Water Use in the Catfish Creek Watershed

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DRAFT

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Executive Summary

As the Catfish Creek watershed continues to experience both economic and population growth, there will be increased demands on the basin's water resources to supply sufficient water to residential, commercial and industrial consumers. In the context of protecting water supplies for drinking water and other uses, the quantity of water takings in the basin is a step towards a better understanding of the various water needs in the Catfish Creek watershed.

This report is an initial summary of the present-day water uses within the Catfish Creek watershed. Water use estimates were broken down into four subgroups: Municipal Supply, Agricultural, Unserviced Population and Other Permitted Takings (larger than 50,000 L/day).

Water use estimates were determined using the best available data. Municipalities were contacted directly to establish municipal water use. Census of Population and Census of Agriculture were utilized to determine rural domestic as well as agricultural water use. The Permit to Take Water (PTTW) database was used to quantify any water uses that did not fall into the previous three categories. A phone survey of the permit holders was completed to refine water use estimates based on their records, with a 50% response rate. The analysis of all water use data identified the following water uses within the basin:

1. Agricultural Irrigation
2. Municipal Water Supply
3. Rural Domestic
4. Agriculture
5. Aquaculture
6. Water Supply Communal
7. Golf Course Irrigation

While annual totals are useful for comparison purposes, seasonal and annual temporal changes in water use must be considered for an accurate representation of water taking. While agricultural irrigation is the largest water user on an annual basis, their water takings are concentrated during the months of June to August. Agricultural irrigation is actually more than the combined total of all non-municipal water takings during these summer months. During an extreme dry year, which requires more irrigation than an average year, this demand for water is much more pronounced.

This study has identified a number of limitations with water use data available to water managers. In an attempt to address these shortcomings and increase the accuracy of water use estimates, the following recommendations are presented:

1. That the water use estimates generated from this report be combined with estimates of water availability to identify possible water quantity issue areas.
2. That the municipalities on the Elgin Area Water Treatment Supply System gather further information on serviced populations along the pipeline and taking amounts in the watershed.

3. That information gathered from the municipal sector be separated into industrial, commercial, institutional and residential components of water use.
4. That investigations into more accurate estimates of irrigated land continue, including assessing the use of alternative methodologies such as remote sensing and crop specific water uses.
5. That consumptive ratios of all major water sectors be determined, as well as the occurrence of water diversions.
6. That the development of a central database of water use in the watershed continue. This database would house recent information on municipal water systems as well as information gathered from phone surveys of permitted water users.

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Acknowledgements

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- The member municipalities in the Catfish Creek watershed for supplying water use information.
- The staff at the Catfish Creek Conservation Authority for reviewing and providing support for the report.
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- The permit holders in the watershed who voluntarily supplied actual water use information for the report.

1.0 INTRODUCTION

This report details the initial estimate of water use for the watershed, and identifies the major water use sectors. For the purposes of this report, water use has been divided into 4 groups: Municipal Supply, Agricultural, Unserviced Population and Other Permitted Takings. The 'Other Permitted Takings' group is further broken down into different user groups using the Permit to Take Water (PTTW) categories, however does not include permits that are considered as part of the other groups of residential or agricultural purposes.

Water use information is divided into subwatersheds within the larger Catfish Creek watershed (see Figure 1) to illustrate the spatial representation of where the takings occur or where the taking is being used. Throughout this report, cubic metres (m^3) will be used to quantify water use. To put this into perspective, a household with 3 people will use approximately 1 m^3 per day, as the average Canadian uses 0.340 m^3 on a daily basis (Environment Canada, 2005).

2.0 DESCRIPTION OF THE WATERSHED

The Catfish Creek watershed, at 490 km^2, is located in south western Ontario in Elgin and Oxford Counties (see Figure 1). The Creek has 3 branches in the headwaters called the West Catfish, East Catfish and Catfish Creeks which meet to become the main Catfish Creek channel halfway to the outlet into Lake Erie at Port Bruce. The major urban centre within the watershed is Aylmer, but St. Thomas is just at the western edge of the watershed. Smaller settlements include Springfield, Brownsville and Port Bruce. Much of the land of the watershed is used for agriculture.

The watershed is topographically divided into the upper subwatershed and lower subwatershed basins (see Figure 1) to differentiate and compare the water use information for the two areas. Much of the upper subwatershed is located in a till plain with relatively tight tills with high runoff potential and small amounts of groundwater recharge. A small portion in the western half of the lower subwatershed is also in the till plain, but the majority is in the Norfolk Sand Plain which allows for more groundwater recharge and low runoff potential.

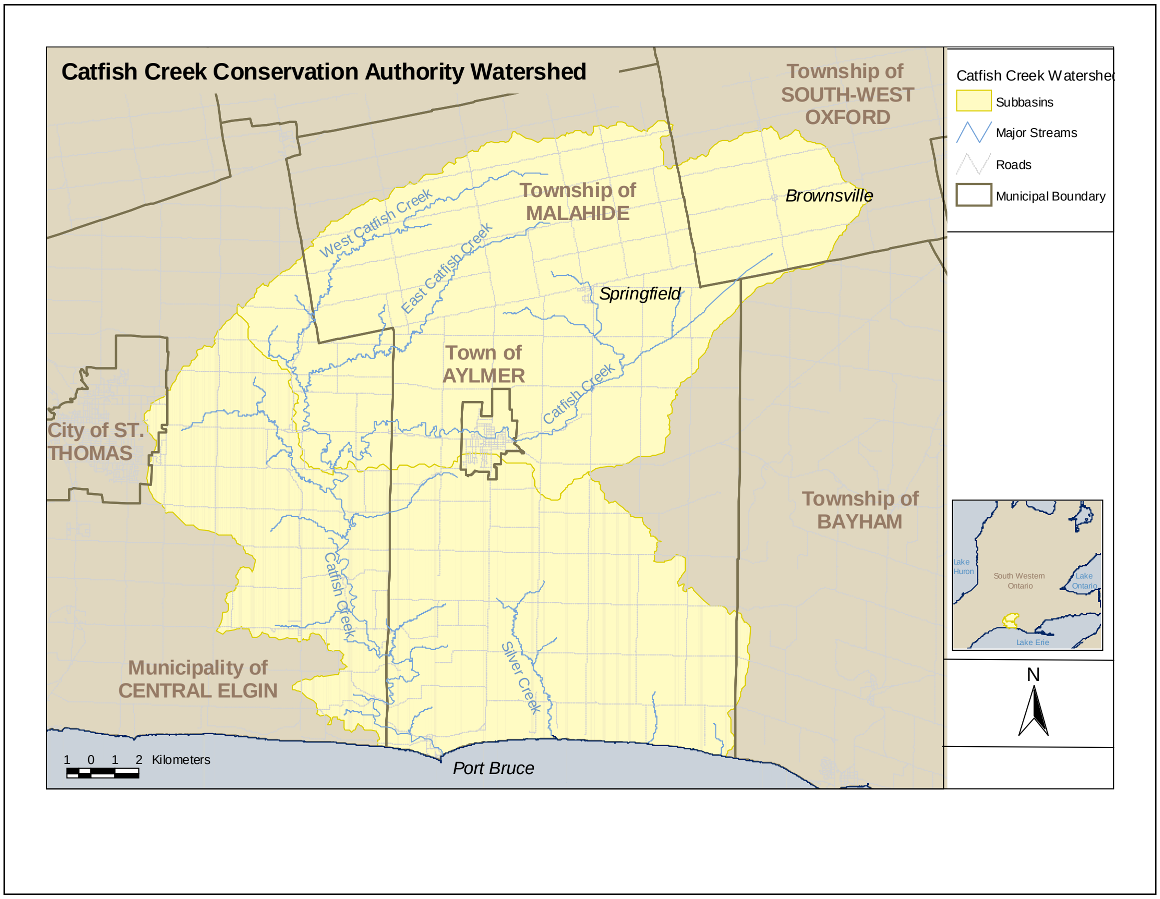

Figure 1. Watershed Overview Map

3.0 MUNICIPAL WATER USE

Municipal water use is the supply of water provided through a central distribution system operated by a municipality. Various methods were employed to determine the amount of water municipalities provided through its distribution. These methods included personal communication with municipal staff, data collected from reports for the Drinking Water regulation requirements (Ontario Regulation 170/03) and information gathered from municipal websites and online documents. Data were collected to obtain a complete picture of municipal water use including serviced population, average daily demand and maximum daily demand, as well as UTM coordinates of the supply wells, river intakes or lake intakes.

It is important to note that municipal water use includes urban domestic use, whether indoor or outdoor and also includes uses for industrial, commercial, institutional or other uses that rely on municipalities for their water supply.

Each municipal water system in the watershed is listed in Table 1, along with the serviced population, average daily demand, average per capita demand, maximum daily demand and maximum per capita demand. While per capita values are listed, they should not be used to compare between municipal systems, as differing proportions of residential, and

Industrial, Commercial and Institutional (ICI) demand may vary widely from municipality to municipality.

Table 1. Municipal Water System Information

Municipality	Municipal System	Year of Data	Serviced Popl'n	Average Day		Max Day		System Capacity (approx.)	Water Source	Data Source
				Actual	Per Capita	Actual	Per Capita			
				m^3/d	$m^3/d/capita$	m^3/d	$m^3/d/capita$	m^3/day		
Elgin	Aylmer	2004	2607	2579	0.989			4,233	Lake Erie	Communication with Town Staff
Elgin	Malahide Township	2004	515	312.59	0.607				Lake Erie, Aylmer and Pt. Burwell Pipes	Communication with Municipal Staff
Oxford	Brownsville	2004	498	90.4	0.182	166	0.333	379	Groundwater	Communication with Municipal Staff
Elgin	Central Elgin and Malahide	2004		297.20					Lake Erie	Communication with Municipal Staff

Much of the Catfish Creek watershed area is supplied by the Elgin Area Primary Water Supply System, which pumps water from Lake Erie. Information provided by the municipalities in Elgin County for Table 1 are recorded values from the secondary water supply, which often service two townships (for example, Central Elgin and Malahide).

