3 Natural Heritage

Three components are included within this section and include Terrestrial Resources undertaken by **Dougan & Associates**, Aquatic Resources undertaken by **C. Portt and Associates** and Fluvial Geomorphology undertaken by **JTB Environmental Systems Inc**. (JTBES).

3.1 Terrestrial Resources

3.1.1 Introduction and Background

The terrestrial resources component of the Erbsville South Environmental Study was completed by Dougan & Associates – Ecological Consulting & Design. The study area is shown on Figure 1.1. This work was scoped based on the Technical Work Plan prepared for the study (see Appendix 1.3). Methods and findings are provided in the following sections.

The qualifications of the terrestrial ecology field study team are summarized in Table 3.1.

Table 3.1 Qualifications of the Terrestrial Ecology Field Study Team

Breeding Bird Surveys	*Ian Richards* specializes in field ornithology has over three decades of experience completing breeding bird surveys in Ontario.
Reptile & Amphibian Surveys	*Ian Richards* and *Karl Konze* each have over three decades of field identification surveys experience identifying wildlife in Ontario. *Dylan White* has three years of wildlife identification experience and completed the Ontario Reptile and Amphibian Field Survey Training Course in 2013. *Kristen Beauchamp* has conducted numerous amphibian call surveys and recently completed the Ontario Reptile and Amphibian Field Survey Training Course in 2016. *Our wildlife assessors have* excellent working knowledge of the various protocols used in wildlife monitoring programs and regularly apply these to effectively monitor amphibians, snakes, salamanders, turtles and other wildlife across Ontario.
American Badger Surveys	*Dylan White* has extensive experience with the habitats in the Erbsville South study area and the protocol used to search for evidence of badger activity was based on communications with OMNR staff in 2010, including Ron Gould, the Chair of the Ontario American Badger Recovery Team.
ELC and Botanical Surveys	*Wendy Charron-Frise* has completed the MNRF ELC certification. She has been completing botanical surveys and ELC assessments at a professional level since 2006.
Wetland Assessment	*Wendy Charron-Frise* is a certified OWES wetland evaluator and has been involved with wetland boundary delineations, complex assessments and OWES evaluations since 2009.

3.1.2 Background Review

Background studies included a review of existing documents related to the study area and proposed development. Ortho-rectified aerial photography was utilized to determine the general character of the natural features on the properties and vicinity. A query of the Ministry of Natural Resources, Natural Heritage Information Centre (NHIC) Biodiversity Explorer online database (2013) was completed in order to anticipate species at risk that have the potential to be present in the immediate vicinity of the properties.

Information reviewed to provide an understanding of the policy designations and ecological character of the properties within the context of its surrounding landscape included:

a) City of Waterloo Official Plan (Dec. 2012) (City of Waterloo, 2012)
b) Regional Official Plan (as approved by the Ontario Municipal Board, June 18, 2015) policies 7.C.9-11
c) Region of Waterloo Draft Greenlands Network Implementation Guideline (2011) (RWM, 2010)
d) 2014 Provincial Policy Statement
e) Natural Heritage Reference Manual 2nd Ed. (OMNR, 2010)

f) Laurel Creek Watershed Study (GRCA, 1992)
g) Final Subwatershed Management Plan 309/313 (PIL, 1996)
h) GRCA Fisheries Management Plan (GRCA, 2005)
i) North Waterloo Scoped Subwatershed Study (Ecoplans *et al*. 2013)
j) Schaefer's Woods ESPA (#17) (RMW, 2003; RMW, No Date (a))
k) Laurel Creek ESPA (#80) (RMW, No Date (b))
l) Laurel Creek Headwaters Environmentally Sensitive Landscape (RMW, 2011)
m) Sunfish Lake – Laurel Creek PSW data record (Drabick, 2003)
n) Natural Heritage Information Centre Database Query (NHIC, 2013)
o) Simpson Lands Stage I Monitoring Reports (2006 - 2011) (Stantec, 2006 – 2011)
p) Sunvest Development Corp. Studies within the Erbsville South Study Area
    a. Wideman Road EIS (Draft) (D&A, 2008)
    b. Hydrogeological Study Report, Michael Property, Waterloo (Mitz & Assoc., 2010)
q) Regal Place Scoped EIS (D&A, 2013)
r) MNR comments on T.O.R. (Norminton, 2013 – Appendix 2.1)
s) Wildlife Observations Submitted by Local Residents; and
t) Breeding Bird Monitoring in Northwest Waterloo (City of Waterloo, ongoing),

3.1.2.1 Landscape Context

The property is situated in the Waterloo Hills Physiographic Region which is an area characterized by upland ridges and sandy hills, including some kames and kame moraines. A series of alluvial terraces of the Grand River spillway system occur in the general vicinity which typically exhibit fairly uniform substrates of sands and gravels (Chapman & Putnam, 1984). The Erbsville South property is situated within the spillway portion of the physiographic region.

The property is located within the Great Lakes St. Lawrence Forest Region, characterized by coniferous and deciduous forests (Rowe, 1972). It is also a part of the MNR Stratford Ecodistrict 6E-1. Sixteen percent of this ecodistrict remains in natural cover, which is primarily comprised of till plain forest and swamp (Henson & Brodribb, 2005).

At a smaller scale, the property is located within the Laurel Creek Watershed, which encompasses the majority of the City of Waterloo, and portions of the Townships of Woolwich, Wilmot and Wellesley. The Erbsville South property is situated within Subwatershed #309, the majority of which is considered a significant ground water recharge feature. The major drainage features of Subwatershed #309 include Laurel Creek and the Wideman Tributary (Planning Initiatives Ltd. and Associates, 1996).

At a regional level, the study area is located within the Regional Municipality of Waterloo and a portion of the study area located outside of the urban boundary forms part of the Laurel Creek Headwaters Environmentally Sensitive Landscape (ESL). The Laurel Creek Headwaters ESL is a one of four systems of sensitive environmental features within the Region of Waterloo protected through the Region's Official Plan. This ESL is a connected system of natural habitats and landforms on the Waterloo Moraine (RMW, 2011). Additionally, the Erbsville South property contains portions of Schaefer's Woods Environmentally Sensitive Policy Area (ESPA), the Laurel Creek Forest ESPA, Significant Woodlands, and the Sunfish Lake – Laurel Creek PSW complex.

3.1.2.2 Legislative & Policy Context

In addition to the policy framework discussed in Section 2.0, the following legislation is also relevant to this Environmental Study and has aided in determining the scope and methodology of background review and field surveys:

<u>Federal Legislation:</u>

- Species at Risk Act (2002)
- Migratory Birds Act (1994)

<u>Provincial Legislation and Policy:</u>

- Endangered Species Act (2007)

A summary of key policy data from these sources is provided below.

Federal Legislation

SPECIES AT RISK ACT (2002)
This legislation provides the federal mandate for the protection of species identified as Endangered, Threatened or Special Concern at the federal level (Government of Canada, 2002). While Threatened and Endangered species are only fully protected on federal lands, some Threatened and Endangered species may also receive protection on non-federal lands via the 2014 Provincial Policy Statement (OMMAH, 2014) by triggering Significant Wildlife Habitat (SWH) designation (OMNR, 2000).

No federal lands are present within or directly adjacent to the study area and none of the Species at Risk documented through field studies or consultation with local residents would trigger SWH designation.

MIGRATORY BIRDS CONVENTION ACT (1994)
Section 6 of the Migratory Birds Regulations made under the federal 1994 Migratory Birds Convention Act makes it an offence to "disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird" (Government of Canada, 1994a,b).

The Act is applicable to all construction activities that require vegetation clearing, since vegetation could harbour nesting birds. Environment Canada normally recommends restrictions on vegetation clearing during 'core' breeding periods. In areas south of the Canadian Shield, this roughly corresponds with the following dates:

- Forested Habitats (May 9 – July 23)
- Open Habitats (May 1 – July 23)
- Wetland Habitats (May 9 – July 31)

Nesting activity outside of these core periods is possible and a more conservative interpretation (*i.e*., March 1 – September 9) should be considered. Appendix B of the Breeding Birds of Ontario, Nidiology and Distribution – Volume 2: Passerines by Peck and James (1987) should be consulted to determine what bird species are likely to be nesting outside the normal 'core' nesting periods. It is the responsibility of proponents to demonstrate that the Act is not contravened. Should it be required to conduct vegetation clearing during these periods, a qualified avian ecologist should be retained to determine whether any nesting birds are present within or directly adjacent to the area being cleared.

Not all bird species are protected under the Migratory Birds Convention Act, 1994. Excluded are birds of prey, fish-eating birds, Blue Jays, American Crows, Common Ravens, Red-winged Blackbirds, Common Grackles and Brown-headed Cowbirds. The full list of species excluded from protection is available online through Environment Canada's website.

Provincial Legislation & Policy

ENDANGERED SPECIES ACT (2007)
This legislation provides the provincial mandate for the protection of species identified as Endangered, Threatened or Special Concern at the provincial level (Government of Ontario, 2007). It also prohibits the damage or destruction of the habitat of species listed as Endangered or Threatened on the Species at Risk in Ontario List. Although habitats of provincial Special Concern species are not protected under the ESA, they do receive protection via Ontario's Provincial Policy Statement (OMMAH, 2014) as Significant Wildlife Habitat (OMNR, 2000).

The following Species at Risk were documented from within or close to the study area during the completion of field studies and consultation with local residents. These species are addressed in detail later in this report:

- Monarch (*Danaus plexippus*) – Special Concern
- Snapping Turtle (*Chelydra serpentina*) – Special Concern
- Blanding's Turtle (*Emydoidea blandingii*) – Threatened
- Northern Map Turtle (*Graptemys geographica*) – Special Concern
- Bald Eagle (*Haliaeetus leucocephalus*) – Special Concern
- Red-headed Woodpecker (*Melanerpes erythrocephalus*) – Special Concern

- Eastern Wood-Pewee (*Contopus virens*) - Special Concern
- Barn Swallow (*Hirundo rustica*) - Threatened
- Canada Warbler (*Cardellina canadensis*) – Special Concern
- Butternut (*Juglans cinerea*) – Endangered

Each Species at Risk documented merits protection appropriate to its level of designation.

3.1.2.3 Background Terrestrial Resources Data

Existing biophysical studies and relevant data were reviewed prior to field studies as they provide valuable information about the species, natural features, ecological functions and relationship with other natural areas in the surrounding landscape. In addition to the documents outlined in Section 2.0 a number of sources were also reviewed. A summary of key background data from these sources follows:

Schaefer's Woods ESPA

Schaefer's Woods is a diverse 103.8 ha complex of high quality upland and lowland forest, located north of Wideman Road, that extends from the west onto the study area and includes the forested communities west of Erbsville Road (RMW, 2003). The area is an important component of the Laurel Creek corridor and contains the confluence of Monastery and Laurel Creeks. Along these creeks are wetlands, including fine examples of Tamarack (*Larix laricina*), Hemlock-Cedar (*Tsuga canadensis-Thuja occidentalis*), Balsam Fir (*Abies balsamea*) and Yellow Birch (*Betula allegheniensis*) swamps as well as deciduous swamps dominated by Silver Maple (*Acer saccharinum*). Upland areas are predominantly Sugar Maple-Beech type forests which include some trees of substantial size and a high quality stand of Hemlocks (*Tsuga canadensis*).

This natural area fulfils six ESPA criteria that led to its designation: high quality of the habitats, presence of coldwater stream, old growth forest elements, the presence of habitat for forest interior species, as well as habitat that supports nine significant bird species and fifteen significant plant species. The vital hydrological functions such as water storage, recharge and discharge areas are also recognized in this designation.

Laurel Creek Forest ESPA

This feature is a combination of swamp and upland forest associated with Laurel Creek and is located between Schaefer's Woods and the Laurel Creek Reservoir, acting as an important natural corridor [RMW, No Date (b)]. Laurel Creek is considered a cool water stream where sections have been rehabilitated to improve fish habitat. The Laurel Creek Nature Centre is located in the eastern portion of this ESPA. Most of the ESPA is contained within the Laurel Creek Class 1 Wetland Complex.

Laurel Creek Headwaters ESL

Environmentally Sensitive Landscapes are landscape-scale environmental features designated by the Region of Waterloo as part of their official plan. The Laurel Creek Headwaters ESL is an approximately 2,075 ha area of land spanning the northwest corner of the City of Waterloo and portions of the Townships of Wellesley, Wilmot and Woolwich. This ESL links important landforms and habitats on the Waterloo Moraine. The Waterloo Moraine is a significant groundwater recharge area and also provides groundwater discharge to wetlands and some of the watercourses within this ESL (RMW, 2005).

Three kettle lakes are considered key features of this ESL (RMW, 2005), however none of these are within the Ersbville South study area. This area is characterized by its rolling topography and contains upland and lowland forest, extensive swamp and marsh wetland complexes. The majority of the wetlands in this ESL are designated as Provincially Significant (RMW, 2005). The ESL contains seven ESPAs including the Shaefer's Woods ESPA (RMW, 2005), which is associated with the Erbsville South study area. Beaver Creek, Monastery Creek and headwater reaches of Laurel Creek are located within the ESL.

The Erbsville South study area is situated along the eastern edge of the Laurel Creek Headwaters ESL. The extended study area is included in the ESL and is primarily the wetland located along the western side of the study area.

Sunfish Lake - Laurel Creek PSW Data Record

The majority of wetlands in the Erbsville South study area are included in the Sunfish Lake – Laurel Creek PSW. A wetland evaluation for Sunfish Lake-Laurel Creek Wetland Complex was completed on March 25th, 2003 by the Ministry of Natural Resources (Drabick, 2003). 109 wetland units were evaluated totaling an area of 811 ha. The wetlands in this complex are primarily swamp with some marsh and are either palustrine or riverine. A small number of isolated wetlands were also identified. An area of bog was identified within the PSW at one point (in association with Bamburg Lake), however this was deleted from the data record during the 2003 update as the surveyor was not able to find sufficient indicator species to confirm presence of a bog.

Provincially significant species noted in the data record include Jefferson X Blue-spotted Salamanders (where the Jefferson genome dominates), and Braun's Holly Fern (*Polystichum braunii*). Locally significant species noted in the data record include Red-shouldered Hawk (*Buteo lineatus*), Hairy-Fruit Sedge (*Carex lasiocarpa*), Rough Sedge (*Carex scabrata*), Native Legume (*Astragalus* sp.), Intermediate Spikerush (*Eleocharis intermedia*), Early Coralroot (*Corallorhiza trifida*), Adder's Tongue Fern (*Ophioglossum vulgatum*), Three-Cleft bedstraw (*Galium trifidum*), Pondweed (*Potamogeton epihydrus*), Bog Goldenrod (*Solidago ulginosa*), Kidney Shaped Violet (*Viola renifolia*), Showy Lady Slipper (*Cypripedium reginae*), Small Purple Fringed Orchid (*Platanthera psycodes*), Pink Moccasin Flower (*Cypridium acaule*), and Dewdrop (*Dalibarda repens*). Other wildlife species recorded in the data record include Snapping Turtle, Muskrat, Raccoon, Beaver, Mink, Red Fox, and Coyote. Since these species have been documented in the PSW complex, it is possible that they could exist within the Erbsville South study area.

Of relevance to this study, there is one wetland present in the Erbsville South study area that was not included as part of the PSW complex during the 2003 evaluation. This small wetland is located at the corner of Wideman Road and Erbsville Road and was identified and staked with GRCA in 2014.

NHIC Query Results

The NHIC database (NHIC, 2013) was checked for significant plant and animal records for the four 1 X 1 km squares that overlap the study area, as well as the 12 additional 1 x 1 km squares that surround them. See Appendix 2.2 for a complete list of the squares queried and Table 3.2 for the vegetation and wildlife records on file in the database. The name of one of the species on file was kept confidential by MNRF to help protect it from potential persecution.

Table 3.2 NHIC Query Results

Scientific Name	Common Name	Conservation Status			Observation dates
		National	Provincial		
		SARA*	ESA**	S-rank	
Restricted Record	?	?	?	?	September 10, 1987
Flora					
Carex albicans var. albicans	White-tinged Sedge	---	---	S3	June 06, 1968
Lithospermum latifolium	American Gromwell	---	---	S3	June 22, 1941
Monarda didyma	Scarlet Beebalm	---	---	S3	July 1892
Phlox subulata	Moss Phlox	---	---	S1?	June 10, 1974
Polystichum braunii	Braun's Holly Fern	---	---	S3	November 02, 1979
Sphenopholis nitida	Shiny Wedge Grass	---	---	S1	August 9, 1973
Vicia caroliniana	Carolina Vetch	---	---	S2	May 14, 1948
Fauna					
Ambystoma hybrid pop. 1	Jefferson X Blue-spotted Salamander, Jefferson genome dominates	---	---	S2	April 25, 1981
Ambystoma jeffersonianum	Jefferson Salamander	THR	END	S2	April 25, 1981
Chelydra serpentina	Snapping Turtle	SC	SC	S3	1996
Chlidonias niger	Black Tern	NAR	SC	S3B	May 08, 1979
Ixobrychus exilis	Least Bittern	THR	THR	S4B	August 22, 1988
Lampropeltis t. triangulum	Eastern Milksnake	SC	NAR	S4	September 27, 1980
Lampropeltis t. triangulum	Eastern Milksnake	SC	NAR	S4	September 19, 1980

Scientific Name	Common Name	Conservation Status			Observation dates
		National	Provincial		
		SARA*	ESA**	S-rank	
Thamnophis sauritus septentrionalis	Northern Ribbonsnake	SC	SC	S3	October 02, 1977
Wilsonia citrina	Hooded Warbler	THR	NAR	S4B	2000

NAR = Not at Risk; SC = Special Concern; THR = Threatened; END = Endangered.

* **Government of Canada. 2002.** Species at Risk Act, Statutes of Canada (2002, c. 29). Retrieved from the Department of Justice Laws Website: http://laws-lois.justice.gc.ca/eng/acts/S-15.3/index.html. See Schedule 1.

** **Government of Ontario. 2007.** Endangered Species Act, Statutes of Ontario (2007, c. 6). Retrieved from the Service Ontario e-Laws website: http://www.elaws.gov.on.ca/html/statutes/english/elaws_statutes_07e06_e.htm See O. Reg. 230/08: Species at Risk List in Ontario.

Of the observations on file, all but two are considered historical in nature, as they were reported more than 25 years ago (*i.e*., before December1989). Snapping Turtle (*Chelydra serpentina*) was reported in 1996 and is designated Special Concern both nationally and provincially (COSEWIC, 2015; COSEWIC, 2016; OMNRF, 2016a). Hooded Warbler was last reported in 2000. However, it is no longer considered to be a Species at Risk in Ontario or Canada (OMNRF, 2016a; COSEWIC, 2015; COSEWIC 2016). Eastern Milksnake is also now designated Not at Risk in Ontario (OMNRF, 2016a).

Suitable habitat exists within the study area for all of the plant species on record (NHIC, 2016; Gleason & Cronquist, 1991; Cobb, Farnsworth & Lowe, 2005; Dore & McNeill, 1980). None of these species would require special surveys for detection aside from the 3-season botanical surveys that were completed as per the Technical Work Plan (TWP).

With the exception of Black Tern (Weseloh, 2007), suitable habitat exists within the primary and extended study areas for all of the wildlife species on record (Petranka, 1998; Badzinski, 2007; Woodliffe, 2007a; Rowell, 2012; Steyermark *et al*., 2008; COSEWIC, 2008). However, for some of the species, existing habitat conditions are considered marginal (Petranka, 1998; Woodliffe, 2007a). Also, similar to the plant species, none of the wildlife species require specialized surveys for detection not already included in the Technical Work Plan.

Finally, the MNRF was contacted to find out what species the restricted record pertained to. Based on the response, it can also be confirmed that the field surveys promised in the Technical Work Plan would do an adequate job of detecting it if it were present.

MNRF's Land Information Ontario Warehouse

According to MNRF's Land Information Ontario warehouse, winter deer yards are not present within or adjacent to the Erbsville South study area. However, the majority of wooded areas within the study area, and wetland habitats along Laurel Creek, are considered Stratum 2 deer wintering areas. See Figure 6-1.

Simpson Lands Stage I Monitoring Report (2006 – 2011)

Stantec Consulting Ltd. conducted Stage I Monitoring on the Simpson Lands, located east of Erbsville Rd. Three transects were established in 2006 and have been monitored each year since then. Locations of these transects were chosen on the basis that "general community structure and composition within the various vegetation communities adjacent to the proposed development on the subject lands and would have a higher probability of short-term responses to environmental change" (Stantec, 2012). A fourth plot was established in 2009 away from any proposed developments to act as a baseline comparison. The four transects are located outside of the Erbsville study area in the mixed swamp (SWM1-1) community to the east. Results from 2007 to 2008 were compared to 2006 results rather than the baseline transect, after the fourth transect was established it was used for comparison. Transects consisted of 2x2 m plots spaced 10 m apart (Stantec, 2007). Photo-monitoring stations were also established along the length (Stantec, 2007). No site grading or alteration has occurred during the monitoring program.

Sunvest Development Corp. Studies within the Erbsville South Study Area

In 2007, Dougan & Associates conducted vegetation and wildlife surveys (breeding birds and herpetofauna) for the purpose of proceeding with a development application on the Michaels Property located within the southern half of the Erbsville South Environmental Study Area at the northwest corner of Erbsville Road and Wideman Road. Breeding birds and herpetofauna were recorded from all parts of the property, and adjacent lands, including the adjacent PSW (D&A, 2008 unpublished). Relevant findings include the following:

i. Vegetation:

- Nine species identified in the Wideman Road property were found to be significant in the Region of Waterloo (RMW, 1999) These include *Carex flava, Carex leptalea ssp. leptalea, Carex scabrata,* and *Cypripedium reginae* which are considered rare (R). *Diphasiastrum digitatum*, *Lycopodium dendroideum*, and *Polygonum punctatum* are considered significant with the expectation that additional research may prove otherwise (R*). *Juglans nigra* is considered significant with the expectation that additional research may prove otherwise and only if demonstrably indigenous (R+*).

ii. Breeding Birds:

- Forty-four (44) bird species were recorded as possibly breeding on the property to the south of Erbsville South.
- One Species at Risk, Barn Swallow (*Hirundo rustica*), designated provincially Threatened (OMNRF 2016a), was detected in 2007. Nesting was confirmed in the Erbsville South Study area in 2013.
- Nine of the bird species recorded are identified by Environment Canada as priority species for conservation in BCR 13 (Lower Great Lakes/St. Lawrence Plain) (EC 2014). This includes: Great Blue Heron (*Ardea herodias*), Green Heron (*Butorides virescens*), Killdeer (*Charadrius vociferus*), Northern Flicker (*Colaptes auratus*), Eastern Kingbird (*Tyrannus tyrannus*), Field Sparrow (*Spizella pusilla*), Savannah Sparrow (*Passerculus sandwichensis*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*), and Baltimore Oriole (*Icterus galbula*). The Eastern Kingbird was seen flying south across the agricultural fields on the north side of the Wideman Road property, and away from the Erbsville South property. The Rose-breasted Grosbeak was along the hedgerow along the south side of the Erbsville South site. However, given its requirements of large forested areas for breeding, it is not likely that it was breeding at this location, and was probably transient in nature.
- Six area sensitive forest bird species were detected in the ESPA including Hairy Woodpecker (*Picoides villosus*), Pileated Woodpecker (*Dryocopus pileatus*), Red-breasted Nuthatch (*Sitta canadensis*), White-breasted Nuthatch (*Sitta carolinensis*), Veery (*Catharus fuscescens*), Pine Warbler (*Setophaga pinus*) (OMNR 2000). Due to the lack of suitable forest habitat, the Erbsville South property would not support these species. Savannah Sparrow was observed along Erbsville Road in cultural meadow habitat.
- Eleven (11) of the 44 breeding bird species observed are recognized to be significant in the Regional Municipality of Waterloo (RMW, 1996), including: Great Blue Heron (*Ardea herodias*), Green Heron (*Butorides virescens*), Hairy Woodpecker (*Picoides villosus*), Pileated Woodpecker (*Dryocopus pileatus*), Alder Flycatcher (*Empidonax alnorum*), Warbling Vireo (*Vireo gilvus*), Red-breasted Nuthatch (*Sitta canadensis*), Veery (*Catharus fuscescens*), Pine Warbler (*Setophaga pinus*), Northern Waterthrush (*Parkesia noveboracensis*), Swamp Sparrow (*Melospiza georgiana*). These species are all associated with the forest and wetland habitats within the ESPA.
- The hedgerow shared with the Erbsville South and Regal Place subdivision did not contain any significant breeding bird species. Nevertheless, it provides foraging opportunities, shelter and singing perches for birds. This hedgerow also acts as a noise and visual buffer for any birds nesting in the wetland, helping ensure that these species are not disturbed during their summer breeding season.

iii. Herpetofauna:

- Six (6) amphibian species were recorded on the Wideman Road site south of the Erbsville South study area during 2007 nocturnal calling frog and toad surveys: American Toad (*Bufo americanus*), Gray Treefrog (*Hyla versicolor*), Spring Peeper (*Pseudacris crucifer*), Green Frog (*Rana clamitans*), Northern Leopard Frog (*Rana pipiens*), and Wood Frog (*Rana sylvatica*). Most frogs and toads were heard calling from the wetland communities at the east side of the woods, in a dug pond and meadow marsh in the southeast corner of the property, and in the localized meadow marsh within the flooded ditch along Erbsville Road. Spring Peepers and a few Northern Leopard Frogs were heard calling from small

wetland pockets adjacent to the hedgerow. Frogs and toads were also heard calling from the Laurel Creek PSW to the west of the Wideman Road study area.

- A Red-spotted Newt (*Notophthalmus v. viridescens*) was recorded, but was within a forest habitat not present on the Erbsville South property, near the southwestern boundary of the Wideman Road property. The Red-spotted Newt is considered "rare" in the Regional Municipality of Waterloo (RMW 1985).
- Most of the amphibians detected in 2007 were found in areas well south of the Erbsville South property, including the regionally significant Red-spotted Newt, which was found in the forested sections along Wideman Road. Some amphibians were heard in small wet areas along the hedgerow along the southern border of the Erbsville South property. These areas are ephemeral in nature and do not support significant breeding populations. The wetlands to the west of the property support more significant populations.

iv. Other Wildlife:

- Four (4) species of mammals were detected from the Wideman Road property located south of Erbsville South: Eastern Chipmunk (*Tamias striatus*), Gray Squirrel (*Sciurus carolinensis*), Red Squirrel (*Tamiasciurus hudsonicus*), and White-tailed Deer (*Odocoileus virginianus*). All of these species are common and widespread in Ontario, with SRanks of S5, indicating "secure" populations (NHIC 2016).
- Monarch butterfly (*Danaus plexippus*), which is designated "Special Concern" in Ontario and Canada (OMNRF 2016; COSEWIC 2015; COSEWIC 2016), was detected on the Wideman Road site in 2007. This widespread species can be detected in any open habitat, whether disturbed or natural. Although a Species at Risk in Canada, this species is at risk due to habitat loss on its wintering grounds, and not its breeding grounds (Crolla and Lafontaine 1996). Two other species of insects were also noted: Little Wood Satyr (*Megisto cymela*) and Ebony Jewelwing (*Calopteryx maculata*); both these species have SRanks of S5, indicating "secure" populations in the province (NHIC 2016).

In addition to the ecological studies, Mitz & Associates was retained by Sunvest Development Corp. to complete a hydrogeological study for the Michaels Property (Mitz & Associates, 2010). The study found that the "Michael property is characterized by low to moderate permeability soils in the potentially developable areas which results in high runoff and generally low direct infiltration. Predevelopment infiltration rates across the developable portions of the site are estimated to be in the 10 to 15 % range."

The soils near the surface are made up of "sand, till, and organic deposits [that] form a discontinuous shallow "aquifer" over much of the area" which supplies baseflow to Wideman Creek. The middle aquifer is located between 20 to 30 m and consists of sands and gravel and the deep aquifer is 5 m wide and located slightly above bedrock. Groundwater was found between 4.5 and 1 m below ground surface. Schaefer's Woods acts as recharge and discharge areas depending on the time of year. Portions of the study area are dominated by clays and silts resulting in more overland flow into the Creeks and less recharge.

