2007 - 2014 Wetland Monitoring Report

April 2016

Prepared By: CAPITOL REGION WATERSHED DISTRICT

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April 21, 2016

Dear Stakeholders and Interested Parties:

I am pleased to provide you with our *2007-2014 Wetland Monitoring Report*. Capitol Region Watershed District's (CRWD) wetland monitoring data collection and analysis was enhanced by the contributions of numerous agencies and individuals, most notably: University of Minnesota-Department of Entomology, Len Farrington Lab (Dr. Len Farrington and Jane Mazack), Rhithron Laboratories, Ramsey Conservation District (Michael Schumann), and Minnesota Pollution Control Agency Surface Water Monitoring staff (Michael Bourdaghs and John Genet).

CRWD produced the first wetland monitoring report in 2009, reporting upon wetland data collected from 2007-2008. For the second iteration of the report, the District analyzed all historical wetland data (including a reanalysis of 2007-2008 data) using consistent methodology for IBI analysis for all years (2007-2014) and all wetlands. The report also includes an analysis of historical water chemistry results, providing a complete picture of collected monitoring data that influences wetland quality and overall wetland health. Data contained in this report will support current and ongoing future wetland management decisions and restoration plans.

I would also like to recognize staff who assisted with the preparation of this report. Sarah Wein, Britta Suppes, and Joe Sellner had a major role in collecting, analyzing, and reporting the data. Numerous former CRWD staff assisted with data collection from 2007-2014 (Wyatt Behrends, David DePaz, Corey Poland, Melissa Baker, Matt Loyas, Katie Huser, and others).

The CRWD *2007-2014 Wetland Monitoring Report* is available at the District's website: www.capitolregionwd.org/press/crwd-reports. If you have any questions pertaining to the enclosed report, contact District Monitoring Coordinator, Britta Suppes at (651) 644-8888 or britta@capitolregionwd.org.

Sincerely,

Bob Fossum

Bob Fossum
Water Resource Program Manager

enc: *2007-2014 Wetland Monitoring Report*

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ac	Acre
BMP	Best Management Practice
BT	Bottle Trap
cBOD	5-day Carbonaceous Biochemical Oxygen Demand
Cd	Cadmium
Chl-a	Chlorophyll-a
Cl-	Chloride
Cr	Chromium
CRWD	Capitol Region Watershed District
Cu	Copper
DN	Dip Net
DO	Dissolved Oxygen
ft	Foot
Hg	Mercury
IBI	Index of Biological Integrity
in	Inch
kg	Kilogram
L	Liter
lb	Pound
m	Meter
MCES	Metropolitan Council Environmental Services
MCWG	Minnesota Climatological Working Group
µg	Microgram
mg	Milligram
mL	Milliliter
MPCA	Minnesota Pollution Control Agency
MSP	Minneapolis-St. Paul International Airport
NA	Not Available
NCHF	North Central Hardwood Forest
NH3	Ammonia
Ni	Nickel
NO2	Nitrite
NO3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NTU	Nephelometric Turbidity Units
NWS	National Weather Service
Ortho-P	Orthophosphate
Pb	Lead
RCD	Ramsey Conservation District

s	Second
SAFL	Saint Anthony Falls Laboratory
SO4	Sulfate
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UMN	University of Minnesota-St. Paul Campus
VSS	Volatile Suspended Solids
Zn	Zinc

DEFINITIONS

Anthropogenic – resulting from the influence of human beings on nature.

Aquatic Guild – Plants which depend on an aquatic environment to survive. Many of these plants float on the water's surface or live just below the surface. Examples are white water lily, duckweed, and Eurasian watermilfoil.

Carex – A genus of plants commonly known as sedges.

Chironomid – A type of aquatic fly, also known as a midge, which resembles a mosquito but lacks wing scales and elongated mouthparts. The juvenile stages of its life are spent in water.

Corixidae – A family of aquatic insects commonly known as the waterboatmen. It is one of the most diverse aquatic insect groups in North America.

Cover Class – The percent coverage of a wetland survey plot by a given plant taxon (singular of taxa).

Depressional Wetland – A low area with soils that are saturated and lack oxygen and in which the surface water is not allowed to drain.

Emergent Zone – Area of a wetland near shore which has ponded water present throughout the year. This zone is as wide as the band of standing plants along the shore that grow towards the open, deeper water. Plants in the emergent zone are typically rooted in mud.

ETSD – Acronym standing for Ephemeroptera (mayflies), Trichoptera (caddisflies), Sphaeridae (fingernail clams), and Dragonflies. A higher number of ETSD invertebrates present indicates a healthier wetland community.

Genera – A unit used to classify and name both living and extinct organisms. It comes before species and after family.

Grasslike – Members of three families of plants which have a grasslike appearance: the grasses, the sedges, and the rushes.

Intolerant Taxa – Groups of organisms which are unable to withstand degraded environmental conditions.

Invertebrate – An animal without an internal skeletal structure. Examples are insects, snails, freshwater shrimp, and leeches.

Nonvascular – Plants that lack ducts or vessels to transport water, food, and minerals. These plants also grow from spores. Examples are mosses and algae.

Odonata – An order of insects which includes damselflies and dragonflies.

Perennial – Plants which have a lifecycle of more than two years.

Persistent Litter – Standing and matted organic remains of previous year's plants.
Taxa recognized in this IBI include Lythrum salicaria, Polygonum sp., Pharagmites sp., Scirpus sp., Sparganium sp., and Typha sp.

Sensitive Species – Species which rely on specific habitat conditions to survive that are limited in abundance, restricted in distribution, or are particularly sensitive to development.

Taxa – Groups of one or more organisms which are classified together.

Tolerant Taxa – Groups of organisms which are able to withstand degraded environmental conditions.

Vascular – Plants that have ducts or vessels to transport water, food, and minerals throughout the plant and generally stand upright. Examples are trees, grasses, cattails, water lily, flowering plants, and ferns, etc. Vascular plants can be aquatic or terrestrial.

LIST OF FIGURES

LIST OF TABLES

1 EXECUTIVE SUMMARY

1.1 CAPITOL REGION WATERSHED DISTRICT

Capitol Region Watershed District (CRWD) in Ramsey County, Minnesota is a special purpose unit of government that manages, protects, and improves water resources within its watershed boundaries. CRWD is a 41 square mile subwatershed nested in the Upper Mississippi River basin that contains portions of five cities, including: Falcon Heights, Lauderdale, Maplewood, Roseville, and Saint Paul. CRWD is highly urbanized with a population of 245,000 and 42% impervious surface coverage. All runoff from CRWD eventually discharges to the Mississippi River from 42 outfall locations within the District.

One goal of CRWD is to understand and address the presence of pollutants and their impacts on water quality within the District in order to better protect, restore, and manage local water resources. To address this goal, CRWD established a monitoring program in 2004 to begin assessing water quality and quantity of various District subwatersheds and stormwater best management practices (BMPs) over time. CRWD collects water quality and continuous flow data from major subwatersheds, lakes, ponds, wetlands, and stormwater BMPs.

1.2 PURPOSE OF REPORT

The purpose of this report is to understand baseline conditions in CRWD wetlands to better understand the value of each wetland and to inform future management decisions.

Described herein are the results from macroinvertebrate and aquatic plant sample collection of 20 major District wetlands from 2007 through 2014. Results were analyzed to calculate the Index of Biological Integrity (IBI) score for both macroinvertebrates and aquatic plants for each survey completed. Additional physical and chemical water quality results from each wetland are also included.

1.3 WETLAND MONITORING METHODS

CRWD organized the collection of macroinvertebrate and aquatic plant data for 20 wetlands from 2007 – 2014, along with information on chemical parameters (nutrients, pH, and conductivity) and physical parameters (dissolved oxygen and temperature). CRWD followed all standard operating procedures from the Minnesota Pollution Control Agency for collection of macroinvertebrates and aquatic plants, as well as the data analysis and calculation procedures for both IBI assessments.

1.4 2007 – 2014 MONITORING RESULTS

CRWD wetlands were assessed as either poor, moderate, or excellent IBI condition categories based on ranges determined by the MPCA (Table 1-1). The historical average IBI scores for macroinvertebrates and aquatic plants for all wetlands (2007 – 2014) are shown in Table 1-2.

Table 1-1: Wetland Health Condition Categories (Gernes and Helgen, 2002).

Condition Category	IBI Score
Excellent	36-50
Moderate	23-35
Poor	10-22

Overall, CRWD contains wetlands of poor to moderate quality based on the biological health of the macroinvertebrate and plant communities. None of the wetlands surveyed in the District scored in the excellent category for either IBI assessment.

Arlington-Jackson wetland and Woodview Marsh were the only two wetlands that scored in the moderate condition category for both plant and macroinvertebrate IBIs for their historical average scores, thus exhibiting the most stable condition and highest quality of all monitored CRWD wetlands (Table 1-2).

Conversely, nine other wetlands in the District had historical averages of poor condition categories for both IBIs. Most notably, Kmart wetland, Western Avenue wetland, William Street Pond, and Willow Reserve wetland had some of the lowest historical average IBI scores for both macroinvertebrates and plants, indicating that these wetlands are some of the most degraded systems in the District (Table 1-2).

Water chemistry samples (NO3+NO2, TKN, TP, Cl-, and SO4) from each CRWD wetland were reported and evaluated using MPCA Stressor Level Categories (low, medium, high) for the Mixed Wood Plain ecoregion. Using this method of evaluation, chloride was the most significant stressor, with every wetland receiving a “high” category for average annual chloride concentration results. TKN and TP were generally “medium” stressor level categories. NO3+NO2 and SO4 were generally “low” stressor level categories. Swede Hollow was the only wetland to receive “high” stressor categories for all parameters, indicating very poor water quality in this wetland system.

Table 1-2: Averages of macroinvertebrate and plant IBI scores for all wetlands from 2007 – 2014.

Wetland Name	Macroinvertebrate IBI Historical Average	Plant IBI Historical Average
Kmart	22.7	11.3
Western Ave	18.0	16.7
William Street	16.7	18.7
Post Office	24.0	12.0
Cottage Ave	20.5	18.0
Swede Hollow	17.5	22.0
Willow Reserve	22.5	17.0
Little Crosby Lake	22.5	18.0
Victoria B	20.7	20.0
Sherren Street Pond	22.0	19.3
Guptil Pond	25.0	16.5
Zittels	24.0	18.0
Reservoir Woods	23.5	19.5
Alta Vista	24.0	20.0
Exxon-Mobil	32.0	12.0
Victoria-Roselawn	25.3	21.3
Villa Park	22.0	27.0
Woodview Marsh	25.0	30.0
Arlington-Jackson	30.0	25.5

Condition Category	IBI Score
Excellent	36-50
Moderate	23-35
Poor	10-22

1.5 2015 RECOMMENDATIONS

It is recommended that the baseline wetland data reported herein be utilized to meet the goals of the wetland monitoring program. Among these goals are to establish baseline quality conditions of major wetlands in the District and to document their health using IBI assessments in order to better understand each wetland's condition and to inform future wetland management decisions. Additionally, this report can be used to better understand and define the services provided by CRWD wetlands, including: the biological function of wetlands; environmental services provided by wetlands; and the human health value of wetlands.

The data reported herein may also be utilized in the District planning process to answer the following questions:

1. Would any CRWD wetland(s) benefit from maintenance or restoration?

2. How does CRWD want to manage District wetlands?

3. How can CRWD better manage wetlands to help achieve the District's overall goal of protecting, managing, and improving the water resources of CRWD?

Finally, it is recommended that CRWD continue wetland monitoring efforts to assist in answering questions regarding the management of District wetlands.

2 INTRODUCTION

2.1 CRWD BACKGROUND

Located in Ramsey County, Minnesota the Capitol Region watershed is a small urban subwatershed nested in the Upper Mississippi River basin with all runoff eventually discharging to the Mississippi River. Capitol Region Watershed District (CRWD) is a special purpose unit of government formed in 1998 to manage and protect all water resources within the Capitol Region watershed boundaries. CRWD contains portions of five cities, including: Falcon Heights, Lauderdale, Maplewood, Roseville, and Saint Paul (Figure 2-1). CRWD is highly urbanized with a population of 245,000 and 42% impervious surface coverage. Land use in the watershed is primarily residential with dense areas of commercial, industrial, and institutional uses.