It was difficult to measure the number of people and the distribution of water users throughout the different townships that are on the Lake Erie pipeline for several reasons. First, residents adjacent to the pipeline can tap into it as it runs through the watershed (see Figure 4), making exact serviced population figures difficult to quantify. Second, data obtained from the municipalities are recorded at the township level but often the pipeline supplied two townships. The water use information was allotted to each subwatershed based on percentage area in and outside the watershed, as well as within each subwatershed (see Table 1). It is likely that ICI water uses were included in these water takings, which may explain the elevated per capita values as seen in Table 1.

Supply sources, outlined in Figure 2, are from groundwater wells, and from Lake Erie, as previously mentioned. The intake point for the Elgin Area Primary Water Supply System shows the water intake location from Lake Erie for the watershed distribution system, which include pipelines that extend through Elgin County up to the southern rural districts of the City of London. There is one community, Brownsville, in the Catfish Creek watershed that is serviced from groundwater well sources.

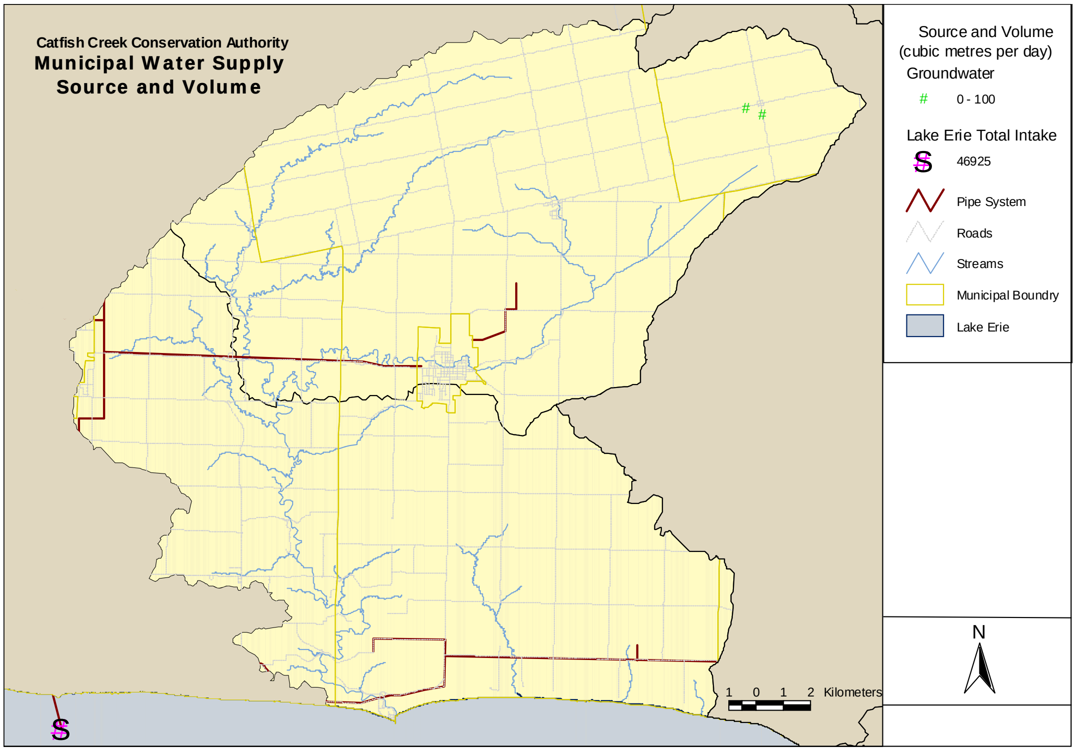

Figure 2. Municipal Supply Sources

Comparisons between water takings and annual average precipitation are useful for comparing water supply and demand, and are best expressed as a depth over the surfacewater subwatershed. For instance, municipal water takings can be expressed as a depth over the subwatershed from which the taking is located by dividing the total volume of the taking by the area (see Equation 1). The annual average precipitation in this region ranges from 985mm to 1010mm (Aylmer is 989mm/year; Environment Canada, 2005a), which provides a constant value for comparing to various water uses. The depth of municipal water takings can be seen in Figure 3. Subsequent maps will utilize this method of displaying water use across the region.

Equation #1:

$$\text{Depth of Water Taking (m)} = \frac{\text{Volume of Total Taking } (m^3)}{\text{Subwatershed Area } (m^2)}$$

For the purposes of water budgeting, the Lake Erie water supply is not considered a watershed-based water taking, and thus the depth of water taking from the Lake Erie intake is not included in Figure 3. As a result, municipal water taking depths in the Catfish Creek watershed are only the groundwater taking for Brownsville, located in the northeast corner of the watershed in Oxford County.

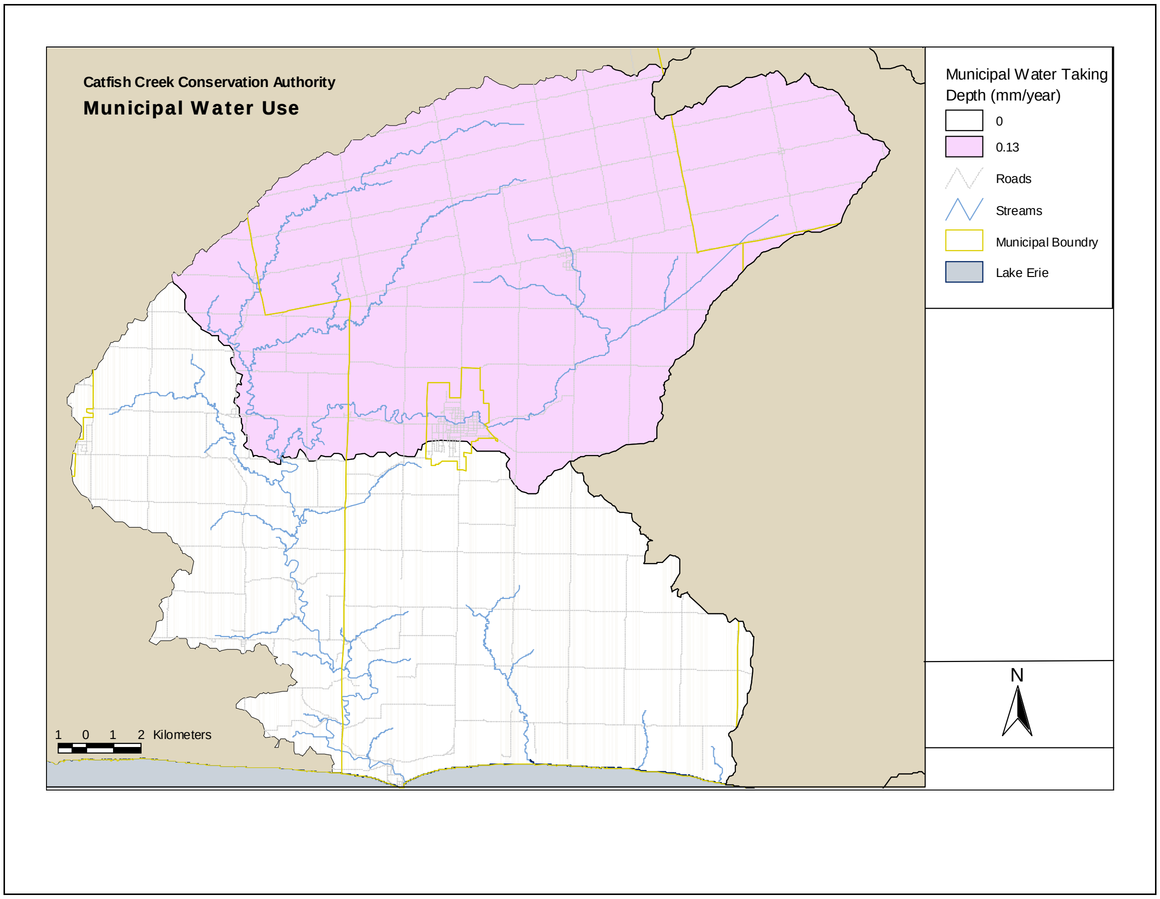

Figure 3. Municipal Water Use

In order to illustrate how municipal supply differs from month to month, information on monthly distributions of municipal water use was required. This information was obtained from the municipality or community, and was often readily available due to the Ontario Regulation 170/03 requirement that all municipalities servicing water to communities keep records of use. Table 2 lists the monthly water use patterns for the serviced municipalities in the CCCA, where available. The values in Table 2 show the average monthly water use as 1.00, and departures from that value show either a lower or higher water use by percentage. For instance, a value of 0.95 would indicate that water use in this month is 5% lower than the average monthly water use. This information provides a distribution of water use throughout the year, and could be beneficial in understanding water demand trends. In the Catfish Creek subwatershed, it appears that the summer months have higher uses then the rest of the year, which may be attributed to summer outdoor uses such as lawn watering.

Table 2. Monthly Distribution of average daily municipal water use

Municipal System	Jan	Feb	Mar	Apr	May	Jul	Jun	Aug	Sep	Oct	Nov	Dec
Aylmer	0.87	0.97	0.97	0.91	1.02	1.24	1.07	0.95	1.06	0.95	0.91	1.07
Brownsville	0.94	0.94	0.95	0.93	1.01	1.11	1.12	1.00	1.06	1.00	0.98	0.96
Central Elgin and Malahide	0.74	0.95	0.85	0.56	1.36	1.09	1.55	1.36	1.16	0.85	0.46	1.08

The percentages of groundwater versus surfacewater supplies for municipally serviced communities in the Catfish Creek watershed are seen in Table 3. Groundwater is the water source for one community in the northern portion of the Catfish Creek watershed, while the proximity to Lake Erie provides easy access to municipally serviceable water supplies to the southern portion of the watershed. Municipal water use totals 1.3M cubic metres per year for the watershed.

