Kemptville Creek Subwatershed Report 2013
Oxford Mills Catchment

RIDEAU VALLEY CONSERVATION AUTHORITY

The RVCA produces individual reports for six catchments in the Kemptville Creek Subwatershed. Using data collected and analysed by the RVCA through its watershed monitoring and land cover classification programs, surface water quality conditions are reported for Kemptville Creek along with a summary of environmental conditions for the surrounding countryside every six years.

This information is used to help better understand the effects of human activity on our water resources, allows us to better track environmental change over time and helps focus watershed management actions where they are needed the most.

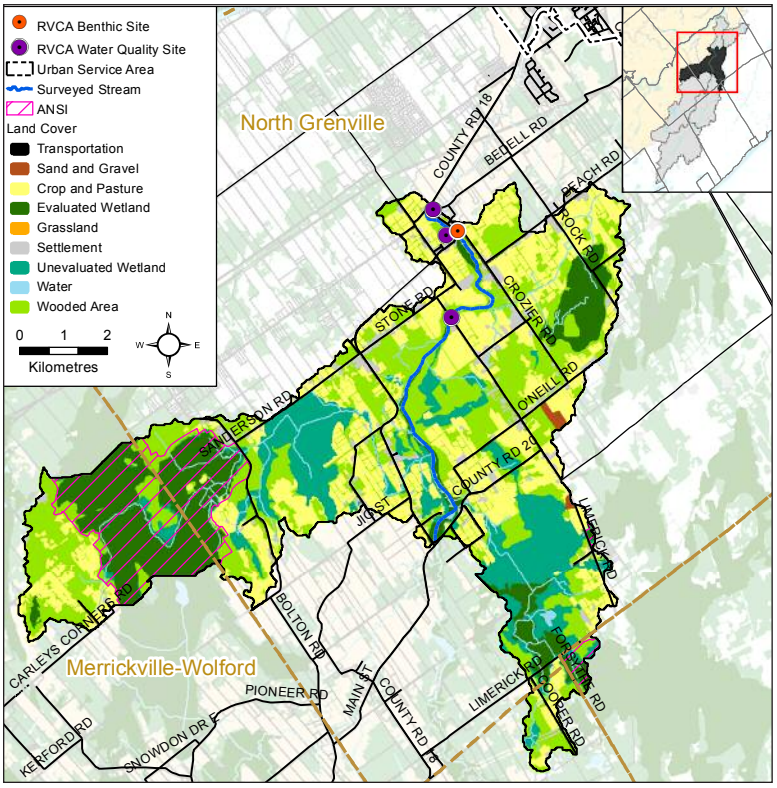
The following pages of this report are a compilation of that work. For other Kemptville Creek catchments and the Kemptville Creek Subwatershed Report, please visit the RVCA website at www.rvca.ca.

What's Inside

Catchment Facts

General Geography

- Oxford Mills is the main settlement area in the catchment. The remainder of the catchment is predominantly rural in character with agriculture being the main land use



- Eighty-one percent of the catchment lies within the Municipality of North Grenville, 16 percent within the Village of Merrickville-Wolford and three percent within Augusta Township

Physical Geography

- The lower half of the catchment (northeast) lies within the Edwardsburg Sand Plain and is made up of sand and clay plains, where Kemptville Creek runs over the clay plains. The upper half of the catchment (southwest) lies within the Smith Falls Limestone Plain. Dolostone, with thinner layers of shale and sandstone, forms the upper geology of the limestone plain and underlies the local sand and clay plains
- The drainage area of 73 square kilometres occupies 16 percent of the Kemptville Creek Subwatershed, less than two percent of the Rideau Valley Watershed and contains one municipal drain
- Dominant land cover is wetland (33 percent), woodland (31 percent) and crop and pastureland (29 percent). Settlement (five percent) and transportation (two percent) occupy the rest of the landscape

Vulnerable Areas

- Flood plain mapping has been available along Kemptville Creek through Oxford Mills since 2009 and regulated since then
- The sand plain along the eastern stretch of the catchment is associated with a regionally important esker feature which is mapped as a significant groundwater recharge area. Shallow bedrock, especially in areas with very thin soils, is mapped as highly vulnerable to land use activities. The northern stretch of the catchment is within the combined wellhead protection area for the Kemptville municipal wells
- Hydrologic model developed by the RVCA has improved our understanding of the effect of the Oxford Mills Dam on land drainage/water levels upstream of the water control structure. Results indicate that during low flow periods in the summer months, it controls water levels all the way upstream to the vicinity of Garreton and Diamond Roads (over a distance of 19.5

kilometres). However, the dam has a limited influence on upstream water levels during wet periods, with naturally occurring constrictions/obstacles (i.e., rock ledges/outcrops, beaver dams/debris) along the reach between Patterson's Corners Road and Garreton having a greater effect. The model has also helped MNR refine its dam operating procedures, in response to landowner concerns raised about upstream water levels that are associated with poor land drainage and a lessening of wildlife habitat values and aesthetics along Kemptville Creek

Development Trends

- Limited residential development has occurred recently through individual lot severance and a plan of subdivision

Conditions at a Glance

- Water quality rating along Kemptville Creek through Oxford Mills is "Fair" and has declined at the three sites over a 12 year reporting period (2001-2006 vs. 2007-2012)
- Woodland cover proportion has decreased by three percent (218 hectares) from 2002 to 2008, due to a combination of changes in land cover and land use
- The riparian buffer (30 metres wide along both sides of Kemptville Creek and its tributaries) is made up of wetland (63 percent), woodland (21 percent), crop and pastureland (13 percent), settlement areas (two percent) and transportation (one percent)
- A warm/cool water baitfish and recreational fishery of 28 fish species is present
- Contains one municipal drain

Catchment Care

- Kemptville Creek Beaver Dam Management Pilot Project undertaken from 2003 to 2007 to address uncontrolled beaver activity along the North and South Branch of Kemptville Creek and its main stem to the Oxford Mills Dam. Subsequent work carried out by the RVCA, including beaver dam survey work and beaver and dam removal, has had a positive effect on the aquatic ecosystem and is an effective and welcome response to landowners concerns about high water levels and its effect on land drainage. Benefits include reduction in damage to woodlots and improved agricultural drainage adjacent to the creek, along with improved aquatic habitat
- Twenty-eight stewardship projects (Rural Clean Water/Tree Planting) have been completed (from 2003 to 2012)
- Fish sampling conducted on Kemptville Creek and its tributaries (RVCA, 2011)
- Annual benthic macroinvertebrate sampling downstream of Bridge Street in Oxford Mills since 2011 (RVCA)
- RVCA macro stream surveys in 2011 on Kemptville Creek, taking measurements and recording observations on instream habitat, bank stability, other attributes and preparing a temperature profile
- RVCA maintains one flowing (artesian) Provincial Groundwater Monitoring Network well in the catchment; related water level data is available from the Ontario Ministry of Environment
- MOE well records show about 585 water wells in the catchment (21 percent of all wells in the Kemptville Creek Subwatershed)
- Ducks Unlimited holds a Permit to Take Water for a wetland habitat initiative
- Watershed model developed by the RVCA in 2009 was used to study the hydrological function of wetlands in the Rideau Valley Watershed, including those found in the Oxford Mills catchment

1. Oxford Mills Surface Water Quality Conditions

Assessment of streams in the Kemptville Creek watershed is based on 22 parameters including nutrients (total phosphorus, total Kjeldahl nitrogen, and ammonia), *E. coli,* metals (like aluminum and copper) and additional chemical/physical parameters (such as alkalinity, chlorides, pH and total suspended solids). Each parameter is evaluated against established guidelines to determine water quality conditions. Those parameters that frequently exceed guidelines are presented below.

The assessment of water quality throughout the Kemptville Creek Subwatershed also looks at water quality targets that are presented in the *2007 Kemptville Creek Watershed Plan Update* (KCWP). The KCWP identifies nutrient and bacteria loading to be of concern as well as maintaining and/or improving water quality aesthetics throughout the Kemptville Creek watershed.

Surface water quality conditions in Kemptville Creek are monitored through the RVCA's Baseline Water Quality Monitoring Program. See Figure 1 and Table 2 for monitoring site locations.

The water quality rating for Kemptville Creek within the Oxford Mills catchment is reported as "Fair" at all sites as determined by the CCME Water Quality Index (CCME WQI); analysis of the data has been broken into two periods 2001–2006 and 2007–2012, to examine if conditions have changed within this timeframe. Water quality scores are largely influenced by nutrient concentrations. For more information on the CCME WQI please see the *Kemptville Creek Subwatershed Report.*

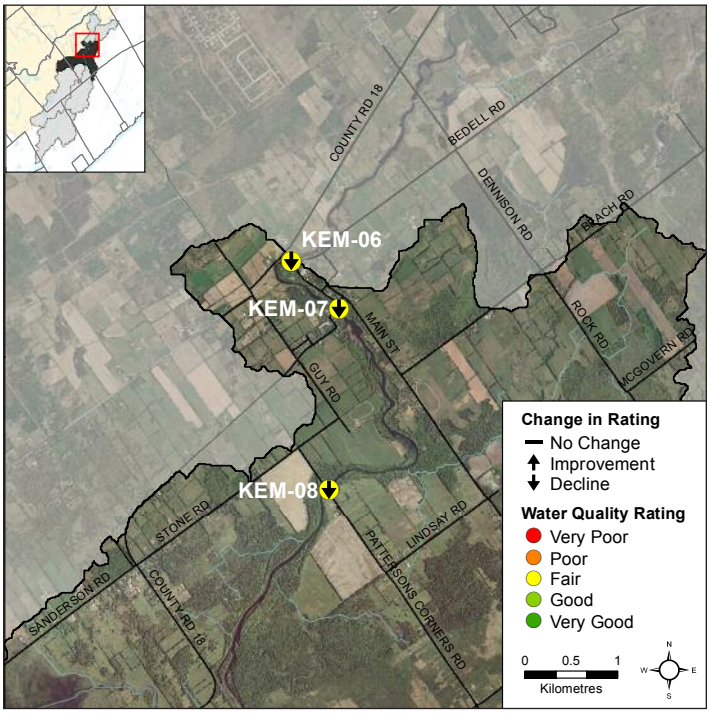


Figure 1 Water quality in Oxford Mills. The rating shown on the map is for the 2007–2012 period. Arrows are used to show a change in the rating from the 2001–2006 period.