2.2 CRWD WATER QUALITY ISSUES

Urban development in the watershed over time has significantly impacted the health and sustainability of the Mississippi River as well as CRWD lakes, ponds, and wetlands. Impervious surfaces generate polluted stormwater runoff which causes poor water quality, increased peak storm flows, decreased groundwater recharge, increased flooding, and loss of biological habitat. Subsequently, stormwater runoff is one of the most significant sources of pollution to CRWD water resources. It delivers fertilizers, pesticides, pet and wildlife waste, nutrients, sediment, heavy metals, and other anthropogenic pollutants to local lakes and multiple ponds and wetlands located in the District. As stormwater runs off the urban landscape, it is directed through various wetlands and stormwater ponds, and conveyed through an extensive network of underground storm sewer pipes that eventually drain to the Mississippi River.

2.3 WETLAND BACKGROUND INFORMATION

Historically, CRWD was replete with wetlands. Now, however, wetlands make up less than 5% of the District's area, as the majority of the District has been developed and is highly urbanized (CRWD, 2010). Therefore, wetlands are an important water resource in CRWD. In addition to treating stormwater runoff from all of the impervious surfaces of the area, they are integral for groundwater recharge and they represent one of the few areas which provide wildlife habitat in the District. All of the District's wetlands, however, have been impacted by stormwater runoff which carries pollutants, sediment, and other waste. In addition, some natural wetlands have been re-designated as stormwater ponds for treatment and retention of stormwater. As a consequence, District wetlands exhibit varying degrees of degradation.

The degree of this degradation is unknown; however, the biological community can provide a good indication of overall wetland health. Research into the use of biological data as a water quality indicator has been developed over the past several decades. Karr (1997) summarizes the concept of "biotic integrity", which is based on the premise that the status of living systems provides the most direct and effective measure of the "integrity of water."

As one of many efforts to remediate and assess CRWD's impacted water resources, a wetland biological monitoring program was started in 2007 as part of the District's water resource monitoring program. Through this program, biological monitoring is used to assess wetland conditions using an Index of Biological Integrity (IBI), consisting of aquatic invertebrate and plant indices. Monitoring consists of a collection of aquatic macroinvertebrates and a survey of aquatic plants, along with collection of water quality and land-use data. These data are then evaluated through macroinvertebrate and plant metrics that provide an overall rating within the IBI. The District uses the IBI developed by the Minnesota Pollution Control Agency (MPCA) for wetlands in the North Central Hardwood Forest Ecoregion (NCHF). Final assessment of an individual wetland relies on the total metric score for each IBI and the associated condition class for that score. The results of the IBI assessment can be utilized in future decision-making for District projects and planning.

2.4 CRWD WETLAND MONITORING PROGRAM GOALS

The goal of the wetland monitoring program is to establish baseline quality conditions of major wetlands in CRWD and document their relative health using an IBI to better inform management decisions and understand their value. The data collected through CRWD wetland monitoring will be utilized to understand the services provided by wetlands in the District, including:

- Biological function:
    - Ecological diversity
    - Urban wildlife habitat and connectivity
- Environmental services:
    - Water quality improvements
    - Flood control
    - Carbon sink
- Community and human health value:
    - Green space/aesthetics
    - Recreation

2.5 OVERVIEW OF CRWD WETLANDS

CRWD monitors 20 wetlands within the District. All of these wetlands have been sampled on a roughly bi-annual basis since 2007, generally alternating monitoring every other year. Biological monitoring of six wetlands was performed during the summer of 2007 and an additional four wetlands were monitored in the summer of 2008. In 2009, CRWD published the *2007-2008*

Wetland Assessment Report , which details the IBI results from those ten wetlands and is available online (www.capitolregionwd.org). Ten additional wetlands were added between 2009 and 2014 as part of CRWD's ongoing plans for biological monitoring within the District.

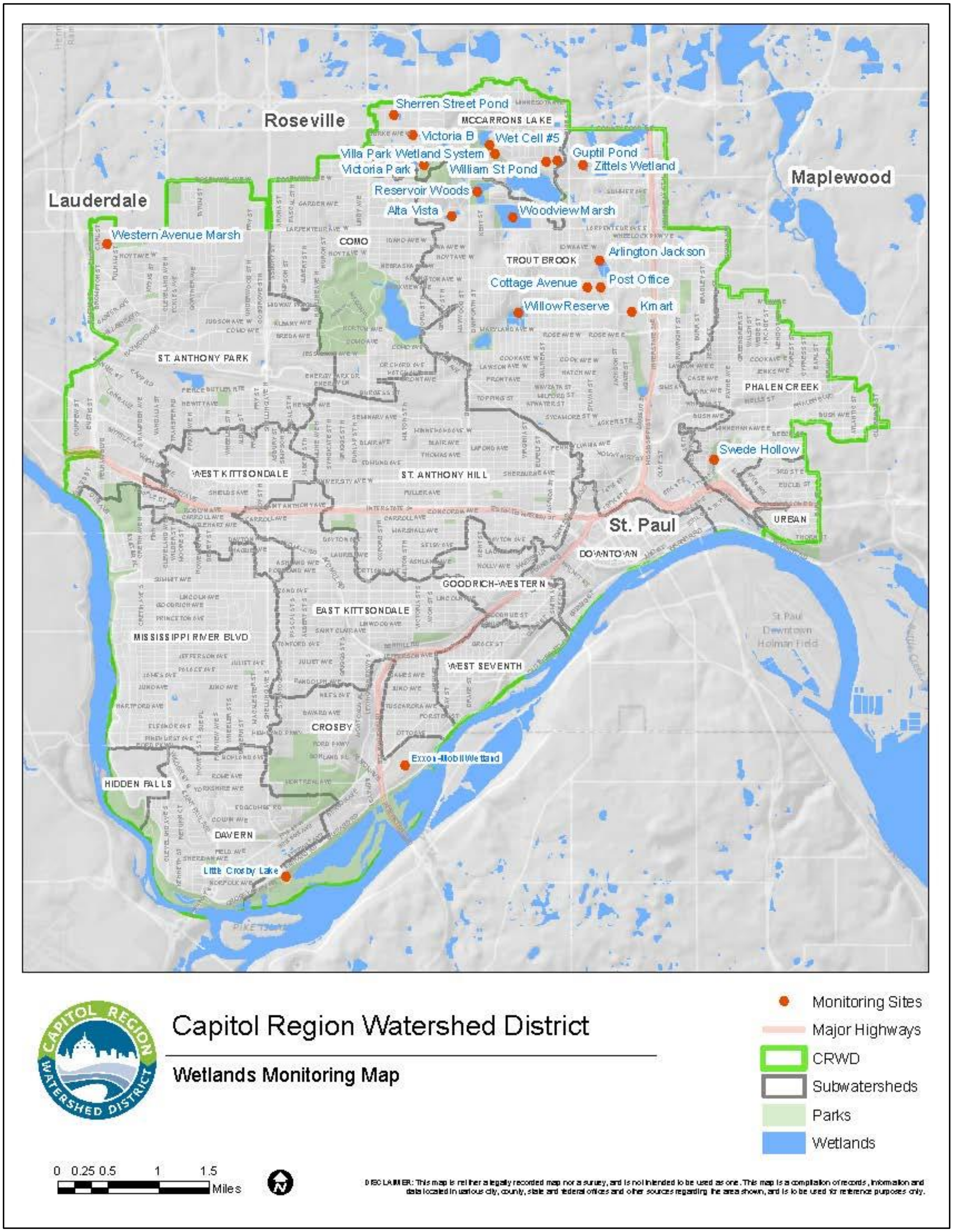

Figure 2-1: CRWD wetland monitoring locations.

3 METHODS

3.1 MONITORING METHODS

All data collection followed MPCA instructions for Macroinvertebrate and Aquatic Plant Community Sampling Protocols for Depressional Wetland Monitoring, which can be found in Appendix A and B (MPCA, 2002a; MPCA, 2002b). When CRWD was performing wetland sampling for 2007 – 2014, the most current protocols from the MPCA were written in 2002. Therefore, CRWD followed these protocols for the field methods, results, and analysis described in this report. These protocols were since updated in October 2014, and updated protocols can be found online on the MPCA Wetland Monitoring and Assessment website (http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/wetland-monitoring-and-assessment.html).

3.1.1 MACROINVERTEBRATE SAMPLING

Macroinvertebrate sampling was generally conducted in June prior to aquatic plant sampling using two methods. The first method uses activity traps (also called bottle traps). Five pairs of activity traps are placed throughout the emergent zone to catch active, swimming species in a representative site within the wetland. The activity traps are left in the wetland for 48 hours after which insects are collected from the traps. The second method involves the use of dip nets. Dip net samples are collected during the same 48 hour period, usually on the same day the activity traps are set. Samples are collected by making large sweeps with the dip net in the vegetated zone to collect invertebrate species attached to plants. Two dip net samples consisting of 3-5 sweeps are collected in the same general area as the activity traps, but avoiding the specific area around each trap. Each dip net and activity trap sample is preserved in ethyl alcohol for identification by the lab. A detailed description of the standard operation procedure for macroinvertebrate community sampling can be found in Appendix A. CRWD staff conducted macroinvertebrate sampling from 2007 – 2014.

3.1.2 AQUATIC PLANT SAMPLING

Aquatic plant sampling is generally performed in July when many wetland plants are flowering. A site within each wetland that is most representative of the overall plant community is chosen for plant sampling, regardless of the macroinvertebrate sampling site. At the site, a 100 square meter plot (also called a “releve”) is created for the vegetation survey. The plot uses either a 10m x 10m or a 5m x 20m configuration, depending on the width of the emergent vegetation zone. All species of vegetation found in the plot are recorded along with an estimate of the area within the plot that each species covers, called percent cover. Any plant unidentified during sampling is collected and returned to the lab where the plant is pressed and later identified using various identification tools. Additionally, human disturbance indicators in and around the wetland are recorded, such as buffer landscape disturbance (mowing, tree removal, farming) or hydrologic alteration (ditch or pipe inlet, berms, dredged or filled). A detailed description of the standard operation procedure for aquatic plant community sampling can be found in Appendix B. CRWD staff conducted plant surveys from 2007 – 2013. Plant sampling in 2014 was conducted by staff from Ramsey Conservation District (RCD).

3.1.3 WATER QUALITY SAMPLING

In addition to macroinvertebrate and plant sampling, sonde data and water chemistry grab samples were collected during at least one wetland visit per year for each wetland. This was normally collected during the aquatic plant site visit. Sonde data was collected using a YSI Quattro probe set up to measure DO, pH, temperature, and specific conductance. The probe was fully submerged and held just below the surface, and data was recorded in the site visit notes after values stabilized.

Water chemistry grab samples were collected using a 4000 mL bottle that was submerged and filled from the surface water near the shore of the wetland. Water quality samples were submitted to the Metropolitan Council Environmental Services (MCES) Laboratory for analysis (see Appendix C for MCES analysis methods, reporting limits, and holding times). The MPCA recommends analyzing samples for: turbidity, color, chloride, sulfate, total organic carbon, calcium, magnesium, nitrogen, and phosphorus.

3.2 DATA ANALYSIS METHODS

3.2.1 INDEXES OF BIOLOGICAL INTEGRITY (IBI) CALCULATIONS

Macroinvertebrate samples from 2007 – 2013 were processed by the University of Minnesota's Department of Entomology (Len Ferrington Lab). Invertebrates were identified to the genus or species level based on MPCA protocols and the count per species was recorded. Macroinvertebrate samples in 2014 were processed by Rhithron Associates, Inc., where organisms were identified to the required taxonomic level based on these MPCA protocols. CRWD staff processed the plant survey data for all years.