Table 3. Municipal Water Use by Source

Source	Water Use (m^3/year)	Percent
Groundwater	33,014	2.51%
Surfacewater – Lake Erie	1,283,937	97.49%
Total Municipal Water Use	**1,316,951**	**100.00%**

4.0 AGRICULTURAL WATER USE

Agricultural water use was divided into two categories; livestock/farming operation water use and crop irrigation water use. This division was based on the information availability of the 2 categories, as well as their differing water requirements throughout the year. For instance, water use for livestock and other farming operations are generally year-round takings, as opposed to crop irrigation, which only occurs during the summer growing season. Other farming operations considered in this water use category include greenhouse operations.

4.1 Livestock and Year-Round Farming Operations

Water use estimates for livestock are more difficult to approximate than other water uses, since a Permit to Take Water is not required for animal watering. The exception is water that is taken into a storage facility prior to animal watering, which does require a PTTW. Often, livestock watering needs are not measured by the farmer and very few records are available for use in this study. Therefore, the estimates would have to rely on external information and research on livestock daily water needs and the number of livestock in the watershed.

The National Soil and Water Conservation Program recognized this gap in livestock water use estimates, and contracted research out to the University of Guelph to, among other objectives, verify and update agricultural water use data on a sector-by-sector basis. The study, by Kreutzwiser and de Loë (1999), built upon previous work by refining existing water use coefficients for specific farming practices.

The spreadsheet tool created in the study by Kreutzwiser and de Loë (1999) provided the framework to import Census of Agriculture data and calculate the total agricultural water use for a particular geographic unit. The study generated various water use coefficients for many of the different variables collected within the Census of Agriculture, such as animal populations and farming practices. Multiplying the water use coefficients (i.e. dairy cows consume 90 L/day) by the information given in the Census of Agriculture database, such as the number of animals or crop type and area, results the total agricultural water use for the geographic region can be calculated. The water use coefficients were applied to the 2001 Census of Agriculture (Statistics Canada, 2001) data to generate water use estimates for this report. Figure 4 displays the results of the analysis on a subwatershed basis.

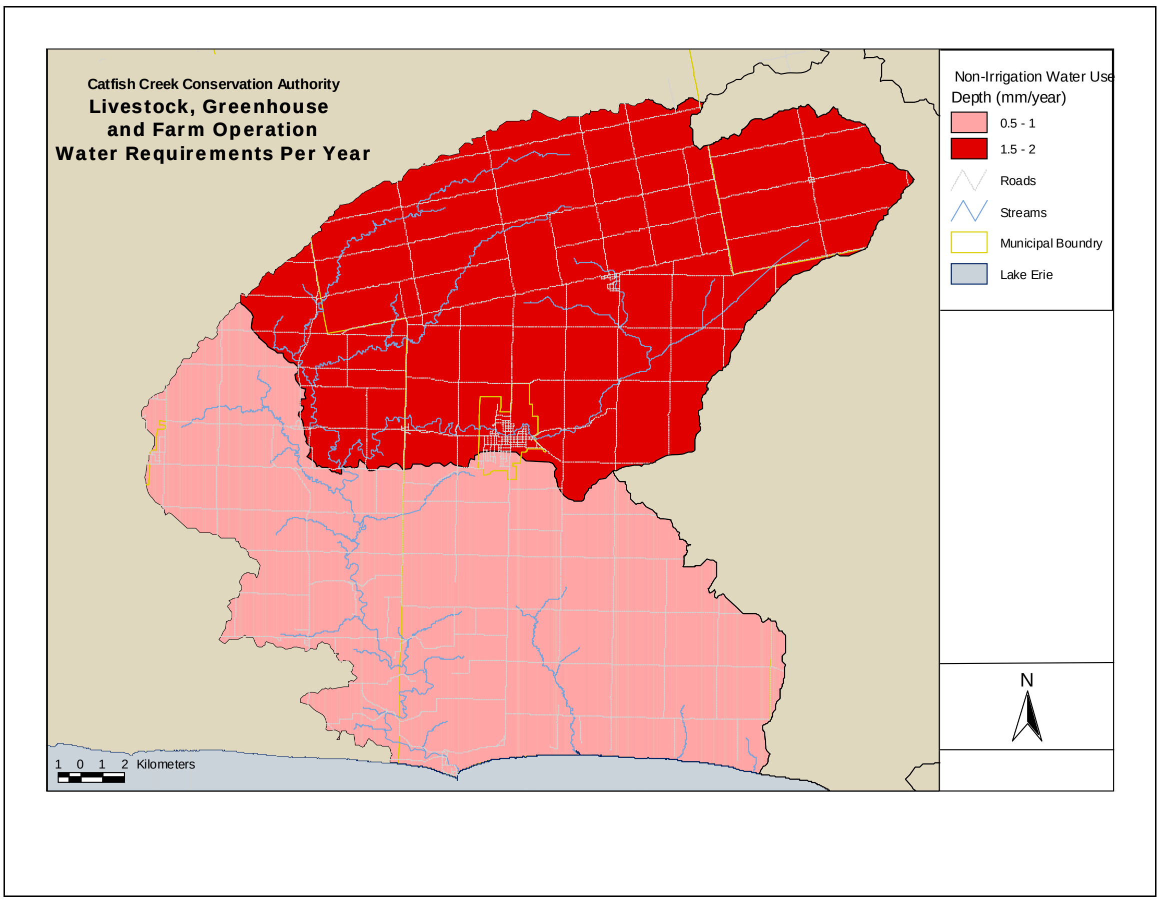

Figure 4. Livestock and Farm Operations Water Requirements.

Census of Agriculture data are generally reported on dissemination areas (DA), which are subsections based on municipal boundaries; however, to keep consistency with other water uses, it was requested that the information be translated to surfacewater subwatersheds for this analysis. Subwatershed basins were provided to Statistics Canada by the Grand River Conservation Authority, based on hand delineation of the topographic surface of the watersheds using the National Topographic System (NTS) and micro-drainage reports (average basin size of 241.4 km^2). Statistics Canada used the subwatershed boundaries to re-cast the information from the original DA divisions. However, privacy issues in census reporting require that no less than 3 farm units of the same type of operation (one type of farming operations may be a sod farm, for example) be available within the basin to release the information concerning that farm type. Information was suppressed if there were less than 3 and greater than zero farm units, but information was also suppressed from adjacent basins to protect the privacy of the owners.

To resolve some of the privacy issues, information was obtained from aggregated Census of Agriculture data, provided from the Ontario Ministry of Agriculture and Food (OMAF). The aggregated data gave more generalized groupings of farm units and thus had fewer limitations due to suppression. As a result, information on total values of the generalized farm units (i.e. total cattle in a subwatershed) were the only categories that were able to be resolved, but aided in gaining a better accuracy for the estimate of water use in agricultural operations.

The coefficients derived by Kreutzwiser and de Loë (1999) assume that some agricultural water uses, such as livestock watering, remains constant throughout the year. Water requirements that are specific to a season, such as crop washing, are assigned solely to that particular season.

All water use related to crop irrigation (e.g. for tobacco, vegetables, and sod) was not included in this exercise, as crop irrigation was accounted for in a separate calculation and is discussed in the following section.

It is estimated that agricultural water uses, excluding irrigation water, account for 636,600m^3 per year.

4.2 Crop Irrigation

Crop irrigation is the application of supplemental water onto cropped fields when natural precipitation is insufficient. While it is possible to calculate water use for crop irrigation using the same technique as for livestock/farming operations in the previous section, the need to investigate annual variations in water use required estimation with an irrigation demand model. The water requirements for crop irrigation are seasonal, and are determined by the area of land irrigated and the number of irrigation events per year.

4.2.1 Area of Irrigated Land

The area of irrigated land reported by the Census of Agriculture was used for this study to quantify the extent of irrigated land in the watershed. Statistics Canada re-cast the information on irrigated land for the subwatershed basins, as previously described. In the

Catfish Creek watershed, the Census of Agriculture data were divided into 2 subwatersheds that were used to display information regarding irrigated land.

By investigating the reported amount of irrigated land in the Census of Agriculture, one can identify certain trends. A summary of the total irrigated land in the Catfish Creek watershed from the 1991, 1996 and 2001 Agricultural Census, is outlined in Figure 5. This shows that a relatively small portion of the watershed is irrigated. There was an increase in irrigated land from 1991 to 1996, however by 2001 the area decreased to approximately the 1991 levels.

