Some of the species that use the drain are potentially sensitive to land development activities (Figure 33).

- **Species Dependence**: The Moore Branch provides principally spawning habitats for species that are able to spawn elsewhere in the Van Gaal/Arbuckle system.

- **Rarity:** None of the sections of the Moore Branch has been demonstrated to be unique or unusual habitats. Species that currently utilize the Moore Branch could find and use other locales for life processes.

- **Habitat Resilience:** The Moore Branch is an intermittent system in sections 4, 5, 7 and 8. The lower section (1, 2, 3) can be classified as coolwater providing groundwater from a tile drain.

There are no species at risk in the Moore Branch.

Section 1 is classified as **moderately sensitive** fish habitat on the basis of the following:

- **Species Sensitivity**: This drain system has a relatively low diversity of fish species that use the lower parts of the drain during the spring, and only one or two species that use the drain during low-flow periods. Some of the species that use the drain are potentially sensitive to land development activities (Table 10).

- **Species Dependence**: Section 1 of the Moore Branch provides principally spawning habitats for species that are able to spawn elsewhere in the Van Gaal/Arbuckle system. Pike potentially use this lower section of Moore Branch to spawn, but there are other more expansive areas for pike to spawn in the Jock River.

- **Rarity:** This lower section of the Moore Branch is unique for the property, providing a confluence for a minor tributary (Moore Branch) and a moderately sized tributary (Arbuckle).

The habitat provided at this confluence is not rare regionally considering the spawning habitats provided in the Jock River.

- **Habitat Resilience:** This Section of the Moore Branch is permanently flowing because of groundwater flows from an upstream tile drain. This section is classified as coolwater on the basis of measured water temperatures.

6.2.1.5 Jock River Estates Drain

Despite being a constructed storm conveyance ditch, this feature is considered by RVCA to be **Intermittent Direct Fish Habitat (**Figure 33**)**. This feature is considered to have **low sensitivity** to land development on the basis of the following:

- **Species Sensitivity**: This drain system has a relatively low diversity of fish species that use the drain during the spring. During low-flow periods, much of the drainage system stagnates and dries. Some of the species that use the drain are potentially sensitive to land development activities (Figure 33).

- **Species Dependence**: The Jock River Estates Drain provided principally spawning habitats for species that are able to spawn elsewhere in the Van Gaal/Arbuckle system.

- **Rarity:** The Jock River Estates Drain is a constructed and temporary feature that has been cut through the topsoil and limestone bedrock to route storm flows south in a fashion that did not occur under historical pre-development conditions.

- **Habitat Resilience:** Jock River Estates Drain is an intermittent system. It classifies as warmwater on the basis of measured water temperatures, though it contains coolwater species.

Table 18. Summary of amount and sensitivity of fish habitat within the study area.

Watercourse	Reach	Section	Class	Flow	Existing Condition						Option 3		
					Length (m)	Bankfull Width	Area (m^2)	Indirect	Direct		Indirect	Direct	
								Intermittent	Intermittent	Permanent	Intermittent	Intermittent	Permanent
Jock River	at JED outlet		Direct	Permanent									
	at Arbuckle confluence		Direct	Permanent									
Arbuckle Drain	VG-R1		Direct	Permanent	609	7.0	4,263			4,263			4,263
Van Gaal	VG-R2		Direct	Permanent	1407	7.0	9,849			9,849			9,849
	VG-R2-1		Direct	Permanent	178	4.3	757			757			757
	VG-R2-2		Direct	Permanent	147	3.0	441			441			441
Moore Branch	VG-R3	1	Direct	Permanent	111	5.0	554			554			554
	VG-R3	2	Direct	Permanent	132	5.0	662			662			662
	VG-R3	3	Direct	Intermittent	108	5.0	542		542			542	
	VG-R3-1	4	Direct	Intermittent	146	3.7	539		539			431	
	VG-R3-1	5	Indirect	Intermittent	101	3.7	375	375			300		
	VG-R3-2	6	Direct	Intermittent	259	2.8	726		726			1064	
	VG-R3-2	7	Indirect	Intermittent	333	2.8	934	934				1367	
	VG-R3-2	8	Indirect	Intermittent	635	3.7	2,351	2,351				2287	
Jockvale Estates Drain	JED-1		Direct	Intermittent	415	3.0	1245		1,245			597	
SWM Pond 1 outlet			Direct	Permanent									150
Total Area of Fish Habitat								3,660	3,052	16,526	300	6,288	16,676
									19,578			22,964	
									23,238			23,264	

Figure 33. Map of the study area showing classifications of fish habitats under existing conditions.

6.2.2 Pathways of Effects

We explore the anticipated potential impacts to fish habitat following DFO's pathway of effects (PoE) analysis (MTO, 2006), and identify mitigation opportunities for each of those anticipated effects. There are three PoE diagrams that address unique effects relevant to this assessment (Figure 34 to Figure 36). The PoE diagram for land-based grading (Figure 34) summarizes the potential effects associated with the re-grading the Mattamy land holding (re-grading is necessary for stormwater management). Potential effects associated with excavation of the proposed SWM ponds are illustrated in Figure 35 (see also DSEL et al., 2009). Potential effects associated with the release of future stormwater to the local surface waters are illustrated in Figure 36. Other pathways (see MTO, 2006) have been considered, but for the purposes of this assessment do not provide unique stressors/effects that are not already considered in the three pathways presented below.

6.2.3 Mitigation

A summary of the effects pathways and proposed mitigations are presented in Table 19. Pathways and mitigation are further discussed for this Option 3 below.

6.2.3.1 Grading

Grading of the Mattamy lands will result in the exposure of soils, with the potential for surface flows to convey suspended particulate materials to the Van Gaal Drain, Arbuckle Drain and Moore Branch. Conventional erosion and sediment controls will be put in place to protect soil stockpiles, and to protect the three watercourses.

The most significant change in surface drainage pattern is the re-routing of water from the Jock River Estates Drain. That drain has for the past few years provided water to the Jock River in the vicinity of an earthen berm, the location of which was moved in the summer of 2009 and is now reflected in the revised flood-plain mapping (Figure 26). In proposed stormwater management option (Option 3, DSEL et al. 2010), water that would normally flow through that drain will be directed to Stormwater Management Pond 1, and subsequently conveyed to the Jock River via the Van Gaal Drain (~1.8 km downstream of the present-day discharge of the Jock River Estates Drain through the earthen berm, and 0.7 km upstream of the Arbuckle confluence with the Jock River). The Jock River, in the vicinity of the earthen berm is a high-quality habitat consisting of pickerel weed and other emergent macrophytes. Water levels in the macrophyte bed are maintained by the Jock River and not by flows from the Jock River Estates Drain. Further, the drainage pattern prior to the construction of the Jock River Estates Drain had surface waters from the property south of Ottawa Street being conveyed north to the Moore Branch. There will, therefore, be no net negative impact resulting from the re-routing of the Jock River Estates Drain on the productivity of fish and fish habitat of the Jock River.

Storm flows will be piped from Stormwater Management Pond 2 to the Jock River in the vicinity of the Ottawa Street road allowance, while flow released from Stormwater Management Ponds 1 and 3 will be directed to the Van Gaal Drain. Existing flow volumes in the Jock River will buffer and dilute the additional storm-related volumes. Energy dissipation devices will be incorporated into the design of the stormwater outlets. Fish habitat assessment will be undertaken in the vicinity of the proposed

storm outlet to ensure that the structure is situated such that is has minimal (to no) impact on existing high-quality and highly sensitive fish habitats. The construction of the outlet and associated structures will respect construction timing-windows to protect sensitive fish life stages.