After sample processing was completed, the data was used to calculate both macroinvertebrate and plant IBI scores for each wetland using methods detailed in Indexes of Biological Integrity (IBI) for Large Depressional Wetlands in Minnesota (Gernes and Helgen, 2002). The methods in Gernes and Helgen (2002) were developed for wetlands in the NCHF ecoregion and incorporate individual indices for aquatic plants and macroinvertebrates. Each index is composed of 10 metrics that assess key attributes of plant and macroinvertebrate communities that reflect overall wetland quality. CRWD staff utilized these methods in Gernes and Helgen (2002) to analyze and calculate corresponding IBIs for each wetland for all years monitored (2007 – 2014). Additional questions regarding IBI calculation were answered through e-mail correspondence by John Genet, MPCA Research Scientist (Personal Communication, 7/13/2015 – 12/11/2015).

To calculate the final plant or macroinvertebrate IBI score, each of the ten metrics is evaluated and given an individual score of either 1, 3, or 5 based on the value of the metric. Individual scores from the 10 metrics are then summed to calculate the total IBI score (Gernes and Helgen, 2002). Total plant or macroinvertebrate IBI scores range from 10 (lowest) to 50 (highest). High IBI scores represent better wetland condition, whereas low IBI scores represent poor conditions. The MPCA developed condition categories using descriptors (Excellent, Moderate, and Poor) to assist in interpreting IBI scores; they are calculated by trisecting the range of scores below the 95th percentile (Table 3-1).

The methods designed by the MPCA and used by CRWD for data collection, sample processing, data analysis, and IBI metric calculations are specific and can be repeated across wetlands and over successive years to aid in wetland management decisions. This overview should be considered an introductory summary of the methods rather than a comprehensive explanation of field, laboratory, and analysis protocols. The MPCA protocols should be consulted by anyone in need of more technical explanations (Gernes and Helgen, 2002; MPCA, 2002a; MPCA, 2002b).

Table 3-1: Wetland health condition categories (Gernes and Helgen, 2002).

Condition Category	IBI Score
Excellent	36-50
Moderate	23-35
Poor	10-22

3.2.2 WATER QUALITY DATA ANALYSIS

Water chemistry in wetlands is complicated and not as fully understood as the water chemistry of lakes and streams (MPCA, 2005). As a result, it is difficult to develop numeric standards for comparisons among wetlands, and it is more pertinent to examine biological condition (i.e. macroinvertebrate and plant health) as an indicator of overall wetland health. The collection of wetland water quality data, therefore, is more important for establishing baseline conditions as an additional means for identifying potential degradation.

For reporting purposes, data was compared to wetland water chemistry data collected by the MPCA in the most recent report detailing the status of Minnesota wetlands (Genet, 2015). The "Stressor Level Categories" of low, medium, and high for the mixed wood plains ecoregion in the report were used to determine the overall quality of CRWD wetland chemistry compared to wetlands in the same ecoregion over a similar time period (Genet, 2015). The Stressor Level Categories and their value ranges are listed in Table 3-2.

A summary of the water chemistry data collected for each wetland from 2007 – 2014 is found in each wetland section, along with a comparison to the stressor level categories found in Table 3-2. All water chemistry data for each wetland can be found in Appendix D.

Table 3-2: Stressor Level Categories for wetlands in the mixed wood plains ecoregion from wetland survey data collected from 2007 – 2012 by the MPCA (Genet, 2015).

Parameter (mg/L)	Stressor Level Categories		
	Low	Medium	High
Nitrate+Nitrite (NO2+NO3)	No detect	N/A	Detect
Kjeldahl Nitrogen (TKN)	<1.49	>1.49, <3.10	>3.10
Total Phosphorus (TP)	<0.148	>0.148, <0.384	>0.384
Chloride (Cl-)	<1.4	>1.4, <7.9	>7.9
Sulfate (SO4)	<5.9	>5.9, <12.5	>12.5

4 OVERALL WETLAND RESULTS

4.1 RESULTS

The total number of wetlands assesssed as poor, moderate, or excellent by either the macroinvertebrate IBI or aquatic plant IBI assessments for all years sampled (2007 – 2014) are shown as ratios by condition categories in Figures 4-1 and 4-2 to depict general trends of wetland health in CRWD. Note that the sample size (n) includes the total annual score of every IBI assessment conducted from 2007 – 2014, so some wetlands are represented more than once in the sample size. Overall, average macroinvertebrate IBI scores (average = 27.3) were higher than average plant IBI scores (average = 17.6), indicating that the aquatic plant community may be showing a stronger response to disturbance conditions. No wetlands scored in the excellent category for either IBI assessment and varying numbers of wetlands fell into the moderate and poor categories. This indicates that human disturbance and outside stressors are affecting each of the biotic communities (macroinvertebrate and plant) to a different degree.

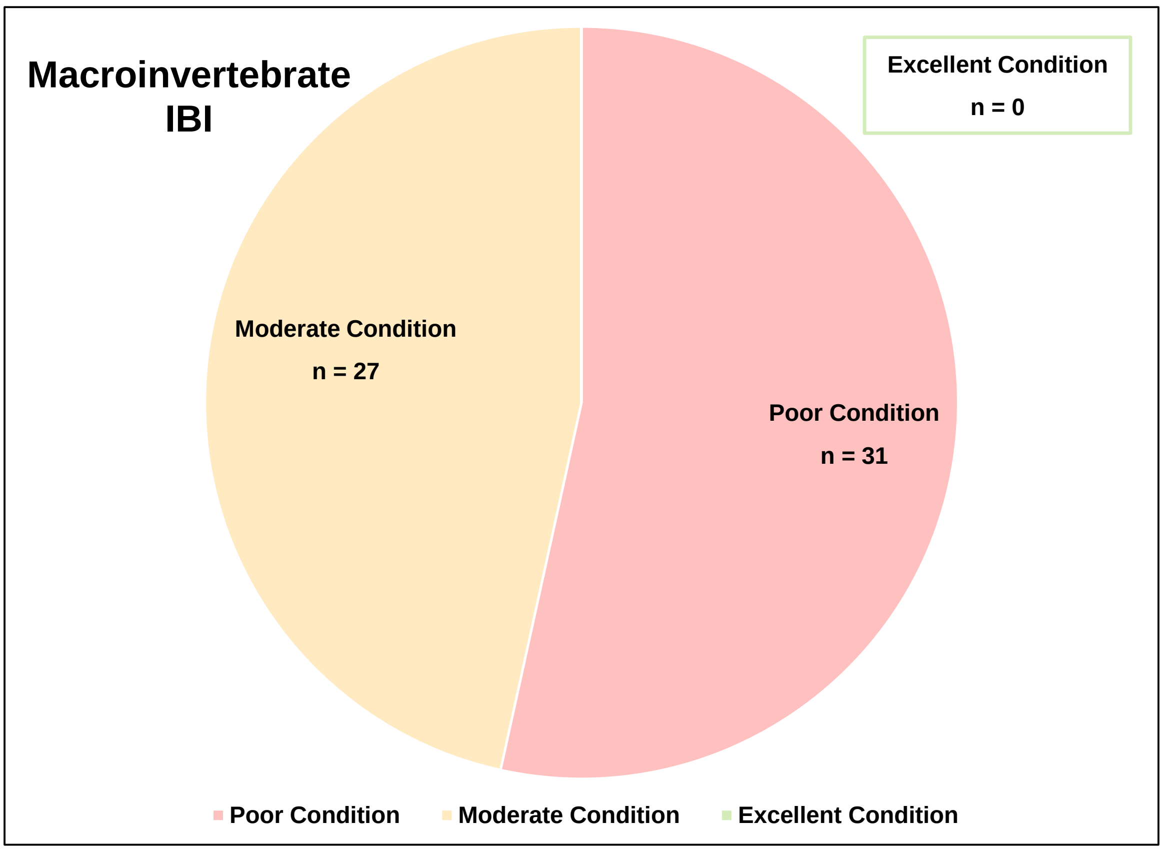

Figure 4-1: Total number of macroinvertebrate IBI scores in the poor, moderate, and excellent condition categories for monitored CRWD wetlands from 2007 – 2014.

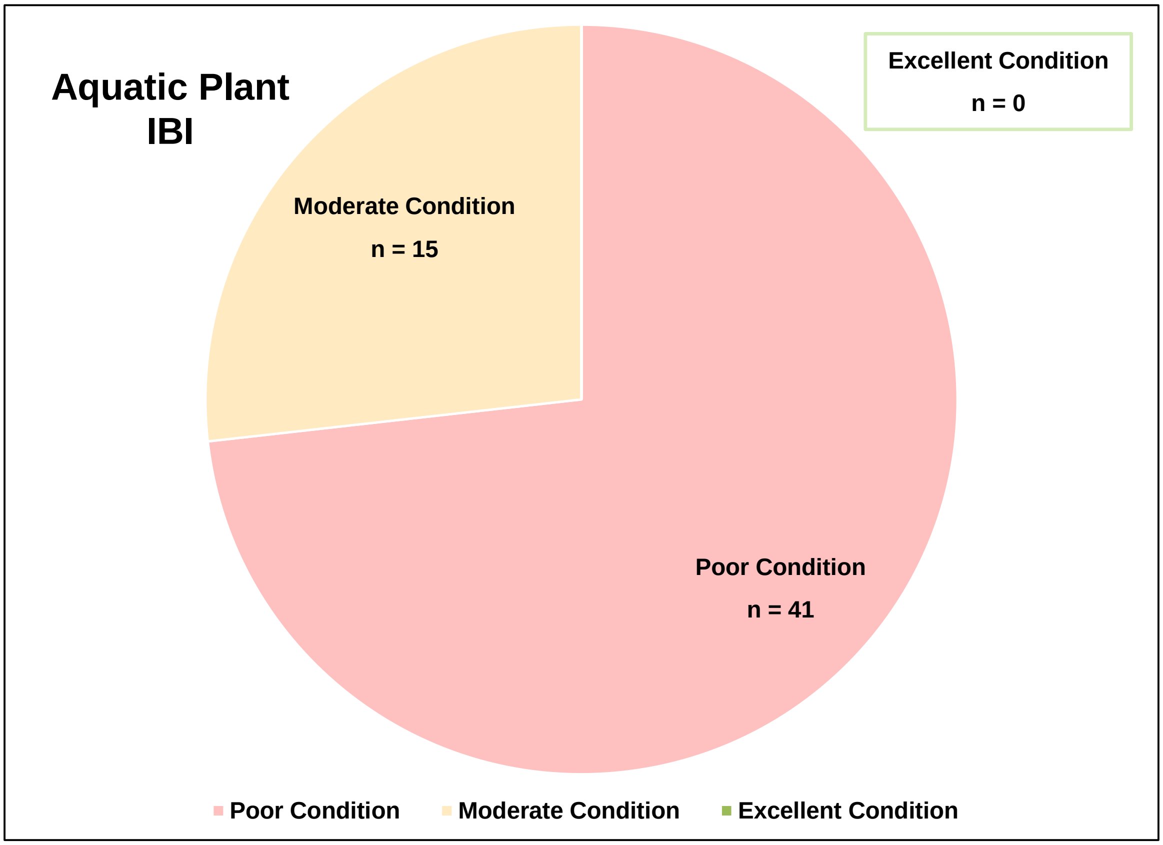

Figure 4-2: Total number of aquatic plant IBI scores in the poor, moderate, and excellent condition categories for monitored CRWD wetlands from 2007 – 2014.

The historical average IBI scores by condition category are shown spatially within CRWD in Figure 4-3. The total annual macroinvertebrate and plant IBI results as well as the historical average for each CRWD wetland that was assessed from 2007 – 2014 are shown in Figure 4-4 and Tables 4-1 & 4-2. Overall, CRWD contains wetlands of poor to moderate quality based on the biological health of the macroinvertebrate and aquatic plant communities.

Arlington-Jackson and Woodview Marsh were the only two wetlands that scored in the moderate condition category for both IBIs for their historical average scores, thus exhibiting the most stable condition and highest quality of all monitored CRWD wetlands (Figure 4-4).

Conversely, nine other wetlands in the District had historical averages of poor condition categories for both IBIs. Most notably, Kmart, Western Avenue, and William Street Pond had the lowest historical average IBI scores for both macroinvertebrates and plants, indicating that these wetlands are some of the most degraded systems in the District (Figure 4-4). Willow Reserve is another wetland that has consistently had both plant and macroinvertebrate IBI scores in the poor condition category for the majority of years monitored.

