

# **Mer Bleue Area 10 Urban Expansion Area**

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## **Headwaters Report**

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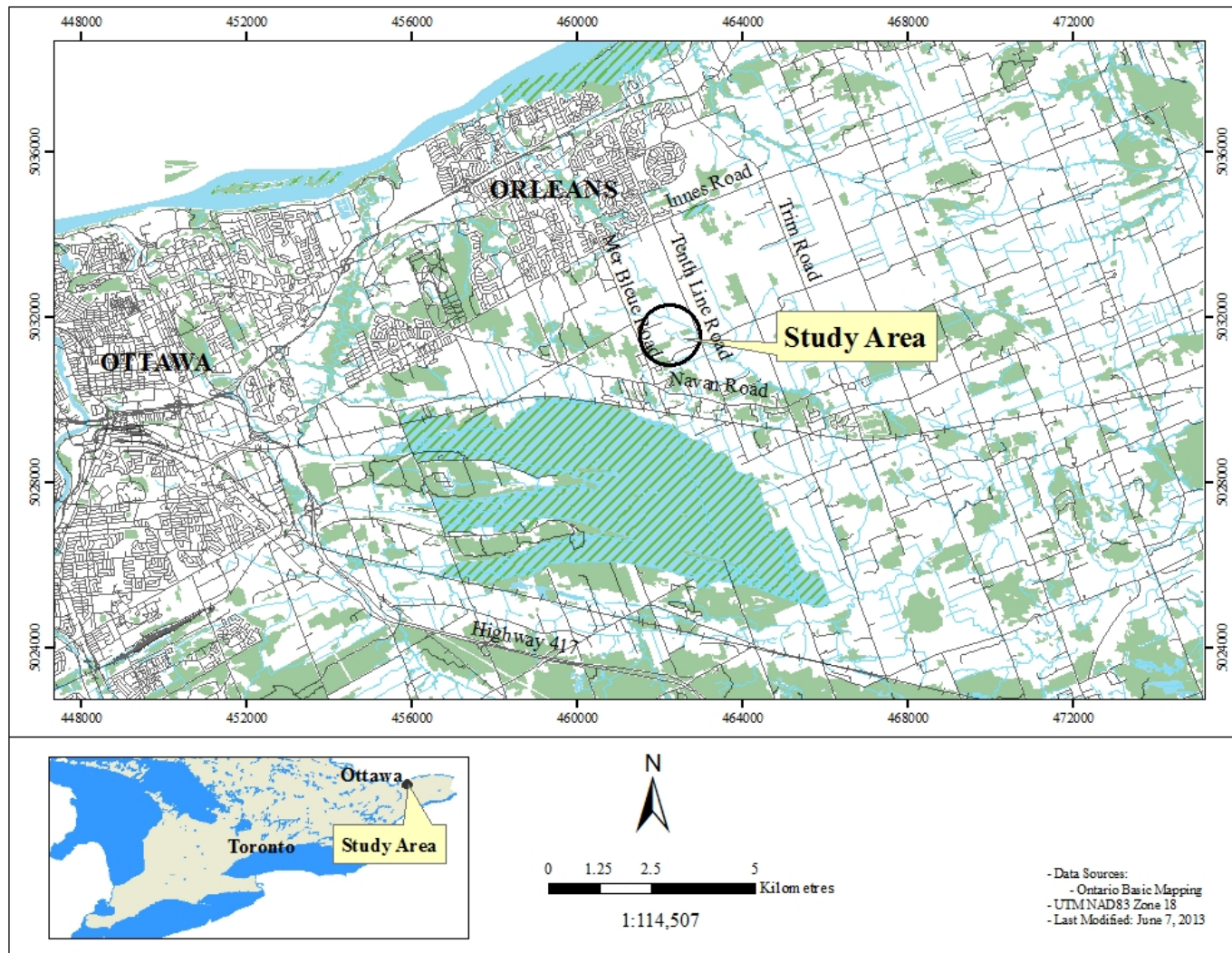
## 1.0 INTRODUCTION

The following report has been prepared by Muncaster Environmental Planning (MEP) and Bowfin Environmental Consulting (Bowfin) on behalf of the Mer Bleue Expansion Area Community Design Plan for the Mer Bleue Urban Expansion Area (UEA). The UEA is 219 ha of former rural land bounded by Tenth Line Road on the east; Wall Road and approximately the south limit of Lot 6/Concession 11 on the south; Mer Bleue Road on the west and, approximately the north limit of Lot 4/Concession 11 on the north (Figure 1). The headwater features all flow into McKinnon's Creek (Figure 2).

The Mer Bleue UEA is in the Community Design Plan (CDP) and Master Servicing Study stage and no detailed plans on the proposed subdivisions are available. The CDP process for the expanded urban area will identify the long-term land use planning and related infrastructure requirements for the community at full build out. The proposed community will be provided with typical urban infrastructure including stormwater runoff collection and conveyance system consisting of catchbasins and storm sewer network. At this time, the concept plan is such that no direct impacts will occur to McKinnon's Creek within the UEA area. A minimum setback of 15 m from the top of slope or 30 m from the normal high water mark, whichever is greater, will be established on both sides of the creek, with recreational pathways on both sides of the creek in the outer portions of the setback. There will be no Municipal roadway crossings of McKinnon's Creek.

This report provides a summary of the findings along with an evaluation of the headwaters as per the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines* created by Credit Valley Conservation and Toronto Region Conservation (July 2013, updated January 2014).

**Figure 1 Location of Study Area**



## **2.0 METHODOLOGY**

The following provides a summary of work which was completed between 2013 and 2016. The habitat in the Urban Expansion Area was described on September 6<sup>th</sup>, 2013 and sampled on April 28<sup>th</sup> and July 17<sup>th</sup>, 2014. Headwater features were described on April 14<sup>th</sup> and 28<sup>th</sup>, and August 9, 2016.

### **2.1 Review of Background Information**

The review of background information was conducted in order to identify potential environmental concerns and to augment the data collected during the site visit. Background information regarding fish species was obtained with a request for information to South Nation Conservation (SNC) and a search of the Natural Heritage Information Centre (NHIC) databases.

### **2.2 Habitat Description**

The fish habitat features within the study area was described based on the MTO *Environmental Guide for Fish and Fish Habitat October 2006* and the *Ontario Stream Assessment Protocol*. Information on the channel morphology was collected (channel width, wetted width, bankfull and wetted depths, cover type and abundance, and substrate type). The location of specific features mentioned in the text is shown on Figure 2.

### **2.3 Fish Community Sampling**

Fish community sampling was performed to document the use of the site by fish during the spring. No sampling could take place during the summer due to a lack of water in all of the headwater drainage features. The community was sampled utilizing electrofishing and hoop netting where appropriate.

### **2.4 Headwater Drainage Features**

The headwater drainage features within the study area were assessed based on the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines* (here after referred to as the Guidelines) (prepared by Credit Valley Conservation Authority and Toronto and Region Conservation, approved January 2014). The Guideline is divided into three parts. Part 1 is the Evaluation and discusses various suggested study designs/methods. Part 2 determines the appropriate Classification following the outcome of Part 1. Finally, Part 3 outlines the Management Recommendations.

### **2.5 Amphibian Surveys**

Nighttime amphibian calling surveys were completed as per the *Environment Canada Marsh Monitoring Program* (MMP) guide. The protocol is summarized below:

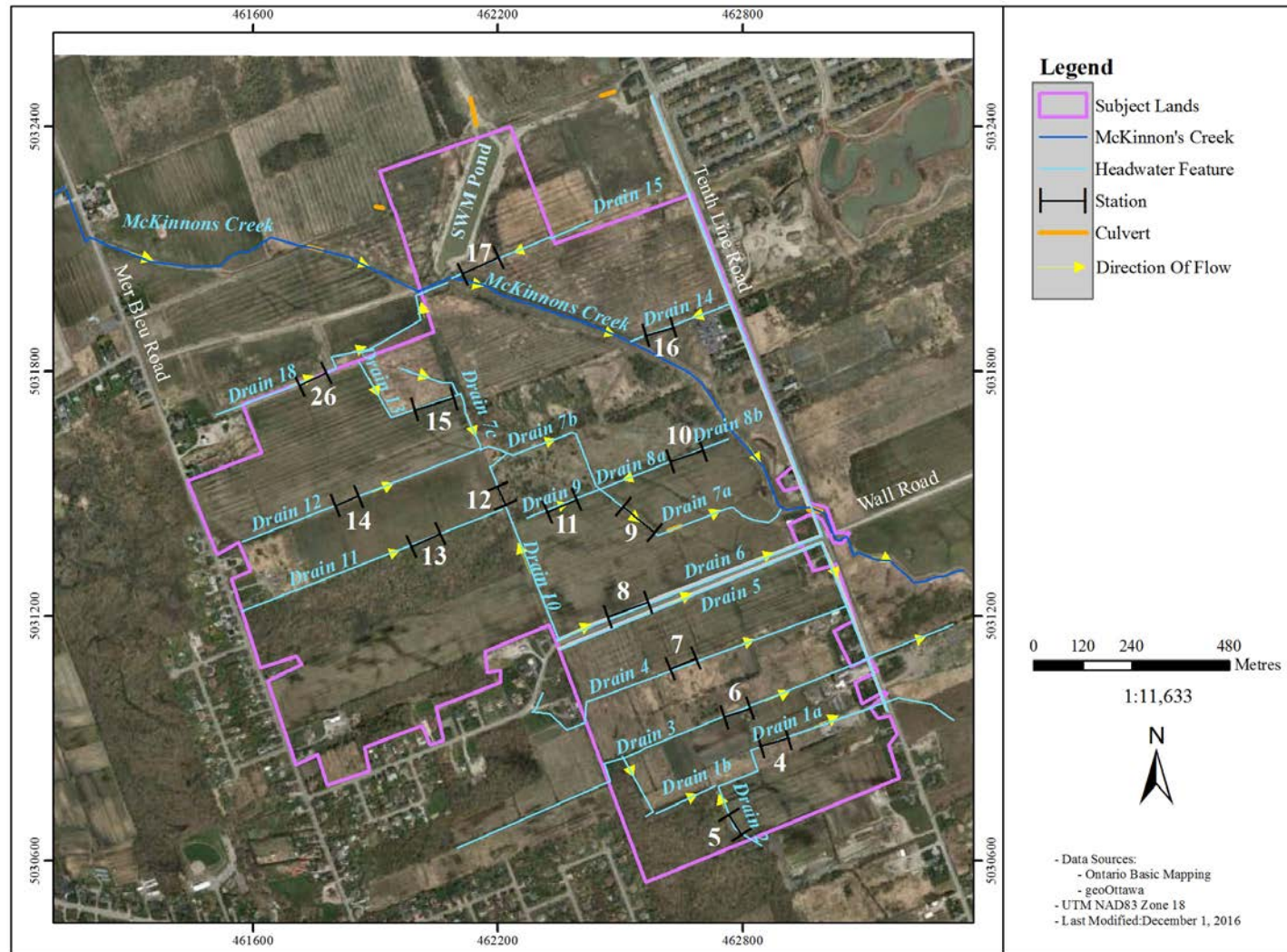
- The surveys were completed 3 times during the spring and early summer (once during each of the three survey period in order to collect data on all species)
- Observations began 30 minutes after sunset and end before midnight;
- Each station was surveyed for 3 minutes during which time the species and the calling code were recorded for each of the following distances: 0-50m, 50-100m, and >100m. Additional notes were taken on whether amphibians were in the feature being assessed. The calling codes were recorded as one of:
  - Code 1: Calls not simultaneous, number of individuals can be accurately counted
  - Code 2: Some calls simultaneous, number of individuals can be reliably estimated
  - Code 3: Full chorus, calls continuous and overlapping, number of individuals cannot be reliably estimated
- Surveys were only conducted if the wind strength was Code 0, 1, 2 or 3 on the Beaufort Wind Scale.
- Amphibian survey stations were separated by at least 500 m.

All surveys include the recording of the following information:

- Date
- Name of observer(s) conducting field work
- Time (start and end time, duration)
- Weather conditions (temperature, % cloud cover, wind)
- GPS location
- Species presence and abundance information



**Figure 2 Location of Headwater Features and Survey Stations**



### 3.0 RESULTS

#### 3.1 Site Investigations

##### 3.1.1 Summary of Visits and Sampling Site Locations

Several visits were completed between September 2013 and August 2016. Fish community sampling was completed during the spring (April 28, 2015). No water was present during the summer for summer sampling. Amphibian surveys were completed during the spring of 2016. Environmental conditions for each visit are described in Table 1 below.

**Table 1 Summary of Dates, Times of Site Investigations**

Date	Time (h)	Staff	Air Temperature (Min-Max) °C	Weather	Purpose
September 6, 2013	0730-1300	S. St.Pierre B. Pierson	10.0-23.0 (4.1-21.0)	5% cloud cover, light air changing to 5% cloud cover , gentle breeze	-Fish Habitat Assessment
September 17, 2013	0745-1245		7.0-19.0 (1.8-17.9)	clear skies, light air changing to clear skies, light breeze	
April 24, 2014	2000-2215	S.St. Pierre B. Pierson	5.0-7.0 (-0.6-12.2)	clear skies, light breeze changing to clear skies light air	- Amphibian Survey
April 28, 2014	1030-1530	S.St.Pierre B. Pierson M. Lavictoire	14.0-13.0 (5.1-15.8)	50% cloud cover, light breeze to 60% cloud cover, moderate breeze	-Fish Community Sampling
May 13, 2014	2030-2300	S.St. Pierre B. Pierson	15 (8.9-16.8)	80% cloud cover, gentle breeze, light showers on the drive up changing to 60% cloud cover, light breeze, full moon	- Amphibian Survey
June 16, 2014	2215-0115		20.0-18.0 (10.3-23.4)	15% cloud cover, no wind changing to clear skies, no wind, 85.9% of moon visible	- Amphibian Survey
April 12, 2016	0930-1330	S. St.Pierre B. Pierson C. Fontaine	3 (-3.0-6.5)	10% cloud cover, gentle breeze	- Headwater Assessment
April 28, 2016	1000-1200	S. St. Pierre B. Pierson	2.0 (-3.3-9.8)	5% cloud cover, light breeze	- Headwater Assessment
	0730-1200	B. Pierson	17-26		

Date	Time (h)	Staff	Air Temperature (Min-Max) °C	Weather	Purpose
August 9, 2016	1045-1145	S. St.Pierre C. Fontaine	(13.4-32.7)	40% cloud cover, light breeze	- Headwater Assessment

M. Lavictoire – Michelle (Nunas) Lavictoire – B. Sc. Wildlife Biology, M.Sc. Natural Resources

S. St. Pierre – Shaun St. Pierre – B. Sc. Biology and Fisheries and Wildlife Technologist

B. Pierson—Brittney Pierson—Honours BSc. Biology and Environmental Science

C. Fontaine - Cody Fontaine - Fisheries and Wildlife Technologist

\*Min-Max Temp Taken From: Environment Canada. National Climate Data and Information Archive. Ottawa International Airport. Available <http://climate.weatheroffice.gc.ca/> [September 7, 2016]

## 3.1.2 Habitat and Fish Community Descriptions

There was one sampling station on each headwater feature (Figure 2). A summary of the water temperatures and other parameters collected at the stations during 2014 is provided in Table 2. Electroshocking surveys were completed on April 28, 2014. The settings utilized were 50-115 volts and 1.0-1.2 amps.

The following sections provide information on the aquatic habitat and fish communities collected between 2013 and 2016. A total of 16 features are described herein (labelled 1-15 and 18; labelling coincides with other reports which included a larger area). Note that the station numbers are also those from the other reports and as such there are no stations 1-3. Also note that some of the channels were broken into separate reaches for the purposes of the headwater assessment in order to highlight specific differences such as the type of riparian vegetation (i.e. Drain 1 is broken into reaches 1a and 1b due to presence of woodland on 1b).

The potential *Fisheries Act* implications are being reviewed by the Department of Fisheries and Oceans (DFO) under a separate process. As per DFO's request, headwater features are not discussed in the fisheries technical reports.

Each of the headwater features were walked in their entirety and a single site was established in a representative area.

### *Comparison of Selected Channel Parameters*

A summary of the water temperatures and other parameters collected at the stations during 2013-2016 is provided in Table 2. To put these into context a summary of the flood conditions for the survey period is provided below.

In 2013 and 2014, the flood conditions were considered to be Normal during the entire sampling period (as per the SNC website).

The snow pack of winter 2014-2015 melted prior to ice off resulting in low peak flows in 2015. This was followed by a period of low precipitation and cooler than normal temperatures until towards the end of April. Above seasonal temperatures were then experienced at the beginning of May. Temperatures returned to near average by mid-May. This resulted in likely lower water levels during spring sampling and in some instances higher water temperatures.

By the end of March 2016, the South Nation Conservation recorded the flood conditions as normal. The snow pack of winter 2015-2016 melted prior to ice off resulting in low peak flows in 2016. This was followed by a heavy snow storm at the start of April and cold air temperatures through to mid-April. Thin layers of ice were present on slow flowing channels in the mornings until after April 15<sup>th</sup>.

**Table 2 Features and Sampling Parameters**

Date	Watercourse	Station No.	Time (h)	Air Temp (°C)	Water Temp (°C)	pH	TDS (ppm)	Cond (µ)	Ave. Depth (cm)	Ave. Wetted Width (m)	Ave. Channel Width (m)
09/17/2013	<b>Drain 1</b>	4	1219	19				DRY			1.5
04/28/2014			1052	14	14.2	8.8	73	178	6	1.4	
04/12/2016			1009	4	4.2	7.9	160	229	5.4	1.7	
09/17/2013	<b>Drain 2</b>	5	1144	14				DRY			1.8
04/28/2014			1101	14	12.5	8.08	64	28	5	1.0	
04/12/2016			0952	4	6.3	6.4	71	138	5.8	1.1	
09/17/2013	<b>Drain 3</b>	6	1223	19				DRY			1.9
04/28/2014			1113	14	11.7	8.09	756	38	11	2.0	
04/12/2016			1020	5	3.1	7.78	317	455	26.1	3.0	
09/17/2013	<b>Drain 4</b>	7	1236	19				DRY			1.7
04/28/2014			1133	14	15.7	7.87	513	1038	8	1.3	
04/12/2016			1030	4	3	NA			10.2	1.7	
09/17/2013	<b>Drain 5 and 6</b>	8	1050	19				DRY			1.2
04/28/2014			1510	13	20.7	7.79	617	1243	5	1.3	
04/12/2016			1040	5	6	NA	NA	NA	5.9	1.7	
09/17/2013	<b>Drain 7</b>	9	0754	7				DRY			3.0
04/28/2014			1144	14	11.2	8.11	361	741	10	2.0	
04/12/2016			1036	5	3.7	7.7	221	316	22.3	3.3	
09/17/2013	<b>Drain 8</b>	10	0813	7				DRY			1.3
04/28/2014			1159	14	13.5	7.89	543	1065	2	0.6	
04/12/2016			1047	5	4.4	7.56	571	791	4.5	0.6	
09/17/2013	<b>Drain 9</b>	11	0832	7				DRY			1.3
04/28/2014			1208	14	14.1	7.74	163	328	4	0.9	
04/12/2016			1052	4	3	NA			15.8	2.5	
09/17/2013	<b>Drain 10</b>	12	1002	19				DRY			2.9
04/28/2014			1220	14	16.2	7.45	211	417	10	2.1	
04/12/2016			1104	5	5	NA	NA	NA	4.5	0.6	