Table 1 WQI Ratings and corresponding index scores (RVCA terminology, original WQI category names in brackets)

Rating	Index Score
Very good (Excellent)	95-100
Good	80-94
Fair	65-79
Poor (Marginal)	45-64
Very poor (Poor)	0-44

Table 2 WQI Ratings for South Branch from 2001–2006 and 2007–2012

Sampling Site	Nearest interesction	2001–2006	Rating
KEM-08	South of Stone Rd. and Patterson's Corners Rd.	86	Good
KEM-07	Oxford Mills dam	84	Good
KEM-06	Main St. and County Rd.18	86	Good
Sampling Site	**Nearest interesction**	**2007–2012**	**Rating**
KEM-08	South of Stone Rd. and Patterson's Corners Rd.	78	Fair
KEM-07	Oxford Mills dam	70	Fair
KEM-06	Main St. and County Rd.18	72	Fair

Oxford Mills Branch Nutrients

Total phosphorus (TP) is used as a primary indicator of excessive nutrient loading and may contribute to abundant aquatic vegetation growth and depleted dissolved oxygen levels. The Provincial Water Quality Objective (PWQO) of 0.030 mg/l is used as the TP Guideline. Concentrations greater than 0.030 mg/l indicate an excessive amount of TP.

Total Kjeldahl nitrogen (TKN) and ammonia (NH_3) are used as secondary indicators of nutrient loadings. RVCA uses a guideline of 0.500 mg/l to assess TKN[1] and the PWQO of 0.020 mg/l to assess ammonia concentrations in Oxford Mills.

Tables 3, 4 and 5 summarize average nutrient concentration at monitored sites on Kemptville Creek and show the proportion of results that meet the guidelines.

KEM-08

Site KEM-08 is the most upstream sites within the Oxford Mills catchment. The majority of samples at KEM-08 were below the TP guideline; 90 percent of samples were below the guideline in the 2001–2006 period (Figure 2a) and declined to 85 percent of samples in the 2007–2012 period (Figure 2b). Average TP concentration increased from 0.020 mg/l (2001–2006) to 0.027 mg/l (2007–2012).

TKN results show that the bulk of results exceeded the guideline (Figures 3a and 3b); only 13 percent of samples were below the guideline in the 2001–2006 period and declined to five percent in the 2007–2012 period. The average concentration increased from 0.802 mg/l to 0.848 mg/l. NH_3 results at this site were generally below the guideline of 0.020 mg/l (Figures 4a and 4b); the proportion of samples below the guideline improved from 97 percent to 100 percent. This was complemented by a decrease in the average concentration from 0.007 mg/l (2001–2006) to 0.006 mg/l (2007–2012).

Table 3 Summary of total phosphorus results for Oxford Mills from 2001–2006 and 2007–2012

Total Phosphorus 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-08	0.020	90%	31
KEM-07	0.020	94%	31
KEM-06	0.019	94%	31
Total Phosphorus 2007-2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-08	0.027	85%	38
KEM-07	0.028	74%	38
KEM-06	0.021	90%	39

Table 4 Summary of total Kjeldahl nitrogen results for Oxford Mills from 2001–2006 and 2007–2012, highlighted values indicate average concentrations exceed the guideline

Total Kjeldahl Nitrogen 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-08	0.802	13%	31
KEM-07	0.801	10%	31
KEM-06	0.787	13%	31
Total Kjeldahl Nitrogen 2007-2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-08	0.848	5%	39
KEM-07	0.837	5%	39
KEM-06	0.762	5%	39

KEM-07

The majority of samples at site KEM-07 were also below the TP guideline for both time periods (Figures 2a and 2b); 94 percent of samples were below the guideline in the 2001-2006 period and declined to 74 percent of samples in the 2007–2012 period. Average TP concentration increased from 0.020 mg/l (2001–2006) to 0.028 mg/l (2007–2012).

[1] No Ontario guideline for TKN is presently available however waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l, Environment Canada (1979) *Water Quality Sourcebook, A Guide to Water Quality Parameters,* Inland Waters Directorate, Water Quality Branch, Ottawa, Canada

Table 5 Summary of ammonia results for Oxford Mills from 2001–2006 and 2007–2012

Ammonia 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-08	0.007	97%	31
KEM-07	0.009	97%	31
KEM-06	0.009	94%	31
Ammonia 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-08	0.006	100%	39
KEM-07	0.008	95%	39
KEM-06	0.008	97%	39

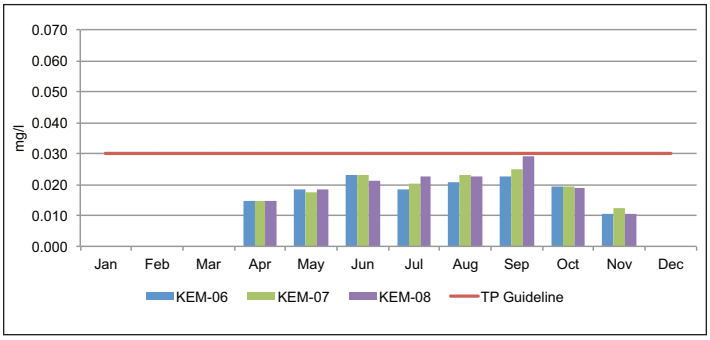


Figure 2a Total phosphorus concentrations in Oxford Mills from 2001–2006

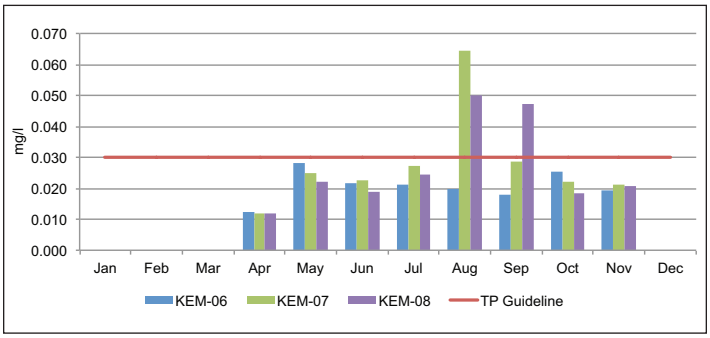


Figure 2b Total phosphorus concentrations in Oxford Mills from 2007-2012

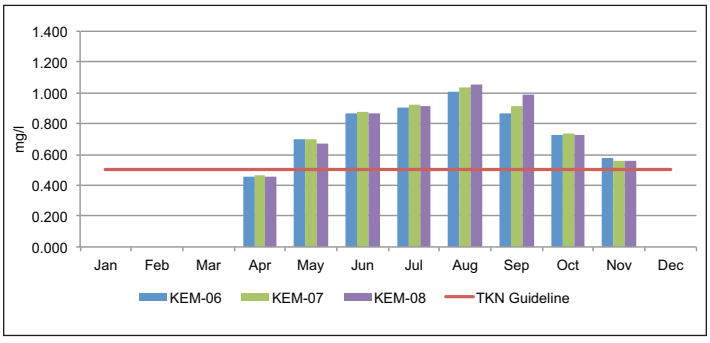


Figure 3a Total Kjeldahl nitrogen concentrations in Oxford Mills from 2001–2006

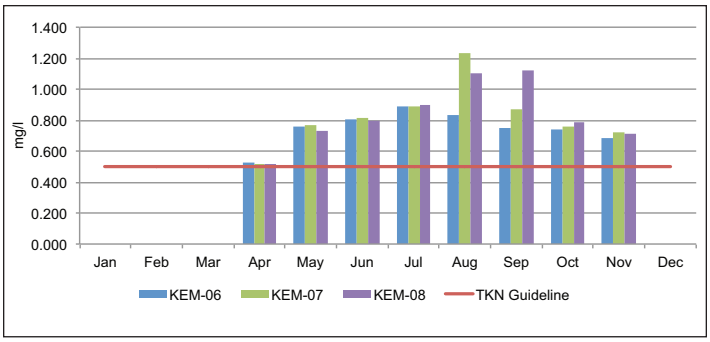


Figure 3b Total Kjeldahl nitrogen concentrations in Oxford Mills from 2007–2012

TKN results show that most results exceeded the guideline (Figures 3a and 3b); 10 percent of samples were below the guideline in the 2001–2006 period and decreased to only five percent of samples in 2007–2012. The average concentration increased from 0.801 mg/l (2001–2006) to 0.837 mg/l (2007–2012). The majority of NH_3 results reported low concentrations, the proportion of samples below the guideline declined marginally from 97 percent to 95 percent (Figures 4a and 4b). A slight change was also observed in the average concentration which decreased from 0.009 mg/l (2001–2006) to 0.008 mg/l (2007-2012).

KEM-06

KEM-06 is the most downstream site within this catchment and results were comparable to those upstream. Most sample results were below the TP guideline for both time periods (Figures 2a and 2b); 94 percent of samples were below the guideline in the 2001–2006 period and decreased slightly to 90 percent of samples in the 2007–2012 period. There was little change in average TP concentration from 0.019 mg/l (2001–2006) to 0.021 mg/l (2007–2012).

Figures 3a and 3b show that the majority of results exceeded the TKN guideline; 13 percent of samples were below the guideline in 2001–2006 and declined to five percent in the 2007-2012 period. The average concentration decreased slightly from 0.787 mg/l (2001-2006) to 0.762 mg/l (2007–2012), and continued to exceed the guideline. The majority of NH_3 results were well below the guideline (Figures 4a and 4b); the proportion of samples below the guideline improved from 94 percent to 97 percent. There was little change observed in the average concentration which decreased from 0.009 mg/l (2001–2006) to 0.008 mg/l (2007–2012).

Oxford Mills Nutrients Summary

The data shows that nutrient enrichment continues to be a concern in Oxford Mills. Water quality guidelines for TP and NH_3 are generally met at monitored sites. However, TKN concentrations are elevated with frequent exceedances across all sites and may be influenced by the organic matter held by the large wetland areas found upstream of the catchment in the Kemptville Creek Subwatershed, resulting in naturally high concentrations of organic nitrogen.

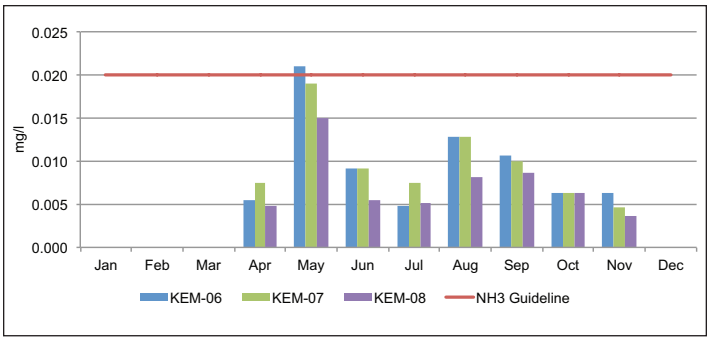


Figure 4a Ammonia concentrations in Oxford Mills from 2001–2006

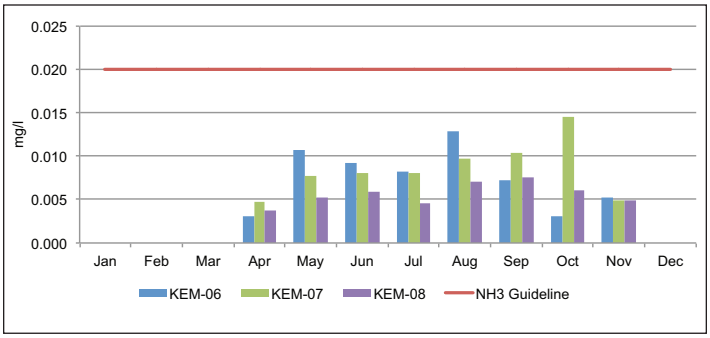


Figure 4b Ammonia concentrations in Oxford Mills from 2007–2012

Oxford Mills *E. coli*

E. coli is used as an indicator of bacterial pollution from human or animal waste; in elevated concentrations it can pose a risk to human health. The PWQO of 100 colony forming units/100 milliliters (CFU/100 ml) is used to assess *E. coli*. Counts greater than this guideline indicate that bacterial contamination may be a problem within a waterbody. The KCWP also set a target of *E. coli* counts of 100 CFU/100 ml at the 70th percentile for Kemptville Creek.