With the conveyance of storm flows to the Jock River, the Arbuckle Drain and Moore Branch will receive less flow during storm (> 2-year) events. These tributaries will, however, continue to receive the equivalent 2-year event. Because it is the 2-year event that is the channel forming flow, the in-stream fish habitat of the Arbuckle Drain and Moore Branch can be expected to be maintained.

6.2.3.2 Excavation

The potential effects of construction of the stormwater management ponds will be mitigated using conventional techniques. Water pumped from the dug ponds will be treated (when necessary) as per requirements of the Ontario Ministry of the Environment. Soils exposed by grading or excavation will be covered or contained with geotextiles or silt curtains to minimize the entry of soils/sediment to surface waters Discharge waters released from work areas (ponds) will be released slowly or through or on energy dissipaters to mitigate potential erosion at points of entry to surface waters.

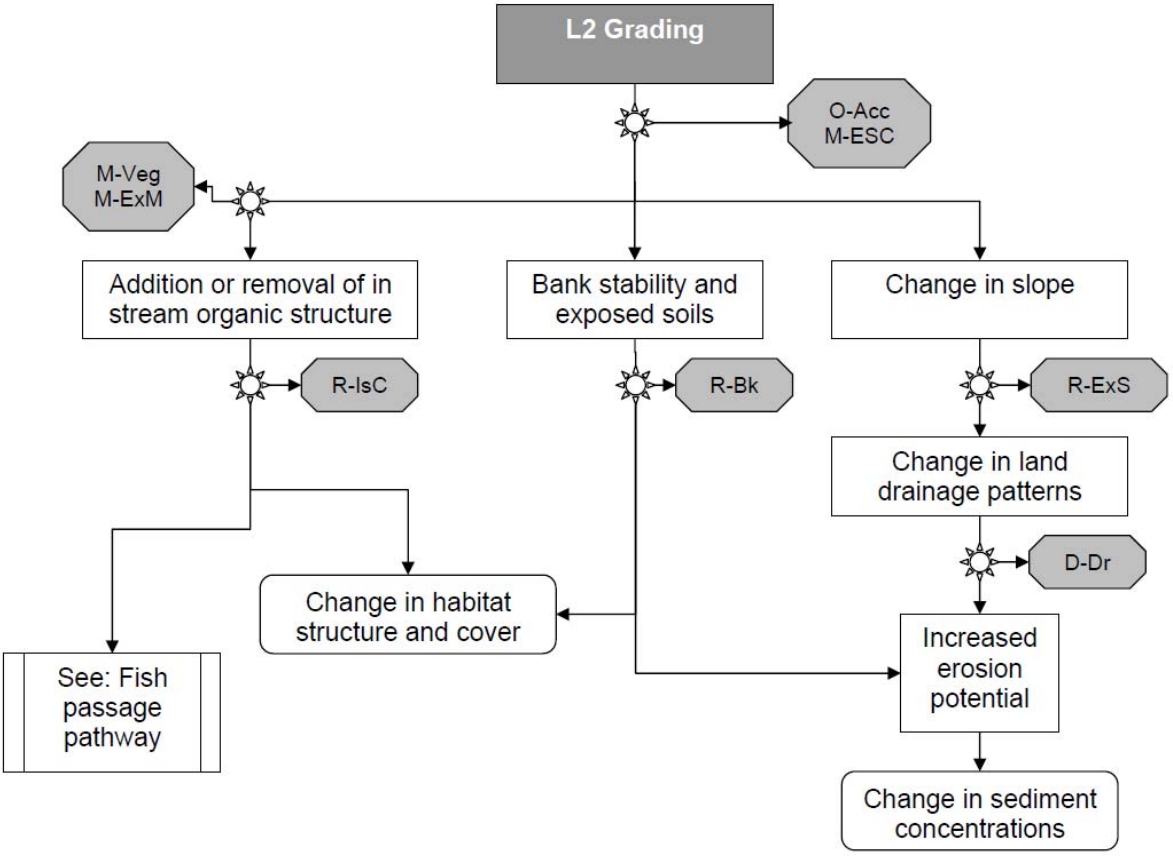
Post construction, soils in the vicinity of SWM Ponds or watercourses will be stabilized with plantings of grasses, sedges, shrubs and trees. Trees that can provide shade to watercourses and stormwater management ponds will be planted to assist in stabilizing the site, and to maximize shade for ponds and channels.

In the event that baseflows to the Moore Branch are interrupted because of the construction of Pond 1, flows to that channel will be augmented artificially to maintain its permanent condition.

6.2.3.3 Stormwater

The Van Gaal/Arbuckle Drain is a cool- to warm-water system with the Moore Branch a cool-water system. Maintenance of groundwater flows to the Van Gaal Drain, Arbuckle Drain and Moore Branch systems is important as each of these features supports cool and cold-water fish species. Maintenance of groundwater flows will ensure that water in these features remains cold/cool. The overall stormwater management design will incorporate infiltration and/or cooling channels to ensure that water provided to these features is cold/cool as appropriate. Pond 1, for example, will provide base flows via cooling trenches to the top of Section 2 of the Moore Branch. The three storm ponds are designed to settle particulates and associated nutrients (phosphorus, nitrogen), generally eliminating potential effects associated with contaminated stormwater (Figure 36; AECOM, 2009). Reduction of nutrient loads will occur as a result of the adsorption of nutrients to suspended particulates, and the precipitation of sediments in the stormwater management ponds. Moreover, the conversion of the landscape from rural to urban will result in a direct reduction in the amount of phosphorus and nitrogen that runs off into watercourses in the first place. The ponds are also not considered to be sources of diseases for fish or disease vectors for fish. The ponds are anticipated to be warmer during summer periods than water of the Van Gaal/Arbuckle Drain, Moore Branch and Jock River. Warming of the ponds will be mitigated to the extent possible by planting shade trees including a mixture of deciduous and coniferous species. The outlet channel from Pond 1 will also be strategically planted to minimize heating and encourage cooling. The base-flow outlet channels from Pond 1 will be

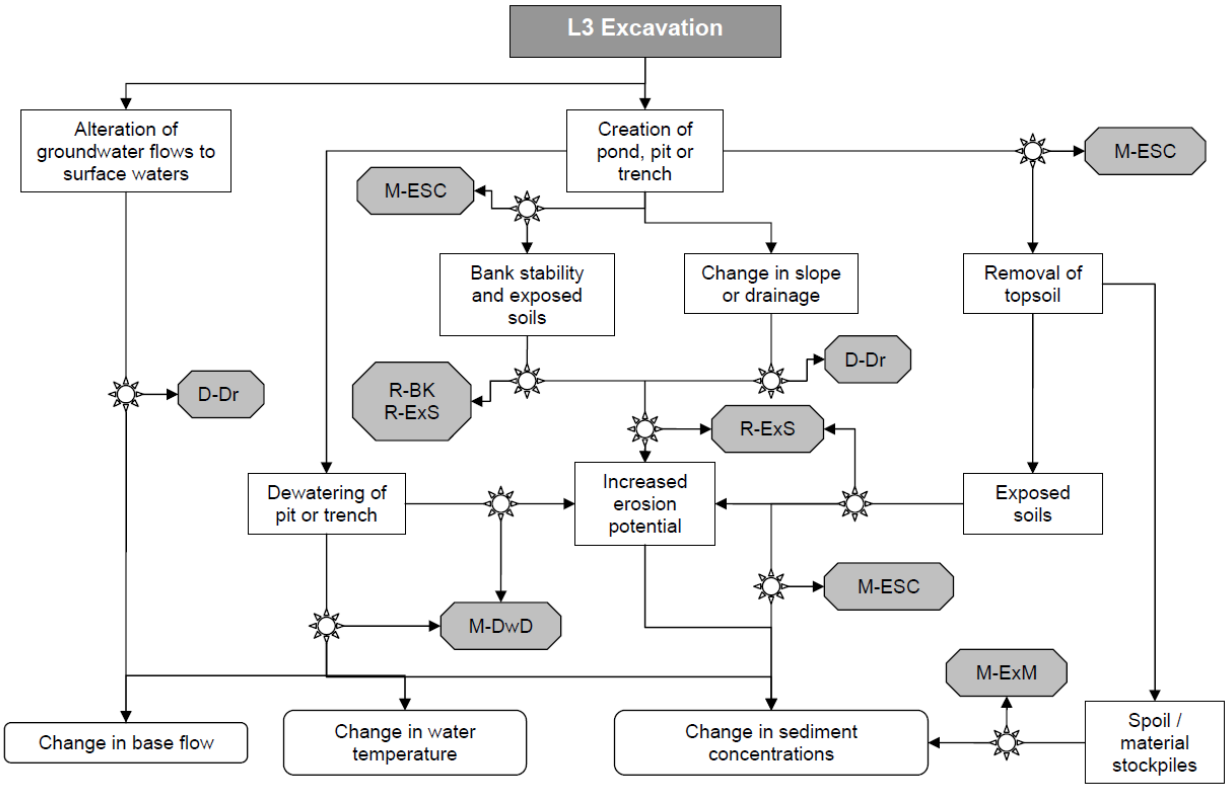
designed as a cooling trench to maintain a cool base flow to the Moore Branch. The outlet channels for Pond 1 will be designed to maximize potential fish spawning.