Mitz & Associates completed a Water Balance Analysis to determine "the amount of water infiltrating into the subsurface (contributing to groundwater) with the amount of water being drawn for water supply." They found that "infiltration in the elevated areas of the site may discharge along the flanks and become surface water before infiltrating again within the [swamp] bordering the south part of the development area and then discharging to Wideman Creek." Impacts caused by developing the site can be mitigated through the implementation of stormwater management system that "direct high quality stormwater to the Schaefer's Woods wetlands in a pattern designed to match the existing distribution of runoff from the site" which can be accomplished through "treatment ponds discharging to some form of spreader swale directing water to the wetlands draining to both Wideman and Laurel Creeks."

Regal Place Scoped Environmental Impact Study (D&A, 2013)

In 2013, Dougan & Associates conducted field investigations for the Regal Place development. Although located in the centre of the Erbsville South Environmental Study area, these lands are excluded from the current study as that development is already approved and under construction. Key findings from the Regal Place EIS include the following:

- Environmental constraints identified included: ESPA and 10 m buffer; PSW and 30 m buffer; Watercourse and 30 m buffer; Regulatory floodplain; Wildlife habitat & linkage features; Species at Risk: Northern Ribbonsnake (ID uncertain), Northern Map Turtle, Barn Swallow; Species of regional significance: Turkey Vulture, Black Walnut, American Water-lily.
- Ecological linkage features include the hedgerow that straddles the boundary between the Regal Place Development and the Erbsville South Study Area. The width of the hedgerow varies from 7 to 14 m along its length. This hedgerow has local linkage opportunities. Erbsville Road represents a barrier to wildlife movements, and as a regional arterial road, may cause significant road kills. Some scattered tree cover extends beyond the general boundary of the hedgerow into a number of lots. Extensive negotiations occurred with City of Waterloo staff regarding this hedgerow. An agreement was reached in March 2013 on the approach to retain and protect the hedgerow as a linkage feature until such time as development and enhancement of a more appropriate corridor to the south can occur. The hedgerow corridor, in this case a 10m width from the southern property line, is subject to a temporary conservation easement. The easement lands remain as private property, however conditions include grading prohibition and tree removal prohibition (except as authorized by the City Forester). The boundary of the easement corridor will be marked with bollards supplied by the City. The temporary nature of this easement was meant to be conditional; release of the easement will depend on the establishment and enhancement of a primary linkage corridor along Wideman Creek to the south (which is anticipated to occur under future development of those lands). Upon release of the temporary easement it was anticipated that residents may choose to retain the hedgerow vegetation as it will provide screening from future neighbouring developments. The northern dripline of the hedgerow was documented by an Ontario Land Surveyor in 2012, and included on Regal Place EIS mapping.
- Impact avoidance measures recommended include: completing vegetation clearing and grading in the dormant season, so that nesting birds are not affected; installation and monitoring of silt fencing outside of the wetland boundary; conservation easement for the south hedgerow as discussed above; applying a 15 m building setback and prohibiting grading within the dripline of the south hedgerow to minimize disturbance to the hedgerow and its ability to function as a linkage feature; installation of paige wire fencing along the south and west edges of the lands to be cleared; installation of signage, distribution of educational materials to new residents, and post development monitoring (with follow-up mitigative action for encroachments identified) along the edges of the natural feature.
- Mitigation/compensation measures recommended include: tree and shrub planting along the rear lot lines of several lots; intensive replanting of the new SWM facility including salvage of some of the quality native species from footprint area; infiltration best practices to be followed as per the Stormwater Management Report, including discharge of roof downspouts to infiltration facilities or onto grassed areas; education of new residents on the nearby natural features including information of the functions of the hedgerow, notification regarding easement conditions and location, and recommendations on pruning, additional plantings with native species, and guidance on placement of backyard structures to minimize disturbance; annual monitoring of the hedgerow to ensure the conditions of the easement are being upheld.

Wildlife Observations Submitted By Local Residents

To help ensure the full range of wildlife species were documented and appropriately considered in this, and the Regal Place planning exercise, local residents submitted numerous wildlife observations to the City of Waterloo between 2008 and 2016. Some were documented within the Primary and Extended Study Area, whereas others were made nearby. The complete list of species reported is summarized in Appendix 2.3.

Of the 59 species reported, nine are currently recognized as Species at Risk. That is they are designated “Special Concern”, “Threatened” or “Endangered” in Ontario (OMNRF, 2016) or Canada (COSEWIC, 2015; COSEWIC, 2016). The nine Species at Risk included: Monarch (*Danaus plexippus*), Snapping Turtle (*Chelydra serpentina*), Blanding’s Turtle (*Emydoidea blandingii*), Northern Map Turtle (*Graptemys geographica*), Eastern Milksnake (*Lampropeltis t.* triangulum), Bald Eagle (*Haliaeetus leucocephalus*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Barn Swallow (*Hirundo rustica*), and Canada Warbler (*Cardellina canadensis*).

In Ontario, Threatened and Endangered species are protected under the Endangered Species Act (2007) (Government of Ontario, 2007). However, Special Concern species do not receive similar protection. Instead,

they can trigger designation as Significant Wildlife Habitat and receive protection through the Provincial Policy Statement (2014) (OMMAH, 2014).

In addition to the above Species at Risk, one provincially 'rare' species was also documented, Great Egret (*Ardea alba*). Great Egret has a provincial conservation rank of S2 or "Imperiled" (NHIC, 2016).

The following discussion addresses the significance of the wildlife species described above. Species with the highest provincial conservation status are discussed first.

Barn Swallow (Threatened in Ontario and Canada)
A pair of Barn Swallows was documented nesting under the eaves of a house along Forest Gate Crescent in 2013, as well as foraging over the open fields and wetlands at the northeast corner of Wideman Road and Erbsville Road in 2014. Clearly, the nest site will not be directly impacted by any proposed development west of Erbsville Road. However, some of its foraging habitat may be lost if the open meadow habitats at the northwest corner of Wideman Road and Erbsville Road were to be developed. Nevertheless, the loss of foraging habitat (*i.e.,* area within 200 m of the nest site) is not expected to come close to 50%, the amount the Ministry of Natural Resources and Forestry considers to be significant (Buck, pers. com., 2015). In addition to the wetland habitats west of Erbsville Road, Barn Swallows would also continue utilizing any stormwater ponds proposed in the vicinity.

Monarch (Special Concern in Ontario and Canada)
A single Monarch was photographed on July 12, 2013 from the Erbsville South study area. No additional observations appear to have been recorded. Nevertheless, suitable host plants are scattered throughout the study area, mostly from along the edges meadows and wetlands, as well as agricultural fields. Given the fact that any proposed development would be buffered from the existing natural areas, the loss of mostly agricultural fields and manicured lawn is not expected to have any meaningful negative impact on its continued presence into the future.

Snapping Turtle (Special Concern in Ontario and Canada)
In June 2013, a Snapping Turtle was observed attempting to nest near the pump house at the end of Schnarr Street on the Regal Place property. Later in September 2013, individual dead baby turtles were observed at the west end of Schnarr Street and on Regal Place. A luckier individual was observed on September 29, 2015, at Erbsville Park.

In addition to the above observations, two Snapping Turtles were also observed in September 2013 in the dug pond behind the house at 665 Erbsville Road. Turtles had previously been observed adjacent to the fence southeast of the home on at least two occasions as well as nesting in an old sandbox between the back of the house and the garden.

Proposed development in the Erbsville South study area is not expected to impact Snapping Turtle foraging or overwintering habitat (*i.e*., Wideman Creek, Laurel Creek, or the dug pond at 665 Erbsville Road. However, nesting habitat may be impacted. According to Steyermark *et al*. (2008), "Snapping turtle nests are located in open canopy areas with minimal vegetation and sandy soils. Natural nest sites include open areas caused by tree falls, muskrat mounds, beaver lodges and dams, beaches, sandbars, and islands. Disturbed nest sites include agricultural areas, flowerbeds, lawns, sawdust piles, old fields, gravel pits, railroad grades, roadsides, driveways, and fire lanes." Clearly, some of these features occur within the Erbsville South study area and will either be lost (*i.e.,* agricultural areas) or reduced in size (*i.e.,* manicured lawn). Even the roadsides at the west end of Schnarr Street may be improved in the future as development proceeds or as initiated by the City of Waterloo as part of a road maintenance or improvement project. Future opportunities for nesting will be limited to the wetland and ESPA buffer areas. However, there is no guarantee that these areas will be suitable as sites with minimal vegetation (*i.e.,* high exposure to the sun) are required. To reduce the potential impact that proposed development may have on turtle nesting habitat, special turtle nesting areas can be created within the buffers. Future local residents can also be encouraged to become stewards.

Blanding's Turtle (Threatened in Ontario and Canada)
On May 22, 2016, a Blanding's Turtle was photographed by a local resident, crossing the laneway that runs across Laurel Creek, west of Schnarr Street. It isn't clear if the turtle was simply using the creek and wetland as

a seasonal movement corridor, or if it was starting to look for a place to nest (the date seemed a little bit early) but regardless, it did provide the first documented confirmation that Blanding's Turtles are present within the study area, at least during part of their life cycle.

According to the Ministry of Natural Resources and Forestry, there are two other records of this species within two kilometres of the site, and as a result, the entire Erbsville South Study Area (terrestrial and wetland) is considered 'General Habitat' of Blanding's Turtle by the Ministry. The General Habitat boundaries are further refined in Section 6.1.1.1 (Habitat of Endangered & Threatened Species) of the Constraints Section. Although no Category 1 habitats have been identified within the study area, Category 2 habitats include all of the wetlands and waterbodies within the study area along with a 30 m buffer. This includes the wetland community at the northwest corner of Wideman Road and Erbsville Road. It should also be noted that an 'Overall Benefit Permit' under the Endangered Species Act (ESA) maybe required if this wetland will be impacted by future improvements to Erbsville Road. Category 3 habitats include the area between 30 m and 250 m around suitable Category 2 wetlands.

Northern Map Turtle (Special Concern in Ontario and Canada)
In May 2012, what appeared to be a hatchling Northern Map Turtle, was photographed along the west end of Schnarr Street (south side) adjacent to the north end of the Regal Place property.

This observation is considered quite remarkable. "Northern Map Turtles are normally found only in larger water bodies" (MacCulloch, 2002), inhabiting "larger lakes, rivers, reservoirs, oxbow sloughs, and open marshes, including some of the bays and inlets of the Great Lakes themselves" (Harding, 1997). There are no such features in close proximity to the Regal Place property or Erbsville South study area. The closest large open water feature to where the turtle was photographed is Laurel Creek Reservoir, 1.58 km to the east; separated by approximately 730 m of field and old field habitats, 650 m of dense forest, 165 m of manicured lawn, and Erbsville Road, a busy roadway. Laurel Creek, a coldwater stream, connects the two sites, albeit by a distance of almost 3 km, upstream. Based on communication with GRCA staff (T. Zammit pers. comm. 2013; L. Campbell, pers. comm., 2013) and their review of the 2005 "Biothon", the Laurel Creek Conservation Area Master Plan (2004), and individual records contained in the GRCA's Species-at-Risk database, they were not aware of Northern Map Turtles being present at the reservoir. The closest record on file for this species was from the Brant Conservation Area, in Brantford, Ontario from 2010. However, according to MNRF, Northern Map Turtle was documented within the Laurel Creek Reservoir in 1993, and probably still occurs there. The observation is described in the wetland evaluation for the Sunfish Lake-Laurel Creek PSW. MNRF believes the source of the juvenile turtle within the study area could be from the reservoir, as movement of these distances by the species is known to occur.

The next closest 'larger' body of water is Sunfish Lake, approximately 2.2 km to the west-southwest of where the Northern Map Turtle was apparently photographed. It is roughly 500 m long and 150 wide, and bordered by about 25 rural residential homes with docks etc. The straight line distance between the two sites is approximately 1445 m of mostly forested habitat (including swamps), 580 m of fields, and 175 m of cultural habitats, including the crossing of Wilmot Line. Similar to Laurel Creek Reservoir, the two sites are connected by Laurel Creek and its smaller tributaries. The distance along the streams between the two is approximately 3.6 km. However, according to Harding (1997), Northern Map Turtles are "less common in smaller lakes and streams, though juveniles may reside in small ponds, then move to into larger bodies of water prior to maturity". As such, Sunfish Lake seems a less likely source for the Northern Map Turtle observation than the Laurel Creek Reservoir.

Despite the 1993 observation from Laurel Creek Reservoir, the maps available on the Ontario Herpetofaunal Summary Atlas website, only showed one record on file for the Regional Municipality of Waterloo, a post 1983 observation from the southern Cambridge area, likely from along the Grand River.

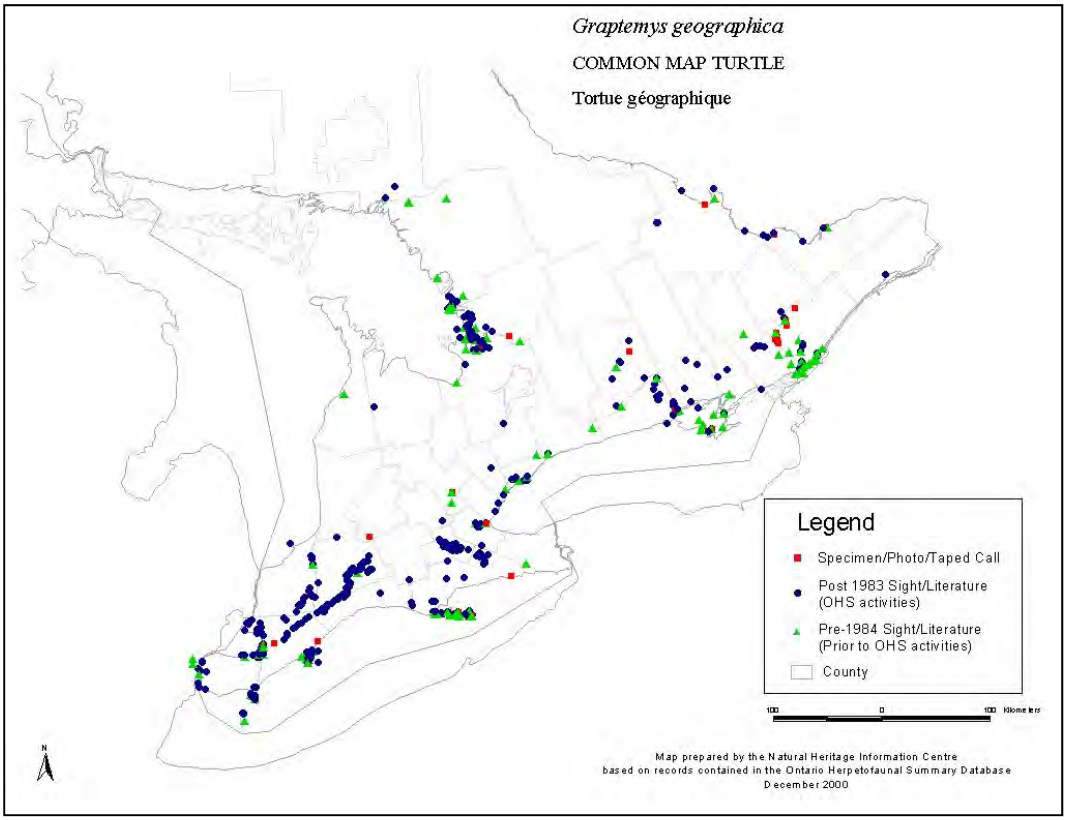

Figure 3-1 Distribution of Northern Map Turtle in Southern Ontario

There are a series of documented records further south along the Grand River in Brant County but no other observations further north or west in Waterloo Region. This highlights the strong association of this species with larger water bodies such as the Grand River, and Lake Erie and Lake Ontario shorelines.

Mike Oldham, Herpetologist with the Ministry of Natural Resource's Natural Heritage Information Centre (NHIC) was contacted, and confirmed a 1989 Grand River record from southern Cambridge which was the only one in their database for Waterloo Region (M. Oldham pers. comm., 2013). This database encompasses all of the herpetofaunal records collected between 1976 and 1981 from Waterloo Region by Francis and Campbell (1983) in their study on the Herpetofauna of Waterloo Region. Mr. Oldham indicated that there have been no additional records for the area since Ontario Nature's Reptile and Amphibian Atlas was initiated in 2010. Given the landscape context of the Lehman observation, he considered the observation to be unusual.

Although most Northern Map Turtle eggs hatch in August or September (Johnson, 1989; Harding 1997), eggs that are laid later in the summer may not hatch until the following spring (Lamond, 1994; Harding 1997). This might explain why the hatchling turtle was reported from the south side of Schnarr Street in late May 2012. If it had emerged nearby; no potential nest site was identified. According to Harding (1997), "Unshaded sites with sandy or loamy soils are preferred, and a female may move distances of up to several hundred metres from the water to find suitable conditions". Despite the fact that potentially suitable nesting habitat could be associated with the roadside verge along Schnarr Street, the grounds of the Early Years Learning Centre located towards Erbsville Road (*i.e.,* the manicured lawn), the majority of the lands within the study area cannot be considered suitable nesting habitat, with the exception of occasional small patches of exposed earth measuring about a metre or so in diameter. As a result, the observation of a baby Northern Map Turtle within the Erbsville South study area should probably be viewed as an anomaly rather than a regular occurrence, especially when considering its normal habitat preferences. Hence the development of the Erbsville South lands, most of which corresponds with actively farmed fields, should not be viewed as a significant loss of habitat for this species.

If a Northern Map Turtle nest is found, the area of exposed mineral soils, plus a 30 – 100 m radius around the nesting area, dependent on slope, riparian vegetation and adjacent land use is considered Significant Wildlife Habitat. This radius includes the travel routes from the wetland to the nesting area (OMNRF, 2015). According to

policy 2.1.5 of the 2014 Provincial Policy Statement: "*Development and site alteration shall not be permitted in: …d) significant wildlife habitat; …unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions*" (OMMAH, 2014). Additional turtle nest searches were carried out in 2016, but no Northern Map Turtle nests were detected.

Eastern Milksnake (Special Concern in Ontario until July 27, 2016. Now designated Not at Risk; Special Concern in Canada)
A single Eastern Milksnake was photographed dead on Erbsville Road, near Conservation Drive in October 2013. As Eastern Milksnakes are known to inhabit a variety of habitat types (Rowell, 2012), it is conceivable that it could be present within the study area as well. However, despite conducting three cover board checks in 2013 and four active hand searches in 2014, no Eastern Milksnakes have been encountered as part of any project specific surveys. Given the fact that future development within the study area would be largely confined to the existing active agricultural lands, loss of high quality foraging habitat is expected to be low.

Bald Eagle (Not at Risk in Canada; Special Concern in southern Ontario)
Bald Eagles have been seen in the Erbsville South Block Plan area, although no details were provided regarding these observations (*i.e.,* exactly where they were observed, the date of the observation, and what the birds were doing). It can be stated with confidence that the Erbsville South study area provides no suitable foraging or nesting habitat. The only thing that would possibly attract Bald Eagles to the study area is Laurel Creek. However, Laurel Creek is quite small in size (approximately 5 m in width) and would offer little opportunity for a Bald Eagle to catch a fish of any meaningful size. Most of the trees that lie along the periphery of the wetland are generally too young and small to accommodate a suitable perching site. It is also possible that Bald Eagles could be attracted to the stormwater management pond and its associated wildlife directly south of Wideman Road. Nevertheless, as the general area is largely built up, the proposed development would have little negative impact.

Red-headed Woodpecker (Special Concern in Ontario and Threatened in Canada)
An adult Red-headed Woodpecker was photographed in mid-May 2012. One juvenile bird was photographed and at least one other juvenile was observed in 2010. All of the birds were photographed in the Erbsville Park area by the creek (*i.e.,* along the farm laneway at the end of Schnarr Street, at Wideman Creek). It seems likely that this species nested in Erbsville South extended study area in the past and may still be a local resident as of 2014.

According to the Atlas of the Breeding Birds of Ontario (Cadman *et al*., 2007), Red-headed Woodpeckers prefer "woodland edges, open parkland, sparsely treed fencerows" (Woodliffe, 2007b). They are attracted to oak savannah and riparian forest and generally need large, dead weathered trees, or live trees with large dead branches, in which to excavate their nests (Woodliffe, 2007b). Although the description of preferred habitat does not generally match the habitat within the study area, elements may be considered attractive. A nesting site could be associated with the treed margins of the wetland along the western boundary of the Regal Place property. However, the tree cover is mostly too young to serve as attractive nesting structures. Furthermore, the area will be retained and buffered as part of that development plan. Development in the Erbsville South primary study area is unlikely to have a negative effect on the occurrence of Red-headed Woodpecker in the area. The species is generally tolerant of human activity, often occurring in parks, golf courses, cemeteries and private woodlands (Woodliffe, 2007b).

Another photograph of a Red-headed Woodpecker was taken in May 2013, from along Wilmot Line, however this observation is too far away to be of any significance to this study.

Canada Warbler (Special Concern in Ontario and Threatened in Canada)
Photographs of an adult male Canada Warbler were taken in August 2008 and another adult in May 2011, both from along the shoulder of Conservation Drive, north of Erbsville South study area. Although no specific dates were provided for either observation, it is possible that both observations pertained to migrants passing through the area, which is not an unusual occurrence. Canada Warbler generally arrives in the province in mid-May and departs generally between mid-August and mid-September (Curry, 2006). If the birds were local breeding residents along Conservation Drive, the closest the observations could have been to the Erbsville South study area is approximately 300 m, a distance great enough that the species would not be considered a constraint to the proposed development.

Great Egret (Provincial Conservation Rank of S2)
Observations of Great Egrets, Great Blue Herons, and Canada Geese at the corner of Wideman and Erbsville Roads between 2008 and 2012 were noted. It was suggested that the loss of fish in 2011 was likely responsible for their numbers being down compared to 2008, 2009, and 2010. Since Great Egrets and Great Blue Herons do not nest in the primary or extended study areas, development would at the most, only potentially impact occasionally used foraging habitat. Although the wetland areas, where the creek occurs, will be protected through their Provincially Significant Wetland designation, adjacent development could still negatively impact their use by increasing levels of disturbance. That said, a Great Egret was observed flying away from the stormwater management pond (SWM pond) at the southwest corner of Wideman Road and Erbsville Road in September 2013 confirming that the pond is also being used as foraging habitat.

Other Noteworthy Wildlife Species Reported
Spotted Salamanders (*Ambystoma maculatum*), considered rare in Waterloo Region (RMW, 1985a), have also been observed under anthropogenic debris adjacent to the pond at 665 Erbsville Road (Polygon 18). Although conditions appear less than ideal, future breeding in this pond would not be entirely unexpected.

Breeding Bird Monitoring In Northwest Waterloo

The monitoring of breeding birds in north-west Waterloo is part of long-term study for the City of Waterloo to understand the impact of urban development on biodiversity over time, and if and how impacts can be mitigated (Cheskey, 2014). Data has been collected annually since 1997. The primary area of focus is the Forested Hills ESPA. In addition, control sites outside the ESPA have also been monitored. These occur up to 1.5 km away from the ESPA. Both the Forested Hills ESPA and control sites contain 18 point count stations. The closest point count stations to the Erbsville South study area are: 2, 8, 3-9 & 3-11. These vary between 330 and 430 m away from the study area.

In total, 109 species of birds have been documented from the study during the breeding season between 1997 and 2014. This compares to 74 species documented from the Erbsville South study area. This represents approximately 68% of the larger total.

Nine Species at Risk (*i.e*., species designated “Special Concern”, “Threatened”, or “Endangered” on Ontario or Canada) were documented as part of the long-term monitoring study. This included: Red-headed Woodpecker (*Melanerpes erythrocephalus*), Eastern Wood-Pewee (*Contopus virens*), Acadian Flycatcher (*Empidonax virescens*), Bank Swallow (*Riparia riparia*), Barn Swallow (*Hirundo rustica*), Wood Thrush (*Hylocichla mustelina*), Cerulean Warbler (*Setophaga cerulea*), Canada Warbler (*Cardellina canadensis*), and Bobolink (*Dolichonyx oryzivorus*). Three of these Species at Risk have been recorded from the Erbsville South study area: Eastern Wood-Pewee, Barn Swallow and Red-headed Woodpecker.

Two Species at Risk were documented from the four closest point count stations: Bank Swallow and Canada Warbler. Neither species is expected to be impacted by the proposed development. The distances are too great and no suitable habitat will be lost.

3.1.3 Field Studies

Field studies were completed from April 2013 to July 2016. Table 3.3 provides a summary of field visit dates, participants and tasks completed.

Table 3.3 Field Visit Summary

	Date	Task	Dougan & Associates Staff
1	April 27, 2013	Basking turtle survey #1	Ian Richards
2	April 27, 2013	Nocturnal amphibian call survey #1	Dylan White
3	May 8, 2013	Coverboard set-up	Dylan White
4	May 16, 2013	Basking turtle survey #2	Ian Richards
5	May 17, 2013	ELC, Spring vegetation survey	Wendy Frise
6	May 22, 2013	Nocturnal amphibian call survey #2	Dylan White
7	June 4, 2013	Coverboard check #1	Dylan White
8	June 7, 2013	Breeding bird survey #1, basking turtle survey #3, turtle nest search #1	Ian Richards
9	June 14, 2013	Breeding bird survey #2, basking turtle survey #4, turtle nest search #2	Ian Richards
10	June 15, 2013	Nocturnal amphibian call survey #3	Dylan White
11	June 19, 2013	Coverboard check #2, turtle nest search #3, basking turtle survey #5	Dylan White

	Date	Task	Dougan & Associates Staff
12	July16, 2013	ELC, summer vegetation survey	Wendy Frise
13	August 14, 2013	ELC, summer vegetation survey	Wendy Frise
14	September 20, 2013	Hatchling turtle survey	Karl Konze
15	October 21, 2013	Coverboard check # 3 and removal	Dylan White
16	October 22, 2013	ELC, Fall vegetation survey	Wendy Frise
17	February 4, 2014	Winter wildlife survey	Dylan White
18	April 4, 2014	Scouting in preparation for salamander trapping	Dylan White
19	April 9, 2014	Salamander trapping survey #1	Dylan White & Karl Konze
20	April 10, 2014	Salamander trapping survey #2	Dylan White & Karl Konze
21	April 11, 2014	Salamander trapping survey #3	Dylan White & Karl Konze
22	April 15, 2014	Salamander trapping survey #4	Dylan White & Karl Konze
23	April 17, 2014	Salamander trapping survey #5	Dylan White & Karl Konze
24	April 24, 2014	Migratory Birds Convention Act compliance check (Regal Place)	Karl Konze
25	May 5, 2014	Basking turtle survey #6	Dylan White
26	May 6, 2014	Basking turtle survey #7	Dylan White
27	May 13, 2014	Basking turtle survey #8, Active hand search survey # 1, roadkill survey	Dylan White
28	June 4, 2014	Basking turtle survey #9, Active hand search survey # 2,	Dylan White
29	July 22, 2014	Active hand search survey # 3, summer vegetation survey	Dylan White & Wendy Frise
30	August 15, 2014	Wetland and ESPA flagging in preparation for agency site walks	Wendy Frise
31	August 18, 2014	Wetland boundary delineation with GRCA, Region and City staff	Wendy Frise
32	August 19, 2014	ESPA boundary delineation	Wendy Frise
33	October 10, 2014	ESPA boundary re-flagging at 720 Erbsville Road.	Wendy Frise & Kristen Beauchamp
34	December 15, 2014	Wetland complexing assessment site walk with MNRF	Jim Dougan & Wendy Frise
35	July 11, 2016	Butternut Health Assessment & tissue sample collection for genetic analysis	Zack Harris

3.1.3.1 Vegetation Assessment

Vegetation communities in the Primary and Extended Study Areas were classified to the highest level of detail possible (Vegetation Type, Ecosite or Community Series) as per the Ecological Land Classification (ELC) System protocol for Southern Ontario, 1st approximation (Lee *et. al*., 1998). Spring, summer and fall botanical surveys were carried out simultaneously within each unique vegetation community. Prior to field surveys, landowners were contacted for permission to access private properties. Access was granted for the majority of properties; however, detailed field surveys were not completed for two properties where permission to access was denied. A combination of air photo interpretation and roadside surveys were used to map these areas as accurately as possible. ELC data was summarized and mapped (see **Figure 3.2**). Botanical data was entered into a computer database, analyzed and summarized. Plant rarity status was assessed using COSEWIC rankings for federal status (COSEWIC, 2015; COSEWIC, 2016), the Species at Risk in Ontario List (OMNRF, 2016) and S ranks (NHIC, 2016) for provincial status, and Region of Waterloo Significant Species List for local status (RMW, 1999).