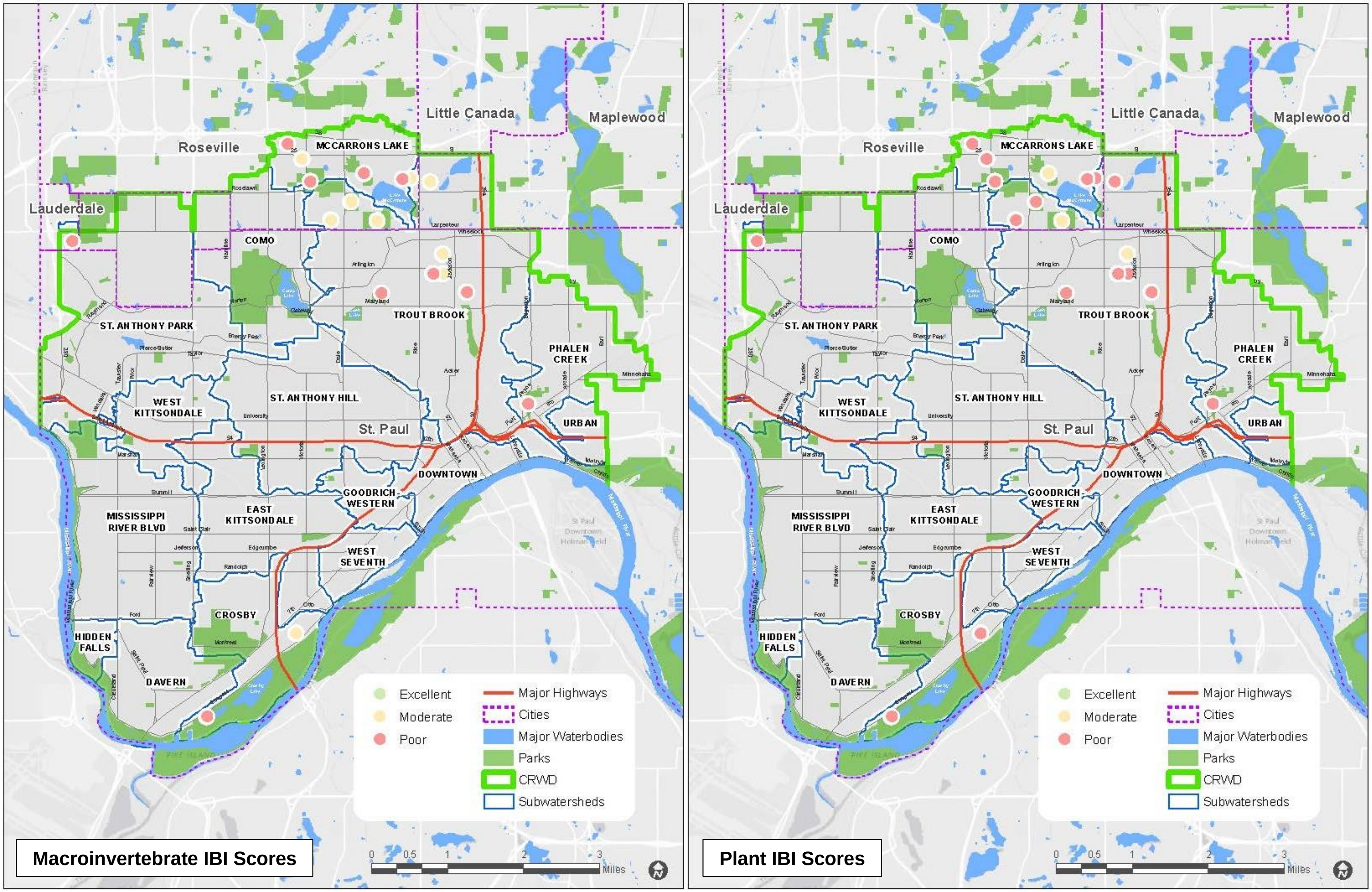

Figure 4-3: Wetland biological condition of monitored CRWD wetlands based the MPCA condition categories for historical average macroinvertebrate and plant IBI scores (Gernes and Helgen, 2002).

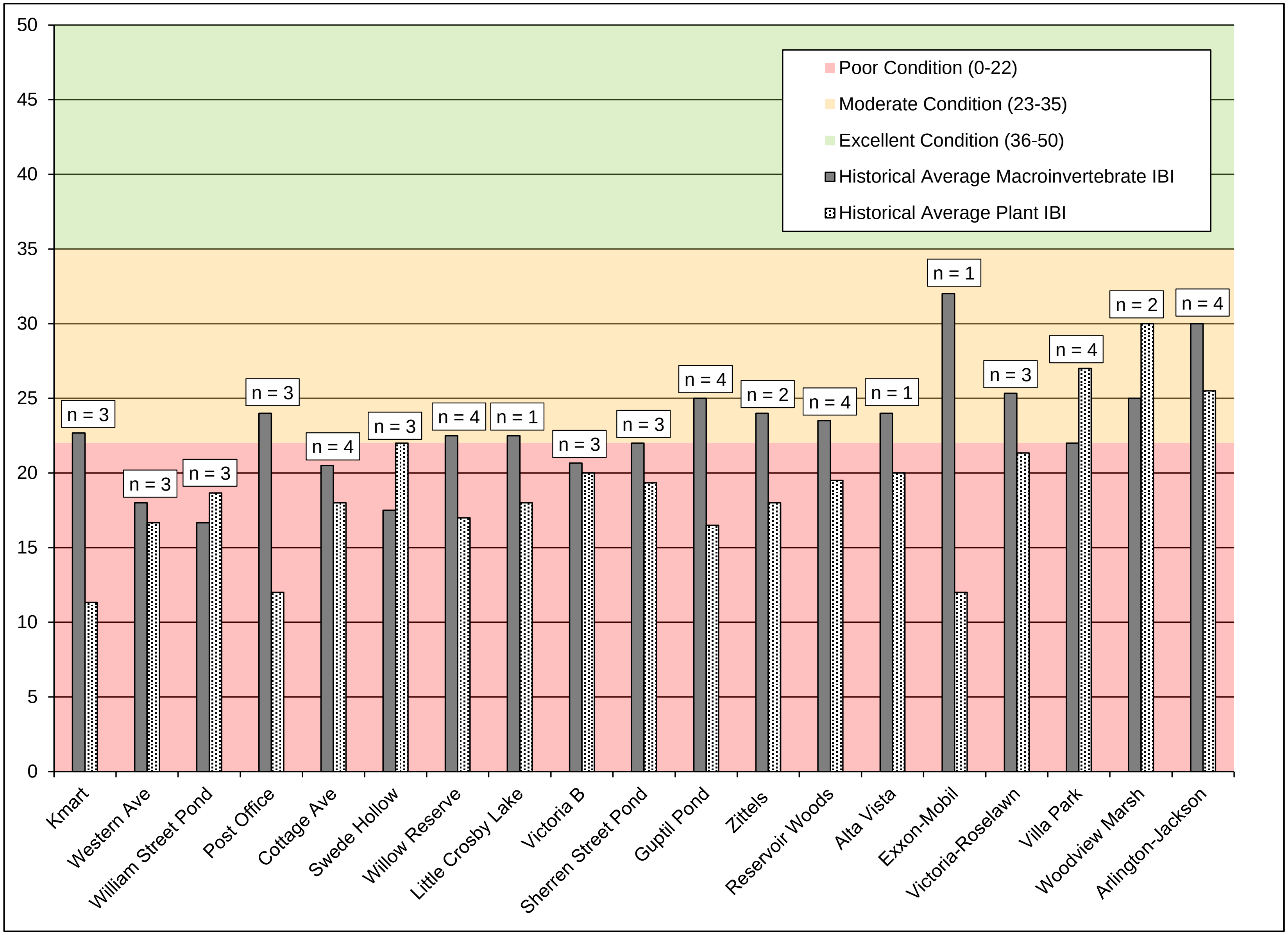

Figure 4-4: Historical average macroinvertebrate and plant IBI scores for monitored CRWD wetlands from 2007 – 2014.

The highest macroinvertebrate IBI score was observed at Victoria-Roselawn in 2012 with a score of 34. The lowest macroinvertebrate IBI score was observed at Swede Hollow in 2008 with a score of 10 (Table 4-1).

The highest aquatic plant IBI score observed was a 34, which was observed at Villa Park in 2014 and Woodview Marsh in 2013. The lowest aquatic plant IBI score observed was a 10, which was observed at Kmart in 2009 and 2012, Post Office in 2010, and Swede Hollow in 2011. No cover class data was collected at Swede Hollow in 2011, however, so this score might be lower than the actual value (Table 4-2).

Water chemistry samples (NO_3+NO_2, TKN, TP, Cl^-, and SO_4) from each CRWD wetland were reported and evaluated using MPCA Stressor Level Categories (low, medium, high) for the Mixed Wood Plain ecoregion (Table 4-3). Using this method of evaluation, chloride was the most significant stressor, with every wetland receiving a “high” category for average annual chloride concentration results. Post Office wetland had the highest annual average chloride concentration of 276.1 mg/L. While chloride ranked as “high” for every wetland, the other parameters and their associated category varied by individual wetlands (e.g. “low” NO_3+NO_2 and “high” TP, or vice-versa). TKN and TP were generally “medium” stressor level categories. NO_3+NO_2 and SO_4 were generally “low” stressor level categories. Swede Hollow was the only wetland to receive “high” stressor categories for all parameters, indicating very poor water quality in this wetland system.

Table 4-1: Macroinvertebrate IBI scores for all monitored CRWD wetlands from 2007 – 2014.

	2007	2008	2009	2010	2011	2012	2013	2014	Historical Average
Alta Vista			24						**24.0**
Arlington-Jackson	30				32	32		26	**30.0**
Cottage Ave		24			20	22		16	**20.5**
Exxon-Mobil							32		**32.0**
Guptil Pond	30			28		24		18	**25.0**
Kmart			22			18	28		**22.7**
Little Crosby Lake[a]		24	21						**22.5**
Post Office				26		28		18	**24.0**
Reservoir Woods	24			32		22		16	**23.5**
Sherren Street Pond			18		22		26		**22.0**
Swede Hollow		10	16		20		24		**17.5**
Victoria B			18		18		26		**20.7**
Victoria-Roselawn			16			34		26	**25.3**
Villa Park	18			22		20		28	**22.0**
Western Ave		16			16		22		**18.0**
William Street Pond				16		20		14	**16.7**
Willow Reserve	18			24		32		16	**22.5**
Woodview Marsh	28						22		**25.0**
Zittels			26				22		**24.0**

[a] Little Crosby Lake was surveyed twice in 2009; the resulting IBI scores were averaged to find an annual total.

Condition Category	IBI Score
Excellent	36-50
Moderate	23-35
Poor	10-22

Table 4-2: Aquatic plant IBI scores for all monitored CRWD wetlands from 2007 – 2014.

	2007	2008	2009	2010	2011	2012	2013	2014	Historical Average
Alta Vista			20						**20.0**
Arlington-Jackson	32				22	24		24	**25.5**
Cottage Ave		16			18	18		20	**18.0**
Exxon-Mobil							12		**12.0**
Guptil Pond	16			18		14		18	**16.5**
Kmart			10			10	14		**11.3**
Little Crosby Lake[a]			18						**18.0**
Post Office				10		14		12	**12.0**
Reservoir Woods	16			24		16		22	**19.5**
Sherren Street Pond			24		16		18		**19.3**
Swede Hollow[b]			26		10		30		**22.0**
Victoria B			14		14		32		**20.0**
Victoria-Roselawn			16			18		30	**21.3**
Villa Park	32			20		22		34	**27.0**
Western Ave[b]		14			14		22		**16.7**
William Street Pond				14		14		28	**18.7**
Willow Reserve[b]	20			16		16		16	**17.0**
Woodview Marsh	26						34		**30.0**
Zittels			12				24		**18.0**

[a] Little Crosby Lake was surveyed twice in 2009; the resulting IBI scores were averaged to find an annual total.