O-Acc = Operational Constraint for Access; M-ESC = Management of Erosion and Sediment Controls; M-Veg = Management of Vegetation; M-ExM = Management of Excess Material; R-IsC = Rehabilitation of In-Stream Cover; R-Bk = Rehabilitation of Banks; R-ExS = Rehabilitation of Exposed Soils; D-Dr = Design of Drainage System

Figure 34. Pathway of effects diagram for land-based grading.

Figure Note: from MTO (2006):



M-ESC = Management of Erosion and Sediment Controls; M-ExM = Management of Excess Material; R-Bk = Rehabilitation of Banks; R-ExS = Rehabilitation of Exposed Soils; D-Dr = Design of Drainage System; M-DwD = Management of Dewatering Discharge

Figure 35. Pathway of effects diagram for land-based excavation.

Figure Note: from MTO (2006)

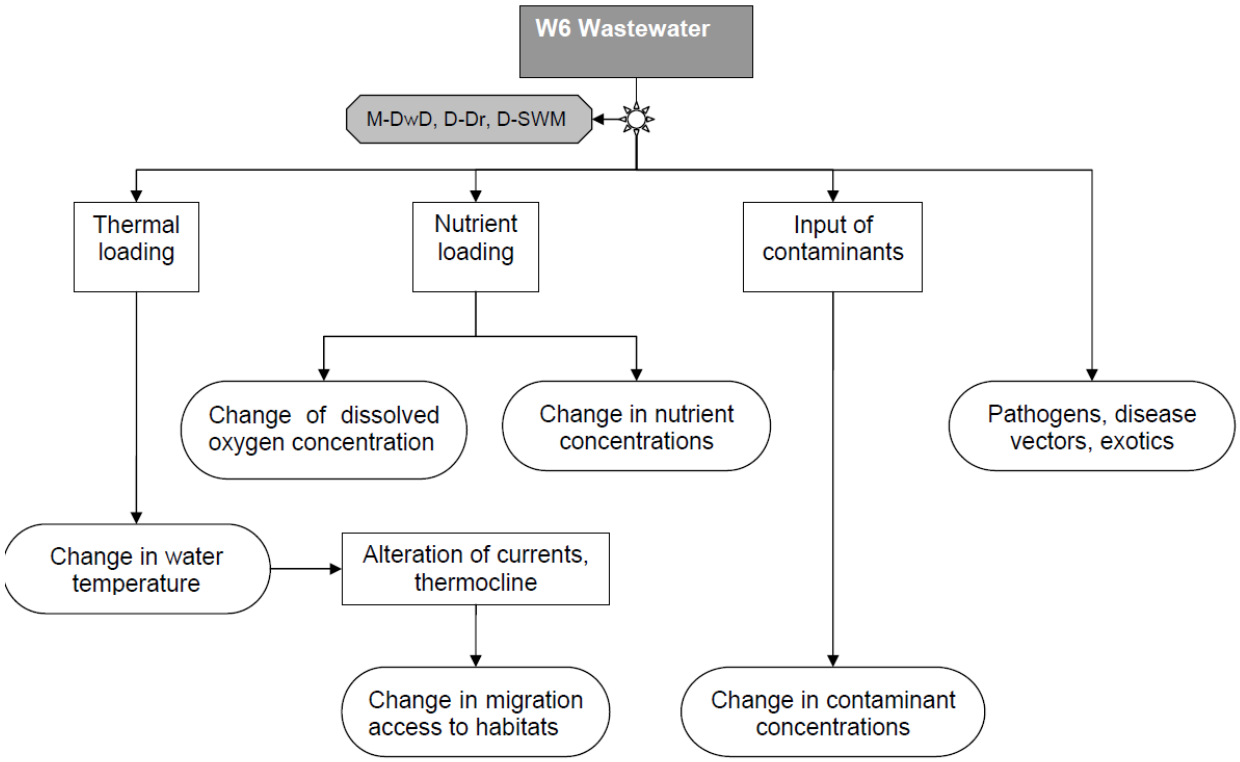


Figure 36. Pathway of effects diagram for wastewater management.

M-DwD = Management of Dewatering Discharge, D-Dr = Design of Drainage System, D-SWM = Design of Stormwater Management

Figure Note: from MTO (2006)

Table 19. Summary of effects pathways and mitigation for SWM Option 3.