Findings:

The study area contains an assemblage of vegetation community types within a landscape of forests, wetlands and growing residential communities. Field surveys identified a total of 45 vegetation polygons representing 19 Ecological Land Classification (ELC) vegetation community types. Three additional codes were added to represent anthropogenic cultural areas not represented by the available ELC vegetation codes: ANTH – anthropogenic, AGR – Agriculture, and HR – hedgerow. The study area contains natural and cultural vegetation community types as defined in the Ecological Land Classification System for Southern Ontario (Lee *et. al*., 1998). Although all of the vegetation community types found on the site are considered to be relatively common in this part of the province, many of the wetlands in particular are considered to be of high ecological value due to their size, undisturbed condition, relatively high native biodiversity, and contiguity with larger natural features in the surrounding landscape.

Table 3.4 provides a detailed summary of the ELC findings. The various vegetation communities are discussed below and their polygon locations are illustrated on Figure 3.2.

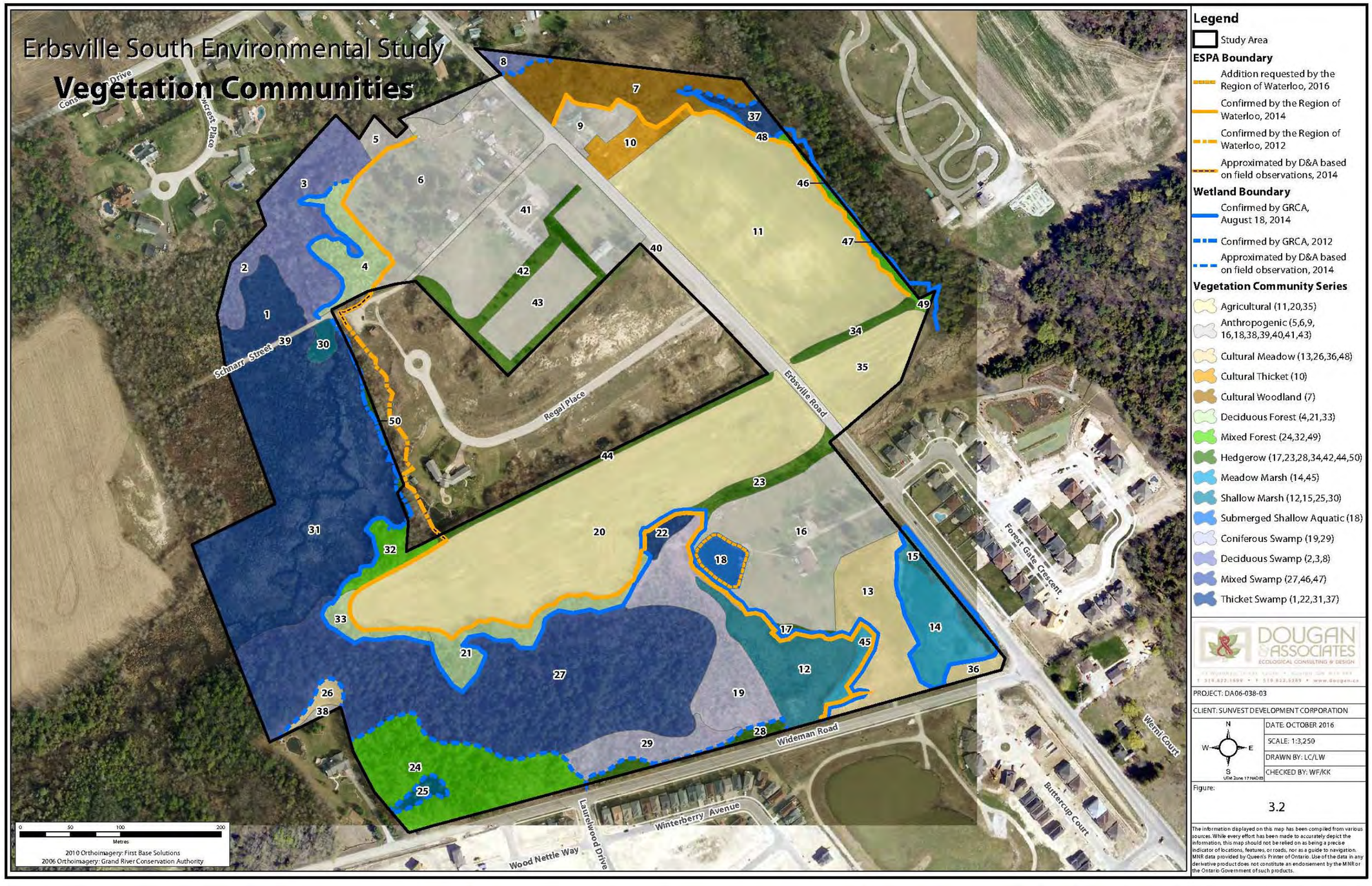

Figure 3-2 Vegetation Communities

Table 3.4 Summary of ELC Vegetation Community Findings

ELC Vegetation Community Code	ELC Vegetation Community Name	Area (ha)	% Area of Total	ELC Polygon #. (Figure 3.2)
Anthropogenic				
AGR	Agricultural	8.74	23.79	11, 20, 35
ANTH	Anthropogenic	7.30	19.86	5, 6, 9, 16, 38, 39, 40, 41, 43
Terrestrial - Cultural				
CUM1-1	Dry - Moist Old Field Meadow	1.13	3.09	13, 26, 36, 48
CUT1	Mineral Cultural Thicket	0.27	0.72	10
HR	Hedgerow	1.32	3.59	17, 23, 28, 34, 42, 44, 50
CUW1	Mineral Cultural Woodland	0.96	2.60	7
Terrestrial - Natural				
FOD3-1	Dry – Fresh Poplar Deciduous Forest	0.49	1.34	21
FOD5	Dry – Fresh Sugar Maple Deciduous Forest	0.18	0.49	33
FOD8-1	Fresh – Moist Poplar Deciduous Forest	0.47	1.27	4
FOM	Mixed Forest	0.17	0.47	49
FOM6-1	Fresh – Moist Sugar Maple – Hemlock Mixed Forest	1.34	3.65	24
FOM7-2	Fresh – Moist White Cedar – Hardwood Mixed Forest	0.25	0.69	32
Wetland/ Aquatic				
MAM	Meadow Marsh	0.18	0.48	45
MAM2	Mineral Meadow Marsh	0.57	1.56	14
MAS2-1	Cattail Mineral Shallow Marsh	1.04	2.83	12, 15
MAS2-9	Forb Mineral Shallow Marsh	0.08	0.23	25
MAS3-8	Rice Cut-grass Organic Shallow Marsh	0.09	0.24	30
SAS1	Submerged Shallow Aquatic	0.17	0.46	18
SWC1-2	White Cedar – Conifer Mineral Coniferous Swamp	0.45	1.21	29
SWC4-2	Tamarack Coniferous Organic Swamp	1.07	2.90	19
SWD7	Birch - Poplar Organic Deciduous Swamp	1.35	3.68	2, 3, 8
SWM	Mixed Swamp	0.01	0.02	46, 47
SWM4-1	White Cedar – Hardwood Organic Mixed Swamp	4.66	12.67	27
SWT2-2	Willow Mineral Thicket Swamp	0.13	0.34	22
SWT3-2	Willow Organic Thicket Swamp	4.34	11.81	1, 31, 37
TOTAL		36.75	100.00	

AGR Agricultural
Agricultural portions of the study area include polygons 11, 20, and 35. In 2013 these fields were planted with soybeans. Permission to access polygon 35 was denied, however it could be adequately reviewed from the roadside. Polygon 11 is relatively flat and surface runoff is partially conveyed to the swamp to the north east of the study area. Polygon 35 slopes down toward Wideman Creek to the southeast and surface runoff would be conveyed to the wetland and watercourse. Polygon 20 is the largest of the agricultural fields in the study area. The east end of the field slopes down toward Wideman Creek in polygon 23, and the west end slopes down toward the forest/swamp feature to the southwest, surface runoff thus being conveyed to the adjacent natural feature.

ANTH Anthropogenic
Anthropogenic portions of the study area include polygon 5, 6, 9, 16, 38, 39, 40, 41, and 43. These include roads (paved and unpaved), rural residential properties, parking lots, and areas of maintained lawn.

CUM1-1 Dry - Moist Old Field Meadow
Polygons classified as Dry – Moist Old Field Meadow are areas of early successional habitat resulting from past disturbance. Woody vegetation is absent to minimal in these areas. Polygons included in this category include 13, 26, and 36. Polygons 13 and 36, located near the corner of Erbsville Road and Wideman Road, are abandoned agricultural fields which were used for grazing horses in the recent past. Polygon 26 is a small area adjacent to a residential backyard.

CUT1 Mineral Cultural Thicket
One Mineral Cultural Thicket was identified in the study area; polygon 10 is a disturbed area of vegetation located between a residential lot and an agricultural field. There are ruins of an old building foundation in this polygon indicating a history of human disturbance. Woody vegetation in this area is patchy and includes

primarily planted and non-native invasive species. Tree cover is dominated by Black Locust (*Robinia Pseudo-acacia*) with some Manitoba Maple (*Acer negundo*) and young Green Ash (*Fraxinus pennsylvanica*). The ground layer is primarily early-successional non-natives. The initial ESPA boundary included this area, however it was determined through further discussion with Region of Waterloo staff that it should be excluded from the ESPA. Several potential Butternut trees were observed in this polygon, however genetic testing has subsequently confirmed these trees to be hybrids rather than pure Butternut.

HR Hedgerow
Hedgerows in the study area include polygons 17, 23, 28, 34, 42, and 44. These linear areas of vegetation vary with respect to vegetation structure, composition and potential to function as linkage features. Hedgerow 17 is a narrow strip of upland vegetation between a residential lawn and the Sunfish Lake - Laurel Creek PSW. Hedgerow 23 is a treed river corridor with some linkage function between the natural features on the east and west sides of Erbsville Road. Hedgerow 28 is a treed area along Wideman Road, bordering the Sunfish Lake - Laurel Creek PSW. Hedgerow 34 is an agricultural windbreak separating two farm fields. It provides some linkage between the natural features to the east and west of Erbsville Road. Hedgerow 42 primarily consists of planted trees on the lawn surrounding the YMCA centre. Hedgerow 44 straddles a property boundary and the edge of the study area, with its northern half located in the Regal Place development. As per the Regal Place EIS (D&A, 2013, the vegetation of this hedgerow includes Sugar Maple (*Acer saccharum*), Black Cherry (*Prunus serotina*), Green Ash, Eastern White Cedar (*Thuja occidentalis*), Buckthorn (*Rhamnus cathartica*), and Garlic Mustard (*Alliaria petiolata*). This canopy of this hedgerow is essentially continuous and it represents a linkage feature between the ESPA/ PSW complex to the west and a system of natural features to the east of Erbsville Road.

CUW1 Mineral Cultural Woodland
One cultural woodland was identified in the study area: polygon 7. This woodland has lower tree cover (<60% canopy cover) and higher disturbance levels than a natural forest. This treed creek valley is included in the ESPA. Several potential Butternut trees were observed in this polygon, however genetic testing has subsequently confirmed these trees to be hybrids rather than pure Butternut. The area is highly disturbed and vegetation composition dominated by non-native invasive species such as Black Locust, Buckthorn, Periwinkle (*Vinca minor*), Garlic Mustard and Orange Daylily (*Hemerocallis fulva*).

FOD3-1 Dry – Fresh Poplar Deciduous Forest
One Dry – Fresh Poplar Deciduous Forest was identified in the study area: polygon 21. This narrow strip of forest represents the interface between an agricultural field and a swamp. The forest slopes gently downward from the field to the low-lying swamp. A watercourse channel is evident in this polygon, however it was dry during 2013 and 2014 field visits. Vegetation composition reflects a relatively young forest with a canopy of Trembling Aspen (*Populus tremuloides*), American Basswood (*Tilia americana*) and Sugar Maple. Green Ash and Eastern White Cedar are present in the sub-canopy. The understory layer is primarily absent and the ground layer contains a mix of species representing the range from dry to moist. The ESPA boundary extends along the outer edge of this forest.

FOD5 Dry – Fresh Sugar Maple Deciduous Forest
Polygon 33 was classified as a Dry – Fresh Sugar Maple Forest. Similarly to polygon 21, this forest is a narrow strip of vegetation representing the interface between an agricultural field and a swamp. This forest is relatively undisturbed and contains primarily native vegetation making it one of the few high quality upland forest habitats within the study area. The well-drained soils (sandy loam over silty sand) differentiate this forest from the adjacent swamp and allow it to support a different composition of species. Tree cover is dominated by Sugar Maple with Eastern Hemlock (*Tsuga canadensis*) and Trembling Aspen at the edge. The understory is characterized by Chokecherry (*Prunus virginiana*), Green Ash, and Eastern White Cedar. The ground layer contains a mix of species representing the range from dry to moist. The ESPA boundary extends along the outer edge of this forest.

FOD8-1 - Fresh – Moist Poplar Deciduous Forest
Polygon 4 was classified as a Fresh – Moist Poplar Deciduous Forest. The majority of this polygon has moist soils and intergrades gradually with the adjacent wetland in polygon 3. This young forest has been disturbed by human activity in the past as evidenced by trails, cut stumps, and piled woody debris. The canopy is dominated by Trembling Aspen. Additionally there is a fragment of coniferous plantation within this forest

containing primarily European Larch (*Larix decidua*). This plantation is in transition towards natural forest cover and was too small to map as a separate polygon.

FOM6-1 Fresh – Moist Sugar Maple – Hemlock Mixed Forest
Polygon 24 was classified as Fresh – Moist Sugar Maple – Hemlock Forest. This mature forest is relatively undisturbed and contains primarily native vegetation making it one of the few high quality upland forest habitats within the study area. This forest is included in the ESPA and is contiguous with a large swamp, which is part of the Sunfish Lake – Laurel Creek PSW. The forest generally slopes downward from Wideman Road towards the larger swamp community. One low-lying wetland pocket was identified within this forest and has been mapped separately as polygon 25. Soils of the polygon range from dry to moist and soil samples examined mid-slope showed sandy loam over silty sand. The canopy is dominated by Sugar Maple and Hemlock with American Beech (*Fagus grandifolia*), American Basswood, Black Cherry, American Hop-hornbeam (*Ostrya virginiana*) and, in areas of higher moisture, Yellow Birch (*Betula alleghaniensis*). The shrub layer contains such species as Alternate-leaf Dogwood (*Cornus alternifolia*) and Chokecherry. Some portions of the polygon have less Hemlock and thus appear as deciduous forest rather than mixed forest.

FOM7-2 Fresh – Moist White Cedar – Hardwood Mixed Forest
Polygon 32, classified as Fresh – Moist White Cedar – Hardwood Mixed Forest, is situated such that it is split between the main study area, extended study area and outside of the study area within the Regal Place development limits. The polygon is included in the ESPA, however due to historic site plan approvals for the Regal Place development, portions of this polygon has been developed as a stormwater management facility. This forested area slopes downward to the northwest, draining towards the marsh in polygon 31. Dominant vegetation species include Trembling Aspen, Eastern White Cedar, Black Cherry, Alternate-leaf Dogwood, Buckthorn, Southern Broadleaf Enchanter's Nightshade (*Circaea lutetiana*) and Virginia Strawberry (*Fragaria virginiana*). Soil analysis revealed moderately-drained sandy loam.

MAM2 Mineral Meadow Marsh
Polygons 14 and 45 have been classified as Mineral Meadow Marsh. These wetlands are sustained by seasonal flooding. Polygon 45 is a small area of meadow marsh along the margin of the cattail marsh in polygon 12. Polygon 45 is included in the Sunfish Lake – Laurel Creek PSW. Polygon 14 is located near the corner of Erbsville Road and Wideman Road. A small watercourse, not evident on GRCA mapping, flows through this polygon. This watercourse is augmented by the stormwater pond south of Wideman Road and is considered fish habitat. Plant species recorded include Soft Rush (*Juncus effusus*), Reed Canary Grass (*Phalaris arundinacea*), Kentucky Bluegrass (*Poa pratensis*), Redtop (*Agrostis gigantea*), Dark-green Bulrush (*Scirpus atrovirens*), Fox Sedge (*Carex vulpinoidea*), Stalk-grain Sedge (*Carex stipata*), Curly Dock (*Rumex crispus*), Broad-leaf Cattail (*Typha latifolia*), American Mannagrass (*Glyceria grandis*) and Canada Goldenrod (*Solidago canadensis*). Soil assessment revealed sandy clay over sandy clay loam. Neither mottles nor gley were evident in the sample, however the water table was encountered at 20 cm depth. This marsh functions as breeding habitat for Spring Peepers (*Pseudacris crucifer*), which typically reside in forested habitats outside of the breeding season, and seasonal migration from nearby forested sites is suspected. The marsh also functions as foraging habitat for Barn Swallows (*Hirundo rustica*), a species designated Threatened in Ontario (OMNRF, 2016) and Canada (COSEWIC, 2015; COSEWIC, 2016), and whose habitat is protected under the Endangered Species Act, 2007 (Government of Ontario, 2007). MNRF staff have recommended that the polygon 14 marsh be included in the Sunfish Lake – Laurel Creek PSW.

MAS2-1 Cattail Mineral Shallow Marsh
Polygons 12 and 15 are classified as Cattail Mineral Shallow Marsh. Polygon 12 is one vegetation community within a larger block of swamp and marsh, all of which are included in the Sunfish Lake – Laurel Creek PSW. It is dominated by Narrow-leaved Cattail (*Typha angustifolia*). The depth of standing water is variable across the polygon and subject to seasonal fluctuation. A soil assessment showed 6 cm of organic soils over sandy clay loam, although it is evident from traversing the polygon that organic soils are deeper in some areas. A smaller feature, polygon 15 is a linear marsh associated with the roadside ditch. Cattails (*Typha angustifolia & T. latifolia*) are the dominant species. Associate species include Common Reed (*Phragmites australis*), Dark-green Bulrush, Soft Rush, Redtop, Path Rush (*Juncus tenuis*), Stalk-grain Sedge, Common Boneset (*Eupatorium perfoliatum*), Porcupine Sedge (*Carex hystericina*), and Rice Cutgrass (*Leersia oryzoides*). Soil assessment showed four distinct horizons including 14 cm of fibric organics over 14 cm of silty clay loam (with some organic content), over 20 cm of humic organics, over 6+ cm of silty sand. The water table was

located in the humic organic layer at 32 cm depth below ground surface. This marsh functions as breeding habitat for Spring Peepers, which typically reside in forested habitats outside of the breeding season, and seasonal migration from nearby forested sites is suspected. The marsh also functions as foraging habitat for Barn Swallows, a species designated Threatened in Ontario (OMNRF, 2016) and Canada (COSEWIC, 2015; COSEWIC, 2016), and whose habitat is protected under the Endangered Species Act, 2007 (Government of Ontario, 2007). MNRF staff have recommended that the polygon 15 marsh be included in the Sunfish Lake – Laurel Creek PSW.

MAS2-9 Forb Mineral Shallow Marsh
Polygon 25 is classified as a Forb Mineral Shallow Marsh. This polygon contains a low-lying pocket of shallow water surrounded by mature forest. A soil assessment completed at the edge of the polygon revealed an accumulation of organic soils 16 cm deep over sandy clay loam. Vegetation of the marsh is characterized by Sensitive Fern (*Onoclea sensibilis*), Royal Fern (*Osmunda regalis*), Ostrich Fern (*Matteuccia struthiopteris*), Spotted Jewel-weed (*Impatiens capensis*) and Fowl Manna-grass (*Glyceria striata*).

MAS3-8 Rice Cut-grass Organic Shallow Marsh
Polygon 30 is a Rice Cut-grass Organic Shallow Marsh. It is situated beside a bermed dirt road (polygon 39) that extends from Schnarr Street westward, across Laurel Creek and through the larger wetland. This is a riverine marsh that has formed through the pooling of water upstream of a culvert under the bermed access road. Seasonal field studies revealed that this marsh contains open standing water throughout the spring/summer and draw down occurs towards late summer/fall leaving mud flats vegetated primarily with Rice Cutgrass (*Leersia oryzoides*). Soil assessment indicated organic deposits > 55 cm depth in this area. A Snapping Turtle (*Chelydra serpentina*), designated Special Concern in Ontario (OMNRF, 2016) and Canada (COSEWIC, 2015; COSEWIC, 2016) was observed basking on a clump of grass along its margins by D&A staff on May 13, 2014.

SAS1 Submerged Shallow Aquatic
Polygon 18 is a shallow aquatic community bordered by a ring of emergent wetland vegetation. The shape, size and location of this feature indicates that it is a dug pond which has gone through some natural succession towards a wetland community. The pond is situated in a rural backyard and mowing occurs around the feature. Emergent vegetation around the perimeter of the pond includes Narrow-leaved Cattail, Soft-stem Club-rush (*Schoenoplectus tabernaemontanii*), Broadleaf Arrowhead (*Sagittaria latifolia*), Dark-green Bulrush, Reed Canary Grass, Sedges (*Carex* sp.) and Spikerush (*Eleocharis* sp.). Wetland vegetation also exists on the slope surrounding the pond including such species as Red-osier Dogwood (*Cornus sericea*), Willow (*Salix* sp.), Spotted Joe-pye Weed (*Eupatorium maculatum*) and Flat-top Fragrant-golden-rod (*Euthamia graminifolia*). Due to the habitat that it provides and its close proximity to the larger wetland system (<10m away), this wetland is able to provide a variety of wildlife habitat functions, including foraging habitat for Species at Risk such as Snapping Turtle, Blanding's Turtle and Barn Swallow. MNRF has confirmed that polygon 18 is part of the Sunfish Lake – Laurel Creek PSW, and the Region of Waterloo has added it to the Schaefer's Woods ESPA.

SWC1-2 White Cedar – Conifer Mineral Coniferous Swamp
Polygon 29 is an Eastern White Cedar dominated swamp near Wideman Road in the south end of the study area. These low-lying lands have a shallow water table and contain a small meandering watercourse. This swamp is one vegetation community within a larger block of swamp and marsh, all of which are included in the Sunfish Lake – Laurel Creek PSW. The tree cover including Eastern White Cedar, Tamarack (*Larix laricina*) and Black Ash (*Fraxinus nigra*) is immature, reaching heights not much greater than 10 m and with coverage of only about 25% of the polygon. Light penetration to the ground layer has allowed for growth of abundant herbaceous wetland vegetation such as Reed Canary Grass, Fowl Manna-grass and American Mannagrass (*Glyceria grandis*).

SWC4-2 Tamarack Coniferous Organic Swamp
Polygon 19 is a coniferous swamp with a sparse canopy of Tamarack and Eastern White Cedar reaching heights < 10 m. Tree coverage is low for a coniferous swamp, only slightly exceeding the 25% cover threshold for this category. A small stream, tributary to Wideman Creek, meanders through this wetland. Substrates contain occasional dry hummocks and open water pockets within a matrix of deep organic soils.

The ground layer vegetation is rich with a variety of grasses, sedges, ferns and wetland herbs. This swamp is one vegetation community within a larger block of swamp and marsh, all of which are included in the Sunfish Lake – Laurel Creek PSW.

SWD7 Poplar Organic Deciduous Swamp
Polygons 2, 3, and 8 are classified as organic deciduous swamp. These young Poplar-dominated wetlands are located in the north end of the study area. Polygon 2 has a canopy of Trembling Aspen and Green Ash, with an occasional Yellow Birch and Tamarack. The understory contains an abundance of Eastern White Cedar and reflects the successional future of this vegetation community. The ground layer contains a variety of wetland species such as Sensitive Fern, Catherinettes Berry (*Rubus pubescens*), Marsh Fern, and sedges. Soil assessment showed 56 cm of organic substrates over silty clay and a shallow water table at 2 cm below ground surface. Polygon 3 has a canopy of Balsam Poplar (*Populus balsamifera*), Eastern Cottonwood (*Populus deltoides*) and Trembling Aspen. Situated directly adjacent to a residential backyard, this area has experienced some human disturbance. The understory and ground layers contain a mix of wet and dry habitat species such species as Silky Dogwood (*Cornus amomum*), Buckthorn, Garlic Mustard, Sensitive Fern and Marsh Marigold (*Caltha palustris*). Soil assessment showed >51 cm of organics and a water table at 26 cm depth. Polygon 8, located east of Erbsville Road, at the northern extent of the study area, is a very small floodplain swamp associated with the Laurel Creek. The canopy is composed of Eastern Cottonwood, Eastern White Cedar and an occasional willow. The understory contains Buckthorn, Red-osier Dogwood, and willow. The ground layer is characterized by such species as Tussock Sedge (*Carex stricta*), Field Horsetail (*Equisetum arvense*), Periwinkle, and Ostrich Fern. Soil assessment showed >30 cm of organic substrates and the water table at 28 cm depth.

SWM4-1 White Cedar – Hardwood Organic Mixed Swamp
Polygon 27 is a relatively large swamp community, covering over 12% of the study area. This swamp is one vegetation community within a larger block of swamp and marsh, all of which are included in the Sunfish Lake – Laurel Creek PSW. These hummocky lowlands contain a diverse assemblage of native plant species. Soil assessment showed organic substrates > 54 cm and a shallow water table at 5 cm depth. The canopy contains such species as Eastern White Cedar, Yellow Birch and Red Maple. The ground layer vegetation is rich with a variety of grasses, sedges, ferns and wetland herbs.

SWT2-2 Willow Mineral Thicket Swamp
This small wetland community (ELC polygon 22) is situated along the south edge of an agricultural field, and is in position to receive surface runoff from that field although no standing water was present during the summer and fall 2013 field surveys. There is a layer of Heart-leaved Willow (*Salix eriocephala*) less than about 5 m in height. Below the willow canopy there is an understory dominated by Red-osier Dogwood and a ground layer dominated by Reed Canary Grass, Virginia Strawberry, and Avens (*Geum* sp.). Substrate assessment revealed sandy clay loam substrates with mottles evident at 19 cm depth.

SWT3-2 Willow Organic Thicket Swamp
Polygons 1, 31, and 37 are classified as willow-dominated thicket swamps with organic soils. Polygons 1 and 31, located in the extended study area, are separated only by a bermed road that extends through the road allowance west of Schnarr Street. Polygon 1 is located north of the road. Polygon 1 is characterized by its shrub layer which is dominated by Pussy Willow (*Salix discolor)* with abundant Red-osier Dogwood. Polygon 31 is much larger in size than polygon 1, and is located south of the road that extends west of Schnarr Street. Polygon 31 contains a mix of shallow open water pockets, mud flats and vegetation. Small braided streams meander through this polygon. Soil assessment showed organic deposits >61 cm, and the water table was located at 20 cm depth in late summer 2013. These wetlands are included in the Sunfish Lake – Laurel Creek PSW. Polygon 37 wetland is located east of Erbsville Road along the edge of an agricultural field. Tree cover within this small polygon includes a few juvenile poplars and Eastern White Cedar. This wetland is characterized by its shrub layer which contains primarily willow and Red-osier Dogwood. Ground layer vegetation contains a mix of plant species in the facultative wetland to facultative upland spectrum.

Vascular Plants

A list of vascular plant species observed during 2013 – 2016 site visits was compiled for the study area. The full list is provided in Appendix 2.4 including associated status information (native or introduced; conservation

status for Waterloo Region, Ontario, and Canada). Table 3.5 provides a summary of the vegetation survey findings.

