

# **Regional Watershed Monitoring Program: Surface Water Quality Summary 2006-2010**



## **Watershed Monitoring and Reporting Section Ecology Division**

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## 1. Introduction

Every living thing on earth needs water to survive. Water is used for personal, recreational, and work related purposes. Good water quality is fundamental for good river health. Water quality sustains ecological processes that support fish populations, vegetation, wetlands and bird life. Protecting water quality requires monitoring to identify problems and implement corrective actions. Monitoring stream water quality helps to provide a greater understanding of the potential impact associated with various land uses on streams and rivers. Land-use activities which may influence water quality include: applying nutrients to agricultural land, salting roads in the winter, discharging waste water from industries and sewage treatment plants, and non-point source urban runoff. Monitoring helps water resource managers understand the impacts of various activities on water quality so that informed decisions can be made to manage and protect this valuable resource. Since 2002, Toronto and Region Conservation Authority (TRCA) has partnered with the Ontario Ministry of the Environment (OMOE) to monitor surface water quality throughout the TRCA's jurisdiction. Surface water quality samples are collected monthly at 38 sites across the jurisdiction plus several other sites on an as-needed basis. Samples are analyzed for a routine set of analytes including metals, nutrients, and bacteria. In addition to the routine monitoring, two sentinel sites at the mouths of the Don and Humber Rivers are also analyzed for mercury and pesticides. The data enables TRCA and other agencies to document long-term water quality trends, identify general locations of water quality problems, and determine the effectiveness of broad pollution control and watershed management programs.

This report summarizes current (2006-2010) stream water chemistry within the TRCA's jurisdiction. Seasonal changes in water chemistry variables and long-term trends at sentinel sites are also explored. Stream water chemistry for the TRCA jurisdiction has been summarized previously for the periods of 1990-1996 (TRCA 1998), 1996-2002 (TRCA 2003) and 2003-2007 (TRCA 2009a).

### 1.1 Background

The OMOE's Provincial Water Quality Monitoring Network (PWQMN) was started in 1964 to collect surface water quality information from watercourses throughout Ontario. Over time, stations were added or discontinued in response to changing needs (OMOE 2003). The PWQMN monitored water quality throughout the Toronto region until the OMOE substantially scaled back the PWQMN due to funding issues in the 1990s. Only two stations continued to operate in the Toronto region (06008501402 at the mouth of the Don River, and 06008301902 at the mouth of the Humber River). In 2002, TRCA began collecting field samples from 11 additional stations as part of the PWQMN, for a total of 13 PWQMN stations in the Toronto region. The 11 stations were sampled eight times per year on a monthly basis during the ice-free period.

In addition to the PWQMN stations, TRCA collects water quality samples as part of the Regional Watershed Monitoring Program (RWMP). Since 2002, TRCA has monitored 23 additional stations previously part of the PWQMN. In the spring of 2009, two additional water quality

stations were added to the RWMP in the Petticoat Creek and Frenchman's Bay watersheds for a total of 38 stations (13 PWQMN + 25 RWMP) in the TRCA region (Table 1, Figure 1). The number of stations in each watershed is roughly proportional to the size of the watershed and efforts have been made to establish one site at the outlet of each subwatershed. Station location information is provided in Appendix A. Currently, water quality samples collected by the RWMP are sent to the York-Durham Regional Environmental Laboratory (2009-present). Previously, the samples have been sent to various laboratories including Entech Inc., City of Toronto Dee Avenue Laborary and Maxxam Analytics Inc.

From 2002-2003, water quality samples were collected approximately eight times per year from approximately April to November. In 2004, the RWMP expanded its water quality sampling to be year-round. This includes sampling the PWQMN stations during the four months not covered under the agreement with the OMOE. From 2004-2005, winter samples were not collected if the stream was ice-covered. From 2006 onwards, an auger was used for ice-covered streams ensuring at least one water quality sample is collected per month. In June 2009, TRCA began sampling stations the Don River (station 85014) and Humber River (station 83019) mouths on behalf of the OMOE. In exchange, the OMOE laboratory began to analyze the water quality at six sites (stations: 85014, 104001, 80006, 83019, 82003, 97011) year round. In addition, the RWMP also collects *Escherichia coli* (*E. coli*) samples from all sites (both RWMP and PWQMN) year round.

**Table 1. Number of water quality sampling locations per watershed and station names**

Watershed	# Stations	Stations
Etobicoke Creek	3	Mayfield, 80007*, 80006* <sup>M</sup>
Mimico Creek	2	MM003WM, 82003* <sup>M</sup>
Humber River	11	83104*, 83018*, 83009*, 83020, 83004, 83103*, HU1RWMP, HU010WM, 83002, 83012, 83019* <sup>M</sup>
Don River	5	85004, 85003, DN008WM, DM6.0, 85014* <sup>M</sup>
Highland Creek	1	94002* <sup>M</sup>
Rouge River	7	97999, 97018*, 97777, 97003, 97007, 97013, 97011*
Petticoat Creek	1	PT001WM <sup>M</sup>
Frenchman's Bay (Pine Creek)	1	FB003WM
Duffins Creek	6	104008*, 104037, 104029, 104027, 104025, 104001* <sup>M</sup>
Carruthers Creek	1	107002 <sup>M</sup>

Notes: \* denotes a OMOE PWQMN station

<sup>M</sup> denotes a station at the mouth of the watershed or on the main tributary

Many station names have been shortened from the original 11-digit OMOE code (e.g. 06008501402 => 85014)

## 1.2 QA/QC

In 2008, a multi-laboratory split sample QA/QC program was initiated. Samples were submitted to several government and private laboratories to ensure the results from various laboratories were comparable. The program was run again in 2010. Results of this biennial program can be

found in the reports "Water Quality Split Sample QA/QC Program 2008" (TRCA 2009) and "Water Quality Split Sample QA/QC Program 2010" (TRCA 2011). Both sets of analyses revealed that some of the City of Toronto results, particularly for metals, were higher than those provided by the OMOE laboratory. Because of this, caution must be taken when interpreting the results presented in this report.

### 1.3 Indicator Analytes

Over 36 water quality analytes are monitored at each station. A subset of these parameters was selected for analysis for this report based on their relevance to common water-use concerns. Table 2 outlines the indicator analytes, their sources as well as their effects on the aquatic environment, and the applicable water quality guidelines for comparison.

**Table 2. Significance, sources and guidelines for key surface water parameters**

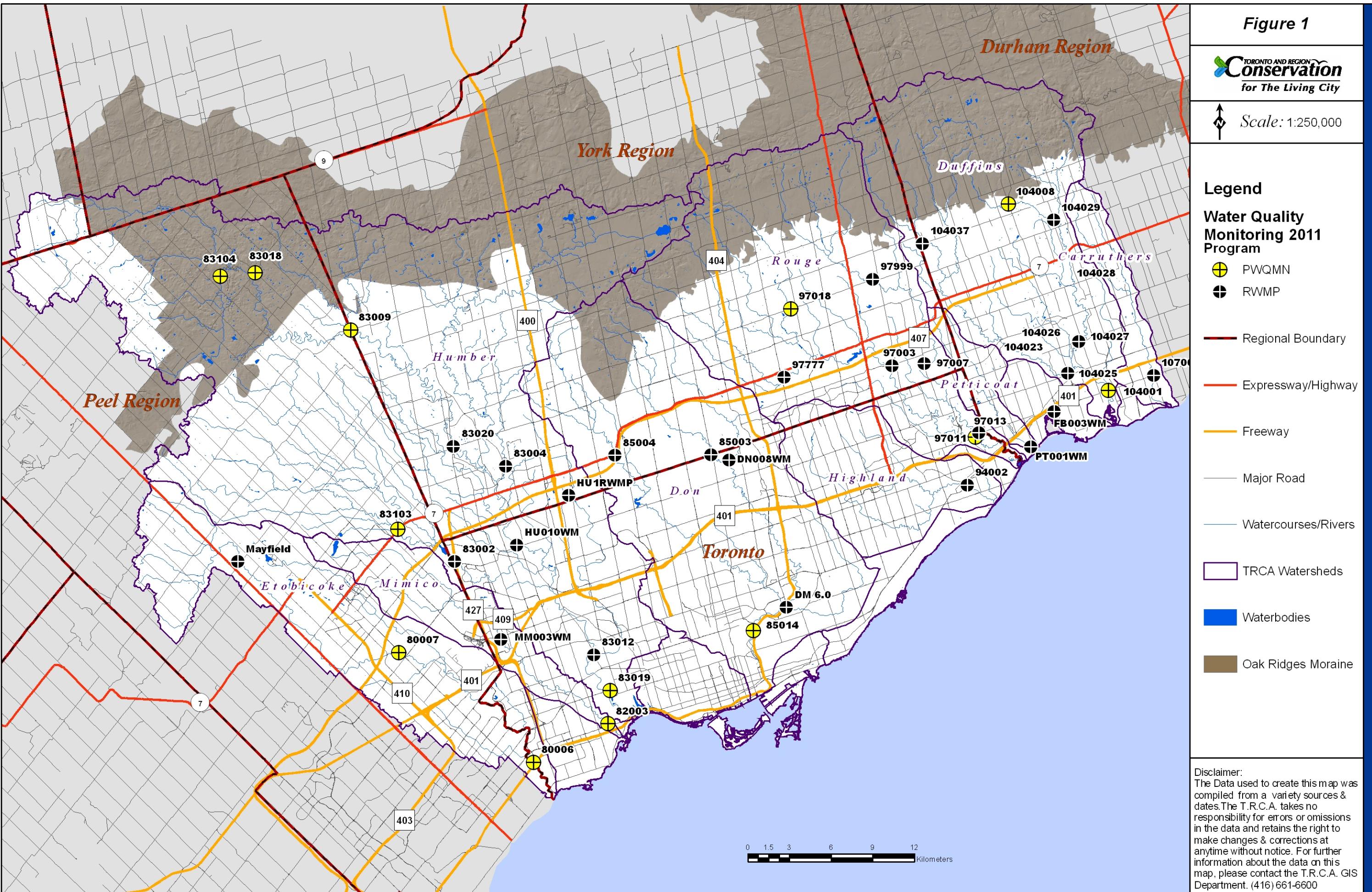
Analyte	Significance	Sources (examples)	Guideline
Total Phosphorus	In excess, phosphorus can have unfavourable effects such as eutrophication (enrichment of a waterbody with nutrients). Phosphorus stimulates plant and algae productivity and biomass. Past a certain point, this can cause reduced biodiversity, changes in the dominant biota, decreases in ecologically sensitive species, increases in tolerant species, anoxia, and increases in toxins (e.g. cyanobacteria).	<ul style="list-style-type: none"> <li>Fertilizers</li> <li>Animal wastes</li> <li>Sanitary sewage</li> </ul>	Interim PWQO <sup>1</sup> : 0.03 mg/L
Nitrates	Nitrates include both nitrate ( $\text{NO}_3^-$ ) and nitrite ( $\text{NO}_2^-$ ). Nitrogen compounds are nutrients with sources and effects similar to phosphorus. Nitrate serves as the primary source of nitrogen for aquatic plants in well oxygenated systems, and as nitrate levels increase, there is an increasing risk of algal blooms and eutrophication. Nitrite can be toxic to fish and other aquatic organisms at relatively low concentrations.	<ul style="list-style-type: none"> <li>Fertilizers</li> <li>Septic tanks</li> <li>Animal wastes</li> <li>Municipal wastewater</li> </ul>	CWQG <sup>2</sup> : 2.93 mg/L
Chloride	Chloride can be toxic to aquatic organisms with acute (short-term) effects at high concentrations and chronic (long-term) effects at lower concentrations.	<ul style="list-style-type: none"> <li>Road salt application</li> <li>Fertilizers</li> <li>Industrial discharge</li> </ul>	CWQG: chronic 120 mg/L; acute 640 mg/L
<i>Escherichia coli</i> ( <i>E. coli</i> )	<i>E. coli</i> are a large and diverse group of bacteria that are commonly found in the intestines of warm-blooded animals. <i>E. coli</i> are used to indicate the presence of fecal waste in water. Some strains of <i>E. coli</i> can cause human illness (e.g. diarrhea, urinary tract infections).	<ul style="list-style-type: none"> <li>Combined sewer overflows (CSO)</li> <li>Inputs from wildlife, livestock and domestic animals</li> <li>Organic fertilizers</li> </ul>	PWQO: 100 CFU/100 mL
Total Suspended Solids (TSS)	TSS represents the amount of particulate matter (e.g. silt, clay, organic and inorganic matter, etc.) suspended in water. TSS can act as a transport vector for contaminants (e.g. metals). Elevated TSS concentrations can affect aquatic organisms such as fish by reducing water clarity and inhibit the ability to find food, clogging of fish gills, and habitat changes such as smothering fish spawning and nursery areas.	<ul style="list-style-type: none"> <li>Construction sites</li> <li>Farm fields</li> <li>Lawns and gardens</li> <li>Eroding stream channels</li> <li>Road grit accumulation</li> </ul>	CWQG: 30 mg/L (background (assumed at <5 mg/L) + 25 mg/L for short term (<24 hour) exposure)
Metals	Several heavy metals are toxic to fish and other aquatic organisms at varying concentrations. Most metals enter waterways through surface runoff. Metals bind to sediment and can affect fish (e.g. clogging of gills) and benthic invertebrates (e.g. habitat changes, smothering food sources).	<ul style="list-style-type: none"> <li>Urban runoff</li> <li>Industrial discharge</li> <li>Sewage treatment</li> <li>Fertilizers/Pesticides</li> <li>Atmospheric deposition</li> </ul>	PWQO: <ul style="list-style-type: none"> <li>Copper – 5 <math>\mu\text{g}/\text{L}</math></li> <li>Iron – 300 <math>\mu\text{g}/\text{L}</math></li> <li>Zinc – 20 <math>\mu\text{g}/\text{L}</math></li> </ul>

<sup>1</sup>PWQO = Provincial Water Quality Objective

<sup>2</sup>CWQG = Canadian Water Quality Guideline

<sup>3</sup>BC OMOE = British Columbia Ministry of the Environment

# Current PWQMN/RWMP Water Quality Monitoring Locations



## 2. Methods

### 2.1 Sample Collection and Analysis

Monthly grab samples were collected year-round in accordance with the PWQMN sampling protocols (OMOE 2003). Flow data were not available for most monitoring stations, therefore, statistical analysis procedures did not include an adjustment for flow. Consideration of flow can aid the analysis of water-quality trends because, on a day-to-day basis, most water-quality characteristics vary in response to changes in flow. Samples were collected on set dates, independent of weather conditions. Thus, changes in flow appear as a source of random variation over the period of analysis. Samples were stored in a cooler with ice and delivered to a laboratory for analysis usually within 24 hours of sampling. Samples are analyzed at various laboratories (Table 3) for a standard set of water quality indicators (Table 4). Where applicable and with the exception of phosphate, results are for total (i.e. particulate) samples rather than the dissolved (i.e. bioavailable) forms. Measurements of water temperature, conductivity, dissolved oxygen and pH were taken in the field using a handheld water quality probe (e.g. Hydrolab, YSI).

**Table 3. Laboratories used for sample analysis of water quality samples**

Parameter	Program	2006	2007	2008	2009	2010
<b>Metals</b>	PWQMN	OMOE <sup>1</sup>				
	RWMP	TOR	TOR	TOR	TOR/YD	YD
<b>Nutrients</b>	PWQMN	OMOE <sup>1</sup>				
	RWMP	TOR	TOR	TOR	TOR/YD	YD
<b>General</b>	PWQMN	OMOE <sup>1</sup>				
	RWMP	TOR	TOR	TOR	TOR/YD	YD
<b>E. coli</b>	PWQMN	OMOE <sup>2</sup>				
	RWMP	ENT/MAX	MAX	MAX	MAX/YD	YD

Notes: ENT = Entech Inc. (Mississauga); MAX = Maxxam Analytics Inc. (Mississauga); OMOE = Ontario Ministry of the Environment Rexdale Laboratory, TOR = City of Toronto Dee Laboratory; YD = York-Durham Regional Environmental Laboratory (Pickering)

<sup>1</sup> Most stations analyzed by OMOE from April to November, remaining months at alternate laboratories; exceptions 85014, 104001, 80006, 830019, 82003, and 97011 analyzed year round by OMOE starting June, 2009.

<sup>2</sup> E. coli analyzed by OMOE at stations 85014 and 83019 only; remaining PWQMN stations analyzed for E. coli by RWMP

**Table 4. Standard suite of water quality parameters analyzed for stream samples**

General	Metals	Nutrients	Microbiological
<ul style="list-style-type: none"> <li>• Total suspended solids (TSS)</li> <li>• Total dissolved solids (TDS)</li> <li>• Conductivity (COND)</li> <li>• Hardness</li> <li>• Dissolved oxygen (DO)</li> <li>• Sodium</li> <li>• Calcium</li> <li>• Chloride</li> <li>• Alkalinity</li> <li>• Turbidity</li> <li>• pH</li> </ul>	<ul style="list-style-type: none"> <li>• Aluminum</li> <li>• Barium</li> <li>• Beryllium</li> <li>• Cadmium</li> <li>• Chromium</li> <li>• Cobalt</li> <li>• Copper</li> <li>• Iron</li> <li>• Lead</li> <li>• Magnesium</li> <li>• Manganese</li> <li>• Molybdenum</li> <li>• Nickel</li> <li>• Potassium</li> <li>• Strontium</li> <li>• Titanium</li> <li>• Vanadium</li> <li>• Zinc</li> </ul>	<ul style="list-style-type: none"> <li>• Total Kjeldahl nitrogen (TKN)</li> <li>• Total phosphorus (TP)</li> <li>• Phosphate</li> <li>• Ammonia</li> <li>• Nitrate</li> <li>• Nitrite</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Escherichia coli</i></li> </ul>

*Note: Additional parameters may be analyzed on a site/project specific basis*

## 2.2 Data Analysis

Statistical analysis was completed using JMP 8.0 (SAS Institute, Cary, North Carolina) and Excel 2007 (Microsoft Corporation, Redmond, Washington). When results were below the laboratory detection limit (i.e. trace amounts), these values were set at half of the laboratory detection for analysis purposes.

### 2.2.1 Spatial Trends

Current (2006-2010) water quality results are presented in bar charts within the text for the indicator variables and in box plots in Appendix B for all water quality parameters. Only sites with greater than 40 samples were analyzed. The bar charts represent average water quality result from 2006-2010 (i.e. one value representing the mean of all samples per site) while the box plots summarize the distribution (median and 25<sup>th</sup>/75<sup>th</sup> percentile) of the samples for each site from 2006-2010. Water quality samples are typically skewed whereby most samples are similar in concentration (base/low flow) with a few samples being significantly higher than the others (storm flow). Median values are often used for skewed distributions. The median value is the numerical value separating the higher half of a sample from the lower half (i.e. 50<sup>th</sup> percentile). The median is often used because the value is less influenced by extreme results compared to average values, therefore depicting what a stream experiences on a typical day. Average values are influenced by extreme results, often with values much larger than their median counterpart. Average values are depicted in the charts and figures in this report because aquatic organisms are exposed to the high concentrations during stormflow. Median values were used for trend analysis. Descriptive statistics (average, median, minimum, maximum, standard deviation) are also presented in Appendix B. In addition, a correlation matrix was completed to determine if there were any inter-relationships between analytes.

The data were also subdivided into four groups to discern if there was any seasonal variation among the parameters. The seasons were defined as follows: winter = December, January, February; spring = March, April, May; summer = June, July, August; and autumn = September, October, November. Again, data are presented as bar charts within the text for indicator variables and as box plots and descriptive statistics in Appendix B for all parameters.

Water quality results were compared to the Provincial Water Quality Objectives (PWQO; OMOEE 1994). The PWQO are a set of numerical and narrative criteria which serve as chemical and physical indicators representing a satisfactory level for surface waters which is protective of all forms of aquatic life and/or the protection of recreational water uses based on public health and aesthetic considerations. When PWQO were not available, other objectives such as the Canadian Water Quality Guidelines for the Protection of Aquatic (CWQG; CCME 2007) were used. Average water quality values for each station are displayed graphically on maps. The size and colour of the dots representing each station indicates whether the station was at, above or below the water quality objective for each indicator analyte.

The Water Quality Index (WQI) is a tool that summarizes water quality conditions from multiple analytes into a single measure of water quality per site. The WQI is a representation of the number of parameters that exceed their guidelines, as well as the frequency and magnitude of those exceedances. Values range between 0 and 100, with higher values indicating water that tends to meet the guidelines more frequently, and that is considered to be of higher quality (Painter and Walther, 2004). Table 5 describes the rating system associated with the WQI. The eight indicator parameters (Table 2) were used to calculate the WQI using the Index Calculator 1.1 (an Excel workbook with macros provided at the website: [http://www.ccme.ca/ourwork/water.html?category\\_id=102](http://www.ccme.ca/ourwork/water.html?category_id=102)). Additional information about WQI can be found in CCME 2001.

**Table 5. Description of the Water Quality Index rating system**

Rating	WQI Score	WQI Score Description
Excellent	95-100	Water quality is protected with a virtual absence of treat or impairment; conditions very close to natural or pristine levels
Good	80-94	Water quality is protected with only a minor degree of treat or impairment; conditions rarely depart from natural or desirable levels
Fair	65-79	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels
Marginal	45-64	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels
Poor	0-44	Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels

## 2.2.2 Relationship with Road Density

The relationships between average current surface water quality results and road density (circa 2007) were examined using regression analysis. Road density was calculated for catchment upstream of the water quality station using the geographic information system (GIS) ArcGIS 10.0. Data was tested for normality using the Shapiro-Wilk goodness of fit test. Data transformations (e.g. log, square root) were used to help improve data normality before analysis.

## 2.2.3 Temporal Trends

For sites where historical data was available, data was analyzed using Mann-Kendall non-parametric test to describe monotonic trends. Monotonic trends occur when a population of observations shifts over time. The detection of a monotonic trend does not imply that the trend is linear, occurs in one or more discrete steps, or in any pattern (Hirsh *et al.* 1991). These analyses test only for the existence of a monotonic trend over the entire period covered by the data set and does not test for the possibility that a “change point” occurred (e.g. trend was increasing during the beginning of the period and then declining during the latter stage). The Mann-Kendall test is a non-parametric test for identifying trends in time series data. The test is well-suited to data with missing values and to data that are truncated at upper and lower detection limits (Gilbert, 1987). The test compares the relative magnitude of sample data rather than the data values themselves. The data values are evaluated as an ordered time series. The initial value of the Mann-Kendall statistic, S, is assumed to be zero (e.g., no trend). If a data value from a later time period is higher than a data value from an earlier time period, S is incremented by one. On the other hand, if the data value from a later time period is lower than a data value sampled earlier, S is decremented by one. The net result of all such increments and decrements yields the final value of S. For example, a very high positive value of S is an indicator of an increasing trend, and a very low negative value indicates a decreasing trend. Because of the wide range of water quality values (i.e. includes baseflow, low flow and storm events), a significance level of  $p < 0.1$  was used to determine if temporal trends were significant. Linear regression was performed to determine if trend was linear rather than curvilinear.

Before and after differences for the Stouffville Water Pollution Control Plant data were tested using the non-parametric Wilcoxon rank test with a significance level of  $p < 0.05$ .

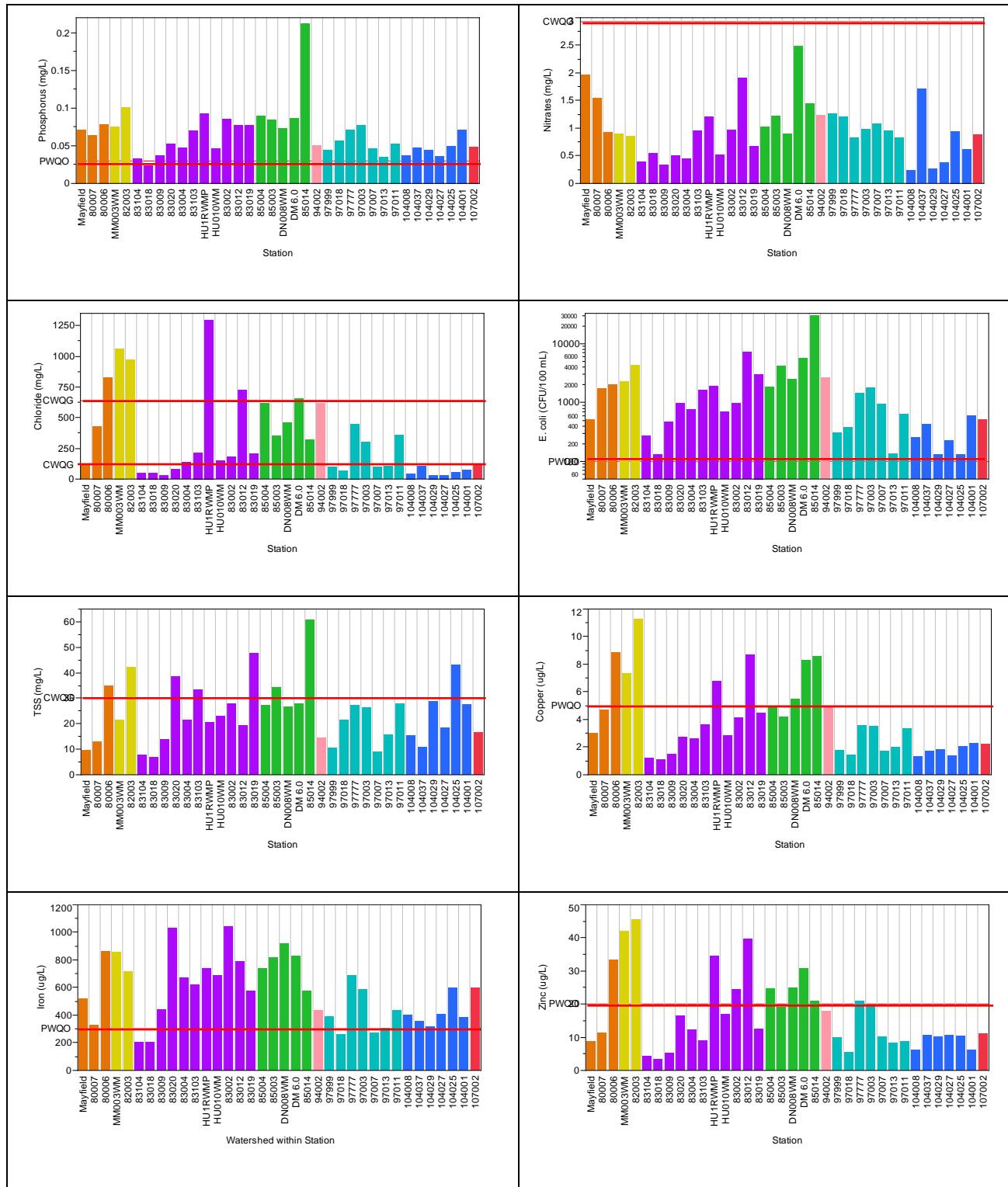
## 3. Results and Discussion

Results are presented using RWMP station names which are often a derivative of the (current/historic) 11-digit PWQMN name. For example, PWQMN station 06008000202 is presented as station 80002. Stations which do not have corresponding PWQMN names have text names rather than numeric codes. Stations are presented by watershed from west to east and from headwaters to mouth. There was insufficient data for the Petticoat Creek and Frenchman’s Bay sites, therefore, data are presented for 36 water quality sites only.

It is important to note that samples were collected on varying field dates, under a variety of weather conditions, and analyzed at several laboratories. Water quality samples collected as part of the PWQMN/RWMP are collected independent of weather conditions. Water quality data should represent the range of water quality conditions that effect the aquatic system (e.g. streamflow conditions including snowmelt, runoff from rain events of varying magnitude and baseflow conditions during varying seasons). Because specific wet-weather events are not targeted, contaminant concentrations presented in this report may be significantly lower than what would be measured during a storm event. The majority of wet weather flow originates from surface runoff, either from agriculture or urban areas. Urban runoff can contain high concentrations of contaminants (e.g. sediments, nutrients, road salts) which are washed off impervious surfaces such as roads and parking lots. Agricultural runoff is surface water leaving farm fields because of excessive precipitation, irrigation, or snowmelt. It can also contain high levels of contaminants such as sediment, pesticides, nutrients and bacteria.

### 3.1 Spatial Trends

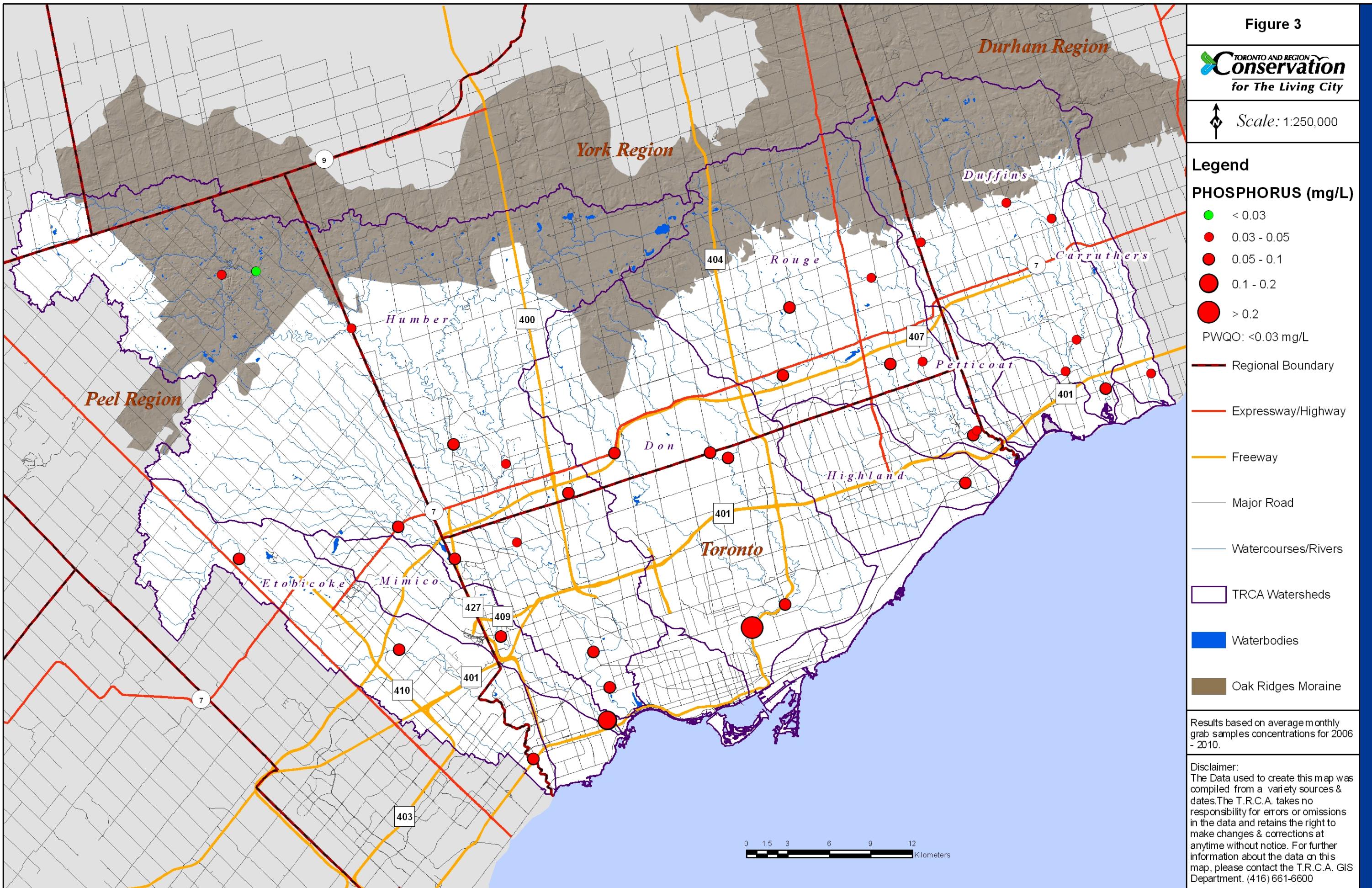
Current (2006-2010) water quality results are summarized in Figure 2 for the indicator variables. This graphic presents the average water quality concentration per site for the 2006-2010 time period in relation to their respective water quality objective. Individual maps for each analyte visually display the data in Figures 3 to 10. The data were broken down to show seasonal changes in Figures 11 to 18. Discussion of the current spatial trends follows the entire set of figures. Box plots and descriptive statistics for the entire dataset are presented in Appendix B.



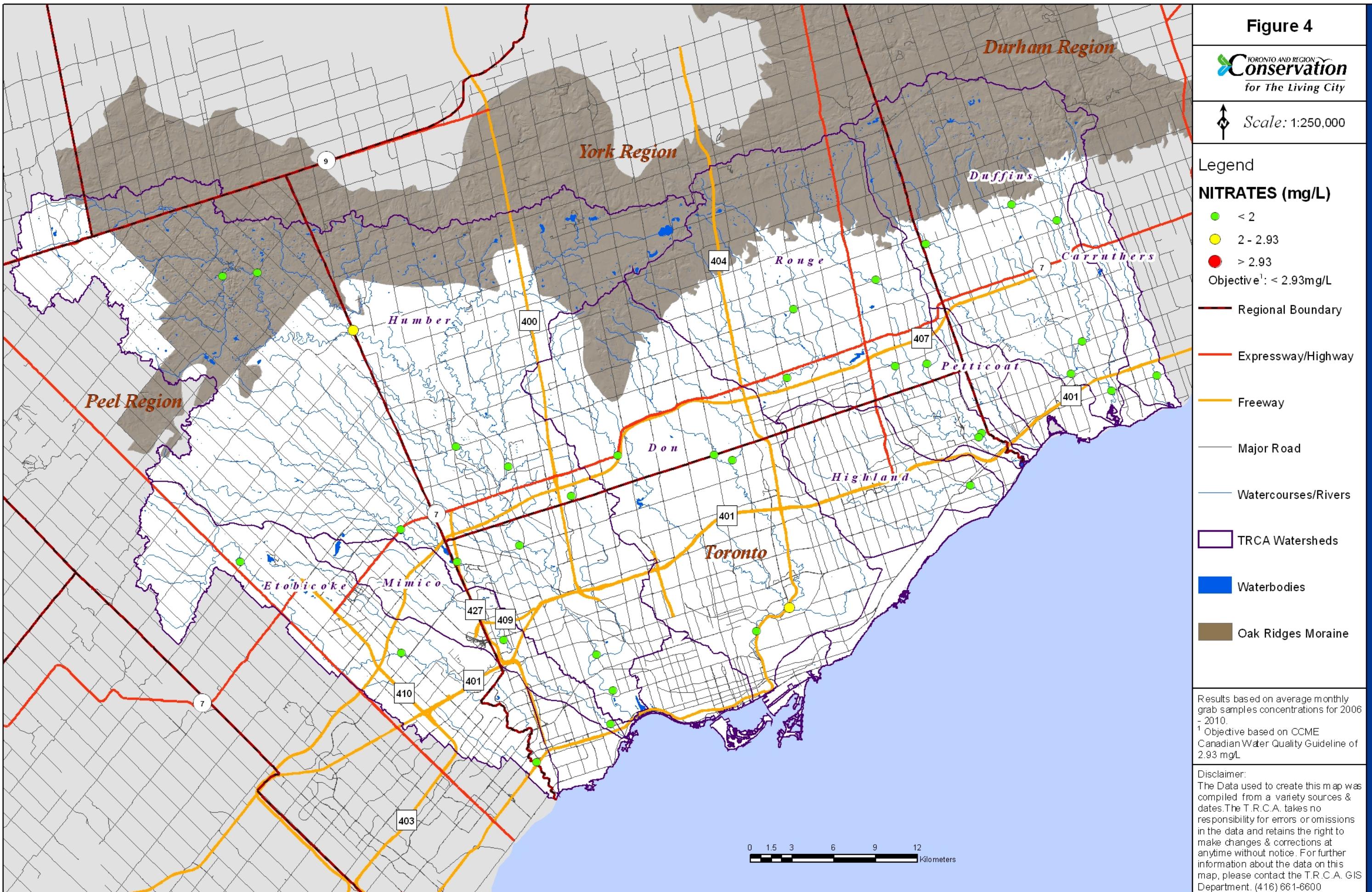
Watershed      ■ Etobicoke    ■ Mimico    ■ Humber    ■ Don    ■ Highland    ■ Rouge    ■ Duffins    ■ Carruthers

**Figure 2. Summary of average water quality data for the TRCA jurisdiction 2006-2010**

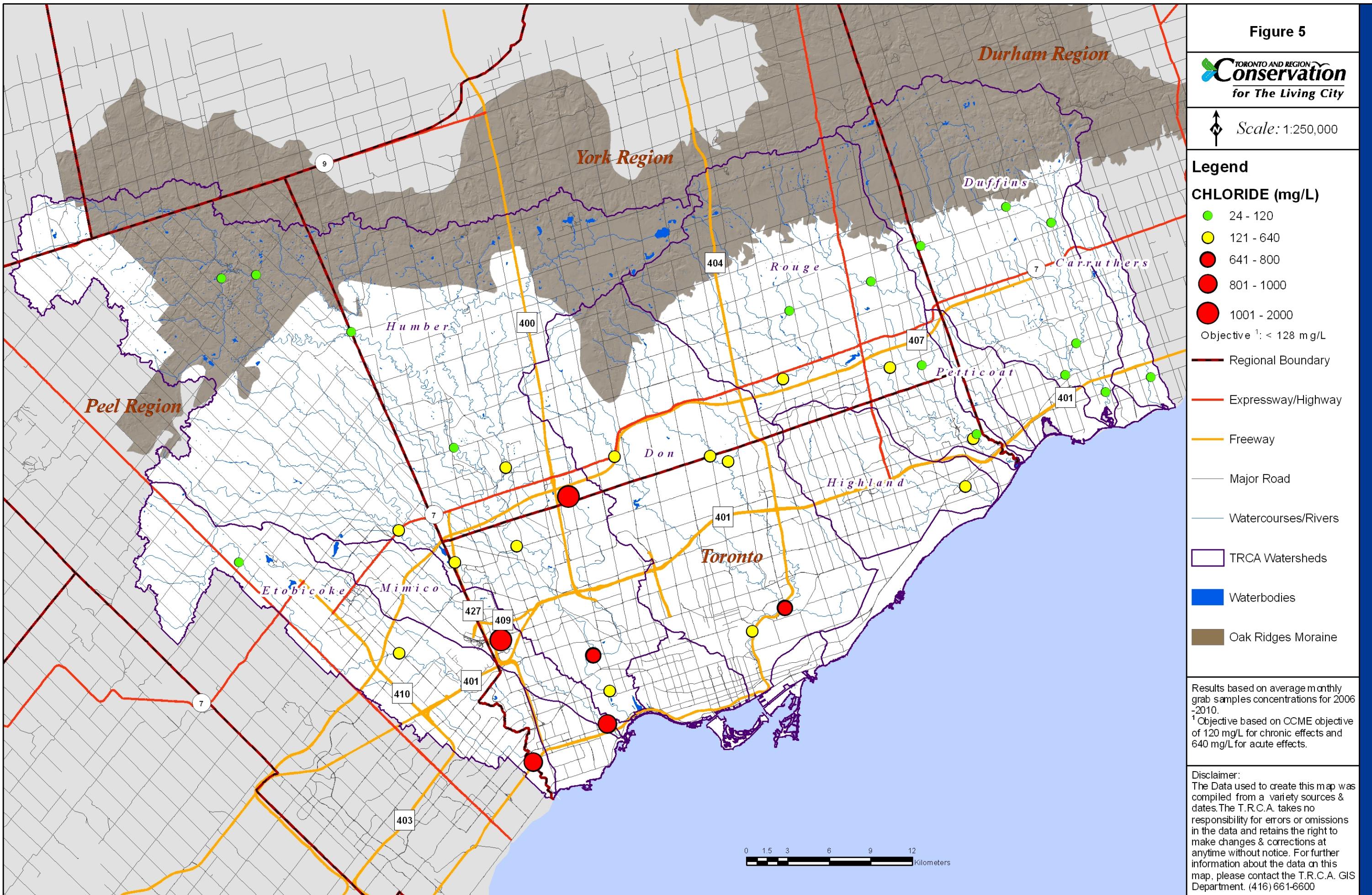
# Average Phosphorus Concentrations 2006 - 2010



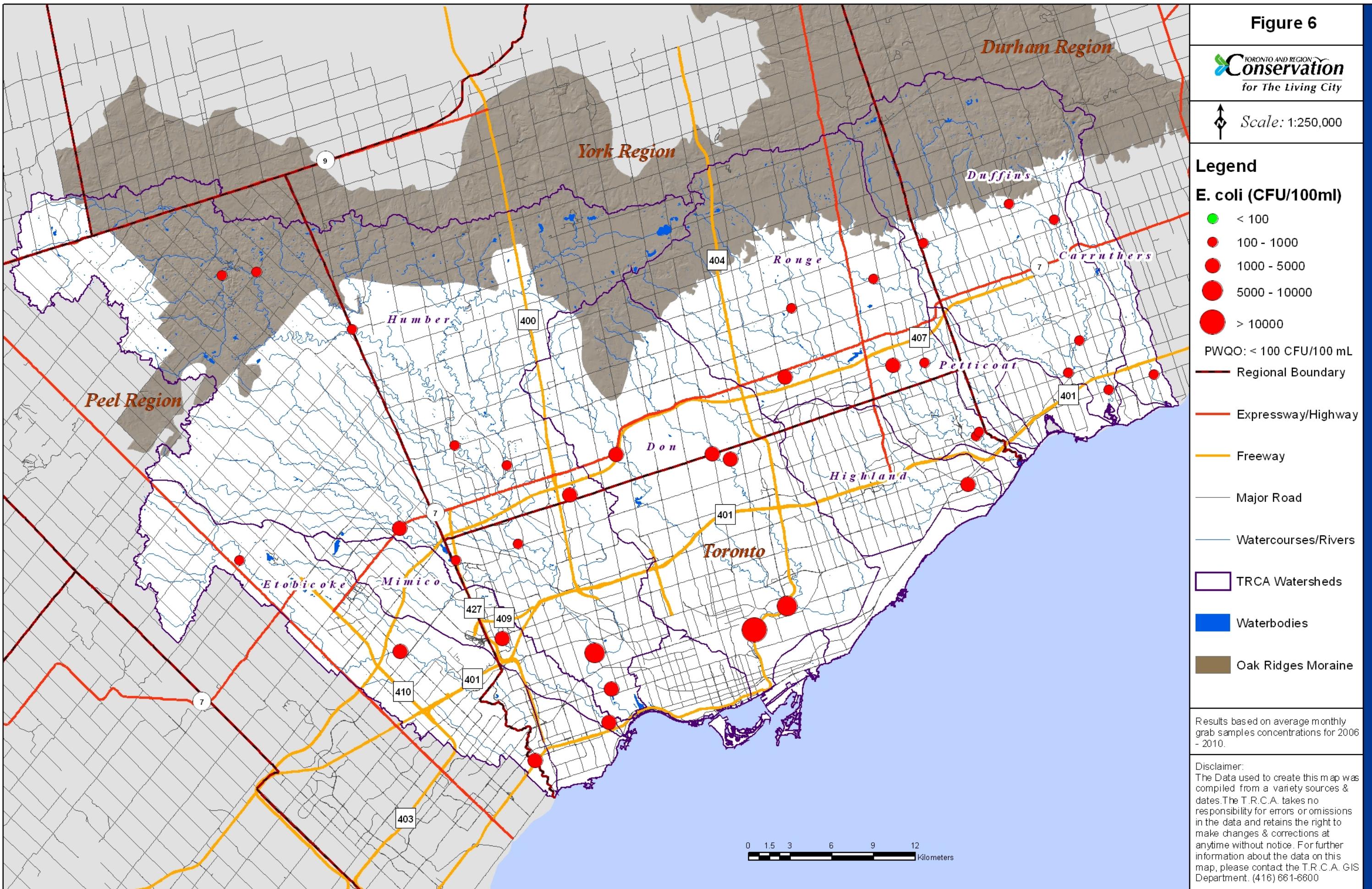
# Average Nitrates Concentrations 2006 - 2010



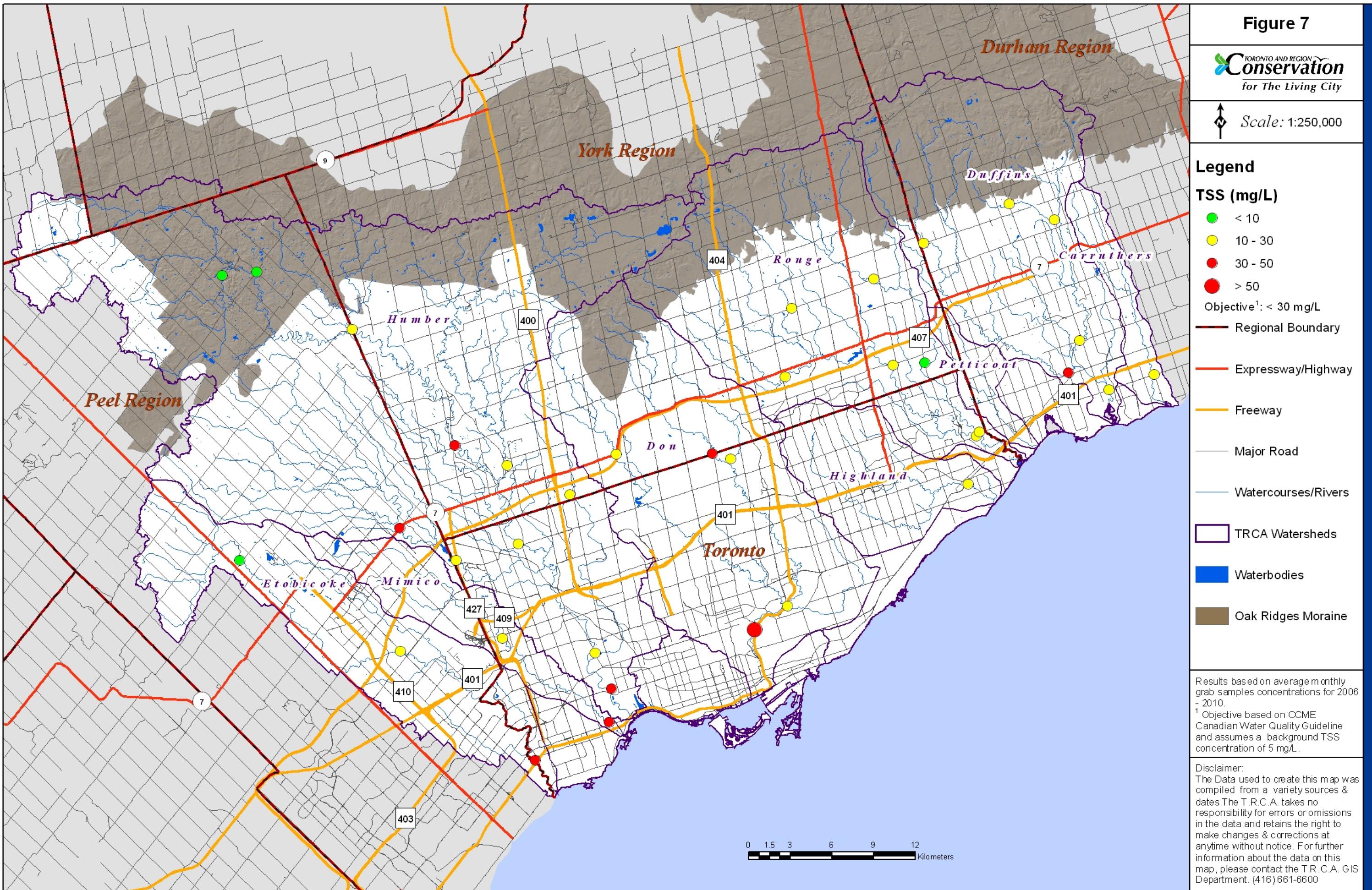
# Average Chloride Concentrations 2006-2010



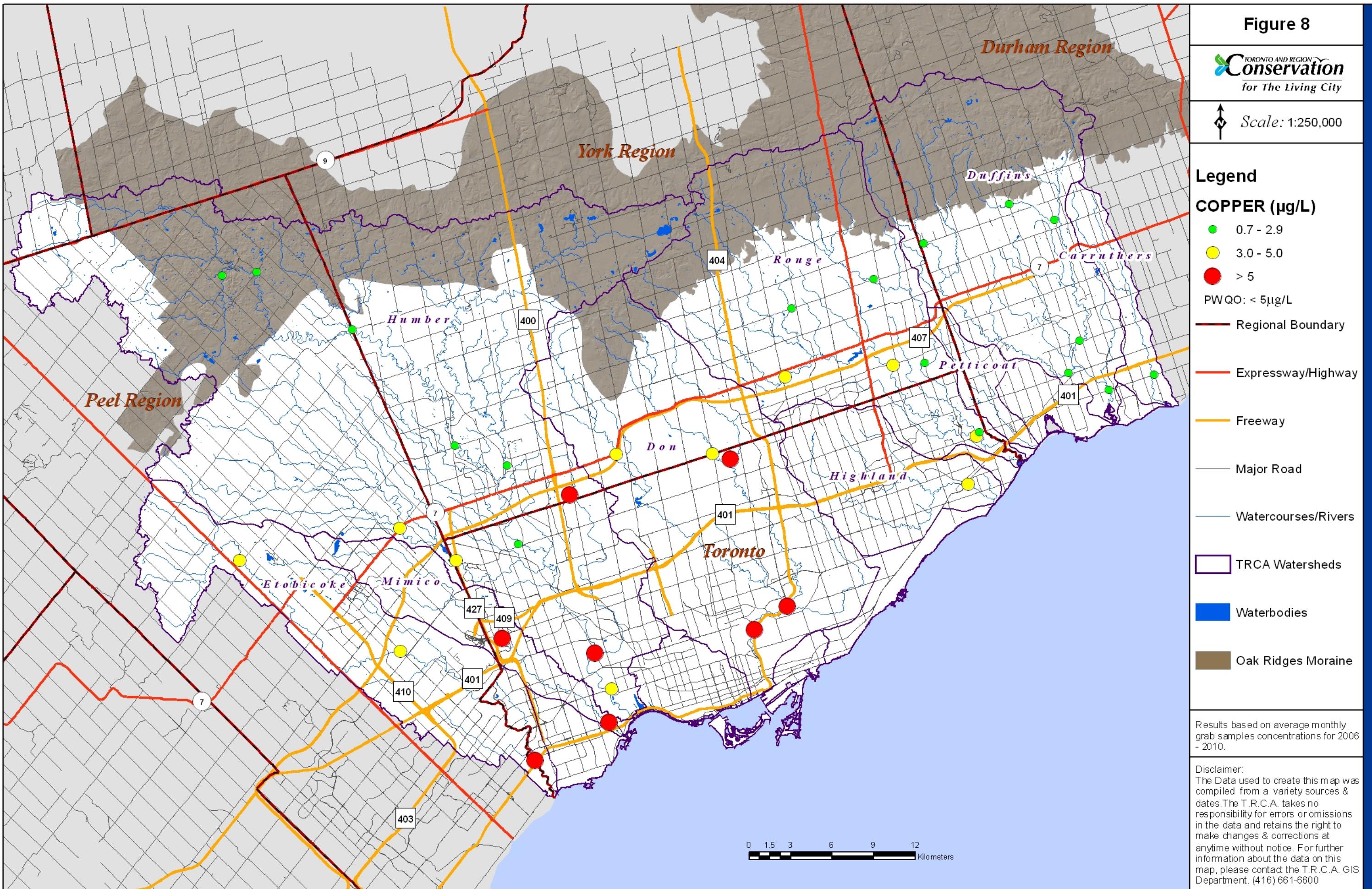
# Average E. coli Concentrations 2006 - 2010



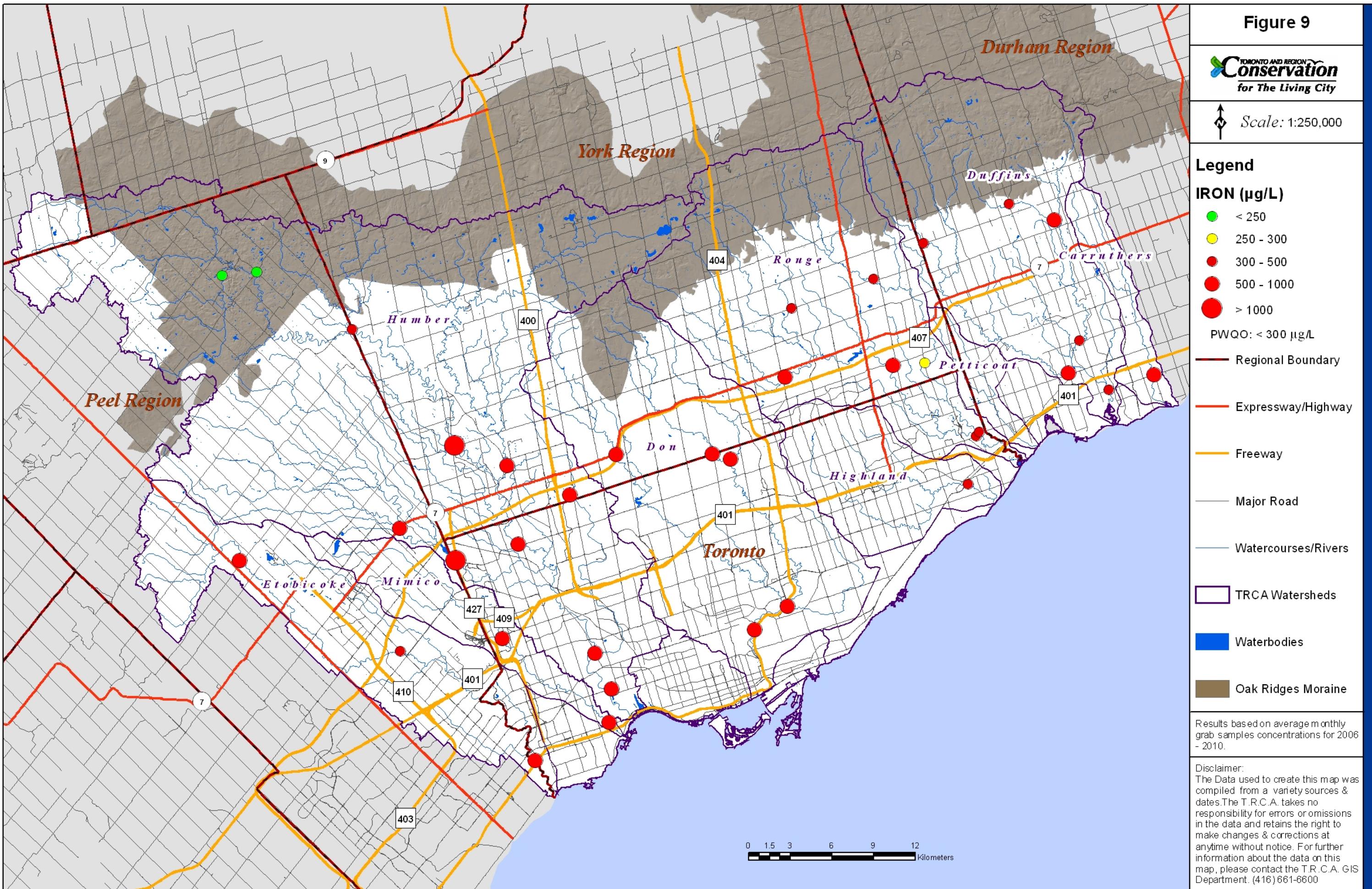
# Average TSS Concentrations 2006 - 2010