Pathway	Stressor	Effect	Mitigation	Watercourses Potentially Affected	Residual Effect
L2 Grading	Exposed Soils	Various parcels of land within the Mattamy holding may require re-grading to facilitate SWM. Exposed soils, and stockpiled soils have the potential to contribute sediments to surface waters	Appropriate containment of stockpiles including the use of silt curtains. Watercourses will be protected with sediment and erosion control measures including silt curtains and setbacks.	Van Gaal, Arbuckle, Moore (Sections 1, 2 3, 4, 5, 6,7)	None.
	Change in Drainage Pattern	Flows to the Jock River Estates Drain will be rerouted to SWM Pond 2. Flows in Section 8 of the Moore Branch will be captured by SWM Pond 1.	None. Jock River Estates Drain is abandoned and filled in this Option. Flows to Section 8 of the Moore Branch are piped. Sections 6 and 7 stay open with enhancements.	Jock River Estates Drain, Section 4, 5, 8 of Moore Branch	The residual effect is considered minor. Jock River Estates Drain is a man-made watercourse. Though it is considered to provide Direct Fish Habitat, the only access to that habitat is from the Jock River and up into the channel through a one-way valve. Most of the drain goes dry in summer and is thus ephemeral. Likewise for Section 8 of the Moore Branch which is considered Indirect Fish Habitat. The upper Sections go dry in mid summer, likely stranding and killing newly hatched fry. Baseflows to Sections 4 and 5 of the Moore Branch may be lower.
		High flows are re-routed to Jock River. Loss of extreme flow events in tributaries.	Maintain baseflow and 2-y event flows to tributaries	Moore Branch (Sections 1, 2, 3), Arbuckle Drain	None. Maintenance of the channel-forming 2-year flows will ensure channel structure is maintained in each of the Arbuckle and Moore Branch.
		High flows are re-routed to Jock River. Potential for additional flows in Jock River to cause erosion	Energy dissipaters integrated in design of SWM outfalls.	Jock River	None
L3- Excavation	Exposed Soils	Excavation of ponds will result in the exposure of top soil, and the creation of soil stockpiles	Appropriate containment of stockpiles including the use of silt curtains. Watercourses will be protected with sediment and erosion control measures including silt curtains and setbacks.	Van Gaal, Arbuckle, Moore (Sections 1, 2 3, 4, 5, 6, 7)	None.
	Dewatering	Ponds will need to be dewatered during construction at various times, with discharge water released to surface waters.	Discharge water to be of high quality and if necessary treated by filtering through filter bags, etc.	Van Gaal, Arbuckle, Moore, Jock	None
	Change in Baseflow	Construction of the ponds may result in local interception of baseflows.	Flow augmentation to Moore Branch Sections 1, 2, 3 if necessary	Moore Branch Sections 1, 2 and 3.	None.
W8: - Stormwater Management	Thermal loading	Higher temperatures of stormwater have potential to increase temperatures of watercourses during mid summer.	Vegetative plantings adjacent to SWM ponds, and outlet channels. Cooling channels. Infiltration basins.	Jock River, Van Gaal Drain, Moore Branch (Sections 1, 2, 3)	The residual effect is considered minor. Moore Branch Sections 1, 2 and 3 may have water temperatures that are somewhat elevated (1 to 2°C) from baseline condition. Impact to the Arbuckle Drain and subsequently to the Jock River is anticipated to be minimal because the volume of those systems is much greater than what will be discharged from SWM ponds.
	Nutrient Loading	Eutrophication	SWM ponds remove phosphorus and other nutrients.		None
	Input of contaminants	Toxicity	SWM ponds settle metals and other contaminants		None
	Pathogens, disease vectors, exotics	Diseases	SWM ponds are not receiving domestic waste.		None
	Discharge of stormwater to watercourse	Potential for erosion at point of discharge.	Energy dissipaters integrated in design of SWM outfalls.	Van Gaal Drain, Moore Branch (Sections 1, 2, 3)	None
	Loss of baseflow	Potential for intermittent habitats to be dry longer	Infiltration to provide water during spring	Moore Branch (Sections 4, 5, 6, 7)	None.

6.2.4 Risks to Fish Habitat

Table 20 provides a summary of the anticipated risks to fish habitat under Option 3 assuming the various mitigation measures are undertaken (Figure 37). The risks to fish habitat are described for the Jock River, Jock River Estates Drain, Van Gaal Drain, Arbuckle Drain, and Moore Branch in the sections below.

6.2.4.1 Jock River Estates Drain

The overall risk to fish habitat in the Jock River Estates Drain is classified as Low (Table 20). Approximately 300 m of the Jock River Estates Drain will be filled under the proposed stormwater management option (Figure 28, Figure 37). The connection between the lower portion of JED-1 and the Jock River (within the floodplain) will be maintained under the future development plan. The value of that connection maybe limited because it may act as a "blind" alley. Surface flows to that feature will be limited, and it is likely to become stagnant as it fills over time with vegetation and detritus. However it would likely continue to function as fish habitat during periodic high water levels on the Jock River. The Low-Risk classification is justified on the basis that: (1) the feature is man made; (2) the feature presents intermittent fish habitat; (3) the feature has until 2009 had a fish-exclusion flap that minimized the upstream movement of fish from the Jock River into the drain; and (4) the impact is to a relatively small area (i.e., ~ 300 m^2). These impacts are offset by enhancements to the Moore Branch (see below).

6.2.4.2 Arbuckle Drain

The overall risks to fish habitat in the Arbuckle Drain is classified as Low (Table 20). The Arbuckle Drain will receive treated stormwater from SWM Pond 1 via a constructed, meandering and naturalized channel. Flows from the SWM Pond will be low in suspended solids and phosphates, meeting Ontario Ministry of Environment discharge limits. Temperature of the released water will be cooled to the extent possible by riparian plantings around the pond and along both sides of the outlet channel.

Since storm flows > 2-year event will be piped to the Jock River, the Arbuckle Drain will receive smaller storm flows. Flows < 2-year event will flow to the Arbuckle Drain via the newly constructed outlet channel. Because it is the 2-year event that is considered the channel-forming flow, fish habitats in the Arbuckle Drain should be maintained.

AECOM (2009) predicts a reduction in both suspended solids and nutrients in overland runoff, as a result in the conversion of the landscape from agricultural to urban. These changes will benefit fish and invertebrates living in the Arbuckle Drain.

The proposed SWM outlet channel will add ~ 50 m^2 of direct fish habitat, as well as additional low-lying areas that should become flooded in the spring of the year and used by various species for spawning.

6.2.4.3 Van Gaal Drain

The overall risks to fish habitat in the Van Gaal Drain is classified as Low (Table 20). There are no activities that will have a direct impact on fish habitat.

The tractor crossing of the Van Gaal Drain currently causes a localized velocity barrier to upstream fish migrations during high-water events. Upgrading of that crossing for use by cars would involve increasing culvert length. Those losses to fish habitat could be offset locally by an improved conveyance through the culvert. This would be accomplished by increasing the size of the culvert so that it can convey spring and storm flow events at velocities that are less than swimming speeds of local fishes (i.e., < 1 m/s).

The riparian zone of the Van Gaal Drain will be protected by the greater of a 30-m setback, the meander belt (42 m in some places; Table 4) and floodplain.

AECOM (2009) predicts a reduction in both suspended solids and nutrients in overland runoff, as a result in the conversion of the landscape from agricultural to urban. These changes will benefit fish and invertebrates living in the Van Gaal Drain.

6.2.4.4 Moore Branch

Changes to fish habitat in the Moore Branch are anticipated as a result of the proposed stormwater management plan, with many of the changes producing a net increase in productive fish habitat. The nature of change to each of Section of the Moore Branch is described below.

6.2.4.4.1 Moore Branch - Section 8

<u>Present Configuration</u>

Section 8 currently provides ~2351 m^2 of indirect- intermittent fish habitat. This section retains water and stagnates as a result of a "high" point in the channel where Sections 7 and 6 meet (Figure 33). This Section of the Moore Branch is already known to be used by fish in the spring of the year, presumably for spawning. There is potential for adults, and YOY of these species to become trapped as waters recede.

The existing channel requires a meander-belt corridor of ~ 18 m in order to allow for development of a more natural, sinuous channel (see Technical Memo from B. Wilkes and J. Parish, January 20, 2010 in Appendix 5).

The field adjacent to the channel is farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

<u>Proposed Built-Out Configuration</u>

A preliminary analysis of the potential configuration for Section 8 was completed by JFSA (2010) and DSEL (2010). The channel, through Section 8, could be constructed to convey the 100-year event (Figure 38; 1.5 m^3/s), with at least 40 cm of freeboard. The bankfull channel width is proposed to be 3.6 m, will have a 3-m wide low-flow channel, and 3:1 side slopes to the top of bank. There would be a

5-m setback on the east side of the channel (i.e., Mattamy's side the channel). The total channel corridor on Mattamy's side is thus proposed to be 7.6 m from the normal high water mark. The total corridor dimension would be 18.8 m assuming 8.9 m on both sides.

The 5 m setback from top of bank will be planted with native shrubs and caliper trees to minimize access to the channel by persons, and to provide a natural vegetated riparian zone. The various plantings will also capture water and nutrients (N and P) flowing from adjacent "back" yards to the channel. Fencing will be required along the backyard of properties adjacent to the feature. The setback and channel will be dedicated to the City of Ottawa.