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Date	Watercourse	Station No.	Time (h)	Air Temp (°C)	Water Temp (°C)	pH	TDS (ppm)	Cond (µ)	Ave. Depth (cm)	Ave. Wetted Width (m)	Ave. Channel Width (m)
09/06/2013	Drain 11	13	1014	19				DRY			2.1
04/28/2014			1228	14	13.7	7.58	263	534	6	1.1	
04/12/2016			1122	5	6	NA	NA	NA	14.3	3.0	
09/06/2013	Drain 12	14	0937	19				DRY			1.6
04/28/2014			1240	14							
04/12/2016			1130	4	6	NA	NA	NA	10.4	1.2	NA
09/06/2013	Drain 13	15	0914	19				DRY			1.4
04/28/2014			1258	14	20.9	7.7	913	1832	7	0.6	
04/12/2016			1120	5	6	NA	NA	NA	8.3	3.7	NA
09/06/2013	Drain 14	16	0900	21				DRY			2.0
04/28/2014			1435	13	17.7	8.2	400	802	2	0.4	
04/12/2016			1227	5	6	NA	NA	NA	7.5	1.3	NA
09/06/2013	Drain 15	17	0924	21				DRY			1.8
04/28/2014			1410	13	22.9	8.76	1568	3147	1	0.4	
04/28/2014			1259	6	6	NA	NA	NA	3.2	1.5	NA
04/12/2016	Drain 18	26	1201	5	6	7.85	625	902	8.8	1.6	NA
04/28/2016			Dry								
08/09/2016			n/a								

### *Aquatic Habitat and Fish Community Sampling Results*

The Mer Bleue UEA consisted of active and historical agricultural fields resulting in a large number of dug drains. A total of 17 watercourses other than McKinnon's Creek were identified as headwater features. Drains 5 and 6 are the roadside ditches for Wall Road. All of the remaining watercourses are constructed ditches one would typically expect to encounter within farmlands with the exception of Drain 7. Drain 7 appears to have been a natural channel that was channelized. A total of 16 sites were established on these watercourses. Their locations are depicted on Figure 3, above. Habitat assessments for the stations were completed in September 2013 while fish sampling was completed at stations with sufficient water in April 2014. Headwater assessments were completed in April and August of 2016.

All drains were dry during September 2013 and August, 2016.

During the early spring visit in 2014 the water depths remained shallow. The three drains with the 'most' water were drains 3, 7 and 10 with an average of 10-11 cm (Table 3). Drains 1, 4, 11 and 13 had depths between 6 cm and 8 cm. Drains 2, 6 and 9 had water depths between 3 cm and 5 cm. Drains 8, 14 and 15 had depths of 1-2 cm. Drain 12 was dry during the spring (Table 3).

Electrofishing could be completed along five drains (Drains 4, 7, 10, 13) and spot electrofishing was conducted on Drain 15. Station 14 (Drain 12) was dry. Dip netting was completed at all other sites with water.

#### *Drain 1*

The southernmost watercourse within the study area was Drain 1. This drain was divided into two different reaches (1a and 1b) due to different riparian vegetation types. Drain 1a was 506 m in length and Drain 1b was 327 m in length. This drain crossed Tenth Line Road roughly 425 m south of the Wall Road. The drain flowed from west to east and was 1315 m long reaching McKinnon's Creek on the east side of Tenth Line Road, outside of the study area. The upstream portion was assessed and sampled as part of this report. Note that additional information is available on this downstream section of this drain under Headwater Feature 11 / Tributary 3 in the Headwater Report for the EUC Improvement Area.

The drain was straight and channelized but with low banks. The surrounding land consisted of a fallow agricultural field (2016) that had been hayed in 2015 and woodland (1b).



#### **Station 4**

Station 4 began 260 m west of Tenth Line Road. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 1.5 m and 20 cm.

The substrate was composed of fines. The entire channel was choked with vegetation (purple loosestrife, reed canary grass and pale smartweed). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation. Herbaceous vegetation consisted of reed canary grass, common sow-thistle and common milkweed. There was no canopy cover.

During the spring visit in April 2014, the site was shocked for 273 seconds over an area of approximately 56 m<sup>2</sup>. The average wetted width and water depth obtained in April were 1.4 m and 6 cm (range 1-14 cm), respectively. No fish were captured.



**Photo 1 Drain 1 (Station 4) looking upstream from the downstream end. April 28, 2014**





**Photo 2 Drain 1 (Station 4) looking upstream from the downstream end.  
September 17, 2013**

### *Drain 2*

Drain 2 was straight, dug but with poorly defined channel. The drain flowed from south to north. This drain was 195 m long. The surrounding land consisted of a fallow agricultural field and (2016) and wooded area. The field had been hayed in 2015.

### **Station 5**

Station 5 was located 60 m upstream from the confluence with Drain 1, situated on a higher gradient compared to the connection with Drain 1. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 1.8 m and 19 cm.

The substrate was composed of fines which were exposed. The only in-stream structure consisted of large woody debris. There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation and woody species. Herbaceous vegetation consisted of sensitive fern, reed canary grass and early goldenrod. Woody species included speckled alder, pussy willow, red maple and trembling aspen. There was good canopy cover.

During the spring visit in April 2014, the site was dipped 60 times as it was too shallow to shock and contained small and large woody debris. The average wetted width and

water depth obtained in April were 1.0 m and 5 cm (range 2-13 cm), respectively. No fish were captured.



**Photo 3 Drain 2 (Station 5) looking upstream from the downstream end. April 28, 2014**



**Photo 4 Drain 2 (Station 5) looking upstream from the downstream end. September 17, 2013**

### *Drain 3*

Drain 3 crossed Tenth Line Road roughly 305 m south of Wall Road. The drain flowed from west to east reaching McKinnon's Creek on the east side of Tenth Line Road, outside of the study area. The channel was 1500 m long of which 700 m was found within the study area. The entire system was a straight, dug channel. The surrounding land consisted of a fallow agricultural field (2016). It had been hayed in 2015. Note that additional information is available on this downstream section of this drain under Headwater Feature 12 / Tributary 4 in the Headwater Report for the EUC Improvement Area.

### **Station 6**

Station 6 was located 325 m west of Wall Road. The station length was 40 m. During the 2013 site visit entire site was dry with the exception of one pool of standing water (approx. 1m long). The following average values were collected from this pool: channel 1.9 m, wetted widths 0.3 m, bankfull depth 17 cm and water depth 4 cm (range 4-7 cm) in spring 2013.

The substrate was composed of fines. The entire channel was choked with aquatic vegetation (reed canary grass and purple loosestrife). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation and poorly vegetated with woody species. Herbaceous vegetation consisted of reed canary grass, New England aster and daisy fleabane. Woody species included American elm and trembling aspen. There was very sparse canopy cover.

During the spring visit in April 2014, the site was dipped 50 times as it was too shallow and was choked with remnant vegetation to shock. The average wetted width and water depth obtained in April were 2.0 m and 10 cm (range 6-25 cm), respectively. No fish were captured.





**Photo 5    Drain 3 (Station 6) looking upstream from the downstream end. April 28, 2014**



**Photo 6    Drain 3 (Station 6) looking upstream from the downstream end. September 17, 2013**

#### *Drain 4*

Drain 4 was located 190 m south of the Wall Road. The drain flowed from west to east until Tenth Line Road where it connected to the road ditch and flowed into Drain 3 which in turn merges with McKinnon's Creek on the east side of Tenth Line Road, outside of the study area. Drain 4 was 1000 m long of which 720 m was found within the study area. The entire system was a straight, dug channel. The surrounding land consisted of a fallow agricultural field (2016). The field had been hayed in 2015.

#### **Station 7**

Station 7 was located 395 m west of Wall Road. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 1.7 m and 19 cm.

The substrate was composed of fines. The entire channel was heavily choked with vegetation (reed canary grass and purple loosestrife). There were no signs of erosion.

The banks were completely vegetated with herbaceous vegetation and poorly vegetated with woody species. Herbaceous vegetation consisted of reed canary grass, daisy fleabane and purple loosestrife. Woody species included common buckthorn. There was no canopy cover.

During the spring visit in April 2014, the site was shocked for 299 seconds over an area of approximately 52 m<sup>2</sup>. The average wetted width and water depth obtained in April were 1.3 m and 8 cm (range 4-14 cm), respectively. No fish were captured.



**Photo 7    Drain 4 (Station 7) looking upstream from the downstream end. April 28, 2014**



**Photo 8    Drain 4 (Station 7) looking upstream from the downstream end. September 17, 2013**



### *Drains 5 and 6*

Drains 5 and 6 were road ditches which flowed east towards Tenth Line Road. One station was created on Drain 6, north side of Wall Road. It was noted that the upper end of Drain 6 was physically connected with Drain 10 though the two watercourses flowed in different directions. The surrounding land use for Drain 5 was a fallow agricultural field. The field around Drain 5 was hayed in 2015. Soybeans were planted in the field adjacent to Drain 6 in 2016.