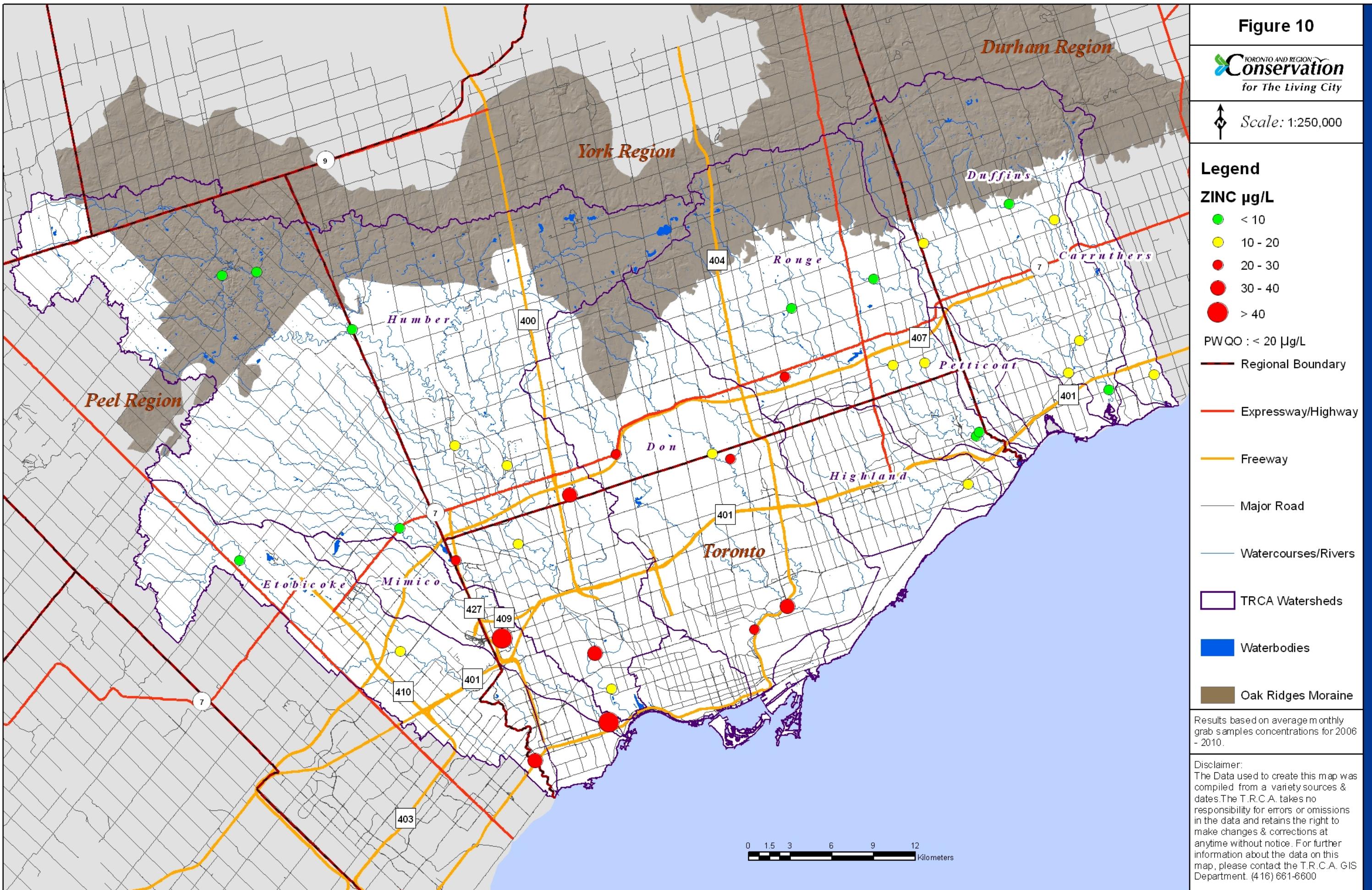
# Average Copper Concentrations 2006 - 2010

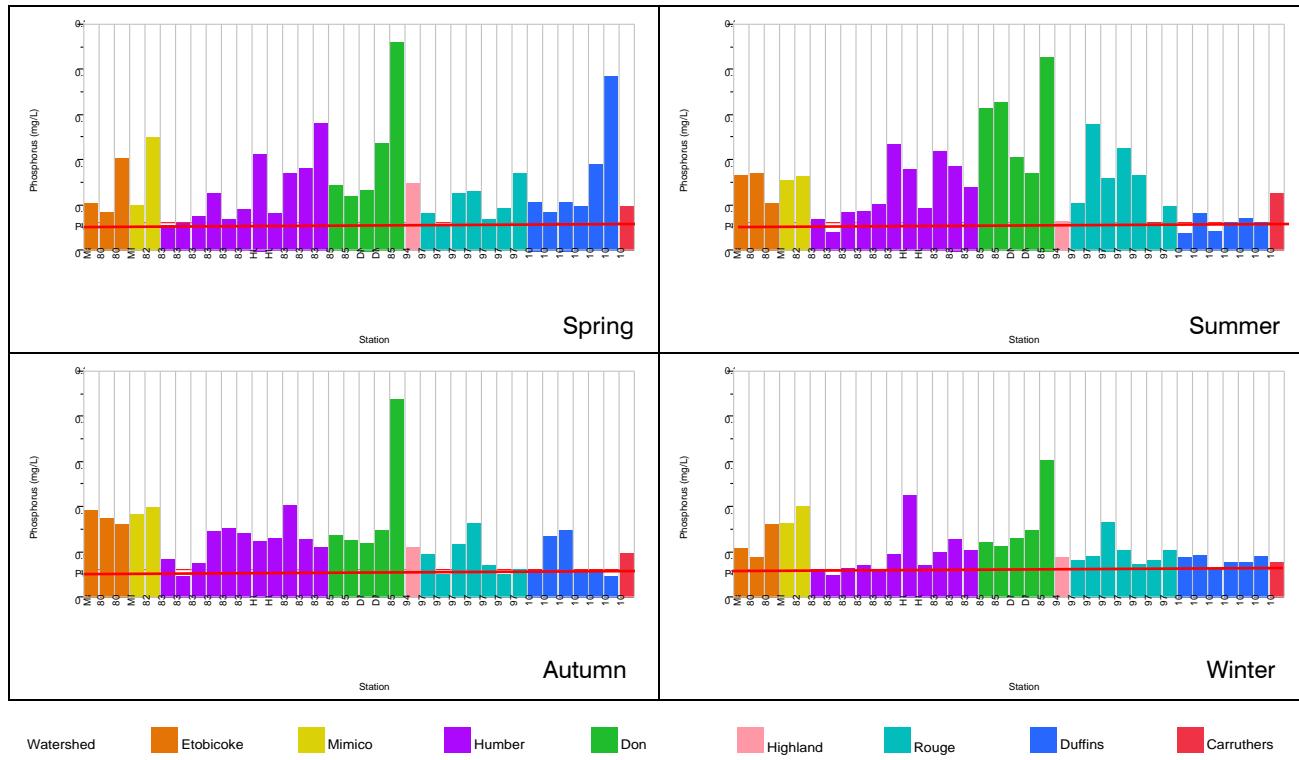


# Average Iron Concentrations 2006 - 2010

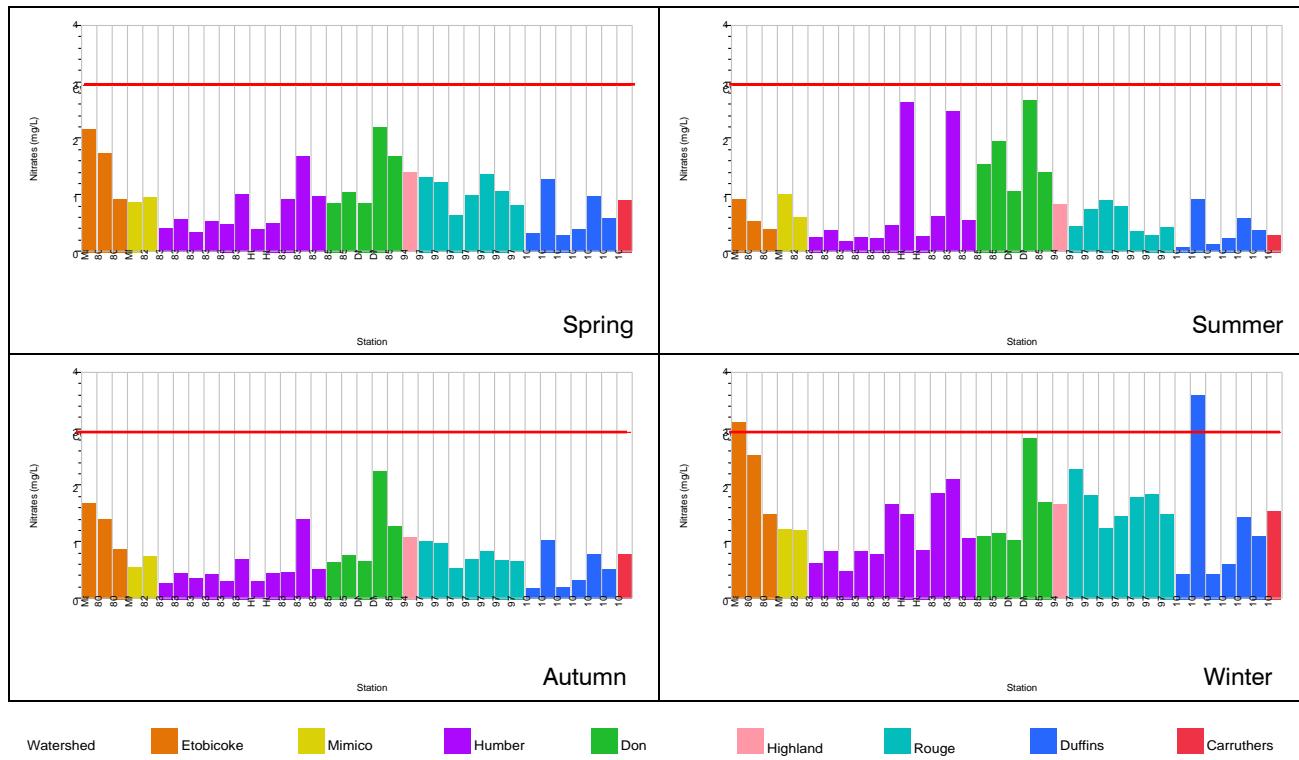


# Average Zinc Concentrations 2006 - 2010

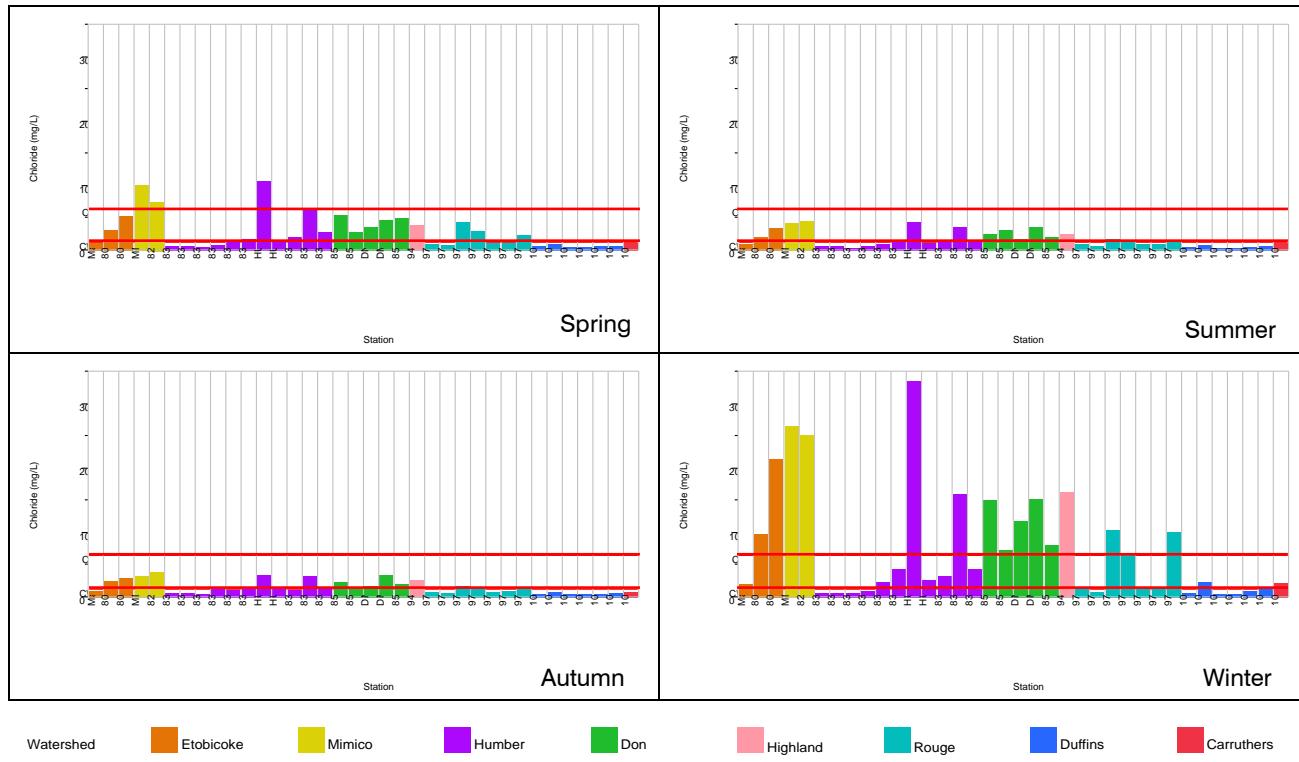




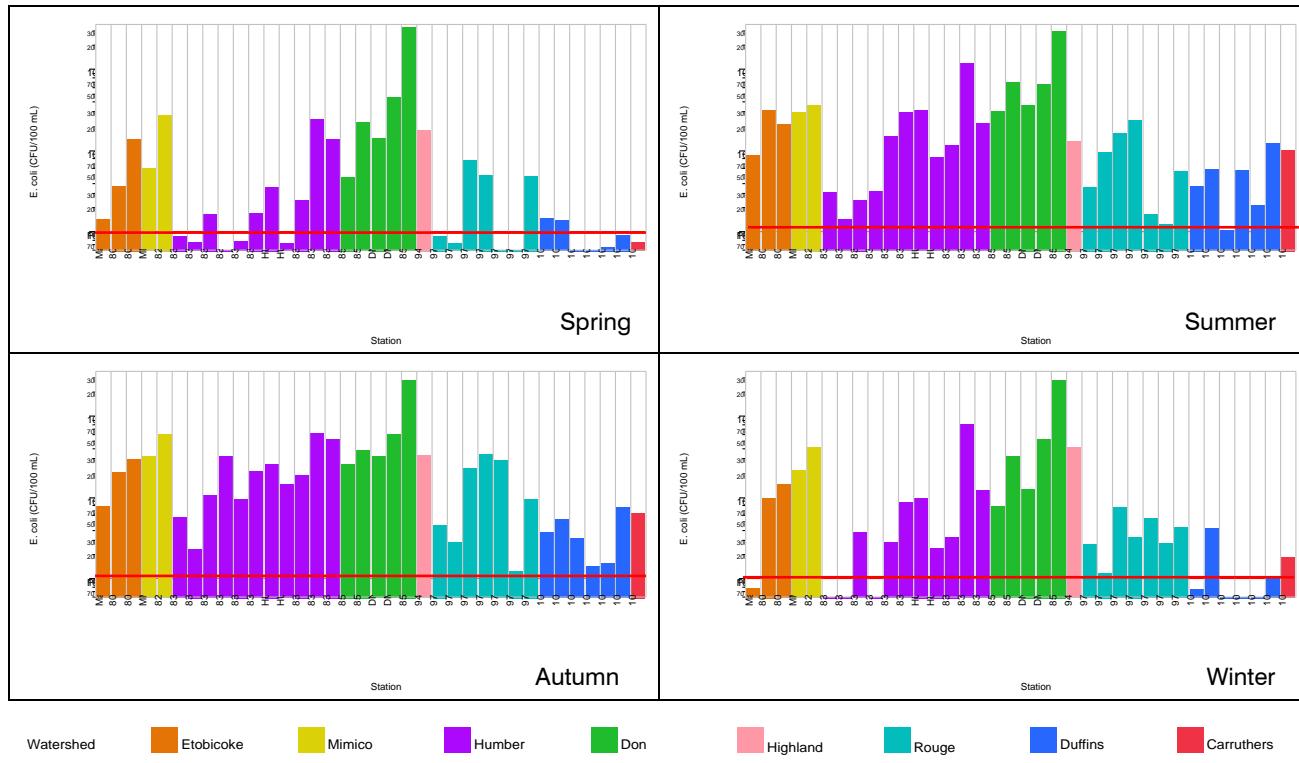
**Figure 11. Seasonal average (2006-2010) phosphorus concentrations in the Toronto region**



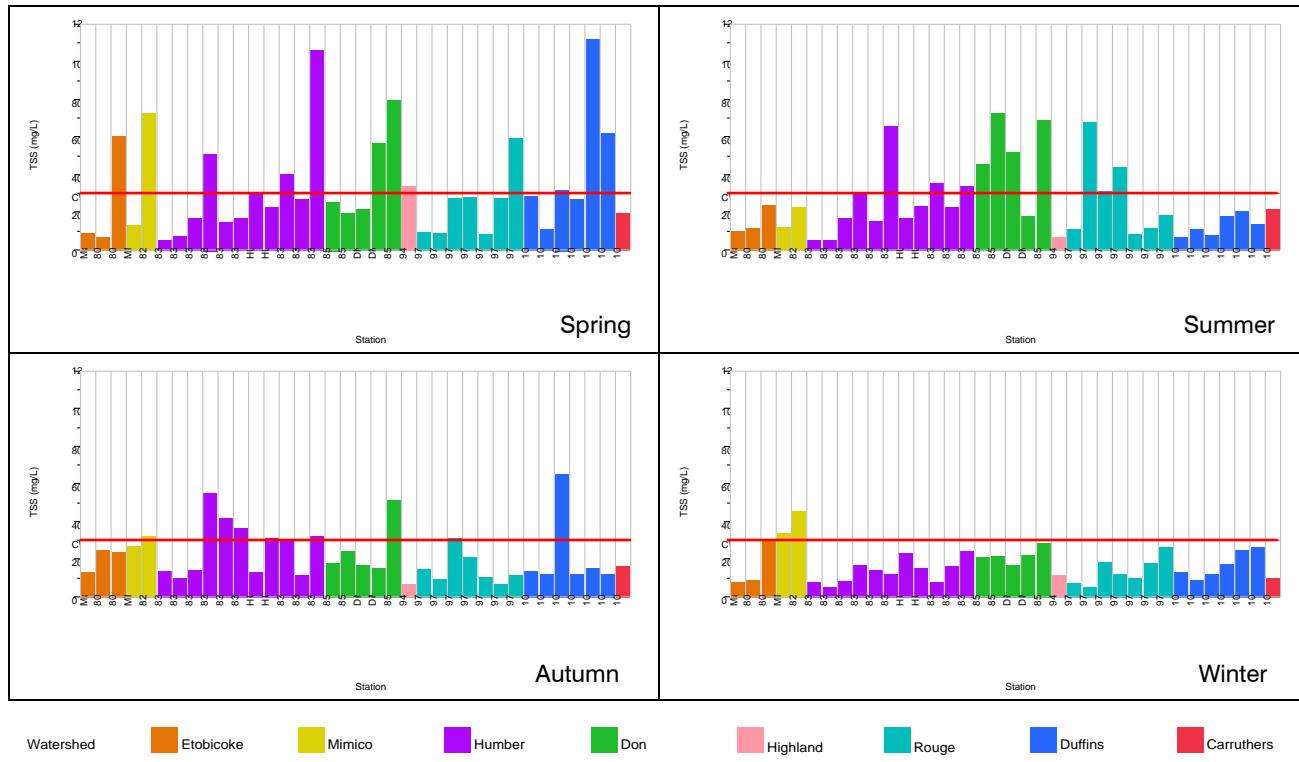
**Figure 12. Seasonal average (2006-2010) nitrates concentrations in the Toronto region**



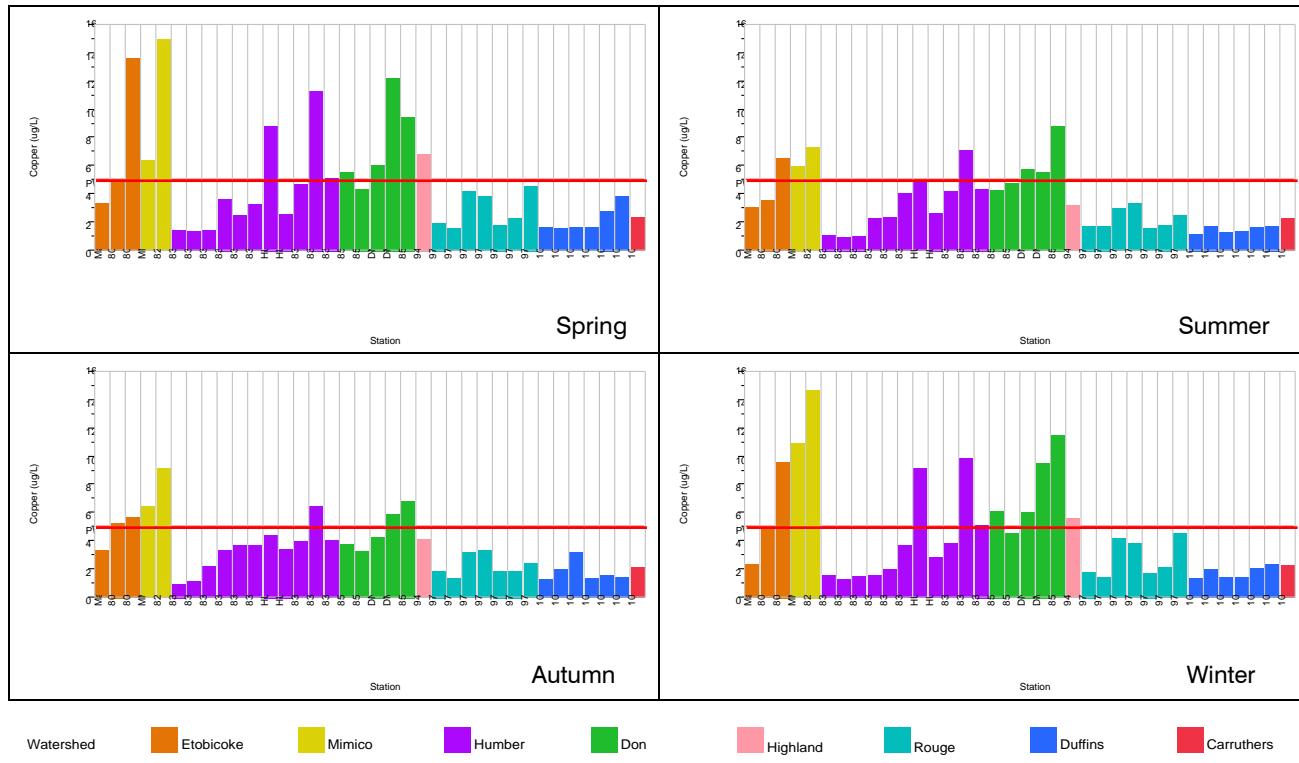
**Figure 13. Seasonal average (2006-2010) chloride concentrations in the Toronto region**



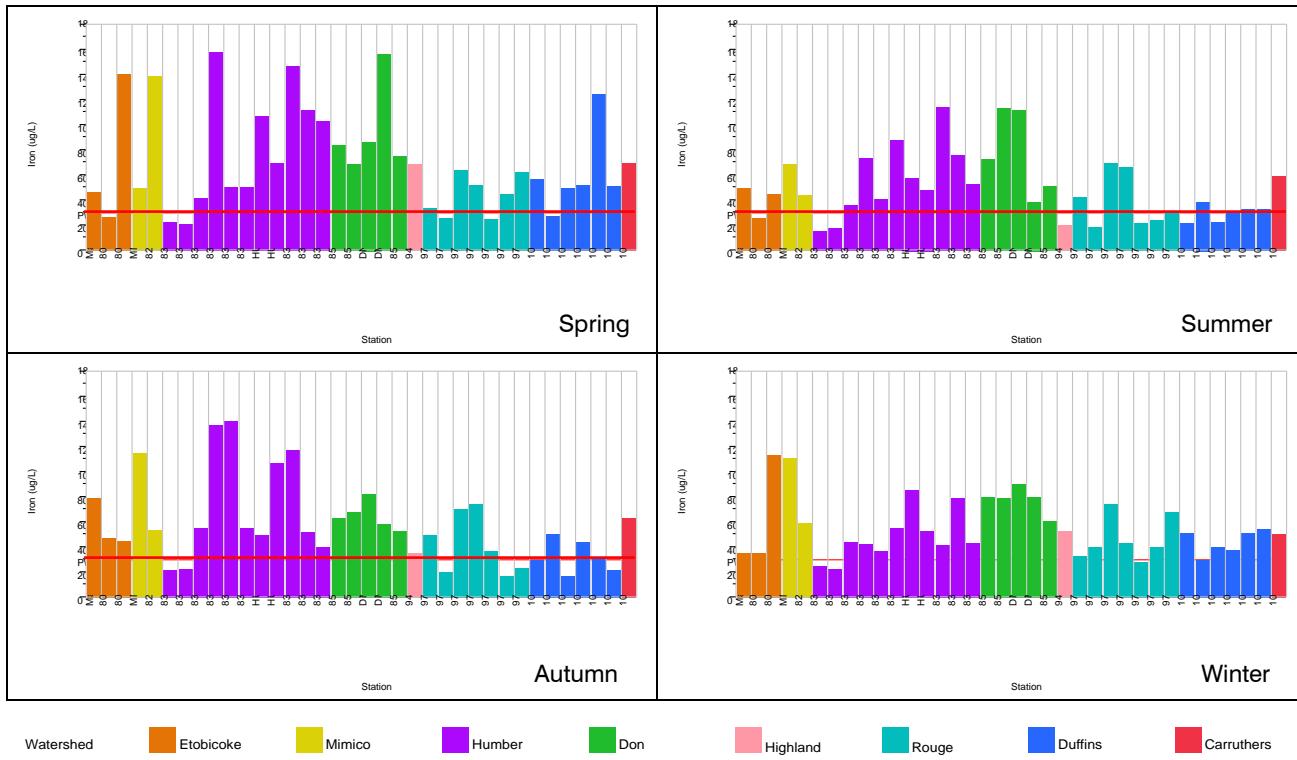
**Figure 14. Seasonal average (2006-2010) E. coli concentrations in the Toronto region**



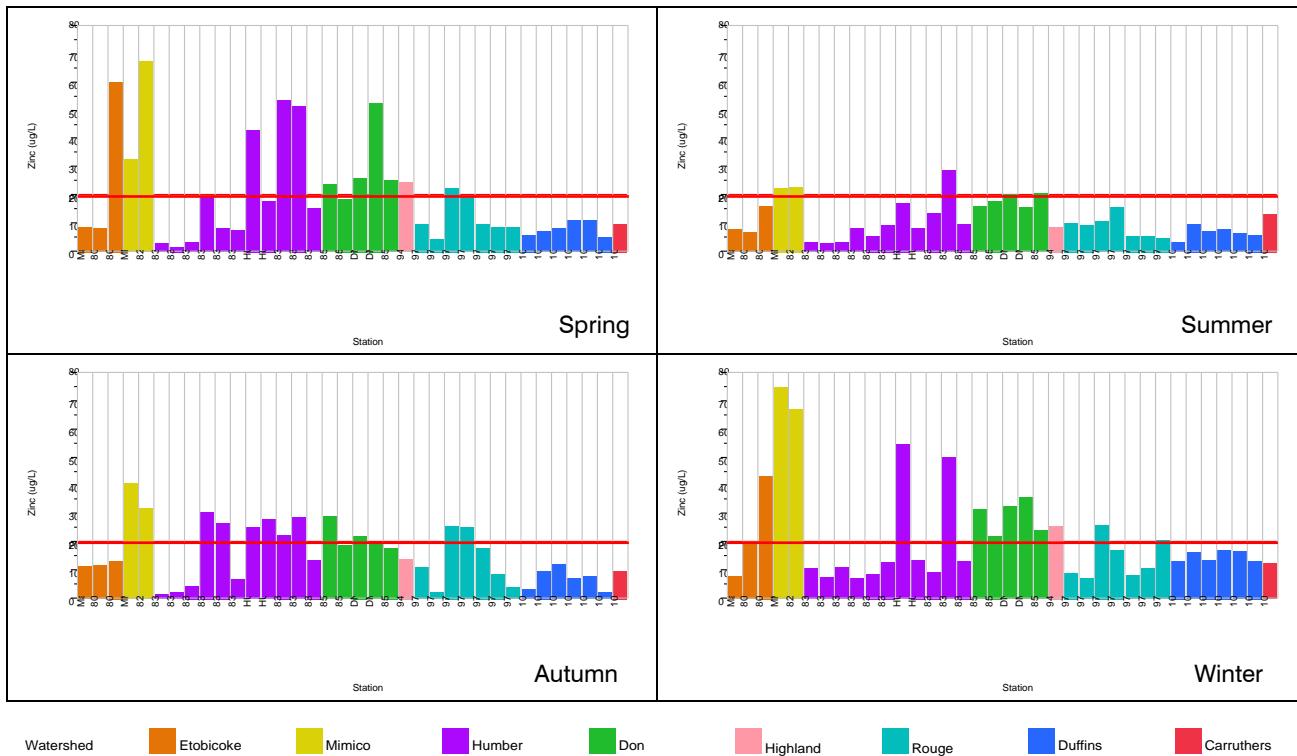
**Figure 15. Seasonal average (2006-2010) TSS concentrations in the Toronto region**



**Figure 16. Seasonal average (2006-2010) copper concentrations in the Toronto region**



**Figure 17. Seasonal average (2006-2010) iron concentrations in the Toronto region**



**Figure 18. Seasonal average (2006-2010) zinc concentrations in the Toronto region**

### 3.1.1 Total Phosphorus

Phosphorus is an essential nutrient for all living organisms but it can have unfavorable effects in high concentrations. Phosphorus is associated with eutrophication – the enrichment of a waterbody with nutrients. Waterbodies with low phosphorus concentrations typically support relatively diverse and abundant aquatic life and support various water uses. However, elevated phosphorus concentrations can adversely affect aquatic ecosystems by increasing plant and algal productivity and biomass (CCME 2004). Further phosphorus additions may cause undesirable effects such as decreased biodiversity and changes in dominant biota, decline in ecologically sensitive species, increase in tolerant species, increase in plant and animal biomass, and anoxic conditions (EC 2004). When the excessive plant growth includes certain species of cyanobacteria, toxins may be produced, causing increased risk to aquatic life, livestock, and human health (CCME 2004). The PWQO for total phosphorus is 0.03 mg/L. This concentration is intended to prevent excessive plant growth in rivers and streams.

Average phosphorus results for 2006-2010 are presented in Figures 2 and 3. Only one station, 83018 in the headwaters of the Humber River, had an average phosphorus concentration of less than the PWQO of 0.03 mg/L while eight stations had median values less than the PWQO (83018 (Humber), 97018 (Rouge), 97007 (Rouge), 97013 (Rouge), 104008 (Duffins), 104029 (Duffins), 104025 (Duffins), 104001 (Duffins)). Two stations had phosphorus concentrations greater than 0.1 mg/L. Station 85014, had the highest average phosphorus concentration of 0.21 mg/L, which is more than seven times the PWQO. This station is located in the Don River watershed downstream of the North Toronto Wastewater Treatment Plant. Station 82003, located near the mouth of Mimico Creek had the second highest average phosphorus concentration at 0.10 mg/L. This is three times higher than the PWQO. This station is downstream of several golf courses in an almost completely urbanized watershed. Total phosphorus concentrations were found to be highly correlated to *E. coli* counts ( $R^2=0.88$ ) (Appendix B) which means that when *E. coli* results were high so were total phosphorus results.

Seasonal changes in phosphorus concentrations are shown in Figure 11. Phosphorus concentrations peak during the summer months when fertilizer use is most active and were the lowest during the winter months. During all four seasons, the phosphorus concentrations at station 85014 are much higher than the other stations. Again, this station is influenced by the wastewater treatment plant upstream.

### 3.1.2 Nitrates

Nitrates include both nitrate ( $\text{NO}_3^-$ ) and nitrite ( $\text{NO}_2^-$ ). Nitrogen compounds are nutrients with sources and effects similar to phosphorus. Because nitrite is easily oxidized to nitrate, nitrate is the compound predominantly found in groundwater and surface waters. In most water bodies, phosphorus is normally the limiting nutrient for algal growth but nitrogen compounds can play a role in the eutrophication process. Anthropogenic discharges of nitrogen can include municipal and industrial wastewaters, septic tanks, agricultural runoff, feedlot discharges, urban runoff, lawn fertilizers, landfill leachate, nitric oxide and nitrogen dioxide from vehicular exhaust, and storm sewer overflow (CCME 2003). Nitrate serves as the primary source of nitrogen for aquatic

plants in well oxygenated systems, and as nitrate levels increase, there is an increasing risk of algal blooms and eutrophication in surface waters. Nitrite and unionized ammonia can be toxic to fish and other aquatic organisms at relatively low concentrations.

Current average concentrations for nitrates are presented in Figures 2 and 4. Environment Canada's Canadian Environmental Sustainability Indicators (CESI) interpreted the interim CWQG for nitrate as 2.93 mg/L (EC 2008a). All stations had average water quality concentrations below the 2.93 mg/L objective. Five stations had average concentrations that were higher than the jurisdictional average (approximately 1 mg/L): Mayfield (Etobicoke), 80007 (Etobicoke), 83012 (Humber), DM6.0 (Don) and 104037 (Duffins). These five stations all had average concentrations greater than 1.5 mg/L for the 2006-2010 time period. DM6.0, at the outlet of Taylor-Massey Creek, had the highest average concentration of 2.49 mg/L. Station 83012 in Black Creek also had a high average concentration of 1.92 mg/L. This station is in highly urbanized area. These older urban areas have little stormwater management so non-point source pollution is a problem. In addition, this station may have sewer cross-connections whereby sanitary sewage is released to the local streams rather than going to a waste water control plant.

Seasonal changes in nitrates are shown in Figure 12. Nitrates during the summer months are most likely due to an the use of agricultural and lawn fertilizers. Sites 83012 and HU1RWMP in the Humber River watershed had the highest nitrates concentrations during the summer (2.47 and 2.64 mg/L, respectively) which approached the objective of 2.93 mg/L. Nitrates tended to be highest during the winter. During the winter months, nitrates often increase due to decomposition of leaves and other dead material. Two stations exceeded the objective of 2.93 mg/L during the winter months: Mayfield (Etobicoke) with an average winter concentration of 3.12 mg/L and 104037 (Duffins) with an average winter concentration of 3.59 mg/L.

### 3.1.3 Chloride

Chloride can be toxic to aquatic organisms with acute effects at high concentrations and chronic effects (e.g. growth, reproduction) at lower concentrations (OMOE 2003). Chloride in our waterways is mainly due to the use of road salts which are mainly used as de-icing and anti-icing agents during winter road maintenance. The predominant chloride road salt is sodium chloride, which is composed of about 40% sodium and 60% chloride by weight. Additional sources of chloride include wastewater treatment, industry discharge and fertilizers (OMOE 2003). Natural background concentrations of chloride in water are generally no more than a few milligrams per litre, with some local or regional instances of higher natural salinity (EC & HC 2001). Chloride is a highly soluble and mobile ion. There are no major natural removal mechanisms (e.g. volatilization, degradation) therefore, all chloride ions from road salts can be expected to be ultimately found in surface water. The CWQG for chloride is 120 mg/L for chronic effects and 640 mg/L for acute effects (CCME 2011).

Average chloride results are presented in Figures 2 and 5. The average chloride concentration was highest at station HU1RWMP at 1297 mg/L. This is more than 10 times greater than the 120 mg/L guideline for chronic effects and twice the acute guideline of 640 mg/L. Station HU1RWMP is located less than 1 km downstream from Highway 407 and is at the confluence of two

tributaries which both drain the highway. Seven other stations (22%) had average chloride concentrations greater than the acute guideline of 640 mg/L: 80006 (Etobicoke), MM003WM (Mimico), 82003 (Mimico), 83012 (Humber), 85004 (Don), DM6.0 (Don), and 94002 (Highland). On the other hand, 44% (16 sites) of the sites had average chloride concentrations less than the chronic guideline of 120 mg/L. These stations were located in Mimico Creek, Humber River, Rouge River and Duffins Creek watersheds. Stations with high chloride levels also tended to have elevated concentrations of metals (e.g. copper, zinc), calcium, conductivity, sodium, TDS and sulphate (Appendix B).

Seasonal changes in chloride concentrations are shown in Figure 13. As expected, the winter season (December, January, February) had the highest chloride concentrations. The highest winter concentration of chloride was at station HU1RWMP at 3349 mg/L which was almost 6 times greater than the acute and 26 times greater than the chronic guidelines. The number of sites which were below the chronic guideline of 120 mg/L during the winter months was 10 sites or 28%. These sites were located in the upper reaches of Humber, Rouge and Duffins Creeks. Chloride concentrations remained relatively high during the spring months and were the lowest during the summer/autumn. Despite chloride concentrations being the lowest during the summer/autumn, 44% of the sites continued to exceed the chronic effects guideline of 120 mg/L.

Elevated concentrations of chloride can also affect the concentrations of certain metals (e.g. cadmium, copper, lead, zinc) in our waterways. Road salt can facilitate the mobilization and transport of these contaminants into the aquatic ecosystem (Maltby *et al.*, 1995). Increased concentrations of chloride in surface water can lead to the release of metals from sediments and suspended particulate matter (Warren and Zimmerman 1994). Chloride was found to be highly correlated to both copper ( $R^2=0.84$ ) and zinc ( $R^2=0.89$ ) (Appendix B).

### 3.1.4 *E. coli*

*Escherichia coli* (*E. coli*) are a large and diverse group of bacteria that are commonly found in the intestines of warm blooded animals. Although most strains of *E. coli* are harmless, others can cause human illness (e.g. diarrhea, urinary tract infections, respiratory illness, pneumonia) (CDC 2008). *E. coli* are often used to indicate the presence of fecal wastes and other harmful bacteria in lakes and streams. The presence of *E. coli* in a water sample suggests there is a greater risk that pathogens are present. Bacteria enters waterways via a variety of sources including sewer systems (e.g. combined sewer overflows), septic systems, wildlife, livestock, pets, waterfowl, and organic fertilizers. The PWQO for *E. coli* is a recreational water quality guideline for swimming. The PWQO for *E. coli* is 100 colony forming units (CFU) per 100 mL based upon a geometric mean of at least five samples per site taken within a one month period. Only one sample was collected monthly for this program. The United States Environmental Protection Agency (USEPA) has established a criterion for beach areas based on a single sample maximum of 235 CFU/100 mL (USEPA 1986).

Average *E. coli* results are presented in Figures 2 and 6. *E. coli* samples analyzed at the Maxxam laboratory were capped at a maximum of 20 000 CFU. This suggests that some sites may have higher average *E. coli* values than what are presented in this report. All of the 36 stations

sampled had an average *E. coli* concentration greater than the PWQO of 100 CFU/100 mL. Eight sites (22%) had median *E. coli* values less than 100 CFU/100 mL and 18 sites (50 %) had median values less than 235 CFU/100 mL. The highest average *E. coli* concentration was at station 85014 in the Don River with an average concentration of 29 794 CFU/100 mL (median = 12 000 CFU/100 mL). This is nearly four times the next highest average (7353 CFU/100 mL at station 83012). Five stations had average values below the USEPA guideline of 235 CFU/100 mL: 104025 (130 CFU/100 mL), 83018 (132 CFU/100 mL), 104029 (133 CFU/100 mL), 97011 (138 CFU/100 mL), and 104027 (224 CFU/100 mL). *E. coli* results were found to be highly correlated to total phosphorus concentrations ( $R^2=0.88$ ) (Appendix B) which means that when *E. coli* results were high so were total phosphorus results.

Seasonal *E. coli* results are presented in Figure 14. Average *E. coli* concentrations were lowest in the winter and spring. Several sites had average values below the PWQO of 100 CFU/100 during the spring and winter: 83104 (Humber), 83018 (Humber), 83020 (Humber), 104029 (Duffins), 104027 (Duffins), 104025 (Duffins). Higher than average *E. coli* counts during the summer months is consistent with other urban areas (e.g. Whitman *et al.* 2006, Crabbill *et al.* 1999). Summer storms are typically heavy, sporadic rain which flushes bacteria into the streams from animal/waterfowl feces and soil. Crabbill *et al.* (1999) found that sediment fecal bacteria was much greater than that found in water suggesting that soil serves as a potential reservoir for fecal bacteria. Re-suspension of bacteria into the water column from both adjacent soil and from bottom sediments due to increased flow velocities are likely contributing to the high *E. coli* counts in Toronto streams during the summer months.

### 3.1.5 Total Suspended Solids

A total suspended solids (TSS) value represents the amount of particulate matter (e.g. silt, clay, organic and inorganic matter, soluble organic compounds, plankton, other microscopic organisms) suspended in water. Suspended sediments can act as transport vectors for contaminants (e.g. metals are charged particles that can bind with sediment) and can affect aquatic organisms. Direct negative effects to fish include clogging and abrasion of gills, behavioural effects (e.g. movement and migration), blanketing of spawning gravels and other habitat changes, the formation of physical constraints disabling proper egg and fry development, and reduced feeding (CCME 2002). Effects to benthic invertebrates include physical habitat changes, smothering of benthic communities, clogging of interstices between gravel, cobbles, and boulders affecting invertebrate microhabitat, abrasion of respiratory surfaces, and interference of food intake for filter-feeding invertebrates (CCME 2002). The CWQG contain a narrative guideline for TSS which the maximum increase of TSS should be no more than 25 mg/L. For this report, an objective of 30 mg/L was used which assumes a background TSS concentration of 5 mg/L.

TSS concentrations are presented in Figures 2 and 7. In general, TSS was higher near the mouths of the rivers or in urbanizing (e.g. areas with development construction) and lowest in the upper reaches. Eight stations had average TSS concentrations above the objective of 30 mg/L: 80006 (Etobicoke), 82003 (Mimico), 83020 (Humber), 83103 (Humber), 83019 (Humber), 85014 (Don), 85003 (Don) and 104025 (Duffins). Median TSS values were all below 30 mg/L. Four

stations had average TSS values of 10 mg/L or less: 83104 (Humber), 83018 (Humber), Mayfield (Etobicoke) and 97007 (Rouge). This may be due to erosion, resuspension of bed sediments and/or construction site runoff.

Seasonal TSS values are presented in Figure 15. TSS values were highest in the spring which is most likely due to snowmelt providing sediment to the stream which was applied to the roads for traction during the winter months. The maximum TSS concentration was 1070 mg/L at station 104025 (Duffins) on April 21, 2009. This value was 35 times the objective of 30 mg/L. The previous day had 26 mm of precipitation. The rain likely caused grit applied to the roads in the winter to wash into the stream as well as stream bank erosion due to high flow. The area upstream is also urbanizing so runoff from development areas may have played a role in the high TSS value.

### 3.1.6 Copper

Copper is an essential trace element that can be toxic to aquatic biota at elevated concentrations. It enters aquatic systems through aerial deposition or surface runoff. Sources of copper include the weathering of copper minerals and numerous sources from human activities (e.g. copper pipe, metal alloys, wiring, fungicides and insecticides). Copper strongly adsorbs to particulate matter (e.g. soil particles) and tends to accumulate in sediments. Because a variety of organisms live in, or are in contact with, the stream bed, sediments act as an important route of exposure to aquatic organisms (CCME 1999a). High levels of copper in the aquatic environment are usually found in more urbanized and industrial areas (OMOE 2003). The PWQO for copper is 5 µg/L.

Average copper results are presented in Figures 2 and 8. Eight stations had average copper results greater than the PWQO: 80006 (Etobicoke), MM003WM (Mimico), 82003 (Mimico), HU1RWMP (Humber), 83012 (Humber), DN008WM (Don), DM6.0 (Don), and 85014 (Don). These sites are in highly urbanized areas. Some stations may also be influenced by point sources such as the airport and highways. Station 82003, at the mouth of the Mimico Creek watershed, had the highest average copper concentration at 11.3 mg/L (median = 6.6 mg/L), which is about twice the PWQO.

Seasonal chloride concentrations are presented in Figure 16. Copper concentrations are highest in the spring and winter and lowest in the summer and autumn. The increased concentrations of copper during the winter and spring may be due to increased concentrations of chloride in surface water which can lead to the release of metals from sediments and suspended particulate matter (Warren and Zimmerman 1994).

### 3.1.7 Iron

Iron is required for all forms of life but, it can be toxic to aquatic organisms at high concentrations. The relationship between the insoluble and soluble forms (bioavailable) depends on several factors including pH, dissolved oxygen, dissolved and total organic carbon, humic and other organic substances, exposure to light and chloride concentrations (BC OMOE 2008). Anthropogenic sources of iron include landfills, water purification, sewage treatment,

pesticides, and fertilizers. Iron bound to other substances (e.g. sediment) can affect aquatic ecosystems. In fish, the clogging of gills which reduces respiratory potential and therefore overall survival can be caused by iron. It can also decrease the number of benthic invertebrates (which serve as the food supply for fish) directly or through changes to aquatic habitat. The PWQO for iron is 300 mg/L. Relatively high concentrations of metals can occur naturally in Canadian soils, stream sediments, and water making it difficult to determine the distinction between anthropogenic pollution versus naturally occurring geological formations.

Average iron results for 2006-2010 are presented in Figures 2 and 9. Only 4 sites (11%) had average iron concentrations that were less than the PWQO of 300 µg/L. This is most likely due to natural occurring sources from soils (Gary Bowen, TRCA, *pers. comm.*). Station 83020, located in the middle reaches of the Humber River, had the highest average concentration of iron at 1034 mg/L. These numbers should be interpreted with caution there was a large range of iron values which may have been caused by differences in laboratories used to analyze the metal concentrations.

Seasonal iron concentrations are presented in Figure 17. Iron concentrations were highest in the spring and lowest in the winter. Spring often has an influx of iron due re-suspension due to increased stream flow, increased iron-rich runoff, and flushing of dissolved organic matter (e.g. decay leaves) into the water (Vuori 1995, Wetzel 2001).

### 3.1.8 Zinc

Zinc is an essential trace element that is toxic to aquatic organisms at elevated levels causing increased behavioural changes and mortality as well as decreased benthic invertebrate diversity and abundance (OMOE 2003). Zinc can enter aquatic systems through aerial deposition or surface runoff. The primary use of zinc is for galvanized products for the automotive and construction industry. Sources of anthropogenic zinc include electroplaters, smelting and ore processing, domestic and industrial sewage, combustion of solid wastes and fossil fuels, corrosion of zinc alloy and galvanized surfaces and soil erosion (OMOE 2003). Zinc has a strong affinity for aquatic particles (especially organic matter) and tends to accumulate in bed sediments. A wide variety of organisms live in contact with the sediments of aquatic systems. Sediments therefore act as an important route of exposure to zinc for aquatic organisms (CCME 1999b). The PWQO for zinc is 20 µg/L.

Average zinc concentrations are presented in Figures 2 and 10. Eleven sites (30%) had average concentrations which exceeded the PWQO. These sites were: 80006 (Mimico), MM003WM (Mimico), 82003 (Etobicoke), HUIRWMP (Humber), 83002 (Humber), 83012 (Humber), 85004 (Don), DN008 (Don), DM6.0 (Don), 85014 (Don), 97777 (Rouge). These sites are in urbanized areas. The lowest average zinc concentration of 3.31 µg/L was at station 83018 which located in the upper reaches of the Humber River watershed with little urban influence.

Seasonal zinc concentrations are presented in Figure 18. Like copper, zinc concentrations were the highest in the spring and winter which is likely related to increased chloride concentrations from road salts.

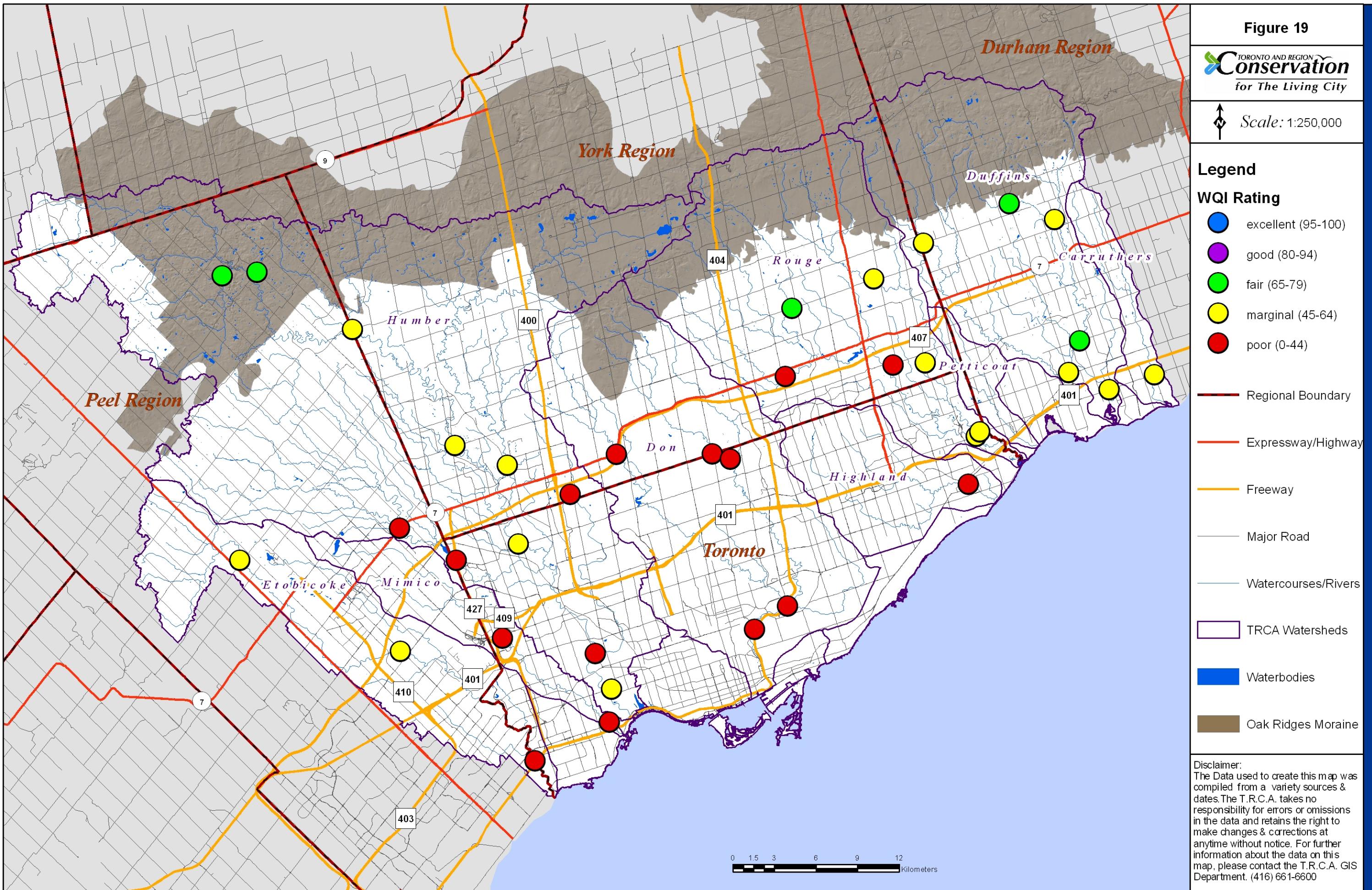
### 3.1.9 Water Quality Index (WQI)

WQI results are presented in Table 6 and Figure 19. According to the WQI, the 36 sites within the TRCA's jurisdiction were characterized into 3 categories: fair, marginal and poor. There were no sites with excellent or good ratings. Only five stations (14%) were categorized as fair: 83018 (Humber), 83104 (Humber), 97018 (Rouge), 104008 (Duffins), 104027 (Duffins). With the exception of 104027, these sites were located in the upper reaches of their respective watersheds. Station 104027 is located in the lower portion of the Duffins Creek watershed but it is upstream of urban activities. The remaining stations were categorized as marginal (44%) or poor (42%). The five stations which received the lowest WQI scores were: DM6.0 (Don), 83012 (Humber), HU1RWMP (Humber), 82003 (Mimico) and MM003WM (Mimico).

**Table 6. Water Quality Index scores and ratings for the TRCA jurisdiction**

Station	WQI	Rating
83018	77.8	fair
83104	72.9	fair
97018	68.3	fair
104008	67.2	fair
104027	65.8	fair
83009	64.7	marginal
104029	64.1	marginal
97007	62.9	marginal
97013	60.7	marginal
104001	59.5	marginal
104025	56.5	marginal
97999	55.4	marginal
107002	55.4	marginal
104037	55.0	marginal
83004	54.5	marginal
83020	52.0	marginal
Mayfield	51.5	marginal
83019	51.3	marginal
80007	49.0	marginal
HU010WM	48.8	marginal
97011	46.2	marginal
83103	43.1	poor
97003	42.0	poor
85003	38.9	poor
97777	38.4	poor
83002	38.3	poor
94002	37.6	poor
85004	36.7	poor
DN008WM	35.8	poor
80006	33.7	poor
85014	33.6	poor
MM003WM	31.9	poor
82003	31.2	poor
HU1RWMP	30.2	poor
83012	28.9	poor
DM 6.0	26.8	poor

# Water Quality Index for the Toronto Region



### 3.2 Point-Source Pollutants

There are many point-sources of pollution in the Toronto region including former landfills, industrial discharge, wastewater treatment plants and illegal sewer cross-connections. Although not designed to track point-source pollution, several water quality sites allow for the monitoring of certain point-source of pollution to Toronto Waterways.

#### ***North Toronto Wastewater Treatment Plant***

The City of Toronto's North Toronto Wastewater Treatment Plant is located in the lower reaches of the Don River. In 2010, the plant met or exceeded all final effluent parameters regulated under Certificate of Approval (CofA) No. 7665-7NWMH2 issued on March 26, 2009 (City of Toronto 2011). This is based on averages or geometric means, therefore, individual sampling events may have exceeded the CofA requirements. The CofA outlines discharge requirements for TSS (25 mg/L), total phosphorus (1 mg/L) and *E. coli* (200 CFU/100 mL) as well as several other parameters. The total phosphorus discharge requirement of 1 mg/L is over three times the PWQO of 0.3 mg/L and the *E. coli* requirement of 200 CFU/100 mL is twice the PWQO of 100 CFU/100 mL. Monthly phosphorus averages ranged from 0.46 to 0.97 mg/L with an average discharge of 0.7 mg/L. Combined sewer overflow (CSO) tanks provide holding capacity for combined sewer overflows resulting from wet weather flow conditions. There were 16 CSO tank overflows in 2010 where raw sewage was outlet directly to the Don River. Station 85014 is located approximately 1 km downstream of the plant. Average water quality results at station 85014 were elevated for the following parameters: ammonia, copper, *E. coli*, nitrate, nitrite, phosphate, TKN and phosphorus. There are no requirements outlined in the CofA for ammonia, nitrate, nitrite, nitrite, and TKN.