Table 3.5 Summary of Vegetation Survey Findings

	Number	% of total	Comments
Total # of species noted for property	268	100.0%	
Total # of species identified to species level	244	91%	
Total # of 'sp' listed	24	9%	
Of total species identified to species level:			
Total native	180	73.8%	
Total non-native / introduced	64	26.2%	
Global rarity (G1-G3)	0	0%	
National rarity (END,THR or SC)	0	0%	
Provincial rarity (S1-S3)	1	0.4%	Ohio Buckeye (*Aesculus glabra*)
Local Rarity (Region of Waterloo)	7	2.9%	***R***: Bristly Sarsaparilla (*Aralia hispida*), Rough Sedge (*Carex scabrata*), Canada Rush (*Juncus canadensis*) ***R****: Wirestem Muhly (*Muhlenbergia frondosa*) ***R+***: Virginia Creeper (*Parthenocissus quinquefolia*), White Spruce (*Picea glauca*) ***R+****: Black Walnut (*Juglans nigra*)
Floristic Quality Assessment:			
# of species without CC values	4	1.6%	Coefficient of Conservatism is a value (0 to 10) assigned to native species in Ontario based on its degree of fidelity to a specific vegetation community type. The lower this value, the more likely the plant is to be found in a wide variety of plant community types including disturbed sites. The presence of plants with a coefficient of conservatism of 9 or 10 indicates later-successional native plants that have undergone only minor disturbance. This calculation was based on the total number of species for which a cc value was available. Although some more conservative species are present on this site, there are many species representing disturbed conditions, leading to the lower average score.
Total number species for CC calculations	240	98.4%	
Low CC (0 - 3)	116	48.1%	
Mid CC (4 - 6)	104	43.3%	
High CC (7 - 10)	20	8.3%	
AVG CC	1.2	-	
Floral Quality Index	16.6	-	Floristic Quality Index (FQI) is a weighted species richness estimate used to compare natural areas in order to evaluate their conservation value. FQI is calculated by multiplying the mean coefficient of conservatism by the square root of the total number of native species present within a natural area. FQI is an index of the relative level of floristic quality at the given natural area, and can be used to compare the level of floristic quality against other natural areas. This calculation was based on the total number of species for which a cc value was available.

Two-hundred and sixty-eight (268) vascular plant species were recorded for the study area. Of these, 244 were identified to species level including 180 (74%) native species and 64 (26%) introduced species. No species of global significance were observed on the property. One (1) species of provincial significance was observed; Ohio Buckeye (*Aesculus glabra*). Ohio Buckeye has a conservation rank of S1 in Ontario (NHIC, 2016). The relevance of the Ohio Buckeye for the Erbsville South study site is low because the observation included just one planted specimen, and provincial rarity status only apply to species that live in the wild in Ontario (not planted specimens) (Government of Ontario, 2007). Initial surveys also recorded Butternut; a provincially and nationally designated species within the study area. However, upon further study it was confirmed that these trees are hybrids rather than pure Butternut, which means that the rarity status and legal protection do not apply. The

Butternut Health Assessment report and genetic test result corroborating these findings are provided in Appendix 2.

Seven (7) species of local significance were recorded including: three graminoids, Rough Sedge, Canada Rush and Wirestem Muhly; two low shrubs, Virginia Creeper and Bristly Sarsaparilla; one deciduous tree, Black Walnut; and one coniferous tree, White Spruce.

Bristly Sarsaparilla, Rough Sedge and Canada Rush are ranked **R** indicating that they are rare in Waterloo Region (RMW, 1999). Bristly Sarsaparilla is a low shrub found as a rare occurrence in polygon 27. It is protected within the area designated ESPA and PSW. Rough Sedge was collected and identified in the D&A herbarium. It was located in polygon 27 and is protected within the area designated ESPA and PSW. Canada Rush is typically found along wetland margins. This small rush was recorded for polygons 12 (a cattail marsh) and 18 (a naturalized pond), which are both within the area protected by PSW/ESPA designation.

Wirestem Muhly is ranked **R***, meaning that is significant in Waterloo Region, but may prove to be too common to be so regarded in the future (RMW, 1999). This graminoid was recorded as a rare observation in the ground layer of a mixed forest (polygon 32). It is protected within the area designated as ESPA.

Virginia Creeper and White Spruce are ranked **R+** meaning that they are significant for Waterloo Region but only if demonstrably indigenous (most populations in Waterloo are thought to be of non-indigenous origin) (RMW,1999). Virginia Creeper was observed in polygons 3 and 19. It is unconfirmed whether the specimens observed are of indigenous origin, however they were both found near edges in areas of anthropogenic disturbance. All occurrences of White Spruce in the Erbsville South study area (polygons 4, 6, 17 and 42) were planted. Since they are of non-indigenous origin, the rarity status is not applicable.

Black Walnut is ranked **R+*** meaning that it is significant for Waterloo Region but only if demonstrably indigenous, and it may prove to be too common to be so regarded in the future (RMW,1999). This tree species was a rare occurrence in the canopy of a swamp (polygon 27), and an occasional occurrence in the canopy of a cultural woodland (polygon 7), both of which are protected within the ESPA. This species was also found in two hedgerows; polygons 34 and 42. It is undetermined whether or not the specimens in the Erbsville South study area are of indigenous origin, however this species is now known to be pervasive throughout the southern Ontario landscape and we suggest that the rarity ranking is not applicable in this case.

3.1.3.2 Feature Staking & Confirmation

Natural feature boundaries were established onsite with agency staff (GRCA, City of Waterloo, Region of Waterloo) with site walks for feature boundary staking and confirmation occurring in summer 2014. MNRF staff were invited to participate in the wetland site walk; however they were unable to attend. Features flagged and surveyed included wetlands, and the Region of Waterloo Environmentally Sensitive Policy Area (ESPA). Hazardlands, which were identified in the Technical Work Plan, generally include areas prone to flooding and/or erosion (*e.g.*, steep slopes). However, since floodline mapping for the area is available from GRCA and no steep slopes are present within the study area, Hazardlands were not staked by D&A. Updated floodline mapping based on proposed culvert improvements have been prepared by IBI Group and are discussed in Section 4.0.

Findings:
Confirmed and surveyed boundaries for wetlands (PSW and unevaluated) and Environmentally Sensitive Policy Area (ESPA) are illustrated on Figure 3.2.

Wetland boundaries were determined based on the Ontario Wetland Evaluation System (OWES, 3rd edition), and flagged by an OWES Certified D&A staff member on August 15, 2014 (OMNR, 2013a). Wetland boundaries were confirmed by GRCA during a site walk on August 18, 2014 and subsequently surveyed. This site walk included boundary delineations for wetlands located at:

1. The southeast corner of Erbsville Road and Wideman Road (polygons 14 and 15),
2. The dug pond behind the residence at 665 Erbsville Road (polygon 18), and for relevant portions of the Sunfish Lake – Laurel Creek PSW, located at:
3. South end of study area from Wideman Road up to the boundary of the Regal Place development,

4. North of Schnarr Street, and
5. East of Erbsville Road, along the east edge of the study boundary.

The wetland boundary within ELC polygon 35 (Trillium Estates property) east of Erbsville Road was not confirmed because the landowner denied permission to access this property. Some other portions of wetland boundary within the Erbsville South study area were not flagged nor confirmed by agencies. This was discussed with GRCA during the site walk; it was determined that some wetland boundaries were unnecessary to stake because they are in locations where there is no possible opportunity for future development (*i.e*., boundaries along roads or boundaries contained within the ESPA).

ESPA boundaries were determined based on specific guidance from Region of Waterloo staff, typically following the forest dripline or edge of the agricultural field. ESPA boundaries were flagged by D&A staff on August 19, 2014 and subsequently confirmed by Regional Municipality of Waterloo (RMW) staff at a later date. Following this field walk, further discussion with RMW staff indicated that a portion of the boundary needed to be re-considered. The ESPA boundary in the north end of the study area, near 720 Erbsville Road initially extended along the edge of an agricultural field, however correspondence with RMW staff concluded that the residence and surrounding lawn and cultural thicket should be excluded from the ESPA. Flagging for this boundary was adjusted and the line re-surveyed. Three sections of ESPA boundary were flagged in total for the Erbsville South study area including:

1. Field edge/ dripline west of Erbsville Road and south of the Regal Place development,
2. Edge of residential backyards north of Schnarr Street, and
3. Forest dripline east of Erbsville Road, including revised boundary in the vicinity of 720 Erbsville Road.

Upon request by RMW in 2016, an additional area was added to the ESPA. This addition encompasses the wetland in ELC polygon 18. The boundary was not re-flagged or surveyed as it was assumed to be coincident with the staked wetland boundary. The final ESPA boundary is shown on Figures 3-2 and 6-1.

3.1.3.3 Wetland Assessment

The majority of wetlands in the study area were previously designated as part of the Sunfish Lake-Laurel Creek Provincially Significant Wetland (PSW) Complex. The Technical Work Plan (TWP) identified a small unevaluated wetland located at the northwest corner of Wideman Road and Erbsville Road and required that its status (PSW or not) be determined through this study. This assessment was completed by a Certified OWES Wetland Evaluator. The assessment included: review of Land Information Ontario (LIO) wetland map layers, Grand River Conservation Authority (GRCA) wetland map layers, historic and current orthophotography; seasonal field surveys to document plants, wildlife and characteristics of the wetland; correspondence with Ministry of Natural Resources and Forestry (MNRF) and GRCA staff; along with the results of the feature boundary staking discussed in the previous section; and preparation of a letter report. As per the TWP, the purpose of the letter report was to provide all available wetland characterization information to MNRF in order to facilitate their decision on whether or not the wetland should be complexed with the existing PSW. Initially the TWP identified only the wetland at the northwest corner of Erbsville Road and Wideman Road for this assessment; however the dug pond behind the residence at 665 Erbsville Road was subsequently added at the request of GRCA staff.

Findings:
The findings of the wetland assessment were documented in a letter to MNRF on September 25, 2014. The letter included detailed characterization information on the wetlands in ELC polygons 14, 15 and 18. In response, MNRF advised that due to existing ecological functions, specifically fish habitat, breeding habitat for amphibians, foraging habitat for barn swallows, and possible overwintering habitat for turtles, the wetland would be complexed with the Sunfish Lake-Laurel Creek PSW. Further discussions and a site review with MNRF occurred to discuss alternative scenarios to protection of the wetland in-situ, as it is reliant on flows from a SWM pond constructed in 2004, and will likely be impacted by the planned widening of Erbsville Road. MNRF agreed to review options, and these were provided in a detailed technical report (March 17, 2015) which compared two options: protection of the small wetland and associated watercourse in situ, vs removal of the wetland and the associated tributary watercourse in ELC polygons 14 and 15, to be offset by enhancement of the main PSW and Wideman Creek corridor, including new wetland creation. MNRF reviewed this document and re-confirmed their decision to apply PSW status to wetland polygons 14, 15 and 18. ***However, MNRF encouraged further***

discussion with GRCA with regard to alternative approaches in this area. Appendix 2.5 contains the written correspondence with MNRF and Appendix 6 provides additional information about the enhancement alternative under discussion. Later, as part of their review of an earlier draft of this report, MNRF indicated that polygons 14 and 15 also represents protected habitat for Blanding's Turtle under the ESA and that an 'Overall Benefit Permit' under the Endangered Species Act (ESA) maybe required if this wetland will be impacted by future improvements to Erbsville Road.

3.1.3.4 Winter Wildlife Survey

The winter wildlife survey was conducted on February 4th, 2014. Weather conditions were ideal for the survey with a temperature of -12.2 ˚C at the beginning of the survey (8 a.m.), rising to about -7 ˚C by the end of the survey (12 p.m.). Skies were sunny and winds were mostly calm (~1.4 km/h max wind speed). This survey was conducted approximately 50 hours after a large snowfall event. This timing window allowed enough time for wildlife activity to have imprinted on the snow while still maintaining fresh snow on site, which presented clear and only lightly weathered signs.

This survey involved a search for evidence of winter wildlife through tracks and other wildlife signs. Particular attention was paid to areas likely to serve as animal movement corridors. When wildlife signs were detected, they were identified to species whenever possible and behaviour was described. Field identification of tracks was aided by taking measurements and descriptions of patterns and shapes. Identifications were confirmed in the office using various identification resources (Rezendes, 1999; Elbroch, 2003).

Findings:
During the winter wildlife survey, seven mammal species were detected: White-tailed Deer (*Odocoileus virginianus*), Striped Skunk (*Mephitis mephitis*), Raccoon (*Procyon lotor*), Meadow Vole (*Microtus pennsylvanicus*), Woodchuck (*Marmota monax*), Eastern Cottontail (*Sylvilagus floridanus*) and Gray Squirrel (*Sciurus carolinensis*). Additionally, domestic dog (*Canis lupus familaris*) tracks were observed throughout the study area. Seven species of birds were detected during the winter wildlife survey: American Crow (*Corvus brachyrhynchos*), Blue Jay (*Cyanocitta cristata*), Red-bellied Woodpecker (*Melanerpes carolinus*), Mourning Dove (*Zenaida macroura*), American Robin (*Turdus migratorius*), Cedar Waxwing (*Bombycilla cedrorum*) and Black-capped Chickadee (*Poecile atricapillus*).

Winter wildlife use of the study area was concentrated around field/forest edges as well as directly within forested and wetland features. The majority of behaviour inferred from tracks was movement, however, foraging and burrowing were observed at the edges of forested habitat (including hedgerows) adjacent to fields. The most abundant species detected were White-tailed Deer and Gray Squirrel, while Woodchuck and Striped Skunk were only detected once each. Raccoon was detected foraging in the creek in Polygon 14 as well as moving near Polygon 7. Within the large forest and swamp feature (Polygons 24, 27 & 29), deer and squirrel tracks were ubiquitous. Deer overwintering and movement are described below. None of the mammal species detected during the winter wildlife survey are federally, provincially or locally significant (COSEWIC, 2015; COSEWIC, 2016; OMNRF, 2016; NHIC, 2016; RMW, 1985b). Furthermore, this diversity represents a widespread and cosmopolitan set of species, characteristic of a suburban/rural environment (Naughton, 2012). Of the winter birds detected only the Red-bellied Woodpecker, which was observed in Polygon 4, is considered to be rare in the Regional Municipality of Waterloo (RMW, 1996). However, this status list is outdated and is likely no longer an accurate reflection of species status within the Region. For example, it is common knowledge that Red-bellied Woodpeckers have experienced a significant range expansion in southern Ontario over the past 25 or so years and are much more likely to be documented now than in the past (Bavrlic, 2007).

White-tailed Deer Overwintering Habitat
Deer movement was examined carefully during the winter wildlife survey. The large forest and swamp feature just north of Wideman Rd (Polygons 24, 27 & 29) was found to have extensive deer activity. This area, in tandem with the adjacent forested regions to the west of the study area, is suitable overwintering habitat for White-tailed Deer. This mixed forest, swamp and coniferous forest provides a sheltered environment with less snow, wind and general exposure than surrounding habitat. Evidence of deer bedding in this feature, especially under large coniferous trees (*i.e.,* Eastern Hemlock), was apparent. Furthermore, deer tracks criss-crossed this feature indicating longer-term use of this habitat. Conversely, deer tracks within the agricultural lands were typically linear and along field edges indicating the use of farm fields primarily as winter movement corridors.

White-Tailed Deer Movement Corridors
One important deer movement corridor was detected during the winter wildlife survey, extending along the central hedgerow running east-west across the study area (Polygons 34 & 44). Deer tracks were noted traveling in both directions across Erbsville Road opposite the hedgerow. This corridor enables deer to move between the large natural features to the east, west and within the study area. As suitable corridor habitat is further constrained by development in the area, and traffic increases along Erbsville Road, there is potential for an increase in wildlife/vehicle collisions at the crossing point described above. White-tailed Deer also likely cross Erbsville Road adjacent to Polygon 23 (and Wideman Creek), between Polygons 5 and 8, as well as between Polygons 42 and 10. Across Wideman Road, north-south deer movement most likely occurs west of the study area, providing a connection with the Forested Hills ESPA.

3.1.3.5 Salamander Trapping Survey

Salamander trapping surveys were conducted to help determine whether the provincially and nationally "Endangered" Jefferson Salamander (*Ambystoma jeffersonianum*) is present within the Erbsville South study area. Surveys were considered necessary since Jefferson Salamanders have been reported from elsewhere in Waterloo region (*i.e*., the study area is within the historic range of the species) and potentially suitable habitat, albeit marginal in size and quality, was identified in the study area.

Applicable permit applications were submitted and approved prior to the initiation of salamander trapping surveys. These permits included a Wildlife Animal Care Committee Research Protocol (WACCRP), a Wildlife Scientific Collector's Authorization (WSCA), and an Endangered Species Act (ESA) "B" Permit. Permits and authorizations were issued by the OMNR on February 28, 2014 (WACCRP), March 10, 2014 (ESA "B" Permit) and March 28, 2014 (WSCA). Permit approval information has been included in Appendix 2.6.

In addition to allowing for trapping, permits also authorized specimens belonging to the "Jefferson Salamander complex" (*i.e., Ambystoma laterale – A. jeffersonianum* complex) to have a small portion of their tail clipped for genetic analysis; it is impossible to visually identify individuals to species or ploidy.

Salamander trapping was conducted in two ponds within the Erbsville South Environmental Study area between April 8 and April 15, 2014 (see Figure 3.3). The timing of the trapping schedule coincided directly with the pond melt. During the first round of trapping (April 8 – 9th), a thin margin of open water existed at the shorelines, while the pond surfaces remained frozen over (salamander traps were submerged in the water by breaking the ice surface with a pick). However, by the second round of trapping (April 9 – 10th) the surface ice had largely melted and by the last round of trapping (April 14 – 15th) both of the ponds had fully melted. Five nights (or "rounds") of trapping took place in total in accordance with MNRF protocols. This timing window was selected in order to target Jefferson Salamander (*Ambystoma jeffersonianum*), which is the earliest pond-breeding salamander that may migrate into ponds while they are still largely covered with ice (Petranka, 1998). While Jefferson and then Blue-spotted Salamanders (*Ambystoma laterale*) are the first seasonal pond-breeders, Spotted Salamanders (*Ambystoma maculatum*) typically breed within a similar timing window to the trapping schedule employed in 2014 (March – April in Michigan) (Petranka, 1998).

Each pond was trapped to determine the presence of pond breeding salamanders using nine standard minnow traps (*i.e.,* galvanized wire mesh, 6 mm squares). Traps were fully submerged in the target ponds, just before dark on five evenings in early April (see Table 3.3 – field schedule). Traps were then checked before 8 am on the mornings immediately following evening deployment. Specimens within the traps were examined, recorded and then released back into the pond. The trapping protocol was undertaken in this way to ensure that any specimens caught would spend a minimal amount of time in the traps.

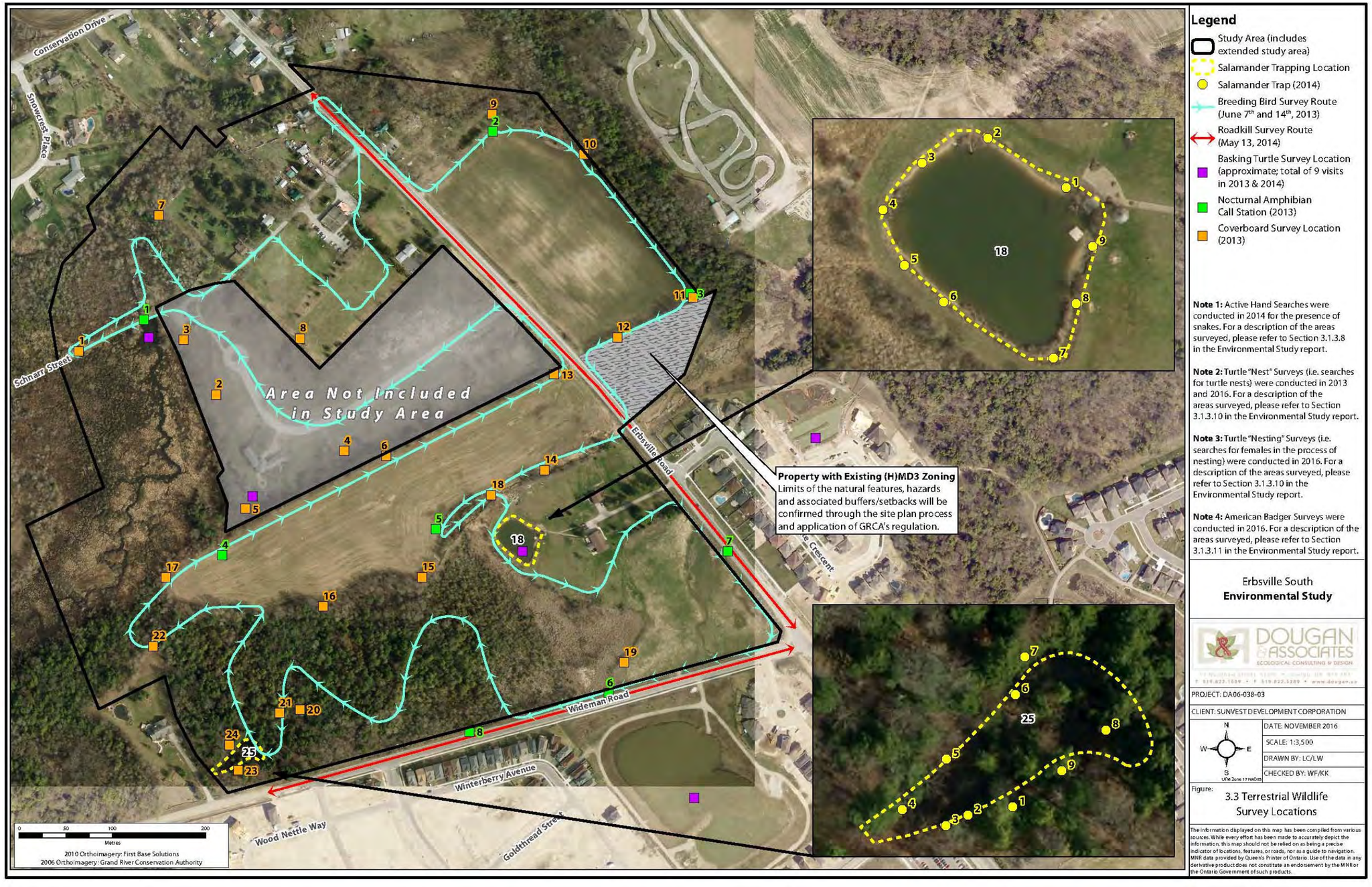

Figure 3-3 Terrestrial Wildlife Survey Locations

Traps were established around the perimeters of the two target ponds and especially in areas with potential breeding microhabitat such as woody debris, vegetation or adjacent suitable upland habitat. The location of each trap is illustrated on Figure 3.3. Prior to deployment, each trap was securely tied and flagged to the shoreline and its GPS coordinates were recorded. After examination during a morning trap-check, each would be opened (disarmed) and removed from the pond.

Findings:
One species of pond-breeding salamander was detected during the course of the 5-day trapping schedule completed in early April, 2014. Two adult male Red-spotted Newts (*Notophthalmus viridescens viridescens*) were captured in Polygon 18, Trap 2 on April 11th (Figure 3.3). No other salamanders were trapped over the course of the study. Other captured specimens included occasional Predaceous Diving Beetles (*Dytiscidae sp*) (Polygon 25 Trap 1 & 4, Polygon 18, Trap 8), two Green Frog tadpoles captured in Polygon 18, Traps 3 and 8, as well as one small minnow (*Leuciscinae sp*) in Trap 3.

Red-spotted Newt has a complex and variable life cycle stages involving larvae, terrestrial subadult, aquatic adult and in some cases a final return to terrestrial adult (Petranka, 1998). During these various transformations the Red-spotted Newt employs a variety of aquatic and terrestrial habitats. The terrestrial 'red eft' subadult stage lives in leaf litter on moist forest floors. After several years on land the eft migrates into an aquatic system with slow-moving or stationary water and transforms into an adult (Petranka, 1998). This adult stage represents the condition of the adult males captured in 2014. Both of the male newts had swollen cloaca indicating a readiness to breed within Polygon 18 (Petranka, 1998).

3.1.3.6 Nocturnal Amphibian Call Surveys

Nocturnal amphibian call surveys were completed according to the protocol outlined in the Marsh Monitoring Program (MMP) (BSC, 2009), including seasonal timing and weather conditions. During each visit, surveyors listened and documented amphibian calls for a 6-minute duration at each of the monitoring stations. The duration of each point count was extended from the standard 3 minute length to 6 minutes to help ensure that all species present were documented and that calling intensity was accurately recorded.

Eight amphibian monitoring station locations were established in the study area with the intention of surveying all suitable amphibian breeding habitat present on the site. Nocturnal amphibian call station locations are illustrated on Figure 3.3. Table 3.6 provides details on site conditions at the time of the 2013 amphibian call surveys.

Table 3.6 Nocturnal Amphibian Call Survey Conditions Summary

Date (2013)	**Surveyor**	**Station ID**	**Start Time** (p.m.)	**Noise Index** (as per NAAMP)	**Wind** (Beaufort Scale)	**Temperature** (°C)	**Precipitation**
April 27	Dylan White	1	9:18	1	Start: 0	Start: 11.2	None
		2	9:28	2			
		3	9:40	3			
		4	9:51	2			
		5	10:05	2	End: 0	End: 10.8	
		6	10:20	1			
		7	10:28	1			
		8	10:45	1			
May 22	Dylan White	1	9:35	1	Start: 2	Start: 20	None; rain event 6 hrs earlier
		2	9:45	2			
		3	9:58	2			
		4	10:10	1			
		5	10:25	1	End: 2	End: 18.6	
		6	/	/			
		7	10:40	2			
		8	10:50	1			
June 15	Dylan White	1	9:48	1	Start: 0	Start: 22.8	None
		2	10:00	2			
		3	10:12	2			

Date (2013)	Surveyor	Station ID	Start Time (p.m.)	Noise Index (as per NAAMP)	Wind (Beaufort Scale)	Temperature (°C)	Precipitation
		4	10:21	2			
		5	10:30	2	End: 0	End: 18	
		6	10:42	2			
		7	10:50	2			
		8	11:01	1			

Noise Index *as per North American Amphibian Monitoring Program (NAAMP)* Frog Call Survey Instructions (http://www.massnaamp.org/online_docs/NAAMP%20MA%20Datasheet%202012.pdf)	
Code	**Indicator**
0	No appreciable effect (*e.g.,* owl calling)
1	Slightly affecting sampling (*e.g.,* distant traffic, dog barking, 1 car passing)
2	Moderately affecting sampling (*e.g.,* nearby traffic, 2 – 5 cars passing)
3	Seriously affecting sampling (*e.g.*, continuous traffic nearby, 6 – 10 cars passing)
4	Profoundly affecting sampling (*e.g.,* continuous traffic passing, construction noise)

Beaufort Wind Scale *as described according to the MMP (BSC, 2009)*		
Code	**Wind Speed** (kph)	**Indicator**
0	0 – 2	**Calm;** smoke rises vertically
1	3 – 5	**Light air movement;** smoke drifts
2	6 – 11	**Slight breeze;** wind felt on face, leaves rustle
3	12 – 19	**Gentle breeze;** leaves and small twigs in constant motion
4	20 – 30	**Moderate breeze;** small branches are moved, raises dust & loose paper
5	31 – 39	**Fresh breeze;** small trees in leaf begin to sway; crested wavelets form
6	40 – 50	**Strong breeze;** large branches in motion.

* Noise code not recorded by surveyor, but was estimated based on other visits to this station

Findings:

In total, five species of anurans were detected during the Nocturnal Amphibian Call Surveys conducted in 2013. Calling amphibians were detected from every station during each round of surveying. As to be expected within seasonal breeding windows, Spring Peepers (*Pseudacris crucifer*) were most prominent during the earliest survey but were not detected during the third survey. Meanwhile, Gray Treefrogs (*Hyla versicolor*) were most prominent during the second survey and remained fairly prominent through the third. Additional species detected include American Toad (*Anaxyrus americanus*), Northern Leopard Frog (*Lithobates pipiens*) and Green Frog (*Lithobates clamitans*). Table 3.7 lists the species and approximate number of calling individuals recorded during each survey visit in 2013.

While only two Northern Leopard Frog were detected during call surveys, more than 100 individual Northern Leopard Frogs were observed incidentally within Polygon 31. This large wetland complex also contained numerous individual anurans representing all five species present within the study area. This extensive wetland feature provides very high quality amphibian breeding habitat.