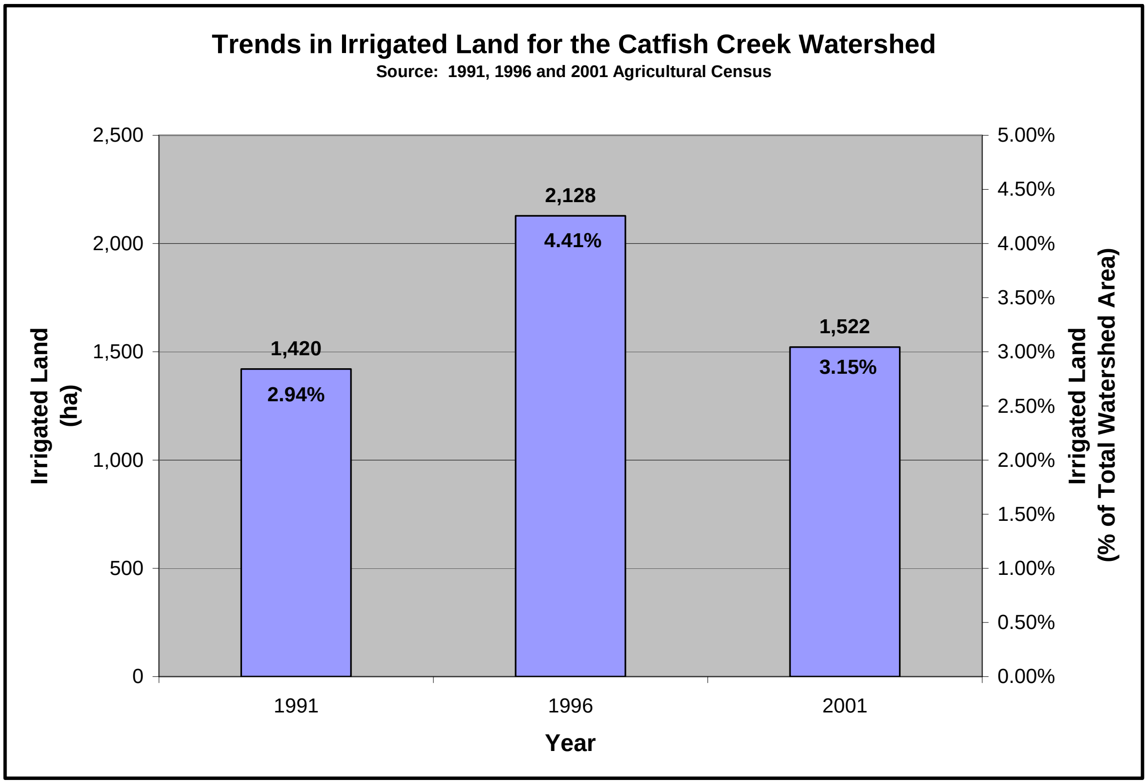

Figure 5. Trends in Irrigated Lands for the Catfish Creek Watershed

Reporting of irrigated land by farmers is retroactive to the year prior to the census year, therefore the reported irrigation data are for irrigated areas of 1990, 1995 and 2000. The decrease in irrigation area in 2000 might have been climate-driven, and partly due to the amount of cropped land in the region slightly decreasing since the 1996 census year, as seen in Table 4.

Table 4. Cropped and Irrigated land percentages in the Catfish Creek Watershed

	1991	1996	2001
Cropped Land in Watershed	63.60%	71.93%	69.94%
Irrigated Land in Watershed	2.94%	4.41%	3.15%
Cropped Land that is Irrigated	4.62%	6.13%	4.51%

4.2.2 Number of Irrigation Events

The estimation for the number of irrigation occurrences utilized an irrigation demand model, developed to predict the number of times farmers would be required to irrigate. This model uses synthetic daily soil moisture from the **G**uelph **A**ll-**W**eather **S**equential **E**vents **R**unoff (GAWSER) model. Further information on the GAWSER model and its applications as a water management tool can be found in GAWSER: A Versatile Tool for Water Management Planning (Schroeter *et al*., 2000).

The GAWSER model uses a combination of quaternary geology, land cover, hummocky topography and precipitation to estimate the water cycle at all points in the watershed. The number of irrigation events is calculated based on soil moisture content in which the crop is grown. It is generally accepted that vegetation becomes stressed when the soil moisture content drops below 55% of the soil water storage ability (Schwab *et al*., 1981), or halfway between field capacity and wilting point. It is assumed that crops would require irrigation at this point.

The GAWSER model requires that the soil moisture remain under 55% for an extended period of time (average soil moisture over a few days) to trigger an event, in order to reduce the number of irrigation events that occur just before a large increase in soil moisture (for example, a large rainfall event). The depth of soil that is assumed to be within the active root zone for measuring soil moisture is 300 mm (AAFC OMAF, 1995). The irrigation demand model tracks soil moisture in the root zone, and when it reaches the critical level, an irrigation event is triggered applying 25 mm or 1 inch of water with a 65% efficiency rating (Keller and Bliesner, 1990; Allen, 1991).

Irrigation modelling was completed for the years from 1961 to 1999 in a subwatershed of the Grand River watershed. The Whitemans Creek watershed is part of the Norfolk Sand Plain, which extends into the Catfish Creek watershed, and thus suitable for this application. It is assumed that the irrigation season for this region falls between June 20 and September 10, and irrigation events can only be triggered between these dates. If the soil moisture falls below the critical soil moisture level outside of these dates, no irrigation event is triggered. The applied water is added to the soil moisture time series and is evaporated by the model over the applicable time periods. When soil moisture reaches the critical level again, another irrigation event is triggered.

With this irrigation demand model running continuously from 1961 to 1999, one can determine how irrigation demand changes from year to year. Figures 6 and 7 illustrate the irrigation demand model output for 1992 – a wet year, and 1999 – a dry year. The solid blue area represents soil moisture, with the yellow areas (see Figure 7) denoting the moisture added by irrigation events.

This analysis is useful in determining the temporal variability of irrigation events and ultimately, water demand. An integral component of water management may be establishing how water use can change with precipitation patterns. The number of irrigation events predicted for each year is identified in Figure 8.