#### ***Kleinburg Water Pollution Control Plant***

The Kleinburg Water Pollution Control Plant (WPCP) is owned and operated by the Regional Municipality of York. The WPCP is located near Highway 27 and Islington Avenue in Kleinburg. The plant discharges to the Humber River. Station 83020 is located approximately 3.5 km downstream of the plant. The water quality at this station did have any elevated concentrations of nutrients or bacteria. This portion of the Humber River appears to have sufficient discharge to allow assimilation of the effluent.

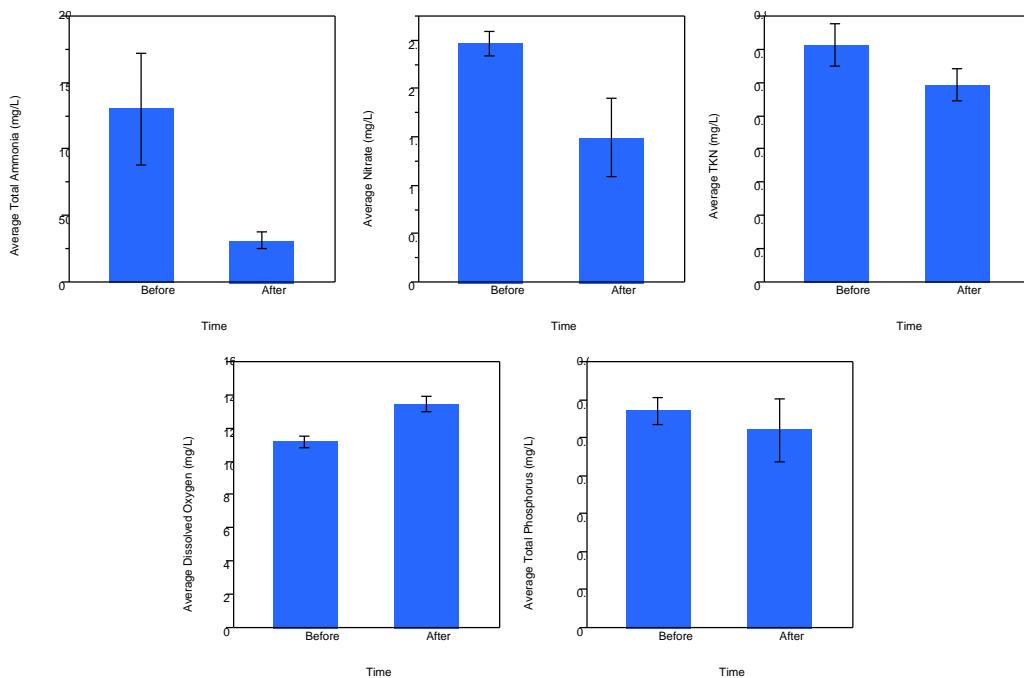
#### ***Former Stouffville Water Pollution Control Plant***

The Stouffville WPCP, owned and operated by the Regional Municipality of York, was decommissioned in the spring of 2006. The WPCP discharged to Stouffville Creek, a tributary of the Duffins Creek for over 30 years (TRCA 2007). Station 104037 is located approximately 5 km downstream of the former plant. Two additional tributaries flow into the Upper West Duffins Creek between the plant and the monitoring station. Despite the confounding influence of the two additional tributaries, a noticeable difference can be seen at station 104037. There were significant differences before and after the decommissioning of the plant for total ammonia, nitrate, total Kjeldahl nitrogen (TKN), and dissolved oxygen (Table 7, Figure 20). There was a decrease in total phosphorous but the difference was not statistically significant

**Table 7. Analyte concentrations before (2002-2005) and after (2007-2010) the decommissioning of the Stouffville WPCP**

Analyte	Average		Median		N	p
	Before	After	Before	After		
Ammonia (mg/L)	130	31	30	10	39	48
Nitrate (mg/L)	2.47	1.49	2.37	1.05	39	67
TKN (mg/L)	0.71	0.59	0.75	0.59	10	44
Dissolved Oxygen (mg/L)	11.2	13.4	11.0	13.7	42	48
Phosphorus (mg/L)	0.057	0.052	0.059	0.0345	55	48

\* = significant ( $p < 0.1$ )



**Figure 20. Analyte concentrations before (2002-2005) and after (2007-2010) the decommissioning of the Stouffville WPCP**

### Lester B. Pearson International Airport

Lester B. Pearson International Airport spans two watersheds: Etobicoke Creek and Mimico Creek. The majority of the drainage flows into Etobicoke Creek. Station 80007 is located upstream of the airport and station 80006 is located downstream of the airport. There are several tributaries between the upstream and the downstream station. When station 80006 (downstream) is compared to station 80007 (upstream), there is an increase in several metals (e.g. barium, cadmium, chromium, cobalt, copper, magnesium, molybdenum, nickel) as well as chloride and *E. coli*. Because of the incoming tributaries between the two stations, the increases in analytes cannot be directly associated to the airport. The increases may be due to increased urban influences, industrial uses, etc. Additional monitoring is needed to determine the impact of the airport on the local watercourses.

### 3.3 Relationship with Road Density

Road density values are presented in Table 8 and Figure 22. Road density in the Toronto region was highest in the Don River, Highland Creek and Mimico Creek watersheds and lowest in the Duffins Creek, Carruthers Creek and Humber River watersheds. In general, road density increased from the headwaters to the mouths of the rivers in the Toronto region.

**Table 8. Average road density (km/km<sup>2</sup>) per watershed**

Watershed	Average Road Density (km/km <sup>2</sup> )
Etobicoke	6.09
Mimico	8.58
Humber	3.55
Don	9.41
Highland	9.41
Rouge	4.39
Duffins	2.02
Carruthers	3.18

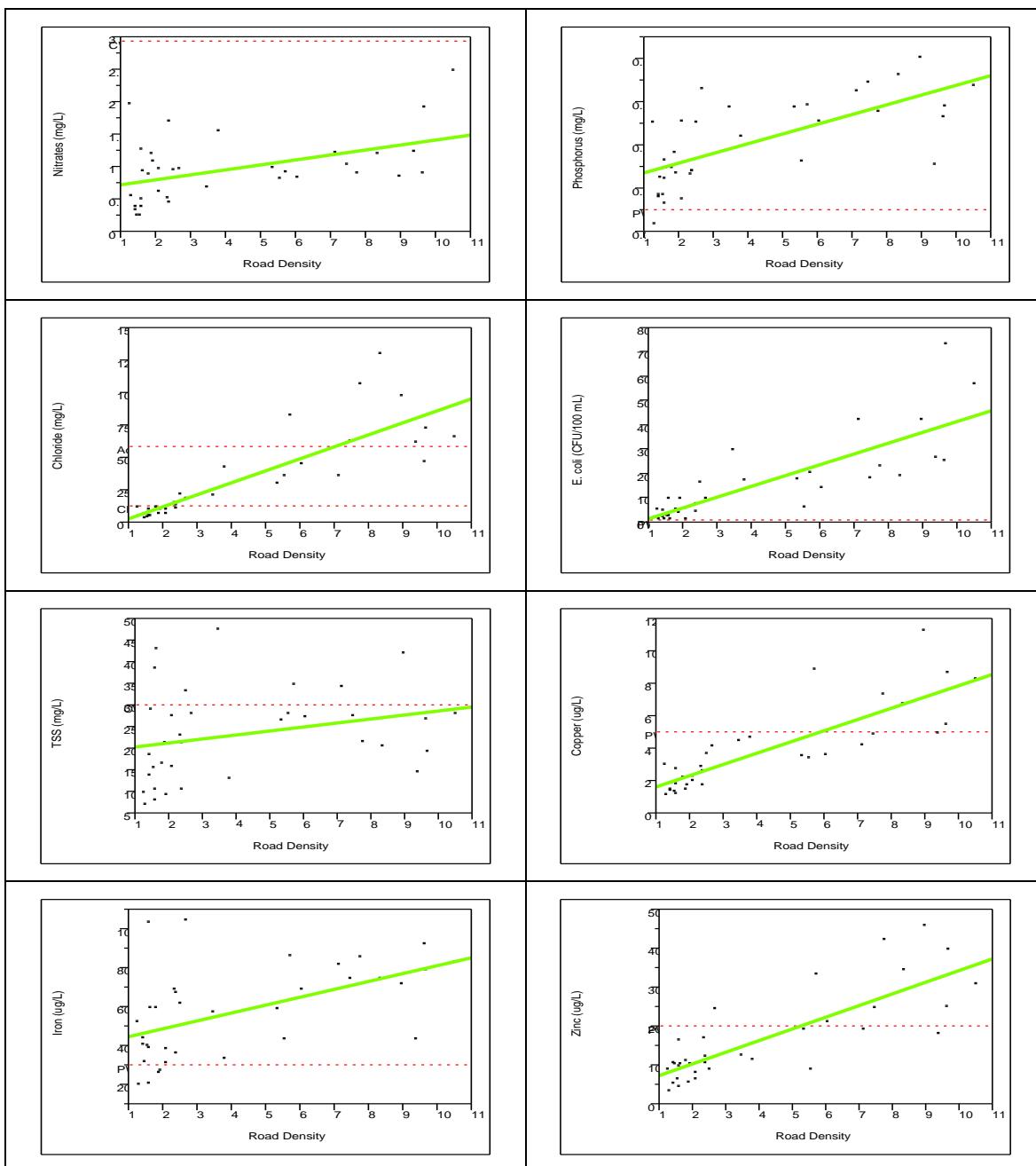
The average concentration for 2006-2010 of the indicator analytes was regressed with road density and is presented in Table 9 and Figure 21. The remaining analytes were also regressed with road density and the results are presented in Appendix B. Of the eight indicator analytes, seven had statistically significant ( $p < 0.05$ ) relationships with road density. The only exception was TSS ( $p = 0.12$ ). All eight analytes had positive relationships with road density. In other words, as road density increased, the concentration of the analyte also increased. WQI values were negatively correlated with road density (Table 8, Figure 21) which suggests that as road density increases, water quality worsens.

**Table 9. Regression relationship between various water chemistry analytes and road density**

Analyte	Trend	Equation	F	p	R <sup>2</sup>
Phosphorus	↑	$y=0.04+0.01*RdDen$	31.46	<0.001*	0.488
Nitrates	↑	$y=0.65+0.08*RdDen$	9.08	0.005*	0.216
Chloride	↑	$y=-64.29+92.42*RdDen$	85.35	<0.001*	0.721
E. coli	↑	$y=-309.99+444.99*RdDen$	66.50	<0.001*	0.668
TSS	↑	$y=19.34+0.92*RdDen$	2.54	0.120	0.072
Copper	↑	$y=0.92+0.69*RdDen$	76.24	<0.001*	0.698
Iron	↑	$y=402.74+40.79*RdDen$	12.94	0.001*	0.822
Zinc	↑	$y=4.22+3.01*RdDen$	63.54	<0.001*	0.658
WQI	↓	$Y=65.46-3.82*RdDen$	99.40	<0.001*	0.745

Note: \* denotes a significant relationship ( $p < 0.05$ )

Using the relationships derived between road density and the indicator analytes, the road density at which the water quality objective (e.g. PWQO) would be reached was calculated (Table 10). *E. coli* and chloride met their respective objectives at very low road densities (<2 km/km<sup>2</sup>) while nitrates would not meet its objective until almost 30 km/km<sup>2</sup>. Two analytes, phosphorus and iron, had negative values which suggests that other factors other than road density are also influencing these relationships.



**Figure 21. Relationship between eight water quality parameters and road density in the Toronto region**

(solid green line denotes trend; dashed red line denotes applicable guideline)

# Road Density (Km/Km<sup>2</sup>) for the Catchment Upstream of Water Quality Sampling Sites

Figure 22

**TORONTO AND REGION**  
**Conservation**  
for The Living City

Scale: 1:250,000

## Legend

RWMP Water Chemistry Monitoring Sites  
Road Density Km/Km<sup>2</sup>

0.00 - 3.00

3.01 - 6.00

6.01 - 9.00

9.01 - 12.00

12.01 - 15.00

Regional Boundary

Expressway/Highway

Freeway

Major Road

Watercourses/Rivers

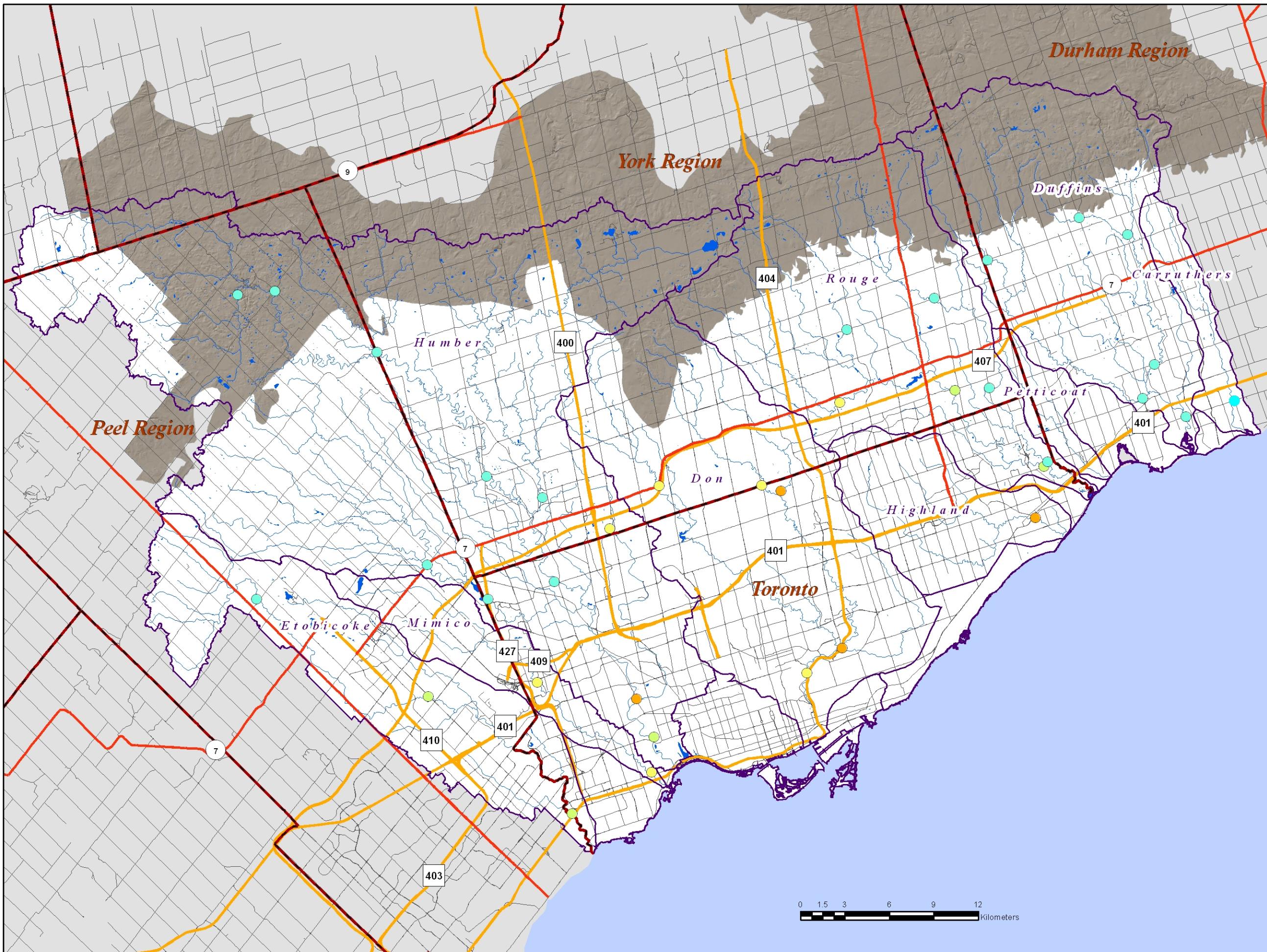
TRCA Watersheds

Waterbodies

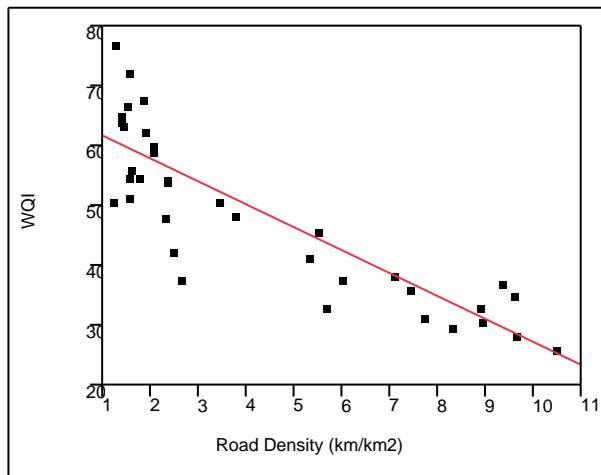
Oak Ridges Moraine

0 1.5 3 6 9 12 Kilometers

**Disclaimer:**  
The Data used to create this map was compiled from a variety sources & dates. The T.R.C.A. takes no responsibility for errors or omissions in the data and retains the right to make changes & corrections at anytime without notice. For further information about the data on this map, please contact the T.R.C.A. GIS Department. (416) 661-6600



**Figure 23. Relationship between road density and Water Quality Index values for the Toronto region**



**Table 10. Regression relationship between road density and water quality analytes and the road density at which the respective water quality objective is met**

Analyte	Equation	Objective	Road Density (at which objective is met)
Phosphorus	$y=0.04+0.01*RdDen$	0.03 mg/L	-1.00 km/km <sup>2</sup>
Nitrates	$y=0.65+0.08*RdDen$	2.93 mg/L	28.50 km/km <sup>2</sup>
Chloride	$y=-64.29+92.42*RdDen$	120 mg/L	2.04 km/km <sup>2</sup>
<i>E. coli</i>	$y=-309.99+444.99*RdDen$	100 CFU/100 mL	0.92 km/km <sup>2</sup>
TSS	$y=19.34+0.92*RdDen$	30 mg/L	11.59 km/km <sup>2</sup>
Copper	$y=0.92+0.69*RdDen$	5 ug/L	5.91 km/km <sup>2</sup>
Iron	$y=402.74+40.79*RdDen$	300 ug/L	-2.52 km/km <sup>2</sup>
Zinc	$y=4.22+3.01*RdDen$	20 ug/L	5.24 km/km <sup>2</sup>

### 3.4 Temporal Trends

Data were broken down into 5-year intervals (beginning with 2010 and working backwards) and median values for the 5-year intervals were calculated. Sites with data for four or more time periods are presented. Trends were analyzed using the Mann-Kendall test with significance set at  $p<0.1$ . Particular attention was paid to the stations at or near the watershed outlets. Watershed mouths are important sentinel sites because they incorporate the water quality of all the incoming tributaries at a single point before the water enters Lake Ontario. These sites also have the longest, most complete data records.

### 3.4.1 Total Phosphorus

Trend analyses for total phosphorus are presented in Table 11. With the exception of one station (83004), a decrease in total phosphorus over time ( $S < 0$ ) was found. Six of the 12 stations with decreasing trends had statistically significant trends ( $p < 0.1$ ). The only station which did not show a decreasing trend was 83004 in the Humber River watershed which is downstream of the National Golf Club (opened in 1974). This station showed a slight decrease from 1999-1980 and has remained around the PWQO from that point onwards. Fertilization practices may be influencing the phosphorus concentrations at this site.

Currently, about half of the median phosphorus values are above the PWQO of 0.03 mg/L, two stations are at the PWQO and two stations are slightly above the objective. Station 85014 near the mouth of the Don River is an exception to this. Station 85014 is located downstream of the North Toronto Wastewater Treatment Plant. The median total phosphorous concentration for 2006-2010 was 0.19 mg/L which is 6 times higher than the PWQO. Despite being elevated, this value is almost 2.5 times lower than the median concentration of 0.46 mg/L for the 1976-1980 period which is a drastic improvement. The current median value (0.19 mg/L) at this station increased compared to the previous 2003-2007 time period at 0.15 mg/L.

**Table 11. Total phosphorus trend analyses over time**

Watershed	Station	Median Total Phosphorus Concentrations in mg/L (N)										Mann-Kendall		Regression $R^2$
		66-70	71-75	76-80	81-85	86-90	91-95	96-00	01-05	06-10	S	p		
Humber	83018			0.030 (54)	<b>0.035</b> (56)		0.024 (41)		0.024 (66)	0.020 (57)	-1.470	0.142	0.747	
	83002	<b>0.160</b> (52)	<b>0.120</b> (42)	<b>0.069</b> (52)	<b>0.090</b> (51)		<b>0.113</b> (41)		<b>0.078</b> (53)	<b>0.080</b> (60)	-1.202	0.230	0.380	
	83004	<b>0.032</b> (52)	0.027 (40)	0.025 (53)	0.029 (52)		<b>0.034</b> (32)		0.030 (50)	0.030 (58)	0.451	0.652	0.101	
	83012			<b>0.240</b> (54)	<b>0.121</b> (52)		<b>0.058</b> (31)		<b>0.060</b> (50)	<b>0.050</b> (60)	-1.715	0.086*	0.714	
	83019 <sup>M</sup>			0.069 (69)	<b>0.080</b> (117)	0.054 (176)	0.047 (346)	0.052 (109)	<b>0.041</b> (149)	<b>0.032</b> (73)	-2.403	0.016*	0.811	
Don	85004	0.510 (54)	<b>1.600</b> (42)	<b>0.280</b> (50)	<b>0.099</b> (51)		<b>0.064</b> (39)		<b>0.065</b> (40)	<b>0.050</b> (60)	-2.403	0.016*	0.373	
	85003	0.250 (57)	<b>0.480</b> (42)	<b>0.277</b> (54)	<b>0.078</b> (51)		<b>0.056</b> (41)		<b>0.065</b> (42)	<b>0.060</b> (60)	-1.802	0.072*	0.563	
	85014 <sup>M</sup>			<b>0.462</b> (65)	<b>0.275</b> (135)	<b>0.178</b> (145)	<b>0.190</b> (372)	<b>0.168</b> (99)	<b>0.139</b> (140)	<b>0.186</b> (64)	-1.802	0.072*	0.584	
Highland	94002			<b>0.054</b> (87)	<b>0.032</b> (52)	0.028 (59)			<b>0.040</b> (36)	0.030 (60)	-0.735	0.462	0.174	
Rouge	97003		<b>0.600</b> (41)	<b>0.145</b> (53)	<b>0.053</b> (60)	<b>0.056</b> (56)	<b>0.050</b> (36)			<b>0.060</b> (48)	-1.127	0.260	0.389	
	97013		<b>0.032</b> (39)	0.020 (51)	0.024 (60)	0.029 (58)	0.018 (41)		<b>0.035</b> (41)	0.020 (48)	-1.150	0.881	0.004	
	97011		<b>0.415</b> (42)	<b>0.099</b> (52)	<b>0.031</b> (60)	<b>0.034</b> (58)	0.025 (44)		<b>0.031</b> (65)	<b>0.032</b> (44)	-1.202	0.230	0.414	
Duffins	104001 <sup>M</sup>	<b>0.072</b> (103)	<b>0.086</b> (53)	<b>0.088</b> (70)	<b>0.035</b> (59)	0.030 (58)	0.022 (48)		0.022 (37)	0.020 (43)	-2.351	0.019*	0.707	

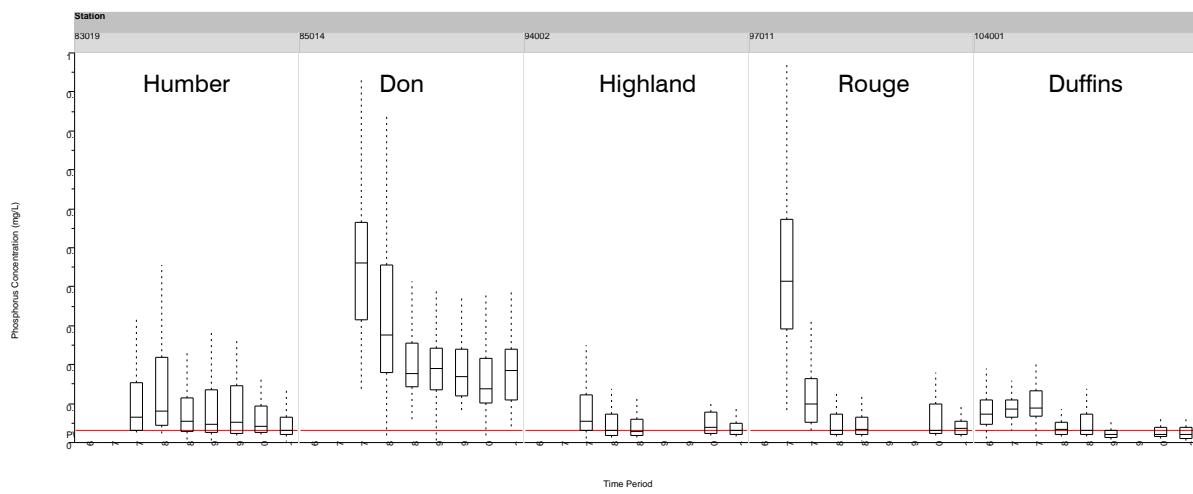
Notes: \* = significant  $p < 0.1$

<sup>M</sup> = mouth of watercourse

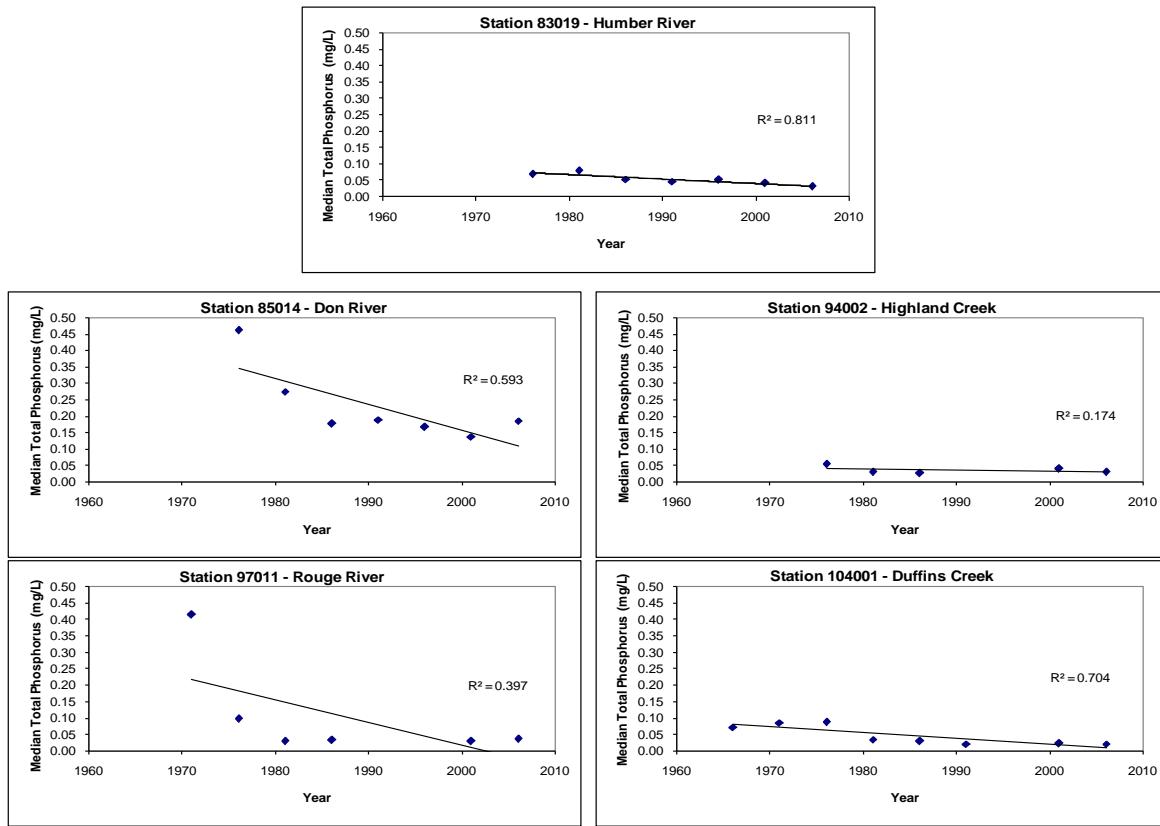
Bolded values indicate exceedance of 0.03 mg/L objective

Total phosphorus concentrations for the mouth of the Humber River (83019), Don River (85014), Highland Creek (94002), Rouge River (97011) and Duffins Creek (104001) are presented in Figure 23. All five watersheds have had decreasing phosphorous concentrations over the last several decades (Figure 24) and the Humber, Don and Duffins watersheds have all had statistically significant decreasing trends (Table 11). The declining trend in phosphorus is

associated with a general reduction in phosphorus use in the 1970s and specifically due to the decommissioning of several sewage treatment plants within the TRCA's jurisdiction. Historically, large phosphorus loads were contributed to the lake water which had limited assimilative capacity. Previously (prior to the 1980s), there was a problem with lake shore fouling with the green algae *Cladophora*. Recently, *Cladophora* problems have returned and it is possible that phosphorus levels are increasing locally along some areas of shoreline and contributing to the enhanced growth of algae (OMOE 2009). To help combat this potential problem, the federal government introduced a ban which almost eliminates phosphorus from household laundry, dishwasher, and dish washing detergents as well as some household cleaners (Canada Gazette 2009). The ban came into effect in July 2010 and reduces the allowable amount of phosphorus to 0.5% by weight (currently 2.2%). This will help to reduce some of the phosphorus released to watercourses but even the most advanced wastewater treatment technologies available cannot totally eliminate phosphorus releases to the environment. Although this is a step in the right direction, municipal wastewater sewers and septic systems only contribute about 14% to the national phosphorus load (Canada Gazette 2009). Additional work is needed to decrease the phosphorus contribution from agriculture which contributes 82% of the national load.



**Figure 24. Total phosphorus concentrations for the mouth of the Humber River (83019), Don River (85014), Highland Creek (94002), Rouge River (97011) and Duffins Creek (104001) over time**



**Figure 25. Median total phosphorus trends over time at the mouths of the Humber River (83019), Don River (85014), Highland Creek (94002), Rouge River (97011), and Duffins Creek (104011)**

### 3.4.2 Chloride

Trend analysis data for chloride is presented in Table 12. All stations (12 of 12) showed an increasing trend for chloride concentrations ( $S>0$ ) with 7 of the 12 stations having a statistically significant increasing trend ( $p<0.1$ ).

There were four stations with sufficient data in the Humber River watershed. All four sites showed an increasing trend for chloride with the trends at three stations (83002, 83004, 83019) being significant. Station 83012, located at the mouth of the Black Creek, had the highest chloride concentrations of all the stations during each time period monitored. Median chloride values ranged from 269-459 mg/L from 1966-2010 for Black Creek. These values are 3 to 8 times higher than other stations in the watershed. Station 83004 in the East Humber River was the only station in watershed that did not exceed the 120 mg/L objective during the current time period.

Three stations in the Don River watershed had sufficient surface water quality data for trend analysis. Two stations (85003, 85004) are located in the upper-middle portions of the watershed and one station (85014) is located at the mouth of the Don River. All three stations showed an

increasing trend in median chloride concentrations over time but only the trend at station 85014 was significant. Both stations 85004 and 85003 had large increases in chlorides during the last decade. Prior to the last sampling period, the median chloride concentrations were approximately half (or less than half) of the current value. These sites are in areas which have undergone considerable urbanization over the past few decades.

There were three stations (97003, 97013, 97011) in the Rouge River watershed which had adequate chloride data for trend analyses. All three stations showed an increase in median chloride concentrations over time with station 97011 having a statistically significant trend. Station 97011 is located near the mouth of the Rouge River (but does not include Little Rouge River) which drains a more urbanized area.

The Highland Creek and Duffins Creek had one station in each watershed with sufficient chloride data for trend analysis. Station 94002 at the mouth of Highland Creek and Station 104001 at the mouth of the Duffins Creek both showed a significant increasing trend in median chloride concentrations over time. The Duffins Creek site has continually had the lowest median chloride concentrations of all the sites with information. This watershed was and continues to be mainly rural.

**Table 12. Chloride trend analyses over time**

Watershed	Station	Median Chloride Concentrations in mg/L (N)								Mann-Kendall	Regression	
		66-70	71-75	76-80	81-85	86-90	91-95	96-00	01-05	06-10		
Humber	83004	28 (52)	37 (42)	42 (45)	46 (49)	-	39 (41)	-	-	106 (60)	1.879	0.060*
	83002	33 (53)	41 (40)	46 (46)	59 (50)	-	83 (31)	-	-	154 (60)	2.630	0.009*
	83012	-	-	<b>315</b> (53)	<b>269</b> (51)	-	<b>304</b> (31)	-	-	<b>459</b> (60)	0.340	0.734
	83019 <sup>M</sup>	-	-	-	-	102 (112)	111 (344)	104 (111)	<b>146</b> (126)	<b>164</b> (72)	1.715	0.086*
Don	85004	<b>147</b> (54)	<b>158</b> (42)	<b>130</b> (50)	107 (51)	-	<b>158</b> (39)	-	-	<b>362</b> (60)	0.564	0.573
	85003	60 (57)	90 (41)	110 (54)	66 (51)	-	87 (41)	-	-	<b>188</b> (60)	1.127	0.260
	85014 <sup>M</sup>	-	-	-	-	<b>148</b> (113)	<b>169</b> (369)	<b>173</b> (105)	<b>199</b> (122)	<b>218</b> (72)	2.205	0.027*
Highland	94002 <sup>M</sup>	-	-	<b>158</b> (87)	<b>178</b> (53)	<b>203</b> (59)	<b>218</b> (43)	-	-	<b>326</b> (59)	2.205	0.027*
Rouge	97003	-	62 (41)	60 (53)	53 (60)	82 (56)	80 (36)	-	-	<b>180</b> (48)	1.127	0.260
	97013	-	-	41 (51)	39 (58)	51 (58)	50 (41)	-	-	84 (48)	1.225	0.221
	97011	-	-	65 (51)	63 (60)	72 (58)	89 (44)	-	<b>162</b> (44)	<b>170</b> (44)	2.234	0.024*
Duffins	104001 <sup>M</sup>	15 (103)	18 (53)	21 (70)	21 (59)	32 (58)	38 (47)	-	52 (33)	53 (43)	3.217	0.001*

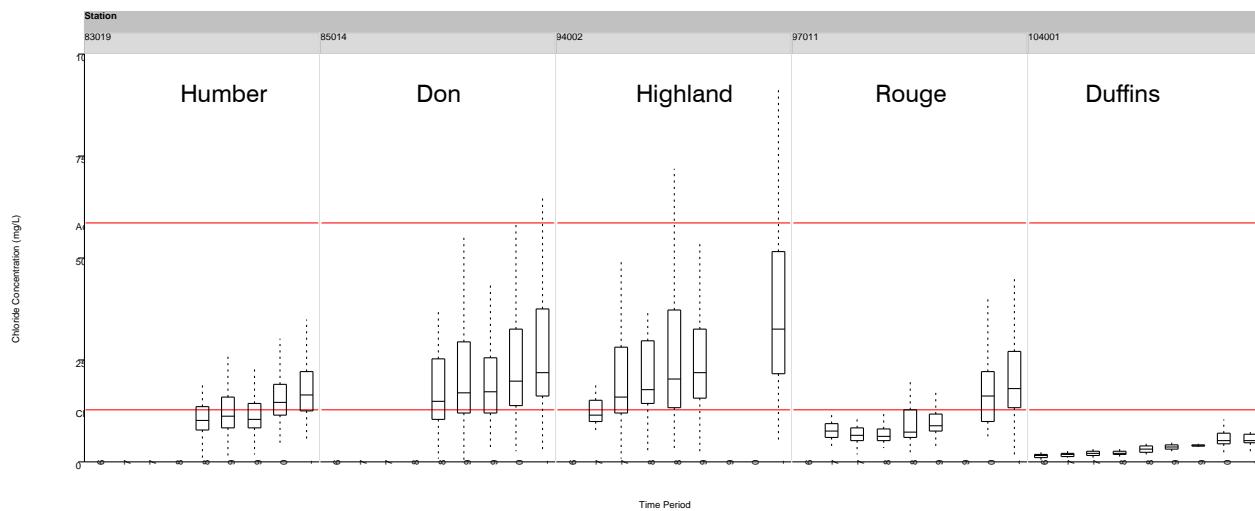
Notes: \* = significant  $p < 0.1$

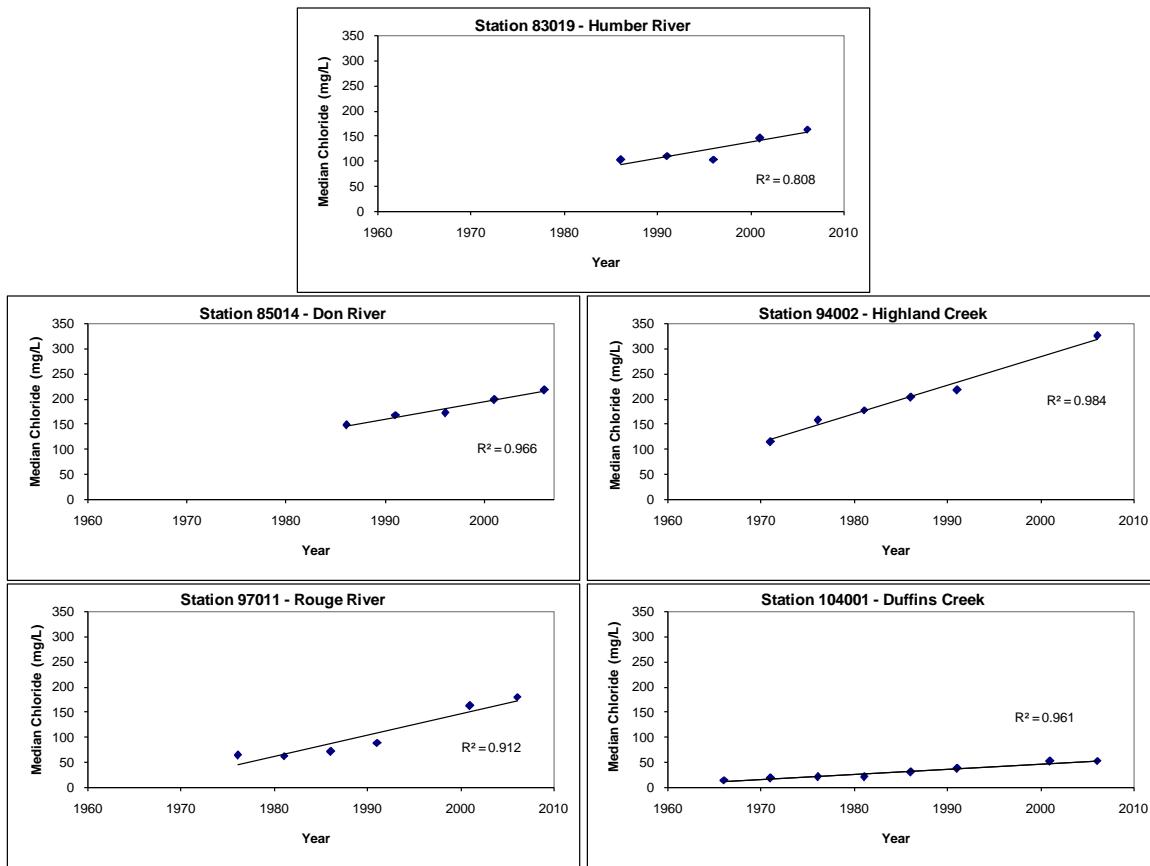
<sup>M</sup> = mouth of watercourse

Bolded values indicate exceedance of 120 mg/L objective for chronic exposure

Chloride results are presented in Figures 25 and 26 for the mouths of the Humber River (83019), Don River (85014), Highland Creek (94002), Rouge River (97011), and Duffins Creek (104001). All five stations showed an increasing trend in chloride concentrations (Figure 23, Table 14). With the exception of the Duffins Creek watershed, the median chloride concentration exceeded the CWQG of 120 mg/L for chronic effects for at least one time period. The Don River (85014) has consistently had median chloride concentrations greater than 120 mg/L for the duration of its monitoring period since the mid-1980s. The median concentration of chloride at the mouth of the Highland Creek has been above the 120 mg/L objective since the mid-1970s. The Humber River (83019) and Rouge River (97011) both surpassed the chronic objective in the early 2000s (although there was insufficient data for 1996-2000 for the Rouge River so it potentially happened earlier). It is important to note that winter samples (when chloride concentrations are expected to be the highest due to road salting activities) were not collected during every time period. At the Duffins Creek site, winter sampling began in 1965. Winter samples were collected at the Rouge River and Highland Creek beginning in the mid-1970s and winter sampling did not start at the Humber River and Don River stations until 1990. This suggests that median chloride concentrations may have been higher than what is presented during periods when winter sampling did not occur.

**Figure 26. Chloride concentrations for the mouth of the Humber River, Don River, Highland Creek, Rouge River and Duffins Creek over time**





**Figure 27. Median chloride trends over time at the mouths of the Humber River (83019), Don River (85014), Highland Creek (94002), Rouge River (97011), and Duffins Creek (104011)**

### 3.4.3 Total Suspended Solids

Trend analyses for TSS concentrations are presented in Table 13. All stations showed a decreasing trend in TSS concentrations ( $S<0$ ). Station 83018 in the upper reaches of the Humber River and Station 85014 at the mouth of the Don River both had statistically significant decreasing trends in TSS concentrations. Of particular note are the stations in the Don River. In the late 1960s and early 1970s, median TSS concentrations were in the 30-40 mg/L range. During the latest time period, concentrations in the Don River were less than 11 mg/L which is a significant improvement over the past few decades. Since untreated stormwater is the main contributor of TSS to streams in urban areas, the continued installation and improvement of stormwater infrastructure will further improve the health of the streams in the Toronto region. In rural areas, the erosion of tablelands and stream channels contribute to the TSS load. Efforts to improve riparian vegetation may help to reduce runoff.

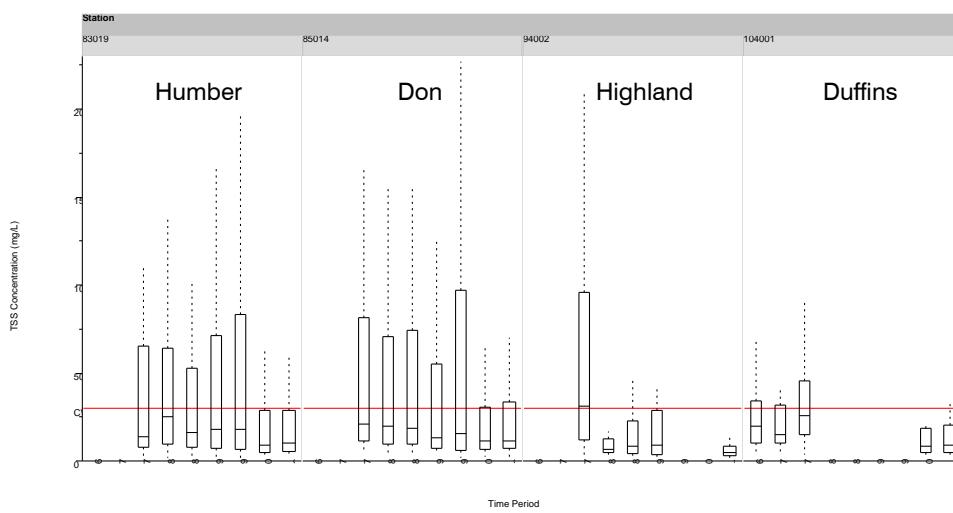
**Table 13.** Total suspended solids (TSS) trend analyses over time

Watershed	Station	Median TSS Concentrations in mg/L (N)										Mann-Kendall S	p	Regression R <sup>2</sup>
		66-70	71-75	76-80	81-85	86-90	91-95	96-00	01-05	06-10				
Etobicoke	80004			12.0 (35)	13.6 (47)		11.0 (31)		7.0 (38)		-1.019	0.308	0.778	
Humber	83018			6.1 (52)	6.0 (50)		5.8 (41)		5.3 (43)	4.6 (55)	-2.205	0.027*	0.873	
	83002	15.0 (52)	10.0 (38)	12.0 (37)						7.2 (60)	-1.359	0.174	0.448	
	83004	28.0 (53)	23.0 (39)	20.0 (39)						20.0 (58)	-1.019	0.308	0.713	
	83019 <sup>M</sup>			14.0 (67)	25.0 (116)	16.0 (179)	18.0 (345)	17.8 (110)	9.0 (126)	9.9 (69)	-0.901	0.368	0.363	
	85004	<b>33.5 (54)</b>	<b>40.0 (41)</b>	21.0 (43)						8.0 (60)	-1.019	0.308	0.793	
Don	85003	15.0 (56)	<b>40.0 (41)</b>	25.0 (47)						10.0 (60)	-0.340	0.734	0.295	
	85014 <sup>M</sup>			21.0 (65)	20.0 (133)	18.7 (144)	13.3 (359)	15.5 (103)	11.5 (121)	11.1 (68)	-2.703	0.007*	0.889	
Highland	94002 <sup>M</sup>			<b>31.0 (80)</b>	6.8 (50)	8.3 (54)				4.5 (60)	-1.019	0.308	0.425	
Duffins	104001 <sup>M</sup>	19.5 (102)	15.0 (50)	26.0 (69)						9.2 (33)	9.5 (42)	-0.735	0.462	0.563

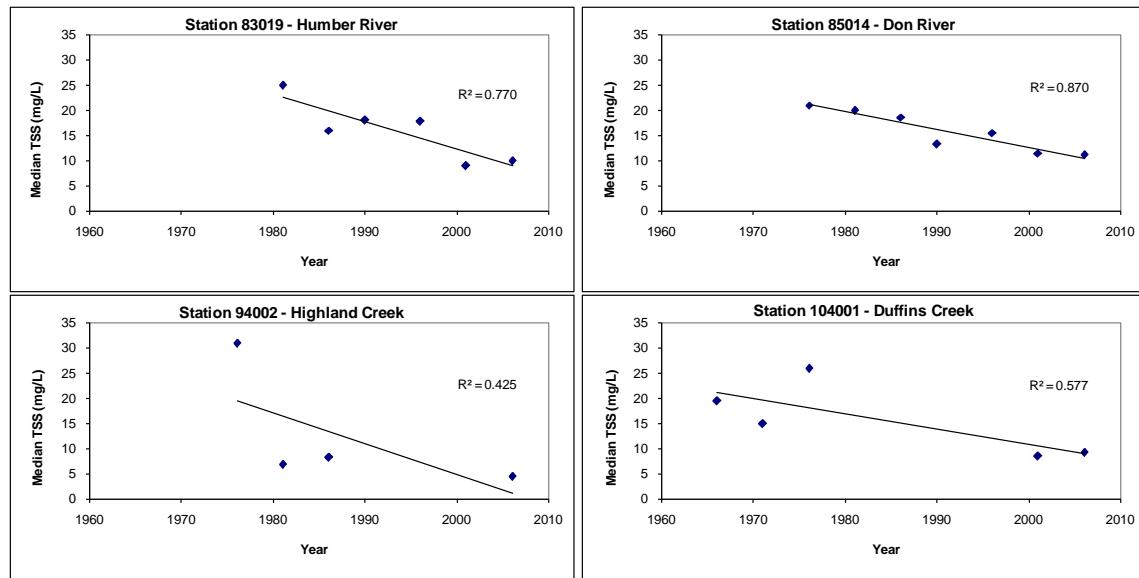
 Notes: \* = significant  $p < 0.1$ 
<sup>M</sup> = mouth of watercourse

Bolded values indicate exceedance of 30 mg/L objective

TSS results for the mouths of the Humber River, Don Diver, Highland Creek and Duffins Creek are presented in Figures 27 and 28. Highland Creek had the only time period with a median concentration greater than the CWQG derived guideline of 30 mg/L (1976-1980, 31 mg/L). The remaining stations had all median values below 30 mg/L for all time periods. All stations showed decreasing trends in TSS concentrations over time (Figure 28) but only the trend for the Don River mouth was statistically significant (Table 14).



**Figure 28.** Total suspended solids (TSS) concentrations for the mouths of the Humber River (83019), Don River (85014), Highland Creek (94002), and Duffins Creek (104001) over time



**Figure 29. Median total suspended solids (TSS) trends over time at the mouths of the Humber River (83019), Don River (85014), Highland Creek (94002), and Duffins Creek (104001)**

## 4. Summary

Surface water quality for the Toronto and Region Conservation Authority's jurisdiction has been analyzed several times (TRCA 1998, TRCA 2003, TRCA 2009) with the general conclusion that water quality issues are correlated to the amount of urbanization within a watershed. The 2006-2010 results are consistent with this broad finding. Some specific findings for 2006-2010 time period include:

### Nutrients

- Only one station (83018 in the upper reaches of the Humber River) had an average total phosphorus concentration which was less than the PWQO of 0.03 mg/L; Station 85014 in the Don River (downstream of the North Toronto Wastewater Treatment Plant) had the highest average total phosphorus concentration at 0.21 mg/L which is seven times higher than the PWQO
- Total phosphorus concentrations peak during the summer months when fertilizer use is at its highest
- All stations had nitrate values below the CWQG of 2.93 mg/L; DM6.0 (Taylor Massey Creek in the Don River watershed) had the highest average nitrate concentration at 2.49 mg/L

### Chloride

- Average chloride concentrations for 44% of the sites monitored exceeded the guideline for chronic effects (120 mg/L) with 22% of sites exceeding the guideline for acute effects

(640 mg/L); individual sampling points often exceeded both the chronic and acute guidelines

- Average chloride concentrations were highest at station HU1RWMP in the Humber River downstream of Highway 407 and lowest in the Duffins Creek watershed and the upper reaches of the Humber River
- Chloride concentrations were highly correlated to metals concentrations (e.g. copper, zinc) and chloride concentrations are highest during the winter months

### Bacteria

- All stations had average *E. coli* values which exceeded the PWQO of 100 CFU/100 mL but 22% of sites had median values less than the PWQO, individual sampling points often exceeded 20 000 CFU/100 mL at many sites; high loadings from tributaries may contribute to waterfront beach closings
- *E. coli* counts were highest during the summer months
- The lowest *E. coli* counts in the Duffins Creek and the upper reaches of the Humber River and Rouge River where urbanization is lowest

### General

- Most stations had average TSS values below the 30 mg/L objective but eight stations did exceed this value
- TSS concentrations were highest during the spring when spring melts carry road grit into the streams and stream flow is high causing increased erosion
- Stouffville Wastewater Treatment Plant was decommissioned in 2006; total phosphorus concentrations as well as other analytes are improving
- All indicator analytes had a positive relationships with road density, in other words, as road density increased so did the concentration of the analyte
- WQI values suggest that the five best sites were: 83018 (Humber), 83104 (Humber), 97018 (Rouge), 104008 (Duffins), 104027 (Duffins) while the five worst sites were: MM003WM (Mimico), 82003 (Mimico), HU1RWMP (Humber), 83012 (Humber), DM6.0 (Don)
- The Duffins Creek watershed along with the upper Humber River and Rouge River continue to exhibit the best water quality within the TRCA's jurisdiction; lower levels of urbanization, larger riparian buffers, and groundwater contributions may play a role in the water quality in these areas
- Total phosphorus and TSS concentrations have decreased over time while chloride concentrations have increased over time

The assessment of long-term water quality changes across a large region is a challenging task. Differences in the number of samples collected, the parameters analyzed, the analytical capabilities of laboratories completing the analysis, improvements in laboratory analysis techniques (e.g. lower detection levels) and varying stream flow complicate water quality analysis. Several of these factors confounded water quality analysis within the TRCA's jurisdiction. For example, the majority of the results for lead and cadmium, two metals commonly associated with urbanization, did not have low enough detection limits to compare against the PWQO.

Stream flow is an important variable in the analysis of water-quality trends because much of the variability in concentration is caused by variability in stream flow. Identifying and removing the stream flow-related variability in concentration increases the ability to detect trends in the presence of stream flow-related variability. Without flow data, we are unable to determine whether detected trends were the direct result of actual changes in water quality, or if they were an indirect result of differences in the distribution of high (or low) flow-volumes-at-sampling throughout the monitoring period. Currently only 14 of the 36 monitoring sites have associated stream flow monitoring.

Overall, the monitoring results presented in this report show that water quality is linked to the amount of urbanization upstream of a monitoring station. Non-point sources of contamination from urbanization continue to be the largest contaminant contributor to water within the TRCA's jurisdiction. Point sources of contamination such as wastewater treatment plants also contribute to the degradation of water quality in the Toronto area. Certain contaminants (e.g. TSS, total phosphorus) have decreased over the past twenty years while others (e.g. chloride) show an increasing trend. Continued routine efforts such as the treatment of urban runoff via stormwater ponds as well as innovative actions (e.g. biophosphorus removal at wastewater treatment) are required to maintain and improve the water quality in the Toronto region.

## 5. Recommendations

The following recommendations are offered for consideration:

- Where possible, further analysis of the data should be completed which takes stream flow into account
- The use of multivariate techniques (e.g. cluster analysis) should be investigated as these techniques may be able to help determine which water quality sites are behaving similarly and knowing which sites behave similarly may allow for targeted restoration work.
- Additional monitoring on the main tributary of the Rouge River would be beneficial and would allow for easier and more direct comparisons among watersheds.
- Additional water quality monitoring downstream of Pearson International Airport should be conducted to determine its load to the Etobicoke and Mimico watersheds
- Addition monitoring of the Humber River upstream and downstream of the new Nobleton Water Pollution Control Plant should be implemented.
- Additional monitoring of pesticides, fertilizers, hydrocarbons, organics (e.g. Polychlorinated biphenyls (PCBs)) and emerging contaminants of concern should be considered.