Table 3.7 Nocturnal Amphibian Call Survey Data

Station		April 27, 2013		May 22, 2013		June 15, 2013	
#	Orientation	Noise*	Species	Noise*	Species	Noise*	Species
1	245º	1	Spring Peeper -L2 (8) Spring Peeper -L2 (5) American Toad-L2 (3) Northern Leopard Frog-L2 (2)	1	Spring Peeper -L2 (5) Gray Treefrog -L3 GRFR-L1 (2)	1	Gray Treefrog -L3 Gray Treefrog -L1 (2)
2	0º	2	Spring Peeper -L3	2	Spring Peeper -L2 (?: distant) Gray Treefrog -L3 (distant) Gray Treefrog -L3 (very distant)	2	Gray Treefrog -L3 Gray Treefrog -L3

Station		April 27, 2013		May 22, 2013		June 15, 2013	
#	Orientation	Noise*	Species	Noise*	Species	Noise*	Species
3	160º	3	Spring Peeper -L2 (9) American Toad -L2 (3) American Toad -L2 (4)	2	Spring Peeper -L2 (5) Gray Treefrog -L3 Green Frog -L2 (3)	2	Gray Treefrog -L2 (7) Gray Treefrog -L2 (6) Green Frog -L2 (4)
4	0º	2	Spring Peeper -L2 (8) American Toad -L2 (2) American Toad -L2 (2)	1	Spring Peeper -L2 (3) Spring Peeper -L1 (1) Gray Treefrog -L2 (2) Gray Treefrog -L3 Green Frog-L2 (4)	2	Gray Treefrog -L1 (1) Gray Treefrog -L1 (1)
5	160º	2	Spring Peeper -L2 (10) American Toad -L2 (2)	1	Gray Treefrog -L1 (1)	2	Gray Treefrog -L1 (1) Gray Treefrog -L1 (1)
6	0º	1	Spring Peeper -L2 (10) Spring Peeper -L2 (2) American Toad -L1 (1)	/	no data	2	Gray Treefrog -L1 (1)
7	260º	1	Spring Peeper -L2 (10) American Toad -L2 (2)	2	Spring Peeper -L2 (3)	2	Gray Treefrog -L1 (1)
8	0º	1	Spring Peeper -L2 (10)	1	Spring Peeper -L2 (3) Gray Treefrog -L3	1	Gray Treefrog -L3

* *Background Noise Level Codes:* 0=No appreciable effect; 1= Slightly affecting sampling; 2=Moderately affecting sampling; 3= Seriously affecting sampling; 4=Profoundly affecting sampling.

Calling Levels: L1(#)=Non-overlapping calls(number of individuals); L2(#)=overlapping calls(approximate number of individuals); L3=Full chorus, numerous individuals, estimate of at least 25 individuals. (BSC, 2009).

Onsite Anuran Breeding Habitat

Within the study area various wetland features were confirmed as suitable anuran breeding habitat. This included a variety of wetland types such as tamarack swamp, willow thicket swamps as well as shallow and meadow marsh. Anuran species occurrences approximate number of calling individuals and exact location and type of breeding habitat is presented in Table 3.8. The two most important anuran breeding areas are the wetland complexes in the western and south-central parts of the study area (Polygons 1, 30, 31 and 18, 19, 22, 12, 45, 14, 15 respectively). Polygon 37 also contained some breeding habitat, however the majority of anuran breeding activity at this edge of the study area occurred offsite to the east.

Table 3.8 Anuran Species Occurrences

Anuran Breeding Habitat (Polygons)	Breeding Habitat Vegetation Communities	Anuran Species and Approximate Number of Individuals				
		AMTO	SPPE	GRTR	NLFR	GRFR
1, 30, 31	Rice Cut-grass Organic Shallow Marsh, Willow Organic Thicket Swamp	3	18	50	2	7
37	Willow Organic Thicket Swamp	-	5	9	-	-
18	Submerged Shallow Aquatic	2	-	-	-	4
19, 22	Tamarack Organic Coniferous Swamp, Willow Mineral Deciduous Thicket Swamp	-	10	5	-	-
12, 45	Cattail Mineral Shallow Marsh, Mineral Meadow Marsh	-	13	-	-	-
14, 15	Mineral Meadow Marsh, Cattail Mineral Shallow Marsh	-	2	-	-	-

Legend: AMTO – American Toad; SPPE – Spring Peeper; GRTR – Gray Treefrog; NLFR – Northern Leopard Frog; GRFR – Green Frog. Polygons are displayed in Figure 3.2.

Offsite Anuran Breeding Habitat

Anuran breeding habitat was also detected adjacent to, but outside of the study area. West of Polygons 27 and 31 (see Figure 3.2), within contiguous wetland habitat, full choruses of Gray Treefrogs were detected on May 22 and June 15, 2013. Similarly, along the eastern edge of the study area (east of Erbsville Rd), numerous Spring Peepers, Gray Treefrogs and several Green Frogs and American Toads were heard calling on April 27 and May

22, 2013. Southeast of Polygon 35, several Gray Treefrogs were heard calling on June 15, 2013. A large SWM pond is located at the southwest corner of Erbsville Road and Wideman Road, directly opposite the southern study area boundary. Although it seems possible that several species of anurans could use this pond, only American Toads were noted calling from it.

3.1.3.7 Roadkill Survey

One designated roadkill survey was conducted in the study area on May 13, 2014. Several other incidental roadkill observations were made throughout the period of the study. The roadkill survey involved walking along all roadside edges and visually inspecting the road surface for roadkill (see Figure 3.3). This included Schnarr Street, Erbsville Road and Wideman Road. Timing of the survey was less than 24 hours after a major rainfall event, which enabled an examination of anuran road mortality. Any reptile, mammal and bird mortality was also noted. Once located, each individual was examined and identified to species whenever possible.

Findings:
One species of anuran and one unidentified small mammal was observed dead on the road during the designated roadkill survey. Six Northern Leopard Frogs (*Lithobates pipiens*) were found dead on the roads within the study area. The majority of these (five) were on Wideman Road, and one was found just east of Polygon 15 on Erbsville Road. The unidentified small mammal had been severely trampled by numerous vehicles on Wideman Road.

On May 6, 2014 one Eastern Gartersnake (*Thamnophis s. sirtalis*) was found dead along the eastern edge of Erbsville Road. It was lying in an exposed area with bare soil and had presumably been using the road surface as basking habitat.

Northern Leopard Frogs were found to be ubiquitous throughout the wetlands within the study area and are known to spend more time foraging outside of wetlands than other anurans. Therefore it was not surprising that Northern Leopard Frogs were the most commonly encountered species of roadkill and the only anuran species detected. All of the observations indicate that the frogs were traveling out of the wetland complex along the southern edge of the study area. All of the carcasses appeared to indicate a direction of travel coming from the study area and attempting to reach habitat on the other side of Wideman Road.

It is worth noting that local residents also documented road mortality, Snapping Turtle, Eastern Milksnake and other species as discussed in Section 3.1.2.3 above.

3.1.3.8 Snake Surveys

Coverboard Surveys

Twenty-four (24) coverboards were placed across the study area in 2013 to help detect the presence of snakes and salamanders. Forest/meadow and forest/wetland edges, adjacent to basking areas, were targeted for snakes, and forested habitats adjacent to woodland pools were targeted for salamanders. Three coverboard checks were conducted over the course of the 2013 field season. One initial reconnaissance survey and coverboard set-up (May 8) was followed by two coverboard checks (June 4, 19) and a final check and coverboard removal (October 21) (see Table 3.9).

Table 3.9 Coverboard Survey Details

Date	**Observer**	**Time**	**Duration** (hrs.)	**Weather Conditions**
May 8, 2013	D. White	9:30am	6	14ºC, Sunny, Calm
June 4, 2013	D. White	9am	6	15.5ºC, Sunny, Calm
June 19, 2013	D. White	9:45am	5.5	14.5ºC, Sunny, Calm
Oct. 21, 2013	D. White	10am	6	11ºC, light rain, light breeze

Coverboards consisted of 24” x 24” x 0.5” boards of untreated plywood, which had been weathered in the field for at least one year prior to deployment Coverboard locations are displayed in Figure 3.3. Each board included a label or tag with our company information and text indicating that boards should not be disturbed due to research purposes.

Findings:
Over the course of three coverboard checks undertaken in 2013, one species of reptile and two small mammals were observed underneath the boards. An Eastern Gartersnake (*Thamnophis s. sirtalis*), was observed under coverboard 17 on June 4, 2013. One unidentified species of shrew (*Soricidae sp*) and one Meadow Vole (*Microtus pennsylvanicus*) were observed under coverboards 15 (June 19, 2013) and 18 (October 21, 2013) respectively. None of the three species documented are considered significant at the national, provincial, regional, or local levels (COSEWIC, 2015; COSEWIC, 2016; OMNRF, 2016; RMW, 1985 a, b).

Meadow Vole is a widespread and abundant mammal in Ontario and Canada (Naughton, 2012) and is not considered at risk federally, provincially or locally (COSEWIC, 2015; COSEWIC, 2016; OMNRF, 2016; RMW, 1985b). The shrew observed under coverboard 15 was not identified to species as it disappeared into the leaf litter very quickly upon detection. However, none of the shrew species found in Ontario are listed as Species-at-Risk federally or provincially (COSEWIC, 2015; COSEWIC, 2016; OMNRF, 2016). Three species of shrew may be present in the study area; Masked Shrew (*Sorex cinereus*), Water Shrew (*Sorex palustris*) and Smoky Shrew (*Sorex fumeus*). Masked Shrew is the most abundant and widespread shrew in North America known to occur within a wide range of habitats including disturbed sites (Naughton, 2012). Water Shrew and Smoky Shrew are considered to be rare in the Regional Municipality of Waterloo (RMW, 1985b). All of these shrew species utilize wetland and moist forest habitat and so protection of the swamp and forest features within the study area (*e.g.,* Polygons 21, 24, 27, & 29) will ensure the protection of shrew habitat.

Nearby natural cover objects were often inspected during the course of coverboard surveys. On June 19, 2013 two Eastern Red-backed Salamanders (*Plethodon cinereus*) were found underneath a rotting log near to coverboard 24. Within suitable upland wooded habitat, this species may be very abundant under woody debris and in the leaf litter (Harding, 1997). As they require a moist microenvironment on the forest floor, the canopy within the swamp and forest onsite (*e.g.,* Polygons 21, 24, 27, 29) should be protected to allow these salamanders to persist within the study area.

Active Hand Searches

Based on guidance provided by the Ministry of Natural Resources (Norminton, 2013 - Appendix 2.1), four active hand searches were carried out across the study area in 2014 (May 13, June 4, June 20 and July 22). The dates were consistent with the time of year and temperature ranges recommended by the MNR Guelph District Milksnake Survey Protocol (OMNR, 2013b) (see Table 3.10). The active hand search protocol involved the removal of cover objects (rocks, woody debris and anthropogenic debris), examination of the sheltered habitat underneath, and then replacement of the cover object. In addition to direct examination of cover objects, potential herpetofauna basking areas, foraging habitat and movement corridors were inspected visually using 8 x 42 *Vortex Optics Crossfire* binoculars. The surveys involved meandering walking transects throughout all habitat types within the study area emphasizing areas with high habitat suitability for herpetofauna such as field/forest edges, pond and wetland edges and upland forest near to ponds.

Table 3.10 Active Hand Search Survey Details

Date	Observer	Time	Duration (hrs.)	Weather Conditions
May 13, 2014	D. White	9:30-11:30	2	22 ºC, sunny, calm
June 4, 2014	D. White	11:00-3	4	16 °C, sunny, calm
June 20, 2014	D. White	7:45-11:15	3.5	20 ºC, sunny, calm
July 22, 2014	D. White	8:00-12:00	4	23 ºC, mixed sun/cloud, calm

Findings:
Eastern Gartersnake (*Thamnophis s. sirtalis*) was the only reptile detected during active hand searches undertaken in 2014. Numerous natural and anthropogenic cover objects were inspected during the four active hand searches, but reptile abundance was found to be very low; two Eastern Gartersnakes were observed over the course of four active hand searches.

Numerous incidental wildlife observations were noted in conjunction with the active hand searches and are discussed in Section 3.1.3.11 Incidental Wildlife.

3.1.3.9 Breeding Bird Surveys

Breeding bird surveys were conducted on June 7 and June 14, 2013 by an avian ecologist following the protocols outlined by the Ontario Breeding Bird Atlas (Cadman *et al*., 2007). This protocol stipulates that the surveys be conducted between sunrise and 10:00 a.m., between May 24 and July 12. The two surveys were completed at least one week apart, and during appropriate weather conditions (*i.e*., with light winds and no heavy rain). The survey visits took place as close as possible to the middle of June when song output is highest and detection rates are greatest. Table 3.11 describes the survey details.

Table 3.11 Summary of Breeding Bird Survey Visits to the Study Area

Date	Observer	Time	Duration (hrs.)	Weather Conditions
June 7, 2013	I. Richards	06:30 – 09:30	3.0	Cloudy, calm, 11 - 15 °C
June 14, 2013	I. Richards	06:20 – 09:30	3.25	Mostly clear, winds west (Beaufort 2 – 3), 15 – 18 °C

Each survey followed a wandering transect in such a way that both the Primary Study Area and Extended Study Areas were appropriately covered (*i.e*., that no location is greater than 125 metres away from any given survey transect). The approximate location of the route walked is illustrated on Figure 3.3.

Findings:
Fifty-two (52) species of birds were detected during the surveys, with 43 species tallied on June 7, 2013 and 47 species on June 14, 2013. Of these 52 species, however, only 51 species were potentially breeding within or adjacent (*i.e.,* within 120 metres) to the study area, with one of them (Great Blue Heron *Ardea herodias*) recorded flying over the site (code X – see Appendix 2.7). Two of these breeding species are introduced (non-native): European Starling (*Sturnis vulgaris)* and House Sparrow (*Passer domesticus*).

Of the remaining 49 species, two are considered 'Species at Risk' (SAR): Eastern Wood-Pewee (*Contopus virens*) is designated as "Special Concern" in Ontario (OMNRF, 2016) and Canada (COSEWIC 2015; COSEWIC, 2016), and Barn Swallow (*Hirundo rustica*) is designated "Threatened" in Ontario (OMNRF, 2015) and Canada (COSEWIC 2015; COSEWIC; 2016). Therefore Barn Swallow receives protection under the provincial Endangered Species Act (ESA), 2007 (Government of Ontario, 2007). At a provincial level, all of the 49 native breeding species have been assigned SRanks of either S4 or S5 by the Natural Heritage Information Centre, which indicates that their provincial populations are "apparently secure" or "secure", respectively (NatureServe Explorer 2016).

One territorial Eastern Wood-Pewee was documented from the mixed forest community near the southwest corner of the study area, adjacent to Wideman Road. A second individual was recorded singing close to Laurel Creek, north of the laneway that extends west of Schnarr Street, and a third individual was documented from another mixed forest community east of the largest field on the east side of Erbsville Road.

At least two pairs of Barn Swallows were documented foraging in the open areas around the pond and house at the northwest corner of Wideman Road and Erbsville Road. One pair was nesting in a gazebo adjacent to the pond, and there was evidence of past nesting on the nearby house. Three other Barn Swallows were observed foraging over the small field directly northwest of Forest Gate Crescent (east of Erbsville Road). This is not far from 521 Forest Gate Crescent, where Barn Swallows were documented nesting in 2013.

At a regional level, eight (8) species are designated by Ontario Partners in Flight as priority species for conservation in Bird Conservation Region (BCR) 13, the Lower Great Lakes/St. Lawrence Plain (OPIF 2008) (see Table 3.12). In Ontario, the Lower Great Lakes – St. Lawrence Plain corresponds roughly with the area south of the Canadian Shield.

Table 3.12 Regionally Significant Breeding Birds Documented From Within and Adjacent to the Study Area

	Common Name	Scientific Name	Primary Study Area	Extended Study Area
1	Black-billed Cuckoo	*Coccyzus erythropthalmus*	✓	✓
2	Northern Flicker	*Colaptes auratus*	✓	
3	Eastern Wood-Pewee	*Contopus virens*	✓	✓
4	Eastern Kingbird	*Tyrannus*	✓	
5	Brown Thrasher	*Toxostoma rufum*	✓	
6	Field Sparrow	*Spizella pusilla*	✓	
7	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	✓	
8	Baltimore Oriole	*Icterus galbula*	✓	

At a local level, most of the 49 species recorded are considered common in the Regional Municipality of Waterloo (RMW, 1996). However, nine were not (see Table 3.13). The first three species in the table are considered “rare”, and the remaining six are considered “uncommon” (RMW, 1996).

Table 3.13 Locally Significant Breeding Birds Documented From Within and Adjacent to the Study Area

	Common Name	Scientific Name	Primary Study Area	Extended Study Area
1	Hooded Merganser	*Lophodytes cucullatus*		✓
2	Sharp-shinned Hawk	*Accipiter striatus*	✓	
3	Red-bellied Woodpecker	*Melanerpes carolinus*	✓	
4	Pileated Woodpecker	*Dryocopus pileatus*	✓	✓
5	Alder Flycatcher	*Empidonax alnorum*		✓
6	Warbling Vireo	*Vireo gilvus*	✓	
7	Brown Thrasher	*Toxostoma rufum*	✓	
8	Mourning Warbler	*Geothlypis philadelphia*	✓	
9	Swamp Sparrow	*Melospiza georgiana*		✓

Finally, the Ontario Ministry of Natural Resources (OMNR) considers three (3) of these breeding bird species to be area sensitive: Sharp-shinned Hawk (*Accipiter striatus*), Pileated Woodpecker (*Dryocopus pileatus*), and White-breasted Nuthatch (*Sitta carolinensis*) (OMNR, 2000). Area sensitive species typically require large areas of suitable habitat for their long-term survival. All three are normally associated with forested habitats.

The highest level of breeding evidence obtained during the surveys was “confirmed” breeding (Cadman *et al*., 2007). This level of evidence was recorded by the observation of fledged young (code FY). Confirmed breeding was established for the following two (2) species: Canada Goose and American Robin. The next highest level of breeding evidence collected was “probable” breeding (Cadman *et al*., 2007). This was evidenced by the observation of territorial males (code T) – defined as being observed singing in the same location at least seven days apart (Cadman *et al*., 2007) – or pairs of birds (code P). “Probable” breeding was the highest level of breeding evidence for 25 species (including incidental species). The next highest level of breeding evidence was “possible” breeding (Cadman *et al*., 2007), as seen with singing males (code S) or birds being present in appropriate breeding habitat during the breeding season (code H). “Possible” breeding was the highest level of breeding evidence for 30 species (including incidental species).

For a complete list of species documented during the breeding bird surveys, please see Appendix 2.7.

3.1.3.10 Turtle Surveys

Basking Turtle Surveys

Numerous basking turtle surveys were conducted over the course of the study, especially since turtles have been documented from the area in the recent past, and the study area contains small amounts of suitable turtle foraging habitat. Two sites were surveyed in 2013 and 2014. This included a small 0.17 ha pond behind 665 Erbsville Road, and sections of Laurel Creek west of Regal Place, including a slightly wider and more open section immediately south of the laneway (see Figure 3.3). The survey program was expanded in 2016 to

increase our understanding of the occurrence of potentially occurring Species at Risk on and adjacent to the study area, including Snapping Turtle, Northern Map Turtle, and Blanding's Turtle. Five sites were surveyed in 2016. This included the same two sites surveyed in 2013 and 2014, as well as the private pond behind the home at the SW corner of the Regal Place block, the Forest Gate Drive stormwater management pond, and finally the large stormwater management pond at the SW corner of Wideman Road and Erbsville Road.

Five survey visits were made in 2013, four in 2014, and five in 2016 (see Table 3.14). The combined complement of surveys is in compliance with OMNR's "Occurrence Survey Protocol for Blanding's Turtle (*Emydoidea blandingii*) in Ontario" (Norminton, 2013 – Appendix 2.1). According to the protocol, "Searching for basking turtles is the most effective method of confirming the presence of this species within suitable habitat." For sites where Blanding's Turtles have not been previously recorded, it recommends at least five visits be conducted, and at least three per year if conducted over multiple years.

Table 3.14 Summary of Basking Turtle Survey Visits Conducted in the Study Area

Date	**Observer**	**Time**	**Duration** (min.)	**Weather Conditions**
April 27, 2013	I. Richards	10:15 – 10:50	30	Completely sunny & calm. 11 °C
May 16, 2013	I. Richards	9:45 – 10:20	30	Completely sunny, winds Beaufort 3 from NW. 16 °C
June 7, 2013	I. Richards	08:35 – 09:30	20	Cloudy, calm, 11 - 15 °C
June 14, 2013	I. Richards	08:20 – 09:30	20	Mostly clear, winds west (Beaufort 2 – 3), 15 – 18 °C
June 19, 2013	D. White	10:00 – 15:00	30	21 °C, sunny & calm
May 5, 2014	D. White	13:00 – 14:00	60	12 °C, Mixed sun/cloud, Calm (light winds)
May 6, 2014	D. White	10:30 – 11:00	30	Sunny, 12 °C, calm
May 13, 2014	D. White	10:00 – 11:00	60	Sunny & approx. 22 °C. Rained during the morning
June 4, 2014	D. White	10:00 – 11:00	60	16 °C, Sunny, Calm
March 9, 2016	D.White	12:30 – 14:45	135	6 °C, 12:30pm, Sunny Clear, Calm
April 27, 2016	D. White	15:00 – 17:30	150	10 °C, 3pm, Sunny, Clear, Calm
May 4, 2016	D. White	12:00 – 15:45	165	14 °C, 12pm, Mixed Sun/Cloud, Calm
May 11, 2016	D. White	11:00 – 13:15	135	15 °C, 11am, Mixed Sun/Cloud, Calm
May 16, 2016	D. White	12:00 – 14:30	150	17 °C, 12pm, Sunny, Clear, Calm

Consistent with the protocol, the basking turtle surveys were conducted before mid-June on sunny or mostly sunny days, between 8 a.m. and 5 p.m., and under adequate temperatures (OMNR, 2013c). The smaller, open water habitats were surveyed using binoculars. In addition, each area was approached very slowly so as not to inadvertently scare any basking turtles back below the surface. Whenever possible, observations took place well before reaching the sites, especially when little intervening vegetation was present to hide the approach. While scanning the sites, careful attention was paid to any shoreline logs, rocks, vegetation hummocks, sedge/grass tussocks, or other habitats where turtle basking could take place. Scans to detect the presence of any floating turtles were also made. In addition to the pond and wider section of Laurel Creek, an extended (170 m) section of Laurel Creek south of the laneway was carefully examined from amongst the vegetation along the east bank. The larger stormwater management pond south of Wideman Road was surveyed using a spotting scope.

Findings:
Two species of turtle were observed during the 2013, 2014 and 2016 basking turtle surveys: Midland Painted Turtle (*Chrysemys picta marginata*) and Snapping Turtle (*Chelydra serpentina*) (see Table 3.15). Although neither species is considered significant at the local (RMW, 1985) or regional levels (Plourde *et al*., 1989), neither of these lists have been updated for 25+ years and may no longer provide an accurate reflection of status. At the provincial level, Snapping Turtle is designated "Special Concern" in Ontario (OMNRF, 2016). Midland Painted Turtle is currently not at risk (OMNRF, 2016). The findings demonstrate that the study area provides small amounts of suitable basking habitat for turtles and nearby nesting is expected. Slightly larger numbers of turtles were documented from the adjacent stormwater management ponds. No Blanding's Turtles were detected during any of the basking turtle surveys.

Table 3.15 Summary of Basking Turtle Survey Results

Date	Observer	Results
April 27, 2013	I. Richards	No turtles observed at either location.
May 16, 2013	I. Richards	No turtles observed at either location.
June 7, 2013	I. Richards	No turtles observed at either location.
June 14, 2013	I. Richards	Two Midland Painted Turtles observed in the pond at 665 Erbsville Road.
June 19, 2013	D. White	No turtles observed at any of the locations.
May 5, 2014	D. White	No turtles observed at any of the locations.
May 6, 2014	D. White	No turtles observed at any of the locations.
May 13, 2014	D. White	One Snapping Turtle observed basking on grass clump in Laurel Creek, south of laneway west of Schnarr Street.
June 4, 2014	D. White	No turtles observed at any of the locations.
March 29, 2016	D. White	No turtles observed at any of the locations.
April 27, 2016	D. White	One SNTU observed south of laneway west of Schnarr Street, along Laurel Creek. Five MPTUs observed at the Forest Gate Drive SWM pond. Four MPTUs observed at the large SWM pond at the SW corner of Wideman Road and Erbsville Road.
May 4, 2016	D. White	One MPTU observed south of laneway west of Schnarr Street, along Laurel Creek. One dead SNTU observed on shoreline of pond at 665 Erbsville Road. Four MPTUs observed at the Forest Gate Drive SWM pond. Six MPTUs observed at the large SWM pond at the SW corner of Wideman Road and Erbsville Road.
May 11, 2016	D. White	Six MPTUs observed at the Forest Gate Drive SWM pond. Eight MPTUs observed at the large SWM pond at the SW corner of Wideman Road and Erbsville Road.
May 16, 2016	D. White	One MPTU observed in the pond at 665 Erbsville Road. Three MPTUs observed at the Forest Gate Drive SWM pond. Five MPTUs observed at the large SWM pond at the SW corner of Wideman Road and Erbsville Road.

Turtle Nest Search Surveys

Evidence of turtle nesting was specifically searched for on three occasions in 2013. All potentially suitable nesting sites (*i.e*., generally areas of bare earth) were examined while conducting breeding bird surveys on June 7 and June 14, 2013. Additional searches focused on the laneway near the cul-de-sac on the Regal Place property were made on June 19, 2013.

In 2016, “turtle nest” and “nesting” surveys were completed concurrently according to the Blanding’s Turtle Nest and Nesting Survey Guidelines (*i.e*. during warm and humid nights between late May and early July) (OMNRF, 2016b), except for the final survey, which could not be conducted between 6:00 p.m. and 10:00 p.m. as recommended by the Ministry. Details of the survey visits, including weather conditions, are presented in Table 3.16. Transects were walked within all possible nesting habitat (OMNRF, 2016b). Blanding’s Turtle nesting habitat is generally defined as “open habitats with low vegetation cover, high sun exposure and well-drained soils” (OMNRF, 2013c). Within the study area, this includes agricultural fields (polygon 11, 20, and 35 [observed from roadside]), cultural meadows (polygon 13 and 36), and anthropogenic features (polygon 6 [observed from roadside], 16, 40, 41, and areas adjacent to 50). While searching suitable nesting habitat for females actively nesting, careful attention was also paid to any potentially disturbed areas of earth, especially those showing slightly concave mounds of earth or darker coloured soils suggesting that they were recently wet. Being aware of and specifically searching for these very subtle signs is key to detection of unpredated turtle nests.

Table 3.16 Turtle Nest and Nesting Survey Visits Conducted in the Study Area

Date	Observer	Time	Duration	Weather Conditions
June 7, 2013	I. Richards	06:30 – 09:30	180 min.	Cloudy, calm, 11 – 15 °C
June 14, 2013	I. Richards	06:20 – 09:30	195 min.	Mostly clear, winds west (BFT 2 – 3), 15 – 18 °C
June 19, 2013	D. White	09:45 – 15:00	330 min.	21 °C, sunny & calm.
June 5, 2016	D. White	18:00 – 19:45	105 min.	17 °C. Cloud cover 50%.
June 7, 2016	D. White	18:00 – 19:45	105 min.	15 °C. Cloud cover 30%.
June 9, 2016	K. Beauchamp	18:15 – 21:45	210 min.	Mostly clear (15% cloud cover). 17 – 11 °C.
June 10, 2016	K. Beauchamp	18:00 – 21:30	210 min.	Sunny (0% cloud cover). 23 – 17 °C.

Date	Observer	Time	Duration	Weather Conditions
June 12, 2016	K. Beauchamp	18:00 – 21:25	205 min.	Sunny (10% cloud cover). 16.5 – 11 °C.
June 20, 2016	Mary Anne Young, Christina Myrdal	13:30 – 15:15	105 min.	Sunny. 29 °C.

Findings:
The three mid-June 2013 visits made in search of turtle nests and/or nesting yielded no positive results for any species, including Snapping and Blanding's Turtle. No turtles or raided nests of any species were observed. However some areas of minor soil disturbance were noted, but the causes of the disturbances were unknown.

Similarly, no turtles were observed actively nesting in 2016, nor were any successful nests or raided nests found during any of the visits. However, this result is not surprising given the relatively low abundance of turtles present, and how well turtles mask their nests once complete. Still, a Snapping Turtle was observed in the open section of Laurel Creek, south of the laneway on June 5th, 2016. A Blanding's Turtle (*Emydoidea blandingii*) was observed on June 10, 2016 basking in the pond at 665 Erbsville Road (polygon 18), and a Snapping Turtle (*Chelydra serpentina*) was also observed basking in the same pond on June 12, 2016. Finally, on June 20, 2016 a possible test scrape was noted near the very western end of polygon 20, the agricultural field.