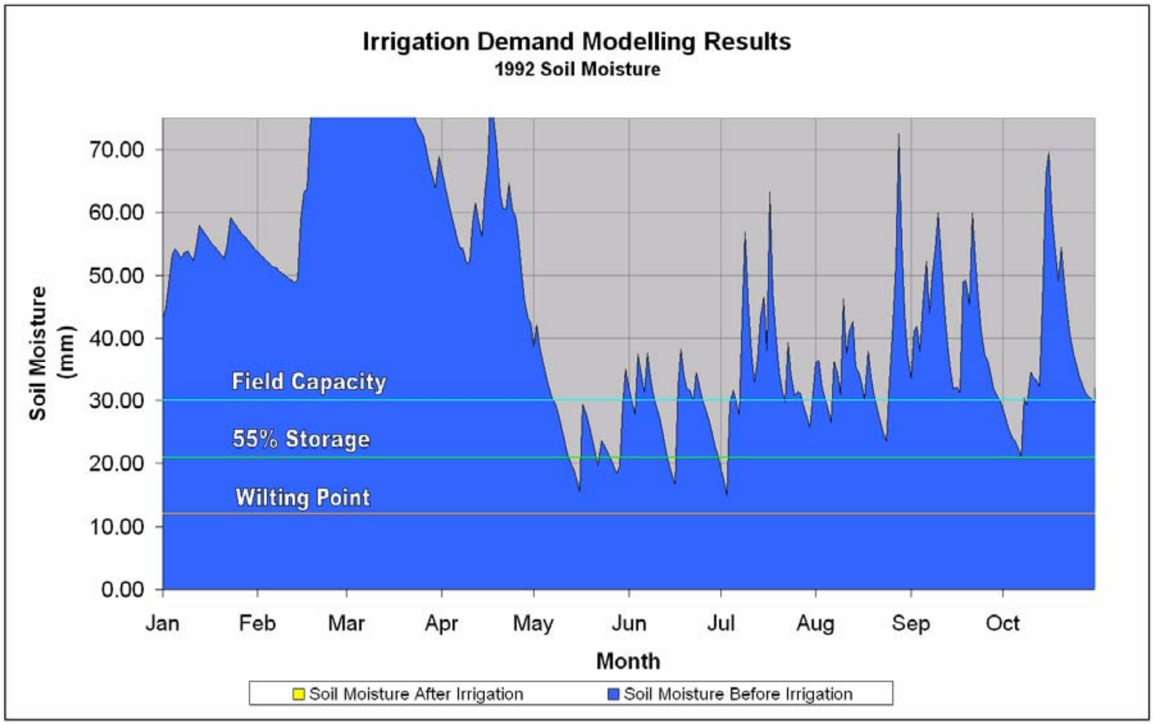

Figure 6. Irrigation Demand Modelling – Wet Year

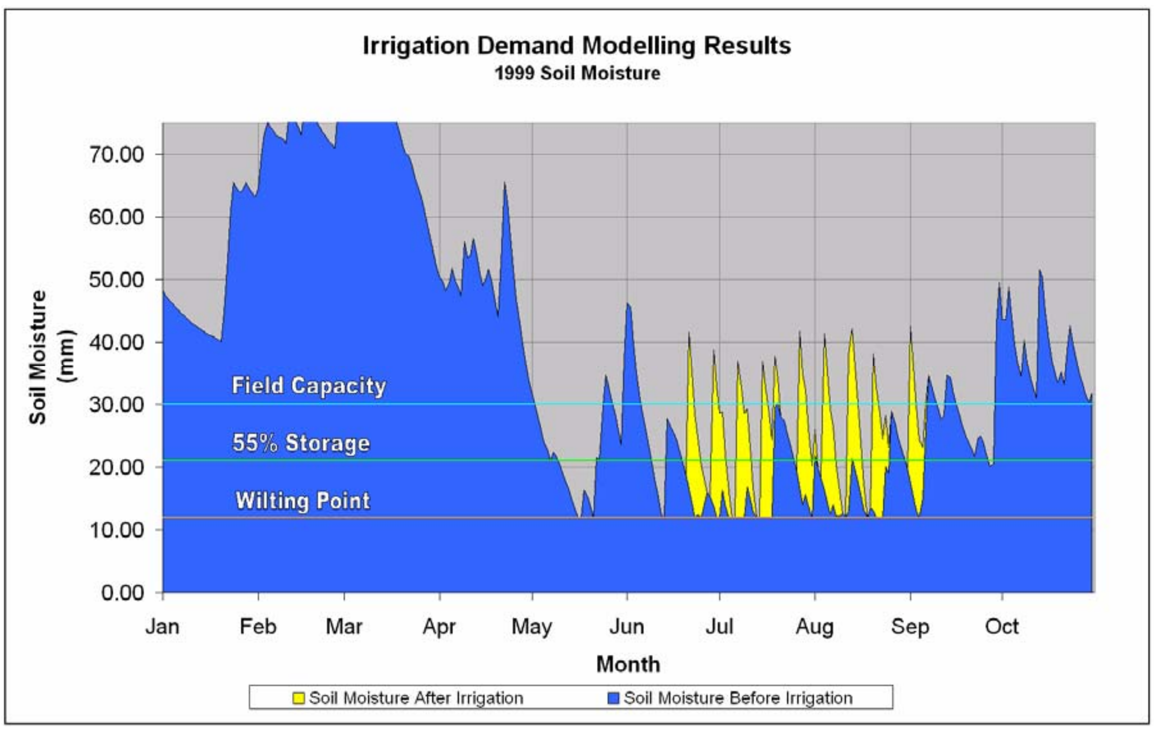

Figure 7. Irrigation Demand Modelling – Drought Year

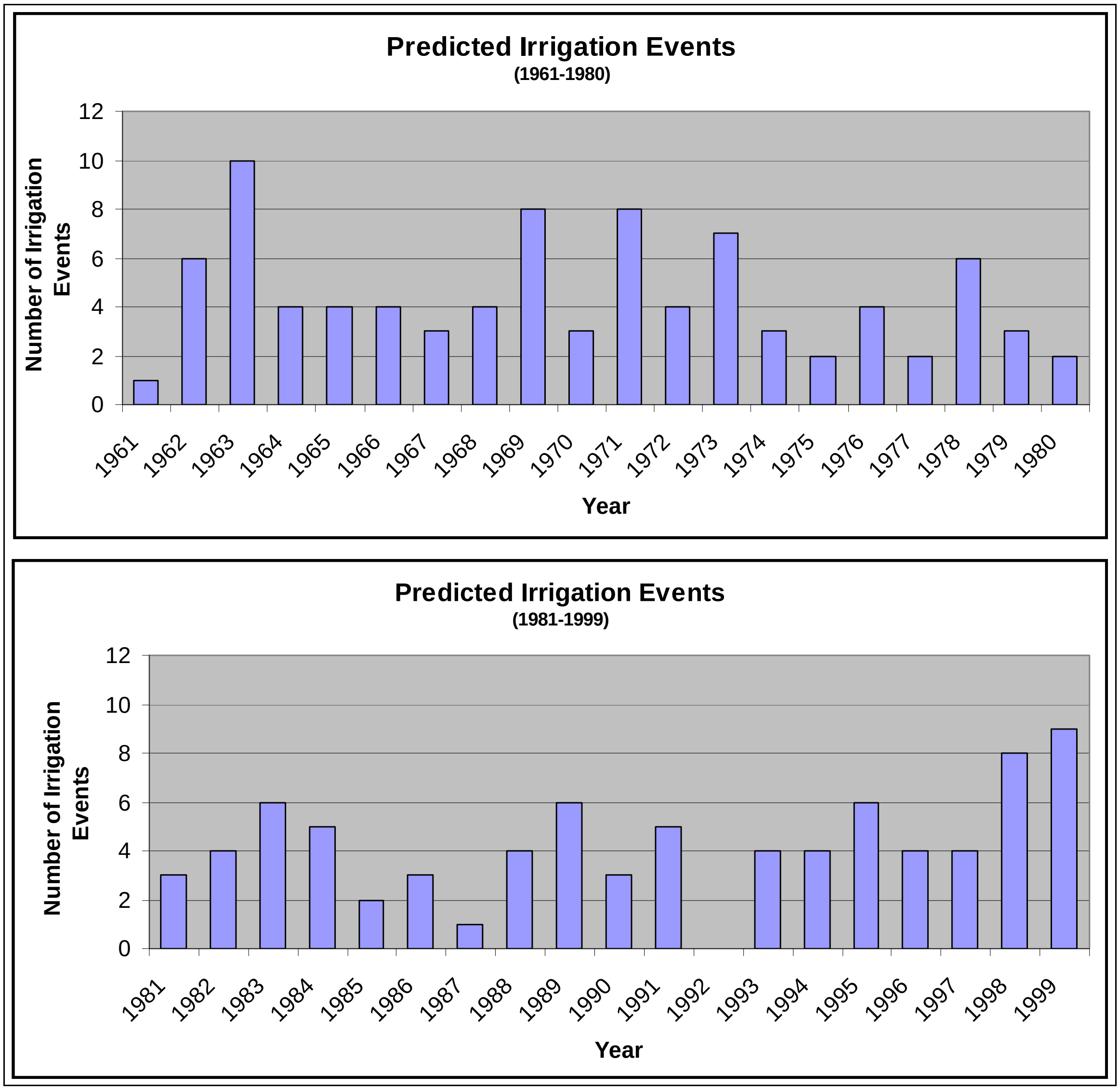

Figure 8. Irrigation Events Predicted 1961-1999

The average of 4 and maximum of 10 irrigation events was used during the modelling exercise to determine the irrigation demand in the Catfish Creek watershed. Table 5 lists the variability of irrigation events as well as the associated water requirement.

Table 5. Range of Irrigation Events and Irrigation Water Demand

	Irrigation Events	Water Demand (m^3)
Minimum	0	0
1st Quartile	3	1,913,000
Median	4	2,551,000
3rd Quartile	6	3,826,000
Maximum	10	6,377,000

The irrigation demand model only considers irrigation events intended to maintain soil moisture at adequate levels for plant growth. Irrigating for climate control, such as spring irrigation to protect against frost, was not considered in this exercise.

The Permit to Take Water database was analyzed to determine a possible breakdown of the source of irrigation water. It was determined that from the 239 agricultural irrigation sources, 138 were supplied by groundwater and 101 were supplied from surfacewater, producing a 58%, 42% split, respectively. Total annual water demand for crop irrigation (for an average year) is displayed in Figure 9.

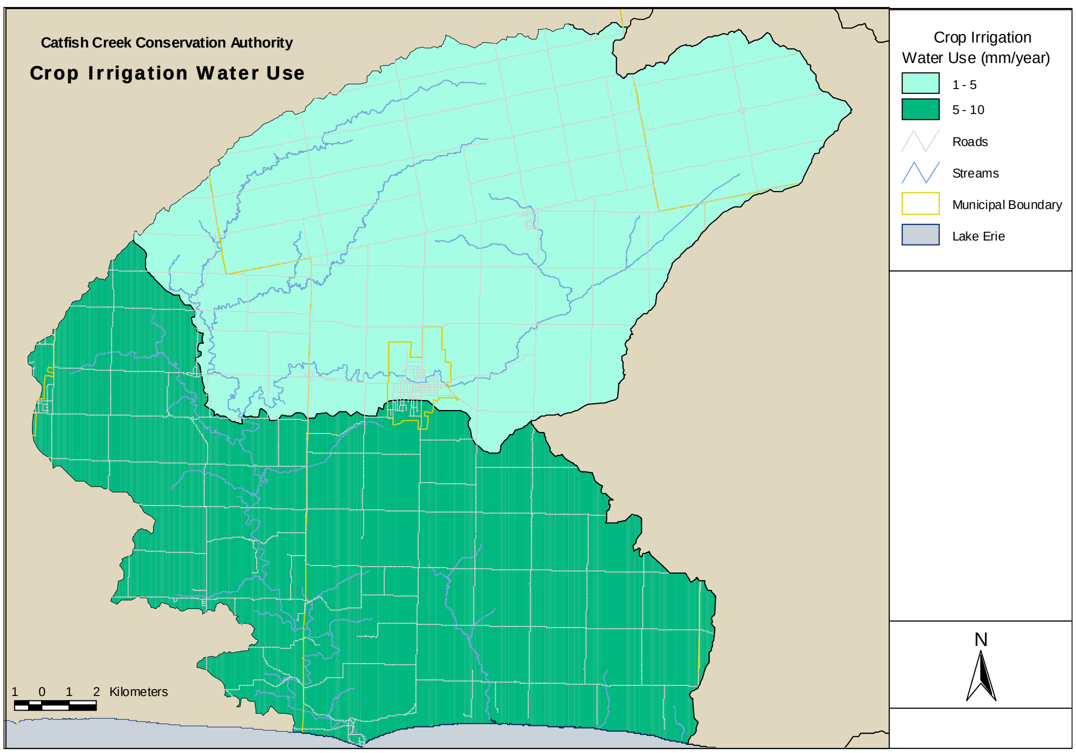

Figure 9. Average Crop Irrigation Water Demand.

5.0 UNSERVICED DOMESTIC WATER USE

Unserviced domestic water use is defined as all water uses for domestic (indoor and outdoor residential water uses) purposes that are not on a municipal distribution system. Generally, these are rural communities and water could be taken from private wells. The estimation of unserviced domestic water use was based on population estimates and per capita water use rates for rural residents.

Rural domestic per capita water use has traditionally been much lower than urban domestic use. While the actual rate varies depending on a large number of factors, 160L/day was assumed to be the rural domestic per capita water use rate (Vandierendonck and Mitchell, 1997). It should be noted that a large percentage of this water is likely returned to the shallow groundwater system via septic systems. This water use is assumed to be relatively constant throughout the year.

Census of Population from Statistics Canada provides human population on a dissemination area (DA) basis. By removing the dissemination areas that are within municipally serviced communities, as outlined in Section 3.0, a total for the unserviced population can be determined. The rural populations from the DA's were summed and the water use calculated was assumed to be evenly distributed across the subwatersheds.

The rural population in the Catfish Creek watershed is estimated at 17,500 and draw 1.0M cubic metres of water per year. The water use by subwatersheds is illustrated in Figure 10.