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## **APPENDICES**



## **APPENDIX A**



## Appendix A – Surface Water Quality Site Descriptions

Watershed	Station	Alternate Name	Northing	Easting	Subwatershed	Township	Municipality	Location Description	Flow Station	Proprietor	Road Density (km/km <sup>2</sup> )
Etobicoke Creek	Mayfield		483488	59028	Upper Etobicoke Creek	Mississauga	Peel	Southeast of Mayfield Road and Highway 10, Mississauga		RWMP	1.25
	80007	06008000702	4836994	606440	Upper Etobicoke Creek	Mississauga	Peel	Northwest of Dixie Rd. and Derry Rd.		PWQMN	3.81
	80006 <sup>M</sup>	06008000602	4829016	616234	Lower Etobicoke Creek	Toronto	Toronto	Southwest of the QEW and Brown's Line	02HC030	PWQMN	5.69
Mimico Creek	MM003WM		4837916	613849	Lower Mimico	Toronto	Toronto	Southwest of Dixon Rd. and Hwy 27, in Royal Woodbine Golf Club		RWMP	7.75
	82003 <sup>M</sup>	06008200302	4831713	621585	Lower Mimico	Toronto	Toronto	Southwest of Park Lawn Rd. and The Queensway, Etobicoke		PWQMN	8.94
Humber River	83104	06008310402	4864112	593560	Main Humber	Caledon	Peel	Northwest of Old Church Rd. and Hwy 50, in Albion Hills CA, at blue gauge station	02HC051	PWQMN	1.59
	83018	06008301802	4864329	595961	Main Humber	Caledon	Peel	Southwest of Old Church Rd. and Hwy 50, downstream Albion Hills CA	02HC012	PWQMN	1.29
	83009	06008300902	4860243	602980	Main Humber	King	York	Northeast of King Rd. and Caledon-King Townline	02HC023	PWQMN	1.42
	83020	06008302002	4851861	610386	Main Humber	Vaughan	York	Northeast of Rutherford Rd. and Hwy 27 at first bridge		RWMP	1.58
	83004	06008300402	4850423	614148	East Humber River	Vaughan	York	At bridge Pine Grove Rd, west of Pine Valley Dr, Woodbridge	02HC009	RWMP	2.39
	83103	06008310302	4845870	606385	West Humber River	Brampton	Peel	Northwest of Hwy 7 and McVean Dr, upstream (north) of Claireville	02HC031	PWQMN	2.49
	HU1RWMP	HU1RWMP	4848311	618678	Black Creek	Vaughan	York	Northwest of Steeles Ave. and Jane St.		RWMP	8.35
	HU010WM	HU010WM	4844744	615027	Lower Main Humber	Toronto	Toronto	Northwest of Finch Ave. and Islington Ave. in Rountree Mills Park		RWMP	2.35
	83002	06008300202	4843562	610459	West Humber River	Toronto	Toronto	Northeast of Hwy 427 and Finch Ave., downstream (east) of Claireville dam outlet	02HC034	RWMP	2.68
	83012	06008301202	4836845	620488	Black Creek	Toronto	Toronto	Northeast of Scarlett Rd. and St. Clair Ave.	02HC027	RWMP	9.66
Don River	83019 <sup>M</sup>	06008301902	4834265	621663	Lower Main Humber	Toronto	Toronto	Northwest of Old Mill Dr. and Old Mill Rd. in Etobicoke	02HC003	PWQMN	3.47
	85004	06008500402	4851207	622014	Upper West Don	Vaughan	York	Northwest of Hwy 7 and Centre St.		RWMP	7.45
	85003	06008500302	4851256	628954	Upper East Don	Markham	York	Northwest of Steeles Ave. and Bayview Ave.		RWMP	7.13
	DN008WM	DN008WM	4850889	630236	German Mills Creek	Toronto	Toronto	Northeast of Cummer Ave. and Bayview Ave.		RWMP	9.63
	DM 6.0	DM 6.0	4840251	634378	Taylor/Massey Creek	Toronto	Toronto	West of the DVP and east of Don Mills Rd.		RWMP	10.5
Highland Creek	85014 <sup>M</sup>	06008501402	4838576	632000	Lower Don	Toronto	Toronto	Pottery Rd, Toronto	02HC024	PWQMN	8.91
	94002	06009400202	4849056	647429	Main Highland Creek	Toronto	Toronto	South of Kingston Rd. and Colonel Danforth Trail	02HC013	RWMP	9.37

<sup>1</sup> Not available

<sup>M</sup> = watercourse outlet/mouth

## Appendix A – Site Descriptions

Watershed	Station	Alternate Name	Northing	Easting	Subwatershed	Township	Municipality	Location Description	Flow Station	Proprietor	Road Density (km/km <sup>2</sup> )
Rouge River	97999	97999	4863887	640589	Little Rouge Creek	Markham	York	Northwest of Major Mackenzie Rd. and 9th Line		RWMP	1.60
	97018	06009701802	4861770	634680	Bruce Creek	Markham	York	Northwest of Major Mackenzie Dr. and Kennedy Rd.		PWQMN	1.86
	97777	97777	4856823	634214	Middle Rouge/Beaver	Markham	York	Northwest of Hwy 407 and Warden Ave.		RWMP	6.04
	97003	RG008WM/06009700302	4857669	641985	Lower Rouge Creek	Markham	York	Southwest of 9th Line and 14th Ave.	02HC022	RWMP	5.35
	97007	RG007WM/06009700702	4857816	644300	Little Rouge Creek	Markham	York	Southwest of 14th Ave. and Reesor Rd.		RWMP	1.91
	97013	06009701302	4852830	648243	Little Rouge Creek	Toronto	Toronto	East of Twyn Rivers Dr.		RWMP	2.07
	97011	06009701102	4852511	648007	Lower Rouge Creek	Toronto	Toronto	Southeast of Twyn Rivers Dr. and Sheppard Ave.	02HC103	PWQMN	5.55
Duffins Creek	104008	06010400802/DuE17.5	4869299	650372	East Duffins Creek	Pickering	Durham	Northwest of Brock Rd and 8th Concession	02HC045	PWQMN	1.55
	104037	8th Concession/06010403702	4866462	644191	West Duffins Creek	Pickering	Durham	Southeast of York-Durham Line and 8th Concession		RWMP	2.37
	104029	7th Concession/06010402902	4868158	653641	East Duffins Creek	Pickering	Durham	Northeast of 7th Concession and Sideline 12		RWMP	1.44
	104027	Paulyn Park/06010402702	4859419	655458	East Duffins Creek	Ajax	Durham	North of Rossland Rd and West of Church St		RWMP	1.42
	104025	Brock Ridge/06010402502	4857115	654656	West Duffins Creek	Pickering	Durham	West of Brock Rd and North of Finch Ave		RWMP	1.63
	104001 <sup>M</sup>	06010400102/Annadale	4855880	657579	Lower Main Duffins	Ajax	Durham	Southwest of Bayly St. and Westney Rd.		PWQMN	2.07
Carruthers Creek	107002 <sup>M</sup>	Shoal Point/06010700202	4856972	660850	Carruthers Creek	Ajax	Durham	Northwest of Bayly St. and Shoal Point Rd.		RWMP	1.80
Petticoat Creek	PT001WM		4851804	652005	Petticoat Creek	Pickering	Durham	Petticoat Creek Conservation Area, Whites Road south of Highway 401		RWMP	3.74
Frenchman's Bay (Pine Creek)	FB003WM		4854372	653673	Pine Creek	Pickering	Durham	Liverpool Road, south of Bayly Street		RWMP	-1

<sup>1</sup>Not available

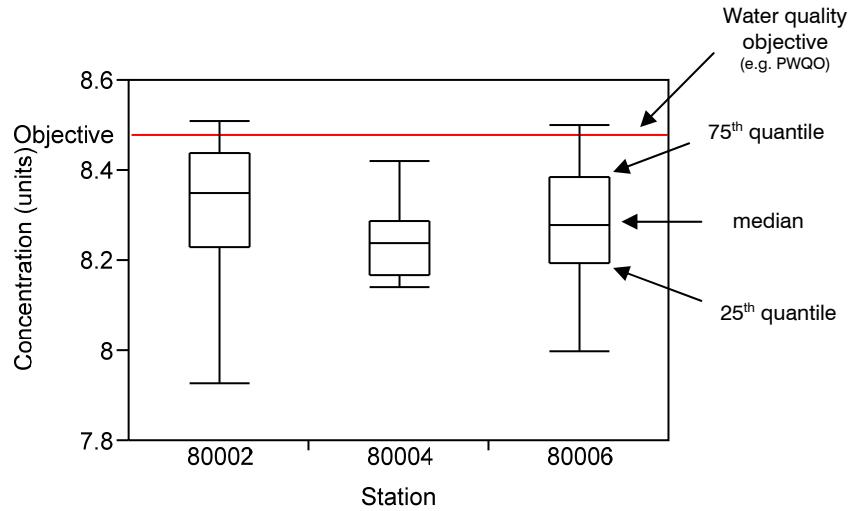
<sup>M</sup> = watercourse outlet/mouth

## **APPENDIX B**



### Box Plot Legend

The ends of the box are the 25th and 75th quartiles. The difference between the quartiles is the interquartile range. The line across the middle of the box identifies the median sample value. "Whiskers" extend from the ends of the box to the outermost data point which is not considered an outlier (upper quartile+1.5\*(interquartile range), lower quartile-1.5\*(interquartile range)). Sampling stations are arranged along the x-axis by watershed (west to east) from headwaters to outlet.



**Appendix B1. Current (2006-2010) Descriptive Statistics**

Station	AVERAGE																			
	Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite
Mayfield	220	387	67	50.2	85			116	868	3.0	513	292	524	19.3	84.3		8.2	5.7	1.97	0.017
80007	206	229	55	57.2	95			428	1857	4.7	1744	321	332	22.9	52.6		4.8	3.2	1.54	0.027
80006	185	583	45	70.3	110			826	2856	8.9	2039	362	862	26.8	93.4		7.5	4.4	0.92	0.054
MM003WM	176	626	201	79.9	108			1066	3847	7.4	2319	375	856	25.6	130.7		12.5	7.1	0.91	0.080
82003	183	613	102	79.8	109			974	3350	11.3	4240	354	717	24.3	116.8		8.1	4.9	0.85	0.071
83104	229	48	31	60.5	82			52	622	1.2	269	266	204	16.6	50.5		4.1	2.4	0.38	0.006
83018	222	46	27	73.3				54	619	1.1	132	258	201	16.5	44.8		3.7	2.3	0.55	0.007
83009	259	94	34	123.0	80			32	579	1.5	478	269	439	18.1	51.1		4.1	3.1	0.33	0.007
83020	219	760	53	94.3	78			78	709	2.7	979	265	1034	16.9	70.3		8.3	5.9	0.51	0.006
83004	238	481	50	76.9	96			137	941	2.6	772	308	671	16.9	61.1		8.7	6.2	0.45	0.007
83103	214	431	35	53.3	89			214	1147	3.7	1642	290	618	19.0	80.1		4.5	3.3	0.95	0.016
HU1RWMP	171	441	121	87.1	119			1297	4062	6.8	1891	387	745	21.7	174.6		10.3	7.4	1.20	0.127
HU010WM	216	499	57	82.4	84			153	987	2.9	689	280	690	17.3	58.5		8.6	6.0	0.52	0.010
83002	195	923	95	61.9	81			186	1053	4.1	978	275	1045	17.4	134.4		8.6	6.5	0.97	0.022
83012	218	438	375	101.6	120			726	3001	8.7	7353	387	790	21.2	118.3		11.2	8.0	1.92	0.084
83019	196	297	54	73.2	76	44.2	4.7	210	1041	4.5	2995	255	572	16.8	67.1	0.022	1.4	1.7	0.69	0.017
85004	178	506	82	77.2	105			622	2464	4.9	1844	328	744	16.1	87.3		9.5	6.6	1.03	0.052
85003	220	564	102	102.3	105			355	1516	4.2	4208	333	815	17.2	78.4		9.2	6.4	1.22	0.040
DN008WM	224	479	144	90.9	110			463	1961	5.5	2518	351	920	18.5	72.2		10.0	6.7	0.90	0.043
DM 6.0	227	552	262	85.7	130			657	2587	8.3	5707	406	827	19.5	88.1		10.9	7.5	2.49	0.121
85014	199	329	1520	80.4	87	46.0	4.3	321	1411	8.6	29794	277	574	15.3	86.8	0.024	2.1	2.3	1.45	0.117
94002	208	251	96	93.8	117			620	2091	4.9	2652	375	433	20.2	57.2		9.8	6.8	1.24	0.043
97999	228	280	55	68.4	93			99	794	1.8	306	291	387	14.2	37.2		8.1	6.0	1.27	0.009
97018	253	178	39	88.9	101			64	726	1.5	382	310	259	15.0	42.2		5.2	3.6	1.20	0.010
97777	203	538	80	80.5	106			448	1817	3.6	1429	330	687	16.0	71.6		9.3	6.3	0.83	0.029
97003	199	440	75	78.6	95			301	1431	3.5	1790	300	586	15.0	74.3		9.0	6.2	0.98	0.051
97007	217	215	54	61.1	90			99	788	1.7	962	283	272	13.8	24.0		8.4	5.7	1.08	0.008
97013	212	264	50	57.5	89			103	790	2.0	138	279	309	14.0	20.3		7.8	6.1	0.96	0.007
97011	194	301	57	73.6				360	1491	3.4	628	296	432	15.7	46.1		4.4	3.1	0.82	0.019
104008	251	206	21	65.4	92			43	621	1.4	255	281	400		46.9		4.8	2.9	0.25	0.004
104037	225	246	55	56.9	93			105	838	1.8	439	295	359	14.3	40.2		8.3	6.0	1.71	0.031
104029	242	196	48	68.5	87			32	580	1.9	133	273	318	13.3	39.0		8.2	6.2	0.26	0.003
104027	229	262	65	68.9	82			30	553	1.4	224	259	404	13.5	34.5		7.9	5.7	0.38	0.004
104025	226	471	73	61.9	89			52	637	2.0	130	276	596	13.4	41.2		8.4	6.4	0.94	0.007
104001	225	254	38	64.6				71	681	2.3	587	272	385		41.5		4.7	3.1	0.62	0.007
107002	221	490	85	51.8	101			117	876	2.2	513	303	597	12.2	81.6		8.6	6.6	0.88	0.027

**Appendix B1. Current (2006-2010) Descriptive Statistics**

AVERAGE																
Station	TKN	pH	Phosphate	Phosphorous	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc	
Mayfield	0.86	8.18	0.026	0.07	4.08	0.47	66.3	514	10	398.6	40.7	8.2	6.4	1.26	8.77	
80007	0.74	8.32	0.017	0.06	5.93				13	564.0		3.7		1.36	11.43	
80006	0.76	8.27	0.011	0.08					35	706.6		10.2		2.95	33.38	
MM003WM	1.06	8.14	0.015	0.08	8.94	0.52	641.8	2145	21	928.3	71.7	13.6	7.6	1.96	42.12	
82003	0.91	8.25	0.018	0.10					42	700.0		10.8		3.45	45.73	
83104	0.48	8.32	0.008	0.03					8	212.0		1.2		0.94	4.34	
83018	0.43	8.38	0.005	0.02					7	233.2		1.2		0.97	3.31	
83009	0.41	8.35	0.010	0.04					14	279.3		2.2		0.97	5.23	
83020	0.53	8.35	0.010	0.05	1.92	0.50	44.4	418	38	291.5	26.2	19.3	11.0	1.82	16.37	
83004	0.56	8.31	0.010	0.05	2.87	0.52	77.3	548	21	330.7	36.7	11.9	8.0	1.37	12.32	
83103	0.76	8.30	0.014	0.07	5.85				33	413.8		8.2		1.72	8.97	
HU1RWMP	0.84	8.10	0.023	0.09	7.58	0.53	633.4	2382	20	611.3	78.0	11.5	10.1	1.60	34.48	
HU010WM	0.56	8.34	0.010	0.05	2.72	0.44	90.0	558	23	353.4	36.8	13.2	7.3	1.40	16.97	
83002	0.90	8.28	0.019	0.09	4.54	0.49	109.9	652	28	412.8	45.0	22.7	15.4	2.37	24.42	
83012	1.11	8.19	0.017	0.08	6.22	0.51	430.6	1708	19	550.2	66.6	12.9	8.9	1.73	39.61	
83019	0.68	8.36	0.010	0.08					48	321.5		4.0		1.86	12.48	
85004	0.76	8.11	0.016	0.09	4.40	0.52	373.5	1403	27	458.4	56.5	13.4	11.3	1.80	24.71	
85003	0.69	8.17	0.019	0.08	5.50	0.55	203.3	858	34	443.6	52.5	17.7	12.0	1.79	19.18	
DN008WM	0.73	8.16	0.015	0.07	3.36	0.66	278.4	1117	27	423.9	56.6	14.7	11.4	1.78	24.89	
DM 6.0	0.85	8.21	0.022	0.09	4.17	0.57	392.5	1458	28	457.7	58.9	17.7	8.8	2.04	30.85	
85014	2.57	8.14	0.089	0.21					61	349.6		5.6		2.48	20.92	
94002	0.59	8.27	0.011	0.05	3.29	0.86	306.6	1203	14	433.3	65.1	8.0	4.8	1.29	17.97	
97999	0.56	8.27	0.012	0.04	2.38	0.51	52.0	464	10	278.6	34.5	8.8	3.6	1.13	9.83	
97018	1.04	8.31	0.009	0.06					21	257.1		3.0		1.34	5.47	
97777	0.71	8.16	0.011	0.07	3.38	0.47	264.6	1019	27	377.9	61.0	16.6	7.3	1.68	20.98	
97003	0.78	8.29	0.012	0.08	3.33	0.53	177.1	787	26	359.0	50.9	13.3	8.2	1.60	19.26	
97007	0.53	8.37	0.009	0.05	2.50	0.50	53.8	455	9	284.7	35.9	6.5	4.6	1.07	10.21	
97013	0.50	8.42	0.009	0.04	2.47	0.48	58.7	477	16	290.0	34.4	10.4	5.1	1.10	8.18	
97011	0.87	8.36	0.007	0.05					28	344.1		9.7		1.88	8.81	
104008	0.42	8.36	0.008	0.04					15	207.1		5.0		1.20	6.37	
104037	0.61	8.31	0.011	0.05	2.25	0.54	59.6	502	11	259.2	43.5	7.4	3.1	1.06	10.65	
104029	0.41	8.42	0.009	0.04	1.54	0.50	19.3	351	29	239.9	23.2	5.1	3.3	0.87	10.16	
104027	0.37	8.40	0.009	0.04	1.44	0.50	18.3	343	19	237.8	23.0	8.1	4.6	1.02	10.57	
104025	0.46	8.39	0.011	0.05	1.74	0.50	28.7	384	43	252.4	29.0	16.3	5.8	1.40	10.30	
104001	0.44	8.37	0.006	0.07					28	244.7		7.5		1.46	6.27	
107002	0.63	8.25	0.010	0.05	2.67	0.52	64.7	522	17	342.2	46.0	18.2	7.2	1.50	11.21	

**Appendix B1. Current (2006-2010) Descriptive Statistics**

Station	MEDIAN																			
	Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite
Mayfield	224	206	47	47.7	86			95	788	2.7	110	287	360	19.2	62.6		5.5	6.0	1.60	0.010
80007	208	110	22	53.2	96			240	1225	3.9	300	326	176	22.2	45.6		1.1	1.5	1.28	0.010
80006	187	121	17	61.9	93			447	1865	5.7	910	327	242	25.8	46.7		4.1	2.0	0.78	0.020
MM003WM	183	165	168	73.5	97			548	2300	5.0	565	333	360	24.5	82.8		10.1	8.0	0.61	0.040
82003	181	86	51	69.0	95			611	2170	6.6	1950	318	184	22.9	45.4		4.4	2.6	0.79	0.030
83104	228	28	16	59.8	84			51	615	0.9	130	268	173	16.8	43.6		0.8	0.8	0.33	0.006
83018	220	24	17	73.0				52	596	1.0	90	255	182	17.0	40.7		0.8	0.8	0.48	0.006
83009	263	46	16	126.5	80			27	556	1.1	240	273	367	18.8	45.3		0.8	0.8	0.25	0.008
83020	220	268	18	87.1	79			55	642	2.0	65	263	462	17.2	42.0		6.0	6.0	0.46	0.005
83004	240	134	12	72.2	94			106	838	2.0	105	306	282	16.3	43.8		6.0	7.0	0.35	0.005
83103	218	362	15	50.0	92			137	907	3.5	155	289	457	18.6	62.4		0.9	1.7	0.68	0.010
HU1RWMP	172	162	69	74.8	110			692	2570	5.0	400	368	470	20.3	124.0		8.0	8.0	0.27	0.020
HU010WM	222	273	23	78.8	84			107	804	2.1	155	280	448	17.3	48.4		6.4	6.1	0.46	0.006
83002	185	490	89	55.8	80			154	949	3.8	305	273	666	17.0	118.0		6.0	7.0	0.59	0.010
83012	230	87	291	95.0	118			459	2105	7.0	3900	381	455	21.6	88.3		8.8	9.0	1.65	0.060
83019	203	117	34	73.4	75	46.0	4.4	164	917	3.0	750	261	258	17.7	39.6	0.020	1.0	1.3	0.51	0.010
85004	187	195	38	74.5	104			362	1725	3.7	500	326	433	16.5	72.0		8.0	7.0	0.72	0.020
85003	237	161	91	102.0	106			188	1095	3.0	1800	340	355	18.1	66.2		7.0	7.0	0.91	0.020
DN008WM	243	93	130	88.4	113			224	1330	3.9	700	363	539	19.7	59.6		9.2	7.9	0.76	0.020
DM 6.0	241	96	150	86.0	130			427	1935	6.0	3000	396	347	19.2	67.5		8.0	8.0	2.27	0.050
85014	210	116	976	82.8	86	49.2	4.1	218	1155	6.6	12000	285	360	16.2	65.7	0.020	1.8	1.8	1.34	0.080
94002	214	69	59	98.2	124			326	1600	4.0	1400	405	237	22.6	46.0		8.2	7.6	1.20	0.025
97999	227	104	26	64.2	97			84	767	1.6	155	294	196	14.5	30.6		7.0	7.0	1.04	0.007
97018	254	32	21	87.0	103			64	730	1.2	110	316	184	15.6	25.9		1.1	1.0	1.06	0.007
97777	205	293	61	73.5	104			242	1265	3.0	475	324	394	16.1	66.0		5.1	7.0	0.57	0.010
97003	201	173	52	72.0	95			200	1090	3.0	330	307	332	15.3	70.0		6.0	7.0	0.72	0.010
97007	214	78	19	56.3	96			83	762	1.5	80	298	133	13.8	17.0		4.4	6.0	0.91	0.007
97013	213	119	16	55.5	91			86	764	1.8	32	284	153	13.8	13.0		6.0	7.0	0.78	0.005
97011	197	118	17	69.6				181	984	2.5	240	288	228	15.8	30.8		1.1	1.4	0.67	0.010
104008	252	59	8	64.3	93			40	615	1.1	90	281	208		29.7		0.8	0.8	0.15	0.003
104037	224	121	14	53.6	95			69	718	1.5	170	295	200	14.4	31.5		6.7	7.0	1.13	0.008
104029	242	67	12	63.2	88			29	587	1.0	40	274	169	13.8	17.0		6.9	6.9	0.18	0.002
104027	229	110	11	67.0	81			29	560	1.2	60	259	244	13.8	24.6		6.8	6.6	0.30	0.003
104025	224	126	31	59.0	88			43	618	1.6	86	275	202	13.5	21.2		7.3	7.4	0.83	0.005
104001	224	89	16	62.7				53	626	1.7	130	265	229		32.5		1.0	1.0	0.52	0.007
107002	226	313	56	47.6	103			102	808	2.0	160	305	419	12.1	74.7		6.6	7.7	0.76	0.010

**Appendix B1. Current (2006-2010) Descriptive Statistics**

MEDIAN																
Station	TKN	pH	Phosphate	Phosphorous	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc	
Mayfield	0.80	8.20	0.010	0.05	3.64	0.20	53.3	492	7	372.5	37.2	4.1	3.6	1.00	7.00	
80007	0.71	8.31	0.010	0.04	5.93				5	538.0		2.4		1.00	5.01	
80006	0.65	8.26	0.007	0.03					8	688.0		2.0		1.70	12.00	
MM003WM	0.82	8.18	0.010	0.06	6.28	0.20	337.0	1365	7	795.0	67.6	4.8	4.6	1.15	23.30	
82003	0.68	8.28	0.010	0.05					6	623.0		2.1		1.70	18.95	
83104	0.46	8.33	0.010	0.03					5	210.0		0.9		0.68	0.90	
83018	0.40	8.37	0.004	0.02					5	229.0		0.8		0.67	0.68	
83009	0.34	8.36	0.010	0.03					8	277.0		1.5		0.53	1.30	
83020	0.49	8.36	0.010	0.03	1.83	0.10	31.2	384	17	275.0	24.9	6.0	5.0	1.00	7.50	
83004	0.51	8.32	0.010	0.03	2.65	0.13	58.3	501	7	314.5	34.2	3.2	3.9	1.00	7.00	
83103	0.71	8.31	0.010	0.05	5.85				18	389.0		5.8		1.25	4.86	
HU1RWMP	0.74	8.12	0.010	0.07	3.95	0.20	350.0	1575	7	534.0	64.8	4.2	4.7	1.00	21.70	
HU010WM	0.55	8.36	0.010	0.04	2.30	0.10	61.4	476	14	335.0	31.8	6.5	4.6	1.00	8.00	
83002	0.86	8.27	0.010	0.08	4.38	0.20	91.8	554	20	388.5	44.2	13.0	9.8	1.90	10.30	
83012	1.01	8.22	0.010	0.05	5.29	0.18	264.5	1265	7	512.0	64.9	2.5	4.5	1.00	28.30	
83019	0.56	8.37	0.005	0.03					10	332.0		2.8		1.16	4.86	
85004	0.62	8.15	0.010	0.05	3.24	0.10	209.5	1020	8	425.0	54.7	6.0	4.6	1.10	16.00	
85003	0.59	8.22	0.010	0.06	2.68	0.11	101.5	662	10	426.0	46.7	5.5	4.5	1.10	13.00	
DN008WM	0.60	8.20	0.010	0.04	2.69	0.11	123.5	793	6	415.0	53.6	2.9	4.9	1.00	12.00	
DM 6.0	0.76	8.25	0.020	0.06	3.70	0.26	238.0	1105	6	435.0	58.0	3.0	3.5	1.00	17.50	
85014	2.35	8.14	0.070	0.19					11	357.0		3.8		1.74	12.10	
94002	0.48	8.28	0.010	0.03	2.64	0.11	170.0	955	5	432.0	70.2	1.7	3.0	1.00	11.00	
97999	0.55	8.29	0.010	0.03	2.31	0.10	45.1	454	7	259.0	32.7	3.7	2.5	0.90	7.00	
97018	0.45	8.30	0.007	0.02					5	254.0		1.4		0.70	1.43	
97777	0.60	8.19	0.010	0.05	2.83	0.10	130.0	762	10	356.0	57.1	8.0	4.0	1.20	13.00	
97003	0.77	8.30	0.010	0.06	2.82	0.10	110.5	641	14	343.0	52.7	6.6	5.5	1.10	13.00	
97007	0.49	8.39	0.010	0.02	2.36	0.10	46.1	453	4	267.0	33.1	3.0	2.5	0.90	5.00	
97013	0.45	8.42	0.010	0.02	2.45	0.10	49.6	445	8	267.0	34.2	4.6	3.0	0.80	7.00	
97011	0.52	8.38	0.006	0.03					12	335.0		4.9		1.51	3.45	
104008	0.34	8.36	0.007	0.02					4	205.0		2.0		0.87	1.36	
104037	0.59	8.32	0.010	0.03	2.10	0.11	35.7	435	6	243.0	33.5	3.1	2.2	0.90	6.40	
104029	0.33	8.42	0.010	0.02	1.50	0.10	19.6	351	5	224.0	22.2	2.0	1.8	0.50	6.50	
104027	0.32	8.41	0.010	0.03	1.36	0.10	17.9	336	8	225.0	22.6	3.1	2.9	0.75	7.00	
104025	0.42	8.40	0.010	0.02	1.70	0.10	24.0	382	10	232.0	28.1	4.7	3.1	1.00	6.00	
104001	0.40	8.37	0.004	0.02					9	235.0		3.9		1.13	3.04	
107002	0.63	8.26	0.010	0.04	2.47	0.16	51.7	485	11	327.0	44.0	11.7	5.0	1.05	7.50	

**Appendix B1. Current (2006-2010) Descriptive Statistics**

Station	MINIMUM																			
	Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite
Mayfield	101	34	8	31.7	49			28	402	1.1	4	160	146	8.1	28.9		0.3	0.1	0.00	0.001
80007	106	8	2	25.2	46			25	524	1.2	5	146	57	7.9	6.4		0.1	0.0	0.01	0.001
80006	75	3	2	32.8	43			88	460	1.5	40	160	20	9.2	6.9		0.5	0.2	0.07	0.001
MM003WM	82	27	8	29.2	27			73	645	2.0	10	92	191	5.8	30.7		0.5	0.6	0.00	0.001
82003	66	2	2	33.8	39			105	518	1.2	67	128	10	7.6	8.6		0.5	0.3	0.06	0.006
83104	186	1	2	48.0	63			39	507	0.0	6	106	13	12.8	0.8		0.2	0.0	0.04	0.001
83018	189	2	2	59.0				43	514	0.1	9	174	46	9.7	23.1		0.1	0.1	0.26	0.002
83009	224	2	2	76.0	63			10	475	0.1	30	232	67	14.1	0.1		0.1	0.0	0.09	0.002
83020	90	27	5	67.0	57			38	483	0.7	5	184	143	7.4	20.3		0.1	0.1	0.06	0.001
83004	153	19	8	51.8	66			1	588	0.9	10	209	106	10.4	16.0		0.1	0.1	0.00	0.001
83103	127	31	2	41.0	47			49	544	0.0	10	163	100	11.2	24.2		0.1	0.0	0.01	0.003
HU1RWMP	69	19	8	26.7	26			63	366	1.7	29	77	227	2.9	20.6		0.4	0.4	0.00	0.001
HU010WM	81	27	5	54.0	18			65	568	0.8	10	53	140	1.9	15.8		0.3	0.1	0.04	0.002
83002	102	36	8	35.4	49			58	524	1.6	8	160	139	9.2	41.2		0.3	0.5	0.01	0.003
83012	90	16	8	38.5	33			84	493	1.5	120	101	229	4.5	10.0		0.4	1.0	0.04	0.001
83019	88	14	2	47.3	12	14.8	2.2	46	345	1.1	90	39	81	2.1	11.4	0.020	0.1	0.2	0.11	0.005
85004	72	21	8	35.0	29			60	377	1.4	20	84	188	3.0	12.2		0.1	0.1	0.00	0.001
85003	45	28	8	56.2	37			37	332	1.2	110	109	216	4.0	20.3		0.1	0.1	0.43	0.004
DN008WM	74	12	8	44.8	31			42	312	1.2	90	89	337	3.0	20.9		0.1	0.1	0.34	0.001
DM 6.0	61	7	8	28.9	24			38	270	1.5	540	69	137	2.2	14.0		0.3	0.2	0.43	0.001
85014	71	13	2	47.5	12	15.8	2.2	24	236	2.4	10	38	160	1.9	28.3	0.020	0.1	0.3	0.01	0.001
94002	91	7	8	33.0	41			46	421	1.7	63	122	91	5.0	10.8		0.4	0.1	0.47	0.007
97999	143	6	8	48.8	42			27	521	0.4	10	141	98	8.5	14.0		0.3	0.1	0.02	0.001
97018	172	2	2	59.7	79			35	528	0.3	6	215	15	9.6	1.1		0.0	0.0	0.45	0.002
97777	125	24	8	40.3	53			58	534	1.0	40	161	196	6.9	21.3		0.3	0.1	0.08	0.001
97003	121	22	8	46.2	47			50	454	1.0	10	143	161	6.5	16.0		0.3	0.1	0.16	0.001
97007	144	18	8	43.0	56			41	511	0.4	2	189	76	8.7	7.0		0.4	0.1	0.00	0.001
97013	136	18	8	44.4	53			0	537	0.7	2	191	56	8.4	5.6		0.2	0.1	0.00	0.001
97011	109	23	2	47.5				19	589	0.6	9	186	38	6.9	5.0		0.0	0.1	0.01	0.001
104008	129	2	2	42.3	52			13	422	0.1	4	168	24		12.5		0.0	0.0	0.01	0.001
104037	118	14	8	43.0	0			32	414	0.4	10	165	99	9.3	11.9		0.2	0.1	0.54	0.002
104029	167	12	8	45.6	65			0	428	0.4	3	208	94	8.9	7.9		0.1	0.1	0.00	0.001
104027	184	18	8	55.2	64			12	451	0.4	9	215	108	9.7	9.0		0.2	0.1	0.08	0.001
104025	168	13	8	49.4	58			21	466	0.5	6	202	75	8.4	7.6		0.2	0.1	0.19	0.001
104001	183	2	2	51.7				24	446	0.0	10	200	29		14.6		0.1	0.0	0.08	0.002
107002	131	63	8	37.0	68			30	531	1.0	6	206	137	7.4	16.0		0.3	0.1	0.00	0.001

**Appendix B1. Current (2006-2010) Descriptive Statistics**

MINIMUM															
Station	TKN	pH	Phosphate	Phosphorous	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	0.08	7.13	0.005	0.02	2.23	0.08	20.8	278	2	173.0	14.7	0.2	0.7	0.10	0.60
80007	0.08	7.93	0.001	0.01	5.93				1	225.0		0.1		0.01	0.55
80006	0.08	7.85	0.001	0.01					2	205.0		0.0		0.08	0.28
MM003WM	0.27	7.68	0.004	0.01	0.10	0.08	40.7	162	2	286.0	16.4	0.2	0.9	0.10	5.00
82003	0.08	7.77	0.002	0.01					1	228.0		0.1		0.14	0.60
83104	0.08	7.98	0.001	0.01					1	172.0		0.1		0.02	0.11
83018	0.08	8.14	0.001	0.01					2	192.0		0.2		0.10	0.08
83009	0.08	8.14	0.002	0.01					2	200.0		0.0		0.07	0.01
83020	0.05	8.11	0.002	0.00	0.10	0.08	21.2	282	2	215.0	18.1	0.2	0.8	0.10	0.10
83004	0.08	7.57	0.002	0.01	1.00	0.08	3.8	336	2	240.0	24.4	0.2	0.6	0.10	0.10
83103	0.08	8.01	0.002	0.01	5.85				2	226.0		0.2		0.10	0.02
HU1RWMP	0.08	7.84	0.007	0.01	0.10	0.08	40.1	209	2	118.0	11.2	0.2	1.0	0.10	4.10
HU010WM	0.08	7.05	0.002	0.01	1.10	0.08	39.2	136	2	255.0	7.4	0.2	0.7	0.10	0.30
83002	0.08	8.05	0.003	0.02	2.69	0.08	38.1	296	2	235.0	20.8	0.2	1.7	0.10	1.00
83012	0.08	7.90	0.002	0.01	0.10	0.08	51.4	272	2	153.0	14.4	0.2	0.7	0.10	5.00
83019	0.03	7.88	0.000	0.00					3	169.0		0.2		0.15	0.35
85004	0.08	6.73	0.002	0.01	0.10	0.08	36.8	220	1	158.0	11.0	0.2	0.9	0.10	2.10
85003	0.08	6.29	0.004	0.01	0.10	0.08	24.2	205	2	180.0	13.2	0.2	1.0	0.10	2.40
DN008WM	0.08	7.34	0.004	0.01	0.10	0.08	27.8	187	1	148.0	10.9	0.2	1.2	0.10	2.20
DM 6.0	0.08	7.80	0.006	0.02	0.10	0.08	24.5	166	1	113.0	8.6	0.2	0.8	0.10	4.30
85014	0.30	7.70	0.001	0.04					2	175.0		0.2		0.25	4.13
94002	0.08	7.91	0.002	0.01	0.10	0.08	32.4	258	1	146.0	16.1	0.2	0.7	0.10	1.90
97999	0.08	8.00	0.002	0.01	1.30	0.08	14.3	296	2	205.0	15.4	0.2	0.6	0.10	0.40
97018	0.08	8.09	0.001	0.01					1	199.0		0.0		0.10	0.13
97777	0.08	7.15	0.002	0.02	0.10	0.08	36.3	60	2	218.0	24.5	0.2	0.9	0.10	1.60
97003	0.08	7.99	0.002	0.01	1.50	0.08	31.1	132	2	195.0	22.7	0.2	0.6	0.10	1.40
97007	0.08	8.00	0.002	0.01	0.20	0.08	23.9	245	1	212.0	25.3	0.2	0.5	0.10	0.40
97013	0.08	8.17	0.002	0.01	0.10	0.08	28.6	307	2	212.0	1.2	0.2	0.6	0.10	0.10
97011	0.08	8.03	0.001	0.01					3	190.0		0.3		0.10	0.13
104008	0.08	8.12	0.001	0.01					1	152.0		0.1		0.01	0.19
104037	0.08	8.04	0.002	0.01	0.70	0.08	18.7	292	1	147.0	14.5	0.2	0.7	0.10	0.20
104029	0.08	8.22	0.002	0.01	0.80	0.08	7.7	244	2	180.0	10.2	0.2	0.6	0.10	0.10
104027	0.02	8.08	0.002	0.01	0.20	0.08	10.4	268	2	195.0	11.0	0.2	1.0	0.10	0.10
104025	0.08	8.08	0.002	0.01	0.10	0.08	13.8	261	2	199.0	12.3	0.2	1.0	0.10	0.10
104001	0.02	8.21	0.001	0.01					2	197.0		0.2		0.18	0.03
107002	0.08	7.97	0.002	0.01	1.50	0.08	19.0	328	2	197.0	18.4	0.2	1.3	0.10	1.30

**Appendix B1. Current (2006-2010) Descriptive Statistics**

Station	MAXIMUM																			
	Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite
Mayfield	291	4570	200	97.4	137			494	2140	8.3	6700	460	4190	31.5	288.0		27.0	13.2	6.49	0.140
80007	318	1140	480	102.0	154			2790	9130	12.6	20000	545	1780	38.9	239.0		28.0	13.7	7.22	0.330
80006	285	6240	260	201.0	355			8350	20400	67.0	13000	1070	6960	52.3	546.0		31.0	17.2	3.90	0.830
MM003WM	314	6370	1100	197.0	286			6380	17100	38.4	20000	803	7530	54.6	406.0		32.0	19.7	7.86	0.860
82003	361	10100	750	230.0	225			6910	19300	61.3	20000	776	6320	52.1	743.0		38.0	21.2	1.99	0.890
83104	250	304	279	88.0	94			73	713	9.0	3100	306	1280	19.4	338.0		24.0	12.1	0.77	0.010
83018	245	309	200	92.5				144	1330	4.0	1800	311	834	19.0	161.0		24.0	12.1	1.03	0.020
83009	280	477	325	164.0	93			150	909	13.1	4400	305	1820	20.5	194.0		33.0	42.0	1.72	0.020
83020	272	8230	200	187.0	108			1080	4060	13.0	20000	335	9180	22.6	376.0		25.0	16.0	1.10	0.040
83004	297	7560	200	179.0	135			497	2120	12.4	20000	427	8730	23.1	364.0		27.0	17.5	2.09	0.060
83103	287	1840	200	108.0	120			1210	4830	9.2	20000	401	2500	24.8	259.0		26.0	13.0	3.54	0.090
HU1RWMP	258	4150	730	252.0	239			15100	25400	36.6	20000	789	5470	47.0	663.0		33.0	18.4	35.50	3.100
HU010WM	272	5450	290	177.0	112			738	3060	10.7	7000	364	6790	23.3	290.0		27.0	14.2	1.29	0.100
83002	308	4510	256	135.0	125			598	2530	10.0	13000	417	5030	27.5	406.0		30.0	14.0	4.06	0.200
83012	309	4570	1470	204.0	194			3270	15600	29.3	32000	628	4540	36.6	355.0		31.0	15.6	14.20	0.670
83019	261	3980	334	115.0	117	64.2	10.9	1360	4610	29.9	70000	377	7070	22.1	480.0	0.080	12.0	8.8	2.66	0.060
85004	288	3300	310	176.0	175			4830	16600	17.5	20000	559	3940	29.5	261.0		31.0	18.2	15.30	1.650
85003	289	4650	420	178.0	158			2850	9120	13.9	20000	485	4830	24.4	309.0		30.0	15.8	16.20	0.650
DN008WM	315	4870	630	165.0	169			3060	9810	30.0	20000	529	7090	27.4	358.0		32.0	18.0	6.93	0.430
DM 6.0	319	5110	2150	163.0	580			3720	13100	44.2	26000	1837	6370	94.3	414.0		36.0	18.4	10.80	2.580
85014	280	6420	5810	155.0	140	66.5	11.3	2440	7240	52.6	140000	425	3480	21.2	518.0	0.180	13.9	20.3	2.76	0.450
94002	281	2800	320	157.0	189			8400	8140	16.1	20000	602	3250	31.6	174.0		25.0	16.1	3.45	0.390
97999	294	2130	200	161.0	123			487	2040	6.0	2500	374	2310	17.9	120.0		22.0	15.2	8.31	0.040
97018	300	5510	200	259.0	129			104	866	9.2	5400	393	1710	18.0	872.0		24.0	25.0	3.82	0.070
97777	277	3650	260	181.0	150			2690	5480	12.9	20000	469	3680	23.4	180.0		33.0	14.3	7.66	0.280
97003	298	2510	200	185.0	154			1290	4450	14.0	20000	483	2460	23.8	246.0		32.0	14.2	5.68	1.610
97007	287	2680	200	161.0	124			260	1290	5.0	20000	374	2800	18.4	107.0		26.0	13.1	3.49	0.050
97013	292	2080	200	83.0	151			267	1290	4.8	2700	491	2170	27.7	136.0		23.3	16.6	3.76	0.050
97011	284	2480	490	176.0				5050	15500	15.5	3400	526	4380	23.3	382.0		27.0	13.6	2.35	0.200
104008	296	2440	200	121.0	111			104	746	4.6	3900	337	3880		559.0		24.0	14.8	1.17	0.040
104037	288	2460	230	91.0	122			567	2960	6.0	5700	375	3150	17.9	199.0		25.0	14.9	28.30	0.660
104029	295	2620	200	348.0	105			95	703	32.0	3600	325	3960	15.3	695.0		22.9	33.0	1.15	0.010
104027	276	1870	1050	91.0	107			78	703	5.0	6000	328	2300	16.3	181.0		23.5	15.8	1.18	0.020
104025	279	5050	658	120.0	118			130	905	12.2	520	362	8280	16.5	687.0		23.0	18.6	2.22	0.040
104001	266	1920	200	88.3				480	1910	26.5	9600	512	2220		297.0		23.0	14.1	1.96	0.020
107002	304	2900	550	112.0	136			489	2200	6.0	4900	403	2940	18.9	483.0		26.0	16.6	3.01	0.920

**Appendix B1. Current (2006-2010) Descriptive Statistics**

MAXIMUM																
Station	TKN	pH	Phosphate	Phosphorous	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc	
Mayfield	3.63	8.42	0.210	0.43	8.60	4.00	263.0	1230	48	1190.0	189.0	73.7	48.0	8.00	45.80	
80007	1.93	8.56	0.190	0.62	5.93				127	1210.0		19.2		11.40	69.00	
80006	2.88	8.53	0.090	0.55					349	1380.0		162.0		15.00	379.00	
MM003WM	7.49	8.54	0.050	0.40	52.40	4.00	3910.0	10200	256	2490.0	188.0	120.0	68.0	13.30	248.00	
82003	3.90	8.56	0.070	0.60					436	1660.0		139.0		29.30	351.00	
83104	1.40	8.66	0.020	0.18					93	322.0		6.4		8.45	53.40	
83018	1.28	8.63	0.020	0.11					67	349.0		9.0		9.18	23.00	
83009	1.03	8.50	0.030	0.17					88	421.0		9.0		9.33	59.00	
83020	1.48	8.50	0.030	0.37	3.98	4.00	643.0	2210	299	744.0	43.6	158.0	130.0	15.00	110.00	
83004	2.19	8.46	0.030	0.39	7.28	4.00	287.0	1150	246	825.0	132.0	189.0	70.0	15.20	121.00	
83103	3.75	8.59	0.110	0.38	5.85				163	709.0		56.0		10.70	42.60	
HU1RWMP	5.78	8.33	0.310	0.36	71.40	4.00	4620.0	14800	202	1480.0	544.0	110.0	78.0	11.20	153.00	
HU010WM	1.27	8.57	0.030	0.33	7.33	4.00	438.0	1660	222	879.0	180.0	114.0	36.0	11.70	135.00	
83002	1.69	8.71	0.130	0.29	9.38	4.00	385.0	2920	105	1040.0	84.6	151.0	79.0	8.00	425.00	
83012	3.29	8.44	0.070	0.31	25.60	4.00	2110.0	8610	133	1170.0	111.0	122.0	60.0	8.30	150.00	
83019	2.45	8.56	0.110	0.68					604	520.0		20.3		9.89	142.00	
85004	4.54	8.31	0.170	1.51	35.60	4.00	3150.0	9340	457	952.0	190.0	103.0	179.0	7.20	112.00	
85003	2.33	8.36	0.160	0.74	88.10	4.00	1850.0	4940	583	947.0	285.0	116.0	165.0	8.40	115.00	
DN008WM	1.98	8.37	0.130	0.66	21.30	9.30	2040.0	5460	509	896.0	165.0	161.0	113.0	13.00	123.00	
DM 6.0	1.89	8.42	0.070	0.57	14.50	4.00	2390.0	7110	265	1070.0	275.0	202.0	63.0	13.10	170.00	
85014	6.60	8.40	0.340	0.91					794	619.0		47.3		17.40	156.00	
94002	1.63	8.46	0.030	0.30	22.10	17.00	2050.0	4650	238	1250.0	108.0	109.0	47.9	7.60	91.20	
97999	1.20	8.48	0.030	0.15	3.82	4.00	282.0	1120	40	780.0	115.0	62.0	30.0	4.00	57.00	
97018	25.00	8.55	0.100	1.46					803	343.0		29.7		18.10	74.00	
97777	5.60	8.35	0.030	0.47	14.50	4.00	1790.0	2940	178	736.0	237.0	93.7	53.0	7.60	95.00	
97003	1.49	8.51	0.030	0.41	17.00	4.00	758.0	2440	228	631.0	99.6	68.6	48.0	5.00	137.00	
97007	1.39	8.59	0.030	0.81	5.70	4.00	138.0	710	86	562.0	126.0	74.0	52.0	6.00	86.00	
97013	1.10	8.60	0.020	0.25	4.12	4.00	140.0	1340	155	766.0	61.2	82.9	44.3	4.30	48.00	
97011	16.80	8.54	0.020	0.56					519	650.0		84.1		10.00	53.90	
104008	2.22	8.59	0.040	0.44					306	302.0		66.0		8.32	49.40	
104037	2.11	8.47	0.030	0.38	4.58	4.00	408.0	1610	55	668.0	556.0	86.0	15.0	4.00	116.00	
104029	1.80	8.58	0.030	0.81	2.95	4.00	51.9	422	924	660.0	41.4	41.0	34.8	5.70	94.20	
104027	0.80	8.59	0.030	0.18	2.79	4.00	41.1	588	161	648.0	35.7	78.0	35.4	4.10	116.00	
104025	0.91	8.57	0.110	0.69	3.22	4.00	79.4	526	1070	643.0	54.0	116.0	43.0	10.20	79.10	
104001	1.63	8.55	0.020	2.10					575	464.0		66.0		8.31	40.50	
107002	1.22	8.47	0.040	0.17	9.06	4.00	321.0	1260	79	875.0	87.6	110.0	43.1	6.00	99.00	

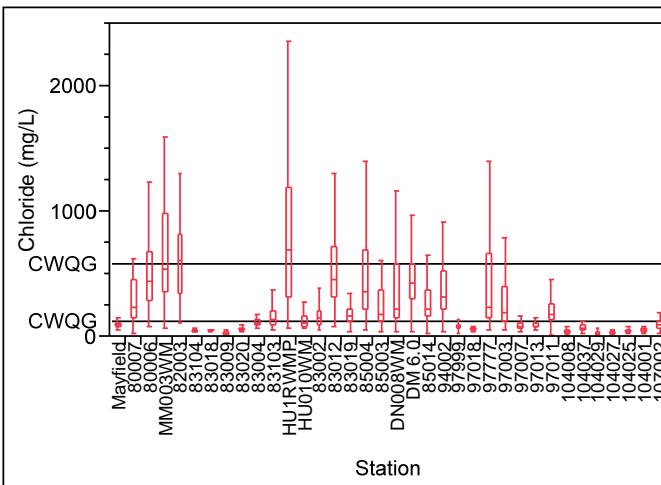
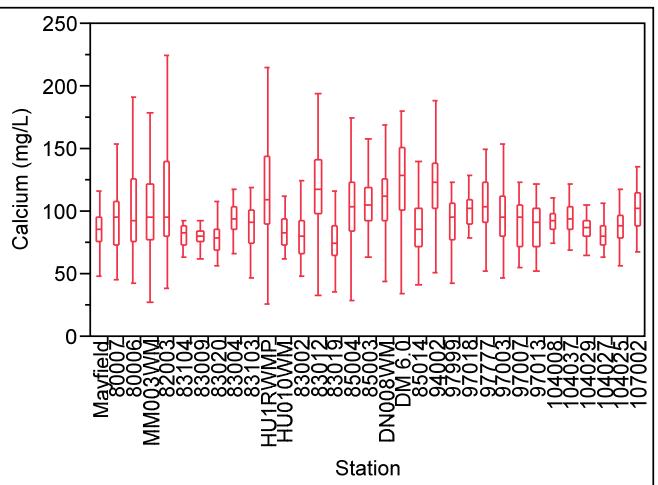
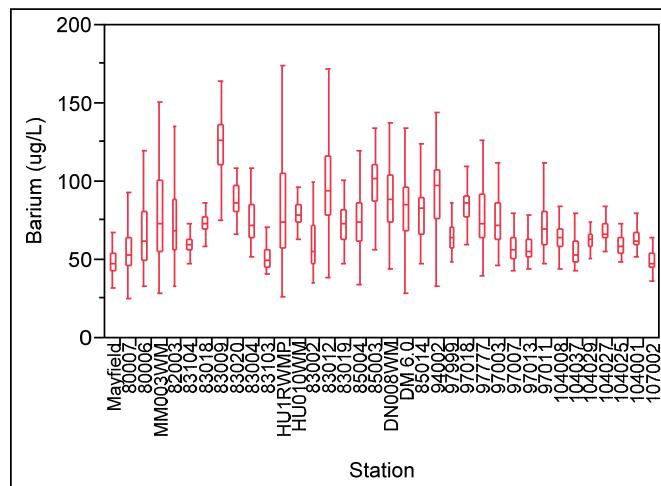
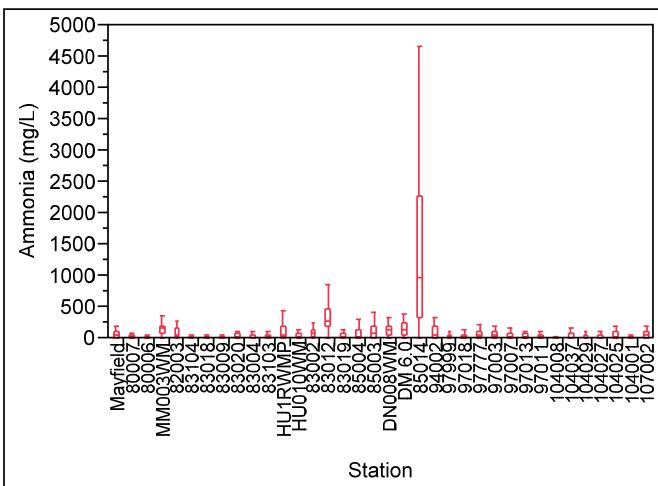
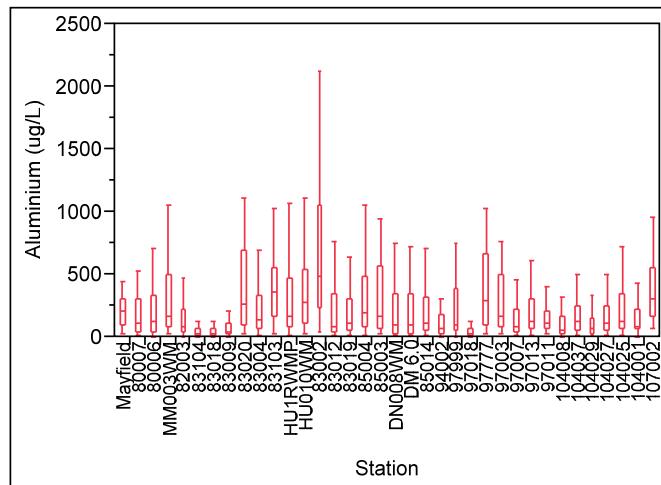
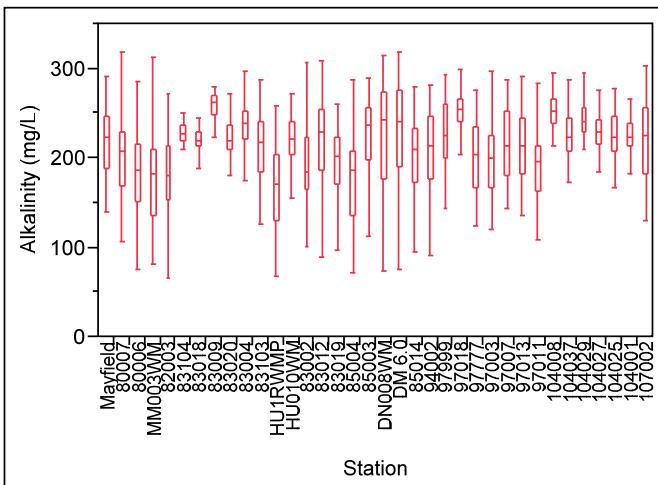
**Appendix B1. Current (2006-2010) Descriptive Statistics**

Station	STANDARD DEVIATION																			
	Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite
Mayfield	39	709	66	12.0	17			73	263	1.5	1340	51	622	4.2	53.8		8.0	4.1	1.77	0.021
80007	46	289	86	15.8	28			508	1665	2.4	4120	93	409	7.4	40.5		7.4	3.7	1.46	0.045
80006	48	1296	64	32.7	55			1276	3321	9.9	3036	157	1668	11.3	110.3		8.0	4.7	0.73	0.118
MM003WM	47	1142	222	33.8	50			1343	3827	6.2	4305	157	1392	11.2	103.3		9.1	4.6	1.20	0.135
82003	52	1643	144	38.7	45			1264	3612	13.2	5403	138	1433	10.2	155.5		8.8	4.8	0.41	0.159
83104	12	58	47	7.0	8			6	47	1.3	571	31	164	1.5	43.1		6.6	3.4	0.19	0.002
83018	13	56	33	7.2				13	103	0.8	242	26	109	1.7	19.4		6.2	3.2	0.21	0.003
83009	15	110	52	21.6	7			23	76	1.8	767	19	292	1.8	27.0		7.1	6.2	0.29	0.003
83020	28	1473	66	22.6	11			133	449	2.6	3776	32	1706	2.3	73.1		7.9	4.5	0.29	0.006
83004	29	1141	66	20.7	12			88	297	1.9	2783	37	1319	2.8	58.0		8.3	4.5	0.40	0.009
83103	37	362	43	13.1	18			236	791	1.7	3945	52	476	3.1	48.4		7.2	3.6	0.83	0.016
HU1RWMP	46	782	152	42.6	48			2221	4675	6.1	3952	158	888	9.9	152.9		9.2	4.5	4.86	0.486
HU010WM	34	807	72	18.0	16			119	474	1.8	1248	47	937	3.0	40.8		8.2	4.4	0.32	0.015
83002	42	1071	73	20.6	19			119	438	1.9	2052	61	1080	4.1	80.4		8.3	4.3	0.98	0.030
83012	56	838	290	33.8	33			706	2658	5.7	8122	110	908	7.5	86.2		8.8	4.4	1.89	0.095
83019	40	556	58	13.3	20	10.1	1.4	179	549	4.7	8896	57	982	4.3	85.0	0.008	1.6	1.6	0.47	0.012
85004	46	758	81	25.2	30			777	2555	3.6	3992	96	809	5.3	54.7		8.6	4.3	1.91	0.211
85003	51	865	91	23.3	22			519	1303	3.3	5195	69	954	3.9	47.0		8.7	4.4	1.99	0.088
DN008WM	62	968	127	24.5	29			540	1663	5.1	4355	94	1134	5.8	51.2		8.8	4.6	0.85	0.076
DM 6.0	64	1128	383	24.6	69			768	2405	7.5	6143	219	1309	11.8	75.7		9.2	4.7	1.37	0.333
85014	48	798	1468	19.3	24	12.0	1.5	333	959	7.4	34401	77	583	4.6	80.5	0.021	1.8	2.5	0.57	0.092
94002	50	472	93	24.3	31			1124	1533	3.4	3839	103	559	6.5	38.5		8.1	4.3	0.59	0.059
97999	35	413	65	18.9	18			71	202	1.1	520	48	440	2.0	21.7		7.7	4.2	1.19	0.007
97018	24	735	46	25.4	12			15	78	1.3	902	36	271	2.1	112.6		7.6	5.0	0.72	0.011
97777	40	727	70	23.9	23			456	1156	2.2	3057	72	723	4.1	35.1		8.9	4.3	1.21	0.045
97003	41	563	65	24.1	24			274	904	2.1	4633	74	587	3.8	43.1		8.7	4.3	0.83	0.208
97007	40	407	69	19.3	19			42	172	1.0	3825	48	402	1.8	19.1		8.2	4.1	0.83	0.007
97013	39	370	66	9.2	20			45	170	1.0	371	53	395	2.5	21.7		7.8	4.3	0.85	0.007
97011	35	515	101	20.7				703	2030	2.7	896	72	685	3.5	58.4		7.0	3.7	0.60	0.028
104008	26	388	39	11.5	11			20	76	1.0	617	30	573		72.1		7.2	3.9	0.27	0.006
104037	29	408	73	10.9	18			100	401	1.2	926	38	453	2.2	31.9		7.9	4.2	3.54	0.111
104029	22	396	67	37.9	9			16	62	4.1	479	22	549	1.6	103.8		7.8	5.4	0.22	0.002
104027	19	399	150	7.3	10			11	56	0.9	807	26	468	1.4	27.7		7.4	4.1	0.23	0.003
104025	25	879	104	12.3	13			26	108	1.8	151	34	1215	1.8	88.9		8.0	4.4	0.45	0.006
104001	21	403	56	8.4				64	213	3.5	1441	50	436		38.8		6.9	3.9	0.36	0.003
107002	44	564	99	13.8	17			85	300	1.1	971	47	550	2.0	59.8		8.3	4.4	0.72	0.118