#### **Station 8**

Station 8 was situated 460 m west of Tenth Line Road. The station length was 40 m. The entire station was dry. The average channel and bankfull depth were 1.2 m and 12 cm in spring 2013.

The substrate was composed of fines. The entire channel was choked with vegetation (reed canary grass, and purple loosestrife). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation. Herbaceous vegetation consisted of grass species, common sow-thistle and purple loosestrife. There was no canopy cover.

During the spring visit in April 2014, the site was dipped 60 times as it was too shallow to shock. The average wetted width and water depth obtained in April were 1.3 m and 5 cm (range 3-12 cm), respectively. No fish were captured.



**Photo 9 Drain 6 (Station 8) looking upstream from the downstream end. April 28, 2014**

### *Drain 7*

Drain 7 connected with McKinnon's Creek to the west of Tenth Line Road, within the study area. This channel was 1230 m long and appeared to have been a natural watercourse that was entirely channelized. There were many side branches which were labelled as Drains 8-10, 12 and 13 (Drain 11 was a side branch to Drain 10). The surrounding land was mostly cropped (reaches 7a and 7c) with the exception of 7b where the watercourse travelled within thicket and woodland habitats.

### **Station 9**

Station 9 was 360 m upstream of the confluence with McKinnon's Creek. The surrounding land consisted of an agricultural field. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 3.0 m and 22 cm.

The substrate was composed of fines. The in-stream cover consisted of aquatic vegetation (reed canary grass, narrow-leaved cattail, and purple loosestrife). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation, and very poorly with woody species. Herbaceous vegetation consisted of reed canary grass, timothy and common sow-thistle. Woody vegetation included green ash. There was no canopy cover.

During the spring visit in April 2014, the site was shocked for 328 seconds over an area of approximately 80 m<sup>2</sup>. The average wetted width and water depth obtained in April were 2.0 m and 10 cm (range 7-22 cm), respectively. No fish were captured.





**Photo 10 Drain 7 (Station 9) looking upstream from the downstream end. April 28, 2014**



**Photo 11 Drain 7 (Station 9) looking upstream from the downstream end. September 17, 2013**

### *Drain 8*

Drain 8 flowed from east to west merging with Drain 7 530 m upstream from McKinnon's Creek. Drain 8 was 335 m long and consisted of a straight channel. The surrounding land along reach 8a consisted of an agricultural field (soybeans in 2016) and of thicket along 8b.

### **Station 10**

Station 10 was situated approximately 185 m east of its confluence with Drain 8. The station length was 40 m. The entire station was dry. The average channel and bankfull depth were 1.3 m and 19 cm in spring 2013.

The substrate was composed of fines. The channel was heavily choked with vegetation (purple loosestrife, narrow-leaved cattail, and reed canary grass). There were no signs of erosion.

The banks were fully vegetated herbaceous vegetation and very poorly vegetated with woody species. Herbaceous vegetation consisted of New England aster, timothy and brome species. Woody species included slender willow, grey birch and trembling aspen. There was scarce canopy cover.

During the spring visit in April 2014, the site was dipped 10 times as it was too shallow to shock and was choked with vegetation. The average wetted width and water depth obtained in April were 0.7 m and 2 cm (range 1-6 cm), respectively. No fish were captured.



**Photo 12 Drain 8 (Station 10) looking upstream from the downstream end.  
April 28, 2014**

### *Drain 9*

Drain 9 was located across from Drain 8 and flowed from west to east. Drain 9 was 185 m long and consisted of a straight channel. The surrounding land consisted of an agricultural field (soybeans in 2016) and a wooded area.

#### **Station 11**

Station 11 was situated approximately 60 m west of the confluence with Drain 7. The surrounding land consisted of an agricultural field and a wooded area. The station length was 40 m. The entire station was dry. The average channel and bankfull depth were 1.3 m and 18 cm in spring 2013.

The substrate was composed of fines. The channel was entirely choked with aquatic vegetation (reed canary grass, black bulrush, and purple loosestrife). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation and very poorly vegetated with woody species. Herbaceous vegetation consisted of common ragweed, reed canary grass and timothy. Woody species included green ash and American elm. There was no canopy cover.

During the spring visit in April 2014, the site was dipped 10 times as it was too shallow to shock and was choked with vegetation. The average wetted width and water depth obtained in April were 0.9 m and 4 cm (range 2-8 cm), respectively. No fish were captured.



**Photo 13 Drain 9 (Station 11) looking upstream from the downstream end.  
April 28, 2014**





**Photo 14 Drain 9 (Station 11) looking upstream from the downstream end.  
September 17, 2013**

### *Drain 10*

Drain 10 flowed from south to north merging with Drain 7 approximately 845 m upstream of McKinnon's Creek. The dug channel was straight. The surrounding land consisted of an agricultural field and wooded area.

### **Station 12**

Station 12 was situated approximately 95 m south of the confluence with Drain 7. The station length was 40 m. The entire station was dry. The average channel and bankfull depth were 2.9 m and 23 cm in spring 2013.

The substrate was composed of fines. The channel was entirely vegetated with purple loosestrife, reed canary grass, and narrow-leaved cattail. There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation and very poorly vegetated with woody species. Herbaceous vegetation consisted of Canada goldenrod, wild carrot and timothy. Woody species included common buckthorn. There was no canopy cover.

During the spring visit in April 2014, the site was shocked for 416 seconds over an area of approximately 84 m<sup>2</sup>. The average wetted width and water depth obtained in April were 2.1 m and 11 cm (range 4-20 cm), respectively. No fish were captured



**Photo 15 Drain 10 (Station 12) looking upstream from the downstream end.  
April 28, 2014**



**Photo 16 Drain 10 (Station 12) looking upstream from the downstream end.  
September 17, 2013**



### ***Drain 11***

As mentioned above, Drain 11 was a side branch to Drain 10. This drain flowed from west to east and was 685 m long. This was yet another straight channel. The surrounding land consisted of an agricultural field and wooded area.

### **Station 13**

Station 13 was situated approximately 155 m south of the confluence with Drain 10. The station length was 40 m. The entire station was dry. The average channel and bankfull depth were 2.1 m and 23 cm in spring 2013.

The substrate was composed of fines. The channel was choked by aquatic vegetation (purple loosestrife, narrow-leaved cattail, and reed canary grass). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation and moderately vegetated with woody species. Herbaceous vegetation consisted of purple loosestrife, late goldenrod and black bulrush. Woody species included pussy willow, common buckthorn and slender willow. There was poor canopy cover.

During the spring visit in April 2014, the site was dipped 50 times as it was too shallow to shock and was choked with vegetation. The average wetted width and water depth obtained in April were 1.2 m and 6 cm (range 2-15 cm), respectively. No fish were captured.



**Photo 17 Drain 11 (Station 13) looking upstream from the downstream end.  
April 28, 2014**



**Photo 18 Drain 11 (Station 13) looking upstream from the downstream end.  
September 17, 2013**

### ***Drain 12***

Drain 12 was located 950 m upstream of Drain 7's confluence with McKinnon's Creek. This drain was 625 m long and flowed from west to east. Again, this was a straight dug channel. The surrounding land consisted of an agricultural field that was planted in soybeans on the north side.

### **Station 14**

Station 14 was situated approximately 315 m east of the confluence with Drain 7. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 1.6 m and 20 cm.

The substrate was composed of fines. The channel was entirely choked by aquatic vegetation (purple loosestrife, broad-leaved cattail, and reed canary grass). There were no signs of erosion.

The banks were fully vegetated herbaceous vegetation and poorly vegetated with woody species. Herbaceous vegetation consisted of purple loosestrife, Canada goldenrod and wild carrot. Woody species included pussy willow and common buckthorn. There was no canopy cover.

The site was dry during the visit in spring 2014; therefore no fish sampling was completed.



**Photo 19 Drain 12 (Station 14) looking upstream from the downstream end.  
April 28, 2014**



**Photo 20 Drain 12 (Station 14) looking upstream from the downstream end.  
September 17, 2013**



### ***Drain 13***

Drain 13 was located 1070 m upstream of the confluence of Drain 7 and McKinnon's Creek, near the end of Drain 7. Drain 13 was 346 m long. The channel was dug and straight. The surrounding land consisted of an agricultural field planted in soybeans.

### **Station 15**

Station 15 was situated approximately 20 m west of the confluence with Drain 7. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 1.4 m and 16 cm, respectively.

The substrate was composed of fines. The entire channel was heavily vegetated with reed canary grass, broad-leaved cattail, and purple loosestrife. There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation. Herbaceous vegetation consisted of common ragweed, common sow-thistle and reed canary grass. There was no canopy cover.

During the spring visit in April 2014, the site was shocked for 264 seconds over an area of approximately 24 m<sup>2</sup>. The average wetted width and water depth obtained in April were 0.6 m and 7 cm (range 3-19 cm), respectively. No fish were captured



**Photo 21 Drain 13 (Station 15) looking upstream from the downstream end.  
April 28, 2014**



**Photo 22 Drain 13 (Station 15) looking upstream from the downstream end.  
September 17, 2013**

#### Drain 14

Drain 14 flowed from east to west entering McKinnon's Creek roughly 660 m upstream from Wall Road. This was a short (266 m), straight, dug channel. The surrounding land consisted of an abandoned agricultural field; soybeans on the north side.