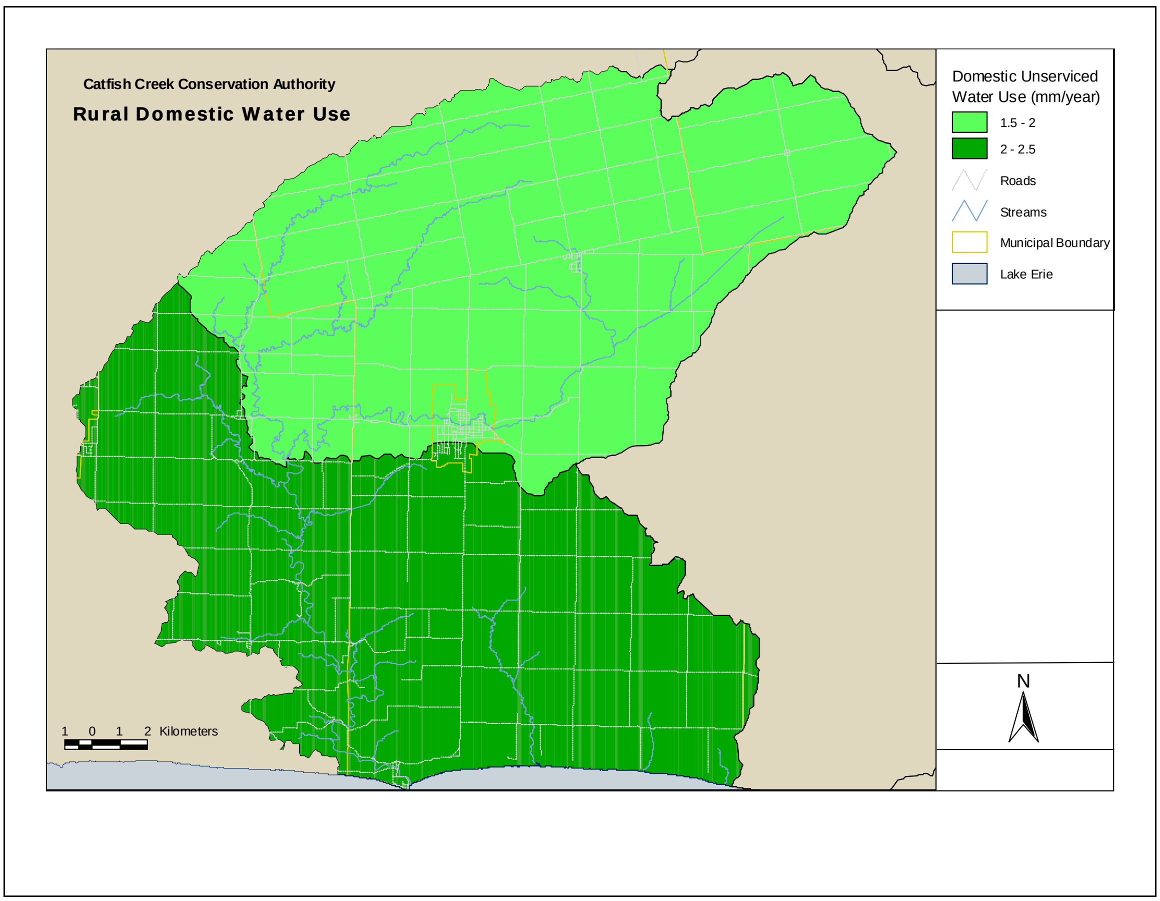

Figure 10. Rural Domestic Water Use

6.0 OTHER PERMITTED WATER TAKINGS

Water uses that did not fall into the 3 previously mentioned categories (municipal, agricultural and rural unserviced), were determined using the Ministry of the Environment (MOE) Permit to Take Water database. The MOE requires any person taking greater than 50,000 litres of water on any day of the year (animal watering, domestic usage, and firefighting excluded) to apply for a PTTW. This generally includes many industrial and larger commercial operations, as well as many agricultural water requirements, such as irrigation.

6.1 Active Permitted Water Takings

The PTTW database was queried to remove any permits that have been expired for longer than 10 years, including as well as cancelled permits or temporary permits. Permit categories that such as municipal, agricultural, and rural domestic uses were dropped from consideration, along with permits which did not represent true water takings. The most common type of excluded permits were those representing Ducks Unlimited wetlands. These constructed wetlands are built to capture runoff during the spring, and can therefore have high water taking volumes associated with them. Since these structures will only utilize their full water taking during the initial filling, they are assumed not to be sustained water takings, and were excluded from the computations.

It is recognized that within certain water use sectors, compliance with the PTTW program may be an issue. This raises additional issues with the accuracy of water use estimates. The MOE has held a number of PTTW clinics attempting to increase compliance with the program.

Four Permits to Take Water remain in the Catfish Creek watershed when permits that have been expired for more than 10 years, cancelled, temporary, agricultural or municipal water supply permits were removed. These 4 permits have a total of 7 sources associated with them, as it is worthwhile to note that there may be more than one source associated with a particular Permit. Of the 7 sources, all rely on groundwater, although 1 draws from a dugout pond which could be considered both surface and groundwater. Figure 11 shows the location, source and proportional volume of the maximum permitted water taking for these permits.

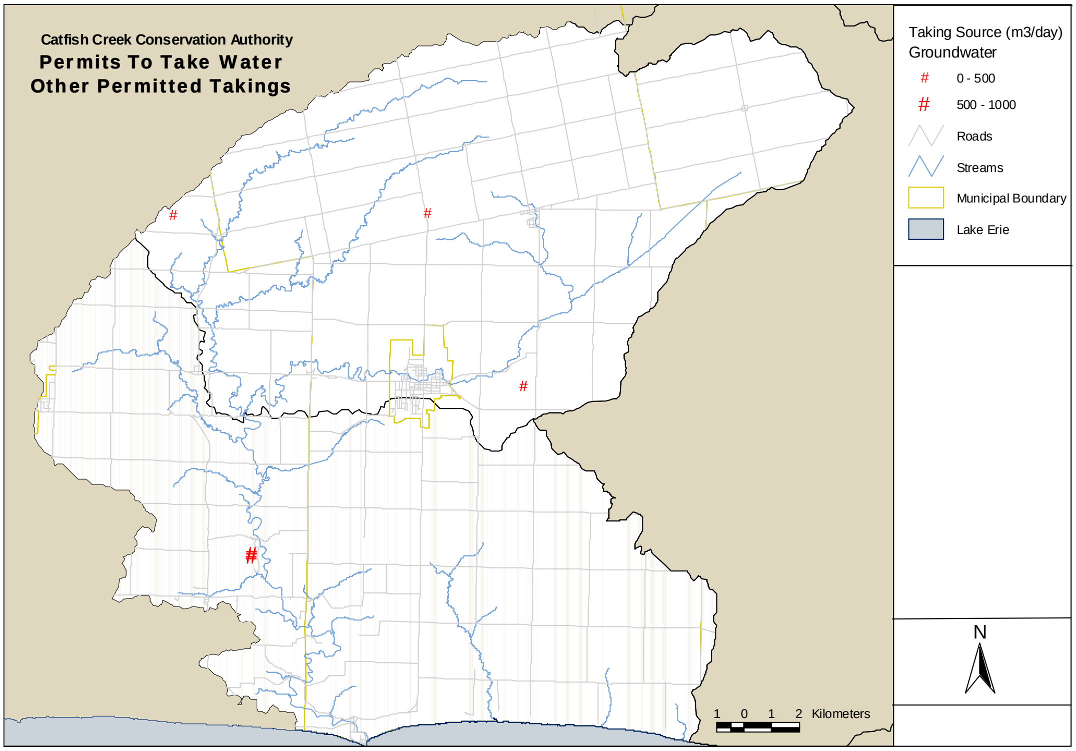

Figure 11. Permits to Take Water: Source, Location and Maximum Volume

6.2 Adjustments to the PTTW Database

When applying for a PTTW, the applicant must declare the maximum volume of water they intend to use. When estimating water use, applying the maximum permitted volume as opposed to the reporting of actual water taking is a shortcoming of the PTTW program. In many cases, the applicant requests a quantity much greater than they would actually use. In addition, it is not known how many days or which season the permit holder is actively taking water. It should be noted that MOE has recognized this issue with the PTTW program, and is currently implementing amendments which would require permit holders to submit actual water use data to the MOE.

In order to address this drawback with the database information collection, monthly adjustment factors were applied to permitted volumes to more accurately reflect actual water usage, as outlined in Table 6. These adjustment factors simply determine when the taking is active. Months when the permit was assumed to be active were given a value of 1, while inactive months were given a 0 value. For the water supply permits (not including campgrounds), monthly patterns are assumed to be the same as the Regional Municipality of Waterloo's pattern for smaller communities, as described in Section 1.0, with the maximum permitted flowrate being the August monthly water use.

Table 6: Permit To Take Water Adjustment Factors

General Purpose	Specific Purpose	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Commercial	Aquaculture	1	1	1	1	1	1	1	1	1	1	1	1
Commercial	Golf Course Irrigation	0	0	0	0	1	1	1	1	1	1	0	0
Water Supply	Communal	0.80	0.75	0.82	0.82	0.89	0.86	0.97	1.00	0.95	0.95	0.87	0.84

There are still known issues with the accuracy of the estimates when using the outlined adjustment factors to gain a better estimate of water use throughout the year. For instance, during the months that a permit is assumed to be active, the taking is assumed to be occurring continuously. While it is unlikely that most water takings will be uninterrupted during the entire month, there are no data available to support an analysis in order to determine the period of taking for each purpose. Therefore, water use estimates for some categories will be elevated due to the assumption of continually active water takings, the maximum permitted takings and the duplication of some permits. These water use categories will be the absolute maximum permitted, and do not represent existing actual conditions.

A survey of all major water users identified in the watershed was completed to gain an insight into actual water takings and taking characteristics. While Figure 11 shows the maximum amount permitted by each taking, Figure 12 identifies depths of water takings with the adjustments. To better estimate or document actual volumes of water use by these users, a phone survey of the 4 water takers was completed in the summer of 2005.

Each water user was asked to identify the time of year and duration of day that they were taking water for their use, the source, and purpose of the taking. From this information, a better estimate than the permitted maximum can be used to estimate water use by subwatersheds. The survey generated 2 responses (50% response rate) to help refine the estimates of their water uses. Where no data could be obtained from the user for monthly water uses, adjustments were made based on the adjustment factors outlined in Table 6.