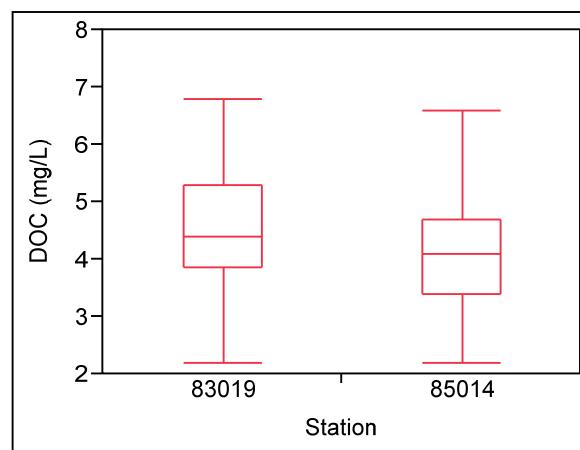
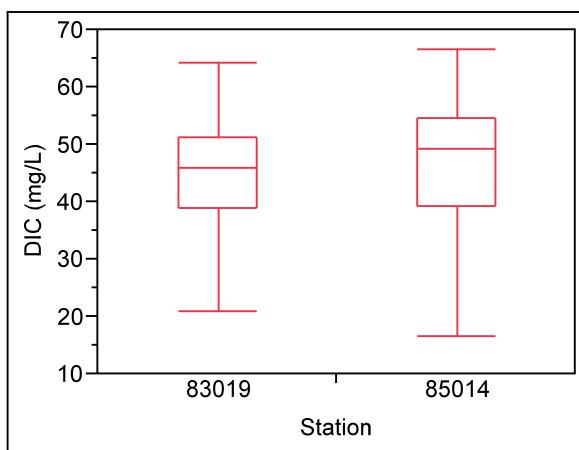
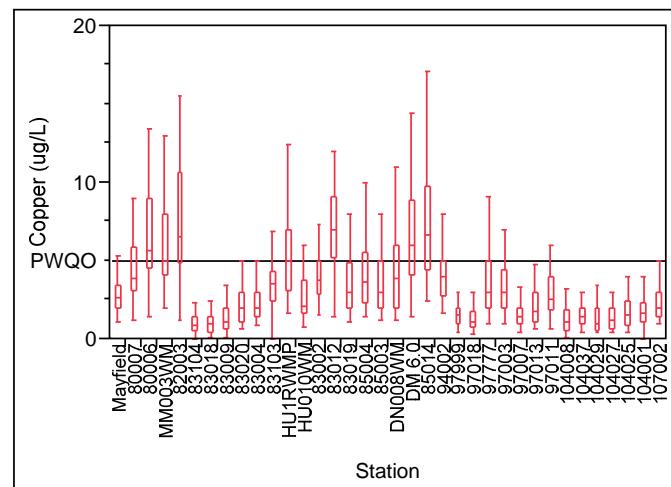
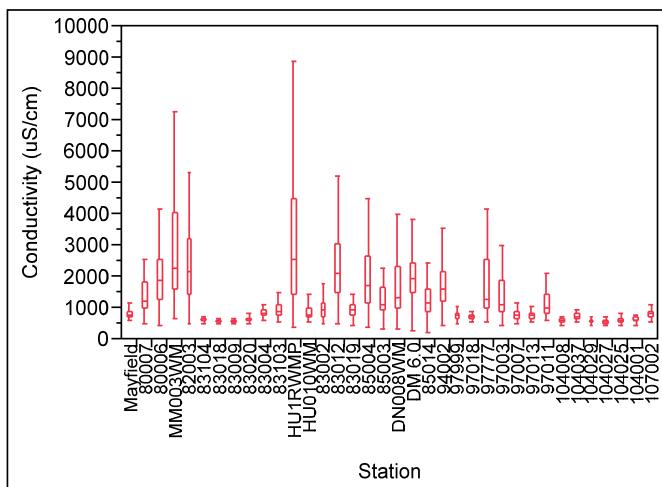
**Appendix B1. Current (2006-2010) Descriptive Statistics**

STANDARD DEVIATION															
Station	TKN	pH	Phosphate	Phosphorous	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	0.51	0.18	0.037	0.07	1.46	0.67	40.5	144	10	145.5	22.9	12.9	8.7	1.25	9.55
80007	0.36	0.13	0.028	0.10					24	204.6		3.8		1.61	15.19
80006	0.48	0.16	0.016	0.12					71	257.2		27.2		3.51	58.09
MM003WM	1.06	0.17	0.009	0.07	8.91	0.69	840.9	2205	44	531.0	34.0	23.3	10.1	2.45	49.24
82003	0.73	0.18	0.014	0.13					90	303.5		27.5		5.19	70.69
83104	0.18	0.13	0.005	0.03					14	24.7		1.2		1.14	8.51
83018	0.18	0.11	0.004	0.02					9	29.4		1.5		1.27	5.34
83009	0.22	0.08	0.005	0.03					17	32.4		2.3		1.27	9.52
83020	0.26	0.09	0.007	0.06	0.60	0.86	79.3	240	63	81.8	6.0	33.9	19.8	2.73	24.20
83004	0.34	0.12	0.006	0.06	1.09	0.85	51.8	155	42	86.1	14.4	28.1	12.8	2.21	20.48
83103	0.51	0.11	0.018	0.07					36	91.3		8.2		1.60	9.99
HU1RWMP	0.77	0.12	0.042	0.08	13.05	0.85	805.8	2683	36	328.0	68.3	21.0	14.2	1.96	33.36
HU010WM	0.25	0.21	0.006	0.05	1.25	0.67	74.2	255	31	101.5	21.6	18.5	7.4	1.64	26.71
83002	0.33	0.13	0.021	0.05	1.14	0.66	71.3	392	24	138.8	12.8	29.8	15.2	1.99	57.29
83012	0.49	0.13	0.013	0.07	4.67	0.67	435.4	1482	31	212.3	20.4	27.2	12.3	1.93	31.88
83019	0.41	0.12	0.015	0.12					104	60.5		3.3		1.95	20.88
85004	0.64	0.21	0.030	0.19	5.09	0.86	497.5	1425	64	169.4	23.4	21.1	24.8	1.68	26.71
85003	0.41	0.28	0.024	0.11	14.34	0.85	306.8	700	79	133.2	34.6	25.9	24.4	1.81	21.70
DN008WM	0.45	0.16	0.017	0.10	3.03	1.49	343.9	915	70	149.7	21.4	30.4	20.2	2.46	29.80
DM 6.0	0.42	0.14	0.015	0.09	2.60	0.75	487.1	1347	56	176.7	33.8	39.2	12.7	2.79	35.82
85014	1.55	0.13	0.061	0.15					144	94.0		6.6		2.69	26.63
94002	0.33	0.10	0.006	0.06	3.04	2.54	369.4	831	36	166.7	19.8	17.0	7.0	1.33	17.67
97999	0.22	0.10	0.007	0.03	0.55	0.86	33.9	109	10	79.2	12.4	13.3	4.2	0.88	9.92
97018	3.40	0.08	0.014	0.19					105	28.0		5.6		2.62	11.22
97777	0.74	0.17	0.005	0.07	2.52	0.67	289.6	625	36	107.2	27.9	22.1	9.9	1.49	22.15
97003	0.33	0.10	0.006	0.06	2.32	0.85	165.9	459	37	94.8	14.5	17.3	9.3	1.22	22.23
97007	0.26	0.11	0.005	0.10	0.77	0.86	23.1	100	13	58.1	13.4	11.8	7.5	0.95	16.06
97013	0.20	0.09	0.005	0.04	0.60	0.83	24.1	149	26	78.8	8.2	15.4	6.6	0.91	9.01
97011	2.18	0.10	0.005	0.08					71	86.3		14.6		1.75	12.77
104008	0.31	0.10	0.008	0.06					43	24.8		9.9		1.35	9.97
104037	0.36	0.09	0.005	0.05	0.78	0.85	69.8	229	12	66.6	67.9	15.1	2.9	0.83	16.15
104029	0.30	0.08	0.006	0.11	0.47	0.86	8.1	39	127	69.2	5.7	8.5	4.7	0.88	16.79
104027	0.16	0.10	0.005	0.03	0.42	0.86	5.4	44	27	63.0	4.6	14.1	5.4	0.87	16.56
104025	0.18	0.10	0.014	0.09	0.48	0.86	14.9	56	142	81.5	7.1	28.6	7.6	1.71	13.67
104001	0.27	0.09	0.005	0.28					78	42.4		11.9		1.29	7.95
107002	0.19	0.12	0.006	0.03	1.16	0.83	52.3	173	16	100.4	13.5	22.3	7.8	1.19	14.30

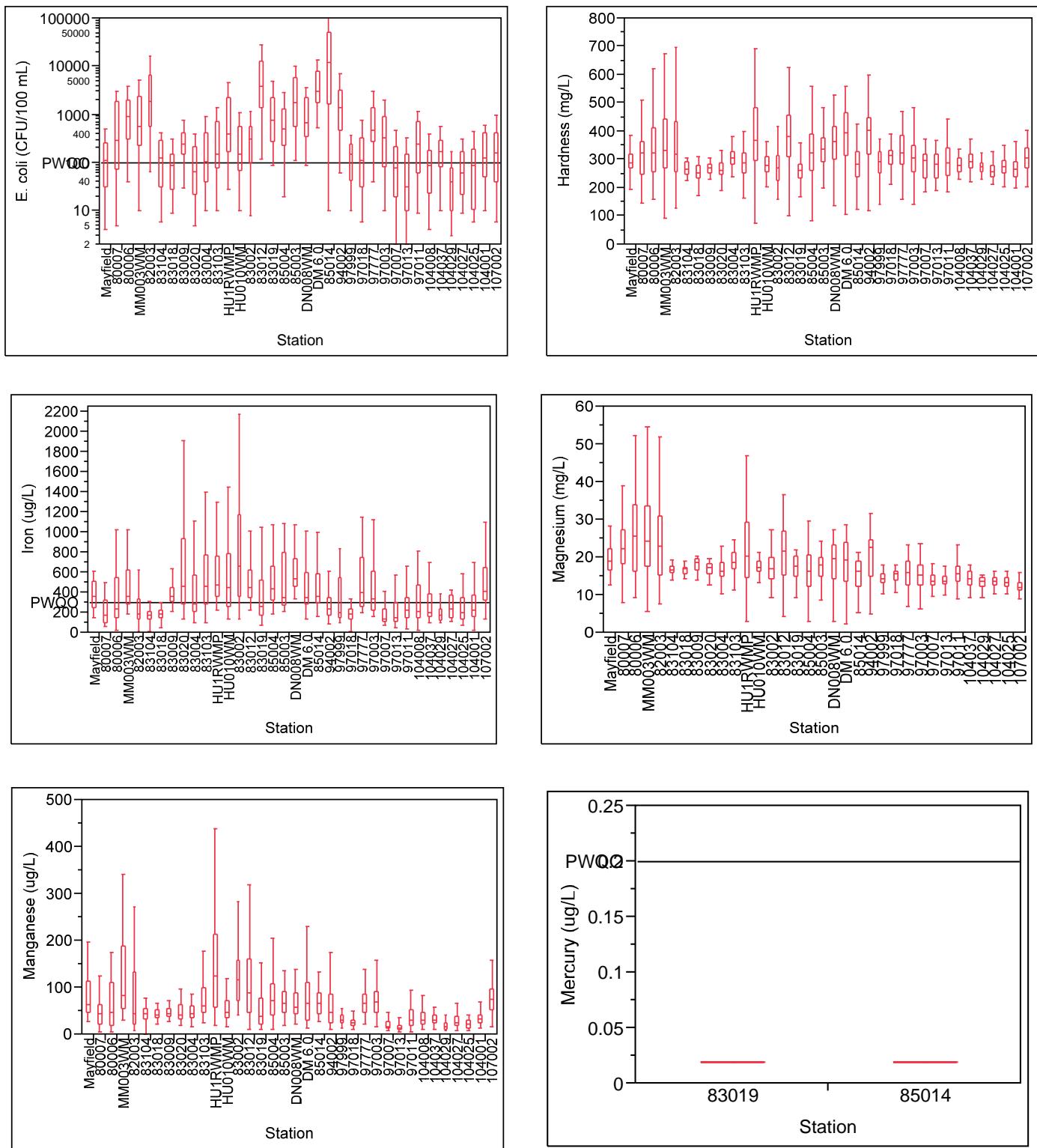
## Appendix B2. Current (2006-2010) Box Plots



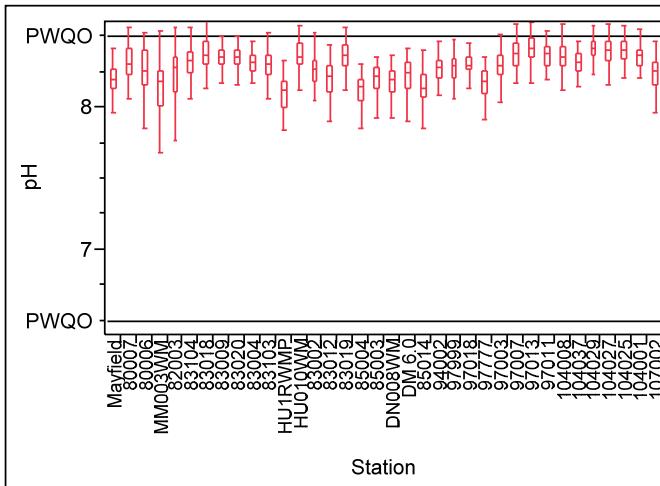
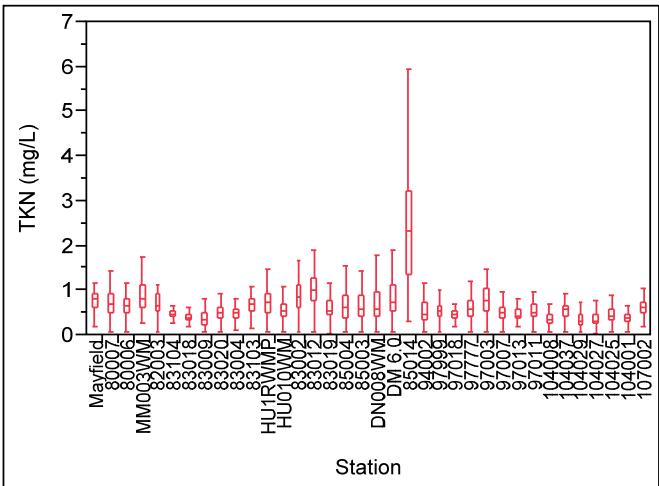
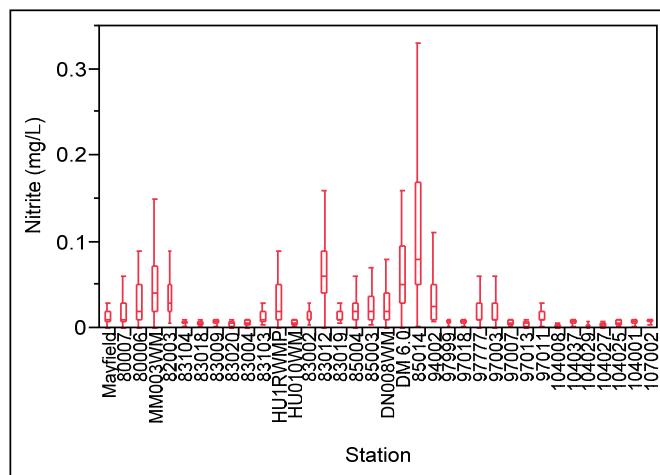
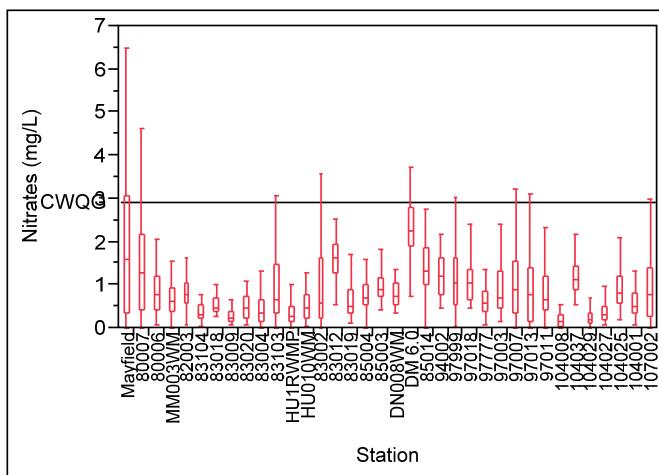
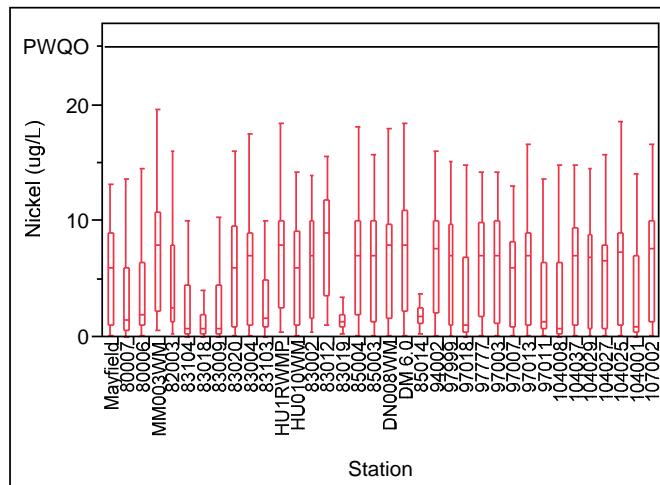
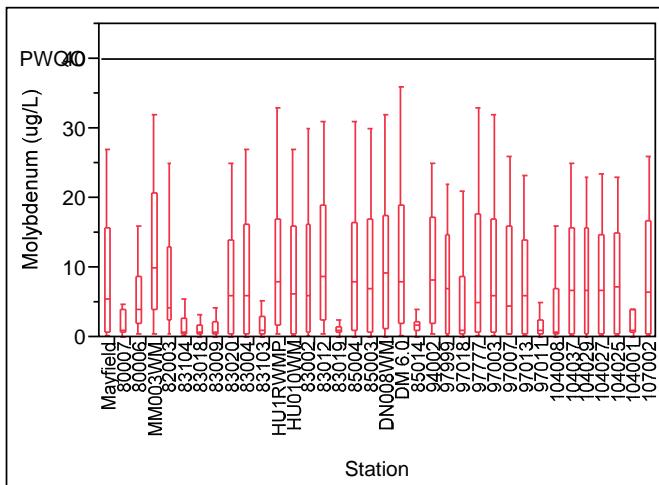
## **Appendix B2. Current (2006-2010) Box Plots**



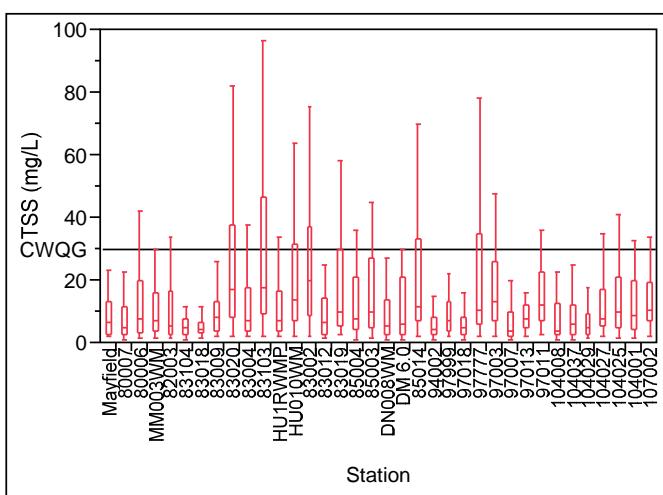
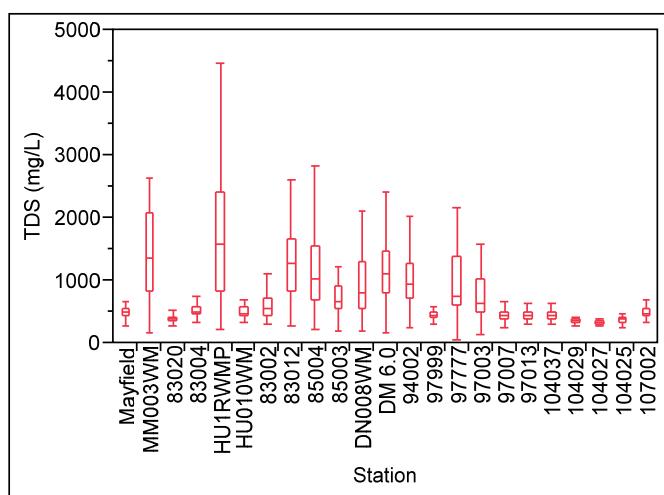
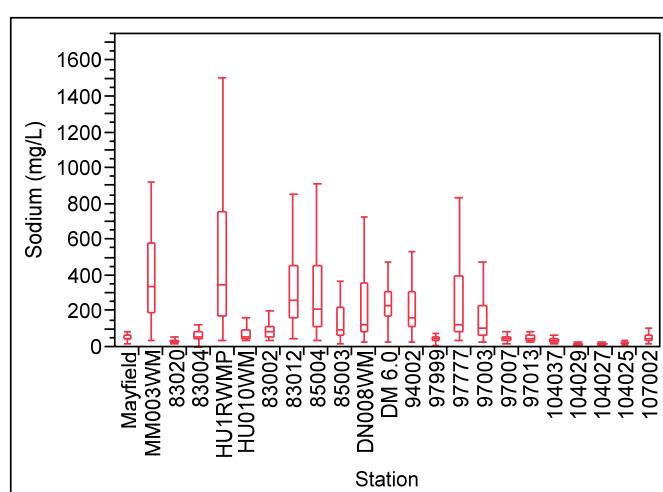
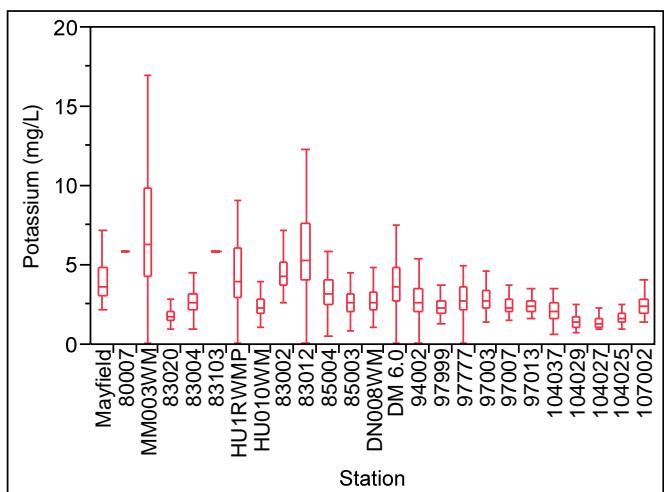
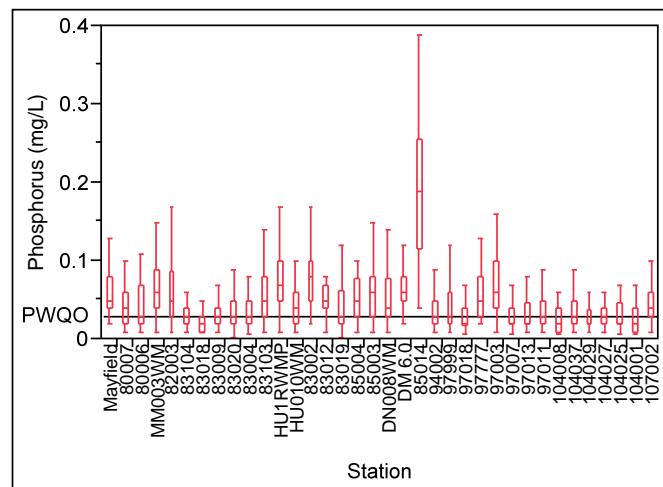
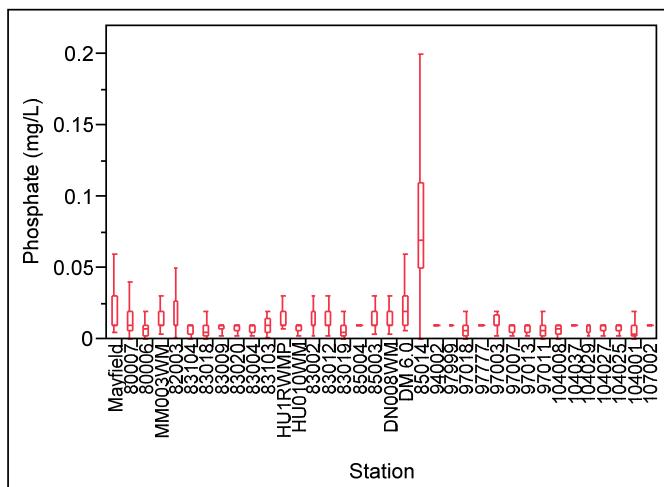
## Appendix B2. Current (2006-2010) Box Plots



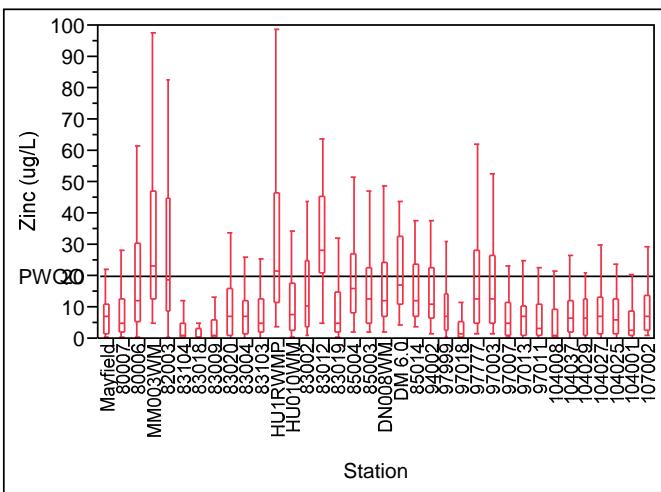
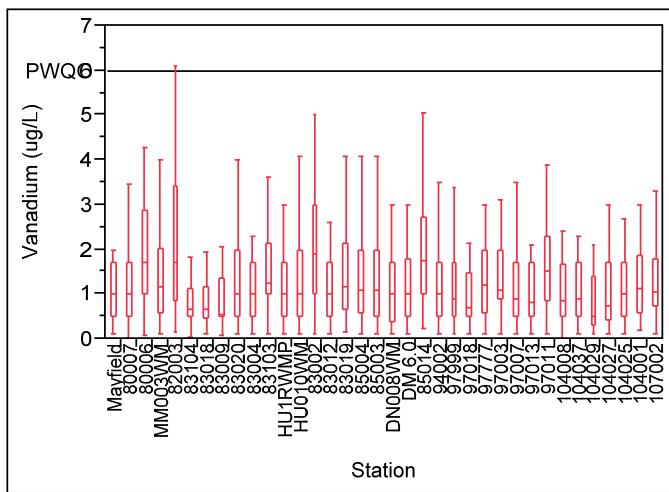
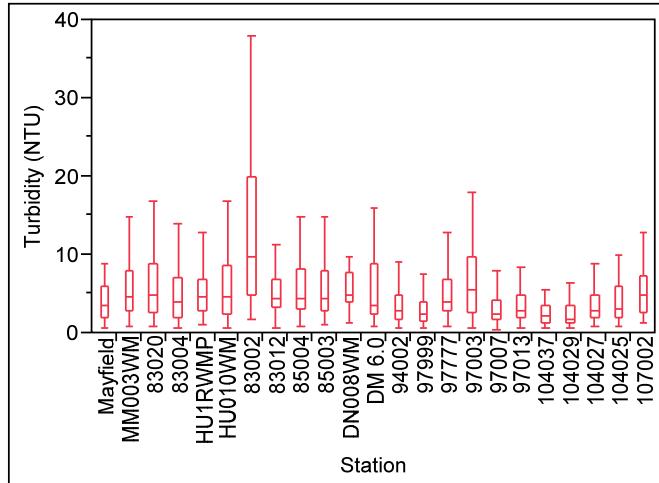
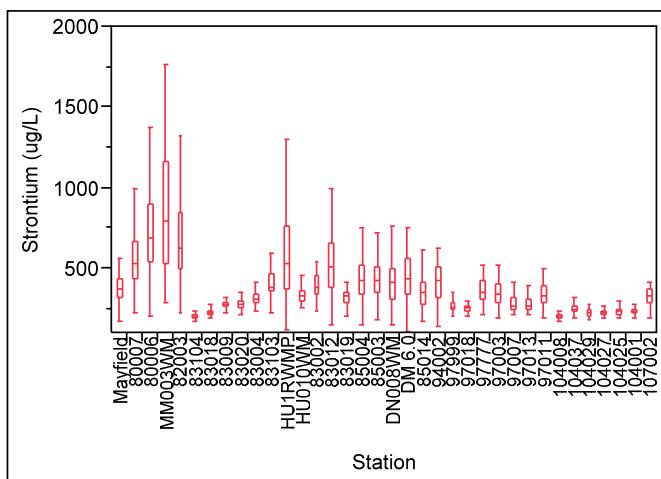
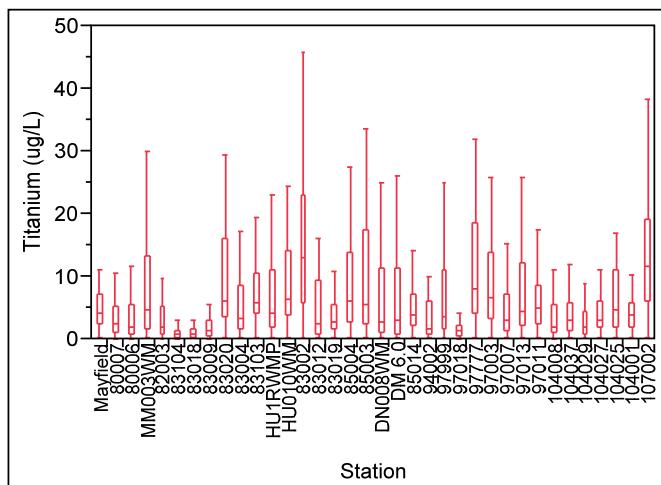
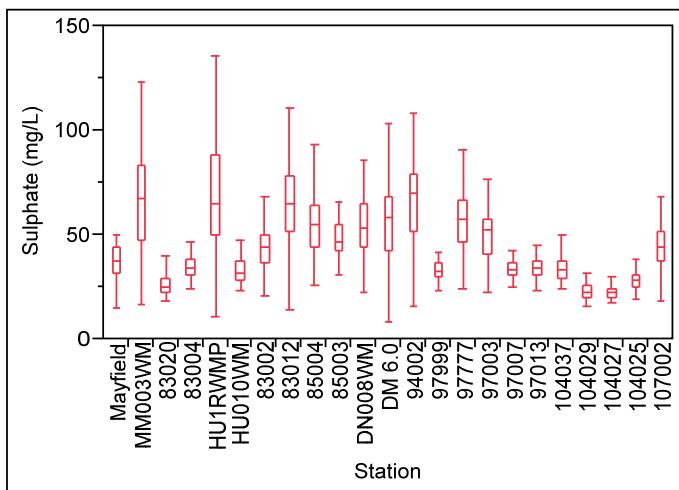
## Appendix B2. Current (2006-2010) Box Plots



## **Appendix B2. Current (2006-2010) Box Plots**



## **Appendix B2. Current (2006-2010) Box Plots**



**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Average																					
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN	
Mayfield	spring	203	311	41	46.7	84			105	815	3.4	145	282	464	17.3	72.4			10.7	6.2	2.17	0.015	0.89
	summer	209	339	81	46.5	72			92	751	3.0	892	261	484	19.4	127.5			7.6	5.1	0.93	0.028	1.08
	autumn	226	689	56	51.6	81			83	763	3.3	781	284	785	19.5	69.6			4.3	5.3	1.68	0.009	0.83
	winter	242	191	86	56.2	103			184	1139	2.3	77	342	346	20.8	65.6			10.5	6.1	3.12	0.015	0.69
80007	spring	208	185	48	53.7	96			305	1412	5.0	369	321	259	22.0	52.3			6.3	3.8	1.73	0.022	0.74
	summer	188	151	31	49.1	78			190	1073	3.6	3098	282	254	22.0	36.6			1.2	1.4	0.52	0.011	0.65
	autumn	196	315	16	52.5	78			240	1172	5.3	2050	287	466	20.3	52.5			1.0	1.2	1.40	0.015	0.84
	winter	230	272	137	74.8	115			966	3769	5.0	994	394	352	25.7	70.1			11.0	6.4	2.52	0.059	0.75
80006	spring	189	908	69	79.8	101			526	2095	13.6	1408	344	1404	24.0	125.9			10.0	5.7	0.92	0.030	0.92
	summer	151	223	14	52.2	74			333	1423	6.5	2123	275	442	22.9	44.8			3.1	2.1	0.39	0.010	0.61
	autumn	177	254	16	51.7	81			290	1286	5.6	2981	304	442	20.9	38.1			3.1	1.5	0.86	0.017	0.74
	winter	221	902	87	96.4	152			2122	6421	9.6	1438	521	1131	34.3	161.6			13.0	7.9	1.48	0.154	0.78
MM003WM	spring	193	325	140	81.5	122			1002	3470	6.3	608	433	485	31.5	134.4			15.4	7.9	0.87	0.080	0.89
	summer	152	456	116	62.1	82			413	1734	6.0	2918	298	677	22.7	80.1			12.0	6.3	1.01	0.056	0.77
	autumn	171	827	103	70.7	81			315	1435	6.4	3186	291	1147	21.6	79.7			7.7	6.0	0.55	0.031	1.16
	winter	188	893	467	107.0	153			2635	8723	10.9	2159	494	1105	27.5	236.1			15.1	8.3	1.21	0.157	1.34
82003	spring	190	916	76	89.7	109			745	2708	14.9	2766	365	1380	24.9	145.0			10.2	5.8	0.95	0.042	1.01
	summer	178	202	53	63.3	86			443	1765	7.2	3707	295	435	22.2	41.1			5.1	3.5	0.61	0.025	0.67
	autumn	170	272	39	58.2	77			376	1448	9.1	6033	283	531	17.5	80.1			3.1	2.0	0.73	0.021	0.76
	winter	195	1180	281	115.2	146			2504	7872	14.7	4187	491	586	30.1	218.3			14.9	10.1	1.19	0.208	1.27
83104	spring	221	45	21	55.1	80			53	610	1.4	90	254	217	14.6	57.1			5.2	3.1	0.40	0.006	0.48
	summer	225	25	19	63.0	72			49	587	1.0	307	243	151	16.8	37.0			1.2	0.5	0.24	0.006	0.46
	autumn	231	35	17	61.2	79			49	610	0.9	564	268	206	17.2	51.1			0.7	0.7	0.27	0.006	0.51
	winter	238	88	69	62.3	90			56	678	1.6	42	296	245	17.3	57.7			9.6	5.5	0.62	0.006	0.49
83018	spring	217	44	18	66.6				51	588	1.3	74	247	196	14.8	52.2			4.3	2.1	0.56	0.007	0.45
	summer	214	23	27	77.5				53	580	0.9	144	242	175	17.0	42.7			1.0	0.7	0.37	0.008	0.44
	autumn	224	50	14	74.5				58	652	1.1	234	255	215	16.4	44.2			1.1	1.1	0.45	0.006	0.43
	winter	232	71	53	73.3				54	653	1.3	53	287	217	17.1	41.3			9.1	5.6	0.83	0.006	0.42
83009	spring	247	98	23	101.9	80			33	567	1.4	165	261	408	15.9	52.5			5.2	3.2	0.32	0.006	0.46
	summer	265	61	21	138.7	74			17	526	1.0	249	261	360	19.1	45.3			0.8	0.5	0.17	0.008	0.32
	autumn	261	120	18	131.7	74			33	582	2.2	1066	265	546	19.1	56.3			0.7	0.8	0.35	0.008	0.43
	winter	260	99	77	117.9	85			43	641	1.4	369	289	439	18.4	50.4			10.0	8.2	0.48	0.007	0.44
83020	spring	218	1240	44	96.1	82			67	659	3.6	50	268	1574	15.6	84.1			11.5	7.0	0.52	0.005	0.60
	summer	205	559	62	91.7	68			50	581	2.2	323	241	734	17.5	77.8			7.5	5.1	0.26	0.006	0.49
	autumn	210	980	52	102.6	74			117	830	3.3	3236	251	1365	16.3	79.7			4.5	5.9	0.42	0.006	0.60
	winter	245	225	53	86.4	91			78	764	1.6	39	301	420	18.2	37.2			9.6	5.7	0.83	0.007	0.45
83004	spring	230	337	44	61.7	98			127	889	2.5	78	309	496	15.								

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Average													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	spring	8.18	0.015	0.05	3.42	0.32	59.0	488	9	341.6	46.2	6.5	5.1	1.04	8.56
	summer	8.19	0.034	0.08	4.02	0.62	54.8	465	10	407.2	30.7	8.6	4.7	1.44	7.59
	autumn	8.20	0.035	0.10	4.74	0.52	47.6	458	13	391.7	37.5	13.4	10.8	1.66	11.13
	winter	8.15	0.017	0.05	4.05	0.39	102.9	642	8	451.2	48.9	4.0	5.1	0.84	7.66
80007	spring	8.35	0.007	0.04					6	549.8		3.5		1.04	8.01
	summer	8.40	0.014	0.08					12	487.5		2.3		2.26	6.53
	autumn	8.28	0.030	0.09					25	494.4		4.1		1.25	11.65
	winter	8.23	0.015	0.04	5.93				9	745.5		4.7		0.89	20.11
80006	spring	8.25	0.012	0.10					60	743.1		16.3		3.56	59.91
	summer	8.41	0.005	0.05					23	594.1		2.8		2.74	15.95
	autumn	8.26	0.014	0.08					24	578.1		3.7		1.98	13.12
	winter	8.19	0.014	0.08					31	942.3		17.6		3.30	43.38
MM003WM	spring	8.19	0.014	0.05	8.09	0.32	581.2	1804	13	914.1	91.3	5.3	5.5	1.27	32.35
	summer	8.24	0.015	0.08	6.05	0.74	240.3	1014	12	727.7	57.0	10.8	5.6	1.99	22.49
	autumn	8.18	0.019	0.09	5.33	0.66	176.7	816	27	641.7	54.3	18.2	7.1	2.21	40.56
	winter	7.97	0.013	0.08	16.67	0.34	1626.8	4901	33	1477.3	86.7	20.0	12.0	2.36	74.61
82003	spring	8.24	0.013	0.12					73	793.7		18.4		3.66	67.41
	summer	8.34	0.023	0.08					23	596.5		2.9		2.92	22.69
	autumn	8.23	0.021	0.10					32	532.7		3.4		2.01	31.57
	winter	8.15	0.015	0.10					45	984.3		20.9		5.37	66.98
83104	spring	8.32	0.006	0.03					5	202.6		1.1		0.88	2.87
	summer	8.41	0.012	0.03					5	205.5		0.9		1.64	3.25
	autumn	8.36	0.005	0.04					13	208.1		0.9		0.57	1.10
	winter	8.21	0.010	0.03					8	232.5		1.7		0.67	10.47
83018	spring	8.39	0.004	0.03					7	216.8		1.3		0.91	1.50
	summer	8.45	0.005	0.02					5	225.4		0.8		1.77	2.80
	autumn	8.40	0.003	0.02					10	236.9		1.6		0.55	1.83
	winter	8.29	0.009	0.02					5	251.4		1.1		0.65	7.39
83009	spring	8.36	0.008	0.04					17	257.0		2.5		0.87	2.93
	summer	8.38	0.010	0.04					17	281.5		1.6		1.52	3.11
	autumn	8.35	0.011	0.04					14	279.1		2.3		0.80	4.44
	winter	8.32	0.012	0.03					8	297.5		2.4		0.69	10.63
83020	spring	8.36	0.014	0.06	1.87	0.38	38.1	384	51	259.8	26.5	28.9	17.2	2.50	18.99
	summer	8.41	0.009	0.04	1.54	0.83	27.9	377	31	308.5	21.2	19.0	6.7	1.60	8.05
	autumn	8.35	0.007	0.07	2.24	0.43	67.8	482	55	303.1	25.1	22.9	13.4	2.31	30.70
	winter	8.28	0.010	0.03	2.02	0.33	43.8	428	17	293.7	31.9	5.6	6.5	0.80	7.13
83004	spring	8.29	0.014	0.03	2.68	0.40	72.1	503	15	287.8	40.2	7.3	7.3	1.08	8.27
	summer	8.35	0.008	0.05	2.43	0.84	51.1	490	15	358.6	32.4	9.6	4.4	1.21	5.55
	autumn	8.31	0.008	0.08	3.28	0.49	59.2	492	42	321.7	35.0	26.3	14.8	2.41	26.67
	winter	8.29	0.010	0.03	3.10	0.35	126.9	709	14	356.5	39.0	3.7	5.4	0.75	8.54
83103	spring	8.33	0.009	0.05					17	400.6		8.4		1.15	7.28
	summer	8.33	0.011	0.12					66	394.9		6.7		2.78	9.33
	autumn	8.28	0.023	0.07					36	358.0		5.7		1.69	6.74
	winter	8.25	0.013	0.05	5.85				12	512.1		12.4		1.26	12.65
HU1RWMP	spring	8.08	0.021	0.11	5.04	0.35	636.1	2104	29	695.2	82.1	17.9	10.4	2.09	42.71
	summer	8.12	0.024	0.09	3.63	0.89	231.4	1105	17	493.5	51.0	8.2	6.3	1.61	17.03
	autumn	8.17	0.013	0.06	3.83	0.47	179.9	904	13	415.4	54.4	7.3	8.4	1.17	25.08
	winter	8.00	0.036	0.11	17.84	0.35	1547.3	5417	23	859.5	124.5	12.7	15.0	1.53	54.45
HU010WM	spring	8.28	0.011	0.04	2.25	0.35	78.3	516	23	313.3	43.9	12.5	9.2	1.11	17.84
	summer	8.45	0.010	0.05	2.30	0.60	54.0	450	23	365.7	29.3	9.7	5.4	1.47	8.27
	autumn	8.35	0.010	0.06	3.31	0.45	69.9	455	32	364.7	37.0	21.3	8.7	2.06	28.01
	winter	8.26	0.010	0.04	2.98	0.32	156.3	804	15	367.1	37.4	9.2	6.2	0.89	13.58
83002	spring	8.31	0.018	0.09	3.94	0.37	106.3	813	40	374.9	43.5	30.2	20.0	2.93	53.18
	summer	8.33	0.021	0.11	4.48	0.63	77.5	491	35	398.8	38.8	26.0			

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Average																					
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN	
DN008WM	spring	220	432	111	87.8	112			361	1677	6.0	1438	358	857	19.2	75.3			14.1	7.4	0.85	0.026	0.71
	summer	218	593	101	82.9	101			163	1041	5.7	3699	324	1112	17.4	75.1			8.9	6.7	1.07	0.026	0.71
	autumn	212	433	86	85.0	95			168	994	4.2	3275	307	813	16.8	47.5			6.0	6.0	0.65	0.020	0.59
	winter	244	456	295	109.0	132			1162	4133	6.0	1278	415	896	20.6	92.5			11.1	6.8	1.02	0.101	0.88
DM 6.0	spring	223	1068	386	93.8	125			449	1941	12.2	4511	390	1557	18.9	125.4			13.8	8.5	2.20	0.068	0.81
	summer	227	191	113	79.9	119			349	1661	5.5	6526	370	383	17.9	36.2			11.1	7.0	2.67	0.064	0.73
	autumn	223	375	125	72.9	110			331	1568	5.9	6083	346	578	17.2	48.0			6.3	6.5	2.24	0.091	0.72
	winter	237	573	471	95.4	168			1500	5179	9.5	5369	516	789	23.8	142.6			12.1	7.9	2.84	0.253	1.12
85014	spring	205	311	1147	84.5	91	47.2	3.9	487	1885	9.4	32916	303	744	15.6	112.9	0.031	2.2	3.0	1.68	0.069	2.40	
	summer	187	473	1303	76.7	86	43.3	5.0	186	1024	8.8	30220	263	502	15.6	89.7	0.020	2.4	2.8	1.40	0.160	2.49	
	autumn	202	211	2026	76.1	80	46.4	4.3	187	1040	6.8	27745	269	524	14.6	65.1	0.024	1.9	1.6	1.28	0.124	2.90	
	winter	212	284	1336	96.8	99	50.2	3.4	799	2738	11.5	28459	289	599	16.0	94.1	0.020	1.6	1.8	1.71	0.066	2.13	
94002	spring	210	375	89	92.6	117			376	1682	6.8	1822	375	675	20.2	76.9			13.3	8.1	1.40	0.036	0.65
	summer	184	104	63	83.7	104			231	1219	3.2	1339	338	194	19.0	27.6			8.2	6.2	0.83	0.023	0.49
	autumn	206	177	70	88.9	109			257	1315	4.1	3373	355	346	20.1	37.3			6.1	6.0	1.08	0.055	0.58
	winter	233	354	168	110.9	138			1615	4121	5.6	4100	433	523	21.5	89.3			11.6	7.1	1.65	0.058	0.65
97999	spring	226	233	45	59.0	94			88	771	1.9	90	290	326	13.1	39.0			11.2	6.8	1.32	0.009	0.56
	summer	191	342	63	64.4	76			79	671	1.7	359	248	415	14.3	45.7			6.8	5.5	0.44	0.008	0.61
	autumn	241	395	54	75.4	94			70	740	1.8	468	295	484	14.5	37.1			4.6	5.7	1.01	0.009	0.57
	winter	253	150	56	75.1	108			160	994	1.8	261	332	321	14.9	26.5			10.0	6.3	2.28	0.008	0.50
97018	spring	246	106	35	78.7	101			71	752	1.5	73	305	254	13.4	31.7			7.2	4.0	1.21	0.012	1.00
	summer	243	463	25	102.6	88			55	653	1.7	981	277	180	15.3	92.1			1.0	1.7	0.73	0.011	2.35
	autumn	259	53	30	90.7	97			58	704	1.3	277	317	190	15.7	23.6			1.0	0.8	0.97	0.007	0.50
	winter	262	119	69	85.4	110			72	786	1.4	119	337	394	15.5	27.1			10.6	7.5	1.82	0.009	0.47
97777	spring	203	496	66	84.2	109			415	1794	4.2	747	341	637	16.4	86.0			13.4	6.8	0.64	0.022	1.00
	summer	185	480	85	66.4	93			174	1018	3.0	1663	293	684	15.1	64.5			8.6	5.9	0.90	0.022	0.63
	autumn	200	576	61	78.0	94			166	1004	3.1	2301	294	694	14.6	43.4			5.1	5.6	0.53	0.014	0.57
	winter	226	603	110	94.2	127			1038	3453	4.2	763	391	737	17.9	94.1			10.3	7.0	1.24	0.058	0.70
97003	spring	201	374	54	76.1	101			286	1381	3.8	499	318	509	15.7	79.8			13.2	6.7	0.99	0.018	0.74
	summer	164	493	94	70.0	76			138	846	3.3	2393	244	657	13.3	85.3			7.8	5.6	0.80	0.024	0.88
	autumn	188	630	65	78.8	84			140	887	3.3	3485	264	742	13.4	59.8			4.9	5.6	0.70	0.024	0.80
	winter	243	251	84	90.2	121			641	2610	3.8	329	376	427	17.7	72.3			10.3	6.8	1.46	0.140	0.70
97007	spring	219	183	56	57.3	94			105	813	1.8	59	289	243	12.9	25.3			11.8	6.2	1.37	0.011	0.59
	summer	176	150	53	49.7	70			78	645	1.6	165	230	206	13.4	25.8			7.5	5.1	0.35	0.006	0.53
	autumn	222	308	51	71.9	88			75	715	1.9	2834	278	362	14.2	22.1			4.8	5.2	0.83	0.007	0.57
	winter	253	220	56	65.5	109			138	978	1.7	553	333	276	14.8	22.7			9.7	6.4	1.78	0.009	0.43
97013																							

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Average													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
DN008WM	spring	8.19	0.013	0.07	2.39	0.40	206.8	934	22	426.9	57.8	14.9	8.2	1.43	25.89
	summer	8.19	0.023	0.10	2.50	0.64	92.8	631	51	389.2	46.5	17.6	14.3	2.39	19.91
	autumn	8.15	0.012	0.06	3.14	1.36	94.4	608	17	351.5	47.6	12.0	11.7	1.95	21.97
	winter	8.11	0.014	0.07	5.43	0.33	719.6	2293	17	534.2	74.5	14.1	11.3	1.32	32.30
DM 6.0	spring	8.23	0.020	0.12	3.72	0.42	257.8	1105	57	461.5	56.8	36.1	10.6	3.01	52.44
	summer	8.26	0.027	0.08	3.84	0.73	201.0	946	18	438.7	49.4	5.1	5.0	1.84	15.61
	autumn	8.20	0.026	0.07	3.82	0.73	185.5	886	15	407.6	48.1	10.6	7.6	1.43	19.66
	winter	8.16	0.015	0.07	5.31	0.40	925.9	2894	22	530.9	81.2	19.1	11.9	1.87	35.67
85014	spring	8.18	0.088	0.23					79	418.4		5.8		2.39	24.94
	summer	8.15	0.086	0.21					69	316.3		6.6		2.91	20.41
	autumn	8.10	0.098	0.22					51	320.6		4.3		1.78	17.85
	winter	8.12	0.076	0.15					28	402.7		6.6		3.55	23.95
94002	spring	8.23	0.012	0.07	2.64	0.40	205.7	996	34	434.6	65.6	12.8	8.7	1.74	24.43
	summer	8.34	0.010	0.03	2.13	2.11	119.4	777	6	410.7	57.8	3.6	2.5	1.33	8.63
	autumn	8.28	0.010	0.05	2.93	0.39	131.8	787	6	394.9	61.7	5.9	3.1	1.03	13.77
	winter	8.22	0.013	0.04	5.44	0.37	769.4	2253	11	499.2	75.4	10.0	4.8	1.05	25.54
97999	spring	8.32	0.011	0.04	2.18	0.40	48.8	444	10	259.1	31.9	6.9	5.3	1.04	9.53
	summer	8.29	0.012	0.05	2.27	0.84	42.3	398	11	286.8	29.3	11.6	2.7	1.51	10.13
	autumn	8.26	0.012	0.05	2.58	0.43	37.1	455	14	288.6	34.2	12.5	4.0	1.11	10.79
	winter	8.22	0.011	0.04	2.48	0.35	79.9	561	7	276.8	42.4	4.1	2.5	0.83	8.85
97018	spring	8.32	0.007	0.03					9	254.3		2.9		0.91	4.41
	summer	8.37	0.014	0.14					68	247.8		3.8		3.23	9.12
	autumn	8.30	0.005	0.03					9	262.5		1.8		0.81	1.98
	winter	8.25	0.011	0.05					5	262.9		3.5		0.74	6.87
97777	spring	8.20	0.011	0.06	2.99	0.44	237.8	992	27	420.0	62.3	13.4	7.5	1.51	22.38
	summer	8.16	0.013	0.08	2.33	0.62	98.2	571	31	337.0	45.7	17.0	5.1	2.09	10.43
	autumn	8.19	0.009	0.06	3.01	0.45	91.4	618	31	323.9	51.7	17.6	7.2	1.58	25.41
	winter	8.08	0.012	0.08	5.19	0.37	631.0	1895	19	436.2	84.2	18.6	9.4	1.53	26.04
97003	spring	8.32	0.012	0.07	2.74	0.42	164.2	769	28	369.3	53.1	11.7	9.1	1.42	19.09
	summer	8.30	0.014	0.11	2.68	0.87	80.0	504	44	319.5	41.5	15.2	9.3	2.20	15.45
	autumn	8.28	0.011	0.08	3.25	0.49	78.7	504	21	313.5	45.0	18.6	8.8	1.68	25.26
	winter	8.27	0.011	0.05	4.67	0.32	385.4	1370	12	435.5	64.0	7.3	5.4	1.08	17.09
97007	spring	8.38	0.011	0.03	2.18	0.39	57.8	464	8	279.8	39.7	5.0	3.8	0.86	9.60
	summer	8.46	0.008	0.08	2.41	0.86	42.3	389	8	275.4	30.3	5.6	3.1	1.31	5.45
	autumn	8.38	0.009	0.04	3.06	0.42	39.8	413	11	282.7	34.3	8.4	6.3	1.14	17.67
	winter	8.26	0.009	0.04	2.36	0.32	75.4	554	10	299.4	39.2	7.1	5.3	0.96	7.96
97013	spring	8.41	0.010	0.05	2.33	0.37	66.9	470	27	280.3	31.8	14.1	8.0	1.31	8.59
	summer	8.50	0.009	0.03	2.33	0.80	47.8	396	12	291.2	30.1	9.0	5.1	1.21	5.37
	autumn	8.45	0.009	0.03	2.79	0.36	45.6	501	6	294.5	36.6	5.2	3.0	0.85	8.61
	winter	8.31	0.009	0.04	2.42	0.36	74.4	540	18	292.8	39.1	13.3	4.1	1.03	10.29
97011	spring	8.33	0.006	0.08					59	363.2		8.4		2.15	8.63
	summer	8.42	0.005	0.05					19	302.1		6.7		2.29	4.55
	autumn	8.38	0.005	0.03					12	299.1		4.6		1.15	3.97
	winter	8.28	0.011	0.05					26	445.4		21.0		1.92	20.37
104008	spring	8.36	0.008	0.05					28	205.3		5.1		1.27	5.94
	summer	8.44	0.007	0.02					6	203.3		2.0		1.72	2.93
	autumn	8.37	0.008	0.03					13	208.7		2.3		1.12	3.10
	winter	8.28	0.009	0.04					13	210.8		10.1		0.79	13.05
104037	spring	8.35	0.011	0.04	1.91	0.42	43.3	422	11	236.1	31.3	4.2	3.3	0.93	6.77
	summer	8.35	0.012	0.04	1.85	0.85	31.5	448	11	273.4	30.6	10.7	2.7	1.40	9.85
	autumn	8.31	0.012	0.07	2.64	0.51	31.0	429	12	260.1	37.4	10.1	3.8	1.13	9.75
	winter	8.24	0.010	0.05	2.64	0.34	132.8								

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Median																					
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN	
Mayfield	spring	216	234	33	43.3	84			92	797	3.2	66	283	390	16.7	60.9			12.5	7.1	2.39	0.010	0.99
	summer	218	108	69	46.0	70			92	785	2.2	190	273	316	18.7	130.0			7.7	6.0	0.22	0.010	0.82
	autumn	230	257	25	50.1	81			85	765	2.9	150	288	415	19.4	49.0			2.1	6.0	0.56	0.008	0.83
	winter	249	174	113	58.1	103			158	985	2.4	20	350	341	21.6	66.2			9.5	6.0	3.02	0.010	0.75
80007	spring	213	110	20	55.0	97			263	1370	5.0	45	339	198	22.4	51.3			1.9	1.3	1.59	0.020	0.71
	summer	199	70	27	49.4	77			153	1140	3.6	300	275	113	21.2	30.8			0.9	1.2	0.45	0.009	0.59
	autumn	194	157	11	50.0	81			163	1010	4.1	260	282	202	19.4	21.5			0.8	0.6	0.51	0.008	0.75
	winter	227	117	120	79.2	119			983	3710	4.0	620	424	213	27.0	59.2			11.3	6.3	1.98	0.030	0.78
80006	spring	190	108	28	66.5	93			503	1970	7.0	355	337	242	24.6	51.3			5.5	4.4	0.89	0.020	0.70
	summer	156	56	15	52.6	78			333	1585	5.0	1200	288	168	24.8	22.2			3.3	1.0	0.30	0.010	0.56
	autumn	180	152	10	50.0	85			242	1235	5.2	1100	309	215	22.6	22.9			3.2	1.2	0.54	0.010	0.63
	winter	223	158	90	92.0	157			1420	4570	5.6	1000	543	285	33.9	129.0			14.0	8.0	1.31	0.090	0.67
MM003WM	spring	204	141	160	75.6	119			756	2885	5.7	300	445	350	32.2	123.0			18.7	8.8	0.70	0.045	0.87
	summer	155	177	109	57.0	83			381	1650	5.0	670	287	381	22.4	54.0			10.2	8.0	0.55	0.040	0.66
	autumn	160	195	90	60.0	83			324	1500	4.0	900	308	356	19.6	55.1			6.0	7.0	0.41	0.020	0.72
	winter	189	213	350	108.5	131			2355	8050	8.2	830	465	383	30.7	255.5			16.8	8.1	0.84	0.055	1.04
82003	spring	192	101	45	75.0	103			692	2480	8.0	875	340	192	22.5	67.5			5.1	4.9	0.93	0.040	0.68
	summer	166	46	37	63.1	91			469	1830	5.1	1500	300	144	22.0	29.0			4.3	2.2	0.60	0.020	0.60
	autumn	167	136	49	57.2	75			342	1415	5.2	3300	269	161	16.2	18.1			2.9	1.6	0.65	0.020	0.67
	winter	207	86	210	121.0	147			1680	5320	8.0	2300	489	214	30.0	210.0			16.8	9.1	1.08	0.100	1.00
83104	spring	220	32	16	54.9	82			53	605	1.2	40	253	207	14.8	50.7			1.2	0.9	0.33	0.006	0.48
	summer	228	23	15	61.2	72			48	588	0.8	310	253	164	16.8	39.6			0.7	0.7	0.25	0.006	0.43
	autumn	233	15	16	61.2	79			50	619	0.8	100	268	126	17.3	31.7			0.8	0.8	0.31	0.005	0.44
	winter	243	69	50	60.3	90			54	678	1.0	20	297	217	17.6	54.9			9.7	5.3	0.64	0.006	0.53
83018	spring	216	41	15	65.5				50	592	1.3	35	247	196	14.7	50.7			0.9	0.8	0.57	0.005	0.46
	summer	213	16	25	76.1				52	582	1.1	130	244	175	16.9	41.8			0.8	0.8	0.36	0.008	0.39
	autumn	227	19	12	73.4				52	609	0.7	110	262	153	17.2	36.9			0.8	0.7	0.42	0.006	0.38
	winter	241	74	32	72.4				52	659	1.0	15	287	201	17.3	40.1			9.0	5.0	0.80	0.006	0.41
83009	spring	246	83	17	97.3	78			31	553	1.4	155	262	393	16.0	45.6			1.4	1.2	0.27	0.007	0.40
	summer	268	42	16	137.0	75			17	520	0.8	215	262	346	19.6	43.5			0.6	0.5	0.16	0.009	0.29
	autumn	264	32	13	133.0	76			24	555	1.2	470	272	329	19.0	38.5			0.8	0.8	0.19	0.008	0.30
	winter	262	81	60	118.5	84			41	619	1.2	260	286	419	18.8	50.7			9.2	6.6	0.34	0.007	0.45
83020	spring	220	331	16	81.7	81			59	646	3.0	20	264	526	15.8	60.0			14.0	7.8	0.52	0.004	0.51
	summer	206	501	31	86.3	68			51	587	2.0	190	245	576	17.5	60.5			9.7	6.0	0.25	0.005	0.53
	autumn	215	270	17	89.0	73			50	626	2.0	170	254	462	17.4	35.0			1.7	5.0	0.35	0.002	0.47
	winter	246	162	45	87.0	89			78	758	1.9	30	301	343	18.5	35.8			10.4	5.4	0.79	0.006	0.45
83004	spring	238	194	13	60.0	96			116	862	2.7	50	304	320	15.3	48.7			14.0	7.0	0.		