Table 6 summarizes the geometric mean[2] at monitored sites on Kemptville Creek and shows the proportion of samples that meet the *E. coli* guideline of 100 CFU/100 ml.

Figure 5 shows the results of the geometric mean with respect to the guideline for the two periods, 2001–2006 and 2007–2012. Figure 6 shows percentile plots of the data for the two time periods of interest. Any point to the left of the 70th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the KCWP target.

KEM-08

E. coli counts at site KEM-08 show bacterial counts have remained consistent and there is little evidence that bacterial contamination should be considered a problem. Counts at the 70th percentile increased marginally from 36 CFU/100 ml (Figure 6a) to 37 CFU/100 ml (Figure 6b), and were below the target set by the KCWP. The proportion of samples below the guideline remained unchanged at 87 percent (Figures 5a and 5b). The count at the geometric mean increased slightly from 23 CFU/100 ml (2001–2006) to 28 CFU/100 ml (2007–2012).

KEM-07

E. coli counts increased slightly at the 70th percentile over the two monitoring periods at site KEM-07, from 32 CFU/100 ml (Figure 6a) to 38 CFU/100 ml (Figure 6b). The proportion of samples below the guideline decreased from 93 percent (Figure 5a) to 90 percent (Figure 5b), and the count at the geometric mean increased from 19 CFU/100 ml (2001–2006) to 24 CFU/100 ml (2007–2012).

KEM-06

Percentile plots of *E. coli* data at site KEM-06 show the 70th percentile target was achieved in both time periods. The *E. coli* count at the 70th percentile decreased from 55 CFU/100 ml (Figure 6a) to 34 CFU/100 ml (Figure 6b). The proportion of samples below the guideline increased

Table 6 Summary of *E. coli* results for Oxford Mills from 2001–2006 and 2007–2012

***E. coli* 2001–2006**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
KEM-08	23	87%	30
KEM-07	19	93%	30
KEM-006	26	83%	29
***E. coli* 2007–2012**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
KEM-08	28	87%	39
KEM-07	24	90%	39
KEM-06	24	87%	39

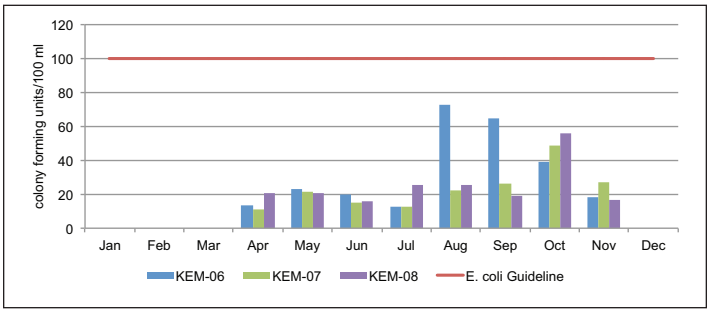


Figure 5a *E. coli* counts in Oxford Mills from 2001–2006

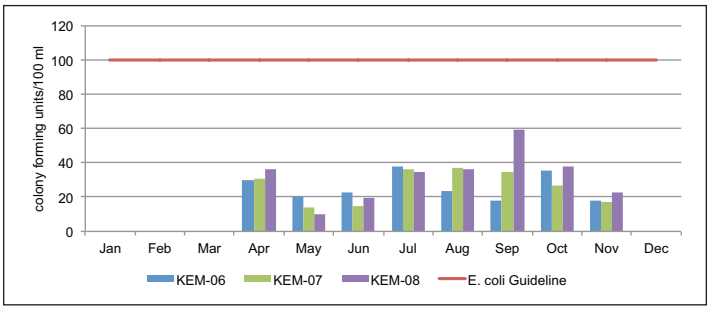


Figure 5b *E. coli* counts in Oxford Mills from 2007–2012

[2] A type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). It is often used to summarize a variable that varies over several orders of magnitude, such as *E. coli* counts.

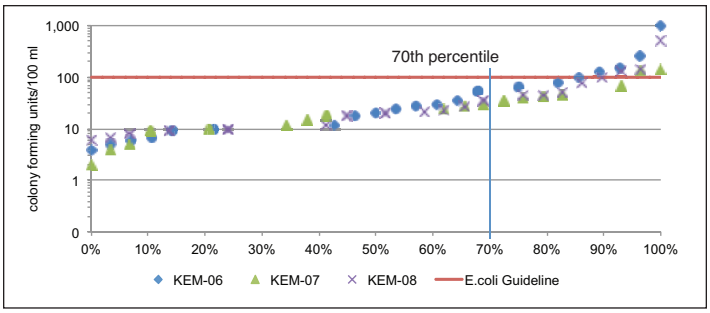


Figure 6a Percentile plots of *E. coli* in Oxford Mills for 2001–2006

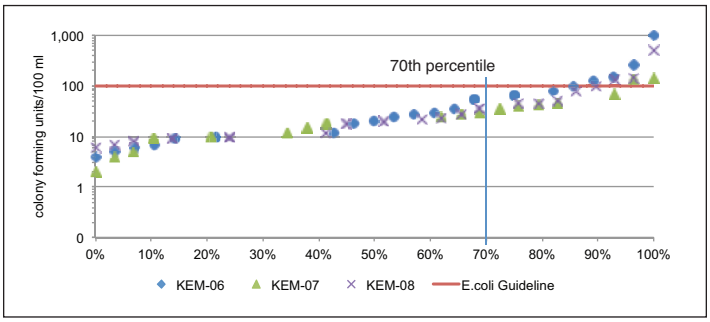


Figure 6b Percentile plots of *E. coli* in Oxford Mills for 2007–2012

from 83 percent (Figure 5a) to 87 percent (Figure 5b), indicating higher counts occur less frequently. Counts at the geometric mean also decreased slightly from 26 CFU/100 ml (2001–2006) to 24 CFU/100 ml (2007–2012).

E. coli Summary

The results indicate that bacterial contamination is not a significant concern within the Oxford Mills Catchment of Kemptville Creek. The target set by the KCWP was achieved at each site and the majority of results are below the established guideline.

Kemptville Creek in the Oxford Mills catchment

2. Oxford Mills Riparian Conditions

OXFORD MILLS OVERBANK ZONE

Riparian Buffer Width Evaluation

Figure 7 shows the extent of the naturally vegetated riparian zone in the catchment, 30 metres on either side of all water bodies and watercourses. Results from the RVCA's Land Cover Classification Program show that 84 percent of rivers, streams and creeks are buffered with woodland, and wetland; the remaining 16 percent of the riparian buffer is occupied by settlement, transportation and crop and pastureland.

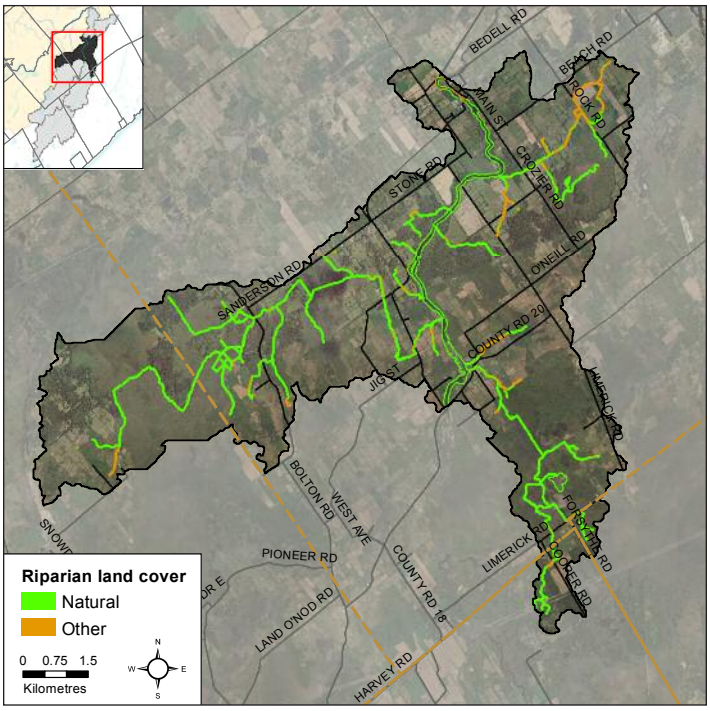


Figure 7 Natural and other riparian land cover in Oxford Mills catchment

The riparian or shoreline zone is that special area where the land meets the water. Well-vegetated shorelines are critically important in protecting water quality and creating healthy aquatic habitats, lakes and rivers. Natural shorelines intercept sediments and contaminants that could impact water quality conditions and harm fish habitat in streams. Well established buffers protect the banks against erosion, improve habitat for fish by shading and cooling the water and provide protection for birds and other wildlife that feed and rear young near water. A recommended target (from Environment Canada's Guideline: How Much Habitat is Enough?) is to maintain a minimum 30 meter wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams. Figure 8 demonstrates the buffer conditions of the left and right banks separately. Kemptville Creek within the Oxford Mills catchment had a buffer of greater than 30 metres along 98 percent of the right bank and 86 percent along the left bank.

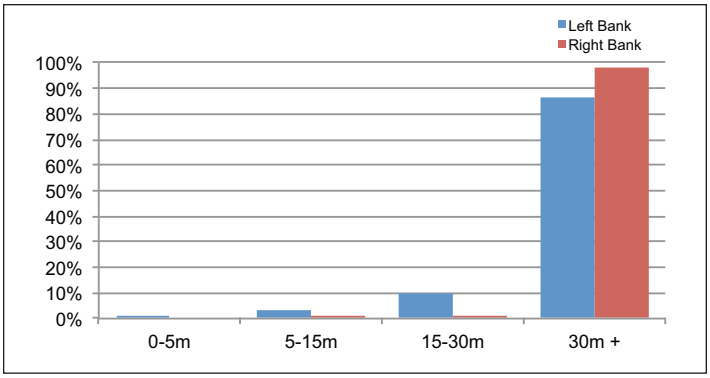


Figure 8 Riparian Buffer Evaluation in Oxford Mills

Adjacent Land Use

The RVCA's Macro stream Survey Program identifies seven different land uses beside Kemptville Creek within the Oxford Mills catchment (Figure 9). Surrounding land use is considered from the beginning to end of the survey section (100 metres) and up to 100 metres on each side of the creek. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 89 percent of the stream, characterized by forest, wetland scrubland and meadow. The remaining land use consisted of agriculture, residential and pasture.