Ecological Benefits of the Re-Configured Channel

This channel will drain more effectively after the site is developed and the channel is reconfigured. The channel will provide ~2287 m^2 of intermittent-direct fish habitat, a small reduction (64 m^2) in total area, but large increase in direct and thus productive fish habitat.

Water quality of the channel can be expected to be of higher quality given that the runoff coefficient for N and P is lower in urbanized catchments than in agricultural catchments (see analysis by AECOM, 2009). The established riparian zone would provide a natural supply of leafy and woody detritus to the stream.

6.2.4.4.2 Moore Branch - Section 7

Present Configuration

Section 7 currently provides ~930 m^2 of intermittent-indirect fish habitat. This section retains water and stagnates as a result of a "high" point at the end of the Section (Figure 32). This Section of the Moore Branch is already known to be used by fish in the spring of the year, presumably for spawning. There is potential for adults, fry and YOY of these species to become trapped as waters recede.

Based on further detailed fluvial geomorphologic assessment carried out in fall 2009, the existing channel requires a meander-belt corridor width of ~ 18 m in order to allow for development of a natural, sinuous channel (see Technical Memo from B. Wilkes and J. Parish, January 20, 2010 in Appendix 5).

The field adjacent to the channel is farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

Proposed Built-Out Configuration

A preliminary analysis of the potential configuration for Section 7 was completed by JFSA (2010) and DSEL (2010). The channel, through Section 7, could be constructed to convey the 100-year event (Figure 38; flows up to 4.8 m^3/s), with at least 40 cm of freeboard. The bankfull channel width is currently proposed to be 4.1 m, including a 3-m wide low-flow channel, and 3:1 side slopes to the top of bank. There would be a 5-m setback on both sides of the channel. The total channel corridor is thus proposed to be 17.3 m, including a setback of 6.6 m from the normal high water mark. This

proposed channel and corridor design is slightly less than the corridor that would be required without channel re-configuration as per the analysis is Section 3.2.3.4 of this report.

The 5 m setback from top of bank will be planted with native shrubs and caliper trees to re-establish the hedgerows. The various plantings will also capture water and nutrients (N and P) flowing from adjacent "back" yards to the channel.

Ecological Benefits of the Re-Configured Channel

This channel will drain more effectively after the site is developed and the channel is reconfigured. With a 4.1 m bankfull width, the channel will provide ~1367 m^2 of intermittent-direct fish habitat, representing a conversion of indirect to direct habitat of some 930 m^2, and a creation of an additional ~434 m^2.

Water quality of the channel can be expected to be of higher quality given that the runoff coefficient for N and P is lower in urbanized catchments than in agricultural catchments (see analysis by AECOM, 2009).

The various plantings will contribute as much or more allochthonous (terrestrial) food supplies for the channel as the existing condition. Total fish habitat will increase.

The ecological (fisheries) integrity and function of this feature is anticipated to increase post development.

6.2.4.4.3 Moore Branch - Section 6

Present Configuration

Section 6 currently provides ~726 m^2 of direct, intermittent fish habitat. This Section of the Moore Branch is already known to be used by fish in the spring of the year, presumably for spawning.

Based on further detailed fluvial geomorphologic assessment carried out in fall 2009, the existing channel requires a corridor of ~ 18 m in order to allow for development of a more natural, sinuous channel (see Technical Memo from B. Wilkes and J. Parish, January 20, 2010 in Appendix 5).

The field adjacent to the channel is farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

Proposed Built-Out Configuration

Along with Section 7, a preliminary analysis of the potential configuration for Section 7 was completed by JFSA (2010) and DSEL (2010). The channel, through Section 6, could be constructed to convey the 100-year event (Figure 38; up to 4.8 m^3/s), with at least 40 cm of freeboard. The bankfull channel width is proposed to be 4.1 m, will have a 3-m wide low-flow channel, and 3:1 side slopes to the top of bank. There will be a 5-m setback on both sides of the channel. The total channel corridor is thus proposed to be 17.3 m.

The 5 m setback from top of bank will be planted with native shrubs and caliper trees to minimize access to the channel by persons. The various plantings will also capture water and nutrients (N and P) flowing from adjacent "back" yards to the channel.

Ecological Benefits of the Re-Configured Channel

This channel will drain more effectively after the site is developed and the channel is reconfigured. With a 4.1 m bankfull width, the channel will provide ~1064 m^2 of intermittent-direct fish habitat, a direct increase in productive fish habitat of some 337 m^2.

Water quality of the channel can be expected to be of higher quality given that the runoff coefficient for N and P is lower in urbanized catchments than in agricultural catchments (see analysis by AECOM, 2009).

The various plantings will contribute as much or more allochthonous (terrestrial) food supplies for the channel as the existing condition.

The ecological (fisheries) integrity and function of this feature is anticipated to increase post development.

6.2.4.4.4 Moore Branch - Section 5

Present Configuration

Section 5 currently provides ~375 m^2 of intermittent-indirect fish habitat, as a result of a blockage that causes fish stranding during periods of low flow. This Section of the Moore Branch is known to be used by fish in the spring of the year, presumably for spawning.

Based on further detailed fluvial geomorphologic assessment carried out in fall 2009, the existing channel requires a corridor of ~ 19 m in order to allow for development of a more natural, sinuous channel (see Technical Memo from B. Wilkes and J. Parish, January 20, 2010 in Appendix 5).

The field adjacent to the channel is currently farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

Proposed Built-Out Configuration

No change to the physical form of the channel is proposed.

Mattamy is proposing a setback of 7.5 m from the channel centerline, to recognize the meander belt width.

The catchment for this feature can be expected to decrease by ~ 1/3rd from its present-day size (see discussion for Section 4 of the Moore Branch).

Ecological Implications of Adjacent Land Development

The change in the size of the catchment poses the only net negative impact to this feature. Presently, the feature conveys water and nutrients to downstream fish habitats. Changes in flow volume (~ 1/3 less flow during 2-y events might produce a small reduction in total area submerged by water, here assumed to be a 20% reduction. This reduction, however, would have no impact to direct fish habitat per se, since Section 5 is classified in the existing and future condition as indirect fish habitat.

Water quality is expected to remain similar or to improve as a result of lower runoff coefficients for N and P associated with the land conversion, which will benefit downstream direct fish habitats.

6.2.4.4.5 Moore Branch - Section 4

Present Configuration

Section 4 currently provides ~539 m^2 of intermittent-direct fish habitat. This Section of the Moore Branch is known to be used by fish in the spring of the year, presumably for spawning.

Based on further detailed fluvial geomorphologic assessment carried out in fall 2009, the existing channel requires a corridor of ~ 19 m in order to allow for development of a more natural, sinuous channel (see Technical Memo from B. Wilkes and J. Parish, January 20, 2010 in Appendix 5).

The field adjacent to the channel is farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

The channel currently drains 2.668 ha, including 0.425 ha of impervious area, and produces ~ 330 L/s during a typical 2-y rainfall event.

Proposed Built-Out Configuration

No change to the physical form of the channel is proposed under the development plan.

Mattamy is proposing a setback of 7.5 m from the channel centerline, to recognize the required meander belt width.

Ecological Benefits of the Re-Configured Channel

The catchment area for this feature, as for Section 5, will decrease from 3.093 ha to 1.972 ha (including 0.415 ha of impervious area) and is anticipated to produce 205 L/s during a typical 2-year rainfall event (Memo from A. Fobert to B. Kilgour, December 18, 2009). If these 2-year events are used as a surrogate for a typical spring melt event, the flows to Section 5 might be reduced by ~ 1/3rd from present-day conditions. As for Section 5, we assume that this might result in a reduction in total wetted area by some 20% for the existing condition, or a loss of some 108 m^2 to 431 m^2.