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Median													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	spring	8.23	0.010	0.05	3.28	0.10	50.6	460	6	339.0	34.1	5.4	3.6	1.00	7.00
	summer	8.23	0.020	0.06	3.53	0.20	53.1	450	6	324.0	30.8	3.0	2.5	1.00	7.00
	autumn	8.21	0.020	0.06	4.53	0.45	46.1	456	8	411.5	39.7	6.9	5.0	1.00	8.00
	winter	8.15	0.010	0.05	3.69	0.10	86.1	580	5	444.0	46.4	3.9	5.5	0.70	6.50
80007	spring	8.31	0.009	0.03					4	543.0		2.2		1.00	7.00
	summer	8.37	0.010	0.04					6	515.0		1.3		1.43	2.79
	autumn	8.37	0.010	0.05					5	490.0		2.9		0.87	2.90
	winter	8.24	0.010	0.04	5.93				3	725.0		3.2		0.75	12.15
80006	spring	8.26	0.007	0.03					5	737.5		3.4		1.70	17.30
	summer	8.45	0.002	0.03					7	644.5		1.5		1.41	7.41
	autumn	8.22	0.005	0.02					8	564.0		3.6		2.18	7.03
	winter	8.22	0.010	0.04					10	1030.0		1.1		1.70	26.20
MM003WM	spring	8.19	0.010	0.04	6.79	0.10	424.0	1540	8	932.5	81.5	2.5	4.5	1.10	21.25
	summer	8.26	0.010	0.06	5.83	0.35	226.0	907	7	720.5	61.2	5.2	3.8	1.70	17.00
	autumn	8.20	0.020	0.06	4.47	0.70	188.0	812	6	622.5	55.8	4.2	5.5	1.00	15.00
	winter	7.97	0.010	0.05	8.95	0.11	1395.0	4570	8	1510.0	83.5	7.7	6.5	1.40	51.65
82003	spring	8.28	0.010	0.04					5	697.0		3.5		1.70	19.70
	summer	8.36	0.020	0.06					5	601.0		1.4		2.82	14.00
	autumn	8.22	0.020	0.05					6	558.0		2.2		1.66	11.60
	winter	8.11	0.010	0.05					8	968.0		1.0		1.70	47.00
83104	spring	8.33	0.007	0.03					5	200.0		1.0		0.87	1.40
	summer	8.40	0.010	0.03					5	205.0		1.0		1.19	0.55
	autumn	8.34	0.004	0.02					5	208.0		0.3		0.58	0.47
	winter	8.21	0.010	0.03					4	217.0		1.8		0.50	5.60
83018	spring	8.44	0.002	0.03					6	215.0		0.9		0.67	0.84
	summer	8.42	0.005	0.02					4	224.0		0.8		1.19	0.36
	autumn	8.38	0.003	0.01					5	237.0		0.9		0.50	0.42
	winter	8.29	0.010	0.02					5	240.5		1.0		0.50	9.00
83009	spring	8.36	0.008	0.03					6	264.0		2.5		0.53	1.51
	summer	8.36	0.010	0.04					13	277.0		1.7		0.79	0.55
	autumn	8.36	0.008	0.03					8	283.0		1.0		0.50	0.80
	winter	8.33	0.010	0.02					6	287.0		1.2		0.50	6.45
83020	spring	8.35	0.010	0.04	1.80	0.10	33.3	376	13	260.0	26.0	7.0	5.3	1.00	11.00
	summer	8.40	0.010	0.04	1.60	0.10	28.8	378	27	275.0	21.5	15.0	6.0	1.80	7.00
	autumn	8.36	0.010	0.02	2.13	0.25	27.4	368	15	293.0	24.2	5.0	4.7	1.00	9.00
	winter	8.30	0.010	0.02	1.90	0.10	41.7	436	12	276.0	30.9	4.1	5.0	0.55	5.55
83004	spring	8.32	0.010	0.02	2.37	0.11	63.4	496	9	282.5	33.5	5.0	3.9	1.00	8.30
	summer	8.35	0.010	0.03	2.49	0.10	53.9	494	8	311.0	33.6	4.0	2.5	1.00	6.00
	autumn	8.32	0.010	0.04	3.00	0.40	50.3	477	6	331.0	34.2	5.0	4.7	0.90	11.60
	winter	8.31	0.010	0.02	2.50	0.13	95.8	643	6	347.0	36.6	2.7	3.4	0.65	7.20
83103	spring	8.34	0.009	0.05					11	384.5		5.9		1.02	4.42
	summer	8.33	0.008	0.08					59	379.0		5.8		2.17	9.91
	autumn	8.32	0.010	0.04					18	369.0		4.7		1.28	3.17
	winter	8.23	0.010	0.04	5.85				9	501.0		8.5		1.00	9.80
HU1RWMP	spring	8.06	0.010	0.08	4.20	0.10	535.0	1720	7	640.5	78.5	3.3	5.0	1.00	28.90
	summer	8.15	0.020	0.08	3.60	0.19	229.0	952	8	389.0	50.1	6.0	4.0	1.60	15.00
	autumn	8.19	0.010	0.06	3.08	0.33	164.0	823	6	435.0	56.4	3.9	4.5	1.00	17.40
	winter	8.00	0.010	0.07	5.73	0.10	1215.0	5110	8	839.0	88.7	4.0	6.6	0.50	48.95
HU010WM	spring	8.36	0.010	0.04	2.15	0.10	65.2	480	19	303.0	32.9	6.0	4.8	1.00	8.55
	summer	8.46	0.010	0.04	2.27	0.14	48.8	456	16	306.0	30.0	6.9	4.1	1.00	7.70
	autumn	8.36	0.010	0.03	2.79	0.35	45.9	440	10	347.0	30.3	5.0	5.2	1.70	9.60
	winter	8.26	0.010	0.04	2.36	0.10	120.0	644	12	354.0	38.4	7.5	4.2	1.00	10.35
83002	spring	8.31	0.010	0.09	4.16	0.16	98.2	608	35	382.0	41.3	21.5	17.5	2.10	22.00
	summer	8.30	0.010	0.08	4.47	0.21	78.8	470	22	341.5	35.5	14.0	9.5	2.40	8.60
	autumn	8.26	0.010	0.09											

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Median																					
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN	
DN008WM	spring	242	101	130	88.4	116			312	1550	5.0	300	371	594	20.4	71.0		17.0	7.9	0.80	0.020	0.61	
	summer	242	104	90	85.9	107			166	1100	3.6	850	342	509	19.0	45.4		4.8	8.0	0.73	0.020	0.55	
	autumn	230	114	54	83.0	101			147	974	3.0	540	327	489	17.7	44.0		3.0	7.0	0.61	0.010	0.50	
	winter	273	73	254	107.5	140			947	3590	4.0	880	436	545	20.8	86.7		9.2	7.0	1.05	0.040	0.84	
DM 6.0	spring	242	63	110	88.3	131			478	2110	6.7	2150	415	451	18.8	92.1		16.0	8.5	2.19	0.050	0.78	
	summer	249	72	110	87.0	122			347	1870	5.0	3200	384	286	18.1	25.1		4.6	8.0	2.18	0.050	0.70	
	autumn	226	133	52	70.9	112			305	1500	5.5	2800	348	348	16.4	44.8		2.6	8.0	2.20	0.040	0.57	
	winter	251	151	370	88.0	153			1120	3820	8.0	4800	469	410	21.1	139.0		13.2	8.0	2.87	0.085	1.14	
85014	spring	228	107	722	86.4	102	51.6	3.6	403	1710	8.6	30000	335	374	18.5	88.9	0.020	2.0	2.4	1.71	0.075	1.91	
	summer	204	122	701	79.1	86	46.7	4.7	204	1110	5.6	12000	279	321	15.6	56.4	0.020	1.9	1.9	1.33	0.145	2.35	
	autumn	210	96	1570	75.7	80	49.2	4.0	178	1025	4.8	6600	269	327	14.8	42.9	0.020	1.8	1.4	1.10	0.120	2.83	
	winter	224	255	648	90.8	111	53.6	3.2	645	2405	7.7	6600	329	574	18.6	86.3	0.020	1.2	1.6	1.66	0.065	1.44	
94002	spring	229	77	70	101.0	127			372	1675	5.0	705	415	290	23.7	61.0		17.0	9.0	1.37	0.030	0.54	
	summer	194	42	32	87.0	111			196	1200	3.0	510	364	162	18.3	25.0		4.4	7.0	0.75	0.010	0.44	
	autumn	211	69	40	93.6	119			270	1380	3.0	1400	382	185	23.1	28.0		2.2	6.0	1.05	0.010	0.42	
	winter	241	137	182	111.0	144			1100	3830	5.0	2700	451	331	21.7	87.2		10.3	7.5	1.58	0.040	0.69	
97999	spring	227	104	24	57.6	95			93	777	1.5	95	285	182	13.4	35.0		12.0	7.0	1.40	0.006	0.60	
	summer	191	118	38	58.9	76			81	680	1.7	200	252	189	14.5	32.0		1.1	6.0	0.38	0.005	0.61	
	autumn	248	181	16	68.5	101			70	775	1.6	220	315	308	14.9	30.0		0.6	6.0	0.90	0.008	0.54	
	winter	261	73	60	70.8	108			121	946	1.6	45	335	194	15.8	26.9		11.8	7.0	1.77	0.008	0.41	
97018	spring	251	29	16	76.6	103			70	746	1.3	55	315	182	13.8	28.5		1.2	1.4	1.06	0.007	0.48	
	summer	251	44	21	89.7	88			56	668	1.2	340	278	178	14.8	29.5		0.9	1.0	0.60	0.006	0.44	
	autumn	260	29	14	89.8	97			60	728	1.4	190	322	175	16.0	18.9		0.8	0.7	0.89	0.007	0.45	
	winter	267	26	70	86.7	110			67	807	1.0	24	342	207	16.1	24.3		13.4	7.0	1.43	0.008	0.40	
97777	spring	205	293	80	78.0	110			345	1520	4.0	330	343	422	16.4	76.0		16.0	7.0	0.62	0.020	0.59	
	summer	197	356	68	65.0	97			174	1030	2.9	1200	314	535	14.5	54.4		5.1	8.0	0.44	0.010	0.63	
	autumn	204	293	42	66.8	95			150	985	2.0	460	299	374	14.8	31.4		2.0	5.0	0.47	0.010	0.49	
	winter	239	115	96	92.8	129			1020	3710	3.0	360	398	278	18.4	85.0		9.3	7.5	0.93	0.020	0.58	
97003	spring	202	386	40	70.8	103			230	1210	3.2	155	323	438	15.6	75.1		15.0	7.4	1.02	0.010	0.72	
	summer	151	240	90	67.0	80			138	883	3.0	800	260	455	13.3	87.0		4.6	7.0	0.50	0.020	0.81	
	autumn	197	163	30	69.0	85			108	874	2.9	510	262	262	13.0	35.3		1.1	7.0	0.57	0.010	0.78	
	winter	242	103	70	87.0	119			542	2290	3.0	210	373	245	18.0	62.9		8.7	7.0	1.41	0.010	0.61	
97013	spring	215	150	21	56.0	97			101	783	1.7	25	297	187	13.2	22.2		15.0	7.0	1.33	0.008	0.54	
	summer	171	98	19	48.1	67			77	637	1.3	140	224	167	13.6	18.7		3.3	6.0	0.18	0.004	0.53	
	autumn	232	71	12	61.0	94			71	749	1.5	120	300	123	14.6	13.3		1.2	5.0	0.73	0.005	0.45	
	winter	260	59	43	64.0	108			126	962	1.5	30	331	126	15.1	16.3		7.6	6.2	1.65	0.007	0.39	
97011	spring	213	125	10	54.0	96			111	808	2.0	16	295	170	13.1	17.0		13.5	8.0	1.10	0.006	0.55	

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Median													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
DN008WM	spring	8.21	0.010	0.04	2.55	0.10	169.0	836	7	425.5	60.3	2.9	6.4	1.00	11.70
	summer	8.23	0.010	0.04	2.66	0.11	96.8	659	9	377.0	43.6	3.2	4.1	1.70	10.00
	autumn	8.20	0.010	0.03	2.75	0.45	80.6	558	6	313.0	49.8	2.2	4.5	1.00	12.00
	winter	8.19	0.010	0.04	4.48	0.11	557.0	2020	4	522.0	72.3	3.0	5.4	0.55	20.25
DM 6.0	spring	8.29	0.015	0.07	3.70	0.10	269.0	1200	11	458.5	63.4	3.0	6.0	1.00	20.80
	summer	8.29	0.020	0.07	3.80	0.37	200.0	1060	4	419.0	54.8	2.3	2.1	1.70	13.00
	autumn	8.27	0.020	0.05	3.40	0.40	170.0	848	4	395.0	46.4	3.8	3.3	1.00	17.00
	winter	8.17	0.010	0.06	4.00	0.22	662.0	2140	10	515.0	72.7	3.0	3.8	1.00	30.00
85014	spring	8.19	0.075	0.19					11	430.5		5.5		1.67	18.25
	summer	8.17	0.070	0.20					16	337.5		3.8		1.82	9.05
	autumn	8.11	0.070	0.18					10	317.0		3.2		1.40	8.03
	winter	8.14	0.075	0.15					20	394.5		5.3		1.91	17.97
94002	spring	8.28	0.010	0.04	3.19	0.10	196.0	1070	5	434.5	72.9	1.2	3.1	1.00	13.00
	summer	8.34	0.010	0.03	2.48	0.20	115.0	728	5	317.0	55.8	1.0	1.9	1.00	8.00
	autumn	8.29	0.010	0.03	2.53	0.10	134.0	816	4	435.0	68.9	1.2	3.0	0.50	10.00
	winter	8.22	0.010	0.03	4.20	0.11	627.0	2220	5	512.0	75.4	4.8	3.3	1.00	26.20
97999	spring	8.31	0.010	0.03	2.20	0.10	50.7	448	8	252.0	33.4	4.4	3.0	0.90	7.60
	summer	8.32	0.010	0.03	2.39	0.10	42.0	424	7	250.0	30.1	3.8	2.8	1.00	6.00
	autumn	8.30	0.010	0.05	2.48	0.25	37.9	460	7	281.0	32.9	5.2	3.3	1.00	8.00
	winter	8.22	0.010	0.03	2.48	0.10	65.7	542	3	271.0	36.5	1.0	2.1	0.50	5.00
97018	spring	8.33	0.002	0.02					5	250.0		1.1		1.00	1.44
	summer	8.38	0.008	0.03					6	245.0		1.9		1.34	0.88
	autumn	8.29	0.004	0.02					5	256.0		0.8		0.86	1.25
	winter	8.25	0.010	0.03					3	261.0		0.7		0.50	5.00
97777	spring	8.20	0.010	0.05	3.41	0.18	191.0	854	13	374.5	61.1	8.2	5.3	1.70	13.90
	summer	8.21	0.010	0.06	2.61	0.10	97.2	598	14	293.0	45.8	11.0	4.0	2.00	8.00
	autumn	8.16	0.010	0.05	2.71	0.30	79.0	610	10	322.0	47.8	8.0	5.4	1.00	12.00
	winter	8.17	0.010	0.04	4.01	0.10	612.0	2050	6	430.0	78.3	3.5	3.4	0.65	21.10
97003	spring	8.33	0.010	0.05	2.87	0.21	130.0	690	14	350.0	54.3	10.0	7.1	1.40	12.20
	summer	8.29	0.010	0.10	2.66	0.11	76.4	512	27	295.0	41.1	7.3	5.5	2.00	13.10
	autumn	8.32	0.010	0.08	2.92	0.35	59.9	507	13	308.0	47.4	6.0	6.0	1.00	6.00
	winter	8.25	0.010	0.04	3.11	0.10	326.0	1330	5	410.0	58.9	2.9	3.0	1.00	14.00
97007	spring	8.39	0.010	0.03	2.19	0.10	54.4	466	5	266.5	32.8	3.0	2.5	0.87	6.00
	summer	8.45	0.010	0.02	2.21	0.15	41.0	396	6	249.0	30.5	3.8	2.5	1.10	5.00
	autumn	8.40	0.010	0.02	2.65	0.25	36.8	432	4	269.0	33.0	3.0	2.1	0.80	5.00
	winter	8.25	0.010	0.02	2.08	0.10	68.5	539	4	284.0	37.0	1.5	2.2	0.50	5.50
97013	spring	8.42	0.010	0.03	2.26	0.10	61.3	465	11	267.0	32.8	5.0	3.5	1.30	7.40
	summer	8.49	0.010	0.02	2.48	0.15	47.6	404	7	246.0	30.5	8.6	2.9	0.90	6.00
	autumn	8.42	0.010	0.02	2.83	0.10	42.3	443	7	288.0	34.1	3.4	3.0	0.70	5.00
	winter	8.32	0.010	0.02	2.16	0.10	69.0	547	7	293.0	37.2	3.0	3.1	0.65	7.50
97011	spring	8.34	0.005	0.03					11	354.0		5.2		1.70	5.00
	summer	8.44	0.004	0.04					12	304.0		3.4		1.84	1.30
	autumn	8.41	0.004	0.03					10	293.0		3.5		1.15	3.03
	winter	8.30	0.010	0.04					22	445.0		9.1		1.60	15.90
104008	spring	8.36	0.003	0.02					4	197.0		1.6		1.00	1.23
	summer	8.44	0.007	0.02					5	205.0		1.8		1.15	0.35
	autumn	8.37	0.005	0.01					4	210.0		1.4		0.69	1.23
	winter	8.28	0.010	0.04					13	207.0		5.4		0.50	7.50
104037	spring	8.35	0.010	0.03	1.90	0.10	42.7	424	9	231.5	30.7	3.5	3.0	0.90	6.80
	summer	8.33	0.010	0.03	1.80	0.11	32.4	401	6	239.0	29.6	3.4	1.7	1.70	6.00
	autumn	8.31	0.010	0.04	2.59	0.40	30.8	422	4	263.0	33.5	2.0	2.1	0.90	5.40
	winter	8.25	0.010	0.04	2.23	0.10	108.0	637	5	261.0	38.5	2.8	2.2	0.50	

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Minimum																					
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN	
Mayfield	spring	101	34	8	34.0	77			67	695	2.3	4	249	197	13.6	30.6		0.3	0.6	0.35	0.004	0.20	
	summer	157	62	8	31.7	49			58	600	1.5	40	195	146	12.7	33.6		0.5	0.1	0.01	0.002	0.55	
	autumn	140	40	8	39.0	51			28	402	1.2	7	160	220	8.1	34.0		0.4	0.2	0.00	0.001	0.29	
	winter	166	51	8	35.0	83			80	738	1.1	5	265	153	13.9	28.9		0.4	0.5	1.04	0.010	0.08	
80007	spring	148	22	7	36.4	59			25	870	3.0	10	192	83	15.5	15.5		0.2	0.0	0.38	0.001	0.20	
	summer	106	19	2	25.2	47			94	554	1.2	25	146	57	9.2	6.4		0.4	0.0	0.01	0.001	0.39	
	autumn	122	12	2	33.2	55			57	524	1.5	5	184	71	13.7	13.7		0.1	0.2	0.06	0.004	0.39	
	winter	129	8	8	42.0	46			122	948	2.1	18	148	89	7.9	28.3		0.5	0.3	0.42	0.010	0.08	
80006	spring	110	30	8	49.8	65			147	838	4.1	40	205	109	12.0	18.5		1.8	0.4	0.33	0.001	0.51	
	summer	75	3	2	32.8	43			88	460	3.0	310	160	20	9.2	13.2		0.6	0.3	0.10	0.005	0.34	
	autumn	97	13	2	32.9	51			106	721	1.8	120	178	87	12.4	6.9		1.2	0.4	0.17	0.006	0.32	
	winter	112	34	8	56.0	66			526	2180	1.5	130	221	165	13.4	42.0		0.5	0.2	0.07	0.010	0.08	
MM003WM	spring	124	67	11	40.6	78			493	1920	3.6	30	269	240	15.2	62.0		3.1	1.3	0.35	0.010	0.27	
	summer	98	65	8	29.2	43			145	747	3.0	150	140	195	7.8	37.8		1.6	0.6	0.15	0.001	0.44	
	autumn	88	30	8	34.5	48			73	645	2.0	25	164	191	8.7	30.7		0.5	0.7	0.22	0.002	0.44	
	winter	82	27	90	50.8	27			435	2480	4.0	10	92	247	5.8	76.0		0.5	1.0	0.00	0.001	0.40	
82003	spring	106	36	8	54.3	83			234	1190	3.8	67	232	130	15.3	28.2		0.7	1.1	0.40	0.020	0.39	
	summer	66	2	2	44.2	51			105	518	2.6	270	165	10	9.6	8.6		1.8	0.5	0.06	0.006	0.41	
	autumn	82	11	2	33.8	39			130	649	3.0	190	128	85	7.6	9.1		1.2	0.3	0.44	0.010	0.31	
	winter	99	24	8	59.3	59			732	2710	1.2	510	217	134	12.3	61.0		0.5	1.4	0.35	0.020	0.08	
83104	spring	210	6	2	48.0	68			45	555	0.6	26	225	117	12.8	34.1		0.4	0.0	0.22	0.001	0.20	
	summer	211	2	2	56.3	63			44	552	0.0	140	106	13	15.0	0.8		0.2	0.1	0.10	0.003	0.31	
	autumn	186	1	2	48.4	72			39	507	0.0	10	233	49	15.9	16.5		0.3	0.1	0.04	0.003	0.22	
	winter	222	16	8	51.0	86			44	613	0.4	6	279	131	15.3	38.0		0.3	0.1	0.50	0.002	0.08	
83018	spring	200	14	6	59.0				43	544	0.4	9	228	81	13.1	36.0		0.3	0.2	0.29	0.002	0.20	
	summer	205	2	2	69.7				49	562	0.1	15	214	46	15.1	26.9		0.1	0.1	0.29	0.004	0.27	
	autumn	189	3	2	60.9				43	514	0.1	20	174	115	9.7	23.1		0.3	0.1	0.26	0.003	0.27	
	winter	212	13	8	61.0				47	612	0.4	10	274	138	15.3	29.0		0.3	0.1	0.64	0.002	0.08	
83009	spring	224	28	3	78.0	71			19	526	0.2	30	237	287	14.1	33.4		0.1	0.1	0.09	0.002	0.20	
	summer	243	2	5	114.0	67			10	475	0.1	80	232	67	17.6	26.5		0.2	0.0	0.12	0.004	0.17	
	autumn	227	2	2	102.0	63			12	507	0.2	100	234	83	17.8	0.1		0.3	0.0	0.11	0.004	0.17	
	winter	238	23	8	76.0	80			26	599	0.5	79	274	282	15.3	38.6		0.3	0.1	0.27	0.002	0.08	
83020	spring	181	59	8	67.0	67			49	605	0.8	8	219	203	12.7	33.3		0.2	0.1	0.15	0.001	0.31	
	summer	161	75	5	81.1	57			38	510	1.0	50	199	166	13.6	22.9		0.1	0.1	0.06	0.001	0.20	
	autumn	90	27	8	67.0	58			40	483	0.7	17	184	143	7.4	20.3		0.4	0.1	0.11	0.001	0.12	
	winter	223	54	8	70.0	84			55	675	0.7	5	283	285	16.7	22.0		0.3	0.3	0.65	0.004	0.05	
83004	spring	153	44	8	51.8	77			86	748	1.0	10	245	186	12.9	32.1		0.3	0.3	0.10	0.001	0.21	
	summer	191	47	8	60.8	74			1	697	1.2	40	242	137	14.0	22.1		0.1	0.1	0.00	0.001	0.20	
	autumn	170	19	8	64.8	66			71	588	0.9	20	209	106	10.4	16.0		0.4					

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Minimum													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	spring	7.13	0.010	0.02	2.26	0.08	43.9	431	2	267.0	29.4	0.2	1.2	0.10	1.50
	summer	7.97	0.007	0.03	2.57	0.08	38.3	363	3	250.0	19.6	0.2	0.7	0.20	0.70
	autumn	7.96	0.005	0.03	2.56	0.08	20.8	278	3	173.0	14.7	0.7	1.5	0.10	0.60
	winter	7.96	0.009	0.02	2.23	0.08	44.3	342	2	299.0	28.8	0.2	1.3	0.10	0.90
80007	spring	8.20	0.001	0.01					2	338.0		0.2		0.20	1.57
	summer	8.23	0.001	0.02					2	288.0		0.2		0.01	0.55
	autumn	7.93	0.001	0.01					1	225.0		0.1		0.26	0.70
	winter	8.06	0.004	0.01	5.93				1	344.0		0.2		0.10	1.50
80006	spring	7.85	0.001	0.01					2	461.0		0.5		0.19	4.93
	summer	8.06	0.001	0.01					3	205.0		0.2		0.40	0.28
	autumn	8.03	0.001	0.01					2	304.0		0.1		0.08	1.35
	winter	8.06	0.003	0.01					2	447.0		0.0		0.50	3.05
MM003WM	spring	8.04	0.008	0.01	0.55	0.08	301.0	400	2	442.0	48.8	0.2	2.3	0.10	8.60
	summer	7.95	0.004	0.04	0.10	0.10	89.1	399	4	286.0	26.5	0.7	0.9	0.30	7.60
	autumn	7.92	0.007	0.03	2.81	0.08	40.7	162	2	293.0	26.3	1.3	1.2	0.10	5.00
	winter	7.68	0.008	0.01	3.30	0.08	261.0	1380	3	408.0	16.4	0.2	2.0	0.40	20.10
82003	spring	7.77	0.005	0.01					2	584.0		0.7		0.64	8.36
	summer	7.84	0.002	0.02					2	228.0		0.1		0.35	0.60
	autumn	7.97	0.006	0.01					1	259.0		0.1		0.14	3.13
	winter	8.00	0.008	0.02					2	462.0		0.2		0.49	4.00
83104	spring	8.12	0.001	0.01					2	176.0		0.2		0.20	0.11
	summer	8.25	0.007	0.02					3	193.0		0.2		0.40	0.12
	autumn	8.09	0.001	0.01					1	172.0		0.1		0.02	0.21
	winter	7.98	0.003	0.02					2	196.0		0.2		0.10	0.70
83018	spring	8.16	0.001	0.01					2	194.0		0.6		0.20	0.35
	summer	8.32	0.001	0.01					2	211.0		0.2		0.50	0.18
	autumn	8.19	0.001	0.01					2	192.0		0.2		0.10	0.08
	winter	8.14	0.002	0.01					2	213.0		0.2		0.10	0.70
83009	spring	8.14	0.002	0.01					2	200.0		0.7		0.20	0.01
	summer	8.29	0.004	0.02					4	264.0		0.1		0.07	0.21
	autumn	8.20	0.005	0.01					3	230.0		0.0		0.07	0.35
	winter	8.17	0.003	0.02					2	243.0		0.2		0.10	0.60
83020	spring	8.21	0.002	0.00	1.00	0.08	30.0	326	2	215.0	20.0	2.1	1.8	0.10	0.10
	summer	8.36	0.002	0.02	0.10	0.08	22.5	318	9	223.0	18.1	3.5	0.8	0.10	0.80
	autumn	8.11	0.002	0.01	1.38	0.08	21.2	282	4	240.0	19.7	0.2	1.8	0.10	0.60
	winter	8.16	0.002	0.01	1.26	0.08	28.9	342	2	253.0	24.3	1.3	1.0	0.10	0.80
83004	spring	7.57	0.002	0.01	1.20	0.08	57.0	412	2	240.0	24.6	0.2	1.6	0.10	0.10
	summer	8.25	0.002	0.01	1.00	0.08	3.8	421	2	275.0	25.2	0.7	0.6	0.10	0.80
	autumn	8.22	0.002	0.01	1.87	0.08	42.1	336	2	241.0	24.4	0.2	1.1	0.10	0.70
	winter	8.17	0.002	0.01	1.60	0.08	55.8	472	2	276.0	31.8	0.2	0.9	0.10	0.80
83103	spring	8.22	0.002	0.02					2	336.0		3.0		0.24	0.78
	summer	8.06	0.002	0.04					14	283.0		3.4		1.15	0.65
	autumn	8.01	0.002	0.01					6	226.0		2.3		0.40	0.02
	winter	8.14	0.007	0.02	5.85				3	367.0		0.2		0.10	1.50
HU1RWMP	spring	7.95	0.009	0.02	1.10	0.08	171.0	640	2	394.0	38.7	0.2	2.2	0.10	8.00
	summer	7.92	0.010	0.03	0.10	0.08	40.1	209	3	118.0	11.2	1.6	1.0	0.60	4.10
	autumn	7.97	0.007	0.04	2.20	0.10	45.1	290	2	186.0	24.0	1.9	1.8	0.10	5.80
	winter	7.84	0.008	0.01	2.30	0.08	266.0	1470	2	281.0	41.6	0.2	1.7	0.30	16.10
HU010WM	spring	7.05	0.005	0.01	1.10	0.08	49.9	431	4	268.0	25.5	2.8	2.3	0.10	0.30
	summer	8.32	0.002	0.01	1.65	0.08	39.2	367	3	288.0	24.2	3.1	0.7	0.30	1.30
	autumn	8.12	0.002	0.01	1.53	0.10	40.3	136	2	255.0	23.6	0.2	1.8	0.10	0.90
	winter	7.78	0.003	0.01	1.55	0.08	71.9	494	2	317.0	7.4	2.1	1.6	0.10	1.00
83002	spring	8.17	0.010	0.04	2.69	0.08	48.9	446	7	269.0	32.4	5.0	4.9	0.30	1.00
	summer	8.05	0.004	0.05	3.15	0.08	38.1	296	9	235.0	20.8	4.5	2.6	0.70	1.40
	autumn	8.15	0.003	0.05	3.47	0.10	41.2	306	12</						

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Minimum																	Maximum				
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN	
DN008WM	spring	104	21	8	54.1	70			152	898	1.9	90	202	426	6.7	45.9			1.1	0.5	0.53	0.004	0.14
	summer	74	17	8	51.1	31			42	312	1.7	130	89	360	3.0	20.9			0.1	0.1	0.38	0.001	0.20
	autumn	99	12	8	44.8	45			65	412	1.2	130	139	358	6.4	29.4			0.5	0.1	0.34	0.010	0.08
	winter	117	21	50	73.9	65			533	2190	1.7	270	202	337	9.7	52.5			0.5	0.4	0.56	0.010	0.08
DM 6.0	spring	104	15	8	55.2	67			113	678	3.5	540	190	257	5.8	34.9			1.6	1.4	0.72	0.010	0.21
	summer	61	26	8	28.9	24			38	270	3.0	570	69	137	2.2	15.0			0.3	0.2	0.43	0.001	0.31
	autumn	76	7	8	34.5	35			74	433	3.1	540	105	144	4.0	14.0			0.5	0.2	0.94	0.010	0.39
	winter	107	22	30	50.1	47			366	1480	1.5	1300	140	281	5.7	53.0			0.5	1.1	0.76	0.020	0.08
85014	spring	94	36	109	58.8	43	21.2	2.8	106	556	5.3	800	129	287	5.3	51.3	0.020	0.7	1.0	0.79	0.020	0.58	
	summer	71	32	2	47.6	51	15.8	3.0	33	236	3.6	340	146	176	7.7	32.3	0.020	0.3	0.5	0.01	0.001	0.57	
	autumn	95	13	130	47.5	41	16.7	2.9	24	411	2.4	10	126	160	5.6	28.3	0.020	0.1	0.3	0.58	0.010	0.30	
	winter	118	29	276	50.0	12	28.2	2.2	147	843	4.1	110	38	342	1.9	58.3	0.020	0.2	0.7	0.94	0.040	0.86	
94002	spring	91	14	8	49.1	41			176	799	2.0	110	122	188	5.0	34.2			0.4	0.9	0.68	0.010	0.20
	summer	98	7	8	33.0	51			46	421	2.0	63	158	91	5.4	11.2			0.5	0.1	0.48	0.010	0.20
	autumn	105	7	8	45.1	58			108	660	1.7	400	181	118	9.0	10.8			0.5	0.1	0.53	0.007	0.32
	winter	140	27	8	72.0	87			348	1710	2.3	550	271	235	13.0	48.0			0.5	1.1	0.47	0.010	0.08
97999	spring	167	25	8	50.3	65			29	697	0.4	10	216	99	8.7	23.0			0.3	0.2	0.59	0.002	0.20
	summer	143	42	8	55.4	58			60	543	1.0	80	188	115	10.7	21.0			0.3	0.1	0.02	0.001	0.29
	autumn	186	32	8	62.2	42			27	521	0.7	20	141	122	8.5	16.4			0.4	0.1	0.18	0.003	0.37
	winter	183	6	8	48.8	78			61	670	0.6	10	232	98	9.1	14.0			0.4	0.2	1.22	0.003	0.08
97018	spring	190	12	2	65.0	84			37	658	0.3	10	250	134	9.6	21.1			0.4	0.0	0.62	0.003	0.20
	summer	172	2	2	80.4	81			40	528	0.4	80	215	15	14.0	1.1			0.0	0.0	0.45	0.004	0.33
	autumn	224	3	2	62.6	79			35	560	0.3	6	263	99	11.3	11.2			0.2	0.1	0.46	0.002	0.27
	winter	195	6	8	59.7	80			54	658	0.4	10	238	128	9.6	15.0			0.4	0.1	0.98	0.003	0.08
97777	spring	125	60	8	59.7	81			160	969	1.6	40	240	209	9.1	48.0			0.7	0.5	0.24	0.003	0.08
	summer	133	49	8	40.3	53			104	686	1.5	130	161	282	6.9	38.0			0.3	0.1	0.24	0.001	0.20
	autumn	141	30	8	54.0	63			58	534	1.0	120	191	196	8.1	21.3			0.5	0.1	0.14	0.006	0.08
	winter	125	24	8	69.4	83			427	1860	1.3	140	257	206	11.6	60.4			0.5	0.5	0.08	0.007	0.08
97003	spring	167	66	8	56.5	83			158	1020	1.4	18	260	181	12.6	36.0			0.6	0.4	0.25	0.002	0.34
	summer	121	68	8	46.7	47			78	604	1.0	60	143	186	6.5	16.0			0.3	0.1	0.16	0.001	0.50
	autumn	125	52	8	46.2	52			50	454	1.2	12	159	162	6.9	26.2			0.5	0.1	0.27	0.010	0.08
	winter	221	22	8	70.8	58			261	1450	1.5	10	178	161	8.0	37.0			0.5	0.3	0.29	0.010	0.08
97007	spring	179	32	8	43.0	77			64	670	0.4	10	231	86	9.5	10.0			0.4	0.3	0.40	0.001	0.20
	summer	144	48	8	43.7	56			65	556	0.5	18	189	97	11.2	11.0			0.4	0.1	0.00	0.001	0.20
	autumn	165	18	8	51.0	60			41	511	0.7	2	211	76	8.7	9.0			0.5	0.1	0.02	0.001	0.14
	winter	199	19	8	50.7	83			78	807	0.5	6	250	83	10.6	7.0			0.4	0.2	1.13	0.004	0.08
97013	spring	195	35	8	46.0	78			0	675	1.0	4	255	78	10.1	9.1			0.2	0.3	0.01	0.002	0.28
	summer	136	67	8	44.4	53			69	548	1.0	10											

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Minimum													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
DN008WM	spring	8.05	0.010	0.02	0.10	0.08	85.7	480	2	265.0	40.5	0.2	2.8	0.10	3.10
	summer	7.93	0.010	0.02	0.10	0.08	27.8	187	2	148.0	10.9	0.2	1.3	0.10	2.30
	autumn	7.62	0.004	0.02	1.88	0.08	41.3	305	1	174.0	22.8	0.2	2.2	0.10	2.20
	winter	7.34	0.010	0.01	0.10	0.08	319.0	1240	2	309.0	45.1	0.2	1.2	0.10	7.00
DM 6.0	spring	7.95	0.010	0.02	0.10	0.08	73.3	357	2	348.0	24.5	0.2	2.8	0.10	5.40
	summer	8.00	0.010	0.03	0.10	0.10	24.5	166	2	113.0	8.6	0.2	0.8	0.10	4.30
	autumn	7.80	0.010	0.03	1.67	0.10	43.9	256	1	159.0	14.8	0.2	1.5	0.20	7.10
	winter	7.90	0.006	0.02	0.10	0.10	221.0	788	2	218.0	27.0	0.2	1.3	0.10	5.00
85014	spring	7.97	0.010	0.04					4	239.0		1.5		0.44	6.70
	summer	7.70	0.001	0.08					5	190.0		0.3		0.57	4.13
	autumn	7.70	0.010	0.04					2	175.0		0.2		0.25	4.47
	winter	8.00	0.020	0.08					3	204.0		1.1		1.16	7.54
94002	spring	7.91	0.008	0.01	0.10	0.08	109.0	440	2	312.0	20.6	0.2	1.0	0.10	5.80
	summer	8.15	0.002	0.01	0.10	0.08	32.4	258	2	146.0	16.1	0.2	0.7	0.20	1.90
	autumn	7.98	0.002	0.01	1.51	0.08	58.9	395	1	188.0	27.4	0.2	1.1	0.10	1.90
	winter	8.09	0.006	0.01	0.10	0.08	216.0	515	2	362.0	48.6	0.2	1.7	0.20	4.00
97999	spring	8.21	0.002	0.02	1.45	0.08	33.9	375	2	226.0	15.4	0.2	0.8	0.10	0.40
	summer	8.16	0.002	0.02	1.60	0.08	30.9	296	3	221.0	24.8	1.0	0.6	0.20	0.70
	autumn	8.01	0.002	0.01	1.30	0.08	14.3	328	5	205.0	17.2	2.1	0.9	0.10	1.10
	winter	8.00	0.004	0.01	1.62	0.08	33.1	362	2	205.0	23.7	0.2	0.7	0.10	0.60
97018	spring	8.20	0.001	0.01					2	209.0		0.5		0.10	0.17
	summer	8.20	0.002	0.02					2	231.0		0.2		0.50	0.13
	autumn	8.24	0.001	0.01					2	233.0		0.0		0.10	0.17
	winter	8.09	0.002	0.01					1	199.0		0.2		0.10	0.60
97777	spring	8.07	0.002	0.02	1.10	0.08	97.6	535	2	313.0	46.6	0.2	2.2	0.10	2.70
	summer	7.80	0.005	0.03	0.10	0.08	62.8	60	7	218.0	24.5	4.5	0.9	0.70	2.30
	autumn	8.01	0.002	0.02	1.80	0.08	36.3	363	3	221.0	36.2	2.5	1.8	0.10	1.60
	winter	7.15	0.007	0.02	0.10	0.08	248.0	1080	2	344.0	54.5	0.2	1.1	0.10	5.10
97003	spring	8.14	0.004	0.02	1.50	0.08	93.5	559	7	307.0	39.2	0.8	2.3	0.10	1.80
	summer	8.04	0.005	0.05	1.97	0.08	47.7	338	8	195.0	22.7	3.0	0.6	0.90	1.50
	autumn	7.99	0.003	0.03	2.05	0.08	31.1	132	3	222.0	26.4	1.0	1.6	0.10	1.40
	winter	8.13	0.002	0.01	1.50	0.08	159.0	782	2	326.0	22.8	0.2	1.6	0.10	3.10
97007	spring	8.17	0.002	0.01	0.20	0.08	39.2	352	2	220.0	27.6	0.2	1.5	0.10	0.50
	summer	8.35	0.002	0.02	1.97	0.08	32.7	310	2	224.0	25.3	0.7	0.7	0.50	0.40
	autumn	8.19	0.002	0.01	1.93	0.08	23.9	245	1	212.0	27.7	0.2	1.1	0.10	0.50
	winter	8.00	0.002	0.01	1.59	0.08	48.0	458	1	220.0	27.5	0.2	0.5	0.10	0.80
97013	spring	8.28	0.002	0.02	1.62	0.08	40.9	355	2	240.0	1.2	0.2	1.0	0.10	0.10
	summer	8.39	0.002	0.01	0.10	0.08	36.2	307	5	233.0	24.4	3.9	1.4	0.40	0.40
	autumn	8.37	0.002	0.01	1.76	0.08	28.6	321	2	220.0	29.8	1.5	1.1	0.10	0.50
	winter	8.17	0.002	0.01	1.70	0.08	43.3	362	2	212.0	23.3	0.2	0.6	0.10	0.50
97011	spring	8.04	0.001	0.02					4	323.0		1.0		0.55	0.38
	summer	8.22	0.001	0.01					3	190.0		0.3		0.20	0.13
	autumn	8.20	0.001	0.01					3	232.0		1.5		0.10	0.24
	winter	8.03	0.006	0.02					5	259.0		1.0		0.30	1.15
104008	spring	8.12	0.001	0.01					1	187.0		0.6		0.01	0.35
	summer	8.31	0.001	0.01					2	184.0		0.2		0.12	0.19
	autumn	8.21	0.002	0.01					1	152.0		0.1		0.03	0.35
	winter	8.14	0.002	0.02					2	177.0		0.2		0.10	0.90
104037	spring	8.15	0.002	0.02	0.70	0.08	28.8	370	1	196.0	14.5	0.2	0.8	0.10	0.20
	summer	8.23	0.007	0.02	1.20	0.08	23.7	294	2	196.0	24.1	0.2	0.7	0.10	0.70
	autumn	8.17	0.002	0.01	1.52	0.10	18.7	292	2	147.0	25.8	0.2	1.0	0.10	0.80
	winter	8.04	0.005	0.01	1.46	0.08	31.0	412	2	227.0	27.5	0.2	1.3	0.10	0.60
104029	spring	8.23	0.002</td												

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Maximum																		Nickel	Nitrates	Nitrite	TKN
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel				
Mayfield	spring	247	984	100	97.4	93			223	1120	5.3	1100	314	1080	22.0	149.0		22.0	10.7	4.96	0.030	1.18	
	summer	252	1680	200	68.0	92			141	965	8.1	5500	309	1880	25.5	288.0		19.0	10.9	5.13	0.140	3.63	
	autumn	286	4570	200	85.0	100			113	951	8.3	6700	348	4190	31.5	196.0		24.0	13.2	6.49	0.040	2.07	
	winter	291	381	200	76.0	137			494	2140	3.1	330	460	571	28.5	102.0		27.0	12.8	5.98	0.040	1.10	
80007	spring	268	956	214	73.5	117			605	2260	10.8	2100	404	1100	27.2	101.0		20.0	11.8	3.88	0.060	1.16	
	summer	241	1010	78	65.3	102			392	1680	5.9	20000	410	1780	37.6	99.1		3.6	5.3	1.55	0.030	1.10	
	autumn	278	1140	42	73.8	100			1080	3560	12.6	14000	426	1740	32.8	239.0		3.3	3.0	5.51	0.050	1.93	
	winter	318	801	480	102.0	154			2790	9130	9.0	2900	545	1060	38.9	124.0		28.0	13.7	7.22	0.330	1.80	
80006	spring	245	4610	260	201.0	155			1080	4140	67.0	12000	555	6960	40.7	546.0		31.0	17.1	1.77	0.080	2.88	
	summer	194	2000	36	74.4	96			602	2270	25.8	7600	381	3760	35.4	251.0		5.4	5.8	1.26	0.020	1.15	
	autumn	245	834	45	74.8	105			660	2510	11.7	13000	490	1530	31.5	111.0		6.7	4.0	2.66	0.050	2.00	
	winter	285	6240	210	190.0	355			8350	20400	27.4	3700	1070	6840	52.3	315.0		28.0	17.2	3.90	0.830	1.83	
MM003WM	spring	239	1870	272	197.0	200			2740	9220	14.0	3900	678	2090	50.4	333.0		32.0	13.4	2.04	0.420	1.75	
	summer	195	1950	200	103.0	117			707	2690	13.0	20000	432	2780	38.4	321.0		24.0	13.0	7.86	0.150	1.34	
	autumn	233	4990	215	123.0	120			684	2650	27.0	20000	478	7530	43.5	333.0		26.0	14.0	1.72	0.180	7.49	
	winter	314	6370	1100	174.0	286			6380	17100	38.4	8000	803	6940	54.6	406.0		31.0	19.7	5.34	0.860	3.72	
82003	spring	239	4970	200	230.0	145			1960	6670	60.0	8000	514	6320	37.6	551.0		38.0	16.0	1.62	0.080	3.35	
	summer	361	2220	200	87.9	111			714	2620	31.6	18000	406	4200	32.2	236.0		14.0	12.0	1.23	0.060	1.00	
	autumn	254	1070	92	96.8	123			711	2540	46.8	20000	444	2330	29.6	743.0		7.7	8.0	1.44	0.050	2.41	
	winter	272	10100	750	200.0	225			6910	19300	61.3	20000	776	4130	52.1	403.0		32.0	21.2	1.99	0.890	3.90	
83104	spring	235	112	71	68.9	89			73	713	3.3	220	288	364	16.2	115.0		19.0	11.0	0.70	0.010	0.67	
	summer	237	66	65	73.0	84			57	620	3.7	680	278	275	18.0	59.6		5.5	0.8	0.44	0.010	0.82	
	autumn	249	304	43	75.7	87			58	666	2.3	3100	299	1280	19.4	338.0		1.8	1.7	0.42	0.010	1.40	
	winter	250	215	279	88.0	94			66	713	9.0	200	306	391	18.8	98.8		24.0	12.1	0.77	0.010	0.74	
83018	spring	229	87	39	78.0				56	620	2.4	240	268	285	16.5	77.3		19.0	8.0	0.93	0.020	0.61	
	summer	231	65	48	92.5				57	595	1.9	310	270	296	18.0	54.9		3.2	1.9	0.48	0.010	1.28	
	autumn	241	309	37	87.1				144	1330	4.0	1800	311	834	19.0	161.0		7.0	9.0	0.68	0.009	1.03	
	winter	245	179	200	85.0				65	691	3.4	260	300	382	18.4	55.7		24.0	12.1	1.03	0.020	0.70	
83009	spring	277	265	77	143.0	89			68	690	3.0	260	296	636	18.7	90.2		18.0	10.9	0.97	0.010	1.02	
	summer	277	250	53	164.0	85			30	593	3.5	670	285	897	20.0	83.8		2.3	0.8	0.25	0.010	0.63	
	autumn	279	477	48	159.0	85			150	909	13.1	4400	289	1820	20.4	194.0		1.0	2.3	1.72	0.020	1.03	
	winter	280	382	325	143.0	93			114	862	3.0	1400	305	740	20.5	63.3		33.0	42.0	1.29	0.010	0.90	
83020	spring	239	8230	200	157.0	108			121	833	12.0	210	335	9180	18.1	281.0		22.0	15.0	0.97	0.010	1.48	
	summer	235	1720	200	127.0	79			59	638	5.0	1300	262	1910	22.6	341.0		20.0	10.4	0.51	0.020	0.80	
	autumn	245	6420	200	187.0	86			1080	4060	13.0	20000	284	8020	19.5	376.0		25.0	16.0	1.10	0.040	1.43	
	winter	272	632	200	97.7	103			105	941	3.0	120	328	941	19.6	63.0		24.0	12.6	1.03	0.010	0.90	
83004	spring																						