[b] Cover Class data was not collected in 2011/2012; the IBI scores listed are potentially lower than the actual value.

Condition Category	IBI Score
Excellent	36-50
Moderate	23-35
Poor	10-22

Table 4-3: Stressor Level Categories for average concentrations (2007 – 2014) of water quality parameters for all CRWD wetlands (Genet, 2015).

Wetland	NO3+NO2 (mg/L)	TKN (mg/L)	TP (mg/L)	Cl- (mg/L)	SO4 (mg/L)
Alta Vista	No detect	-	-	36.0	-
Arlington-Jackson	Detect	0.8	0.072	58.1	22.9
Cottage Avenue	No detect	7.6	1.302	70.4	2.0
Exxon-Mobil	No detect	1.4	0.158	61.3	4.9
Guptil Pond	No detect	3.0	0.318	33.6	2.1
Kmart	No detect	19.9	3.950	112.8	3.2
Little Crosby Lake	No detect	1.6	0.056	156.0	15.5
Post Office	No detect	4.0	0.465	276.1	2.3
Reservoir Woods	No detect	2.9	0.472	19.5	0.5
Sherren Street	No detect	1.3	0.263	56.8	0.5
Swede Hollow	Detect	13.7	1.675	116.2	50.3
Victoria B	No detect	1.1	0.178	62.6	22.0
Victoria-Roselawn	No detect	2.0	0.140	37.9	3.0
Villa Park	Detect	1.8	0.466	91.5	8.2
Western Avenue	Detect	1.6	0.317	77.7	9.8
William Steet Pond	Detect	2.4	0.440	28.3	3.8
Willow Reserve	No detect	3.1	0.283	37.7	4.4
Woodview Marsh	No detect	3.8	0.335	67.2	0.6
Zittels	No detect	43.0	6.340	137.6	1.9

Parameter (mg/L)	Stressor Level Categories		
	Low	Medium	High
Nitrate+Nitrite (NO2+NO3)	No detect	N/A	Detect
Kjeldahl Nitrogen (TKN)	<1.49	>1.49, <3.10	>3.10
Total Phosphorus (TP)	<0.148	>0.148, <0.384	>0.384
Chloride (Cl-)	<1.4	>1.4, <7.9	>7.9
Sulfate (SO4)	<5.9	>5.9, <12.5	>12.5

5 ALTA VISTA

5.1 BACKGROUND

Alta-Vista Wetland is located north of Larpenteur Avenue and Dale Street (Figures 5-1 and 5-2). Alta-Vista wetland was sampled for macroinvertebrates and plants in 2009 (Table 5-1). Surrounding land use is primarily residential with the Roselawn Cemetery residing on the west side of the wetland.

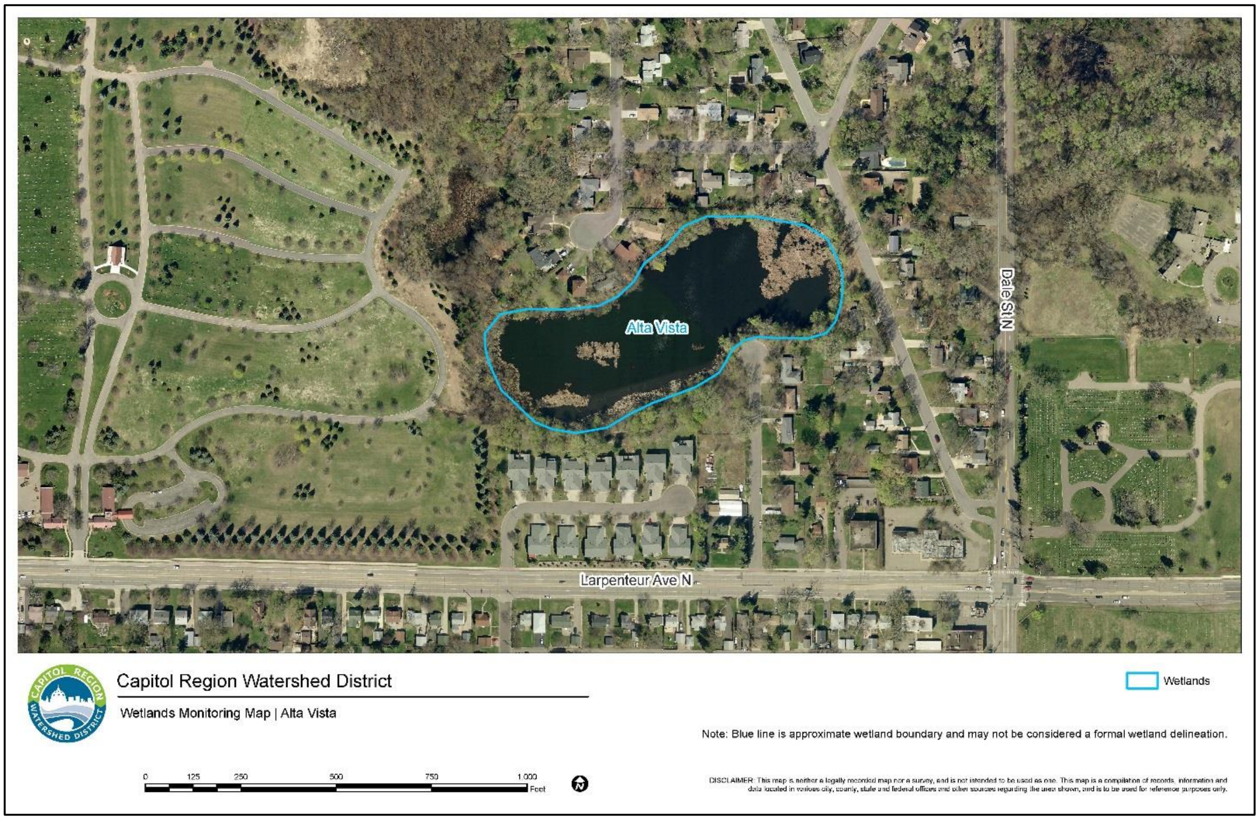

Figure 5-1: Map of Alta Vista wetland.

Figure 5-2: View of western shoreline in Alta Vista wetland.

Table 5-1: Dates monitored for Alta Vista wetland (2009).

Year Monitored	Macroinvertebrate Date	Plant Date
2009	6/23	7/29

5.2 RESULTS

Alta Vista received a macroinvertebrate IBI score of 24, which is in the lower range of the moderate condition category (Figure 5-3). Of note in the macroinvertebrate IBI is the wetland's low proportion of Corixidae in the bottle trap samples (Table 5-2), resulting in a score of 5 for this metric, which decreased the overall macroinvertebrate IBI score.

The plant IBI score of 20 falls within the upper range of the poor condition category (Figure 5-3). Six of the ten plant metrics received scores of one, the lowest score possible (Table 5-3). The Carex cover metric (the sum of the cover class values of sedge species observed) was the only metric to receive the maximum score of 5 points. However, Alta Vista wetland has moderate plant species diversity and robustness (Table 5-3).

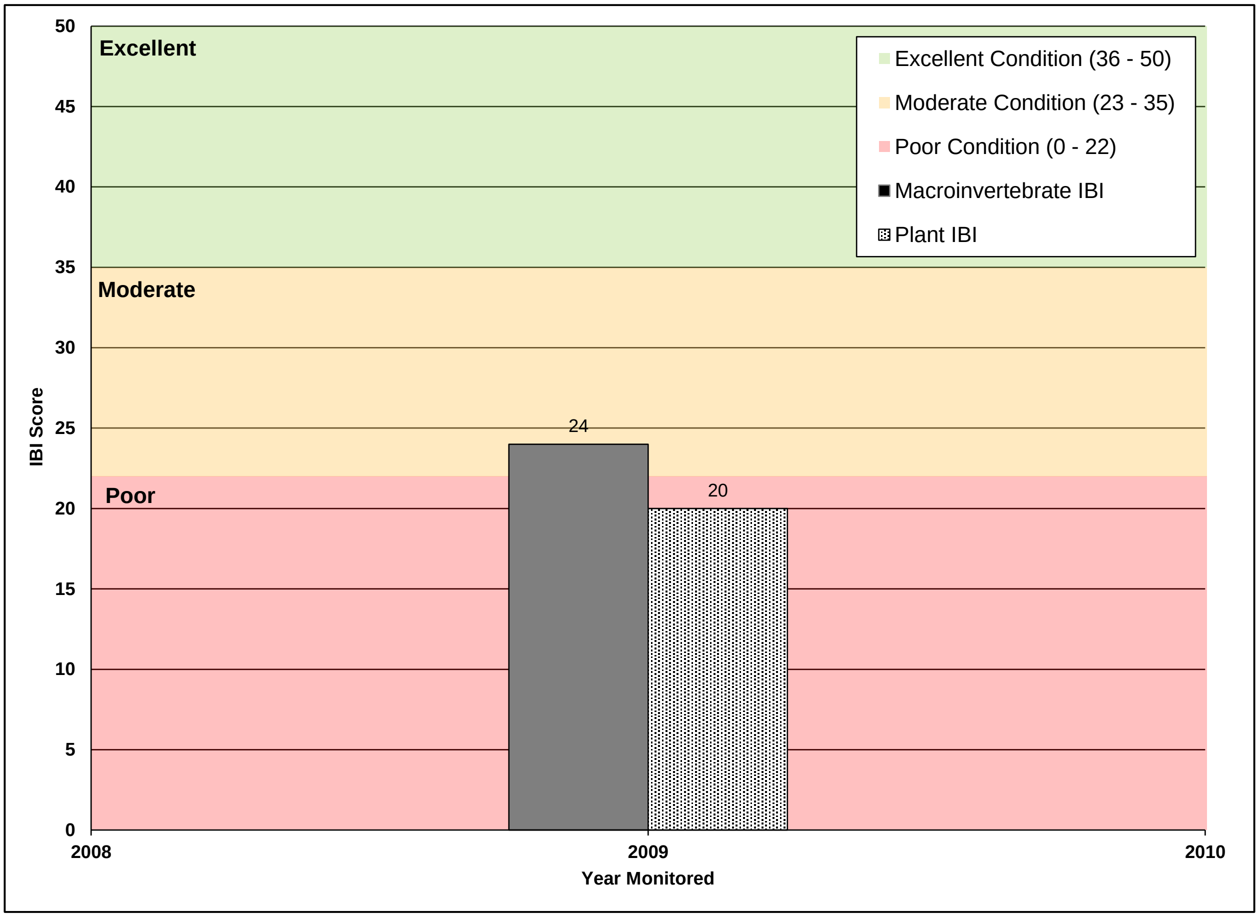

Figure 5-3: Macroinvertebrate and plant IBI scores for Alta Vista wetland.

Table 5-2: Alta Vista macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2009	
		value	score
1	Total invertebrate taxa	34	1
2	Odonata taxa	2	1
3	Chironomid genera[a]	9	3
4	Leech taxa	3	3
5	Snail taxa	3	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	2	1
7	Number of intolerant taxa	4	3
8	Tolerant taxa proportion of sample count[a]	44.6%	3
9	Dominate 3 taxa as proportion of sample count[a]	72.3%	3
10	Corixidae proportion of beetles and bugs in AT[b]	13.1%	5
	Total Macroinvertebrate IBI Score		**24**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 5-3: Alta Vista aquatic plant metric scores/values and total score.

	Plant Metrics	2009	
		value	score
1	Vascular genera[a]	11	3
2	Nonvascular genera	0	1
3	Carex cover[a]	2.1	5
4	Sensitive species (#)[a]	1	1
5	Tolerant taxa proportion	0.62	1
6	Grasslike species (#)[a]	2	1
7	Perennials species (#)[a]	6	3
8	Aquatic guild species (#)	2	1
9	Proportion of dominant 3 taxa cover class	0.54	3
10	Persistent litter	36.4%	1
	Total Plant IBI Score		**20**

a Only native species used in metric calculation.

The physical properties and water chemistry data for Alta Vista wetland are reported in Tables 5-4 and 5-5. Since Alta Vista was sampled only once in 2009, no general trends or conclusions on water quality can be drawn from this data. However, according to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); and Cl- (high) (Tables 3-2 and 5-5).