Figure 12 illustrates the depth of water use on a surfacewater subwatershed, including the adjustments to refine the depths from the survey and adjustment factors.

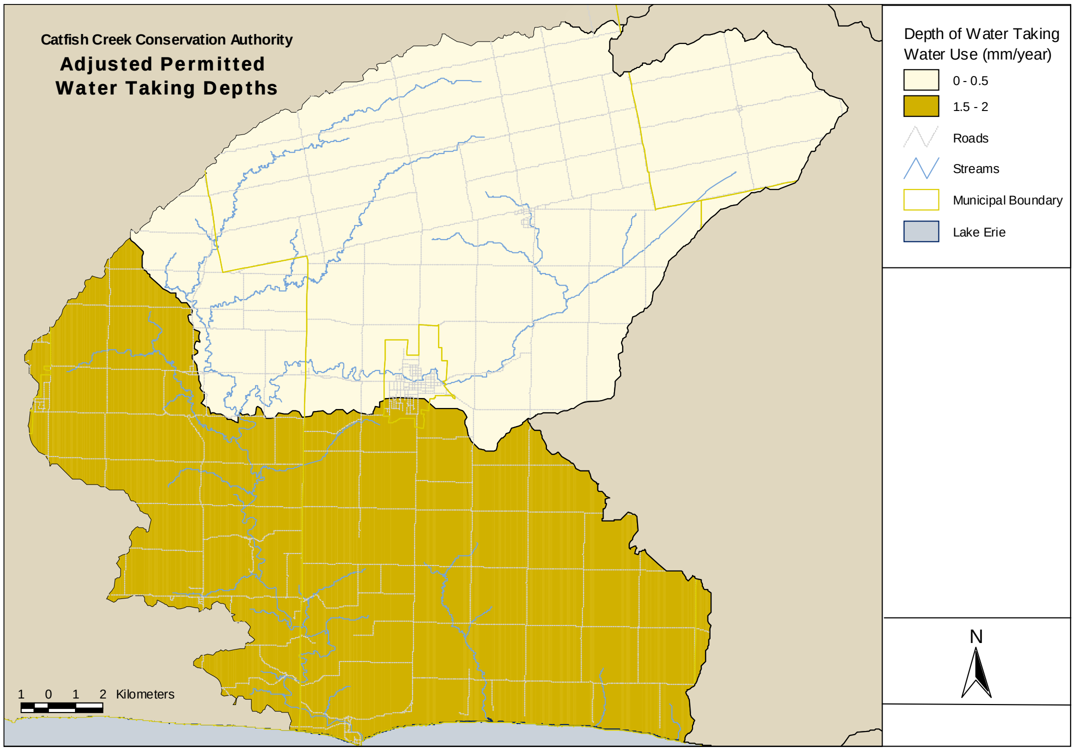

Figure 12. Adjusted Depth of Water Takings from Permits to Take Water

The estimated annual water use for each category listed in the PTTW database is quantified in Table 7. It should be noted that this analysis uses the amount either refined by the survey, monthly adjustment factors, or when not available, the amount identified by the database.

Table 7. Adjusted Permit To Take Water Volumes – By Source

Purpose	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**TOTAL**
Aquaculture	33,800	30,530	33,800	32,710	33,800	32,710	33,800	33,800	32,710	33,800	32,710	33,800	397,920
Water Supply Communal	6,630	5,610	6,790	6,570	7,370	6,890	8,040	8,280	7,620	7,870	6,970	6,960	97,540
Golf Course Irrigation					1,180	1,140	1,180	1,180	1,140	1,180			7,000
Total (m^3)	40,420	36,140	40,590	39,280	42,350	40,740	43,010	43,260	41,460	42,850	39,680	40,750	**490,530**

The adjusted water takings are considerably less than the permitted maximums provided in the database, averaging 47% of the database value. The most drastic change in volume was seen in the Aquaculture category, which had the 42% of the actual permitted use. The Communal Water Supply category showed the least change in volume (85%), as there was no feedback given by these permit holders. The survey also assisted in clarifying the information in the database, since there were some errors found in the purpose category or termination of the water use.

7.0 ANALYSIS

The major water use sectors in the Catfish Creek watershed will be the focus of this section. A summary of all the water uses in each of the subwatersheds is shown in Figure 13. This shows the sum total of all the water uses including municipal, livestock and greenhouse, crop irrigation, rural domestic and PTTW adjusted takings, on an annual basis.

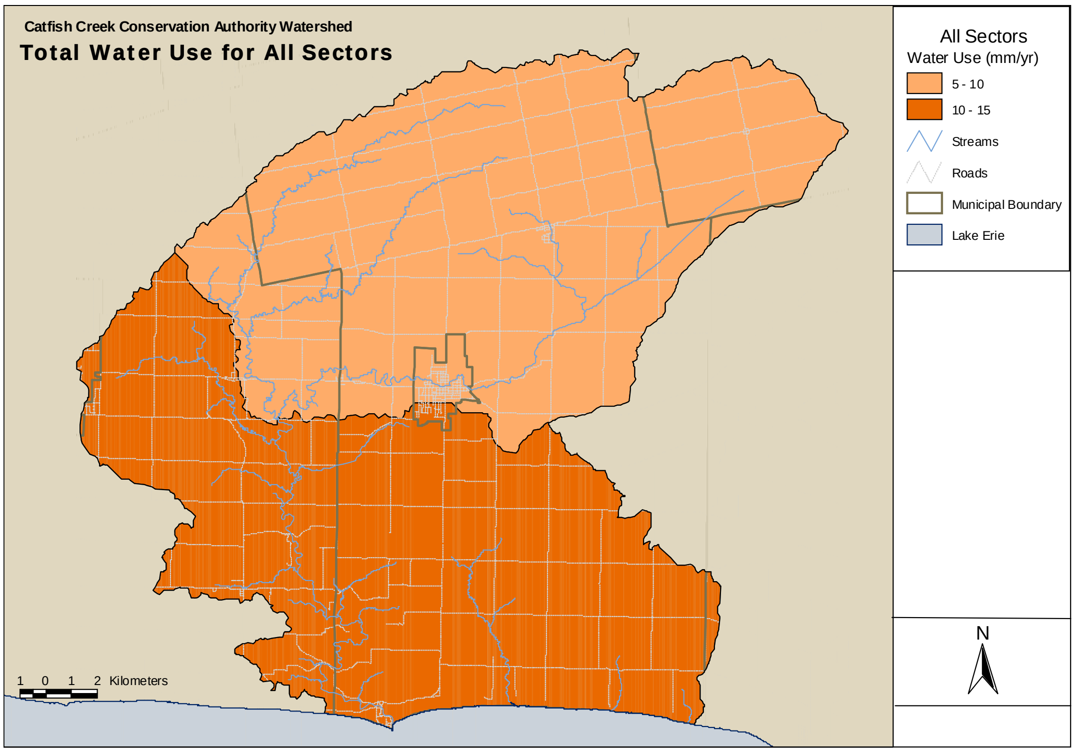

Figure 13. Total Subwatershed Water Depths for All Sectors

Table 8 lists all the water uses described in the previous sections and compares them against each other, as well as illustrates the monthly and annual variation of water use. Figure 14 shows the percentages of major water uses on an annual basis.

Table 8. Total Water Use Comparison

	Water Use Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
1	Agricultural - Irrigation						637,750	1,275,500	637,750					2,551,000
2	Municipal	103,960	97,260	105,440	91,940	120,160	115,240	141,280	114,560	115,090	104,000	89,980	118,050	1,316,950
3	Rural Domestic	87,160	78,720	87,160	84,350	87,160	84,350	87,160	87,160	84,350	87,160	84,350	87,160	1,026,200
4	Agricultural	40,150	36,260	40,150	38,850	40,150	38,850	94,770	94,770	93,470	40,150	38,850	40,150	636,560
5	Aquaculture	33,800	30,530	33,800	32,710	33,800	32,710	33,800	33,800	32,710	89,975	32,710	33,800	397,920
6	Water Supply Communal	6,630	5,610	6,790	6,570	7,370	6,890	8,040	8,280	7,620	7,870	6,970	6,960	97,540
7	Golf Course Irrigation					1,180	1,140	1,180	1,180	1,140	1,180			7,000
	TOTAL	271,700	248,380	273,340	254,420	289,820	916,930	1,641,730	977,500	334,380	330,335	252,860	286,120	6,033,170