Hatchling Turtle Surveys

On September 20th 2013, the Regal Place property and lands directly south were searched for evidence of hatchling turtles. These areas were considered the habitats of highest potential to support turtle nesting. Although small patches of bare or disturbed earth only a square metre in size could potentially support nesting activity; only areas of highest potential were examined for signs of previous nesting activity and evidence and exit holes. For example the exposed soils on the Regal Place property represented the largest areas of exposed and/or disturbed soils. Other areas searched included the habitat along and directly adjacent the laneway, north of Regal Place, the short, mowed grass adjacent to Regal Place, YMCA Early Years Centre (including its large expanses of mowed grass), the laneway margins that crosses the creek, as well as the lawn habitat at 665 Erbsville Road.

The hatchling turtle survey was timed to correspond with normal emergence period in the fall. Although the timing of emergence varies according to a number of variables such as temperature over the course of the summer, and differences in microhabitat selection, the month of September is generally considered the optimal time when hatchling turtles emerge. The hatchling turtle survey was also conducted to correspond with mild temperatures and recent precipitation/humid conditions. Weather conditions at the time of the survey were totally overcast with periods of very light drizzle. Relative humidity was high at 86.7%. Temperatures varied between 20.1 and 22.8 °C. Mild and wet conditions induce emergence by softening the ground and reducing the likelihood of desiccation.

Findings:
No hatchling turtles of any species, including Snapping and Blanding's Turtles, were found during the September 20, 2013 survey. However, this result was not unexpected given the low likelihood of observing hatchlings emerging or on the move except through repeated visits. Hatchlings are very small in size and difficult to detect if moving through vegetation. No potential exit holes were observed that might suggest successful nesting had occurred. These holes are only marginally bigger than the hatchling turtles themselves, which are about the size of a two dollar coin.

Although no hatchling turtles were discovered, other recent signs of nesting were observed. An apparently raided Snapping Turtle (*Chelydra serpentina*) nest was discovered a short distance southwest of the cul-de-sac on the Regal Place property and another potential turtle "scrape" was found several metres away. Scrapes are places where a turtle may have initiated digging a nest cavity but abandoned the effort prior to completion. This particular scrape was very shallow, suggesting little effort was made, if it was caused by a turtle. Another raided turtle nest was discovered on the Regal Place property; based on the small sized egg shell fragments (smaller than a ping pong ball) observed, it appeared to belong to a Midland Painted Turtle (*Chrysemys picta marginata*).

3.1.3.11 American Badger Surveys

Careful investigation of suitable onsite badger denning habitat was undertaken on two spring days in 2016 (Table 3.17). Open, upland habitats, hedgerows and forest edges were thoroughly searched for the presence of burrows. Regular transects across large open habitats (*i.e*. agricultural lands) were employed to ensure comprehensive survey coverage. Wooded areas were examined within approximately 25 m of open habitats.

Table 3.17 Summary of American Badger Survey Visits Conducted in the Study Area

DATE	TIME	DURATION	OBSERVER(S)	WEATHER
April 20, 2016	14:00 – 19:30	5 hrs. 30 min.	Dylan White	4˚ C, sunny, clear and calm
April 26, 2016	12:45 – 16:00	3 hrs. 15 min.	Dylan White	6˚ C, overcast, calm

Badger den surveys were conducted prior to vegetation leaf-out to enhance visibility. Both surveys were completed during dry, calm conditions. One of the den surveys (April 20) was conducted from the late afternoon until just before sunset and the other (April 26) was undertaken from early to late afternoon.

When a mammal den was located, various den characteristics were measured and noted, and photographs and GPS information were recorded. As with all field investigations, incidental wildlife observations were noted during the badger den surveys.

Findings:
Seven mammalian denning areas were located during the 2016 badger den surveys. These burrow sites were considered to be in active use by: Woodchuck (*Marmota monax*) [five sites], Eastern Chipmunk (*Tamius striatus*) [one site), and Striped Skunk (*Mephitis mephitis*) [one site]. One 'denning area' is defined as a discrete occurrence or grouping of burrow holes. In the case of the Woodchuck denning areas, numerous burrows (upwards of 8) were located within a 10 m radius.

No American Badgers, or badger signs, were observed during any of the den surveys or incidentally at any point during the other field surveys. None of the dens exhibited characteristics of typical badger dens (throw mounds, distinct claw dig marks, tracks, remains of prey, scat, etc.) (Naughton, 2012; OABRT, 2010).

Two larger burrow openings (approaching 20 cm across) were detected during badger den surveys. These were determined to be Woodchuck burrows and both were within a cluster of active Woodchuck burrows.

During the den surveys, the presence of 10 mammal species was noted within the study area: Red Squirrel (*Tamiasciurus hudsonicus*), Gray Squirrel (*Sciurus carolinensis*), Eastern Chipmunk (*Tamias striatus*), Woodchuck (*Marmota monax*), Striped Skunk (*Mephitis mephitis*), Raccoon (*Procyon lotor*), Eastern White-tailed Deer (*Odocoileus virginianus*), Red Fox (*Vulpes vulpes*), Coyote (*Canis latrans*) and Virginia Opossum (*Didelphus virginiana*).

3.1.3.12 Incidental Wildlife

All non-target wildlife species observed during the various field surveys were duly recorded, along with their location and number of individuals. This included damselflies and dragonflies, butterflies, amphibians and reptiles, birds and mammals.

Findings:
Given the large number of survey visits made to the study area over the course of this study, all wildlife observations have been summarized, including incidental observations, in Appendix 2.8. For completeness, this master list also includes observations made during the Wideman Road EIS (D&A, 2008), the Scoped Regal Place EIS (D&A, 2013), as well as observations made by local residents (see Appendix 2.3).

3.2 Aquatic Resources

3.2.1 Background Review

To gain an understanding of aquatic resources within the study area, the following studies were examined:

- Laurel Creek Watershed Study (Grand River Conservation Authority, 1992),
- Final Subwatershed Management Plans #313 and #309 (Planning and Engineering Initiatives Ltd., 1996),
- Regional Municipality of Waterloo, Waterloo North Water Supply Class Environmental Assessment Hydrogeological and Natural Environment Report (Golder Associates, 2011),
- North Waterloo Scoped Subwatershed Study (Ecoplans, NHBC, & Stantec, 2013),
- Ministry of Natural Resources Files (Trout Unlimited, 1991 and Trent University, 1998)
- Results of previous investigations on Wideman Creek in C. Portt and Associates files.

A brief summary of relevant background data follows.

Background information regarding the aquatic resources in reaches of Laurel Creek immediately downstream from Erbsville Road was recently compiled for the North Waterloo Scoped Subwatershed Study (NWSSS) and additional data were collected for Laurel Creek during that study. Data collected during the NWSSS included electrofishing Erbsville Creek a short distance upstream from the confluence with Wideman Creek, as well as some distance downstream from that confluence.

3.2.1.1 Habitat Characterization

During the NWSSS, Laurel Creek was characterized from just upstream of Erbsville Creek downstream to the confluence with Beaver Creek, and Wideman Creek was characterized between Erbsville Road and its confluence with Laurel Creek.

Within the NWSSS Reach L1 of Laurel Creek extends from the confluence of Laurel Creek and Wideman Creek upstream to the confluence of Laurel Creek and Erbsville Creek (see Figure 3.4). A large beaver dam, constructed near the downstream end of this section between the 2008 and 2009 field observations, created a backwater effect through most of the reach. (This was still the condition during the field observations for this study.) The habitat instream was characterized as a mix of flats, pools and riffles with a mix of substrates ranging from coarse in the riffles (boulder, cobble, gravel and sand) to fine (slit, sand and clay) in the pools and flats. Scattered areas of groundwater seepage were observed along both banks. For Reach L2 Laurel Creek was characterized as a mix of flats, riffles and some small deep pools with a mix of substrates in the riffles (cobble, gravel, sand and silt) and in the flats and pools (sand, gravel, site with some cobble). One nick point was observed, associated with a woody debris jam, in reach L2 which was thought to be a potential barrier to upstream fish movement during low flows. Evidence of groundwater seepage was observed along both banks and groundwater upwelling was observed near the downstream end of this reach. The banks in both reaches L1 and L2 were well-vegetated with woody vegetation. The NWSSS described Wideman Creek as poorly defined with dense vegetation along the banks, flowing though riparian wetland communities and thicket swamp.

3.2.1.2 Fish Community

Laurel Creek was electrofished downstream from Erbsville Road by GRCA staff in April of 1990 (see Table 3.16 and Figure 3.4) and five fish species were captured including four brown trout (fork length range 26.0 – 33.1 cm; source OMNRF files). Adult brown trout were also captured further downstream, in the vicinity of the Laurel Creek Nature Centre, during those investigations.

Two brown trout (33 cm and 35 cm total length; source OMNRF files) and five other fish species were captured by electrofishing in Laurel Creek downstream from Erbsville Road in March of 1991 by Trout Unlimited (TU1, see Table 3.18 and Figure 3.4). One 25 cm (total length) brown trout was captured between Erbsville Road and Schnarr Road (TU2, see Table 3.16 and Figure 3.4) on the same date. The other fish species were not documented at TU2.

In the Laurel Creek Watershed Study, the fish community in Laurel Creek upstream of the Laurel Creek Reservoir was summarized as follows:

> "While past studies have observed brook and more recently, brown trout on Laurel Creek upstream of the reservoir, no trout were collected in this study. However the minnows species collected upstream of the reservoir were typical of those often found in coldwater streams. The fish community in Laurel Creek at Erbsville was primarily minnows such as rainbow darter [sic], common shiner and blacknose dace with a single largemouth bass recorded."

A field collection record in the OMNRF files documents electrofishing in Laurel Creek downstream from Erbsville Road in September of 1998 by a Trent University researcher that captured 9 fish species including one 25.5 cm brown trout.

Electrofishing was conducted at three locations (see Figure 3.4) on Wideman Creek in 1995 during the preparation of the Final Subwatershed Management Plan #313 and #309. Central Mudminnow, Common Shiner, Fathead Minnow and Creek Chub were captured at one location, immediately upstream from Erbsville Road. No fish were captured at a site further upstream or at a site further downstream near the confluence with Laurel Creek. That study stated that although the results of the fish collections indicated that Wideman Creek was a warmwater baitfish stream, the water quality and water temperature warranted classifying it as a coldwater baitfish stream. The study stated "While the water is relatively cool, physical constraints such as size and a poor substrate limit its potential for salmonid fish species."

Two reaches of Laurel Creek were electrofished in 2009 as part of the data collection for the NWSSS. That study describes Laurel Creek as having "a diverse fish community makeup of tolerant and moderately tolerant fish species, with the exception of Rainbow Darter and Blackchin Shiner, two species that are generally intolerant to changes in the watercourse." The NWSSS further states "Fish community sampling results indicate that both Beaver and Laurel Creeks support diverse coolwater and warmwater forage/baitfish communities." That study, however, also notes that "based on results from previous fish sampling and spawning surveys completed by others, the MNR considers Laurel Creek to be a coldwater stream containing a naturally reproducing population of Brown Trout and possibly Brook Trout (MNR pers. comm. March 21, 2013)."

C. Portt and Associates electrofished a reach of Wideman Creek in 2006. In 2007 a second reach as well as a reach of the tributary to Wideman Creek that flows along Erbsville Road and the perimeter of the pond located on-site (see Figure 3.4). A total of eight fish species were captured in Wideman Creek. Six fish species were captured in the tributary that flows along Wideman Road and 4 species were captured by electrofishing the perimeter of the pond, including Largemouth Bass and Black Crappie, which are typically lake species and were almost certainly introduced into the pond.

Table 3.18 below summarizes the number of each fish species captured by electrofishing in Laurel Creek in 2009 for the NWSSS, in Wideman Creek in 1995 for the Final Subwatershed Management Plans #313 and #309 study, and studies undertaken by C. Portt and Associates in 2006 and 2007. No fish were captured at PEIL1 and PEIL3. Sampling locations are shown in Figure 3.4.

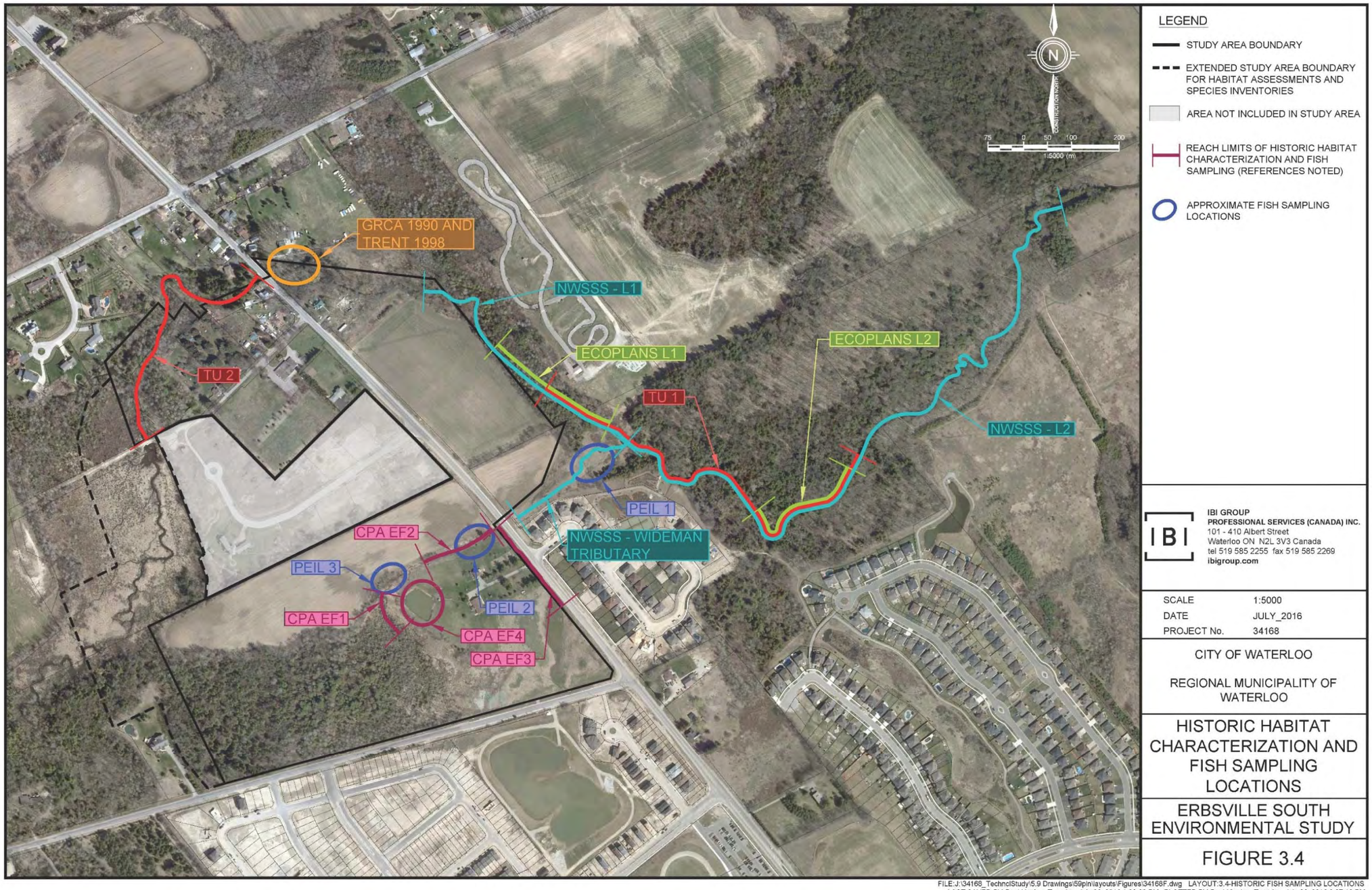

Figure 3-4 Historic Fish Sampling Locations

Table 3.18 Summary of Electrofishing Results from Previous Studies

	Laurel Creek						Wideman Creek						
	NWSSS Ecoplans L1, 2009	NWSSS Ecoplans L2, 2009	GRCA April 26, 1990	Trout Unlimited (TU1) March 21, 1991	Trout Unlimited2 (TU2) March 21, 1991	Trent University Sept. 20, 1998	SWS 313/309 PEIL1, July 3, 1995	SWS 313/309 PEIL2, July 3, 1995	SWS 313/309 PEIL3, July 3, 1995	CPA EF1 Nov. 27, 2006	CPA EF2 May 25, 2007	CPA EF3 May 25, 2007	CPA EF4 Nov. 14, 2007
Station length (m)	50	50	na	na	na	na	na	na	na	50	50	130	135
Electroseconds	880	868	868	1700	900	460	na	na	na	396	214	258	821
Black Crappie													17
Blacknose Dace	4	25		P*		7							
Bluntnose Minnow		2	50			23							
Brassy Minnow						9							
Brook Stickleback		6								1	1	1	
Brown Trout			4	2	1	1							
Central Mudminnow								1		1	1		
Central Stoneroller	1	2											
Common Shiner	5	10						9					
Creek Chub	58	2118	100	P*		44		4			11	7	
Fathead Minnow	53	827				2		1		3	88	57	
Iowa Darter				P*		250				26	11	5	3
Johnny Darter	90	86	10										
Largemouth Bass													12
Longnose Dace	3	4											
Northern Redbelly Dace	6	53								3	5	4	
Pumpkinseed													3
Rainbow Darter	100	70		P*		5							
Rosyface Shiner		1											
White Sucker	8	37	>100	P*		1					1		

* P – Indicates the species was present, but not enumerated.

3.2.1.3 Trout Spawning Surveys

The Laurel Creek Watershed Study indicated that during a late fall spawning survey upstream from Laurel Creek Reservoir, “no clear spawning redds were observed although some potential redds were spotted.”

Brown Trout spawning was reported by the Ministry of Natural Resources in the lower reaches of Laurel Creek from 1984 to 1994 as cited in the NWSSS. No trout redds were observed in the reach of Laurel Creek upstream from the reservoir during a spawning survey conducted by Ecological Services for Planning in support of the Laurel Creek Watershed Study (GRCA, 1992). Trout spawning surveys were conducted through reaches 1 and 2 of Laurel Creek in 2007, 2008, 2009 and 2010 as part of the NWSSS. No spawning or confirmed redds were observed during any of these years. The 2008 results conflict with the reported observation of 13 trout redds in

Laurel Creek between Erbsville Road and the Laurel Creek reservoir in November, 2008, reported by Golder Associates (2011).

3.2.1.4 Benthic Invertebrates

The Laurel Creek Watershed Study reported a very impoverished benthic invertebrate community in Laurel Creek relative to other coldwater streams, with only ten taxa identified in a sample taken at Erbsville Road.

Benthic invertebrate sampling was conducted at two locations annually in Laurel Creek from 2008 through 2011 as part of the NWSSS. The site that was furthest upstream was relocated in 2011 as its previous location was flooded by a beaver dam downstream. At the sampling sites upstream from the confluence with Wideman Creek the biotic indices indicate “poor” to “fair” water quality, depending upon the year. At the location downstream from the confluence with Wideman Creek the biotic indices indicated water quality was “fair” to “good” depending upon the year. The results were summarized as follows:

> “Overall, the benthic community is reflective of the habitat and water quality characteristics found at each of the stations. The stations located closer to the headwaters of Laurel Creek (S1 and S6) and Beaver Creek (S4 and S5) generally have benthic communities with a greater presence of aquatic worms and midges, which are typically more tolerant of finer substrates and higher organic inputs which characterize these areas.”

Benthic macroinvertebrates and supporting environmental data were collected immediately upstream from the Erbsville Road culvert and roadside ditch by C. Portt and Associates staff on June 15, 2007, following the Ontario Benthos Biomonitoring Network (OBBN) protocol (Jones et al, 2005). A total of 43 taxa were identified, with the number of taxa per sample ranging from 23 to 27. Diptera were dominant, which is consistent with the low gradient and fine-textured sediment in the watercourse. The high taxa richness and diversity were considered to be indicative of good water quality. The absence of Ephemeroptera (mayflies) and Plecoptera (stoneflies) and low numbers of Trichoptera (caddisflies) were thought to reflect the physical habitat, not poor water quality.

3.2.1.5 Water Temperature

Previous water temperature monitoring has, to the best of our knowledge, been limited to spot measurements. The Laurel Creek Watershed Study characterizes Laurel Creek within the study area as a coldwater stream. The Subwatershed # 309 Plan also characterizes Wideman Creek “as a coldwater stream because it is perennial and fed by groundwater and contributes baseflows to Laurel Creek which has been classified as a coldwater fishery.” The NWSSS reported that “the majority of species recorded are ‘coolwater’ (11 of 16) with only four being warmwater species: Fathead Minnow, Bluntnose Minnow, Rosyface Shiner and Northern Hog Sucker. GRCA recorded two warmwater species: Fathead Minnow and Brown Bullhead. Some of these may be more closely associated with the Laurel Creek Reservoir, using the creek at various times. The NWSSS study indicates that the portion of Laurel Creek between Erbsville Road and the reservoir “is considered by MNR to be ‘a trout stream containing a naturally reproducing population of Brown Trout and possibly Brook Trout, based on: earlier inventories (1984 to 1994 Brown Trout spawning surveys); the absence of significant changes to the watershed upstream of the PSA; and the observations of Brown Trout spawning in the PSA as recently as 2008 (Art Timmerman, MNR Guelph District; personal communication March 11, 2013)”. The GRCA currently characterizes both Laurel Creek and Wideman Creek as coldwater habitat.

3.2.2 Field Investigations

3.2.2.1 Habitat Characterization

Stream reaches within which habitat conditions are similar were initially identified based on field observations on November 10, 14 and 19, 2013, supplemented by observations during field investigation in 2014. The upstream portions of Wideman Creek were examined on January 20, 2015, when the most of the ground was frozen, except immediately adjacent to the creek, facilitating access. Key features and representative areas were photographed and the locations of features and photographs were determined using a Garmin model CS76CSx gps. Photographs are found in Appendix 3.1.

Findings:
Reaches with similar habitat characteristics are shown on Figure 3.5 and are described below. All of the reaches exhibited perennial flow and no complete barriers to upstream fish migration were observed, although the beaver dam between reaches L2 and L3 would be an impediment to upstream movement under normal flow conditions. This beaver dam appeared to be abandoned and was deteriorating, although there was still a pond behind it, in the autumn of 2014.

Laurel Creek
Reach L1 has pool/riffle/run channel form with substrate ranging from cobble and gravel in the riffles to sand and silt in the pools and slower runs. Woody debris is abundant. The riparian vegetation is dominated by White Cedar (*Thuja occidentalis*) and woody shrubs. Electrofishing site F-L1 was in this reach.
Reach L2 is immediately downstream from the beaver dam on Laurel Creek. There are multiple narrow channels here as a result of flow originating at multiple points along the beaver dam. The channels had pool/riffle/run channel form. Substrate was primarily clay, with some sand and gravel. The riparian vegetation was dominated by grasses and shrubs.

Reach L3 is the ponded section of the creek behind the beaver dam. Velocity was low and substrates were silts. Riparian vegetation was dominated by deciduous hardwoods. There was evidence of groundwater seepage along the north valley wall. The south valley wall was not examined as permission was not granted to access the adjacent property.

Reach L4 extends from the upstream end of the beaver pond to Erbsville Road. This reach had a pool/riffle/run configuration with cobble and gravel substrates dominant. Erbsville Creek enters Laurel Creek within this reach. There is an abandoned road or farm lane crossing within this reach where the creek has eroded around the culverts and the remnants of a bypass channel and pond. Electrofishing site F-L2 was in this reach.
Reach L5 extends from Erbsville Road upstream to the City of Waterloo property boundary. This reach was not examined because permission to access was not granted.

Reach L6 extends from the downstream limit of the City of Waterloo property upstream to Schnarr Street. This reach is dominated by deep pools and runs with occasional riffles. Substrate is primarily silt and sand and the riparian vegetation is primarily shrubs. Groundwater discharge was observed on the east bank a short distance downstream from Schnarr Street. Electrofishing site F-L3 was in this reach.

Reach L7 extends from Schnarr Street upstream to the study area boundary. There is what appears to have formerly been a pond immediately upstream from the Schnarr street culvert. That culvert may be a barrier to upstream fish migration at high flows. The remainder of the reach is relatively low gradient with extensive flooding during high-water periods. The substrate is primarily silt which is of sufficient depth in the pools to make wading nearly impossible. The riparian vegetation is a mixture of wetland shrubs and herbaceous vegetation. There is evidence of past beaver activity (abandoned dams and lodges), and numerous side-channels that are probably a consequence of former beaver activity.

Wideman Creek
Reach W1 extends from the confluence with Laurel Creek upstream to Erbsville Road. The narrow channel, which is braided in places, has a pool/riffle/run form and flows over hard till for most of its length. The riparian vegetation is primarily herbaceous with some shrubs also present. The Erbsville Road culvert is not a barrier to upstream fish migration. Electrofishing reach F-W1 is within this reach.

Reach W2 extends from Erbsville Road upstream to a wetland and is bordered by an agricultural field to the north and a residential lot to the south. There are naturally vegetated buffers between the agricultural field on the north side of the creek and the residential lawn on the south side of the creek that vary in width from approximately three to ten metres. The vegetation in this buffer ranges from cattails to shrubs and small trees. This reach has probably been straightened (ditched) at some time based on how straight its alignment is, but it has begun to meander again. The substrate is predominately fine-textured through this reach with a run/pool/riffle configuration.

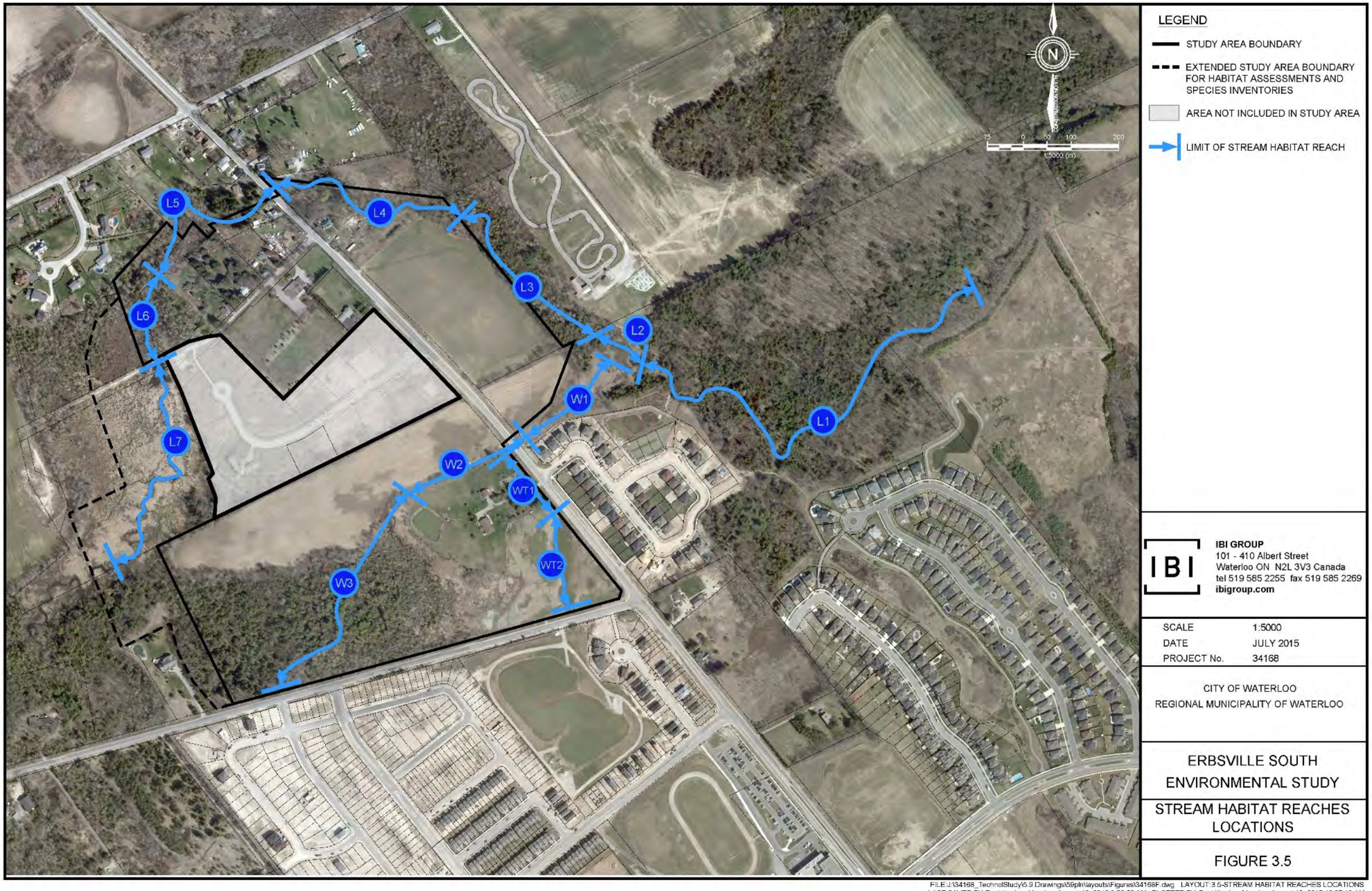

Figure 3-5 Stream Habitat Reaches Locations

Reach W3 extends upstream through a wetland to the source of the creek near Wideman Road. The channel is shallow and dominated by woody debris through the wetland. Three areas of groundwater seepage, where there was no snow and low herbaceous plants were still unfrozen, were observed along the channel on January 20, 2015. Other smaller, less evident areas of groundwater discharge are probably present based on the variation in the degree of freezing adjacent to the creek.