Table 5-4: Sonde data for Alta Vista wetland (2009).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
06/25/2009 --:--	80.85	6.0	233	44.0	3.49
07/16/2009 12:15	72.74	6.3	251	129.6	11.29

Table 5-5: Water chemistry data for Alta Vista wetland (2009).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/16/2009 12:15	-	0.014	-	-	0.05	0.03	36.0	-	-
Average	**-**	**0.014**	**-**	**-**	**0.05**	**0.03**	**36.0**	**-**	**-**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

6 ARLINGTON-JACKSON

6.1 BACKGROUND

The Arlington-Jackson wetland is located between Larpenteur Avenue (to the north) and Arlington Avenue (to the south), and runs along the west side of Jackson Street (Figure 6-1). The wetland has two main bays and a stream that runs through it from the north to the southeast. The northern bay is the only location of open water in the wetland and was where sampling took place (Figure 6-2). Arlington-Jackson was monitored in 2007, 2011, 2012, and 2014 (Table 6-1).

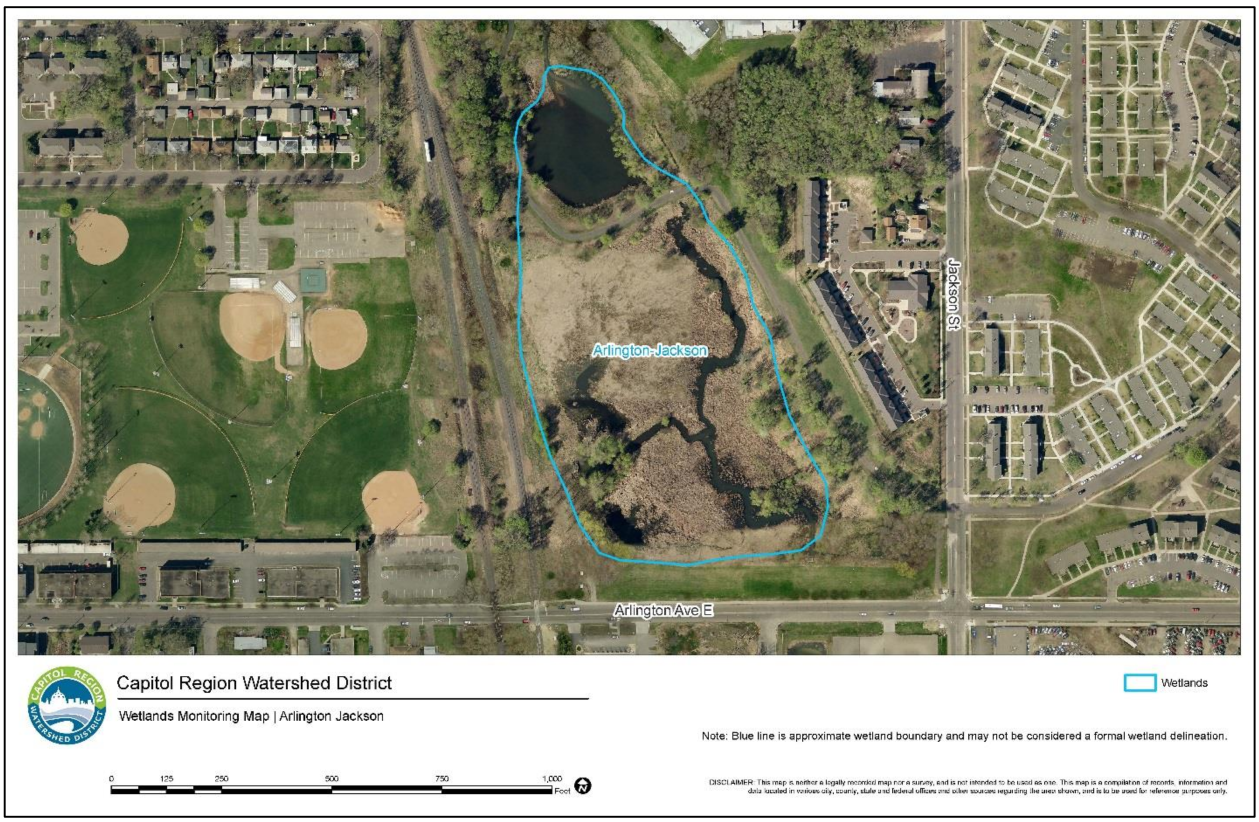

Figure 6-1: Map of Arlington-Jackson wetland.

Figure 6-2: View of the north bay of Arlington-Jackson wetland.

The surrounding land use of the Arlington-Jackson wetland is primarily residential and parkland. The wetland also receives effluent water from the St Paul Regional Water Services upstream treatment facility through a channel at the north end of the north bay. The wetland is surrounded on most sides by a wide buffer zone containing grassy flats and upland forest. A paved recreation path follows one side of the wetland and the only mowing occurs in a narrow strip along the path.

Table 6-1: Dates monitored for Arlington-Jackson wetland (2007, 2011, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2007	6/22	7/31
2011	7/7	8/16
2012	6/27	9/5
2014	6/26	6/26

6.2 RESULTS

The Arlington-Jackson wetland was initially sampled in 2007, and was revisited in 2011, 2012, and 2014 (Figure 6-3). The macroinvertebrate IBI score was in the moderate condition category for all four sampling events, indicating a relatively healthy invertebrate community. The highest scores were observed in 2011 and 2012. However, while 2 macroinvertebrate metrics received a score of 1 in the 2011 IBI, all metrics received a score of 3 or higher in 2012 (Table 6-2). This overall improvement likely indicates the presence of a well-balanced macroinvertebrate community. Most notable for all IBI results from all years is the presence of odonata taxa, which received a scoring of 5 for all years except 2007.

The aquatic plant IBI score was 32 (moderate) in 2007, dropping to 22 (poor) in 2011 (Figure 6-3). Despite the drop in score from 2007 to 2011, the IBI score improved to 24 (moderate) in 2012, and stayed constant at this value again in 2014. For all years, results from the plant IBI show a strong presence of vascular plant species and persistent litter (Table 6-3).

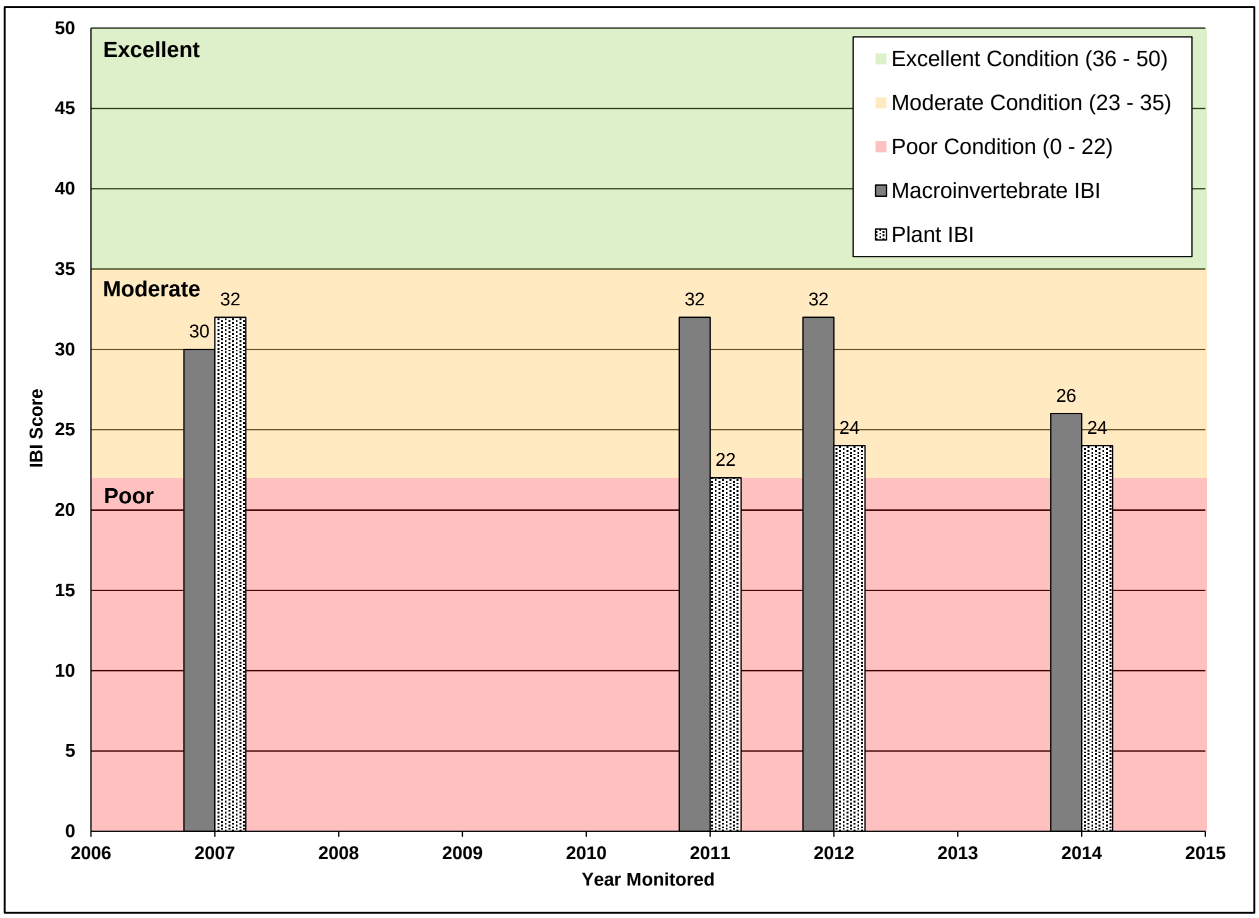

Figure 6-3: Macroinvertebrate and plant IBI scores for Arlington-Jackson wetland.

Table 6-2: Arlington-Jackson macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2007		2011		2012		2014	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	35	1	42	3	48	3	41	3
2	Odonata taxa	4	3	5	5	6	5	6	5
3	Chironomid genera[a]	9	3	10	3	11	3	5	1
4	Leech taxa	1	1	3	3	4	3	1	1
5	Snail taxa	5	3	3	1	5	3	6	3
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	5	3	3	1	4	3	2	1
7	Number of intolerant taxa	4	3	4	3	3	3	4	3
8	Tolerant taxa proportion of sample count[a]	28.7%	5	55.3%	3	59.6%	3	43.1%	3
9	Dominate 3 taxa as proportion of sample count[a]	69.6%	3	42.4%	5	47.6%	5	63.8%	3
10	Corixidae proportion of beetles and bugs in AT[b]	11.4%	5	20.3%	5	68.1%	1	34.2%	3
	Total Macroinvertebrate IBI Score		**30**		**32**		**32**		**26**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 6-3: Arlington-Jackson aquatic plant metric scores/values and total score.

	Plant Metrics	2007		2011		2012		2014	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]	18	5	8	3	11	3	14	5
2	Nonvascular genera	0	1	0	1	0	1	0	1
3	Carex cover[a]	3.1	5	0	1	0	1	0	1
4	Sensitive species (#)[a]	1	1	0	1	0	1	0	1
5	Tolerant taxa proportion	0.33	3	0.55	1	0.33	3	0.58	1
6	Grasslike species (#)[a]	3	3	0	1	0	1	0	1
7	Perennials species (#)[a]	13	3	7	3	8	3	12	3
8	Aquatic guild species (#)	6	3	6	3	6	3	6	3
9	Proportion of dominant 3 taxa cover class	0.39	3	0.50	3	0.41	3	0.36	3
10	Persistent litter	9.2%	5	12.5%	5	10.8%	5	14.2%	5
	Total Plant IBI Score		**32**		**22**		**24**		**24**

a Only native species used in metric calculation.

The physical properties and water chemistry for the Arlington-Jackson wetland are reported in Tables 6-4 and 6-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (high); TKN (low); TP (low); Cl- (high); and SO4 (high) (Tables 3-2 and 6-5).