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Maximum													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	spring	8.41	0.030	0.08	5.08	1.00	115.0	640	24	413.0	189.0	23.0	22.0	2.00	34.20
	summer	8.31	0.180	0.32	8.60	4.00	85.1	564	34	1190.0	48.0	55.1	25.0	4.20	22.00
	autumn	8.42	0.210	0.43	7.19	1.00	68.0	546	48	523.0	48.6	73.7	48.0	8.00	45.80
	winter	8.29	0.060	0.13	8.46	1.00	263.0	1230	44	661.0	94.1	10.5	13.0	1.70	19.90
80007	spring	8.49	0.020	0.16					25	777.0		16.0		2.42	21.80
	summer	8.56	0.040	0.62					76	750.0		8.0		11.40	26.20
	autumn	8.49	0.190	0.38					127	834.0		10.5		3.46	69.00
	winter	8.44	0.050	0.10	5.93				38	1210.0		19.2		2.00	66.80
80006	spring	8.50	0.070	0.55					349	1200.0		109.0		15.00	379.00
	summer	8.53	0.020	0.31					230	903.0		13.8		10.80	107.00
	autumn	8.50	0.090	0.49					110	936.0		11.6		4.26	46.80
	winter	8.32	0.030	0.37					184	1380.0		162.0		14.40	145.00
MM003WM	spring	8.36	0.030	0.13	17.00	1.00	1700.0	5240	57	1430.0	188.0	30.0	19.0	4.00	100.00
	summer	8.54	0.030	0.13	16.20	4.00	403.0	1650	44	1520.0	79.8	34.0	14.0	4.80	79.00
	autumn	8.48	0.050	0.40	11.40	1.50	363.0	1770	218	1330.0	83.8	99.0	20.0	12.00	186.00
	winter	8.29	0.020	0.36	52.40	1.00	3910.0	10200	256	2490.0	158.0	120.0	68.0	13.30	248.00
82003	spring	8.45	0.050	0.60					436	1660.0		96.0		12.00	351.00
	summer	8.53	0.070	0.30					252	1050.0		16.2		10.90	161.00
	autumn	8.56	0.060	0.58					190	894.0		9.6		5.30	178.00
	winter	8.35	0.040	0.42					320	1480.0		139.0		29.30	279.00
83104	spring	8.42	0.010	0.04					11	253.0		3.3		1.70	11.50
	summer	8.66	0.020	0.05					9	227.0		2.0		8.45	25.20
	autumn	8.63	0.020	0.18					93	253.0		6.4		0.85	6.12
	winter	8.34	0.020	0.08					51	322.0		4.0		1.70	53.40
83018	spring	8.47	0.010	0.08					16	256.0		2.8		2.30	5.00
	summer	8.63	0.010	0.03					23	245.0		2.0		9.18	23.00
	autumn	8.61	0.010	0.11					67	332.0		9.0		0.95	14.00
	winter	8.37	0.020	0.05					12	349.0		3.0		1.70	18.90
83009	spring	8.50	0.010	0.10					88	291.0		5.5		1.81	11.90
	summer	8.48	0.020	0.11					41	306.0		4.1		9.33	19.90
	autumn	8.50	0.030	0.17					61	320.0		8.4		2.06	27.80
	winter	8.41	0.020	0.06					18	421.0		9.0		1.70	59.00
83020	spring	8.50	0.030	0.26	2.63	1.00	64.9	482	284	303.0	39.7	154.0	130.0	15.00	62.00
	summer	8.49	0.030	0.09	2.10	4.00	32.2	516	64	744.0	24.9	78.0	23.0	4.00	34.00
	autumn	8.48	0.010	0.37	3.98	1.00	643.0	2210	299	554.0	38.9	158.0	73.0	13.60	110.00
	winter	8.44	0.020	0.11	3.63	1.00	68.0	492	76	394.0	43.6	13.0	37.0	1.70	18.80
83004	spring	8.46	0.030	0.08	4.66	1.00	152.0	762	38	366.0	132.0	25.8	30.0	2.30	17.00
	summer	8.45	0.020	0.21	3.99	4.00	66.2	600	100	825.0	41.2	48.8	20.0	2.30	11.30
	autumn	8.41	0.020	0.39	5.60	1.00	196.0	850	246	376.0	50.3	189.0	70.0	15.20	121.00
	winter	8.44	0.020	0.06	7.28	1.00	287.0	1150	63	498.0	58.3	15.0	22.0	1.70	26.00
83103	spring	8.45	0.030	0.07					46	512.0		26.0		2.68	32.40
	summer	8.59	0.040	0.38					163	482.0		12.6		10.70	23.50
	autumn	8.53	0.110	0.25					111	467.0		11.4		4.43	35.80
	winter	8.39	0.020	0.09	5.85				59	709.0		56.0		4.10	42.60
HU1RWMP	spring	8.24	0.100	0.36	9.12	1.00	1670.0	5050	202	1270.0	125.0	110.0	45.0	11.20	153.00
	summer	8.25	0.050	0.27	7.90	4.00	431.0	1920	106	1370.0	92.3	23.0	33.2	5.00	48.00
	autumn	8.31	0.030	0.10	12.40	1.00	426.0	1740	87	749.0	82.0	34.0	44.8	3.00	121.00
	winter	8.33	0.310	0.34	71.40	1.00	4620.0	14800	101	1480.0	544.0	86.0	78.0	8.00	119.00
HU010WM	spring	8.50	0.020	0.07	3.79	1.00	206.0	882	55	368.0	180.0	38.6	31.0	2.50	135.00
	summer	8.57	0.030	0.10	2.99	4.00	83.5	572	64	879.0	37.0	32.0	18.4	3.70	23.00
	autumn	8.49	0.030	0.33	7.33	1.00	179.0	804	222	711.0	67.5	114.0	36.0	11.70	106.00
	winter	8.39	0.020	0.07	6.32	1.00	438.0	1660	35	439.0	57.4	22.0	20.0	1.70	66.60
83002	spring	8.53	0.050	0.15	5.18	1.00	205.0	2920	88	46					

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Maximum																				
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	TKN
85003	spring	264	2040	280	111.0	130			474	2070	13.7	8700	414	2680	21.8	163.0		30.0	15.8	1.59	0.050	1.20
	summer	252	2240	210	134.0	113			2780	1130	13.0	20000	372	3330	21.8	309.0		21.0	12.1	16.20	0.650	2.33
	autumn	278	2720	200	170.0	116			250	1360	7.0	20000	374	2990	21.0	110.0		27.0	13.0	1.34	0.070	1.45
	winter	289	4650	420	178.0	158			2850	9120	13.9	16000	485	4830	24.4	175.0		24.0	13.6	1.93	0.170	1.64
DN008WM	spring	285	1700	200	115.0	140			949	3800	16.6	13000	453	2180	26.3	136.0		32.0	15.2	1.27	0.060	1.94
	summer	294	4870	200	114.0	126			237	1360	30.0	20000	419	7090	25.4	358.0		21.0	18.0	6.93	0.060	1.98
	autumn	310	4440	200	165.0	134			591	2350	10.0	20000	433	4890	25.3	99.0		26.0	14.0	1.19	0.060	1.33
	winter	315	2720	630	152.0	169			3060	9810	18.1	3600	529	3020	27.4	139.0		28.0	14.0	1.82	0.430	1.80
DM 6.0	spring	292	5110	2150	163.0	175			730	2830	44.2	25000	555	6370	28.6	414.0		27.0	18.4	3.23	0.200	1.74
	summer	280	1190	280	106.0	158			504	2220	12.1	26000	503	1200	26.3	104.0		36.0	14.0	10.80	0.150	1.38
	autumn	319	1840	571	117.0	161			538	2360	14.0	20000	514	2230	27.3	85.3		26.0	13.6	3.25	0.630	1.54
	winter	310	3980	1080	129.0	580			3720	13100	27.1	11000	1837	3940	94.3	306.0		26.0	15.2	5.99	2.580	1.89
85014	spring	257	1370	3870	106.0	112	60.5	7.3	998	3330	20.4	78000	425	2650	20.6	329.0	0.180	5.4	7.7	2.76	0.110	6.60
	summer	262	6420	4610	120.0	140	61.8	8.7	309	1400	52.6	140000	400	1510	21.2	518.0	0.030	13.9	20.3	2.31	0.390	5.70
	autumn	280	1780	5810	104.0	112	64.0	11.3	526	1950	26.7	120000	384	3480	20.5	390.0	0.110	5.5	4.9	2.41	0.450	5.95
	winter	269	792	3990	155.0	131	66.5	6.1	2440	7240	31.6	97000	412	995	20.6	170.0	0.020	5.5	3.5	2.52	0.100	5.02
94002	spring	265	2800	320	121.0	152			719	2740	16.1	5900	488	3250	27.2	174.0		24.0	16.1	2.09	0.120	1.56
	summer	228	648	200	121.0	140			391	1810	5.0	4200	443	611	28.3	63.0		20.0	12.0	1.63	0.090	1.00
	autumn	275	815	200	125.0	137			544	2170	14.0	20000	454	1180	28.8	119.0		24.0	15.2	2.19	0.390	1.63
	winter	281	1510	320	157.0	189			8400	8140	10.0	20000	602	1840	31.6	154.0		25.0	14.5	3.45	0.160	1.16
97999	spring	262	752	200	87.0	111			129	847	6.0	170	338	840	15.9	85.3		20.0	15.2	3.02	0.040	0.93
	summer	228	1890	200	126.0	91			101	745	3.0	1200	290	2020	16.2	106.0		18.0	11.8	0.98	0.040	0.98
	autumn	277	2130	200	109.0	114			118	874	4.0	2500	344	2310	16.5	120.0		22.0	11.7	2.03	0.020	0.87
	winter	294	599	200	161.0	123			487	2040	3.0	1700	374	1490	17.9	38.3		22.0	12.7	8.31	0.020	1.20
97018	spring	264	733	200	95.9	115			102	825	4.0	240	352	953	15.8	57.7		22.0	14.8	2.60	0.070	8.35
	summer	266	5510	75	259.0	99			72	752	9.2	5400	308	340	16.8	872.0		2.3	10.7	1.67	0.060	25.00
	autumn	293	344	91	111.0	116			71	824	2.7	870	368	492	17.7	67.0		3.3	3.3	2.41	0.010	0.85
	winter	300	765	200	107.0	129			104	866	3.7	530	393	1710	18.0	67.2		24.0	25.0	3.82	0.020	1.19
97777	spring	242	1940	200	181.0	132			785	2940	9.1	3000	415	2240	21.8	173.0		33.0	12.5	1.37	0.070	5.60
	summer	232	1960	200	97.0	114			242	1270	6.1	9900	374	2370	22.3	131.0		22.0	12.8	7.66	0.090	0.96
	autumn	263	2550	200	136.0	121			494	2010	7.0	20000	376	2850	21.4	119.0		25.0	14.0	1.12	0.060	1.17
	winter	277	3650	260	127.0	150			2690	5480	12.9	2600	469	3680	23.4	180.0		25.0	14.3	6.35	0.280	2.15
97003	spring	235	1370	200	143.0	118			632	2340	6.8	4000	359	1810	19.4	157.0		32.0	12.9	1.87	0.050	1.17
	summer	201	1640	200	112.0	96			211	1130	7.0	20000	322	1900	20.1	155.0		18.0	11.4	5.68	0.060	1.23
	autumn	269	2510	200	185.0	109			526	2080	7.0	20000	350	2460	19.6	246.0		27.0	12.7	1.70	0.080	1.49
	winter	298	1430	200	126.0	154			1290	445												

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Maximum													
		pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
85003	spring	8.35	0.020	0.18	3.20	1.00	277.0	1170	96	644.0	141.0	61.6	17.0	5.10	80.20
	summer	8.33	0.160	0.74	88.10	4.00	1390.0	724	583	947.0	45.9	67.0	165.0	6.00	55.00
	autumn	8.36	0.060	0.19	73.50	1.00	151.0	780	89	544.0	58.1	73.0	55.0	6.00	115.00
	winter	8.36	0.030	0.23	18.20	1.00	1850.0	4940	149	728.0	285.0	116.0	68.0	8.40	76.80
DN008WM	spring	8.33	0.020	0.22	3.80	1.00	566.0	2110	91	675.0	74.0	74.9	18.0	4.70	93.40
	summer	8.37	0.130	0.66	3.84	4.00	130.0	908	509	896.0	66.3	161.0	113.0	13.00	123.00
	autumn	8.33	0.030	0.19	9.30	9.30	365.0	1320	102	541.0	75.1	113.0	90.0	10.00	123.00
	winter	8.28	0.030	0.26	21.30	1.00	2040.0	5460	105	770.0	165.0	103.0	65.0	5.70	109.00
DM 6.0	spring	8.39	0.060	0.57	6.71	1.00	434.0	1590	265	659.0	75.5	202.0	31.0	13.10	170.00
	summer	8.42	0.070	0.31	7.93	4.00	287.0	1510	169	1070.0	68.9	26.2	34.7	8.50	44.00
	autumn	8.38	0.050	0.21	7.49	3.00	288.0	1530	92	642.0	77.3	53.0	34.9	5.00	44.00
	winter	8.28	0.040	0.20	14.50	1.00	2390.0	7110	134	925.0	275.0	124.0	63.0	10.30	123.00
85014	spring	8.36	0.180	0.88					600	527.0		15.5		6.81	69.10
	summer	8.40	0.200	0.62					794	427.0		47.3		17.40	156.00
	autumn	8.35	0.340	0.91					658	444.0		28.5		7.28	141.00
	winter	8.23	0.170	0.22					91	619.0		14.3		10.50	52.90
94002	spring	8.38	0.030	0.29	4.35	1.00	400.0	1610	238	624.0	85.9	109.0	47.9	7.60	91.20
	summer	8.46	0.020	0.09	3.05	17.00	190.0	1290	19	1250.0	85.0	27.2	9.2	5.40	18.00
	autumn	8.44	0.020	0.30	7.48	1.00	314.0	1250	25	625.0	84.9	27.0	5.9	3.00	35.00
	winter	8.31	0.030	0.12	22.10	1.00	2050.0	4650	64	618.0	108.0	51.0	15.0	3.00	58.10
97999	spring	8.48	0.020	0.08	3.00	1.00	72.0	533	27	358.0	37.2	21.0	30.0	2.00	26.00
	summer	8.38	0.030	0.12	2.98	4.00	53.0	458	36	780.0	32.3	57.8	6.2	4.00	57.00
	autumn	8.38	0.030	0.08	3.82	1.00	61.0	528	40	353.0	54.6	62.0	9.2	4.00	30.00
	winter	8.38	0.020	0.15	3.57	1.00	282.0	1120	21	340.0	115.0	18.5	7.5	1.80	31.00
97018	spring	8.45	0.030	0.07					59	343.0		16.2		1.70	21.10
	summer	8.55	0.100	1.46					803	269.0		29.7		18.10	74.00
	autumn	8.36	0.020	0.08					47	340.0		9.8		1.92	10.40
	winter	8.38	0.020	0.20					16	330.0		25.8		1.80	34.30
97777	spring	8.30	0.020	0.16	4.00	1.00	442.0	1700	86	719.0	84.5	60.0	26.6	4.19	62.50
	summer	8.34	0.030	0.28	3.73	4.00	124.0	822	129	736.0	66.5	66.4	13.8	4.60	31.00
	autumn	8.34	0.020	0.17	7.66	1.00	294.0	1130	178	465.0	75.6	79.7	40.0	5.70	95.00
	winter	8.35	0.020	0.47	14.50	1.00	1790.0	2940	122	498.0	237.0	93.7	53.0	7.60	77.20
97003	spring	8.46	0.020	0.16	3.84	1.00	367.0	1320	128	520.0	61.7	44.1	40.0	3.70	53.00
	summer	8.51	0.030	0.41	3.50	4.00	120.0	687	228	631.0	54.6	58.3	41.0	4.80	40.00
	autumn	8.42	0.020	0.20	8.13	1.00	321.0	1160	113	436.0	57.9	68.6	48.0	5.00	137.00
	winter	8.44	0.020	0.13	17.00	1.00	758.0	2440	78	619.0	99.6	41.0	18.0	3.00	51.00
97007	spring	8.47	0.020	0.07	3.09	1.00	128.0	710	26	366.0	126.0	21.0	12.6	1.70	30.00
	summer	8.59	0.020	0.81	2.99	4.00	56.3	492	22	562.0	37.4	15.2	8.2	3.50	12.00
	autumn	8.52	0.030	0.12	5.70	1.00	99.3	644	86	348.0	53.9	74.0	52.0	6.00	86.00
	winter	8.47	0.020	0.15	3.46	1.00	138.0	698	46	412.0	58.2	46.4	27.0	2.90	23.30
97013	spring	8.55	0.020	0.15	3.00	1.00	140.0	752	155	394.0	44.9	65.0	44.3	3.80	24.80
	summer	8.60	0.020	0.06	3.31	4.00	61.1	450	36	766.0	35.5	18.0	14.0	3.80	13.70
	autumn	8.56	0.020	0.06	3.55	1.00	116.0	1340	12	362.0	61.2	17.0	6.0	1.70	48.00
	winter	8.43	0.020	0.25	4.12	1.00	129.0	728	101	369.0	58.3	82.9	12.0	4.30	44.40
97011	spring	8.46	0.010	0.56					519	429.0		30.5		7.83	46.80
	summer	8.52	0.020	0.16					103	491.0		33.0		10.00	22.10
	autumn	8.54	0.010	0.06					31	396.0		8.5		2.91	26.40
	winter	8.38	0.020	0.22					77	650.0		84.1		4.80	53.90
104008	spring	8.46	0.040	0.44					306	302.0		33.0		4.70	21.60
	summer	8.59	0.010	0.04					19	216.0		6.2			

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Standard Deviation																		TKN		
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Nitrates	Nitrite	
Mayfield	spring	37	272	36	15.0	4			39	101	0.8	303	17	261	2.3	37.7		7.8	3.4	1.20	0.008	0.28
	summer	30	515	67	9.0	14			22	100	1.9	1807	37	474	3.8	72.0		6.7	3.9	1.44	0.038	0.84
	autumn	41	1248	76	11.5	16			22	130	2.0	1716	50	1078	5.4	46.7		6.1	4.8	2.12	0.009	0.41
	winter	37	120	71	10.4	14			112	378	0.6	111	51	134	4.1	19.9		10.0	4.3	1.53	0.008	0.26
80007	spring	31	234	72	9.7	16			166	393	2.1	644	68	251	3.8	21.9		7.4	4.0	1.00	0.014	0.26
	summer	42	249	22	10.9	19			85	305	1.1	6652	72	432	8.9	25.9		0.9	1.4	0.54	0.008	0.21
	autumn	48	365	12	10.7	16			259	726	3.4	3697	73	563	5.9	65.0		0.8	1.0	1.58	0.015	0.45
	winter	52	297	133	17.7	31			741	2371	2.5	1036	112	321	8.6	30.0		10.2	4.4	1.73	0.082	0.45
80006	spring	39	1518	87	37.6	23			208	740	16.3	3365	90	2270	8.3	155.2		9.2	5.2	0.39	0.024	0.71
	summer	26	517	9	11.6	19			144	479	5.8	2295	72	962	10.3	62.3		1.5	2.1	0.30	0.005	0.21
	autumn	39	259	14	13.1	20			149	493	2.9	4290	85	420	6.3	34.3		1.6	0.9	0.70	0.012	0.42
	winter	56	1940	75	34.5	71			2053	5015	7.9	1253	211	2140	12.6	98.7		9.7	5.4	0.91	0.206	0.46
MM003WM	spring	37	474	77	36.6	35			636	1935	2.7	1054	129	478	10.9	73.6		8.8	3.8	0.49	0.105	0.39
	summer	30	593	73	19.8	22			186	616	2.7	4993	91	762	9.5	71.3		8.2	4.3	1.92	0.044	0.29
	autumn	42	1377	80	27.7	21			170	586	6.8	5859	91	1977	9.7	83.3		6.4	4.8	0.38	0.043	1.76
	winter	64	1680	319	34.4	69			1907	4455	9.2	2886	198	1756	12.7	102.5		11.2	5.5	1.30	0.236	0.94
82003	spring	39	1728	69	45.1	23			396	1297	15.6	3115	89	2360	7.5	171.5		11.4	5.1	0.35	0.020	0.91
	summer	61	541	52	13.0	18			169	564	7.1	4899	74	1048	7.8	54.9		3.1	3.3	0.30	0.017	0.21
	autumn	47	327	29	19.9	27			181	543	11.1	6928	96	703	7.0	186.8		1.6	1.8	0.26	0.013	0.50
	winter	58	2846	226	43.2	54			1925	5136	17.3	5687	178	1134	12.4	127.8		10.3	5.2	0.51	0.295	1.00
83104	spring	8	31	19	5.6	6			7	37	0.9	78	18	70	1.2	21.2		7.0	3.8	0.16	0.003	0.11
	summer	9	16	17	4.9	6			3	20	1.1	170	41	62	0.9	13.4		1.4	0.3	0.10	0.002	0.12
	autumn	15	78	13	6.1	6			5	42	0.7	1045	18	300	1.0	80.0		0.3	0.4	0.11	0.002	0.29
	winter	11	67	83	8.8	2			7	27	2.2	51	6	79	1.1	16.8		9.1	4.1	0.08	0.002	0.16
83018	spring	7	26	10	6.1				4	20	0.6	74	14	54	1.1	14.5		6.5	2.8	0.18	0.005	0.11
	summer	7	17	13	6.4				2	11	0.5	80	14	66	0.9	9.2		0.8	0.5	0.06	0.002	0.24
	autumn	15	90	9	6.7				23	190	1.0	444	31	182	2.6	32.1		1.6	2.1	0.11	0.002	0.19
	winter	12	47	61	5.9				5	21	0.8	75	7	64	1.0	8.2		9.0	4.2	0.12	0.004	0.17
83009	spring	15	70	20	19.9	6			13	43	0.7	78	18	95	1.6	15.6		6.8	3.6	0.24	0.002	0.23
	summer	10	61	14	14.0	6			5	27	0.9	143	14	190	0.9	14.9		0.6	0.3	0.04	0.002	0.12
	autumn	14	178	14	16.2	7			33	100	3.2	1285	18	513	0.8	48.9		0.2	0.7	0.42	0.004	0.29
	winter	13	95	94	16.8	4			21	64	0.9	361	9	145	1.6	8.1		10.3	10.6	0.28	0.002	0.21
83020	spring	13	2243	58	28.5	10			20	57	3.2	61	26	2472	1.4	69.3		7.8	4.1	0.26	0.003	0.31
	summer	16	484	76	11.7	6			6	33	1.3	334	17	526	2.0	77.0		7.0	3.9	0.12	0.005	0.17
	autumn	41	1754	77	30.9	9			266	895	3.7	6955	32	2176	3.4	99.3		6.6	5.9	0.26	0.011	0.33
	winter	14	165	56	7.7	5			16	73	0.7	31	13	176	1.0	9.3		9.0	4.2	0.12	0.002	0.22
83004	spring	28	376	58	8.8	12			45	137	1.1	81	38	389	2.2	18.0		8.3	3.3	0.55	0.003	0.54
	summer	16	379	76	11.9	6			27	41	0.9	4939	21	357	2.4	54.0		7.6	4.0	0.18	0.007	0.21
	autumn	32	2133	78	30.5	10			65	207	3.3	1659	34	2472	3.5							

**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

		Standard Deviation													
Station	Season	pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Mayfield	spring	0.32	0.007	0.02	0.85	0.39	18.9	62	7	44.0	41.3	6.1	5.2	0.58	8.54
	summer	0.10	0.043	0.07	1.60	1.12	11.4	68	9	263.6	6.7	14.8	6.4	1.15	7.28
	autumn	0.11	0.054	0.11	1.52	0.37	12.1	70	12	100.3	8.2	19.0	14.5	2.01	14.02
	winter	0.11	0.014	0.03	1.51	0.41	64.0	218	11	97.5	16.2	3.4	3.3	0.52	6.76
80007	spring	0.10	0.005	0.04					6	132.9		3.9		0.69	5.81
	summer	0.11	0.012	0.15					18	132.4		2.4		2.80	8.12
	autumn	0.15	0.052	0.12					42	179.7		3.3		1.09	19.78
	winter	0.11	0.012	0.03					11	254.7		5.4		0.67	19.47
80006	spring	0.19	0.018	0.15					113	215.3		30.7		4.24	98.17
	summer	0.13	0.006	0.08					60	186.8		3.6		2.90	27.13
	autumn	0.13	0.023	0.12					32	197.5		3.4		1.24	14.58
	winter	0.09	0.009	0.11					54	263.7		43.5		4.44	42.90
MM003WM	spring	0.10	0.008	0.03	4.38	0.39	387.1	1165	14	308.7	36.6	7.9	4.0	1.00	28.85
	summer	0.17	0.008	0.03	3.74	1.10	94.8	388	12	361.7	17.5	11.7	4.0	1.47	18.58
	autumn	0.14	0.012	0.09	2.53	0.48	86.6	426	57	285.7	18.7	28.2	5.8	3.25	57.03
	winter	0.15	0.005	0.09	14.59	0.40	1185.7	2605	65	675.2	42.2	34.0	18.0	3.31	65.08
82003	spring	0.20	0.012	0.19					137	322.6		34.4		4.11	106.07
	summer	0.19	0.016	0.07					64	197.9		4.1		2.84	39.07
	autumn	0.15	0.016	0.14					54	184.2		3.1		1.60	47.10
	winter	0.12	0.010	0.12					92	330.1		44.0		9.15	73.27
83104	spring	0.08	0.004	0.01					3	21.4		0.8		0.50	3.59
	summer	0.11	0.005	0.01					2	10.3		0.6		2.05	6.66
	autumn	0.15	0.005	0.05					24	19.7		1.6		0.25	1.49
	winter	0.10	0.004	0.02					12	33.6		1.5		0.51	14.09
83018	spring	0.09	0.004	0.02					4	19.0		0.8		0.68	1.70
	summer	0.09	0.003	0.01					5	10.8		0.6		2.20	6.18
	autumn	0.13	0.003	0.03					16	33.5		2.5		0.24	3.48
	winter	0.07	0.004	0.01					3	37.4		1.0		0.53	6.61
83009	spring	0.09	0.003	0.03					27	27.9		1.5		0.58	3.60
	summer	0.06	0.003	0.02					11	12.1		1.2		2.31	5.83
	autumn	0.10	0.007	0.05					19	26.4		3.1		0.64	8.01
	winter	0.07	0.005	0.02					5	46.3		2.8		0.53	15.35
83020	spring	0.09	0.009	0.07	0.46	0.43	10.4	38	80	20.5	4.8	47.9	32.6	3.86	19.89
	summer	0.04	0.007	0.02	0.46	1.50	3.4	56	16	146.1	2.2	20.1	5.9	1.02	8.46
	autumn	0.09	0.004	0.10	0.69	0.41	159.2	479	93	75.6	4.6	41.7	19.9	3.57	39.14
	winter	0.08	0.005	0.03	0.60	0.41	11.0	39	18	39.2	6.2	3.8	8.7	0.54	6.56
83004	spring	0.21	0.007	0.02	0.87	0.43	24.3	82	13	33.0	26.2	7.9	8.0	0.66	5.42
	summer	0.06	0.005	0.06	0.68	1.50	14.5	46	24	158.5	5.8	13.8	4.8	0.75	3.90
	autumn	0.06	0.005	0.10	1.06	0.39	38.2	117	76	37.7	6.7	51.8	22.5	4.16	36.50
	winter	0.08	0.005	0.02	1.48	0.40	72.8	204	18	58.5	8.0	4.2	5.3	0.51	7.92
83103	spring	0.07	0.007	0.02					13	49.8		6.6		0.69	10.52
	summer	0.12	0.010	0.09					43	57.8		3.0		2.43	6.66
	autumn	0.14	0.033	0.07					34	73.4		2.9		1.16	10.08
	winter	0.07	0.005	0.03					14	100.4		14.2		1.14	12.07
HU1RWMP	spring	0.08	0.025	0.10	2.30	0.39	374.5	1057	56	260.7	23.5	33.7	12.0	3.11	42.28
	summer	0.11	0.014	0.06	1.84	1.48	108.2	509	26	340.0	19.0	6.9	8.1	1.05	11.15
	autumn	0.10	0.006	0.02	2.53	0.39	91.7	408	22	151.5	15.5	8.2	11.9	0.81	30.02
	winter	0.12	0.080	0.10	23.48	0.40	1183.7	3842	31	358.4	121.6	23.2	21.3	2.06	31.23
HU010WM	spring	0.36	0.005	0.02	0.66	0.41	41.4	118	16	30.7	39.6	12.2	8.8	0.72	34.19
	summer	0.07	0.007	0.03	0.40	1.12	12.1	60	18	164.6	3.5	8.2	4.5	0.99	6.25
	autumn	0.11	0.008	0.08	1.76	0.40	50.6	164	57	111.4	15.5	32.5	9.8	2.92	35.84
	winter	0.15	0.004	0.02	1.39	0.41	107.6	362	11	40.7	10.7	6.2	5.1	0.49	17.09
83002	spring	0.10	0.013	0.03	0.78	0.39	36.0	661	25	46.4	8.4	27.0	16.5	1.98	109.29
	summer	0.18	0.020	0.06	0.71	1.11	26.1	120	30	214.0	12.6	38.8	10.8	2.16	11.91
	autumn	0.09	0.												

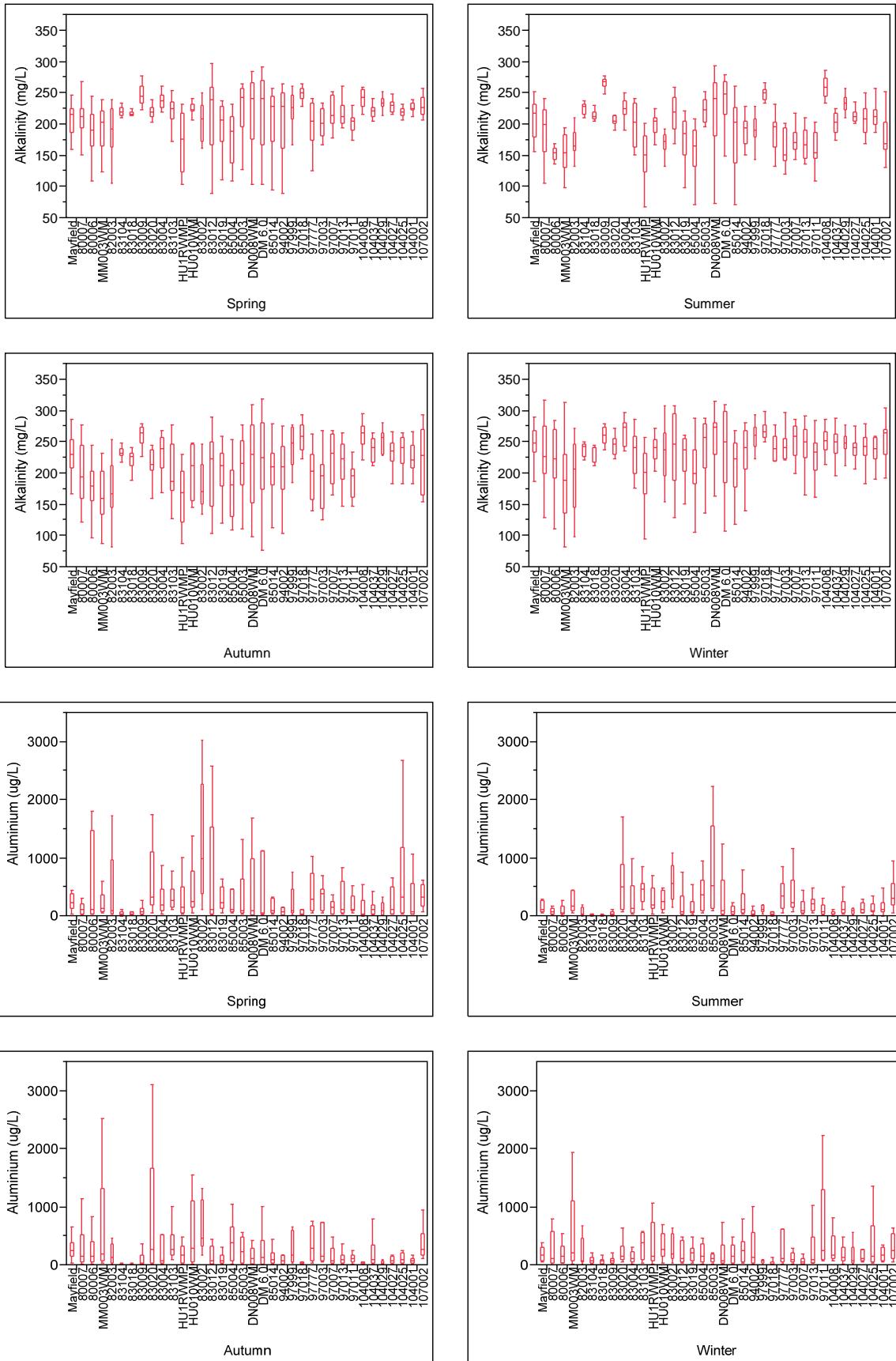
**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

Station	Season	Standard Deviation																	Nickel	Nitrates	Nitrite	TKN
		Alkalinity	Aluminium	Ammonia	Barium	Calcium	DIC	DOC	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Mercury	Molybdenum				
DN008WM	spring	57	612	58	17.8	24			195	685	4.6	3661	82	591	5.5	23.9		8.6	4.0	0.23	0.017	0.47
	summer	65	1240	64	19.6	25			50	273	7.3	5315	87	1736	6.5	90.6		8.1	5.1	1.63	0.017	0.53
	autumn	66	1119	80	30.0	24			124	463	2.8	5371	83	1137	5.7	19.5		6.9	4.9	0.26	0.016	0.33
	winter	61	868	161	21.9	29			669	1963	5.1	1085	93	811	5.1	25.8		10.3	4.7	0.34	0.137	0.47
DM 6.0	spring	62	1786	626	26.6	32			174	607	12.1	6914	108	2192	7.1	98.2		8.4	4.8	0.66	0.059	0.42
	summer	60	317	86	19.7	31			139	535	2.3	7308	102	321	6.1	24.8		10.4	4.7	2.33	0.045	0.29
	autumn	69	551	154	22.4	34			126	518	3.1	6689	110	566	6.2	24.1		6.9	4.8	0.69	0.157	0.36
	winter	70	1143	360	23.9	121			1182	3711	6.4	2742	388	1071	20.7	63.4		9.6	4.8	1.12	0.625	0.50
85014	spring	49	437	1137	13.4	23	11.1	1.1	246	763	3.8	26979	81	769	5.1	66.6	0.040	1.3	2.1	0.66	0.029	1.56
	summer	50	1284	1376	18.0	20	11.9	1.3	68	306	10.1	37556	66	391	4.2	100.3	0.002	2.7	3.9	0.56	0.110	1.42
	autumn	46	370	1703	14.1	18	12.7	1.6	98	348	5.4	35432	62	674	3.9	75.5	0.018	1.1	0.9	0.48	0.095	1.72
	winter	50	255	1340	35.3	44	11.9	1.2	707	1969	9.1	40883	129	234	7.0	35.7	0.000	1.7	0.9	0.53	0.023	1.41
94002	spring	55	755	99	20.0	34			134	491	4.8	2055	115	914	7.6	41.3		7.1	3.8	0.42	0.029	0.44
	summer	37	165	75	24.6	26			97	391	0.8	1438	91	135	7.0	12.6		7.5	4.2	0.33	0.023	0.20
	autumn	53	262	72	22.8	28			115	434	3.2	4909	97	355	6.6	27.0		6.8	5.0	0.48	0.101	0.37
	winter	42	467	98	22.9	27			1962	1769	2.3	5113	89	435	5.2	28.0		9.5	4.5	0.74	0.045	0.27
97999	spring	24	242	57	9.2	13			23	55	1.5	56	34	249	1.8	16.0		6.8	3.9	0.62	0.009	0.21
	summer	21	549	74	17.5	9			12	58	0.7	372	24	551	1.5	28.0		7.2	4.3	0.25	0.009	0.20
	autumn	31	532	76	15.8	20			20	90	1.2	792	54	544	2.0	25.6		6.4	4.7	0.57	0.005	0.15
	winter	31	197	56	25.6	12			123	309	0.8	475	38	369	2.5	8.5		9.1	4.3	1.80	0.004	0.30
97018	spring	18	189	55	8.9	9			15	46	1.0	61	25	208	1.9	11.0		8.3	4.5	0.55	0.017	2.12
	summer	23	1517	20	47.3	7			10	60	2.3	1594	24	82	1.1	234.6		0.7	2.9	0.34	0.015	6.81
	autumn	22	86	33	14.1	12			11	77	0.7	285	31	94	1.9	13.7		0.7	0.8	0.53	0.003	0.17
	winter	28	221	59	11.6	11			15	61	1.0	159	35	455	2.2	13.2		9.5	6.5	0.88	0.005	0.29
97777	spring	34	516	56	30.0	17			199	625	2.1	948	57	527	3.8	35.6		9.4	3.4	0.29	0.018	1.48
	summer	29	465	66	14.0	16			45	187	1.3	2321	57	531	4.3	26.4		8.3	4.1	1.87	0.023	0.20
	autumn	39	786	74	24.9	17			103	353	2.0	5285	59	815	4.1	26.1		6.9	5.1	0.31	0.014	0.26
	winter	50	1077	78	15.5	22			532	909	3.1	839	70	1006	3.8	29.7		9.8	4.8	1.47	0.079	0.52
97003	spring	22	343	56	22.7	11			132	407	1.6	1116	31	400	2.1	33.4		9.0	3.6	0.46	0.015	0.33
	summer	28	534	67	20.6	14			35	156	1.6	5257	48	533	3.9	34.1		7.4	4.1	1.36	0.017	0.25
	autumn	42	831	75	32.9	17			111	369	2.0	6871	55	857	3.7	57.5		7.2	4.9	0.39	0.022	0.35
	winter	21	387	59	13.5	23			325	971	3.1	339	73	447	3.8	42.9		9.8	4.7	0.58	0.413	0.38
97007	spring	24	225	66	12.1	11			39	127	0.8	81	26	200	1.3	12.3		8.0	3.3	0.81	0.012	0.33
	summer	23	118	76	7.3	12			12	64	1.0	140	29	110	1.4	17.1		7.3	3.9	0.38	0.005	0.18
	autumn	39	673	77	31.5	16			32	139	1.3	6973	42	687	2.1	24.7		7.0	4.9	0.68	0.006	0.30
	winter	28	407	59	7.2	10			46	133	1.1	1702	29	378	1.9	21.8		9.4	4.5	0.64	0.005	0.20
97013	spring	20	434	58	10.5	17			53	139	1.0	65	56	511	4.0	33.4		7.5	4.0	0.61	0.012	0.13
	summer	23	126	76	3.3	11			10	62	0.8	104	26	109								

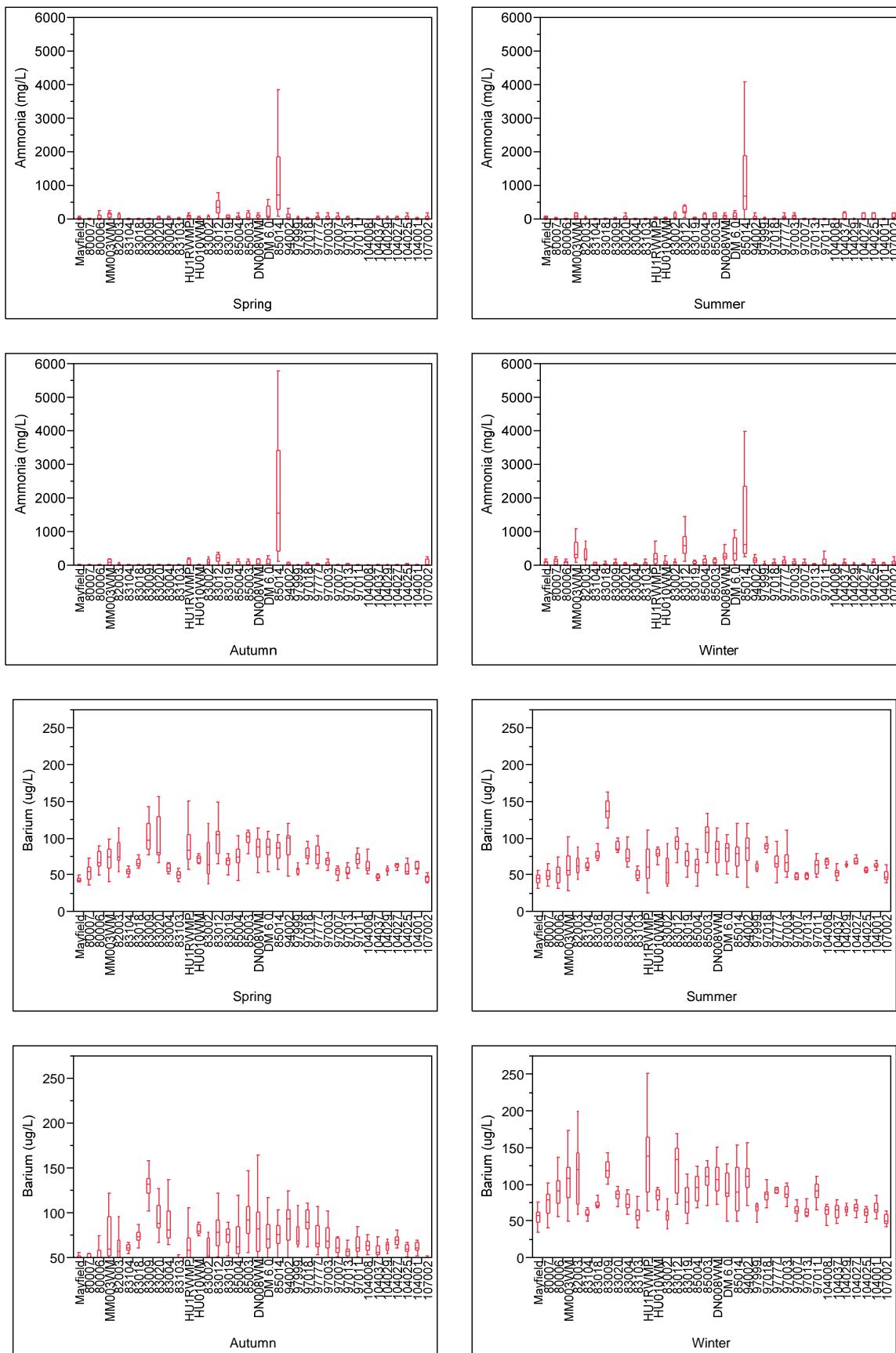
**Appendix B3. Seasonal (2006-2010) Descriptive Statistics**

		Standard Deviation													
Station	Season	pH	Phosphate	Phosphorus	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
DN008WM	spring	0.08	0.005	0.06	1.17	0.43	118.8	382	29	120.5	11.0	23.7	4.8	1.51	27.25
	summer	0.12	0.030	0.17	0.81	1.12	26.1	202	131	196.2	15.0	40.5	28.9	3.27	30.92
	autumn	0.19	0.006	0.05	1.76	2.82	77.2	248	32	107.9	12.8	28.4	22.6	2.94	31.34
	winter	0.22	0.006	0.07	5.21	0.41	436.2	1111	31	116.6	29.6	29.5	18.2	1.66	31.24
DM 6.0	spring	0.15	0.015	0.15	1.62	0.43	92.4	350	90	95.4	16.7	64.4	10.4	4.30	57.45
	summer	0.11	0.017	0.07	2.26	1.09	72.1	368	42	234.8	15.8	7.2	8.6	1.97	10.94
	autumn	0.17	0.015	0.06	1.48	0.88	69.5	339	25	158.2	15.5	15.4	9.7	1.22	11.73
	winter	0.11	0.010	0.05	4.09	0.38	756.3	2073	36	182.2	57.3	38.3	19.4	2.75	30.69
85014	spring	0.12	0.051	0.20				163	84.9		4.0		1.86		19.35
	summer	0.15	0.047	0.11				164	75.7		9.2		3.67		31.27
	autumn	0.13	0.081	0.17				136	69.2		5.5		1.64		29.46
	winter	0.07	0.044	0.06				29	139.0		4.5		3.17		14.93
94002	spring	0.12	0.006	0.08	1.22	0.43	74.4	287	67	109.0	19.2	29.0	12.7	1.97	25.71
	summer	0.08	0.005	0.02	0.96	4.69	44.9	275	4	277.2	20.7	6.9	2.3	1.28	5.18
	autumn	0.10	0.005	0.07	1.44	0.41	64.3	275	7	125.5	19.4	8.0	1.7	0.88	11.58
	winter	0.05	0.006	0.03	5.25	0.41	502.7	1033	16	85.5	17.1	14.3	3.6	0.82	16.65
97999	spring	0.08	0.005	0.02	0.42	0.43	9.9	43	7	35.7	5.4	7.0	7.4	0.63	7.40
	summer	0.08	0.007	0.04	0.39	1.50	6.9	50	10	149.2	2.5	18.8	1.4	1.11	14.11
	autumn	0.10	0.010	0.03	0.66	0.41	11.1	58	12	39.6	8.0	15.9	2.6	0.99	9.11
	winter	0.10	0.005	0.04	0.64	0.40	58.3	166	6	36.1	21.2	5.8	1.9	0.62	8.69
97018	spring	0.06	0.009	0.02				15	32.7		4.4		0.55		5.86
	summer	0.10	0.026	0.40				221	10.8		7.8		5.28		20.69
	autumn	0.04	0.005	0.02				12	27.2		2.4		0.60		2.58
	winter	0.08	0.006	0.05				6	35.6		7.0		0.63		8.71
97777	spring	0.08	0.005	0.05	0.84	0.43	118.9	358	28	116.5	10.9	15.6	6.7	0.98	20.24
	summer	0.16	0.007	0.06	1.06	1.12	19.2	183	33	142.4	10.5	15.8	3.3	1.12	7.76
	autumn	0.09	0.004	0.04	1.43	0.41	60.4	215	49	68.2	10.9	23.1	9.3	1.63	30.61
	winter	0.28	0.004	0.12	4.24	0.42	359.1	479	34	50.2	45.0	32.5	16.1	2.11	22.21
97003	spring	0.09	0.005	0.05	0.65	0.42	79.6	232	31	58.7	6.4	12.1	9.3	0.95	17.60
	summer	0.12	0.007	0.09	0.42	1.49	18.5	111	55	125.0	9.9	15.8	10.6	1.31	13.23
	autumn	0.12	0.005	0.04	1.45	0.41	68.5	228	29	65.4	10.3	25.2	11.4	1.51	36.17
	winter	0.09	0.005	0.04	4.15	0.41	193.5	484	19	76.4	18.1	11.8	4.7	0.79	14.52
97007	spring	0.08	0.005	0.02	0.66	0.43	20.8	82	7	40.3	24.2	5.5	3.1	0.52	8.16
	summer	0.08	0.005	0.20	0.34	1.49	6.5	50	6	96.3	3.4	4.6	1.7	0.81	4.27
	autumn	0.10	0.007	0.03	1.01	0.41	17.3	100	22	43.3	6.3	18.4	12.8	1.44	29.08
	winter	0.10	0.004	0.04	0.65	0.41	24.7	76	14	48.1	7.7	14.0	7.5	0.83	7.26
97013	spring	0.07	0.004	0.04	0.34	0.41	26.1	97	42	43.5	9.5	19.3	11.7	0.99	6.05
	summer	0.05	0.006	0.02	0.74	1.44	6.3	44	9	149.8	3.3	4.7	4.1	0.91	4.08
	autumn	0.06	0.007	0.02	0.52	0.41	20.1	246	3	43.4	7.9	5.0	1.2	0.60	12.22
	winter	0.06	0.005	0.06	0.67	0.41	25.8	100	28	41.9	8.0	23.0	3.6	1.11	11.39
97011	spring	0.10	0.004	0.15				141	29.9		8.5		1.84		12.17
	summer	0.08	0.005	0.04				26	71.3		8.8		2.43		6.64
	autumn	0.09	0.003	0.02				8	47.6		2.7		0.75		6.39
	winter	0.09	0.004	0.05				21	93.7		25.9		1.40		18.11
104008	spring	0.10	0.011	0.11				78	31.1		8.7		1.18		7.20
	summer	0.07	0.003	0.01				4	9.6		1.5		2.16		6.05
	autumn	0.09	0.010	0.06				34	29.2		2.8		1.19		4.70
	winter	0.07	0.004	0.02				8	25.8		16.4		0.55		15.14
104037	spring	0.09	0.005	0.02	0.53	0.43	9.8	34	11	30.4	6.3	4.5	2.3	0.53	3.50
	summer	0.07	0.006	0.03	0.45	1.49	4.5	210	14	120.6	5.6	21.7	3.5	1.01	10.73
	autumn	0.08	0.007	0.09	0.55	0.37	7.4	65	13	41.6	12.2	20.3	3.6	1.02	9.20
	winter	0.09	0.003	0.04	1.11	0.41	112.3	331	9	31.6	133.3	4.8	1.5	0.55	28.92

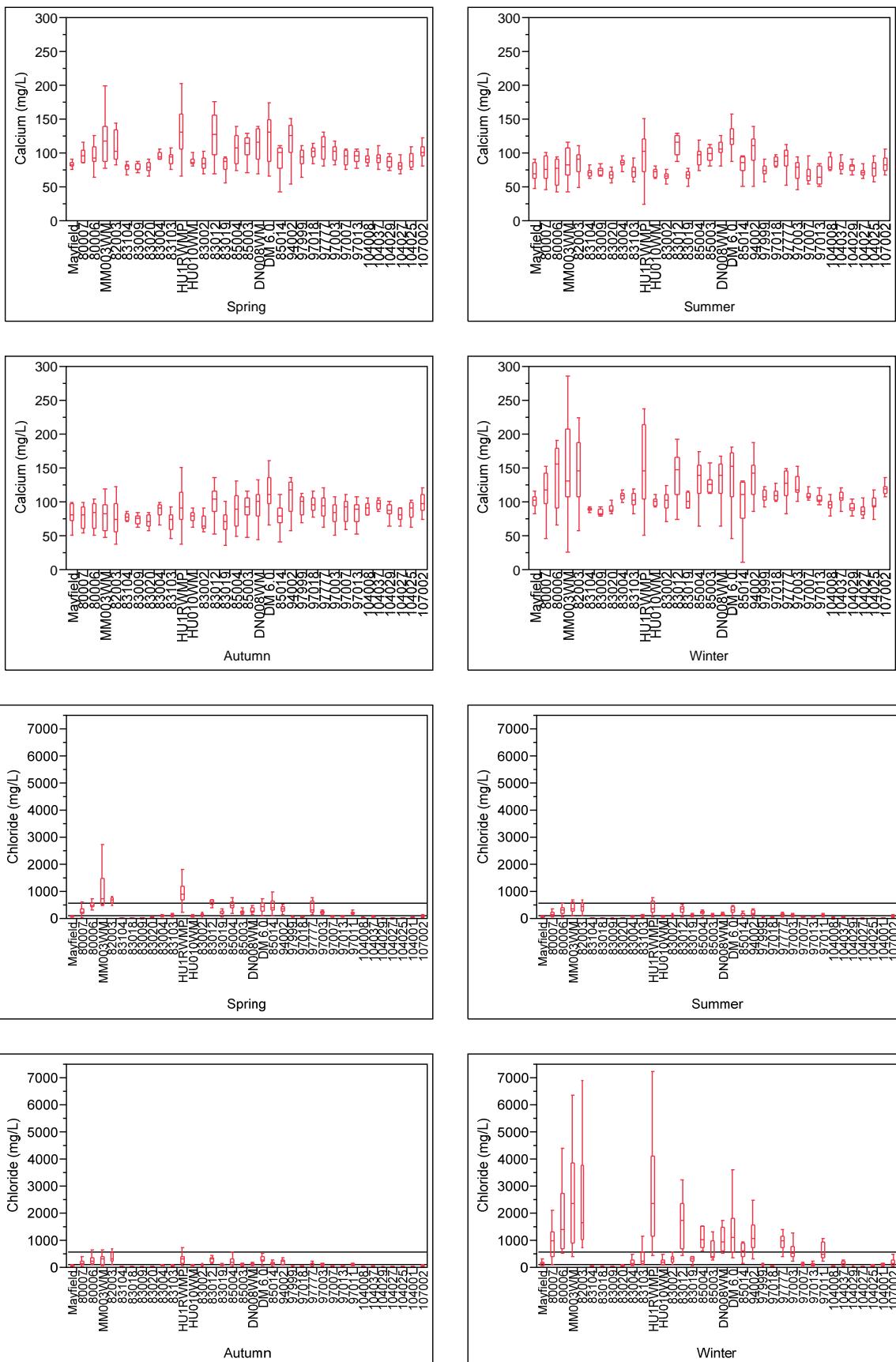
## Appendix B4. Seasonal (2006-2010) Box Plots



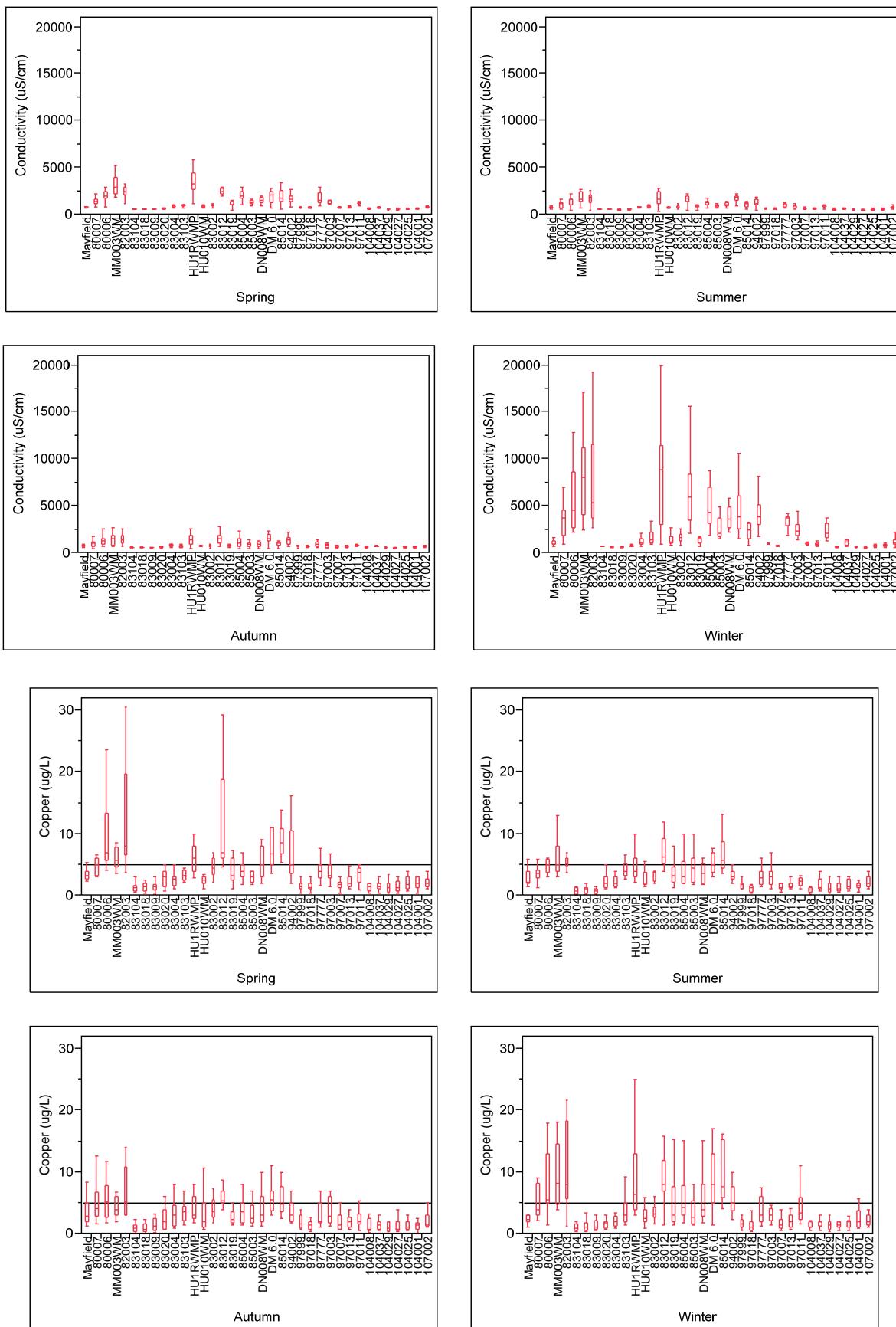
## Appendix B4. Seasonal (2006-2010) Box Plots