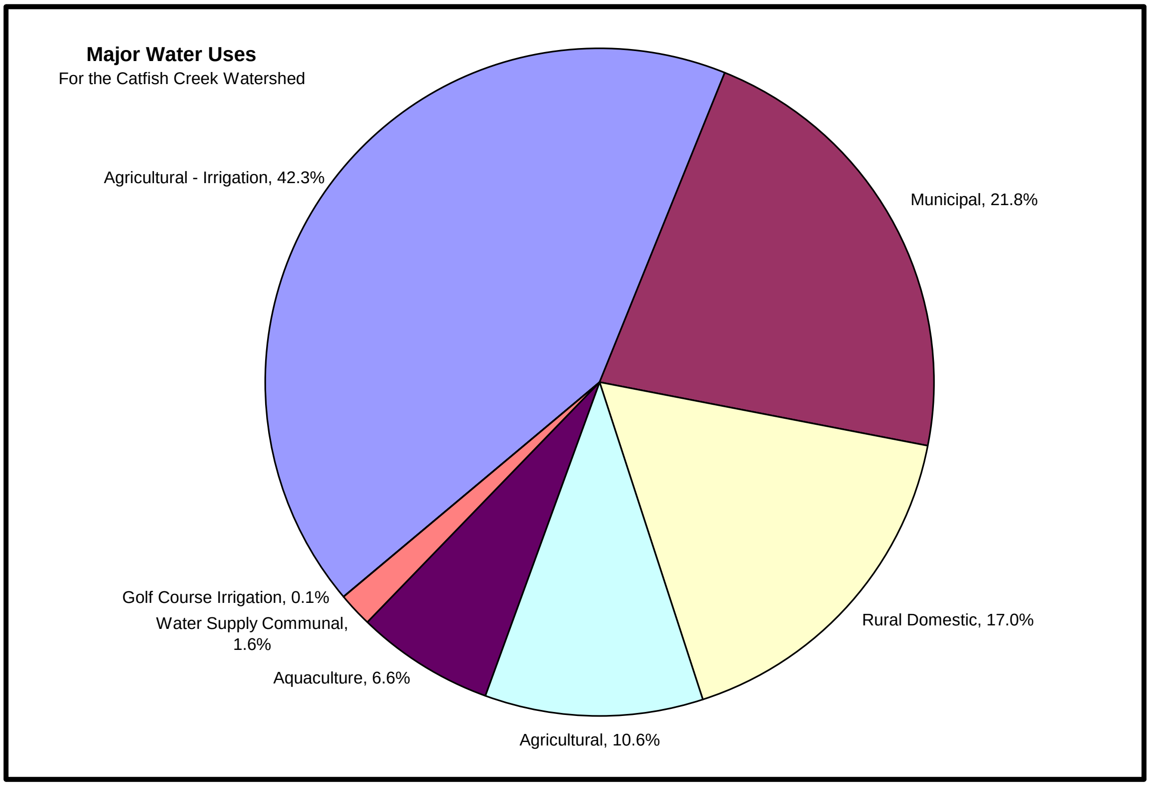

Figure 14. Major Water Uses – Annual Basis

Agricultural irrigation is the highest annual water taking in the Catfish Creek watershed, as seen in Figure 14. Aquaculture, as the fifth largest user, is a non-consumptive water taking, as it often stays in the surfacewater body, is diverted back into the river from temporary storage, or the water is re-circulated through its system. There are cases in Ontario where groundwater wells are used to supplement surfacewater takings for aquaculture, which is considered a diversion of water to another source, but this is only an occasional occurrence of water use.

While Figure 14 is useful for comparing totals, this analysis will under-represent the significance of short but intense water uses, such as crop irrigation. A line graph (Figure 15) illustrates the importance of monthly variability. Agricultural irrigation is the highest annual water taking, but is concentrated in only 3 months of the year and is considerably higher than other water uses. In the month of July alone, agricultural irrigation is 3.5 times greater than all the other water uses combined.

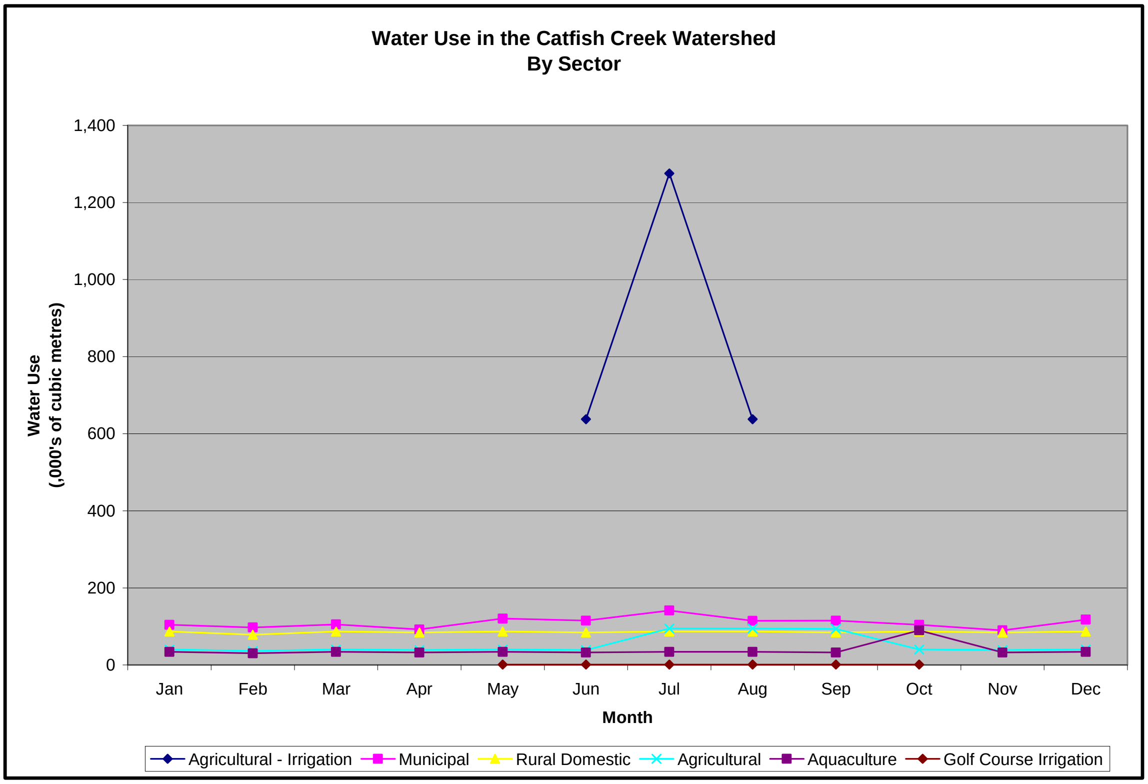

Figure 15. Monthly Variation of Major Water Uses

It should be noted that in regard to Crop Irrigation, the actual water use may be more intense than what is represented by the monthly analysis. Crop Irrigation can be concentrated into a single week depending on climate conditions, making it by far, the largest water taking in the watershed, albeit for a short duration.

For effective water management, one must understand the intensity of surfacewater takings. The intensity of groundwater takings is generally less important due to the delayed response associated with groundwater, however, when considering unconfined aquifers, which are well connected to the surfacewater system, the intensity of takings may be more significant.

In addition to monthly variation, water use also varies on an annual basis. Climate variation plays an enormous role in certain types of water use. The longer the watershed goes without receiving rain, the more water is needed to water lawns, or irrigate agricultural crops.

While the amount of water used by many water takers is largely dependent on the climate, some water users operate independently of climate. Climate independent uses may include aquaculture operations and industrial processes, who require the same amount of water during the entire year. Other water uses are driven by the climate including golf course irrigation and aggregate producers who only operate during the summer months. Due to data limitations, it is not possible to quantify the impact of dry periods on every water user listed in Table 8, but water users can be qualitatively separated into climate-dependent and climate-independent subgroups, as seen in Table 9.

Table 9. Climate-Sensitive Water Uses in the Catfish Creek Watershed

Category	Climate Sensitive	Climate Insensitive
Agricultural	X	
Agricultural Irrigation, Average	X	
Aquaculture		X
Golf Course Irrigation	X	
Municipal Supply	X	
Rural Domestic	X	
Water Supply, Communal	X	
Water Supply, Other	X	

Water diversions and consumptive water uses are a consideration for the continuation of water use estimates. There are water uses that move water from one source to another. For example, wastewater discharge from aquaculture, dewatering operations or sewage treatment plants all increase the amount of water available in the surfacewater system. While not consumptive, a dewatering operation that removes groundwater and discharges it to surfacewater represents a diversion of groundwater to surfacewater. Dewatering is the removal of seeping water during construction below the water table. When investigating water takings at an individual source scale (such as an aquifer), these non-consumptive diversions do play a significant role in determining the production capacity of the source. Currently, there is not sufficient information to develop consumptive use ratios for all major water uses.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Identification of the various water uses in the Catfish Creek watershed was the focus of this report. The following water use sectors have been identified as being important in a watershed-wide context:

1. Agricultural Irrigation
2. Municipal Water Supply
3. Rural Domestic
4. Agriculture
5. Aquaculture
6. Water Supply Communal
7. Golf Course Irrigation

The study attempted to use a variety of information from different sources such as the PTTW database, municipal records, phone surveys of specific water users and Statistics Canada information from census results.

The PTTW database gives a broad understanding of the different types of water uses in a watershed, however, accuracy of the information is lacking and poses a problem for water managers who use the PTTW database to quantify the amount of water use within a specific area. The database currently does not contain sufficient detail or reliability to determine the actual amount of water used, or show the annual or seasonal fluctuations of water takings.

Phone surveys of the users in the PTTW database helped to refine these estimates, and wherever possible, other sources of information were used. For example, municipalities were contacted to determine actual rates of consumption, and Census of Agriculture and Census of Population data were used to determine agricultural and rural domestic water use. An irrigation demand model, using soil moisture data from a continuous hydrological model, coupled with Census of Agriculture data, has made it possible to determine water demand for crop irrigation and the annual variability of water use.

While annual totals are useful for comparison purposes, seasonal and annual variations must be considered to fully understand the water use in a watershed. Some seasonal and annual variations were shown, however they were limited due to limitations with the data sources. The variations are most significant when considering extremely variable and intense water takings, such as crop irrigation.

This study has identified a number of limitations with water use data available to water managers. In an attempt to address these shortcomings and increase the accuracy of water use estimates, the study has made the following recommendations:

1. That the water use estimates generated from this report be combined with estimates of water availability to identify possible water quantity issue areas.
2. That further information is gathered by the municipalities on the Elgin Area Water Treatment Supply System on serviced populations along the pipeline and taking amounts in the watershed.
3. That information gathered from the municipal sector be separated into industrial, commercial, institutional and residential components of water use.
4. That investigations into more accurate estimates of irrigated land continue, including assessing the use of alternative methodologies such as remote sensing and crop specific water uses.
5. That consumptive ratios of all major water sectors be determined, as well as the occurrence of water diversions.
6. That development of a central database of water use in the watershed continues. This database would house recent information on municipal water systems as well as information gathered from phone surveys of permitted water users.

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