#### Station 16

Station 16 was situated 50 m east of McKinnon's Creek. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 2.1 m and 20 cm.

The substrate was composed of fines. The entire channel was fully vegetated (reed canary grass and purple loosestrife). There were no signs of erosion.

The banks were fully vegetated with herbaceous vegetation and poorly vegetated with woody species. Herbaceous vegetation consisted of common ragweed, wild carrot and grass species. Woody species included staghorn sumac, Manitoba maple and white spruce. There was no canopy cover.

During the spring visit in April 2014, the site was dipped 10 times as it was too narrow and shallow to shock. The average wetted width and water depth obtained in April were 0.4 m and 3 cm (range 1-6 cm), respectively. No fish were captured.



**Photo 23 Drain 14 (Station 16) looking downstream from the upstream end.  
April 28, 2014**



**Photo 24 Drain 14 (Station 16) looking downstream from the upstream end.  
September 6, 2013**



### ***Drain 15***

Drain 15 was 843 m long and flowed from north to south veering to the west merging with McKinnon's Creek 1130 m upstream from Tenth Line Road. Again, this was a dug channel. The channel was recently cleaned and the banks were steep, near vertical in some areas, and tall. The upstream portion of this feature was recently filled in as part of the site preparation on Mattamy lands. The surrounding land consisted of a fallow agricultural field.

### **Station 17**

Station 17 was situated 15 m upstream of the confluence with McKinnon's Creek. The station length was 40 m. The entire station was dry in spring 2013. The average channel and bankfull depth were 1.8 m and 25 cm.

The substrate was composed of fines and was exposed. Little in-stream cover was provided by overhanging vegetation. Both banks were eroding

The banks were fully vegetated with herbaceous vegetation, and poorly vegetated with woody species. Herbaceous vegetation consisted of reed canary grass, common sow-thistle and wild carrot. Woody species included common buckthorn and pussy willow. There was no canopy cover.

During the spring visit in April 2014, the site was spot shocked for 154 seconds as it was too shallow to shock in areas. The average wetted width and water depth obtained in April were 0.4 m and 1 cm (range 1-2 cm), respectively. No fish were captured.



**Photo 25 Drain 15 (Station 17) looking upstream from the downstream end.  
April 28, 2014**



**Photo 26 Drain 15 (Station 17) looking upstream from the downstream end.  
September 6, 2013**

### *Drain 18*

Drain 20 was 312 m long and flowed from west to east emptying into McKinnon's Creek approximately 1849 m upstream from Tenth Line Road. The surrounding land consisted of an agricultural field (planted in soybeans) and overgrown stockpiles.

### **Station 26**

Station 26 was located 531 m upstream from the confluence with McKinnon's Creek. The station length was 52 m. The entire station was dry.

The substrate was composed of fines. Little in-stream cover consisted of aquatic vegetation (narrow-leaved cattail, wool-grass and reed canary grass).

The top of banks were fully vegetated with herbaceous vegetation. Herbaceous vegetation consisted of wheat. There was no canopy cover. The banks were only partially vegetated along their sides resulting in erosion from rain events.

This drain was not sampled for fish as it was dry.



**Photo 29 Drain 18 (Station 26) looking downstream from the upstream. April 12, 2016**



**Photo 30 Drain 18 (Station 26) looking downstream from the upstream. August 9, 2016**



## 4.0 HEADWATER DRAINAGE FEATURES ASSESSMENT

### 4.1 Classification

#### 4.1.1 Step 1: Hydrology Classification

In Step 1 the flow is classified based on the amounts recorded during the three visits. These are summarized in Table 4 (as per OSAP S4.M10).

The amount of rainfall recorded in the seven days preceding each station visit is summarized in Table 3 to provide context to the water depths in Table 4.

**Table 3 Summary of Rainfall for the 7 Days Preceding the Flow Surveys**

Dates	Total Rainfall (mm)
August 30, 2013 - September 6, 2013	30.4
September 10, 2013 - September 17, 2013	36.6
April 21, 2014-April 28, 2014	20.4
April 5, 2016-April 12, 2016	20.2
April 21- April 28, 2016	4.8
August 2, 2016-August 9, 2016	0

Total Rainfall taken from: Environment Canada. 2014 and 2016.  
National Climate Data and Information Archive – Ottawa INTL.  
On-line (<http://climate.weatheroffice.gc.ca>) accessed October 1,  
2014 and September 30, 2016.

While almost all of the channels were dug resulting in a straight pattern with defined banks (though these were still poorly defined in some instances) the amount of flow was not sufficient to carve a channel. As such, many features were fully vegetated in reed canary grass and other species that for the most part were not obligate wetland species giving them a swale classification. Others were vegetated in more wetland obligate species (cattails) and while the vegetation was mostly confined to the channel they were ranked as wetland.

Five features had standing water during the spring freshet (Drains 8, 10-12 and 18). All of the others contained substantial surface water flow during this visit. By the second visit most features had standing water only with the exception of four (Drains 1, 2, 6 and

13) which were dry. All features were dry come summer (note that there was little rainfall in the general area in the summer of 2016). Figures 3-5 depict the flow conditions during the three visits.

The five stations with standing water only during the first visit were classified as Limited. All others were ranked as Contributing. Contributing was chosen over Valued as none of the features had substantial or minimal flow during the second visit.



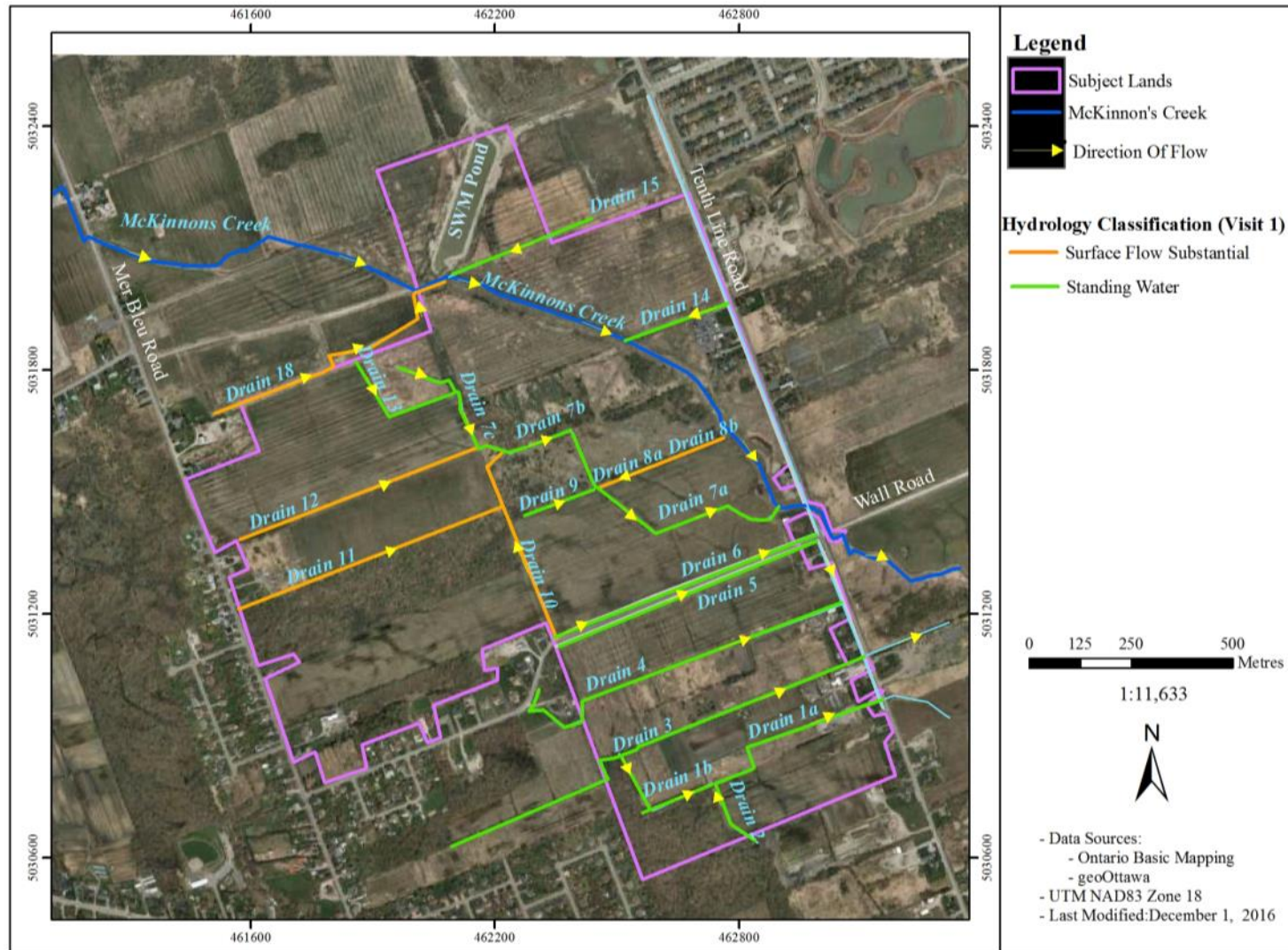
**Table 4 Hydrology classification features using data from OSAP S4.M10.**