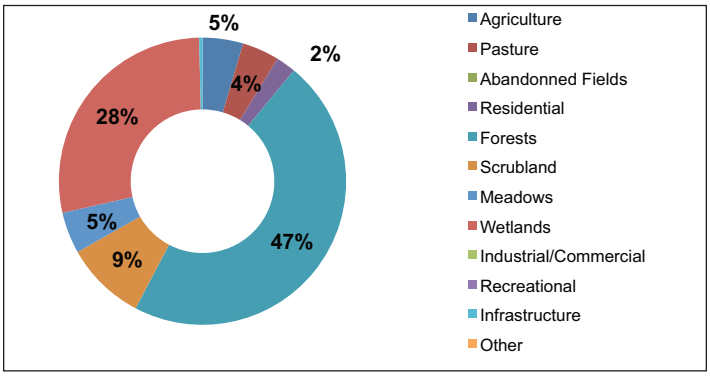


Figure 9 Land Use in the Oxford Mills catchment

47 percent of Oxford Mills catchment is forested

OXFORD MILLS SHORELINE ZONE

Instream Erosion

Erosion is a normal, important stream process and may not affect actual bank stability; however, excessive erosion and deposition of sediment within a stream can have a detrimental effect on important fish and wildlife habitat. Poor bank stability can greatly contribute to the amount of sediment carried in a waterbody as well as loss of bank vegetation due to bank failure, resulting in trees falling into the stream and the potential to impact instream migration. Figure 10 shows that there was very limited bank erosion observed on the left and right bank along Kemptville Creek within the Oxford Mills catchment.

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 11 shows that Kemptville Creek within the Oxford Mills catchment. has very few locations with identified undercut banks.

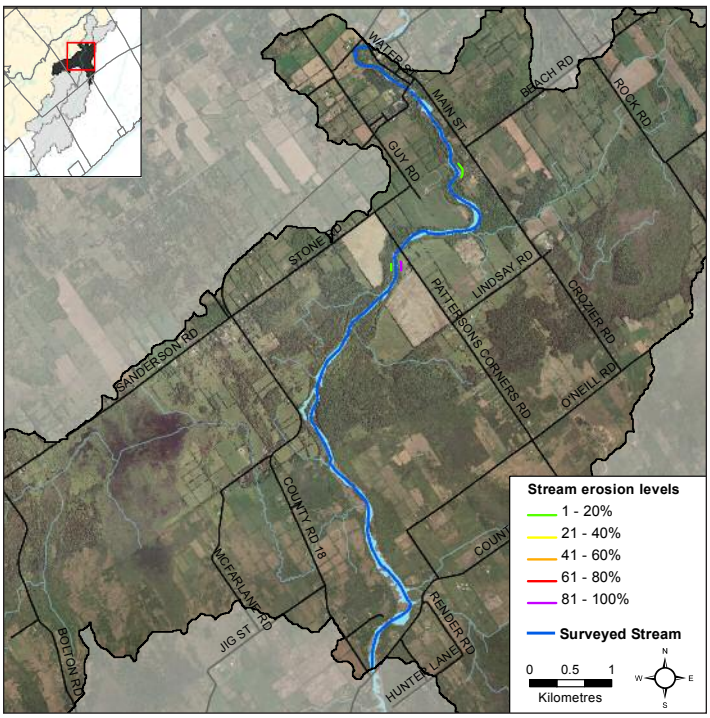


Figure 10 Erosion along Kemptville Creek Oxford Mills catchment

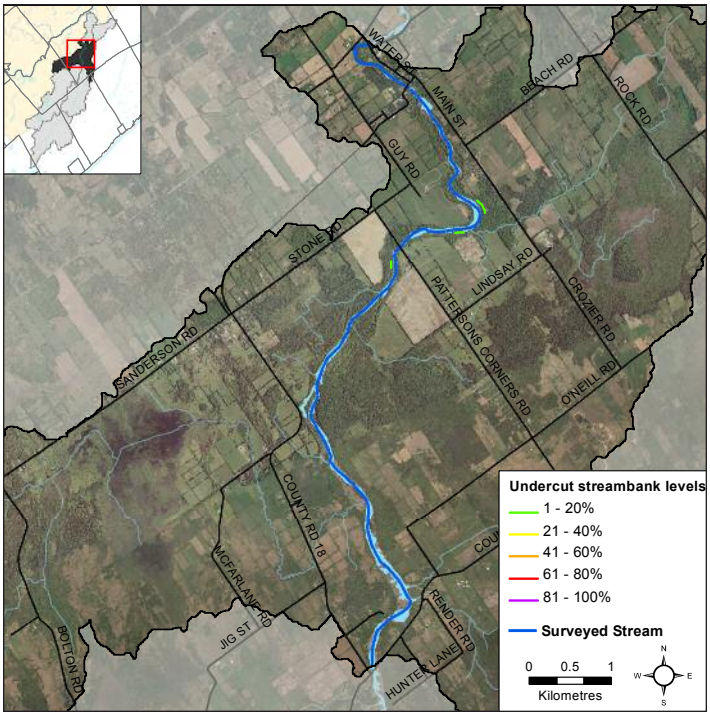


Figure 11 Undercut stream banks along Kemptville Creek Oxford Mills catchment

There is very limited bank erosion in Kemptville Creek Oxford Mills catchment

Kemptville Creek Oxford Mills catchment has few areas of undercut banks.

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Figure 12 shows the stream shading locations along Kemptville Creek within the Oxford Mills catchment.

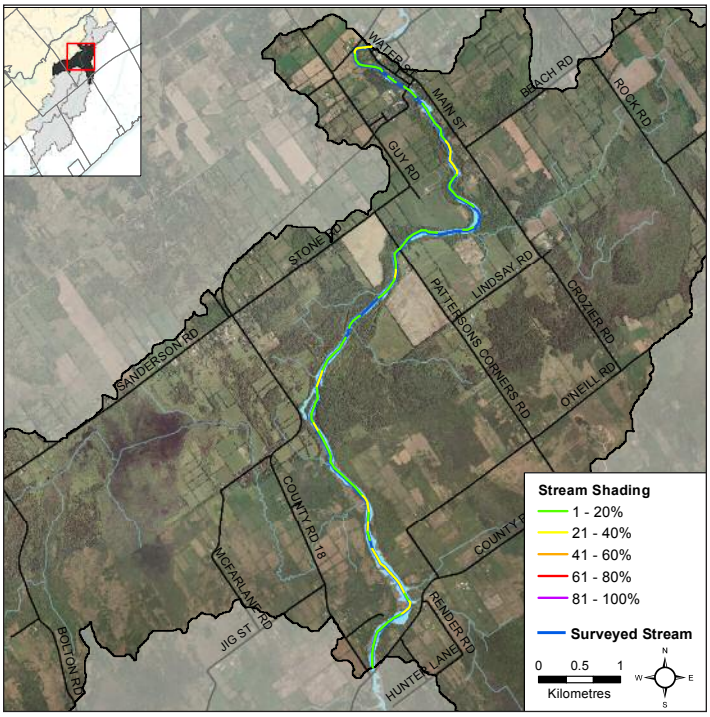


Figure 12 Stream shading along Kemptville Creek Oxford Mills catchment

Instream Woody Debris

Figure 13 shows that the majority of Kemptville Creek within the Oxford Mills catchment had low levels of instream woody debris in the form of branches and trees. Instream woody debris is important for fish and benthic habitat, by providing refuge and feeding areas.

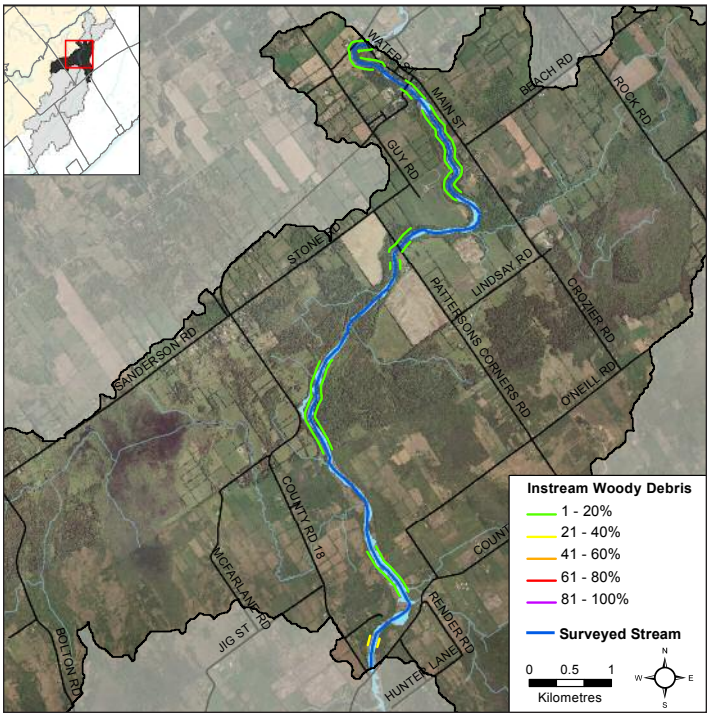


Figure 13 Instream woody debris along Kemptville Creek Oxford Mills catchment

Stream shading on Kemptville Creek Oxford Mills catchment

Instream woody debris in Kemptville Creek Oxford Mills catchment

Overhanging Trees and Branches

Figure 14 shows that the majority of Kemptville Creek within the Oxford Mills catchment has varying levels of overhanging branches and trees. Overhanging branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

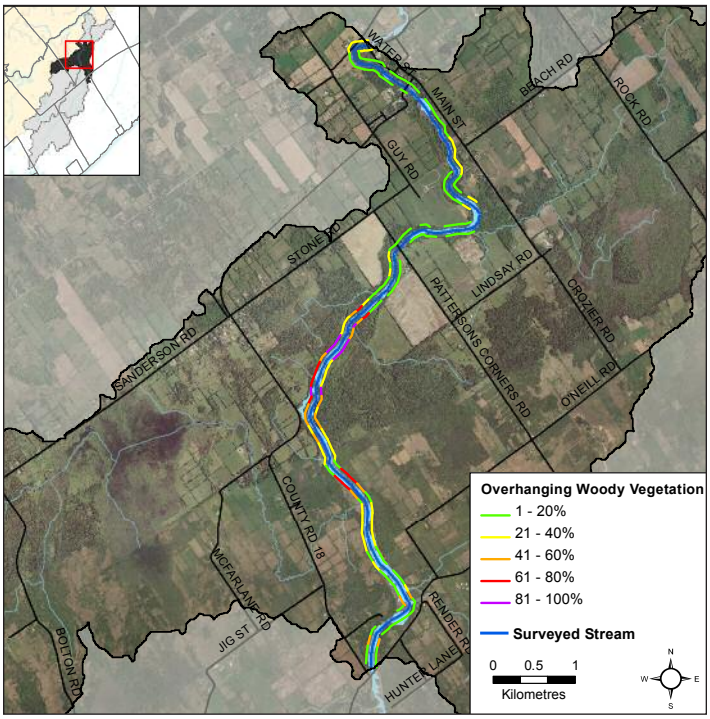


Figure 14 Overhanging trees and branches along Kemptville Creek Oxford Mills catchment

Overhanging trees and branches

Anthropogenic Alterations

Figure 15 shows 97 percent of Kemptville Creek within the Oxford Mills catchment remains “not altered.” Sections considered “natural” with some human changes account for three percent of sections. No sections were classified as "altered" and “highly altered.” Areas classified as natural with some human changes included areas with shoreline/instream modifications and little or no buffer.