Water quality is expected to remain similar or to improve as a result of lower runoff coefficients for N and P associated with the land conversion.

6.2.4.4.6 Moore Branch – Section 3

Present Configuration

Section 3 currently provides 542 m^2 of intermittent-direct fish habitat. Based on fluvial geomorphologic assessment carried out in fall 2008, the existing channel requires a meander belt of ~ 30 m in order to protect its natural function.

The field adjacent to the channel is farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

Proposed Built-Out Configuration

No change to the physical form of the channel is proposed under the development plan.

Mattamy is proposing a setback of 30 m from the channel centerline in the upper portion of Section 3, to recognize the required meander belt width. The lower portion of Section 3 is within the 100-year Regulatory floodplain, which will be respected by the proposed development, and which provides for a much larger setback.

The quality of runoff to Section 3 can be expected to improve as a result of the conversion of the land from agricultural to urban (AECOM, 2009). No other changes to the channel or its habitat are anticipated.

Ecological Benefits of the Re-Configured Channel

There will be no net negative impact to Section 3 of the Moore Branch. Improvements in water quality may provide for a net benefit.

6.2.4.4.7 Moore Branch – Section 2

Present Configuration

Section 2 currently provides 662 m^2 of permanent-direct fish habitat. Based on fluvial geomorphologic assessment carried out in fall 2008, the existing channel requires a meander belt ~ 30 m in order to protect its natural function.

The field adjacent to the channel is farmed to within 4 to 5 m of the existing channel top of bank. Runoff from the field travels through a thin understory.

Proposed Built-Out Configuration

No change to the physical form of the channel is proposed under the development plan.

Section 2 is within the 100-year Regulatory floodplain, which will be respected by the proposed development and provides a large development setback.

The quality of runoff to Section 2 can be expected to improve as a result of the conversion of the land from agricultural to urban (AECOM, 2009). No other changes to the channel or its habitat are anticipated.

Riparian zone plantings are proposed for Section 2 in areas that are currently devoid of cover, and within the existing road allowance.

A French drain is proposed to provide a permanent flow of cool water from the SWM pond to the head of Section 2.

Ecological Benefits of the Re-Configured Channel

There will be no net negative impact to Section 2 of the Moore Branch. Improvements in water quality may provide for a net benefit. Riparian plantings will help keep the channel cool, and will add leaf litter as a food resource to the channel.

6.2.4.4.8 Moore Branch – Section 1

Present Configuration

Section 1 currently provides 554 m^2 of permanent-direct fish habitat. Based on fluvial geomorphologic assessment carried out in fall 2008, the existing channel requires a meander belt ~ 30 m in order to protect its natural function.

The field adjacent to the channel is currently not farmed.

Proposed Built-Out Configuration

No change to the physical form of the channel is proposed under the development plan.

Section 1 is within the 100-year Regulatory floodplain, which will be respected by the proposed development and provides a large development setback.

The quality of runoff to Section 1 can be expected to improve as a result of the conversion of the land from agricultural to urban (AECOM, 2009). No other changes to the channel or its habitat are anticipated.

Ecological Benefits of the Re-Configured Channel

There will be no net negative impact to Section 1 of the Moore Branch. Improvements in water quality may provide for a net benefit.

6.2.4.4.9 Moore Branch Summary

The re-grading and re-alignment of Sections 6, 7 and 8, will increase the total amount of direct fish habitat by some upwards of 4,000 m^2. Stormwater management will result in Sections 4 and 5 receiving ~1/3 less flow during high-flow events (2 y event). That loss is expected to result in a negligible reduction in direct fish habitat, which is easily offset by the gains resulting from changes to

Sections 6, 7, and 8. The proposed built-out condition can be considered to be an enhancement of the natural function of the Moore Branch in terms of its provision of fish habitat. Riparian habitat will be largely unchanged as a result of the built-out design.

The proposed French Drain will provide cool base flow to the top of Section 2 of the Moore Branch, mitigating the potential effects of urban development, and ensuring the long-term sustainability of the cool-water fish assemblage that has developed in the Moore Branch.

The extension of the riparian zone along Section 2 of the Moore Branch will provide shade, keeping the stream cool. The additional riparian area will also provide a new source of leaf litter that will provide substrate for stream invertebrates.

6.2.4.5 Arbuckle/Moore Pike Spawning Area

Flow in the vicinity of the pike spawning area (Figure 21) will be unchanged during spring spawning periods. Flows to that area, via the Moore Branch will be, overall, increased during other times of the year because surface flows from JED-1 are to be re-routed to the SWM pond adjacent to the Moore Branch.

6.2.4.6 Jock River

There will be no residual impacts to the Jock River. The Jock River is the ultimate recipient of all upstream activities including the following:

- Filling of portions of JED-1;
- Re-configuration of various sections of the Moore Branch;
- Proposed riparian plantings along the Moore Branch, Arbuckle Drain,;
- Proposed upgrading of the culvert on the Van Gaal Drain; and,
- Proposed creation of a SWM Pond outlet channel and associated pike spawning habitat.

Apart from the footprint of the SWM outlet at the end of Ottawa Street, there is no physical footprint of any Mattamy-related infrastructure proposed for the Jock River. The proposed development will have indirect influences on the Jock River including changes to flow routing (more storm flows to the Jock River, see DSEL 2010), and changes to runoff water quality (reduced TSS and nutrients; see AECOM 2010). Thus, indirect impacts of the proposed development on the Jock River are anticipated to have no net negative impact.

At detailed design, the stormwater outlet will be designed in consultation with an aquatic and fluvial geomorphology consultant to minimize impacts to the Jock River and associated aquatic habitat. The outlet design will be subject to approval from the City of Ottawa, Rideau Valley Conservation Authority, Ministry of Natural Resources, and Ministry of Environment.

6.3 Summary of Net Ecological Benefits

The Mattamy design maintains or enhances major terrestrial features/functions including the following:

- function of the significant woodland adjacent to the Jock River;
- function of the riparian corridor along the Jock River;
- enhanced, minor corridor functions associated with hedgerows situated with the Moore Branch; and,
- enhanced corridor function along the Van Gaal and Arbuckle Drains associated with densification of riparian plantings.

The design also maintains or enhances major aquatic system features/functions, including the following.

The proposed French Drain will provide cool base flow to the top of Section 2 of the Moore Branch, mitigating the potential effects of urban development, and ensuring the long-term sustainability of the cool-water fish assemblage that has developed in the Moore Branch.

The extension of the riparian zone along Section 2 of the Moore Branch will provide shade, keeping the stream cool. The additional riparian area will also provide a new source of leaf litter that will provide substrate for stream invertebrates.

The SWM outlet channel will be designed using natural channel-design principles. The channel, by itself, will provide an additional 50 m^2 of new permanent-direct fish habitat. The channel side slopes are also designed to provide potential pike spawning habitat. The landscape through which the channel drains will be landscaped to ensure flooding during the spring. The side slopes will be planted with a variety of sedges and grasses to match vegetation that typically is found in pike-spawning habitat. Regardless of use of the area by spring-spawning pike, the area will present spawning habitats for a variety of cyprinids and other species that currently use the Van Gaal/Arbuckle Drain. The side slopes are anticipated to provide over 4500 m^2 of spawning habitat in the spring.

Plantings along the mainstem of the Arbuckle Drain will shade that channel, possibly cooling water and providing leaf litter for consumption by invertebrates.

The SWMP pond and associated vegetative plantings will provide a potentially important ecological linkage to the north-west parcels of the Mattamy property, from the corridor provided by the Moore Branch.