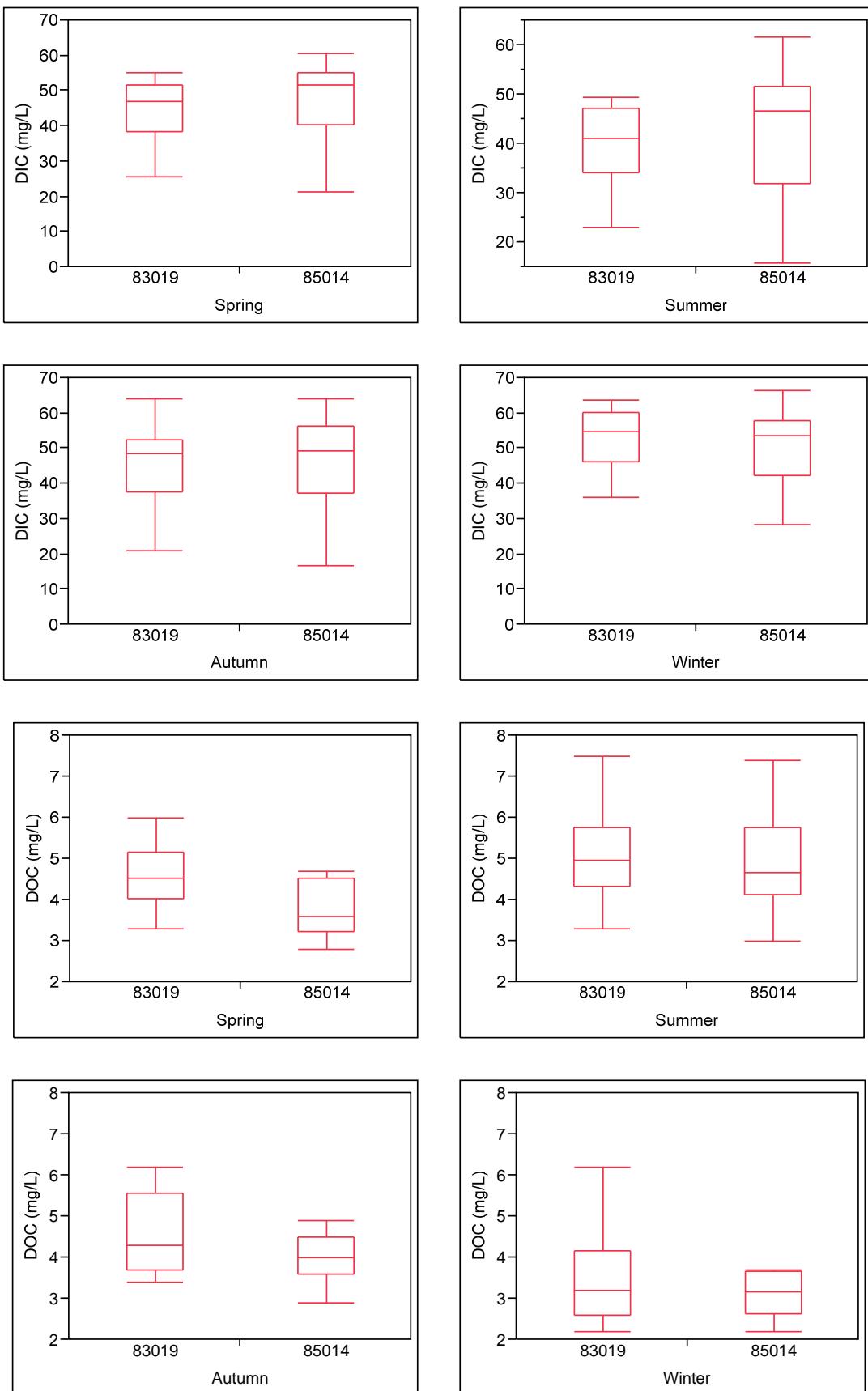
## Appendix B4. Seasonal (2006-2010) Box Plots



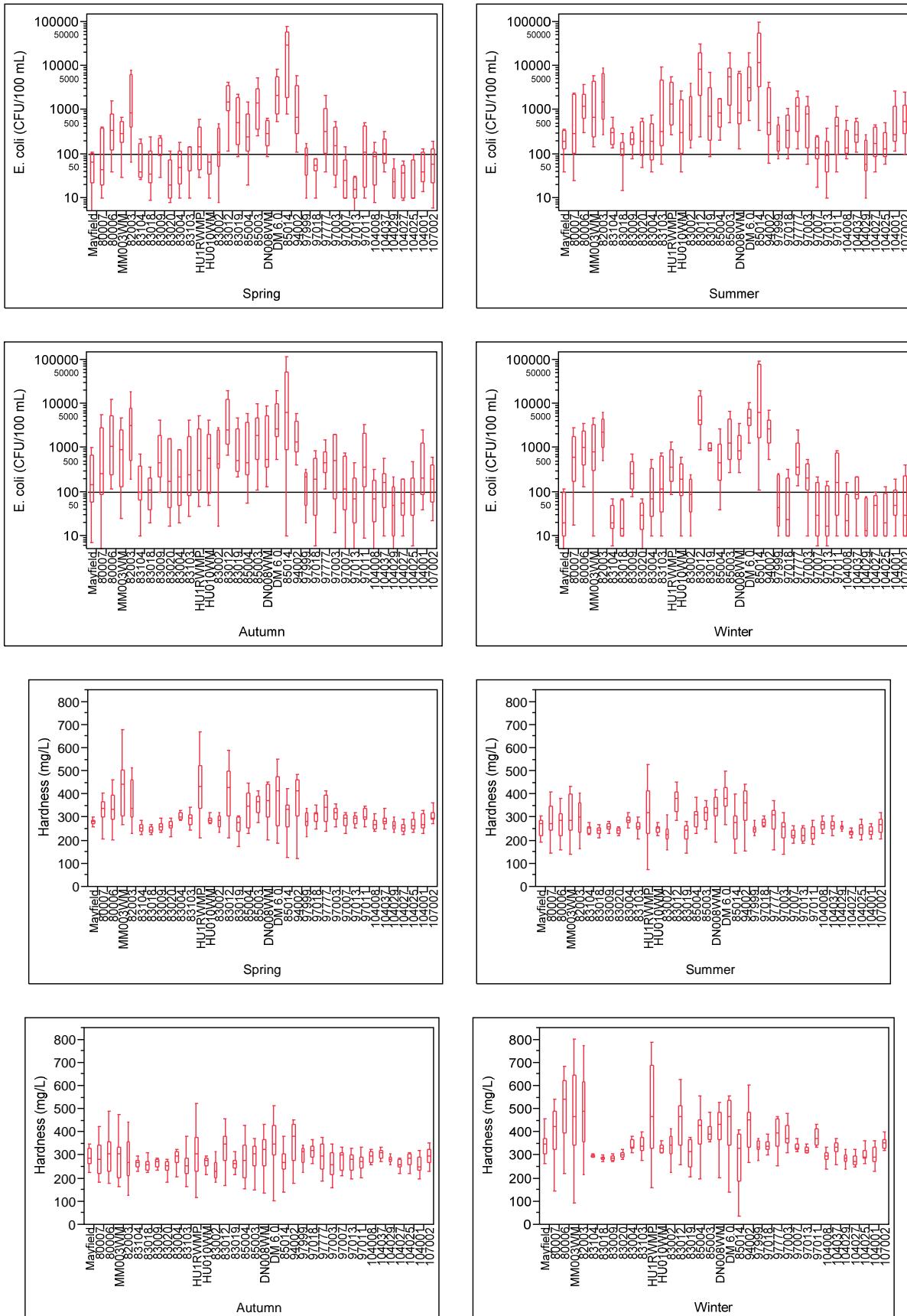
## Appendix B4. Seasonal (2006-2010) Box Plots



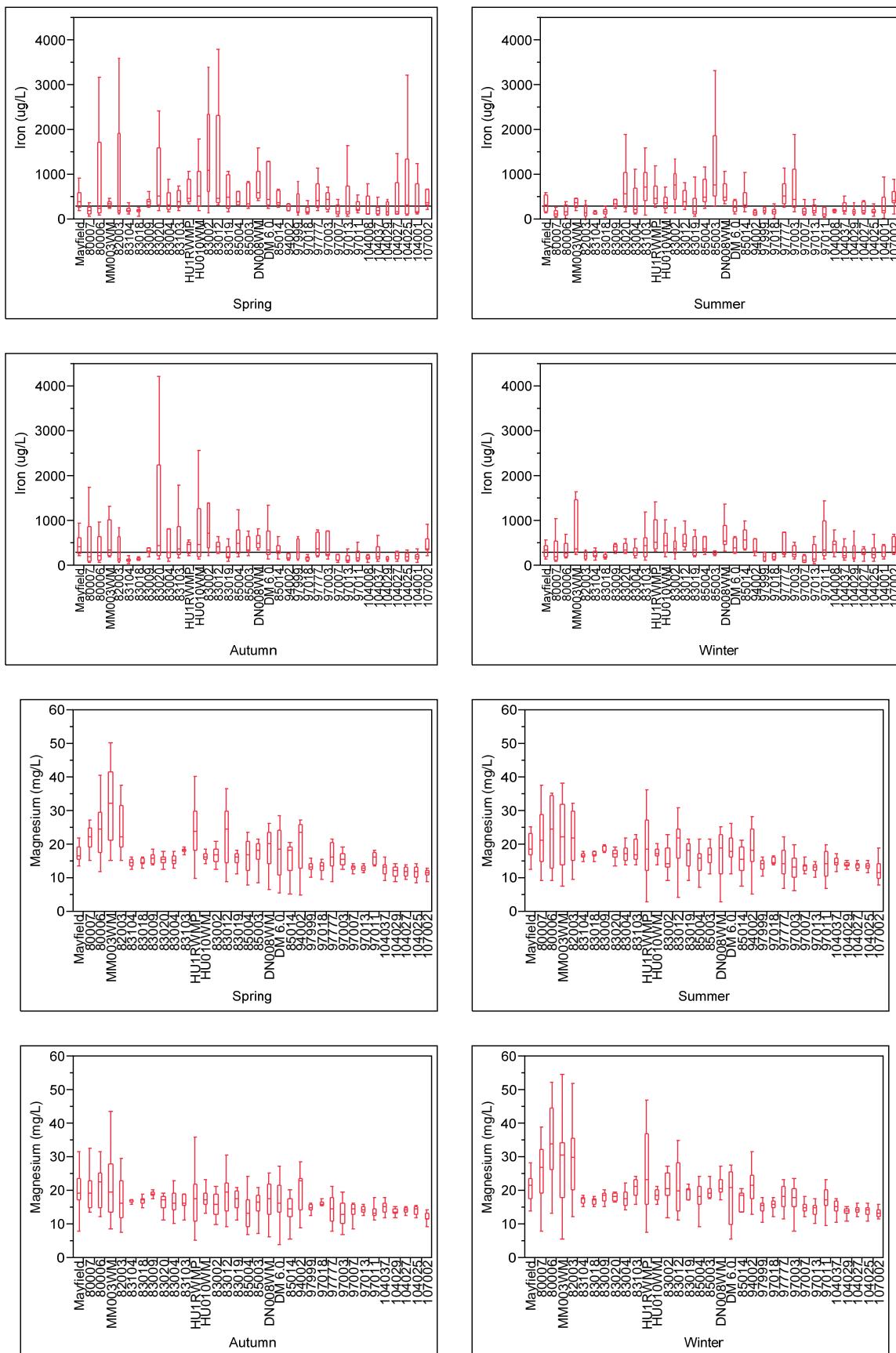
## Appendix B4. Seasonal (2006-2010) Box Plots



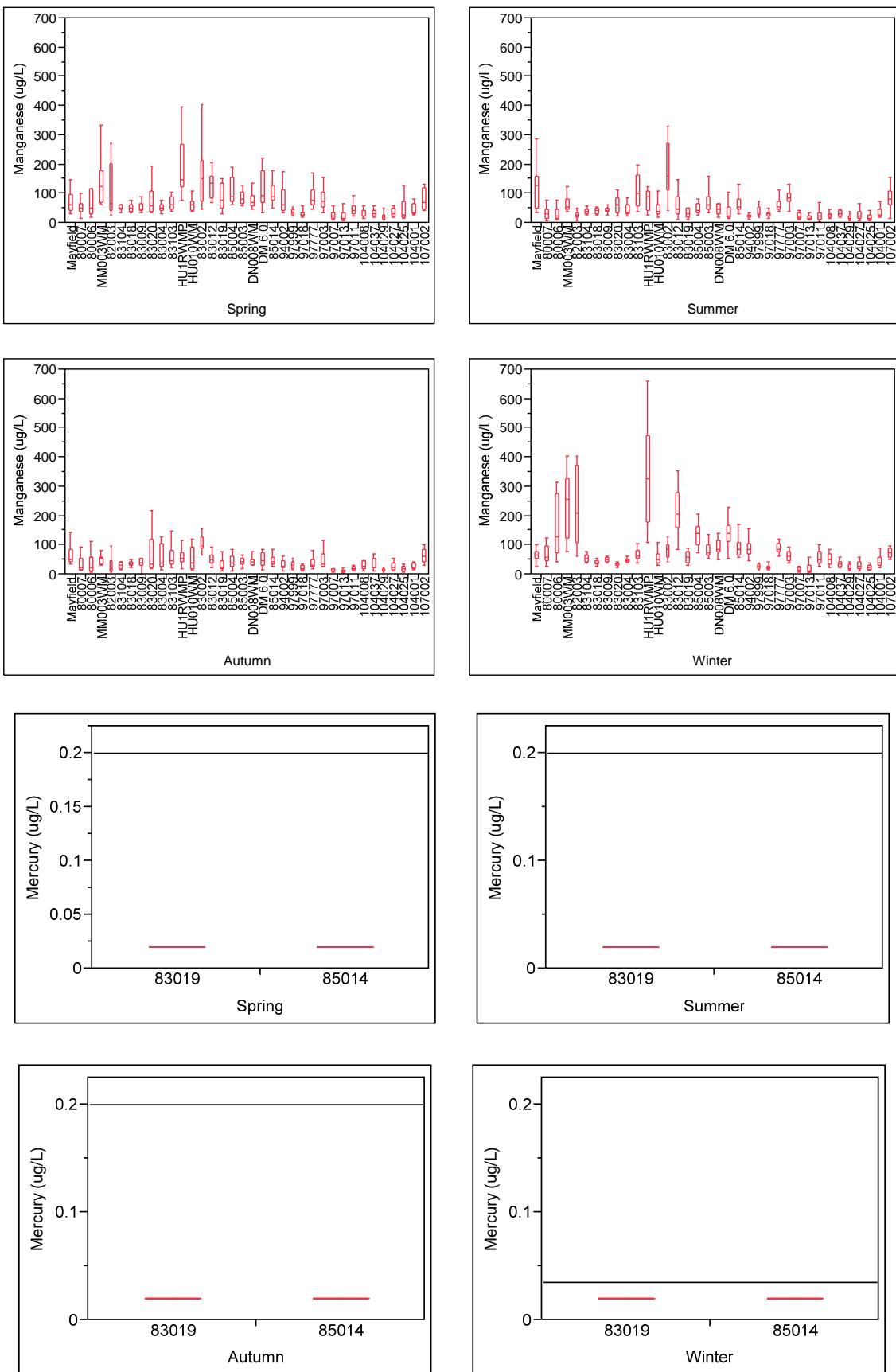
## Appendix B4. Seasonal (2006-2010) Box Plots



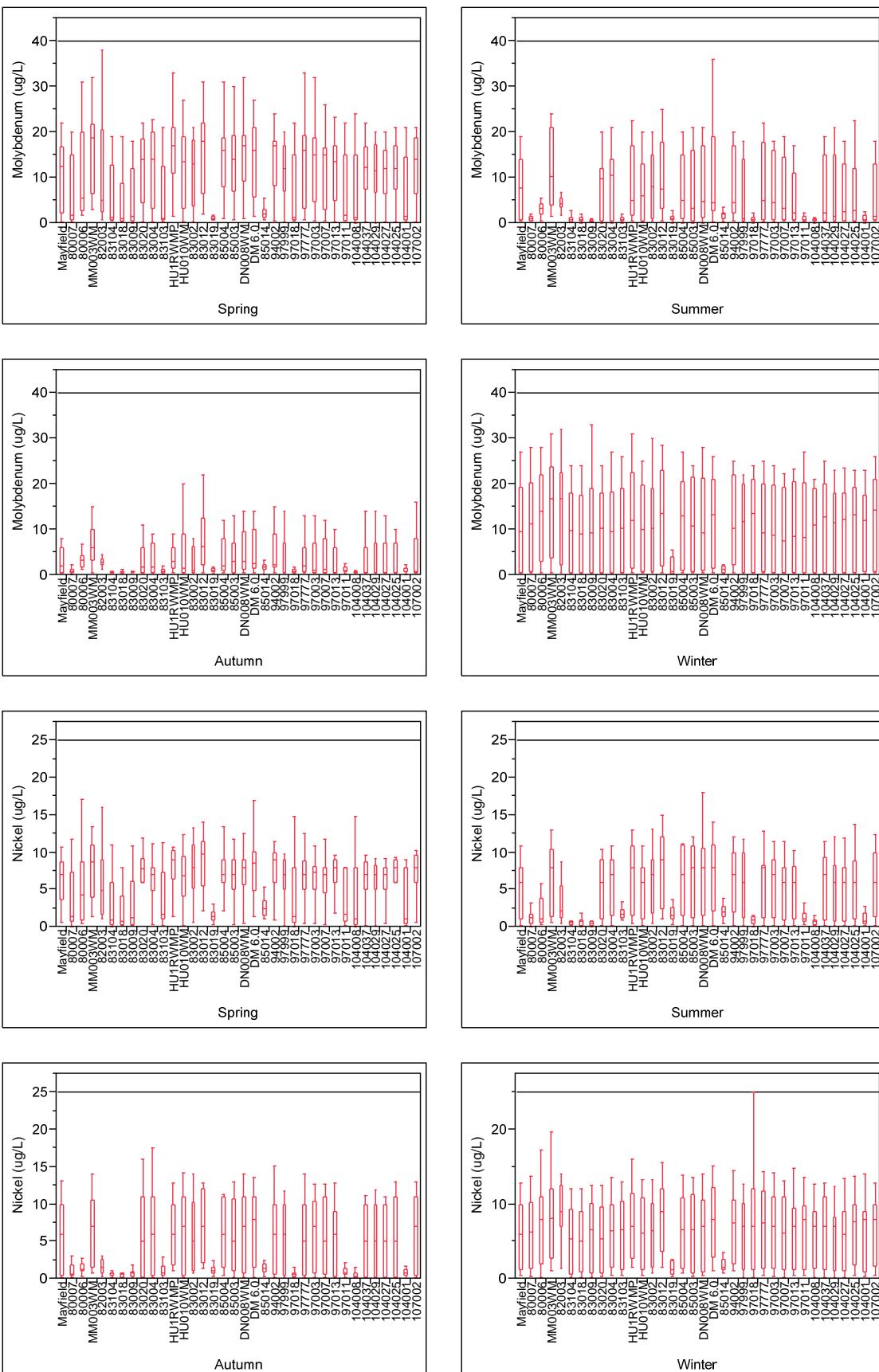
## Appendix B4. Seasonal (2006-2010) Box Plots



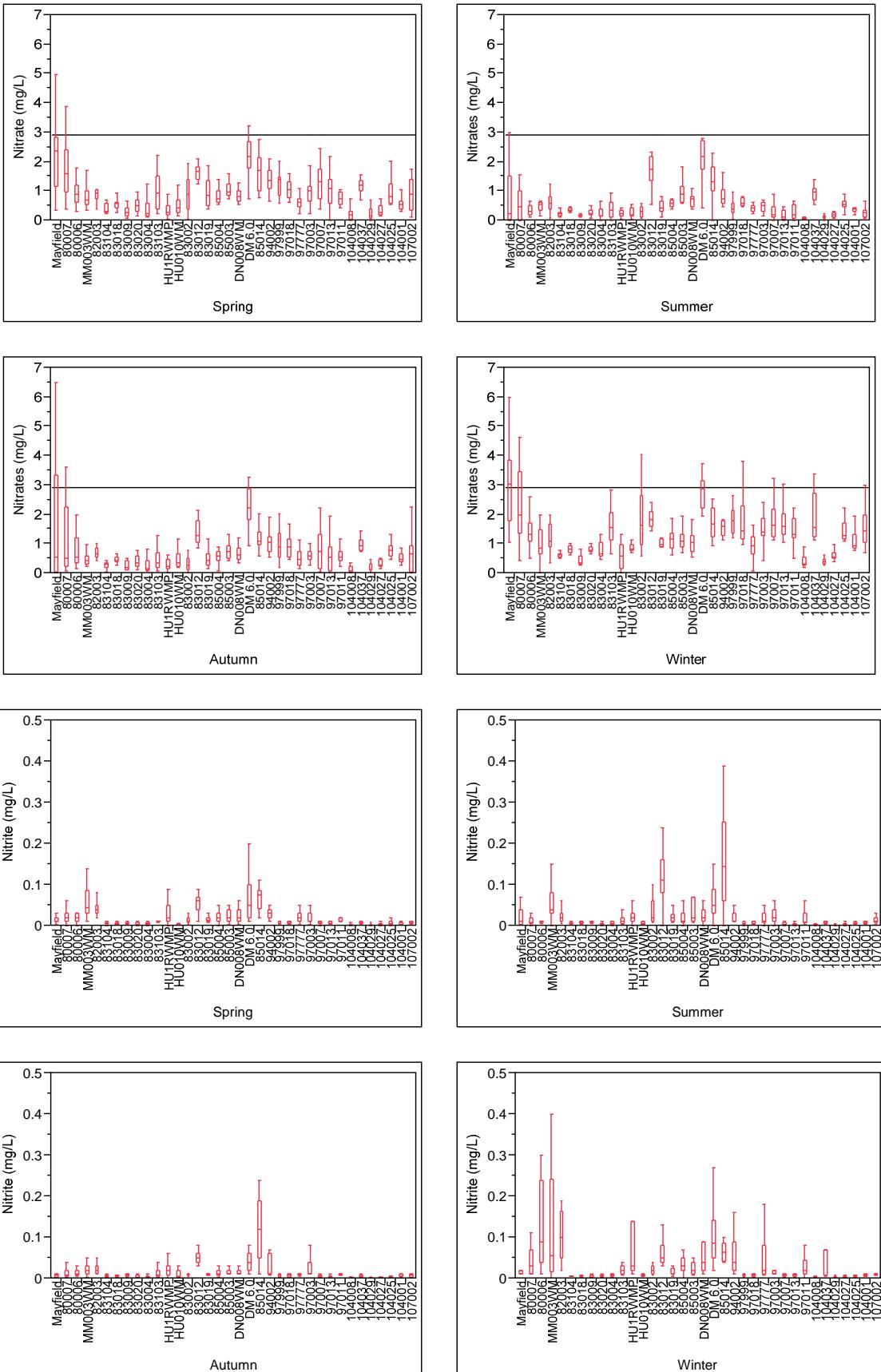
## Appendix B4. Seasonal (2006-2010) Box Plots



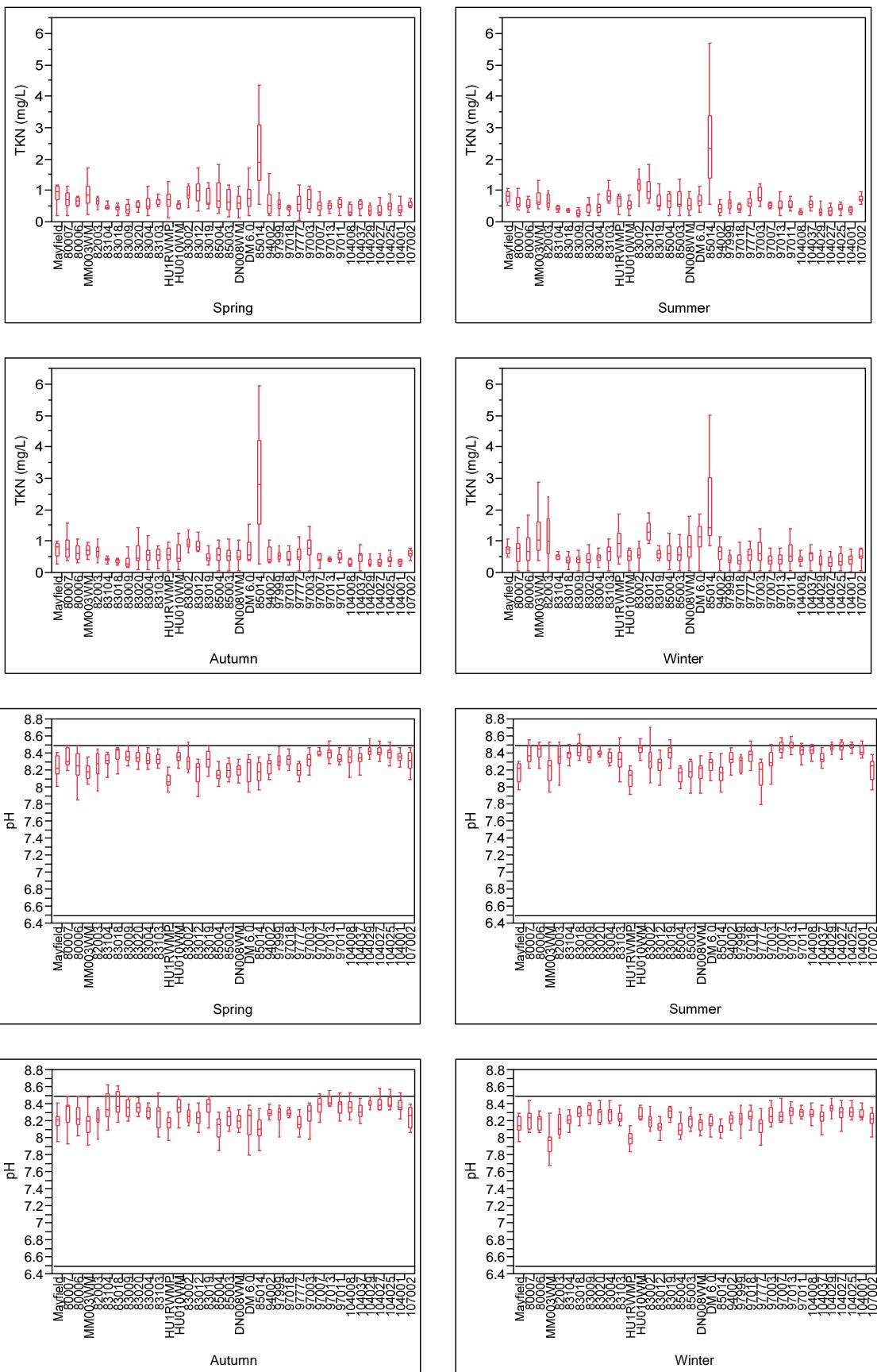
## Appendix B4. Seasonal (2006-2010) Box Plots



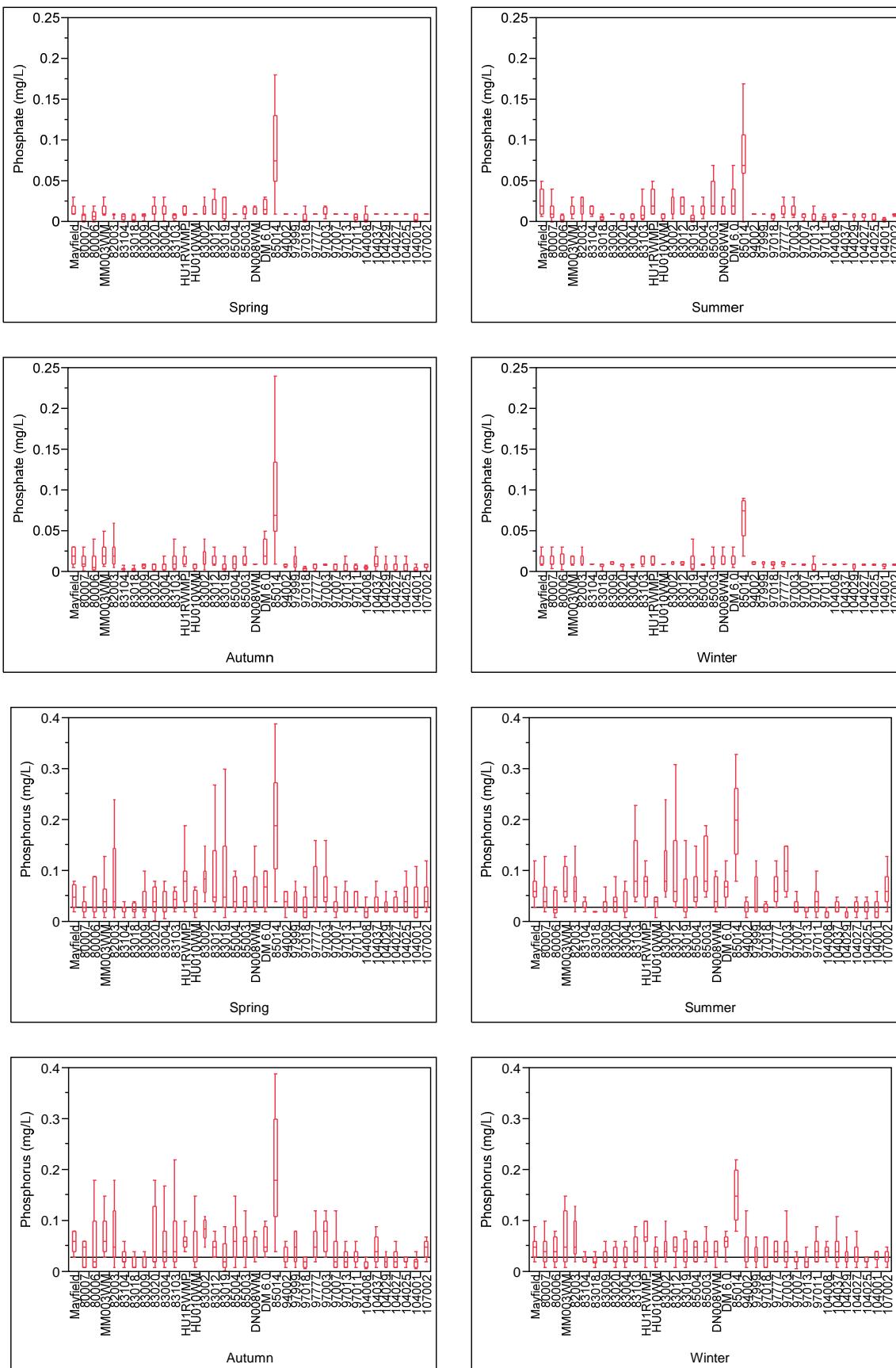
## **Appendix B4. Seasonal (2006-2010) Box Plots**



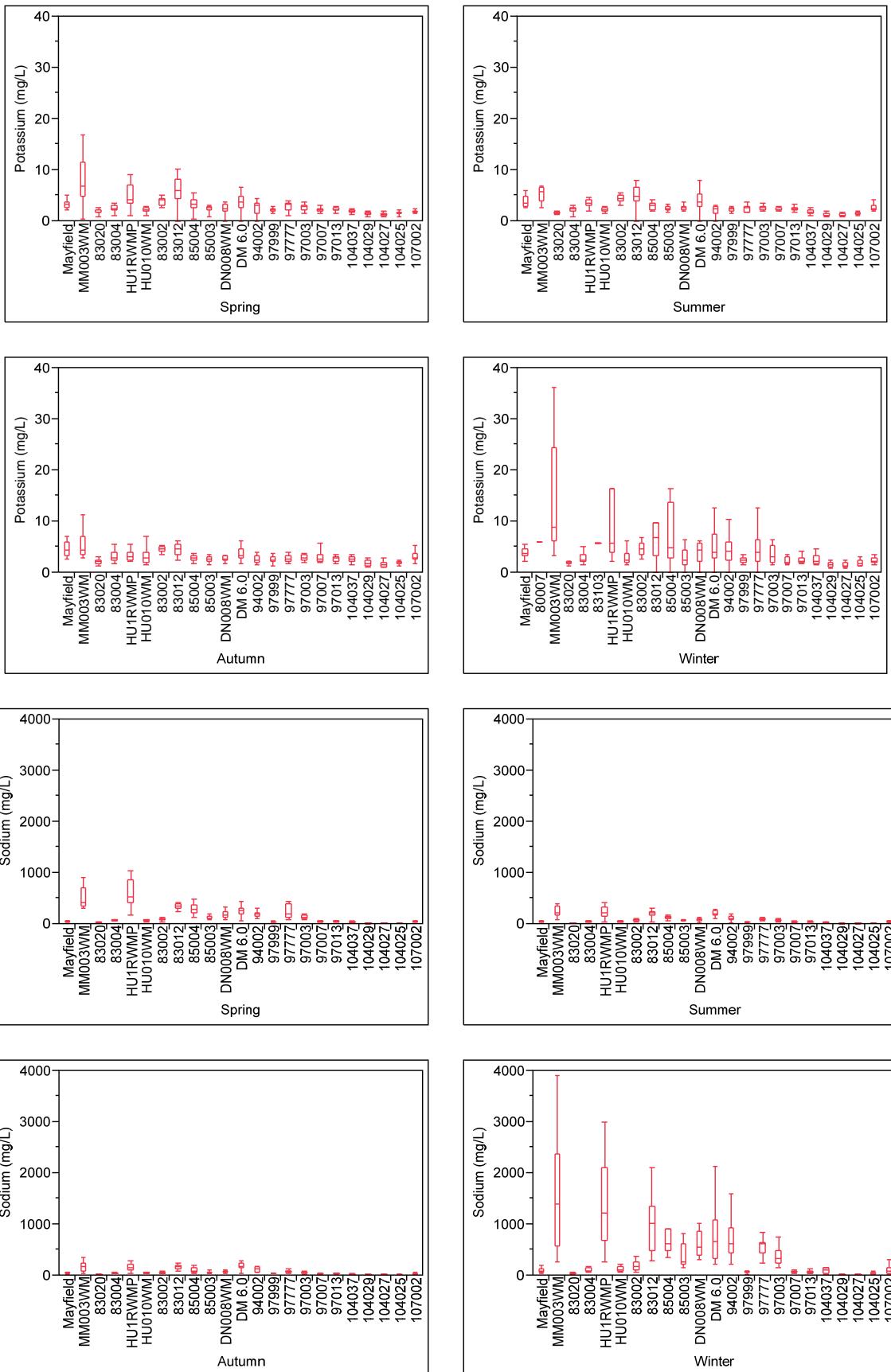
## Appendix B4. Seasonal (2006-2010) Box Plots



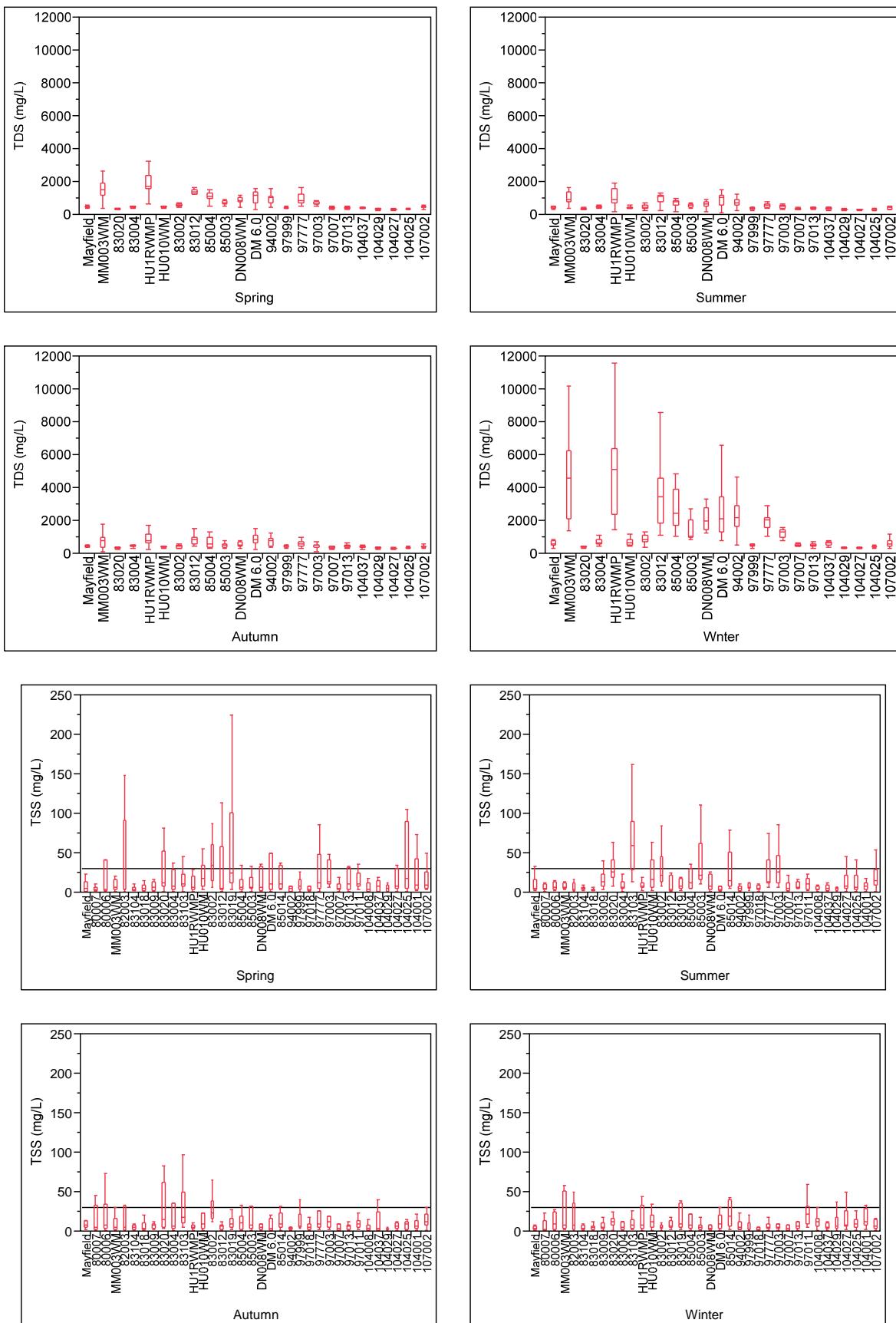
## Appendix B4. Seasonal (2006-2010) Box Plots



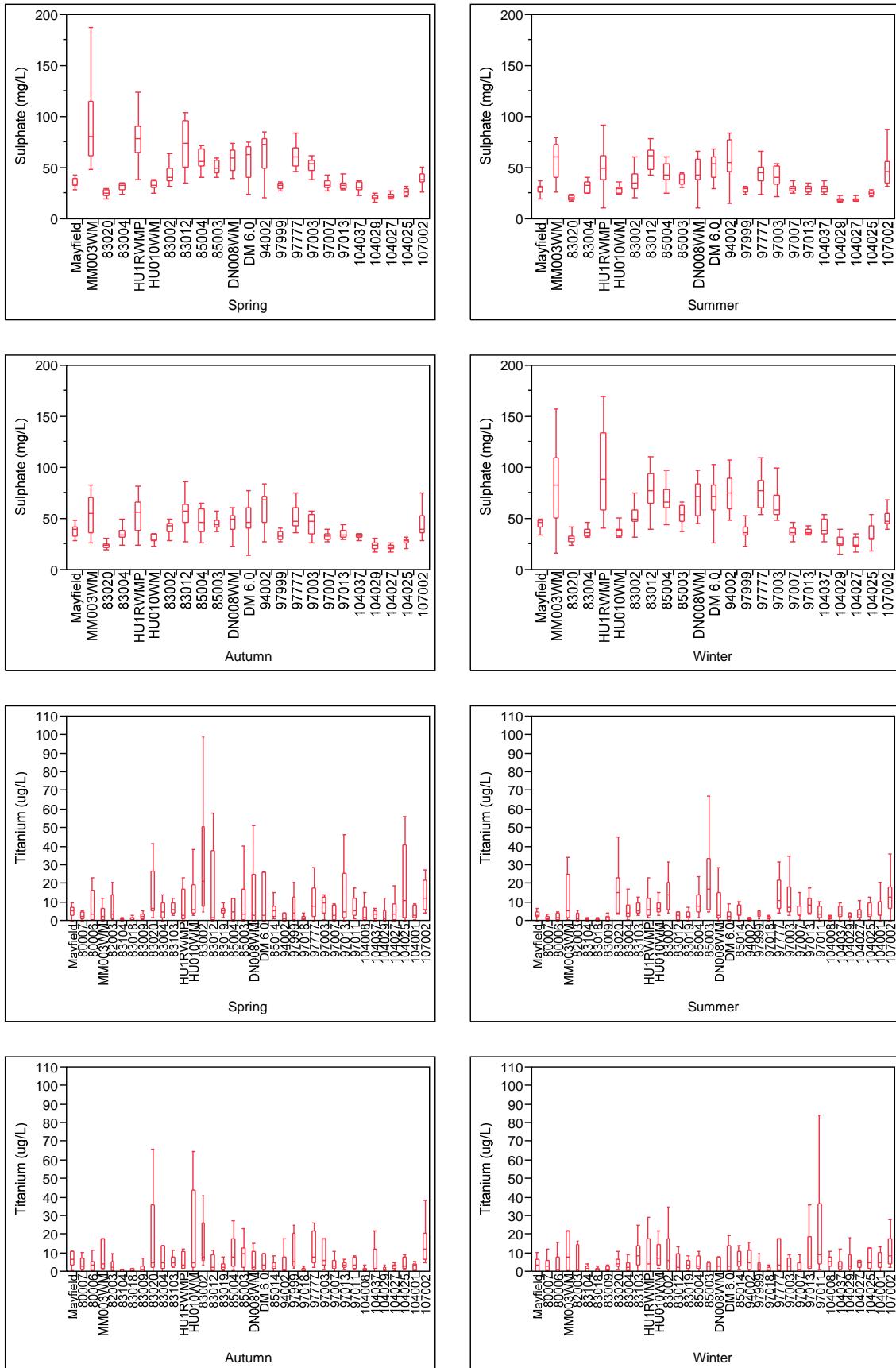
## **Appendix B4. Seasonal (2006-2010) Box Plots**



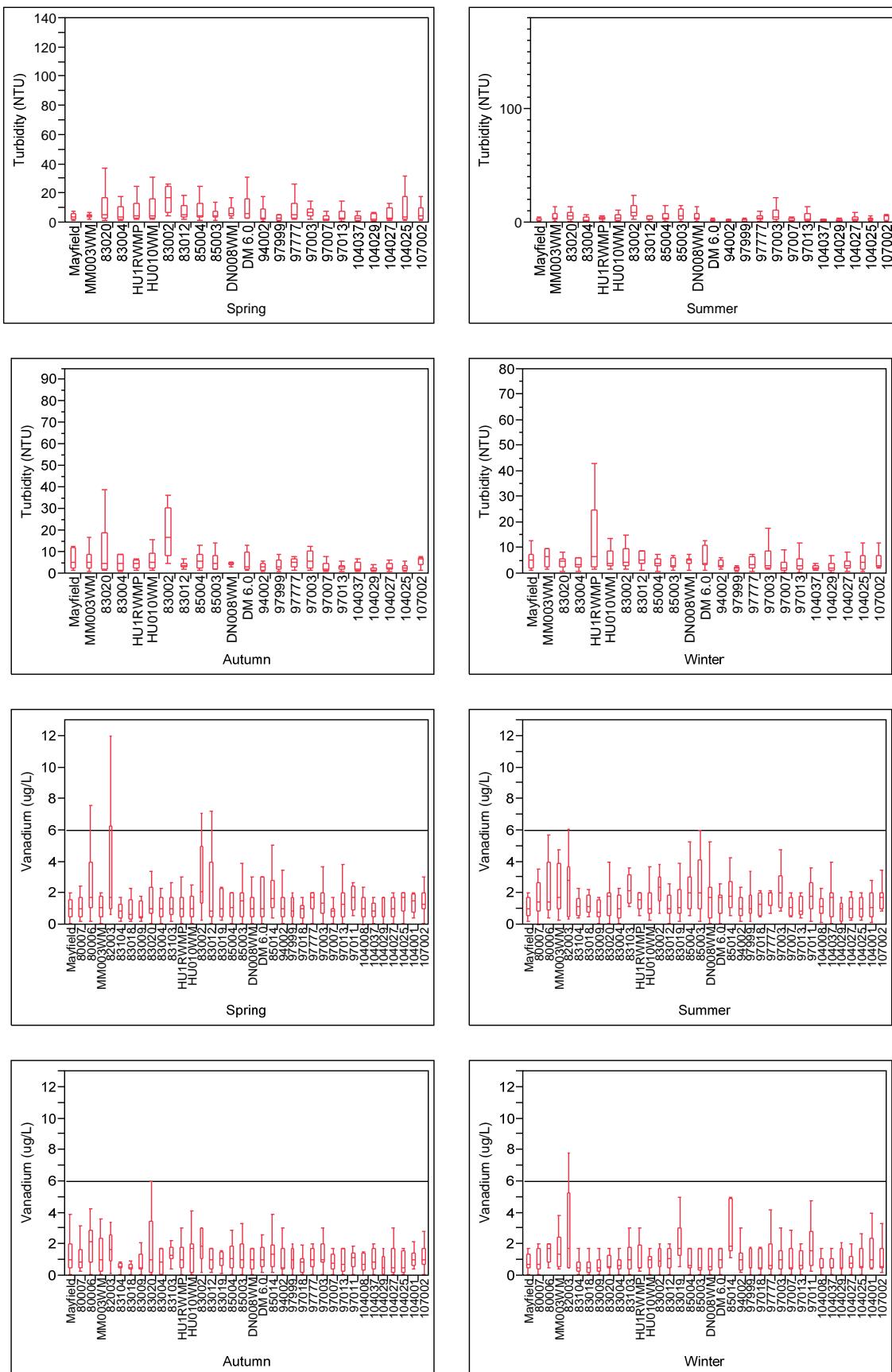
## Appendix B4. Seasonal (2006-2010) Box Plots



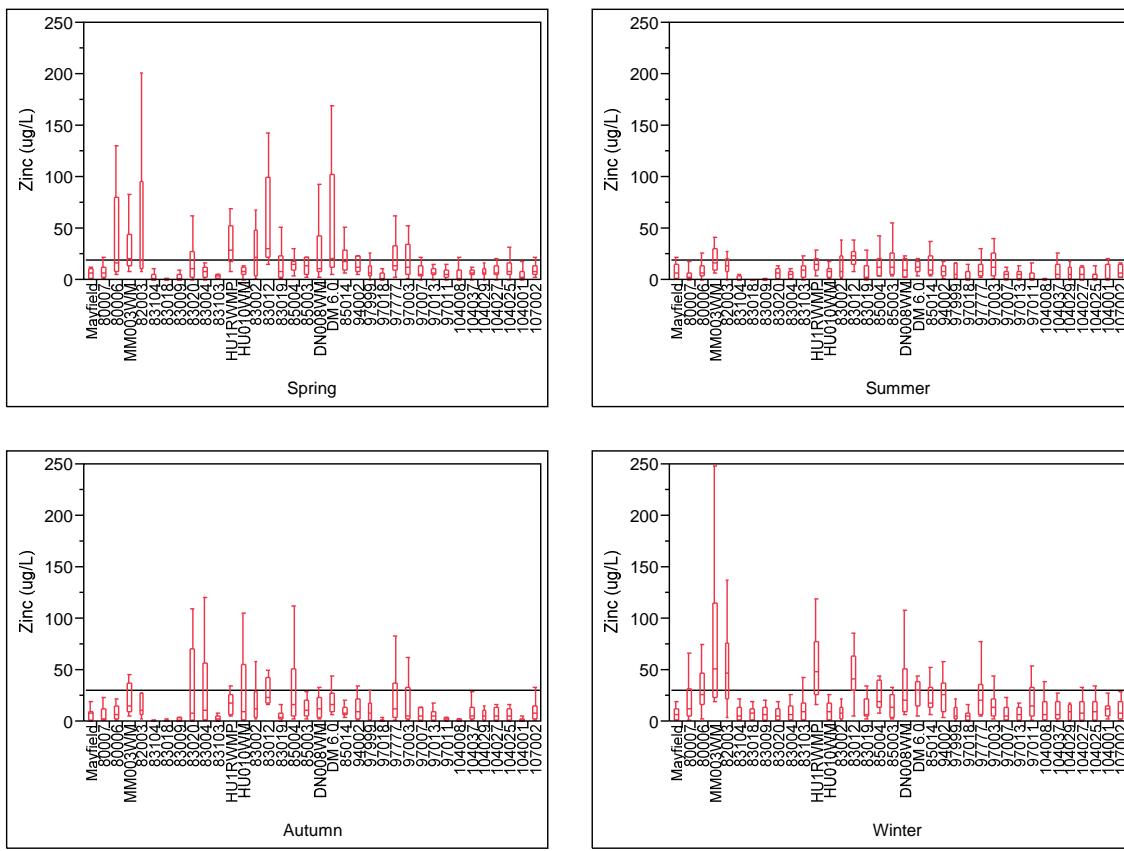
## Appendix B4. Seasonal (2006-2010) Box Plots



## Appendix B4. Seasonal (2006-2010) Box Plots



## Appendix B4. Seasonal (2006-2010) Box Plots



### Appendix B5. Analyte Correlation Matrix

	Alkalinity	Aluminium	Ammonia	Barium	Calcium	Chloride	Conductivity	Copper	E. coli	Hardness	Iron	Magnesium	Manganese	Molybdenum	Nickel	Nitrates	Nitrite
Alkalinity	-																
Aluminium	-0.4911	-															
Ammonia	-0.1833	0.0543	-														
Barium	0.0841	0.1013	0.1598	-													
Calcium	-0.3023	0.2423	0.0584	0.3245	-												
Chloride	-0.7323	0.4191	0.1601	0.3135	0.7683	-											
Conductivity	-0.7123	0.4365	0.1693	0.3166	0.7818	0.9943	-										
Copper	-0.6365	0.4992	0.4618	0.2929	0.6284	0.8425	0.8545	-									
E. coli	-0.2226	0.0744	0.9832	0.2076	0.0972	0.2106	0.2160	0.5382	-								
Hardness	-0.4037	0.3727	0.0797	0.3721	0.9670	0.8646	0.8796	0.7352	0.1244	-							
Iron	-0.4457	0.9272	0.1382	0.3421	0.3295	0.5095	0.5295	0.5895	0.1703	0.4709	-						
Magnesium	-0.4978	0.3254	0.0007	0.2415	0.4862	0.7740	0.7781	0.7404	0.0732	0.6642	0.4342	-					
Manganese	-0.6391	0.6498	0.2363	0.2386	0.4732	0.7805	0.7828	0.7216	0.2596	0.6079	0.7192	0.6265	-				
Molybdenum	-0.2274	0.5565	-0.1705	0.1830	0.6167	0.4807	0.5099	0.2892	-0.2054	0.6474	0.5215	0.2072	0.4039	-			
Nickel	-0.1739	0.5467	-0.1112	0.1679	0.5403	0.3759	0.4015	0.2201	-0.1547	0.5575	0.5058	0.0336	0.3588	0.9672	-		
Nitrates	-0.1922	0.1739	0.3178	-0.0165	0.5309	0.3533	0.3850	0.4526	0.3341	0.5572	0.1711	0.2282	0.2922	0.3269	0.3550	-	
Nitrite	-0.5517	0.3452	0.5833	0.3287	0.7026	0.8123	0.8178	0.8366	0.6117	0.7496	0.4674	0.4992	0.7347	0.3548	0.3275	0.5837	-
TKN	-0.3758	0.2082	0.9037	0.1372	0.1713	0.3427	0.3560	0.5998	0.9048	0.2376	0.2518	0.1924	0.4368	-0.1212	-0.0996	0.4431	0.6589
pH	0.5050	-0.4541	-0.4063	-0.2878	-0.6182	-0.6916	-0.7060	-0.6281	-0.4253	-0.6812	-0.5616	-0.4240	-0.7378	-0.4477	-0.4034	-0.5031	-0.7475
Phosphate	-0.2587	0.1364	0.9470	0.0880	0.0302	0.2068	0.2050	0.4868	0.9437	0.0955	0.1966	0.0730	0.3417	-0.1540	-0.0952	0.3914	0.6067
Phosphorous	-0.4915	0.3649	0.8404	0.1594	0.2203	0.4384	0.4392	0.7019	0.8805	0.2854	0.4212	0.2543	0.5390	-0.0559	-0.0306	0.4062	0.7278
Potassium	-0.6854	0.2895	0.4999	0.2481	0.5097	0.8142	0.8313	0.7729	0.5292	0.6599	0.3924	0.8559	0.7816	0.2912	0.0786	0.3515	0.6785
Selenium	-0.0247	-0.1830	0.1428	0.3962	0.5039	0.3001	0.2575	0.2865	0.2921	0.4880	-0.0138	0.2859	-0.0063	0.2971	0.3133	0.1687	0.2396
Sodium	-0.7105	0.2433	0.6651	0.5526	0.8018	0.9912	0.9979	0.8942	0.6251	0.8879	0.4488	0.8291	0.7636	0.9233	0.8140	0.3385	0.8926
TDS	-0.7043	0.2267	0.6737	0.5395	0.8013	0.9947	0.9992	0.8940	0.6242	0.8860	0.4378	0.8230	0.7862	0.9049	0.8315	0.3537	0.9047
TSS	-0.3440	0.4624	0.5130	0.1725	-0.0495	0.1917	0.1807	0.4950	0.5777	0.0084	0.4931	0.0773	0.2776	-0.1800	-0.1268	-0.0262	0.3355
Strontium	-0.7013	0.5279	0.1082	0.1870	0.5959	0.8912	0.9064	0.8115	0.1535	0.7606	0.5644	0.8805	0.7479	0.4669	0.3302	0.3252	0.6487
Sulphate	-0.6760	0.2302	0.6169	0.4981	0.8464	0.9168	0.9169	0.8399	0.6405	0.9016	0.4071	0.7504	0.7356	0.8495	0.7804	0.4544	0.8491
Titanium	-0.3173	0.8944	-0.0181	0.1106	0.3102	0.2744	0.2956	0.2842	-0.0296	0.3547	0.8157	0.0308	0.4640	0.6844	0.7213	0.2081	0.2707
Turbidity	-0.4339	0.8561	0.2879	0.4401	0.1864	0.3443	0.3591	0.4902	0.3857	0.2593	0.8994	0.3832	0.6737	0.3312	0.3608	0.0327	0.3476
Vanadium	-0.6309	0.6782	0.3433	0.1473	0.3456	0.6079	0.6072	0.8399	0.4289	0.4359	0.6681	0.5705	0.6266	0.0996	0.0365	0.2001	0.5606
Zinc	-0.6528	0.6558	0.2554	0.3479	0.6750	0.8853	0.9058	0.8998	0.2996	0.7831	0.7182	0.6957	0.8064	0.5983	0.5132	0.3423	0.7821

Shaded cells =  $R^2 > 0.8$

## Appendix B5. Analyte Correlation Matrix

	TKN	pH	Phosphate	Phosphorous	Potassium	Selenium	Sodium	TDS	TSS	Strontium	Sulphate	Titanium	Turbidity	Vanadium	Zinc
Alkalinity															
Aluminium															
Ammonia															
Barium															
Calcium															
Chloride															
Conductivity															
Copper															
E. coli															
Hardness															
Iron															
Magnesium															
Manganese															
Molybdenum															
Nickel															
Nitrates															
Nitrite															
TKN															
pH	-0.5636														
Phosphate	0.9068	-0.5106													
Phosphorous	0.9047	-0.6360	0.8970												
Potassium	0.8380	-0.6827	0.6456	0.7262											
Selenium	0.0121	-0.1738	0.0039	0.0592	0.0531										
Sodium	0.7441	-0.7760	0.5272	0.7155	0.8848	0.2706									
TDS	0.7454	-0.7700	0.5454	0.7112	0.8852	0.2573	0.9957								
TSS	0.5263	-0.1774	0.5126	0.6957	-0.0112	-0.0992	0.0395	0.0147							
Strontium	0.3375	-0.6162	0.1751	0.3924	0.9339	0.1504	0.8997	0.8832	0.1768						
Sulphate	0.7812	-0.8446	0.5409	0.7396	0.8279	0.3953	0.9177	0.9148	-0.0822	0.8103					
Titanium	0.0436	-0.3914	0.0142	0.1853	0.0699	-0.1204	0.1597	0.1433	0.2981	0.3063	0.2117				
Turbidity	0.5295	-0.5231	0.5158	0.7470	0.4680	-0.0202	0.3648	0.3634	0.5131	0.3859	0.3811	0.7919			
Vanadium	0.5323	-0.4510	0.3936	0.6690	0.5572	0.0415	0.5390	0.5189	0.6829	0.6507	0.5473	0.4165	0.8875		
Zinc	0.4018	-0.6608	0.2696	0.5142	0.7115	0.1351	0.9176	0.913466665	0.3444	0.8556	0.8219	0.4970	0.5401	0.7437	-

Shaded cells =  $R^2 > 0.8$