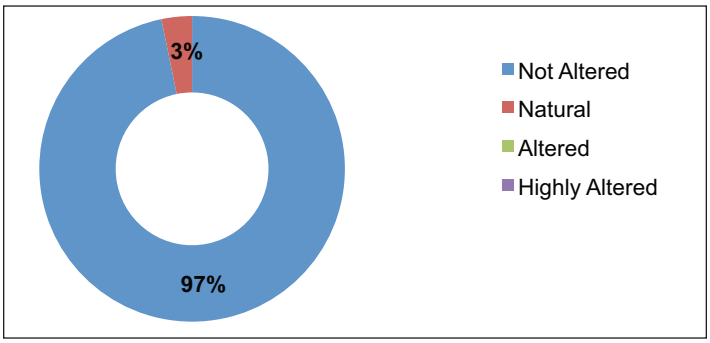


Figure 15 Anthropogenic alterations along Kemptville Creek Oxford Mills catchment

Altered shoreline along Kemptville Creek Oxford Mills catchment

OXFORD MILLS INSTREAM AQUATIC HABITAT

Benthic Invertebrates

Freshwater benthic invertebrates are animals without backbones that live on the stream bottom and include crustaceans such as crayfish, molluscs and immature forms of aquatic insects. Benthos represent an extremely diverse group of aquatic animals and exhibit wide ranges of responses to stressors such as organic pollutants, sediments and toxicants, which allows scientists to use them as bioindicators. As part of the Ontario Benthic Biomonitoring Network (OBBN), the RVCA has been collecting benthic invertebrates at the location on Kemptville Creek in Oxford Mills downstream of the dam since 2011. This site was added in 2011 as a gap in the network was identified within this catchment. Monitoring data is analyzed and the results are presented using the Family Biotic Index, Family Richness and percent Ephemeroptera, Plecoptera and Trichoptera.

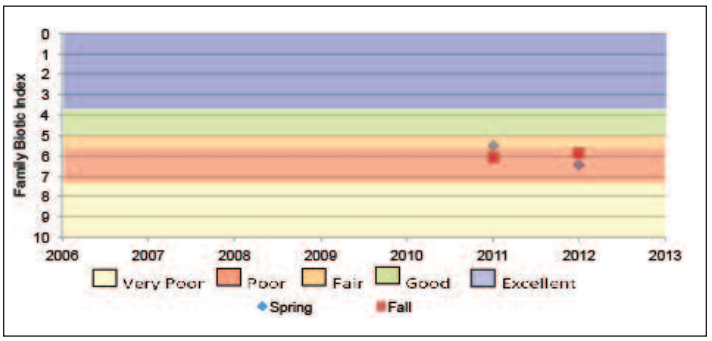


Figure 16 Hilsenhoff Family Biotic Index in Kemptville Creek Oxford Mills catchment

Hilsenhoff Family Biotic Index

The Hilsenhoff Family Biotic Index (FBI) is an indicator of organic and nutrient pollution and provides an estimate of water quality conditions for each site using established pollution tolerance values for benthic invertebrates. FBI results for Kemptville Creek show that it has "Poor" water quality conditions in 2011 and 2012 (Figure 16) using a grading scheme developed by Conservation Authorities in Ontario for benthic invertebrates.

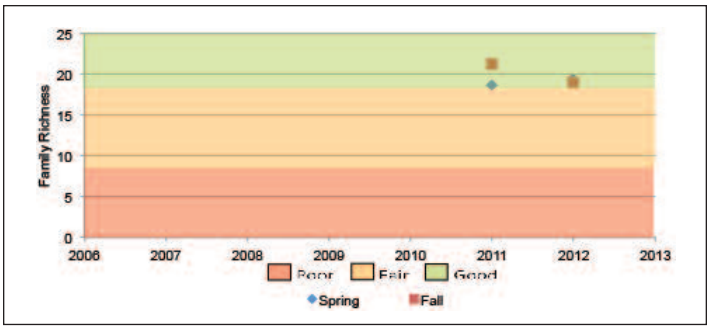


Figure 17 Family Richness in Kemptville Creek Oxford Mills catchment

Family Richness

Family Richness measures the health of the community through its diversity and increases with increasing habitat diversity suitability and healthy water quality conditions. Family Richness is equivalent to the total number of benthic invertebrate families found within a sample. Although the family richness appears to be high the samples are dominated by species that are moderately tolerant and tolerant to poor water quality conditions. Using Family Richness as the indicator, Kemptville Creek is reported to have "Poor" water quality (Figure 17).

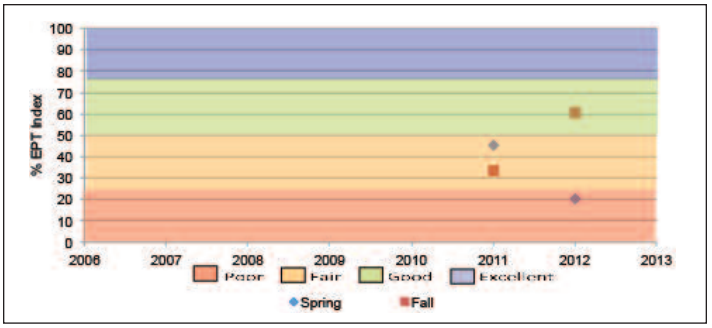


Figure 18 EPT in Kemptville Creek Oxford Mills catchment

EPT

Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies) are species considered to be very sensitive to poor water quality conditions. High abundance of these organisms is generally an indication of good water quality conditions at a sample location. The community structure is dominated by species that are not sensitive to poor water quality conditions. As a result, the EPT indicates that the Oxford Mills Kemptville Creek sample location is reported to have "Poor" water quality (Figure 17) in 2011 and 2012.

Conclusion

Overall Kemptville Creek at Oxford Mills has a water quality rating of "Poor" in 2011 and 2012. It is recognized that this rating is based on only two years of data, as a result, RVCA will continue to monitor this sample location moving forward to the next reporting cycle.

Habitat Complexity

Streams are naturally meandering systems and move over time; there are varying degrees of habitat complexity, depending on the creek. Examples of habitat complexity include variable habitat types such as pools and riffles as well as substrate variability and woody debris structure. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Fifty-two percent of Kemptville Creek within the Oxford Mills catchment was considered heterogeneous, as shown in Figure 19.

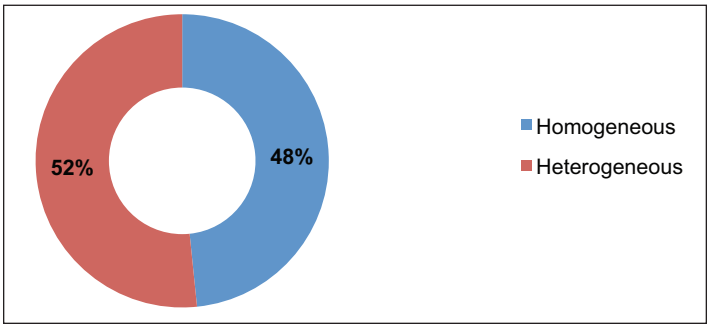


Figure 19 Habitat complexity along Kemptville Creek Oxford Mills catchment

Instream Substrate

Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current. Cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Cobble can also provide habitat conditions for benthic invertebrates that are a key food source for many fish and wildlife species. Figure 20 shows where cobble and boulder

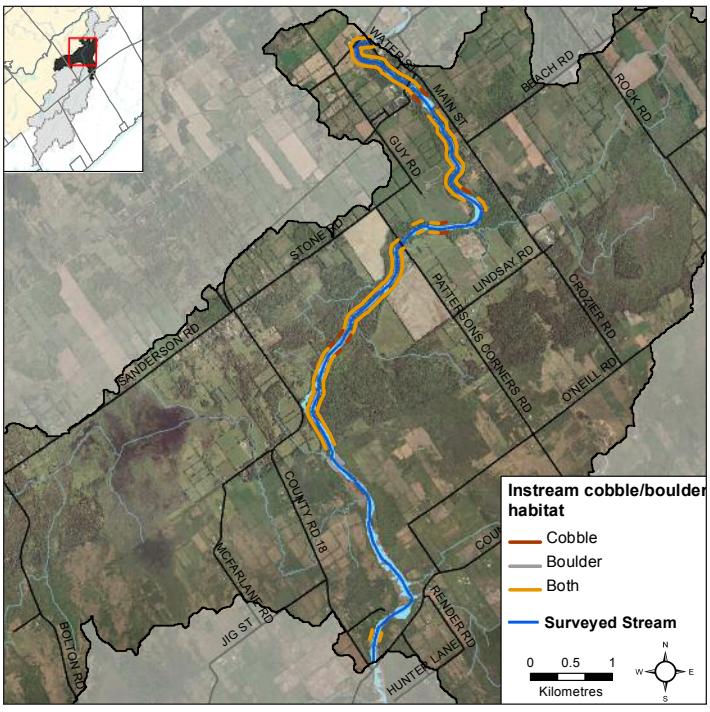


Figure 20 Instream substrate along Kemptville Creek Oxford Mills catchment

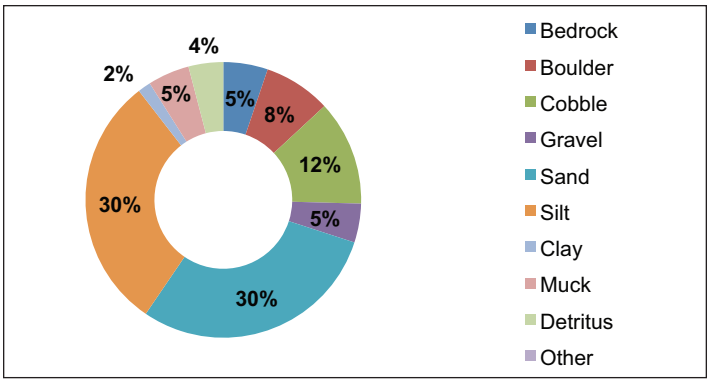


Figure 21 Instream substrate along Kemptville Creek Oxford Mills catchment

substrate is found in Kemptville Creek within the Oxford Mills catchment. Diverse substrate is important for fish and benthic invertebrate habitat because some species have specific substrate requirements and for example will only reproduce on certain types of substrate (Figure 21).