Re-grading of the Mattamy land holdings, and the subsequent construction and operation of the SWM ponds will have minimal impact on fish habitat within the Mattamy land holding. The proposed SWM option should produce a net increase in direct fish habitat of some ~1,400 m^2 (Table 21). Outlet channels from Pond 1 under this option could be designed as fish spawning habitats, in particular for

pike. A low-flow outlet channel from this pond is proposed to outlet through a cooling trench so that cool base flows are provided to the Moore Branch as per existing conditions.

Table 20. Risk classification for each of the watercourses potentially affected by the proposed Mattamy development, SWM Option 3

Watercourse	Reach	Section	Class	Flow	Sens	SAR	Mitigation Prevents Potential Impacts (yes/no)				Potential Impacts			Category of Risk	Comments
							Footprint	Flow Volumes	Water Temp	Water Quality	Extent	Duration	Intensity		
Jock River	at JED outlet		Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	Normal water levels in Jock River will maintain seasonal fish habitats
	at Arbuckle confluence		Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	Water temperature increases at Jock River are predicted to be negligible considering volume SWM flows and temperature mitigations.
Arbuckle Drain	VG-R1		Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	All impacts to lower Arbuckle to be mitigated through appropriate SWM design.
Arbuckle/Van Gaal	VG-R2		Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	Van Gaal will be protected from construction activities using conventional mitigations. SWM ponds will have negligible effect on temperature because of low flow volumes.
Van Gaal Drain	VG-R2-1		Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	
	VG-R2-2		Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	
Moore Branch	VG-R3	1	Direct	P	M	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	Flows to lower Moore Branch will be maintained, and will have same quality and temperature as pre-development.
	VG-R3	2	Direct	P	L	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	
	VG-R3	3	Direct	P	L	No	Yes	Yes	Yes	Yes	Low	Low	Low	Low	
	VG-R3-1	4	Direct	I	L	No	Yes	No	No	No	Low	High	Medium	Low	Flows to Sections 4 and 5 will be diminished because of SWM management. Channels will remain.
	VG-R3-1	5	Indirect	I	L	No	Yes	No	No	No	Low	High	Medium	Low	
	VG-R3-2	6	Direct	I	L	No	No	NA	NA	NA	Low	High	High	Low	Channel enhanced
	VG-R3-2	7	Direct	I	L	No	No	NA	NA	NA	Low	High	High	Low	Channel enhanced
	VG-R3-2	8	Indirect	I	L	No	No	NA	NA	NA	Low	High	High	Low	Channel piped.
Jock River Estates Drain	JED-1		Direct	I	L	No	No	NA	NA	NA	Low	High	High	Low	Channel is filled in.
SWM Pond 1	Outlet channel		Direct	P											Channel will be created with natural channel design principles, and is a gain of fish habitat. Channel likely to be > 50 m long.

Table 21. Summary of fish habitat losses and gains for Option 3.

Habitat Class	Area (m^2)		
	Existing	Option 3	Change
Direct, Permanent	16,526	16,676	150
Direct, Intermittent	3,052	6,288	3,236
Indirect, Intermittent	3,660	300	-3,360
Total Direct	19,578	22,964	3,386

Table Note: detailed numbers are presented in Table 20 above.

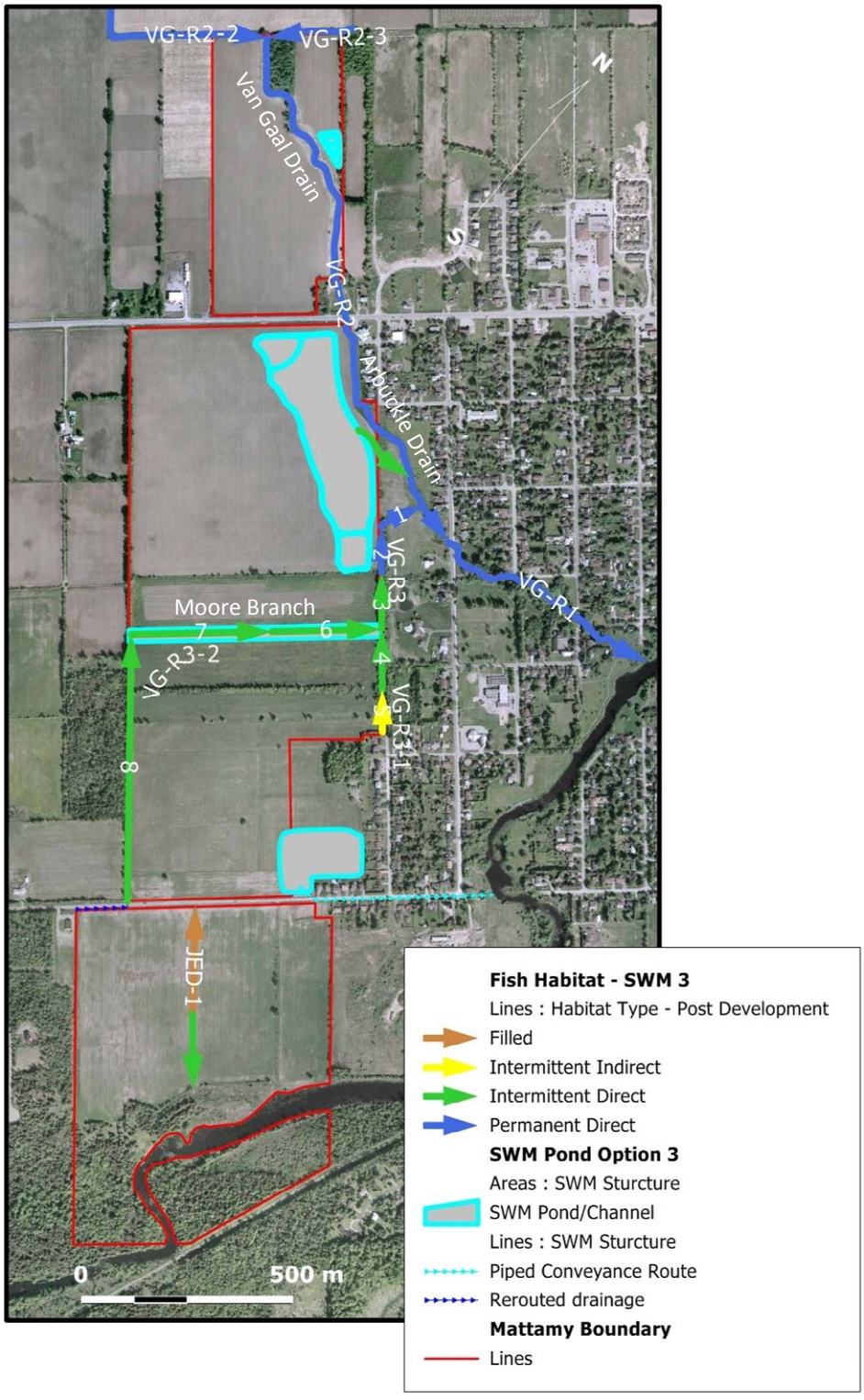


Figure 37. SWM Option 3 and resulting fish habitats.