Drain ID	Definitions of Flow Influence	Flow Conditions	Feature Code Type	Hydrology Classification
1a and 1b	Spring Freshet or rainfall events	Surface flow Substantial (5)	Swale (7)	Contributing
	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August	No surface water (1)		
2	Spring Freshet or rainfall events	Surface flow Substantial (5)	Channelized (2)	Contributing
	Late April-May	Standing water (2)	Likely dug ditch for draining purposes of agricultural field. Poorly defined banks in some areas.	
	July-August	No surface water (1)		
3	Spring Freshet or rainfall events	Surface flow Substantial (5)	Swale (7)	Contributing
	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August	No surface water (1)		
4	Spring Freshet or rainfall events	Surface flow Substantial (5)	Swale (7)	Contributing
	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August	No surface water (1)		
5 and 6	Spring Freshet or rainfall events	Surface flow Substantial (5)	Swale (7) or Roadside Ditch (8)	Contributing
	Late April-May	No surface water (1)	Note that Wall Road is not impervious.	
	July-August			
7	Spring Freshet or rainfall events	Surface flow Substantial (5)	Channelized (2)	Contributing
	Late April-May	No surface water (1)		
	July-August	No surface water (1)		

Drain ID	Definitions of Flow Influence	Flow Conditions	Feature Code Type	Hydrology Classification
			While this feature was also heavily vegetated it has been left as channelized at it appears to have been a natural channel at one time.	
8	Spring Freshet or rainfall events	Standing water (2)	Swale (7)	Limited
	Late April-May	No surface water (1)	Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August			
9	Spring Freshet or rainfall events	Surface flow Substantial (5)	Swale (7)	Contributing
	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August	No surface water (1)		
10	Spring Freshet or rainfall events	Standing water (2)	Swale (7)	Limited
	Late April-May		Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August	No surface water (1)		
11	Spring Freshet or rainfall events	Standing water (2)	Swale (7)	Limited
	Late April-May		Dug, straight channel that is fully vegetated mostly by reed canary grass.	
	July-August	No surface water (1)		
12	Spring Freshet or rainfall events	Standing water (2)	Wetland (6)	Limited
	Late April-May		Dug, straight channel that is fully vegetated but the plant species include cattails.	
	July-August	No surface water (1)		
13	Spring Freshet or rainfall events	Surface flow Substantial (5)	Wetland (6)	Contributing

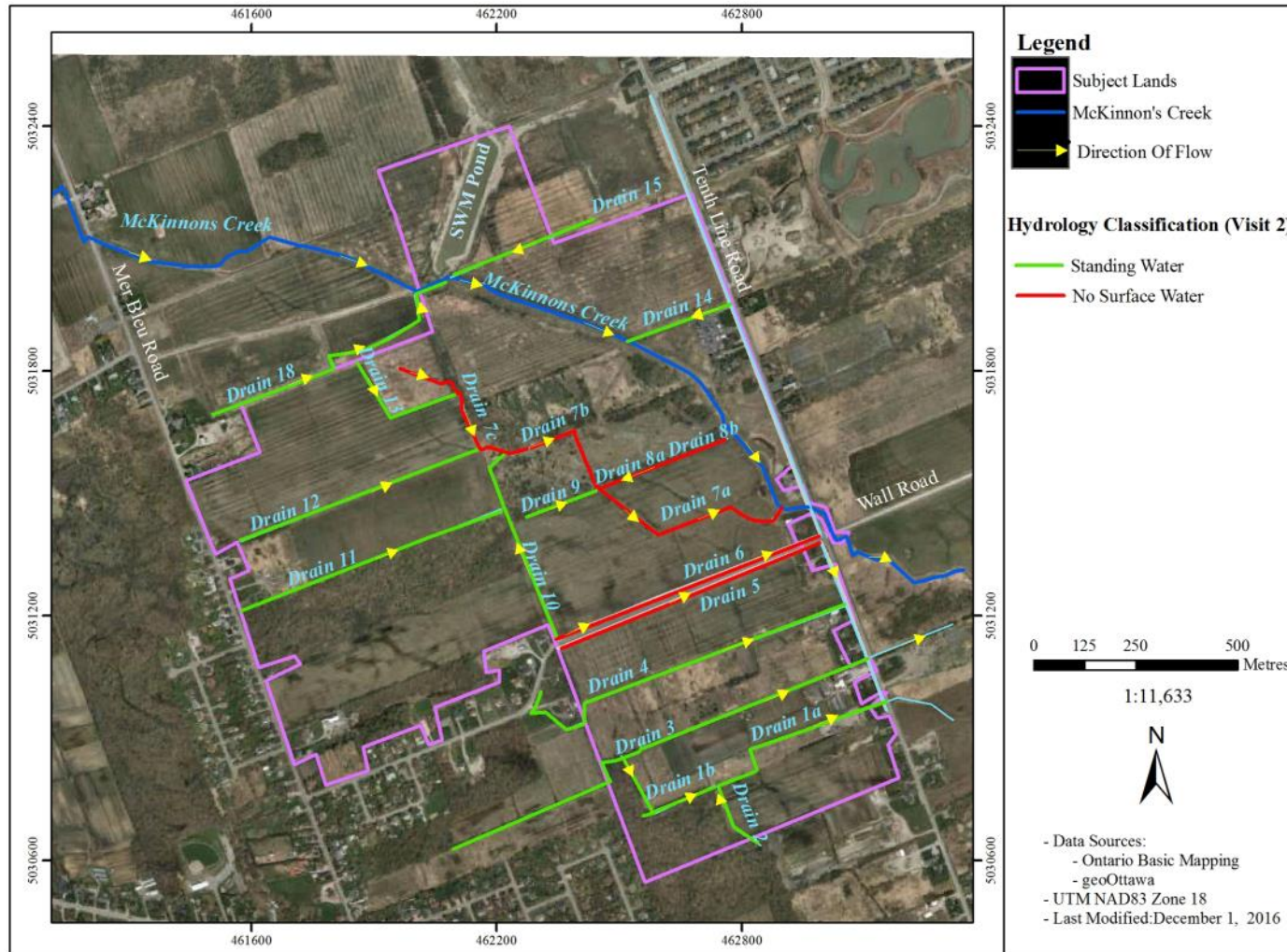
Drain ID	Definitions of Flow Influence	Flow Conditions	Feature Code Type	Hydrology Classification
14	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated but the plant species include cattails.	Contributing
	July-August	No surface water (1)		
	Spring Freshet or rainfall events	Surface flow Substantial (5)	Swale (7)	
15	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated mostly by reed canary grass.	Contributing
	July-August	No surface water (1)		
	Spring Freshet or rainfall events	Surface flow Substantial (5)	Channelized (2)	
18	Late April-May	Standing water (2)	Entire length remained as a straight dug channel.	Limited
	July-August	No surface water (1)		
	Spring Freshet or rainfall events	Standing water (2)	Wetland (6)	
18	Late April-May	Standing water (2)	Dug, straight channel that is fully vegetated but the plant species included cattails.	Limited
	July-August	No surface water (1)		