Instream Morphology

Pools and riffles are important habitat features for fish. Riffles are areas of agitated water and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as walleye. Pools provide shelter for fish and can be refuge pools in the summer if water levels drop and water temperature in the creek increases. Pools also provide important over wintering areas for fish. Runs are usually moderately shallow, with unagitated surfaces of water and areas where the thalweg (deepest part of the channel) is in the center of the channel.

Figure 22 shows that Kemptville Creek within the Oxford Mills catchment is uniform with 100 percent of the habitat consisting of a run.

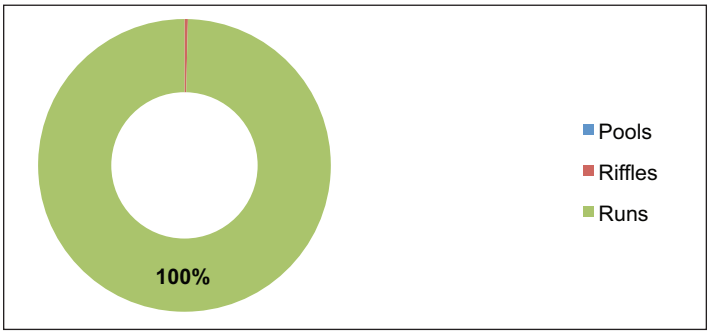


Figure 22 Instream morphology along Kemptville Creek Oxford Mills catchment

Vegetation Type

Instream vegetation provides a variety of functions and is a critical component of the aquatic ecosystem. For example emergent plants along the shoreline can provide shoreline protection from wave action and important rearing habitat for species of waterfowl. Submerged plants provide habitat for fish to find shelter from predator fish while they feed. Floating plants such as water lilies shade the water and can keep temperatures cool while reducing algae growth. Kemptville Creek within the Oxford Mills catchment had a healthy level of diversity of instream

vegetation. The dominant vegetation type recorded at twenty-nine percent consisted of submerged vegetation. Figure 23 depicts the plant community structure for this reach of Kemptville Creek.

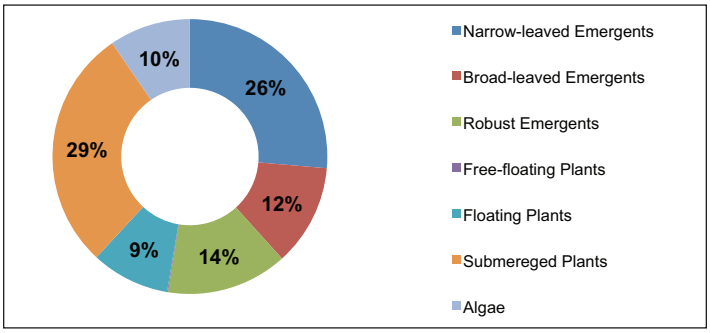


Figure 23 Vegetation type along Kemptville Creek Oxford Mills catchment

Instream Vegetation Abundance

Instream vegetation is an important factor for a healthy stream ecosystem. Vegetation helps to remove contaminants from the water, contributes oxygen to the stream, and provides habitat for fish and wildlife. Too much vegetation can also be detrimental. Figure 24 demonstrates that Kemptville Creek within the Oxford Mills catchment has predominantly healthy levels of instream vegetation for most of its length.

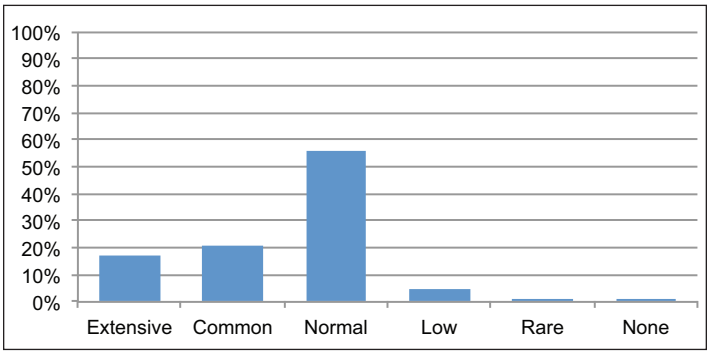


Figure 24 Instream vegetation abundance along Kemptville Creek Oxford Mills catchment

Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. The majority of the sections surveyed along Kemptville Creek had invasive species. The invasive species observed in Kemptville Creek within the Oxford Mills catchment were European frogbit, purple loosestrife and Manitoba maple.

14 percent of vegetation on Kemptville Creek Oxford Mills catchment are robust emergents like these cattails

Purple loosestrife is an invasive species found along Kemptville Creek Oxford Mills catchment

Thermal Regime

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Water temperature is used along with the maximum air temperature (using the Stoneman and Jones method) to classify a watercourse as either warm water, cool water or cold water. Analysis of the data collected indicates that Kemptville Creek within the Oxford Mills catchment is classified as a warm water system (Figure 25).

Figure 26 shows the location of temperature loggers at one sampling location on Kemptville Creek in the Oxford Mills catchment.

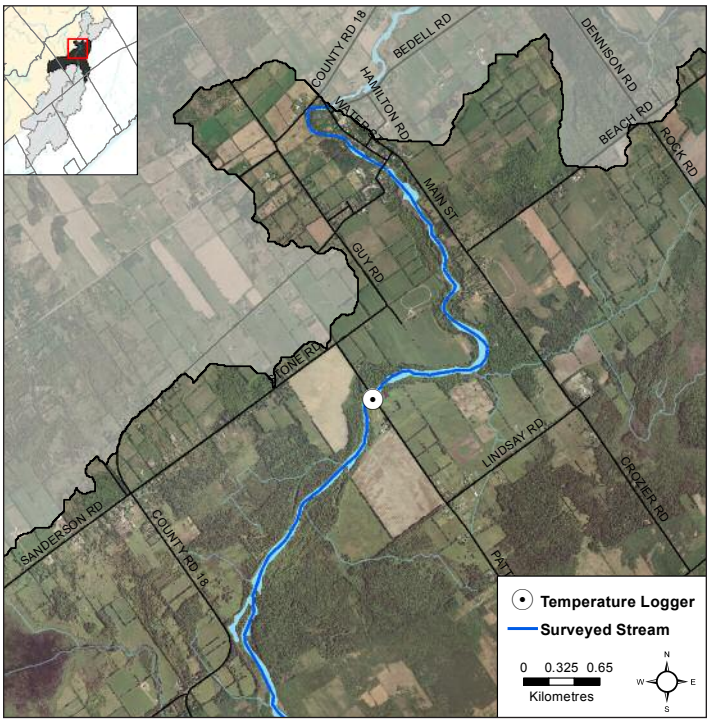
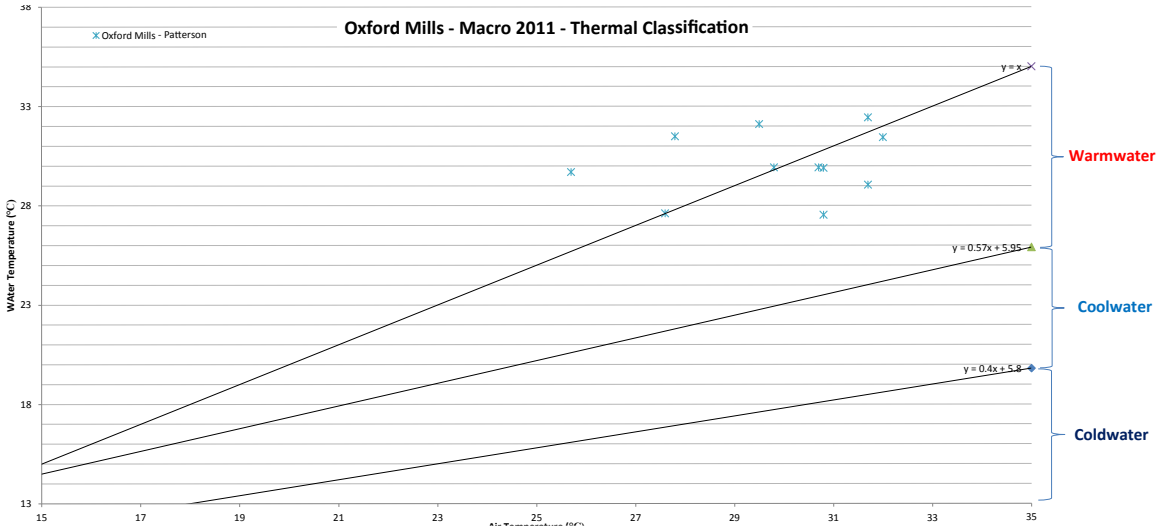


Figure 26 Temperature loggers in Kemptville Creek Oxford Mills catchment

Kemptville Creek Oxford Mills catchment is a warm water system



SITE ID	SOURCE_ID	Y_WATER	X_AIR	CLASSIFICATION	PROGRAM	YEAR
Oxford Mills — Patterson	KMPT-2	30.17	30.3	WARMWATER	MACRO	2011

Figure 25 Temperature logger data for one site location on Kemptville Creek in the Oxford Mills catchment. Each point on the graph represents a temperature that meets the following criteria:

- Sampling dates between July 1 and September 7
- Sampling date is preceded by two consecutive days above 24.5 °C, with no rain
- Water temperatures are collected at 4 p.m.
- Air temperature is recorded as the max temperature for that day.

Migratory Obstructions

It is important to know the locations of migratory obstructions because they can prevent fish from accessing important spawning and rearing habitat (Figure 27). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There was one migratory obstruction within the Kemptville Creek Oxford Mills catchment at the Oxford Mills Dam.