Table 6-4: Sonde data for Arlington-Jackson wetland (2007, 2011, 2012, 2014).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/31/2007 10:50	83.22	8.8	244.0	135.0	10.47
08/16/2011 13:17	77.36	8.4	410.2	123.2	10.70
09/05/2012 10:34	71.83	8.3	296.3	109.6	9.49
06/26/2014 09:25	70.88	8.2	507.2	-	8.74

Table 6-5: Water chemistry data for Arlington-Jackson wetland (2007, 2011, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
06/27/2007 14:30	-	0.008	0.100	0.8	-	-	40.0	-	-
08/16/2011 13:10	8.6	0.007	0.015	0.6	0.15	0.03	67.0	15.9	-
09/05/2012 10:45	3.2	0.015	0.100	1.0	0.32	0.10	36.8	19.4	2
06/24/2014 09:30	6.3	0.018	-	0.9	0.08	0.03	88.4	33.4	-
Average	**6.0**	**0.012**	**0.072**	**0.8**	**0.18**	**0.05**	**58.1**	**22.9**	**2**

(light blue)	Actual number less than value (<)
(gray)	Estimated concentration above the method detection limit and below the reporting limit (~)

7 COTTAGE AVENUE

7.1 BACKGROUND

Cottage Avenue wetland is located at the intersection of Cottage and Sylvan Streets in Saint Paul, MN (Figure 7-1). The wetland is located in the Trout Brook-West Branch subwatershed and the land use classification of its drainage area is commercial and residential (CRWD, 2015b). Wetland delineation performed in 2008 showed that the wetland covered almost one square block and is bordered on the north by Arlington Avenue and on the south by Sylvan Street. The open water portions of the wetland are found along the eastern side along Cottage Avenue (Figure 7-2). Cottage Avenue wetland was monitored in 2008, 2011, 2012, and 2014 (Table 7-1).

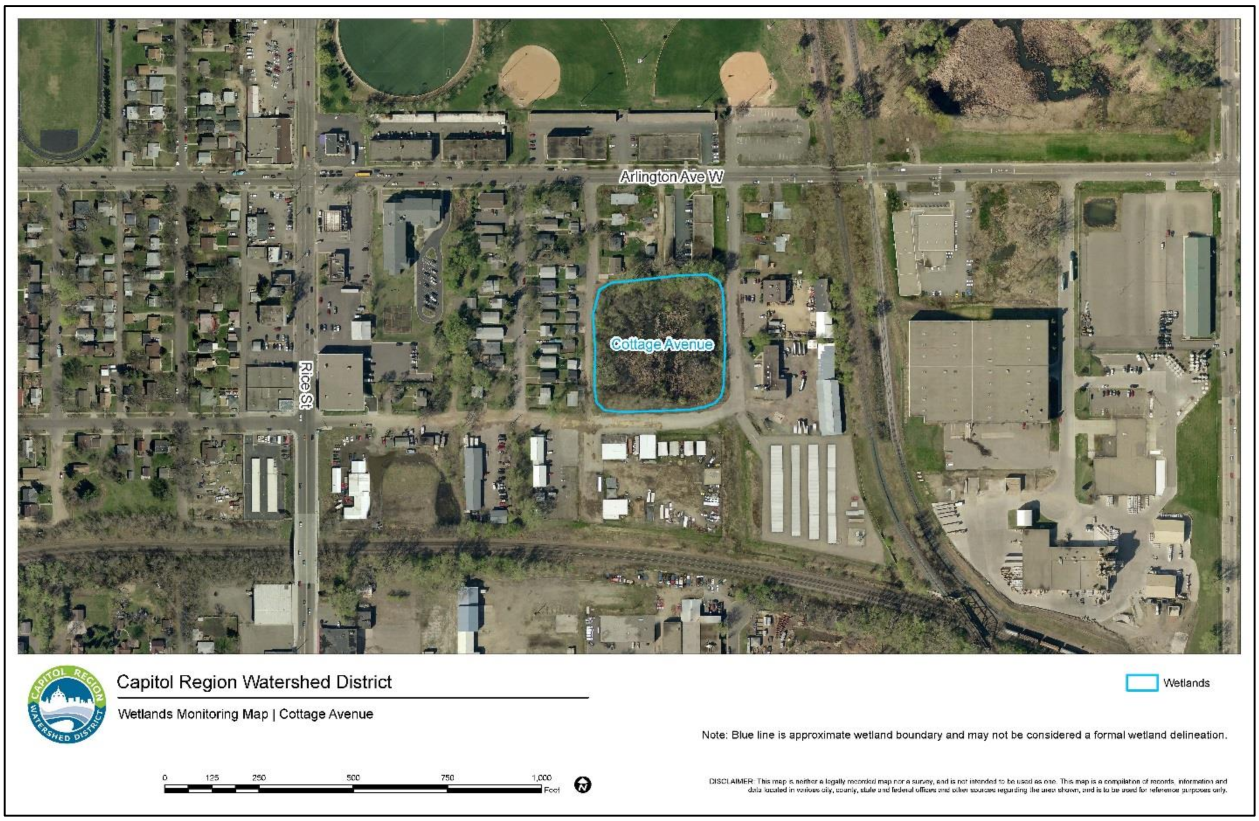

Figure 7-1: Map of Cottage Ave wetland.

Figure 7-2: View of north portion of Cottage Ave wetland.

Table 7-1: Dates monitored for Cottage Ave wetland (2008, 2011, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2008	7/11	7/31
2011	7/7	8/16
2012	6/28	9/5
2014	6/26	6/26

7.2 RESULTS

Cottage Avenue wetland was first sampled in 2008 and received a moderate macroinvertebrate IBI score of 24 (Figure 7-3). However, when it was re-sampled in 2011 and 2012, Cottage Avenue wetland received macroinvertebrate IBI scores of 20 and 22, respectively, which moved into the poor condition category. It declined further in 2014 to a score of 16. Despite the decline in macroinvertebrate IBI scores from 2008 to 2014, Cottage Avenue wetland still received excellent metric scores for having a low proportion of Corixidae (Table 7-2). In addition, the wetland exhibited a large diversity of chironomid genera in the 2011 and 2012 sample events.

Cottage Avenue wetland has only received poor aquatic plant IBI scores, but showed a small amount of improvement in score from 16 in 2008 to 20 in 2014 (Figure 7-3). Plant IBI metric scores are relatively static across the sampled years compared to the macroinvertebrate metric scores (Table 7-3). The persistent litter metric consistently exhibited the highest scores (ranging from 3-5), whereas the other plant metrics typically scored 1, showing poor plant diversity and robustness.

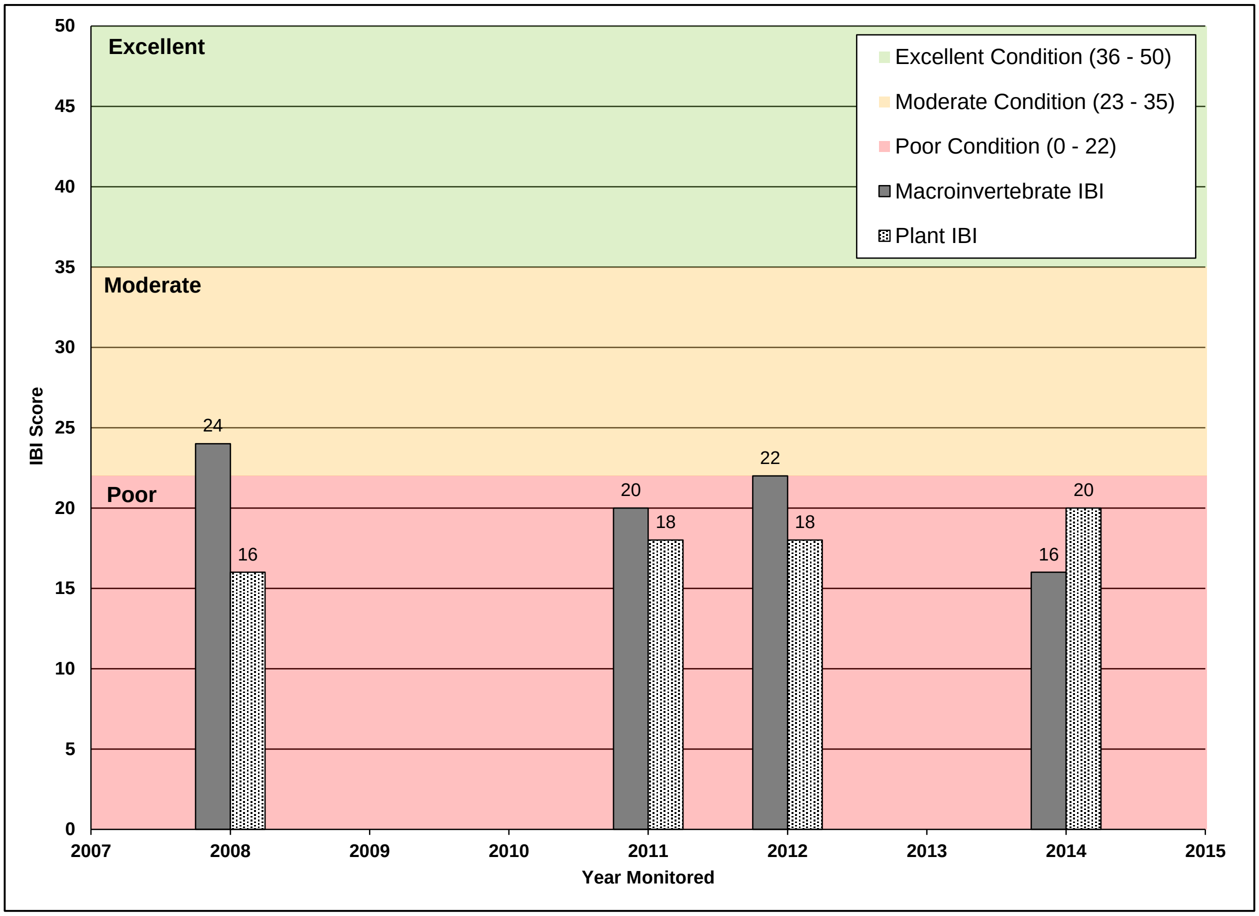

Figure 7-3: Macroinvertebrate and plant IBI scores for Cottage Ave wetland.

Table 7-2: Cottage Ave macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2008		2011		2012		2014	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	34	1	45	3	42	3	27	1
2	Odonata taxa	3	3	2	1	1	1	2	1
3	Chironomid genera[a]	9	3	16	5	17	5	3	1
4	Leech taxa	1	1	1	1	2	1	2	1
5	Snail taxa	2	1	3	1	3	1	3	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	2	1	1	1	1	1	2	1
7	Number of intolerant taxa	2	1	1	1	2	1	2	1
8	Tolerant taxa proportion of sample count[a]	26.7%	5	59.2%	3	70.4%	1	58.9%	3
9	Dominate 3 taxa as proportion of sample count[a]	52.6%	5	75.9%	1	67.0%	3	74.8%	1
10	Corixidae proportion of beetles and bugs in AT[b]	35.3%	3	41.8%	3	3.8%	5	8.9%	5
	Total Macroinvertebrate IBI Score		**24**		**20**		**22**		**16**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 7-3: Cottage Ave aquatic plant metric scores/values and total score.

	Plant Metrics	2008		2011		2012		2014	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]	5	1	6	1	4	1	6	1
2	Nonvascular genera	1	3	1	3	1	3	0	1
3	Carex cover[a]	0	1	0	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	1	1	1	1	0	1
5	Tolerant taxa proportion	0.57	1	0.67	1	0.75	1	1.00	1
6	Grasslike species (#)[a]	1	1	0	1	0	1	0	1
7	Perennials species (#)[a]	5	1	6	3	4	1	6	3
8	Aquatic guild species (#)	4	1	4	1	4	1	5	3
9	Proportion of dominant 3 taxa cover class	0.93	1	0.55	3	0.67	3	0.52	3
10	Persistent litter	0.9%	5	18.2%	3	8.3%	5	4.0%	5
	Total Plant IBI Score		**16**		**18**		**18**		**20**

a Only native species used in metric calculation.