**Figure 3 Summary of Flow Conditions (Visit 1)**

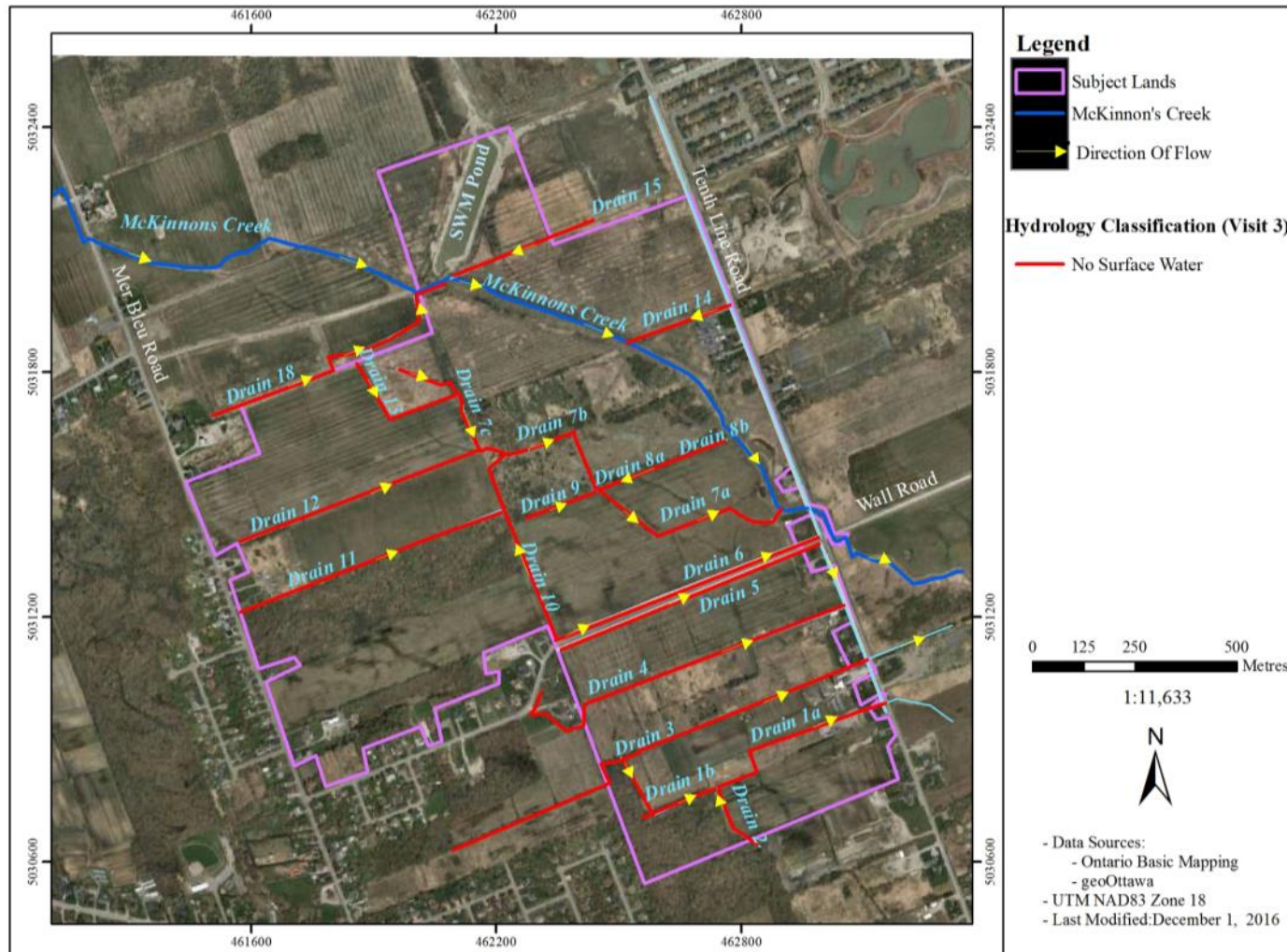




**Figure 4 Summary of Flow Conditions (Visit 2)**



**Figure 5 Summary of Flow Conditions (Visit 3)**



#### 4.1.2 Step 2: Riparian Classification

In Step 2 the riparian habitat is classified based on the width and type of vegetation on the banks. The differences in riparian classification on the same feature resulted in reach breaks on drains 1, 7 and 8. These are summarized in Table 5.

**Table 5 Riparian Classification**

Drain	Riparian Feature Code (OSAP S4.M10)	Riparian Classification	Comments
<b>1a</b>	3 (cropped)	Limited	In the subject lands the feature is surrounded by an agricultural field that was hayed in 2015.
<b>1b</b>	3 (cropped) 6 (forest)	Important	This upstream section travels along the woodland with a small wetland component. The channel does not enter the wetland.
<b>2</b>	3 (cropped) 6 (forest)	Important	In the subject lands the feature is surrounded by an agricultural field that was hayed in 2015. Upstream there is a woodland with a small wetland component. The channel does not enter the wetland.
<b>3</b>	3 (Cropped)	Limited	In the subject lands the feature is surrounded by an agricultural field that was hayed in 2015.
<b>4</b>	3 (Cropped)	Limited	In the subject lands the feature is surrounded by an agricultural field that was hayed in 2015.
<b>5 and 6</b>	1 (None) 3 (Cropped)	Limited	The feature is located along the edge of Wall Road and an agricultural field (hay in 2015 for Drain 5 and soybeans in 2016 for Drain 6).
<b>7a and 7c</b>	3 (Cropped)	Limited	Upper and lower portions of feature are located within a soybean field.
<b>7b</b>	5 (Scrubland) 6 (Forest)	Important	Middle section of channel travels within the thicket and woodland communities.

Drain	Riparian Feature Code (OSAP S4.M10)	Riparian Classification	Comments
<b>8a</b>	3 (Cropped) 5 (Scrubland)	Limited	Located within an agricultural field.
<b>8b</b>	3 (Cropped) 5 (Scrubland)	Important	The very upstream end travels in the thicket.
<b>9</b>	3 (Cropped) 5 (Scrubland)	Important	The south side fallows along a soybean field. The north side includes both thicket and woodland communities.
<b>10</b>	3 (Cropped) 5 (Scrubland)	Important	The feature is surrounded by an agricultural field to the west (soybeans) and a cultural woodland area to the east.
<b>11</b>	3 (Cropped) 6 (Forest)	Important	Feature contains an agricultural field to the north and a deciduous forest to the south.
<b>12</b>	3 (Cropped)	Limited	Feature contains an agricultural field (soybean on north) with a hedgerow running along it.
<b>13</b>	3 (Cropped)	Limited	The feature is surrounded by an agricultural field (soybean).
<b>14</b>	3 (Cropped)	Limited	The feature is surrounded by an agricultural field (soybean on north).
<b>15</b>	3 (Cropped)	Limited	The feature is surrounded by an agricultural field (soybean on south) and construction area on north.
<b>18</b>	3 (Cropped)	Limited	The feature is located within an agricultural field. South of the feature overgrown stockpiles are present.



#### **4.1.3 Step 3: Fish and Fish Habitat Classification**

The fish habitat is classified based on fish observations during the spring and summer. Features that provide habitat for Species at Risk or critical (spawning) habitat would be considered the most significant.

The fish habitat is classified based on fish observations during the spring of April 2014. All Drains have been listed as Contributing for the following reasons:

- No critical habitat or species at risk or species of conservation is present in any of the headwater features as no fish were present in any of the drains
- All features flow into McKinnon's Creek and eventually into Bear Brook River. The contribution of allochthonous material downstream via these ephemeral channels with little flow would not affect the overall productivity of such a large watercourse.

#### **4.1.4 Step 4: Terrestrial Habitat Classification**

This step is more of a classification of amphibian habitat than of the terrestrial habitat. According to the guidelines, only those features associated with wetland habitats can be considered Important or Valued. Features classed as Contributing are those that may or do provide a linkage between habitat for wildlife movement and Limited is given to those that do not meet any of the above criteria.

At a landscape scale, these features do not provide good corridor options as they are one or more of: poorly defined, very short or lead to Tenth Line Road or into residential areas. While there is a small wetland located within 400 m of Drains 1 and 2 it does not lead to any other wetlands and aquatic habitat and as such does not provide stepping stone function.

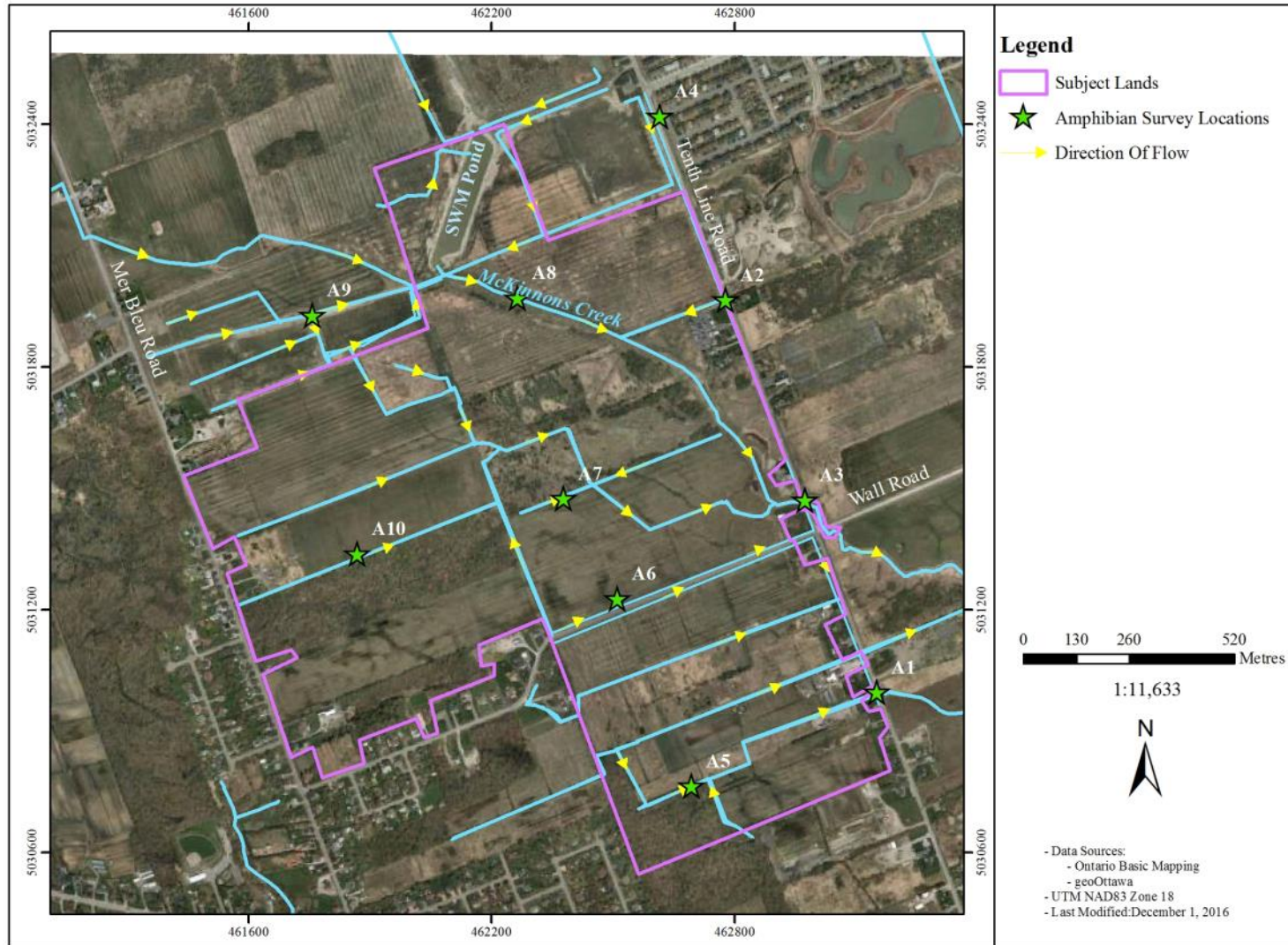
The MMP amphibian monitoring protocol was followed with the extra step of identifying whether or not amphibians were calling from the specific feature or not. Details are provided in Appendix A.