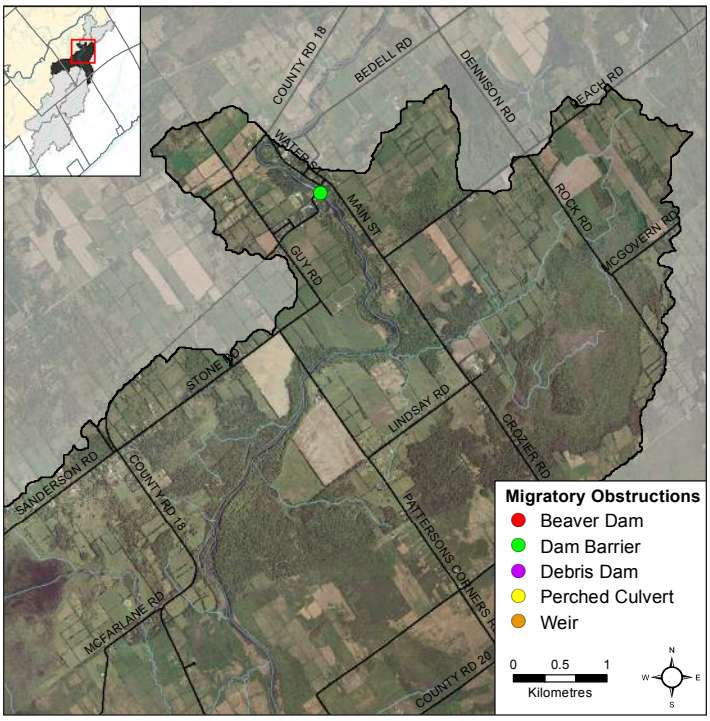


Figure 27 Migratory obstructions along Kemptville Creek Oxford Mills catchment

The Oxford Mills dam is a migratory obstruction

Fish Sampling

Fish sampling sites located along Kemptville Creek within the Oxford Mills catchment are shown in Figure 28. The provincial fish codes shown on the preceding map are listed (in Table 7) beside the common name of those fish species identified in Kemptville Creek. Kemptville Creek is classified as a warm/cool water recreational and baitfish fishery with 28 species observed in the Oxford Mills reach.

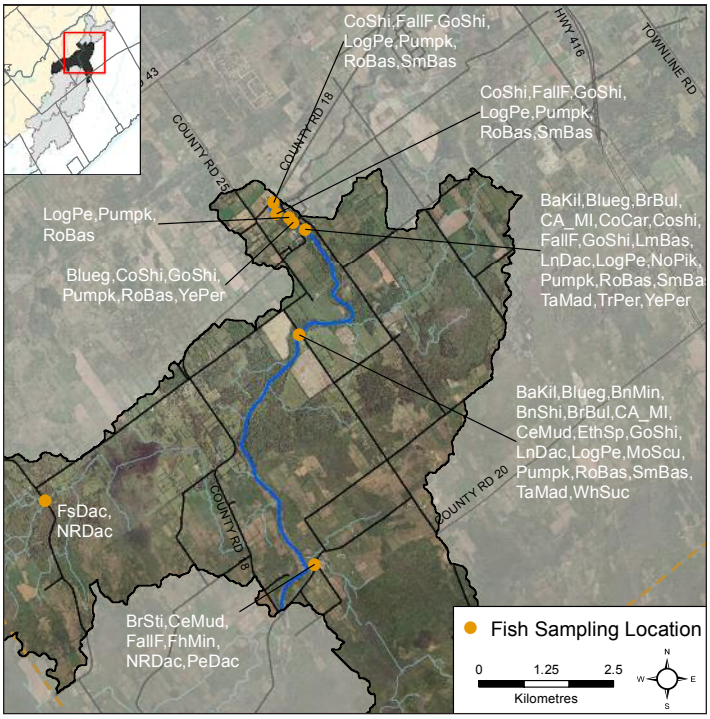


Figure 28 Fish sampling along Kemptville Creek Oxford Mills catchment

Table 7 Fish species identified in South Branch

Species observed in South B (with fish code)			
banded killifish	BaKil	largemouth bass	LmBas
blacknose shiner	BnShi	logperch	LogPe
bluegill	Blueg	longnose dace	LnDac
bluntnose minnow	BnMin	mottled sculpin	MoScu
brook stickleback	BrSti	northern pike	NoPik
brown bullhead	BrBul	northern redbelly dace	NRDac
central mudminnow	CeMud	pearl dace	PeDac
common carp	Ca_MI	pumpkinseed	Pumpk
common shiner	CoShi	rock bass	RoBas
etheostoma sp.	EthSp	smallmouth bass	SmBas
fallfish	FallF	tadpole madtom	TaMad
fathead minnow	hMin	trout perch	TrPer
finescale dace	FsDac	white sucker	WhSuc
golden shiner	GoShi	yellow perch	YePer

Riparian Restoration

Figure 29 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

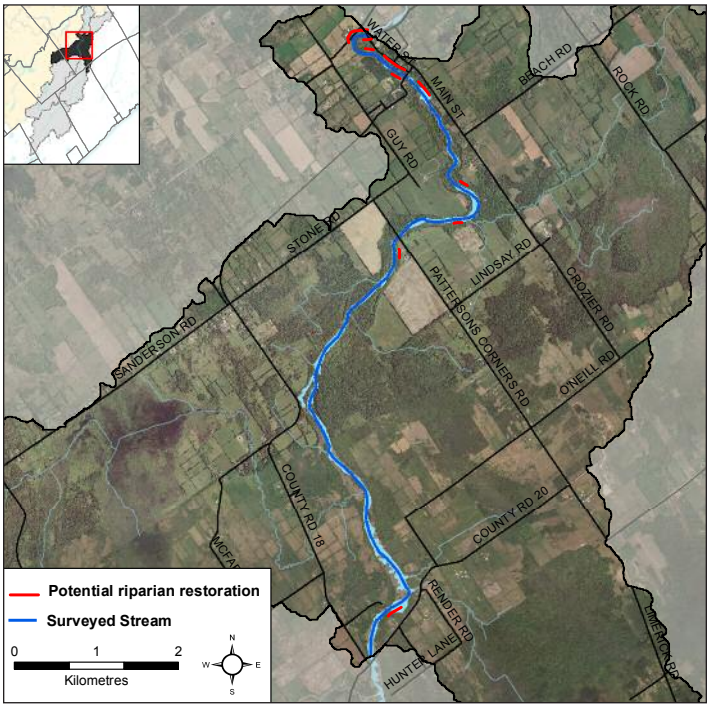


Figure 29 Riparian restoration along Kemptville Creek Oxford Mills catchment

Water Chemistry

During the macro stream survey, a YSI probe is used to collect water chemistry, as follows:

- Dissolved Oxygen is a measure of the amount of oxygen dissolved in water. The lowest acceptable concentration of dissolved oxygen is 6.0 mg/L for early stages of warm water fish and 9.5 mg/L for cold water fish (CCME, 1999). A saturation value (concentration of oxygen in water) of 90 percent or above is considered healthy.
- Saturation levels above one hundred percent are not uncommon in sections of stream where there are high amounts of algae and other aquatic plants.
- Conductivity is the ability of a substance to transfer electricity. This measure is influenced by the presence of dissolved salts and other ions in the stream.
- pH is a measure of relative acidity or alkalinity, ranging from 1 (most acidic) to 14 (most alkaline/basic), with 7 occupying a neutral point. 2011 data for these four parameters is summarized in Table 8.

Table 8 Water chemistry in Kemptville Creek Oxford Mills catchment

Month	Range	DO (mg/L)	DO(%)	Conductivity (µs/cm)	pH
June 2011	Low	3.48	43.0	334	7.25
	High	10.89	134.6	367	8.33

Kemptville Creek Oxford Mills catchment downstream of the Oxford Mills dam

3. Land Cover

Wetland, woodland and crop and pastureland are the dominant land cover types in the catchment as shown in Table 9 and displayed in the map on the front cover of the report.

Table 9 Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Wetland**	2,428	33
Woodland*	2,211	31
Crop & Pasture	2,136	29
Settlement	352	5
Transportation	143	2

* Does not include treed swamps ** Includes treed swamps

Woodland Cover

The Oxford Mills catchment contains 2211 hectares of upland forest and 653 hectares of lowland forest (treed swamps) (Figure 30) that occupies 39 percent of the drainage area (versus the 36 percent of woodland cover in the Kemptville Creek Subwatershed). This figure is greater than the 30 percent of woodland area required to sustain forest birds, according to Environment Canada's Guideline: "How Much Habitat is Enough?" When forest cover declines below 30 percent, forest birds tend to disappear as breeders across the landscape.

Eighty-five (49 percent) of the 175 woodland patches in the catchment are very small, being less than one hectare in size. Another 67 (38 percent) of the wooded patches ranging from one to less than 20 hectares in size tend to be dominated by edge-tolerant bird species. The remaining 23 (13 percent of) woodland patches range between 21 and 348 hectares. Fourteen of these patches contain woodland between 20 and 100 hectares and may support a few area-sensitive species and some edge intolerant species, but will be dominated by edge tolerant species.

Conversely, nine (five percent) of the 175 woodland patches in the drainage area exceed the 100 plus hectare size needed to support most forest dependent, area sensitive birds and are large enough to support approximately 60 percent of edge-intolerant species. Three of these patches top 200 hectares, which according to the Environment Canada Guideline will support 80 percent of edge-intolerant forest bird species (including most area sensitive species) that prefer interior forest habitat conditions.

Forest Interior

The same 175 woodlands contain 34 forest interior patches (Figure 30) that occupy ten percent (725 hectares) of the catchment land area (versus the eight percent of interior forest in the Kemptville Creek Subwatershed). This is the same as the ten percent figure referred to in the Environment Canada Guideline that is considered to be the minimum threshold for supporting edge intolerant bird species and other forest dwelling species in the landscape. Most patches (20) have less than 10 hectares of interior forest, nine of which have small areas of interior forest habitat less than one hectare in size. Another five patches contain between 10 and 30 hectares of interior forest. Conversely, nine patches have greater than 30 hectares of interior forest, with one patch exceeding 100 hectares (at 128 hectares).