Wideman Creek Tributary
This tributary to Wideman Creek originates from a SWM pond south of Wideman Road. Reach WT-1 extends from the confluence of this tributary with Wideman Creek upstream along the roadside ditch on the west side of Erbsville Road. The substrate in this reach is dominated by gravel that probably originates from the road. There is some watercress present, indicating groundwater discharge, but this reach was nearly all frozen on January 20, 2015, suggesting that the groundwater discharge is limited.

Reach WT-2 extends from the Erbsville Road ditch upstream to Wideman Road. The narrow channel is dominated by silt substrate and the riparian vegetation is primarily herbaceous. Electrofishing location F-W2 is within this reach.

3.2.2.2 Fish Community and Habitat Assessment

Reconnaissance-level electrofishing was conducted at a location on the Tributary to Wideman Creek that originates from a stormwater pond south of Wideman Road (EF-W2) on May 29, 2014.Fish habitat and community assessments were conducted following the Ontario Stream Assessment (OSAP) protocol (Stanfield, 2013) from August 18 – 22, 2014, at four sites on Laurel Creek and one site on Wideman Creek (Figure 3.6). It was not possible to conduct fish community sampling upstream from Regal Place on Laurel Creek due to the depth and extremely soft substrates. The Site ID, Site Features, Channel Morphology (Point-Transect Sampling for Channel Structure, Substrate and Bank Conditions - S4:M1), and Fish Community Sampling modules were completed at each site. Fish were sampled by a single pass through each site, without blocking nets, using a Halltech backpack electrofisher. All fish were identified in the field and released. The number captured, bulk weight and size range were determined for non-game species. Individual weights and lengths were determined for game species.

Findings:
The length, mean width, mean depth, and effort (number of electroseconds) at each fish sampling station are presented, together with the catches, in Table 3.19. Iowa Darter was the most abundant species at all three stations in Laurel Creek and at the station on Wideman Creek. Fathead Minnow was the most abundant species on the Wideman Creek tributary that originates at the stormwater management facility south of Wideman Road. Iowa Darter, Brassy Minnow, and Central Mudminnow are considered coolwater species that, in southern Ontario, are typically found in watercourses receiving groundwater discharge. None of the fish species captured are considered to be at-risk in Ontario.

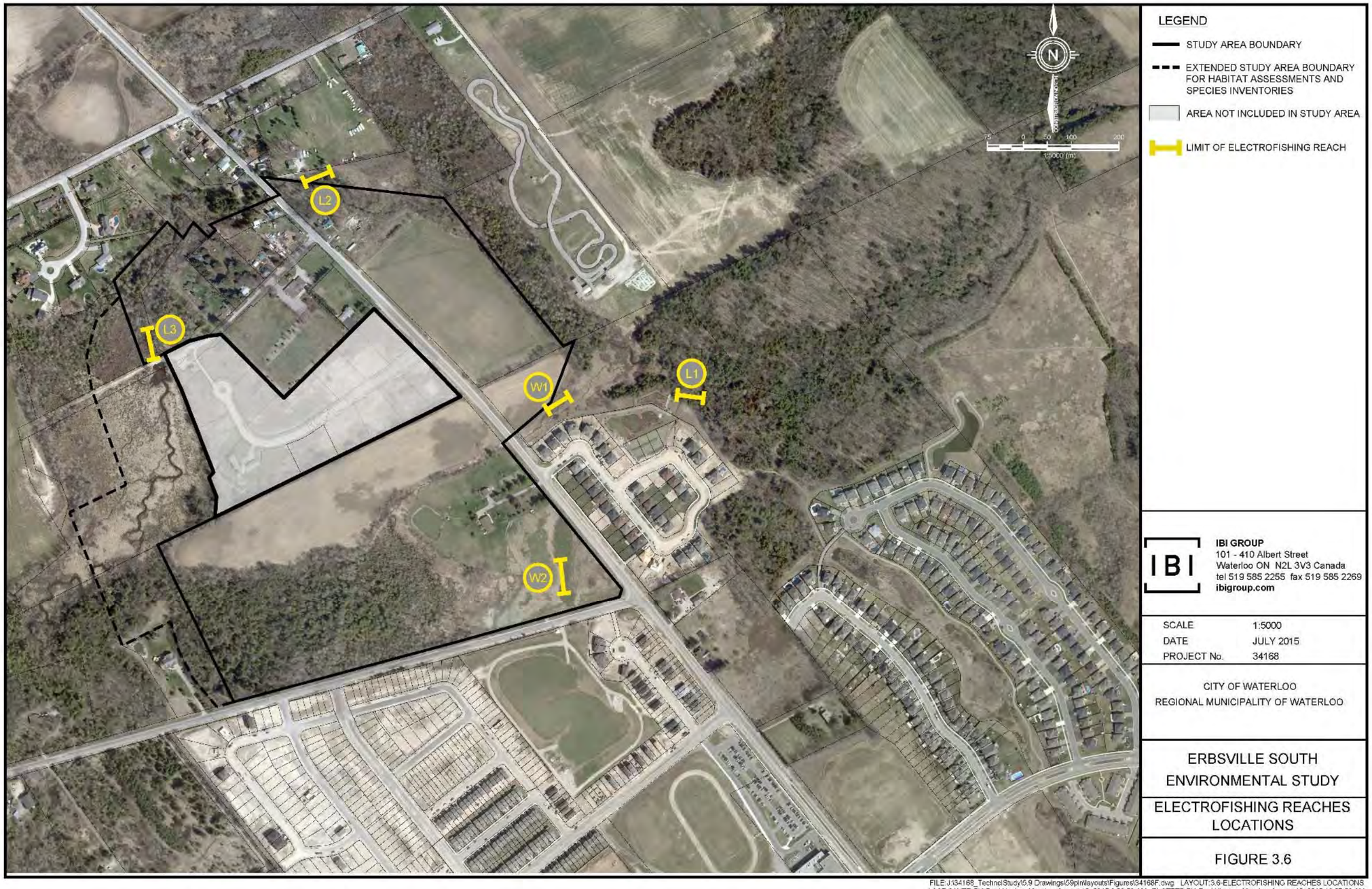

Figure 3-6 Electrofishing Reaches Locations

Table 3.19 Electrofishing Results in 2014

	Laurel Creek			Wideman Creek	
Species	**F-L1**	**F-L2**	**F-L3**	**F-W1**	**F-W2**
date sampled	August 18	August 18	August 18	August 18	May 30
station length (m)	40	42.3	42.6	40.3	~60
mean width (m)	5.2	4.2	4.4	0.9	0.6
mean depth (mm)	128	184	211	105	50
electroseconds	3410	2752	2047	812	511
Blacknose Dace	2	39	15	1	
Bluntnose Minnow	14	17	21	2	
Brassy Minnow		13	84		
Brook Stickleback			3	2	8
Central Mudminnow			4		
Common Shiner			4		
Creek Chub	2	56	37	2	
Fathead Minnow	7		8	1	40
Iowa Darter	332	417	225	30	12
Largemouth Bass	1				
Northern Redbelly Dace		6	26		1
Pumpkinseed	1				
White Sucker	1	4	33	2	1

3.2.2.3 Spawning Surveys

Trout spawning surveys were conducted on November 10, 14 and 19, 2013, and on October 27, 2014 (Figure 3.7). The creeks were carefully examined looking for evidence of the substrate being disturbed in a manner consistent with spawning activity by Brown Trout or Brook Trout having occurred.

Findings:

No evidence of salmonid spawning was observed in the spawning surveys conducted in 2013 and 2014. Based on the substrate, channel form and stream size, Reaches L1 and L4 contain potential Brown Trout spawning habitat; portions of reaches L2 and L3 might also if the beaver dam was not present. No coarse substrate suitable for Brown Trout spawning was observed in Reaches L6 or L7. No coarse substrate suitable for Brown Trout spawning was observed in Wideman Creek, which may be too narrow and shallow to support that species.

Figure 3-7 Salmonid Spawning Survey Locations

3.2.2.4 Benthic invertebrates

Benthic invertebrates were sampled at five locations on Laurel Creek and one location on Wideman Creek (Figure 3.8) following the Ontario Benthic Biomonitoring Network (OBBN) protocol (Jones et al, 2007). At each site three kick and sweep samples were collected – two in riffles and one in a pool or run – using a 500 µ mesh dip net. Each sample was preserved in 7% buffered Formalin for subsequent sorting and identification.

In the laboratory, each benthic sample was placed in a 500 µm brass sieve and rinsed with water for several minutes to remove the remaining preservative and to eliminate fine particulate matter. Large rocks, twigs, and debris were thoroughly rinsed and removed. The remaining dewatered sample was weighed to the nearest gram using a Sartorius Model BL6 electronic balance and transferred to a white plastic tray. A small amount of water was added to create a slurry. The sample was lightly mixed and small sub-samples were removed using a teaspoon and placed in a clear 9 mm square polycarbonate counting dish. Sorting was done with the aid of a dissecting microscope using 6X magnification. Benthos were removed, rinsed, tallied with a hand counter and placed in plastic vials containing 70% ethanol fitted with screw caps for subsequent identification. Sub-sampling continued until 100 organisms were recovered. The sub-sample containing the 100th organism was picked until no more invertebrates were found. All sorted material was transferred to the 500 µm sieve and weighed to the nearest gram. The proportion of the sample that was sorted was calculated by dividing the weight of the sorted material by the weight of the whole sample.

The specimens were identified by William Morton to the lowest practical level, to species where possible. The total number of taxa present in each sub-sample and in the three sub-samples combined was determined for each location and sampling date. The number of EPT taxa, which is the sum of the number of taxa of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), present in each sub-sample and in the three sub-samples combined was determined for each location and sampling date. Shannon-Weaver diversity was calculated for three sub-samples combined for each location as:

$$H=-\Sigma p_i \ln p_i$$

where p_i is the proportion of the sample comprised of species i.

The Hilsenhoff Biotic Index (HBI) was calculated for the three sub-samples combined for each location and sampling date as:

$$HBI=\Sigma n_i T_i / \Sigma n_i$$ where

Σn_i is the number of individuals of species i, and

T_i is the tolerance value of species i from the literature.

The HBI tolerance values are directly or inferred from Hilsenhoff (1982, 1987) and Bode (1988a). The water quality implied by these indices is from Shannon and Weaver (1949; Shannon's diversity), Hilsenhoff (1987; HBI) and Bode (1988b, number of EPT taxa).

Findings:
The numbers of individuals of each species present in each of the benthic invertebrate samples are provided in Appendix 3.2. The results are summarized in Table 3.20. The numbers of species identified per site ranged from 26 to 37, which is generally indicative of good water quality. Similarly, the numbers of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa are consistent with slightly to moderately impacted water quality except at TB-L5 where none were present in the sample. Station TB-L5 is located in a low-gradient reach of Laurel Creek where there is no coarse substrate present and the absence of EPT species and lower taxa richness is consistent with this habitat. The Hilsenhoff Biotic Index (HBI) is an indicator of the level of organic pollution and indicated fair to fairly poor water quality at all locations while Shannon-Weiner diversity indicated moderately polluted conditions at all locations.

Figure 3-8 Temperature and Benthic Monitoring Locations

Table 3.20 Benthic Survey Results

	Sampling Location					
	TB-L1	**TB-L2**	**TB-L3**	**TB-L4**	**TB-L5**	**TB-W1**
date sampled	14.06.30	14.06.30	14.06.30	14.07.04	14.06.30	14.06.30
Number of organisms	317	308	308	305	304	311
Taxa richness	37	27	36	32	26	34
Water quality implied	non-impacted	non-impacted	non-impacted	non-impacted	moderately impacted	non-impacted
Number of EPT taxa	5	3	6	4	0	3
Water quality implied	moderately impacted	moderately impacted	slightly impacted	moderately impacted	severely impacted	moderately impacted
HBI	6.7	6.0	6.9	6.3	7.2	6.4
Water quality implied	fairly poor	fair	fairly poor	fair	fairly poor	fair
Shannon-Weiner diversity	2.3	2.0	2.2	2.2	2.0	2.1
Water quality implied	moderately polluted	moderately polluted	moderately polluted	moderately polluted	moderately polluted	moderately polluted

3.2.2.5 Water Temperature

Temperature loggers (Watertemp Pro V2, Onset Corporation) were installed at one location in Wideman Creek (TB-W1, see Figure 3.8) and at five locations in Laurel Creek on May 22, 2014. Two additional temperature loggers were installed, one in the tributary to Wideman Creek that originates from a SWM pond south of Wideman Road (T-W3) and one in Wideman Creek just upstream from the confluence with that tributary on June 8, 2014 (T-W2). Temperature was logged at 15 minute intervals, on the quarter hour. Data were retrieved periodically, with the last retrievals occurring late October and early November, 2014.

The maximum daily water temperature at each location was plotted versus the maximum daily air temperature at the Kitchener-Waterloo weather station, retrieved from the Environment Canada website (StationID=48569) for the dates between June 16 and August 30 when both air and water temperatures were available and maximum daily air temperature was 24°C or higher. These plots were compared to the nomogram in Chu et al (2009) to determine the thermal classification of the watercourses.

Findings:
The water temperatures at the five monitoring locations in Laurel Creek from May 23 through October 26, 2014, are presented in Figure 3-9. Water temperatures were very similar at four of the stations but were considerably higher on numerous occasions at Station TB-L2. Station TB-L2 was located in one of several channels immediately downstream from a beaver dam. Temperatures at this location converged with those at the other sites after significant rainfall events, based on Environment Canada data for the Kitchener/Waterloo weather station. This and the fact that both the daily maxima and daily minima were often higher and lower, respectively, than at the other locations suggest that this channel ceased to flow during low flow periods and, consequently the temperature of standing water or air temperatures were being recorded during periods when temperatures diverged. If the data from TB-L2 are disregarded, the water temperatures in Laurel Creek never reached 24°C at TB-L5 or TB-L1, exceeded 24°C on one day at TB-L4 (June 29, maximum = 24.4), and exceeded 24°C on two days (June 27 and 29; maxima = 24.03 and 24.3 respectively) at TB-L3.

The water temperatures at the two monitoring locations in Wideman Creek June 9 through October 26 and at one location on the Wideman Creek tributary from June 9 through October 26, 2014, are presented in Figure 3-10. Water temperature at TB-W1 exceeded 24°C once, on June 28 (maximum = 24.1) and were quite similar to the water temperatures in Laurel Creek. Wideman Creek was considerably colder upstream at T-W2, where the maximum temperature was 19.9°C and daily maxima were usually less than 18°C. Water temperatures in the

tributary to Wideman Creek that originates in the SWM pond south of Wideman Road were consistently higher than at either of the stations in Wideman Creek.

The relationship between maximum daily water temperature and maximum daily air temperature is similar at four locations on Laurel Creek (see Figure 3-11). Comparison of these plots to the nomogram derived from Ontario stream data and presented in Chu et al (2009) indicates that Laurel Creek should be characterized as a cool warmwater, or possibly a coolwater, stream. Plots of water temperature and maximum daily air temperature for two of the sites on Wideman Creek and one site on the tributary to Wideman Creek are presented in Figure 3-12. Comparison with the nomogram indicates that Wideman Creek at TB-W1 is similar to Laurel Creek and is cool-warmwater, or possibly a coolwater habitat. At the temperature monitoring station upstream from Erbsville Road and the tributary, comparison with the nomogram indicates that Wideman Creek is cold-coolwater or coolwater habitat. The tributary to Wideman Creek is either cool-warmwater or warmwater habitat, based on comparison to the Chu (2009) nomogram.

3.2.3 Discussion

The results of the fish and fish habitat investigations undertaken during this study are generally consistent with those of previous studies. The physical habitat characterizations do not differ substantively from those previously documented. The water quality values implied by the benthic invertebrate community in Laurel Creek are consistent with those reported in the NWSSS, and indicate considerably better habitat conditions in the vicinity of Erbsville Road than were reported in the Laurel Creek Watershed Study when only ten benthic invertebrate taxa were present there. The most notable difference among the recent studies is the species of darter present. Iowa Darter was abundant, and the only darter species present, in the samples collected in this study (Table 3.19) and in samples collected from Wideman Creek by C. Portt and Associates in 2006 and 2007 (Table 3.18). The NWSSS reported the capture of large numbers of Rainbow Darter and Johnny Darter at two Laurel Creek sites, but no Iowa Darters. Otherwise, the reported fish communities were similar, with several cyprinid species present and no coldwater species (Brook Trout or Brown Trout or Sculpin) captured by any of the investigators. None of the fish species reported from the Erbsville South study area are considered to be at risk in Ontario.

The temperature data collected during this study indicate that Laurel Creek and the lower portion of Wideman Creek are coolwater or cool-warmwater streams, which is consistent with the fish community. Based on the temperature data, Wideman Creek upstream from the confluence with the tributary that originates from the SWM pond located south of Wideman Road is cold-coolwater or coolwater habitat which is also consistent with the fish community that is present. The tributary originating from the SWM pond is warmer and probably contributes to the warming of Wideman Creek between temperature monitoring locations T-W2 and TB-W1 (Figure 3.10) but this effect cannot be quantified using the existing data.

The absence of coldwater species (trout or sculpin) in recent fish collections from Laurel Creek, together with the temperature data collected during this study, suggest that Laurel Creek, and possibly Wideman Creek, might more appropriately be considered coolwater than a coldwater streams. The absence of salmonids in recent fish collections is in apparent conflict with the report of trout redds in Laurel Creek between Erbsville Road and the reservoir (Golder Associates, 2009). Regardless of how the watercourses are characterized, groundwater discharge is considered an important factor for maintaining the existing thermal regime which is suitable for coolwater fish species such as Iowa Darter.

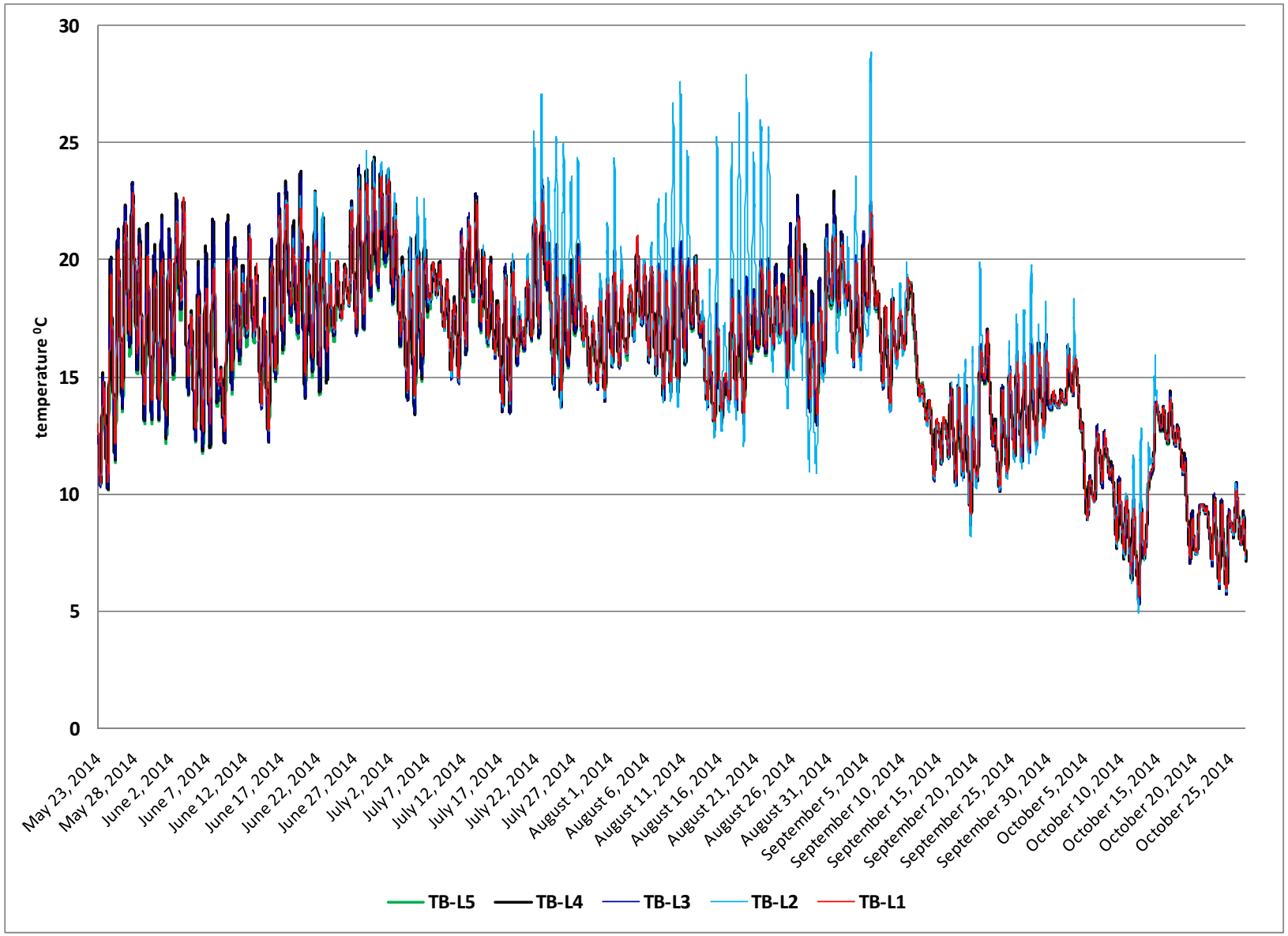

Figure 3-9 Water Temperature From May 23 through October 26, 2014; At Five Locations in Laurel Creek

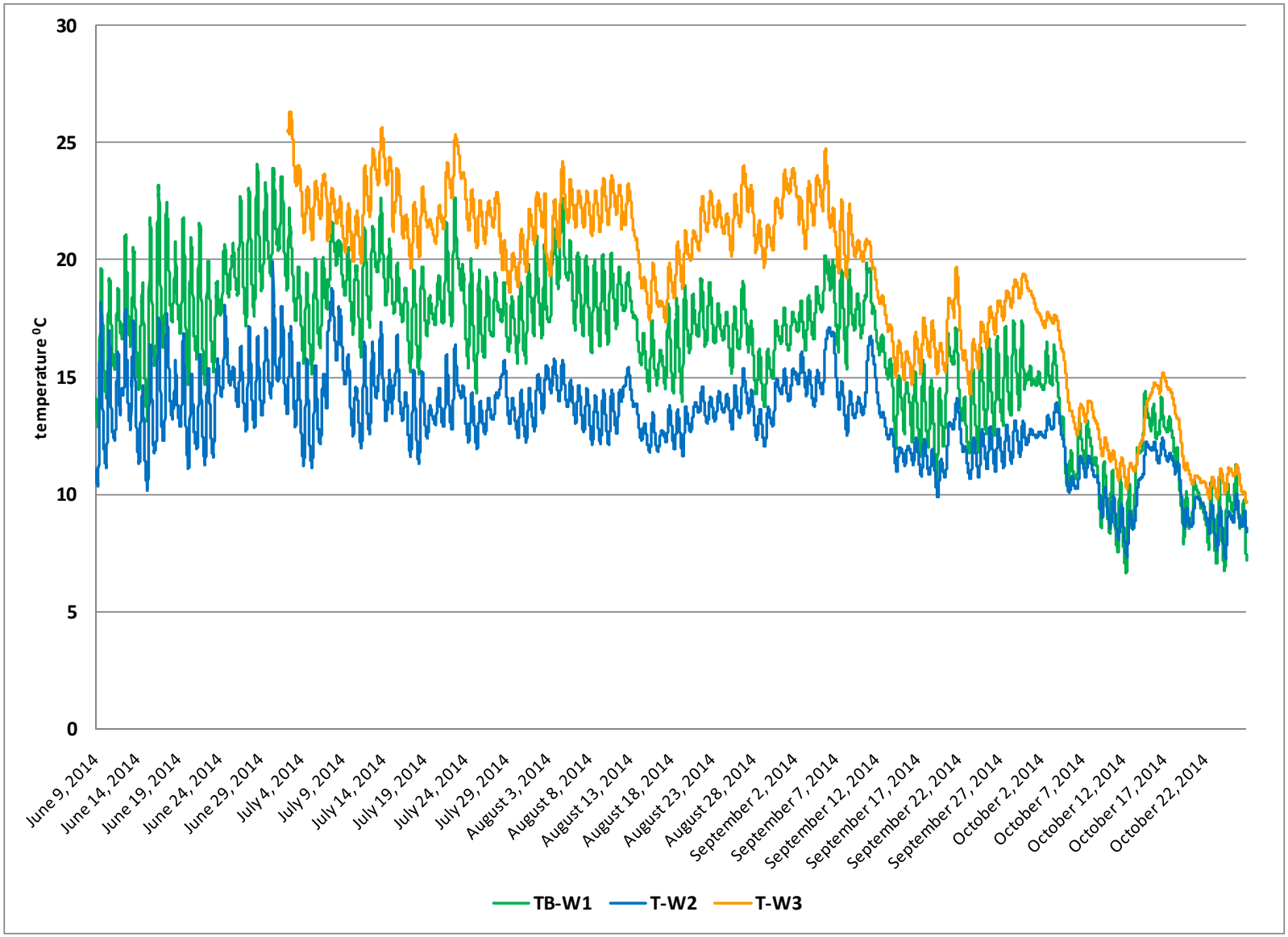

Figure 3-10 Water Temperature From June 9 Through October 26, 2014 at Two Locations in Wideman Creek and at One Location in the Tributary to Wideman Creek From July 2 Through October 26, 2014

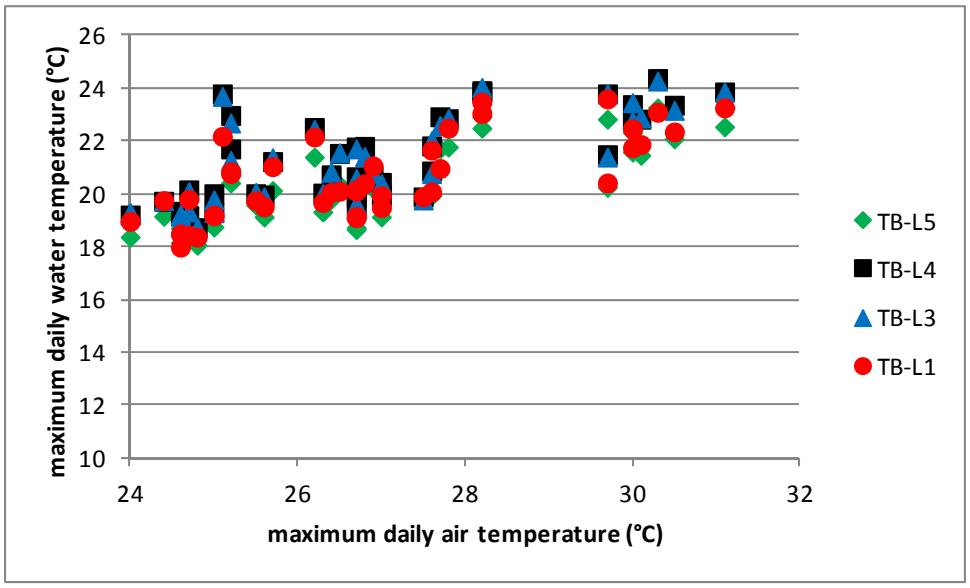

Figure 3-11 Maximum Daily Water Temperature Versus Maximum Daily Air Temperature For Four Locations on Laurel Creek on Days That Maximum Air Temperature Exceeded 24°C From June 16 Through August 31, 2014

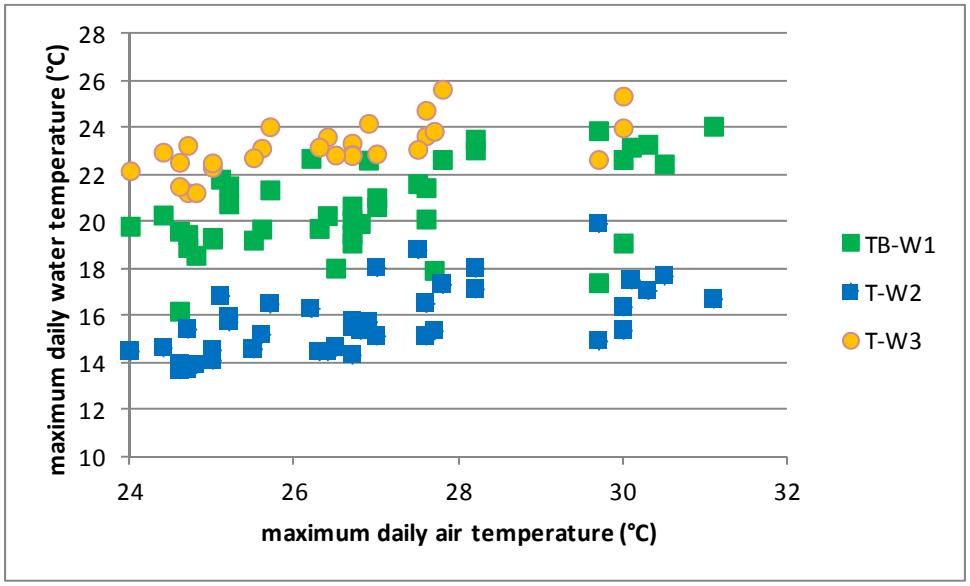

Figure 3-12 Maximum Daily Water Temperature Versus Maximum Daily Air Temperature for Two Locations on Wideman Creek on Days That Maximum Air Temperature Exceeded 24°C From June 16 Through August 31, 2014 and on the Wideman Creek Tributary from July 2 Through August 31, 2014

3.3 Fluvial Geomorphology

3.3.1 Introduction

The overall objective of the fluvial geomorphic assessment was to ascertain the current state of the fluvial system on a local, reach and watershed scale. The current state is benchmarked against its “natural” or undisturbed state, and divergences are noted. Geomorphic assessments, in combination with an erosion

threshold analysis, also aid in determining how resilient a certain reach will be to a future disturbance, such as an altered hydrologic regime as a result of urban development.