**Table 6 Terrestrial Habitat Classification**

<b>Drain</b>	<b>Riparian Condition (OSAP S4.M10)</b>	<b>Marsh Monitoring Protocol Calling Code</b>	<b>Comments</b>	<b>Classification</b>
<b>1a and 1b</b>	3 (cropped) 6 (forest)	2 or 3	During all three visits there were frogs present. Located within 400m of a small wetland feature.	Limited
<b>2</b>	3 (cropped) 6 (forest)	2 or 3	During all three visits there were frogs present. Located within 400m of a small wetland feature.	Limited
<b>3</b>	3 (Cropped)	0	No frogs calling	Limited
<b>4</b>	3 (Cropped)	0	No frogs calling	Limited
<b>5 and 6</b>	1 (None) 3 (Cropped)	1	Few calls. These features are roadside ditch.	Limited
<b>7a-c</b>	3 (Cropped) 5 (Scrubland) 6 (Forest)	0	There were no frogs located within the feature.	Limited
<b>8a and 8b</b>	3 (Cropped) 5 (Scrubland)	1	Few calls.	Limited
<b>9</b>	3 (Cropped) 5 (Scrubland)	1	Few calls.	Limited
<b>10</b>	3 (Cropped) 5 (Scrubland)	0	No frogs	Limited
<b>11</b>	3 (Cropped) 6 (Forest)	3	Many frog calls heard in a fresh moist poplar deciduous forest to the south	Limited
<b>12</b>	3 (Cropped)	0	No frogs	Limited
<b>13</b>	3 (Cropped)	0	No frogs	Limited
<b>14</b>	3 (Cropped)	0	No frogs	Limited

Drain	Riparian Condition (OSAP S4.M10)	Marsh Monitoring Protocol Calling Code	Comments	Classification
<b>15</b>	3 (Cropped)	0	No frogs	Limited
<b>18</b>	3 (Cropped)	0	No frogs	Limited

**Figure 6 Amphibian Survey Stations**





## **4.2 Part 3 – Management Recommendations**

The management recommendations are grouped into six categories: protection, conservation, mitigation, maintain recharge, maintain/ replicate terrestrial linkage, and no management required.

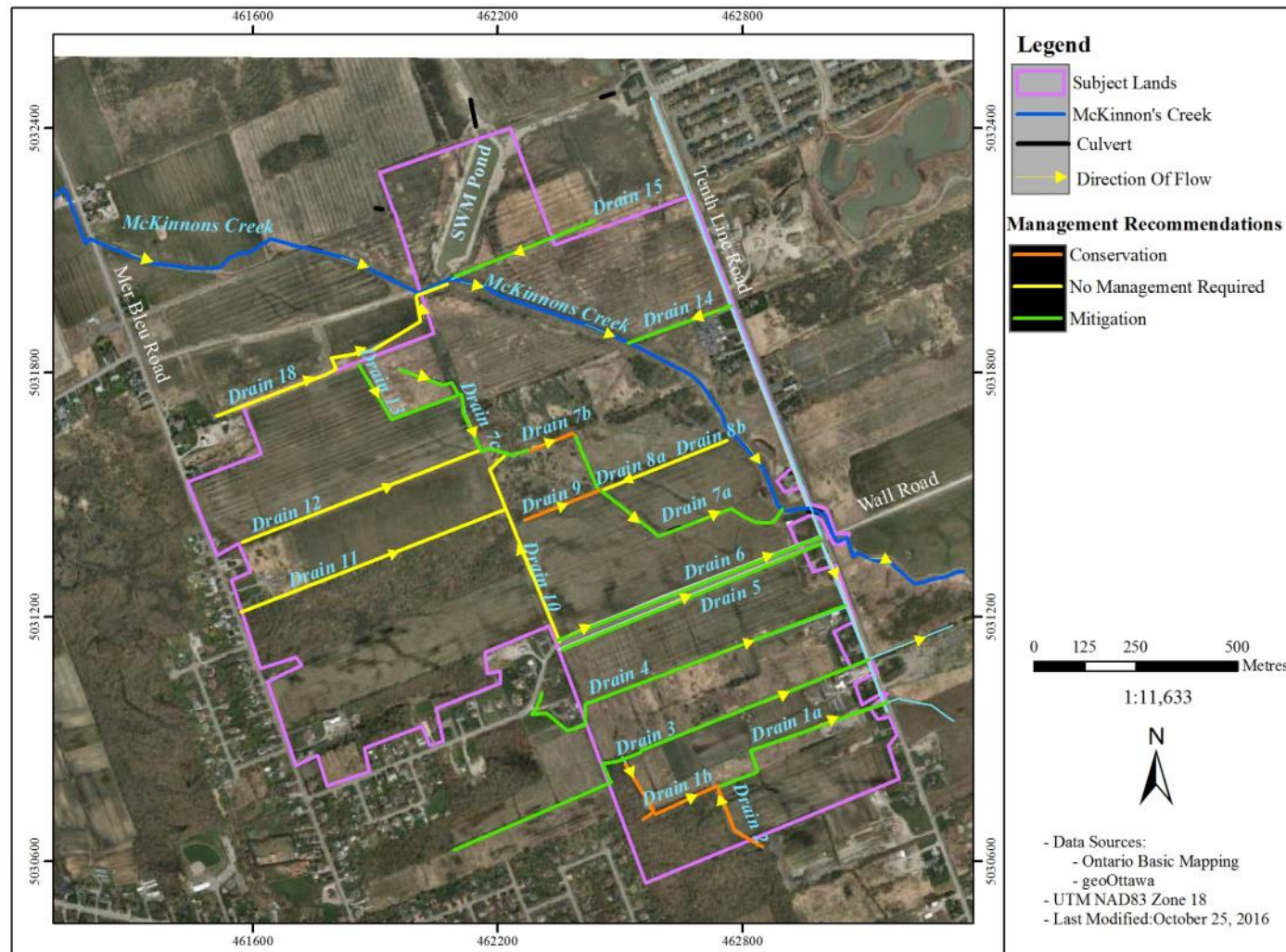
The classification of Contributing hydrology together with Limited fish and terrestrial habitat resulted in many features being ranked as either Conservation (those with Important terrestrial habitat) (Drains 1, 2, 7b, and 9) or Mitigation (those with Limited terrestrial habitat) (Drains 1a, 3, 4, 5, 6, 7a, 7c, 13, 14 and 15). The features with Limited hydrology were all classed as No Management Required (Drains 8a, 8b, 10, 11, 12 and 18).

**Table 7 Evaluation, Classification and Management Summary**

Drainage Feature Segment	Hydrology Classification	Fish and Fish Habitat Classification	Terrestrial Habitat Classification	Riparian Classification	Management Recommendation
<b>1a</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>1b</b>				Important	Conservation
<b>2</b>	Contributing	Contributing	Limited	Important	Conservation
<b>3</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>4</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>5 and 6</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>7a and 7c</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>7b</b>				Important	Conservation
<b>8a, 8b</b>	Limited	Contributing	Limited	Important (but only for a small section) rest is Limited	No Management Required
<b>9</b>	Contributing	Contributing	Limited	Important	Conservation
<b>10</b>	Limited	Contributing	Limited	Important	No Management Required
<b>11</b>	Limited	Contributing	Limited	Important	No Management Required
<b>12</b>	Limited	Contributing	Limited	Limited	No Management Required

Drainage Feature Segment	Hydrology Classification	Fish and Fish Habitat Classification	Terrestrial Habitat Classification	Riparian Classification	Management Recommendation
<b>13</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>14</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>15</b>	Contributing	Contributing	Limited	Limited	Mitigation
<b>18</b>	Limited	Contributing	Limited	Limited	No Management Required

**Figure 7 Summary of Management Recommendations**





## 5.0 SUMMARY

The study area included the headwater features that flowed into McKinnon's Creek. The features were visited multiple times during various years including three visits during 2016 for flow classification. Almost all had been channelized to some degree. All features contained water and substantial surface flow present during the spring freshet visit with the exceptions of Drains 8, 10, 11, 12 and 18 which only contained standing water. By the second visit in April all features were either dry (Drains 1, 2, 6 and 13) or contained standing water. All features were dry come the summer. None of these features contained fish habitat. The only two features associated with a wetland (located near but not on the feature) were Drains 1 and 2.

The management implications and options are as followed (as described in the guideline):

### Mitigation:

1. The channel may be maintained, relocated or enhanced. No natural channel design is required. Can be replaced by well-vegetated swales or constructed wetland features.
2. Replicate on-site flow and outlet flows at the upstream end of the system to maintain.
3. Direct connection to downstream.

### Conversation:

1. The channel may be maintained, relocated or enhanced. It is noted that should the channel be relocated then it is to be done using natural channel design.
2. The groundwater or wetland contribution is to be maintained or replicated. If the catchment drainage will be removed as part of the development then the function should be restored through enhancement of lot level control (i.e. restore original catchment using clean roof drainage), as feasible
3. Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary.
4. Maintain or replace external flows
5. Drainage feature must connect to downstream

## **6.0 REFERENCES**

Evaluation, Classification and Management of Headwater Drainage Features Guideline. Toronto and Region Conservation Authority and Credit Valley Conservation, TRCA Approval July 2013 (Finalized January 2014).

Marsh Monitoring Program Participant's Handbook Surveying Amphibians. 2008 Edition. 20 pages. Published by Bird Studies Canada in cooperation with Environment Canada and the U.S. Environmental Protection Agency. February 2008.