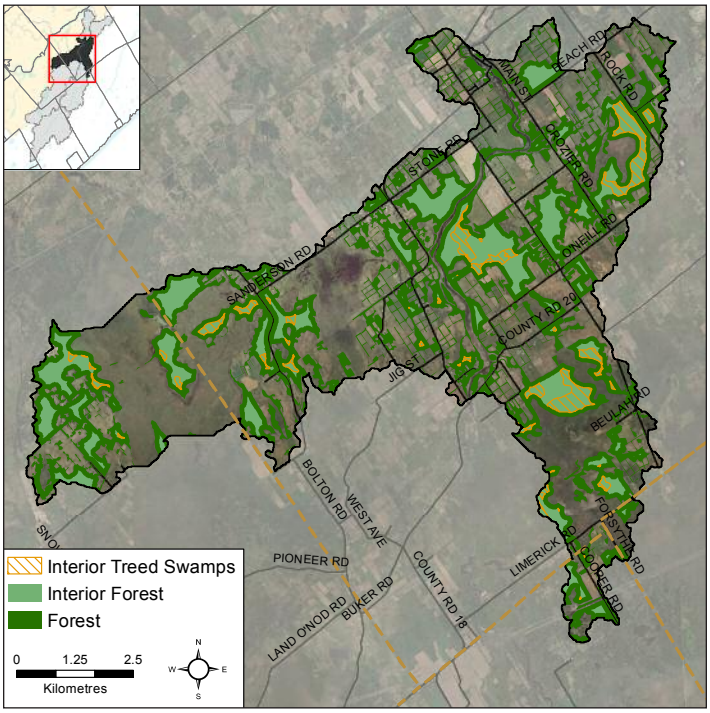
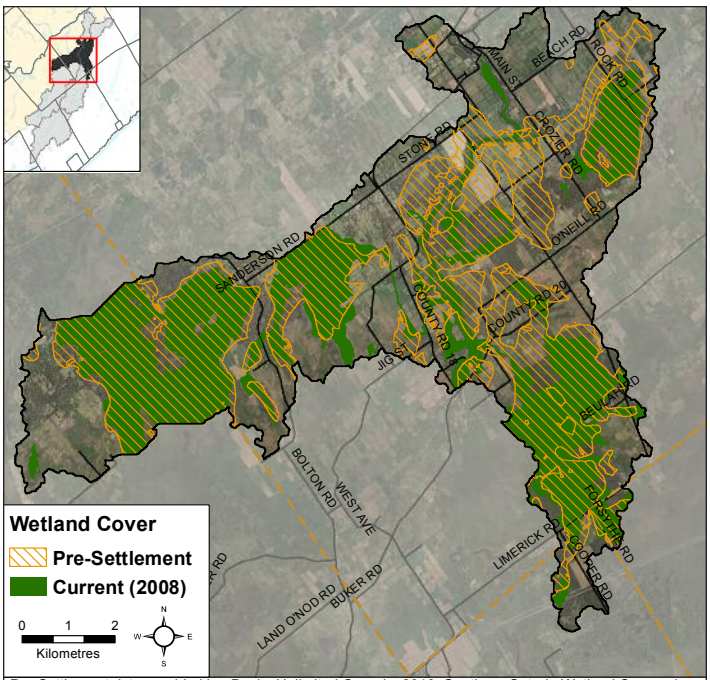


Figure 30 Catchment woodland cover and forest interior

Wetland Cover

Figure 31 shows pre-settlement versus current (2008) wetland cover in the catchment



Pre-Settlement data provided by: Ducks Unlimited Canada, 2010. Southern Ontario Wetland Conversion Analysis, http://www.ducks.ca/aboutduc/news/archives/prov2010/pdf/duc_ontariowca.pdf, (March 2010)

Figure 31 Catchment wetland cover

4. Stewardship and Protection

The RVCA and its partners are working to protect and enhance environmental conditions in the Kemptville Creek Subwatershed.

Rural Clean Water Projects

Figure 32 shows the location of all Rural Clean Water Projects in the Kemptville Creek - Oxford Mills drainage area. From 2007 to 2012, landowners completed 16 projects including 9 septic system repairs/replacements and 7 well upgrades. In total, RVCA contributed $15,072 in grant dollars towards the total project cost of $78,948.

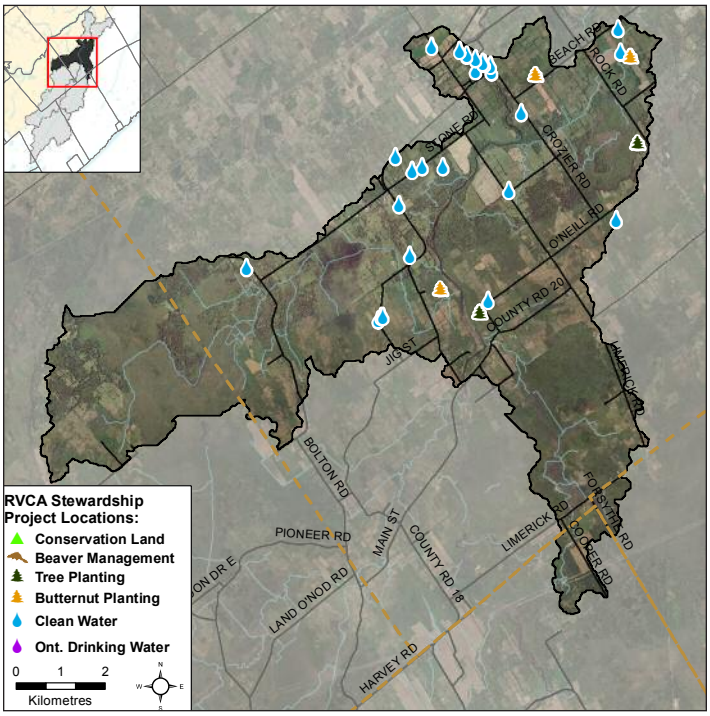


Figure 32 RVCA stewardship program project locations

Prior to 2007, the RVCA completed 10 projects in the area consisting of five septic system repairs/ replacements, two well upgrades, two well decommissionings and one chemical-fuel storage/handling facility. In total, RVCA contributed $9,374 in grant dollars to projects valued at $49,999.

Tree Planting Projects

The location of all tree planting projects is also shown in Figure 32. From 2007 to 2012, 7550 trees were planted at 2 project sites through the RVCA Tree Planting Program. Total project value is $12,940 with fundraised dollars contributing $7,568 of that amount.

Valley, Stream, Wetland and Hazard Land Regulation

Seventeen and a half square kilometres or 24 percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Figure 33), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

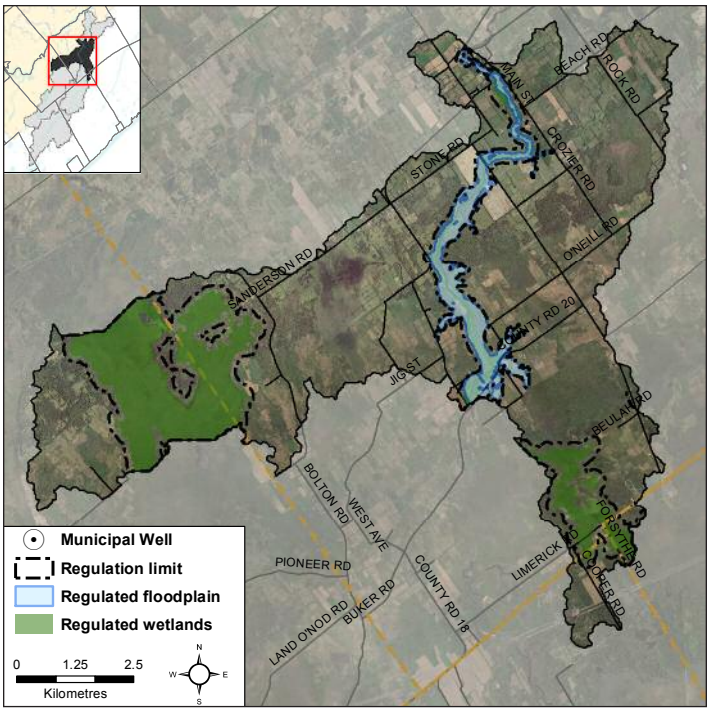


Figure 33 RVCA regulation limits

Natural features within the regulation limit include 10 sq. kilometre of wetlands (representing 41.1 percent of all wetlands in the catchment) and 38.4 kilometres of streams (representing 49 percent of all streams in the catchment). Some of these regulated watercourses (25 kilometres or 32 percent of all streams) flow through regulated wetlands.

Regulation limit mapping has been plotted along 13.4 kilometres (or 35 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the remaining 40.3 kilometres (or 51 percent) of streams requires identification of flood and erosion hazards and valley systems.

Within the regulation limit, “development” and “site alteration” require RVCA permission. The “alteration to waterways” provision of Ontario Regulation 174/06 applies to all watercourses.

5. Issues

- Water quality along Kemptville Creek is "Fair" as determined by benthic invertebrate and surface water chemistry data. However, the surface water quality data shows a decline at all three monitoring sites through the catchment over a 12 year reporting period. Exceedances of total Kjeldahl nitrogen and total phosphorus above water quality guidelines are largely responsible for this change
- There are flood susceptible areas adjacent to Kemptville Creek as identified by the RVCA's Kemptville Creek Floodplain Mapping Study (2009). Although private property extends into the flood risk area, most development is located outside the floodplain due to past (and ongoing) efforts to minimize landowner exposure to natural hazards by regulating development in the floodplain. Regulations administered by the RVCA have been in place around wetlands since 2006 and along the creek since 2009
- Water levels and land drainage have been a subject of controversy within the catchment for many years. Work carried out by the RVCA (from 2003 to 2007) through the Kemptville Creek Beaver Dam Management Pilot Project included aquatic habitat/beaver surveys and beaver/dam removals and has had a positive effect on the creek's aquatic ecosystem and concerns about high water levels
- The catchment contains 1,115 hectares of unevaluated wetland (occupying 15 percent of its total area) that provides many important social, hydrological, biological and ecological functions/services. Although not under imminent threat from development activity, they do remain vulnerable to drainage and land clearing activities in the absence of any regulatory and planning controls that would otherwise protect them. Similarly, a large expanse of evaluated wetland, known as the Oxford Mills Wetland Part One, provides many benefits that have been identified as having a "High" priority for protection in a 2007 report prepared for the RVCA entitled "A Prioritization System for Wetlands within the Rideau Valley Watershed"

6. Opportunities for Action

- Investigate cause of "Fair" surface water quality rating along Kemptville Creek. Reported decline (from "Good"to "Fair") in the rating may be attributed to sources such as upstream water quality, land use conversion, wetland cover change and wildlife activity within the catchment. Further study is necessary to better understand the contributing factors
- Continue to use official plan policy, zoning and regulatory controls under Section 28 of the *Conservation Authorities Act* to restrict development in and adjacent to the Kemptville Creek floodplain and the Provincially Significant Wetlands found in the catchment (i.e., Kemptville Creek Wetland Parts One and Two and the Wolford Bog Wetland Complex)
- Consider establishing RVCA regulations limits in areas of unevaluated wetlands subject to site alteration and extend regulation limits around the Oxford Mills Wetland Part One
- Target riparian restoration at areas shown in Figure 29 (to address minimal shoreline buffers and identified erosion sites)
- Work with landowners to implement agricultural best management practices and pursue improvements to the riparian corridor along Kemptville Creek and tributaries (by increasing buffers through reforestation/riparian plantings and invasive species removal)
- Protect shorelines, floodplains, locally/regionally/provincially significant natural heritage features such as wetlands, woodlands, valleylands, wildlife habitat, areas of natural and scientific interest, aquatic habitat and municipal drinking water intake/wellhead protection zones/areas through conservation agreements/easements or land acquisition programs