Erosion threshold analysis (often referred to as a tractive force analysis) involves the quantitative analysis of physical parameters measured in the watercourse to determine the maximum permissible shear stress, velocity and corresponding discharge (referred to as a critical discharge) which, if exceeded, will result in the initiation of channel degradation. This channel degradation can have implications on: proximal infrastructure, water quality and aquatic species and habitat.

3.3.2 Site Location and General Characteristics

3.3.2.1 Surficial Geology

The Ontario Geological Survey 1:50 000 base maps (Ontario Geological Survey, 2010) indicate that the surficial geology is part of the Maryhill Till formation which is a clayey till with poor drainage and can contain layers of weathered pebbles (Presant & Wicklund, 1971). A more detailed description of the geology within the study area can be found in Section 5.1.3.

3.3.2.2 Wideman Creek

Wideman Creek originates in a wetland west of Erbsville Road and flows east, crossing Erbsville Road and eventually draining into Laurel Creek. The reach appears to have been channelized to accommodate the agriculture adjacent to the watercourse, however historical aerial photographs dating back to before the agricultural development were not available to confirm this. The study reach is bound on the upstream by the headwater wetland and downstream by the Erbsville Road culvert.

3.3.2.3 Wideman Creek Tributary

This tributary drains an urban development to the south of Wideman Road through a SWM pond approximately 1.7 hectares in area. The SWM pond drains under Wideman Road and runs through a single thread channel that enters a small wetland adjacent to Erbsville Road. It then follows parallel to Erbsville Road where it outlets to Wideman Creek on the upstream side of the Erbsville Road culvert.

Figure 3-13 Site Map Indicating Study Reaches

3.3.2.4 Laurel Creek

The Wideman Creek Tributary and Wideman Creek become confluent on the west side of Erbsville Road and from that point Wideman Creek flows into Laurel Creek.

Laurel Creek from Erbsville Road downstream to the reservoir has been recently studied by Parish Geomorphic as part of the North Waterloo Scoped Subwatershed Study - Fluvial Geomorphology Assessment (dated April 12, 2011). Their assessment of four reaches on Laurel Creek (LC-1 to LC-4) is summarized below.

Reach LC-1 (Erbsville Road downstream for approximately 850 metres to an unnamed 'watercourse') is characterized by a formal channel approximately 5 metres in width with a range of depths between 0.35 to 0.60m. The bed is characterized by fine sands and silts with some coarser materials on the riffles, and is considered to be overloose (not well packed), indicating recent sedimentation. The banks are very fine sand and silt with narrow vegetated buffers in some areas. Large woody debris is present throughout the reach.

Reach LC-2 is approximately 200 metres from the end of LC-1 to a tributary junction (unnamed) adjacent to the Laurelwood subdivision. Channel widths range from 3.2 to 6.1m and depths range between 0.25m and 0.60m. The planform of the creek in this section is classified as meandering and the riparian buffer is larger (mixed deciduous forest). There is also considerable woody debris in the channel.

Reach LC-3 extends from the end of LC-2 to the junction with Beaver Creek (a distance of approximately 660m). Channel widths are wider (4.5-7.1m) and depths are somewhat greater (0.40-0.65m). Substrate and bank material is consistent with upstream reaches; there is major woody debris and there is one pedestrian crossing.

The final reach, (LC-4), is approximately 500m long. Widths range between 6.4-7.0m and depths range from 0.69-0.90m. Substrate is getting coarser and bank materials are consistent with upstream reaches. Very little woody debris is present in the reach. This reach appears to be affected by the levels of the Laurel Reservoir as there is turbid water and minimal observed flow.

Reference should be made to the full study for more information. In all, our assessment of the reaches is consistent with those of Parish Geomorphic.

The following section outlines the methods used to evaluate the two reaches shown in Figure 3.13. The results for each reach follows in Section 3.3.4.

3.3.3 Methods

3.3.3.1 Geomorphic Assessments

A major shortcoming of the standardized rapid assessments described below is that they are often only done for local sections along the reach, which can bias the characterization on the overall reach scale. For example, there may be one location of an actively eroding bend (which is a natural process for many types of channels), and based on the standardized indicators the reach would score low, even though the majority of the reach is stable and healthy. To account for this shortcoming, prior to starting the geomorphic assessments, each reach shown in Figure 3.13 was walked in its entirety and geomorphic stability/instability indicators were observed and noted on customized field sheets developed by JTBES. Each reach was then walked a second time, and the standardized rapid assessment forms were filled out with a combination of observations on the second pass and the indicators noted on the first pass.

3.3.3.1.1 Rapid Geomorphic Assessment (RGA)

An RGA was conducted for each reach following the Ministry of Environment (2003) standards. The RGA assesses channel stability in four components; aggradation, degradation, channel widening and planometric form adjustment. Each component has a number of instability indicators included on a standardized field form. These channel instabilities are observed through a thorough field reconnaissance program and noted on the field form. A Stability Index (SI) for each of the four components is obtained by the following formula:

$$SI_i = \frac{IN_{OBS}}{IN_{OBS} + IN_{NOT}}$$

where IN_{OBS} is the number of observed indicators and IN_{NOT} is the number of indicators not observed. It should be noted that $IN_{OBS} + IN_{NOT}$ may not always correspond with the total number of indicators for that specific component as there may be some indicators which do not apply to a specific reach. For example, if a reach does not have any storm sewers, then the degradation indicator "Elevated storm sewer outfall(s)" would not be included in either IN_{OBS} or IN_{NOT}. The overall reach Stability Index is obtained by taking the average of the four component's Stability Index.

An SI index between 0 and 0.2 corresponds to a channel in quasi-equilibrium, or "In Regime". This implies that any observed instabilities are associated with normal fluvial processes and are not necessarily problematic. Values between 0.2 and 0.4 correspond with a channel that is "Transitional or Stressed", implying that evidence of instability is more frequent. An SI greater than 0.4 corresponds to a channel that is "In Adjustment", meaning that instability is frequent and the channel is shifting to a new state of quasi-equilibrium in response to the adjusting boundary conditions imposed on it.

3.3.3.1.2 Rapid Stream Assessment Technique (RSAT)

The RSAT was completed for each reach following the methods outlined in Galli (1996). The RSAT assessment is broken into six evaluation categories:

- Channel Stability;
- Channel Scouring/Sediment Deposition;
- Physical Instream Habitat;
- Water Quality;
- Riparian Habitat Conditions; and,
- Biological Indicators (macroinvertebrates).

The assessment covered the length of the entire reach, with a review of the six evaluation categories occurring approximately every 120 m along the channel length. At the end of the reach, all reach notes were reviewed and a final reach score assigned for each evaluation categories. All data was collected on standardized field data collection sheets and later transferred into an electronic database. All points of interested were recorded through photographic record and accompanying GPS co-ordinates.

The RSAT employs a 50 point scoring system which is the sum of the scores assigned to each of the six evaluation categories. The channel stability evaluation category is weighted slightly higher in the overall evaluation than the other categories. A final ranking of the assessment reach is assigned based on the total points scored:

Table 3.21 RSAT Evaluation Scheme

Total Points	Ranking
42 – 50	Excellent
30 – 41	Good
16 – 29	Fair
< 16	Poor

It should be noted that study water quality sampling and analysis was not conducted as part of this study, therefore the criteria for assessing total dissolved solids (TDS) in the water quality evaluation category was dropped from the evaluation. Water quality was inferred based on temperature and a visual estimate of total suspended solids.

3.3.3.1.3 Rapid Reach Assessment Form (RRAF)

The RRAF is another rapid assessment technique, originally developed in Ohio and modified for use in Ontario by Dr. Beebe. This technique assesses sensitivity to erosion using five geomorphic parameters:

- Instream substrate characterization
- Morphological diversity in flow conditions
- Channel stability (base level)
- Bank stability
- Riparian vegetative zone width

Each parameter is given a score ranging from zero to twenty based on a matrix of condition categories, with higher scores reflecting optimal conditions (or less sensitivity to erosion).

Table 3.22 RRAF Evaluation Scheme

Total Points	Ranking
16 – 20	Optimal
11 – 15	Suboptimal
6 – 10	Marginal
0 – 5	Poor

The sum of all parameters is then obtained for an overall score out of 100 with the same four categories: optimal condition (75-100), suboptimal condition (50-74), marginal condition (25-49) and poor condition (0-24). This technique allows better identification of the exact parameters which contribute to the overall observed strength/weakness of the system, therefore facilitating the interpretation of the active processes involved in the system. The understanding of the fluvial processes involved, not just observed form, leads to effective prescribed rehabilitation measures, should they be required.

3.3.3.2 Erosion Threshold Methods

In order to adequately determine the erosion thresholds and channel hydraulics longitudinal profiles and cross sections were surveyed using both a total station and first-order differential GPS. The purpose of these surveys is to physically characterize the slope of the channel, dimensions of the channel cross section, and how the channel interacts with the floodplain. In addition, the longitudinal profile can assist in identifying any abrupt changes in local slope, referred to as headcuts or knickpoints, which are indicators of channel incision (instability).

The concept of critical flow as it relates to mobility of bed and banks assumes that a watercourse having an erodible boundary has a stable form that is a function of the flow and sediment moving through the system. The presumption is that a change to this balance between flow and sediment may initiate instability, subject to the system's inherent resiliency and ability to adapt to this change. Adaptability to change is a function of the materials on the bed and banks, and is often referred to as the system's 'sensitivity' to erosion.

From a stormwater management perspective, the changes in runoff that result from paved surfaces and stormwater pond attenuation have the potential to change the flow and conveyance of sediment. This potential impact may be quantified based on the nature of the flow change (e.g., peak flow reduction, volumetric reductions, etc.) and the type of resisting material in the watercourse.

A number of methods are available in determining and controlling for the permissible erosion threshold for watercourses. The Ministry of Environment's *Stormwater Management Planning and Design Manual* (2003) outlines a process whereby development objectives are established based on the ecological productivity of the receiving watercourse, and the geomorphic processes that sustain that productivity. The approach acknowledges that geomorphic processes are complex and a number of reach specific factors may influence a system's response to stormwater controls.

3.3.4 Results

3.3.4.1 Wideman Creek

3.3.4.1.1 General Morphology

Wideman Creek resides in an over widened channelized agricultural drain and is exhibiting indicators of channel evolution in the longitudinal direction, a common symptom of channelization. The downstream reach is dominated by a depositional zone, where a defined bankfull channel and meander pattern have formed. The small floodplain has evidence of overbank deposits and contains an abundance of riparian vegetation. Moving upstream, the channelized agriculture drain becomes more confined and there is a section where the channel has eroded down to the native Maryhill Till with active knickpoints, indicating that incision is an ongoing process.

Figure 3-14 Downstream Depositional Channel With Developed Floodplain (left) and Actively Incising Upstream Reach Indicating Scour to Native Till (right)

Moving further upstream, there is a gravel depositional feature at the wetland-channel boundary, which likely results from the channel cutting through a weathered pebble layer common of Maryhill Till (Presant & Wicklund, 1971). This gravel feature appears to be supplying gravel to the downstream reach, as sporadic gravel patches were observed, especially in locations where the channel had incised to native till.

Figure 3-15 Gravel Deposit At Wetland Channel Upstream Boundary

3.3.4.1.2 Geomorphic Assessments

In summary, the reach scored on the mid-to-low range for the three assessment techniques used (Table 3.23).

Table 3.23 Geomorphic Assessment Summary for Wideman Creek

Assessment	Overall Score	Classification
RGA	0.38	Transitional or Stressed
RSAT	29	Fair
RRAF	55	Suboptimal

In general, the scores were reduced by the excess deposition in the downstream reach and the excess erosion in the upstream reach, as shown in Tables 3.24 - 3.26. Overall, the banks were considered stable, largely due to the dense vegetation on both sides.

Table 3.24 RGA Results for Wideman Creek

Form/Process	Factor Value	Classification
Evidence of Aggradation	0.83	In Adjustment
Evidence of Degradation	0.50	In Adjustment
Evidence of Widening	0.17	In Regime
Evidence of Planometric Adj.	0.00	In Regime

Table 3.25 RSAT Results for Wideman Creek

Category	Score	Classification
Channel Stability	5	Fair
Channel Scouring/Deposition	3	Fair
Physical Instream Habitat	6	Good
Water Quality	7	Excellent
Riparian Habitat Conditions	5	Good
Biological Indicators	3	Fair

Table 3.26 RRAF Results for Wideman Creek

Parameter	Score	Classification
Instream Substrate Characterization	10	Marginal
Morphological Diversity and Flow Conditions	8	Marginal
Channel Stability (Base Level)	9	Marginal
Bank Stability	13	Suboptimal
Riparian Vegetative Zone Width	15	Suboptimal

3.3.4.1.3 Erosion Thresholds

Based on the longitudinal profile survey (Figure 3.16), the reach slope was determined to be 0.7 %. It should be noted that knickpoints, which were observed in the field visits, are visible in the longitudinal profile at distances of approximately 40 m and 110 m.

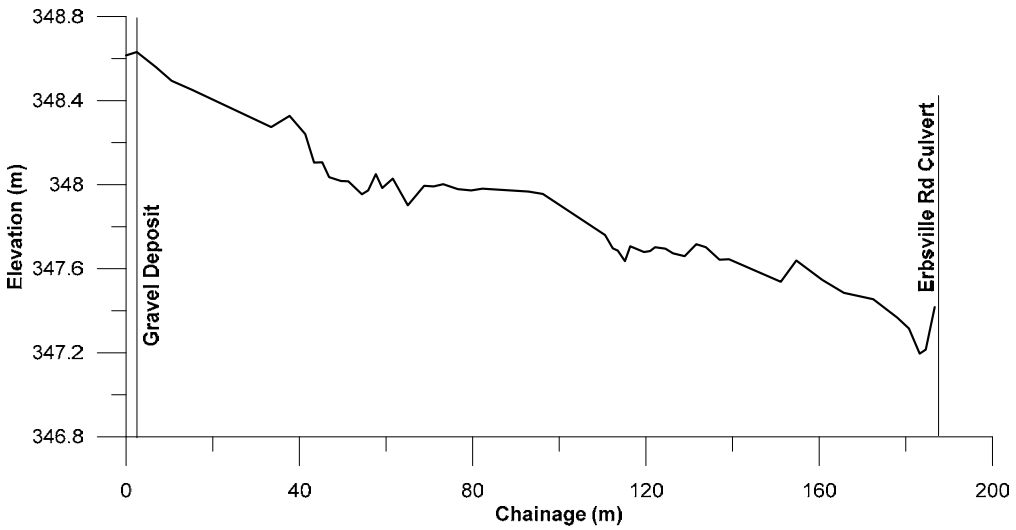

Figure 3-16 Wideman Creek Longitudinal Profile

In total, 6 cross sections were surveyed. However, the most downstream cross section was immediately upstream of the Erbsville culvert where there is a small wetland, and therefore it was not a representative section to use for the erosion threshold analysis. The remaining 5 sections are summarized in Table 3.27.

Table 3.27 Wideman Creek Cross Section Summary

	# XS	Median	St. Dev.	Max	Min	W/h
Bankfull Width W_{bf} (m)	5	1.31	0.81	2.84	0.78	8.33
Mean Bankfull Depth h_{bf} (m)		0.16	0.07	0.26	0.11	
Wetted Width (m)		0.72	0.48	1.70	0.48	8.12
Mean Wetted Depth (m)		0.08	0.02	0.09	0.05	

Three boundary types were identified as being dominant along the reach, two bed materials and one bank material. The bed in the downstream reach is comprised mainly of noncolloidal silts, which is known to be easily mobilized with increasing discharge. The bed upstream has incised to the native till, which is dominated by colloidal silt and stiff clay, notably more resilient to erosion. Although the downstream reach has easily mobile sediment on the surface, below this is the same native Maryhill Till as upstream. In the case of a competent discharge, those highly mobile sediments will be quickly eroded and the till layer will be the controlling factor in further channel incision. Therefore colloidal silt and stiff clay were chosen as the representative bed material. The bank material throughout the reach was dominated by long native grasses and other miscellaneous riparian vegetation. As indicated in Table 3.28, the critical values for the banks are much higher than for the bed. As such, the bed is considered the controlling parameter in the erosion threshold analysis.

Table 3.28 Critical Erosion Thresholds for Identified Boundary Types

Boundary Type	Critical Shear Stress (pa)	Critical Velocity (m/s)	Reference
Noncolloidal alluvial silt	2.25	0.61	Chang (1988), Fischenich (2001)
Colloidal Silt / stiff clay	12.45	1.14	Chang (1988), Julien (1995), Fischenich (2001)
Long native grasses	69.43	1.52	Norman (1975), Kouwen et al., (1980), Fischenich (2001)

Based on a hydraulic analysis of each cross section, it was found that the critical shear stress parameter governed the analysis. The Manning roughness coefficient was established at 0.045, which best fits the channel characteristics (Chow, 1959). Table 3.29 summarizes the discharges which resulted in the critical discharge reported in Table 3.28. Based on these results, the overall critical discharge for the reach is between approximately 0.3 m^3/s and 0.5 m^3/s. It should be noted that this discharge will still be confined in the overall channelized agricultural drain, however, it will exceed the limits of the established channel within this.

Table 3.29 Critical Discharge for Wideman Creek

	Mean	St. Dev.	Max	Min	Median
Wetted Discharge (m^3/s)	0.02	0.01	0.03	0.01	0.01
Bankfull Discharge (m^3/s)	0.11	0.03	0.14	0.08	0.12
Critical Discharge (m^3/s)	0.47	0.08	0.56	0.32	0.47

3.3.4.2 Wideman Creek Tributary

General Morphology

This watercourse is dominated by an actively incising bed, indicated by a number of knickpoints (localized abrupt changes in slope), which has eroded down to the native till. The banks of the reach appear stable due to the dense vegetation along the channel banks. There are many patches of in-channel vegetation, which effectively acts as a sediment trap for fine sediment passing through the reach. The downstream limit is dominated by a wetland where the channel loses its definition and the substrate is dominated by fine silt and organic deposits. Adjacent to the channel is predominantly grassland, with a wetland (headwaters of Wideman Creek) immediately to the west. As previously mentioned, this channel discharges a SWM pond for a residential development on the south side of Wideman Road.

Figure 3-17 Typical Channel Within Stream Vegetation (left) and Downstream Limit at Wetland (right)

3.3.4.2.1 Geomorphic Assessments

The reach scored on the low range of the multiple assessments, mainly due to the amount of incision that is occurring in the reach (Table 3.30).

Table 3.30 Wideman Creek Tributary Geomorphic Assessment Summary

Assessment	Score	Classification
RGA	0.81	In Adjustment
RSAT	25	Fair
RRAF	39	Marginal

In general, the banks appeared stable due to the dense riparian vegetation stabilizing them (see Figure 3.17). The poor scores arose from the lack of morphological features on the bed, as well as the indicators of channel incision prevalent along the upper portion of the reach. Moving downstream, the eroded material is deposited near the wetland, and the layer of fine material is about 0.3m over the native till. There is evidence of island formation, indicating that although the banks appear stable, there may be some planometric adjustment occurring. This could also be due to localized zones of more readily erodible till, which would preferentially erode to that alignment.

Table 3.31 RGA Results for Wideman Creek Tributary

Form/Process	Factor Value	Classification
Evidence of Aggradation	0.75	In Adjustment
Evidence of Degradation	1.00	In Adjustment
Evidence of Widening	0.50	In Adjustment
Evidence of Planometric Adj.	1.00	In Adjustment

Table 3.32 RSAT Results for Wideman Creek Tributary

Category	Score	Classification
Channel Stability	6	Good
Channel Scouring/Deposition	3	Fair
Physical Instream Habitat	4	Fair
Water Quality	3	Fair
Riparian Habitat Conditions	5	Good
Biological Indicators	4	Fair

Table 3.33 RRAF Results for Wideman Creek Tributary

Parameter	Score	Classification
Instream Substrate Characterization	5	Poor
Morphological Diversity and Flow Conditions	8	Marginal
Channel Stability (Base Level)	6	Marginal
Bank Stability	8	Marginal
Riparian Vegetative Zone Width	12	Suboptimal

3.3.4.2.2 Erosion Thresholds

The longitudinal profile revealed that a reach break was necessary at approximately 70 m, with the upstream reach possessing a slope of 1.9 % and the downstream reach possessing a slope of 0.5 %. The upper reach was observed to be the most active in terms of observed incision, which can be seen in Figure 3.18 in the form of localized changes in slope (knickpoints), notably at approximately 25 m.

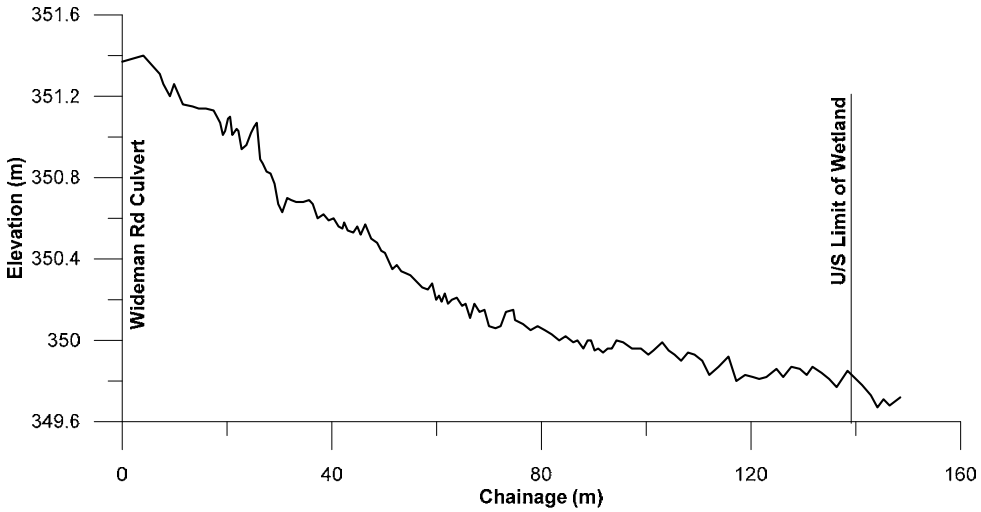

Figure 3-18 Wideman Creek Tributary Longitudinal Profile

Four cross sections in the upper reach were selected as representative sections for the erosion threshold analysis. The remainder of the sections surveyed were in the lower reach which possessed the lower slope. As such, these lower reach sections would have a lower shear stress for a given discharge, and thus would not be the controlling sections.

Table 3.34 Wideman Creek Tributary Cross Section Summary

	# XS	Median	St. Dev.	Max	Min	W/h
Bankfull Width W_{bf} (m)	4	1.93	0.74	2.68	0.91	24.38
Mean Bankfull Depth h_{bf} (m)		0.08	0.04	0.16	0.07	
Wetted Width (m)		1.42	0.54	2.00	0.86	17.60
Mean Wetted Depth (m)		0.09	0.03	0.13	0.07	

The same boundary materials identified for Wideman Creek (Table 3.28) were used for the Wideman Creek Tributary. As with Wideman Creek, the shear stress was found to govern the calculated discharges. A Manning roughness coefficient of 0.045 was selected for the hydraulic analysis (Chow, 1959). The critical discharge for the tributary was found to be approximately 0.6 m^3/s to 0.8 m^3/s. It should be noted that the range of critical discharges spanned over an order of magnitude, with the mean and median converging on a similar result. This critical discharge is similar to the estimated discharge during the reach survey on July 17, 2014 (Table 3.33).

It should be noted that the area received a summer convective storm of approximately 23mm on July 15th, 2014 (two days prior to the site survey). This was confirmed by the rain gauge readings at the University of Waterloo weather station (UW Weather Station, 2014). It is possible that the observed discharge through this tributary was still elevated due to the SWM pond outflow, however the schematics of the pond were not reviewed to confirm this.

Table 3.35 Critical Discharge for Wideman Creek Tributary

	Mean	St. Dev.	Max	Min	Median
Wetted Discharge (m^3/s)	0.07	0.01	0.08	0.06	0.08
Bankfull Discharge (m^3/s)	0.12	0.01	0.12	0.11	0.12
Critical Discharge (m^3/s)	0.08	0.07	0.18	0.03	0.06

3.3.5 Conclusions and Discussion

Both reaches scored on the low end of all geomorphic assessments, mainly due to some active channel incision occurring at both reaches. Wideman Creek has developed a meandering channel and active floodplain within the confined agricultural drain in its lower reach, however in the upper reach it is still in transition. The Wideman Creek Tributary is actively incising through its upper reach, which is the steepest reach surveyed in this study. The lower reach is dominated by in-channel vegetation, silt and organic deposits and wetlands.

The erosion threshold analysis for Wideman Creek revealed that the critical discharge exceeded the estimated bankfull discharge, but would still be contained within the overall agricultural drain. The critical discharge for the Wideman Creek Tributary was determined to be less than the bankfull discharge, verifying the field observations of channel instability.

Further frequency analysis should be performed on both of these channels to determine the percent of time that these erosion thresholds are exceeded, which can give insight into the rate that these channels are adjusting. Given that there are no discharge gauges on these reaches, this would involve developing a calibrated continuous hydrologic model. Moreover, the hydraulic analysis performed to calculate the discharges was done on an at-a-station basis. As such, there is a possibility that these estimates can be refined in a 1D backwater model, such as HEC-RAS.