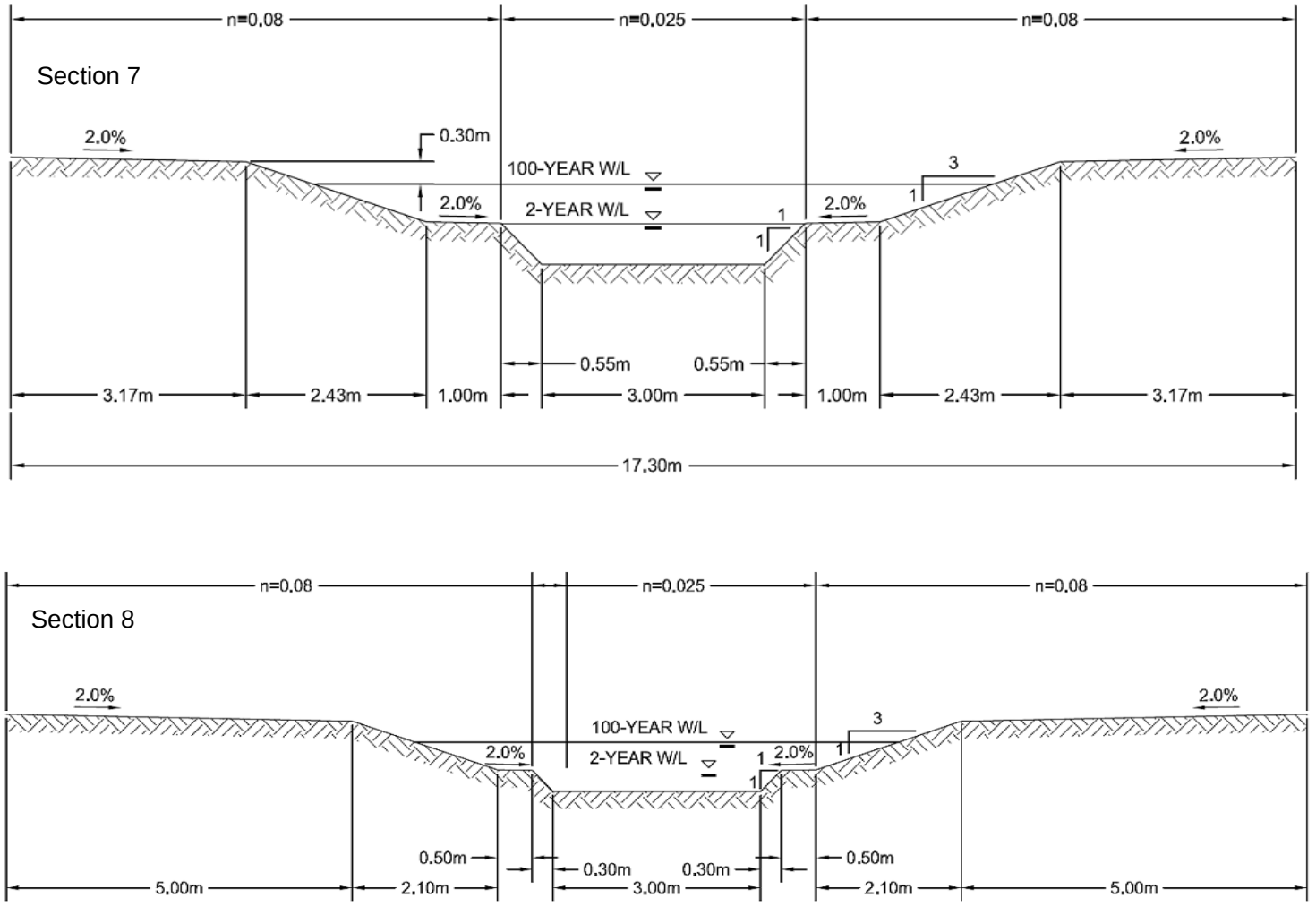


Figure 38. Proposed cross-sections for Sections 7 and 8 of the Moore Tributary.

Figure 39. Photo of Section 5 of the Moore Tributary, facing upstream.

Figure Note: from Appendix 7

7.0 FUTURE STUDY REQUIREMENTS

This report satisfies the requirements of an environmental management plan for Mattamy's Richmond lands Official Plan Amendment. The findings, analysis and recommendation of this report can also support the City's Community Design Plan (CDP) being prepared for the Village of Richmond. Once the OPA is approved, Mattamy will be submitting a Plan of Subdivision and Zoning Amendment applications to the City as the next step in planning approvals for the Richmond lands. The table below provides a summary of the expected level of detail to be produced with these planning applications as it relates to the environmental requirements.

Table 22 - Clarity on Level of Detail at Official Plan Amendment versus Subdivision Level

Environmental Topic	Official Plan Amendment /CDP Level	Subdivision Level
Watercourse Setbacks and opportunities for restoration and fisheries enhancements	Determine watercourse setbacks. Include how normal high watermark is determined. Identify opportunities and triggers for restoration and fisheries enhancements.	Watercourse setbacks delineated on the Plan of Subdivision. Opportunities for restoration and fisheries enhancements confirmed and where executed, will form part of the landscaping/channel plan.
Environmental Impact Statement (EIS) requirements	Identify where and when EIS will be needed and what to address as per Section 4.7.8, Policy 9 (OPA 76). OPA 76 states that an EIS must demonstrate there will be no negative impacts to a natural feature when a change in land use requiring approval under the Planning Act is submitted (Section 4.7.8, Policy 3 and 6). However, Mattamy's application was deemed complete on May 26, 2009. As such, the 2003 OP policies apply to this application and as a result the EIS will be prepared at the plan of subdivision stage.	EIS submitted with Plan of Subdivision application if development proposed within 120 m from the significant woodland and Jock River corridor. The EIS will need to conform to PPS, OPA 76 and any other guidelines in place at the time of submission. A Table of Contents will be submitted to the City and RVCA for input prior to submission of the EIS.
Pathways	Conceptually illustrated as part of the broader Village Greenway System in Concept Plan. General guidelines on location,	Pathway locations, width, materials, etc determined through Tree Conservation Plan, Landscape Plan and

Environmental Topic	Official Plan Amendment /CDP Level	Subdivision Level
	considerations at subdivision stage provided.	EIS. The Plan of Subdivision will clearly locate the location of the pathway within the hazard setback.
Tree Conservation Report	References to the Tree Conservation Report in terms of mechanism for more specific requirements at Plan of Subdivision stage	Tree Conservation Report as per the Tree Conservation Report Guidelines, will be submitted with the development application. The City's Trees in Sensitive Clays policy will be reviewed to determine its applicability to areas of clay within the property and required setbacks to allow for street trees.
Boundary of significant woodland and Jock River Corridor	Determine boundary of significant woodland and Jock River corridor based on City's criteria specified in OPA 76. 120 meter adjacent lands trigger identified.	EIS will be undertaken to define the required buffer width for the Jock River corridor including the significant woodland. Conditions of subdivision will provide the mechanism for conveyance and associated terms.
Boundary of local natural features (hedgerows, woodlands)	General boundary delineation based on concept plan.	Through Tree Conservation Report, boundary to be finalized for retained features and incorporated into the Plan of Subdivision.
Adjacent land uses	Establish guidelines and/or specific targets for parklands, paths, single-loaded roads abutting natural features; avoidance of rear lotting on parks and natural features to preserve accessibility.	Plan of Subdivision develop consistent with the approved concept plan that has addressed urban design elements associated with adjacent uses to natural features and areas.
Grading	Preliminary grading plan associated with the stormwater management and drainage report. Based on this preliminary grading plan, determine feasibility of retaining natural features and recommended general guidelines and mitigation measures.	Grading plan refined at Plan of Subdivision and mitigation measure details provided for natural features and individual species. This will form part of the Tree Conservation Report.
Well Head Protection Study	Master Servicing Study	Well Head Protection Study

Environmental Topic	Official Plan Amendment /CDP Level	Subdivision Level
	identified communal well as the preferred solution for water supply for future growth and existing development when warranted. Communal well facility located and shown on concept plan.	for new communal well facility will be required as part of registration for the subdivision.

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