The physical properties and water chemistry for the Cottage Ave wetland are reported in Tables 7-4 and 7-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (high); TP (high); Cl- (high); and SO4 (low) (Tables 3-2 and 7-5). Note that individual samples significantly vary by year which alters the total average for each parameter; for example, TP (3.45 mg/L) and TKN (23.0 mg/L) were unusually high in 2011, so the total averages were increased.

Table 7-4: Sonde data for Cottage Ave wetland (2008, 2011, 2012, 2014).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/15/2008 11:35	71.35	6.74	590	19.8	1.73
08/06/2011 12:30	67.46	6.7	557	1.3	0.14
09/05/2012 09:10	65.84	6.9	671	1.1	0.10
06/26/2014 09:10	65.12	7.0	331.2	-	0.52

Table 7-5: Water quality data for Cottage Ave wetland (2008, 2011, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/15/2008 11:35	8.8	0.066	0.257	1.6	-	-	85.0	3.5	12
08/16/2011 12:31	1100.0	0.028	3.450	23.0	0.05	0.03	71.0	0.8	-
09/05/2012 09:10	336.0	0.020	0.200	1.7	0.10	0.10	94.6	2.5	25
06/24/2014 08:45	390.0	0.047	-	3.9	0.05	0.03	31.1	1.4	-
Average	**458.7**	**0.040**	**1.302**	**7.6**	**0.07**	**0.05**	**70.4**	**2.0**	**19**

(light blue)	Actual number less than value (<)
(gray)	Estimated concentration above the method detection limit and below the reporting limit (~)

8 EXXON – MOBIL

8.1 BACKGROUND

Exxon-Mobil wetland is located southeast of the intersection of Montreal Ave and Adrian Street in Saint Paul in the Victoria Park complex (Figure 8-1). It generally consists of some trees, large stands of cattails, and open water (Figure 8-2). It also has a paved path winding through the wetland from the northwest to the northeast corners. The surrounding land use was formerly a large fueling facility for Exxon-Mobil, but was reclaimed by the City of Saint Paul to be converted into a public park and sports complex. Exxon-Mobil was monitored in 2013 only (Table 8-1).

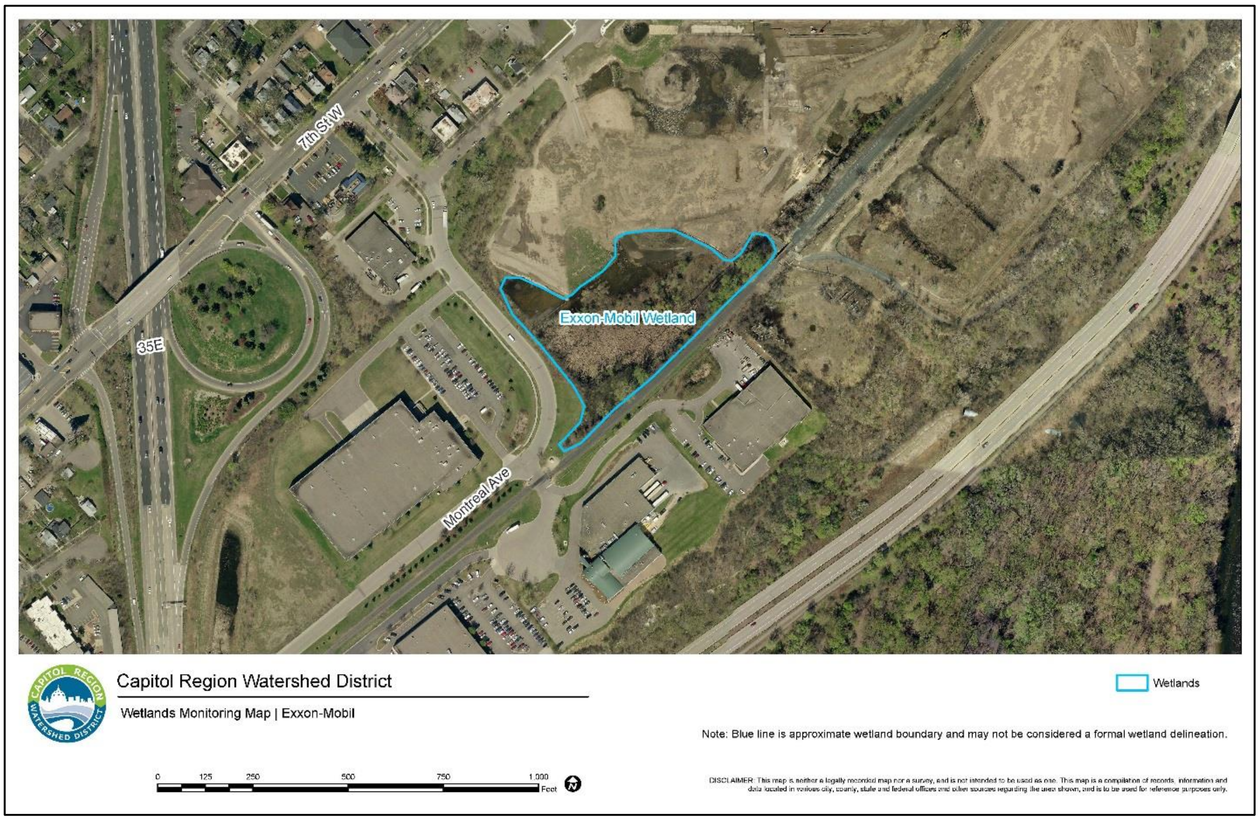

Figure 8-1: Map of Exxon-Mobil wetland.

Figure 8-2: View of western shore in Exxon-Mobil wetland.

Table 8-1: Dates monitored for Exxon-Mobil wetland (2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2013	7/24	7/29

8.2 RESULTS

Exxon-Mobil received a macroinvertebrate IBI score of 32, which is in the upper range of the moderate condition category (Figure 8-3). Of note in the macroinvertebrate IBI is the wetland's high number of chironomid genera, low proportion of tolerant taxa found in the dip net samples, and low proportion of Corixidae in the activity trap samples, resulting in a score of 5 for these metrics (Table 8-2).

The plant IBI score of 12 falls within the middle range of the poor condition category (Figure 8-3). All but one of the ten plant metrics received scores of 1, the lowest score possible (Table 8-

3). The nonvascular metric (the count of the nonvascular genera observed) was the only metric to receive a score of 3. In general, plant species diversity and robustness in the Exxon-Mobil wetland is low and severely degraded.

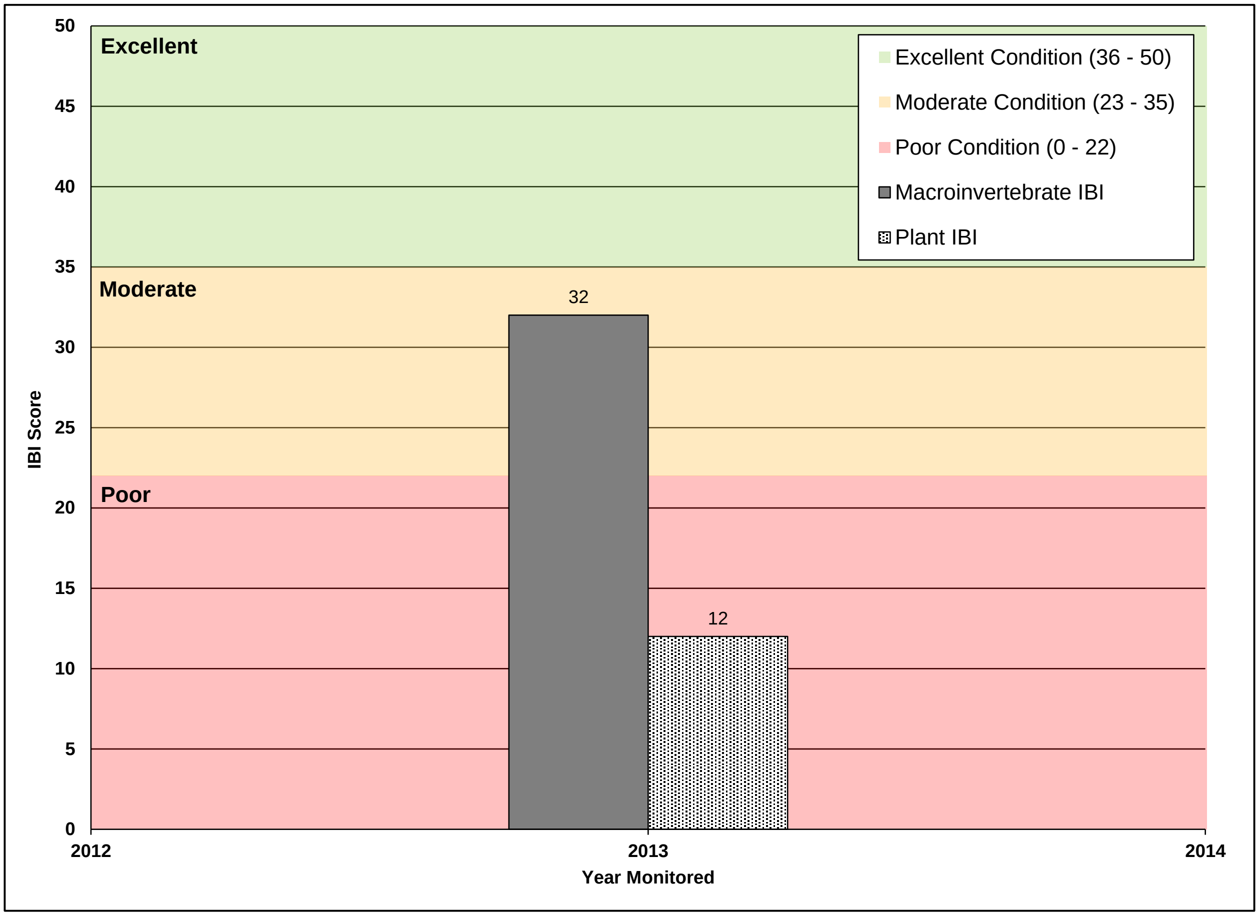

Figure 8-3: Macroinvertebrate and plant IBI scores for Exxon-Mobil wetland.

Table 8-2: Exxon-Mobil wetland macroinvertebrate metric scores/values and total score.

Macroinvertebrate Metrics		2013	
		value	score
1	Total invertebrate taxa	45	3
2	Odonata taxa	4	3
3	Chironomid genera[a]	19	5
4	Leech taxa	1	1
5	Snail taxa	2	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	4	3
7	Number of intolerant taxa	4	3
8	Tolerant taxa proportion of sample count[a]	28.1%	5
9	Dominate 3 taxa as proportion of sample count[a]	55.1%	3
10	Corixidae proportion of beetles and bugs in AT[b]	32.3%	5
Total Macroinvertebrate IBI Score			**32**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 8-3: Exxon-Mobil wetland plant metric scores/values and total score.

Plant Metrics		2013	
		value	score
1	Vascular genera[a]	2	1
2	Nonvascular genera	1	3
3	Carex cover[a]	0	1
4	Sensitive species (#)[a]	1	1
5	Tolerant taxa proportion	0.75	1
6	Grasslike species (#)[a]	0	1
7	Perennials species (#)[a]	2	1
8	Aquatic guild species (#)	3	1
9	Proportion of dominant 3 taxa cover class	0.92	1
10	Persistent litter	38.5%	1
	Total Plant IBI Score		**12**

a Only native species used in metric calculation.

No Sonde data was collected for Exxon-Mobile wetland in 2013. Water chemistry data for Exxon-Mobil wetland is reported in Table 8-4. Since Exxon-Mobil wetland was sampled only once in 2013, no general trends or conclusions on water quality can be drawn from this data. However, according to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (low); TP (medium); Cl- (high); and SO4 (low) (Tables 3-2 and 8-4).

Table 8-4: Water chemistry data for Exxon-Mobil wetland (2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/24/2013 09:00	31.0	0.019	0.158	1.4	0.05	0.03	61.3	4.9	6
Average	**31.0**	**0.019**	**0.158**	**1.4**	**0.05**	**0.03**	**61.3**	**4.9**	**6**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

9 GUPTIL POND

9.1 BACKGROUND

Guptil Pond is a small wetland pond located in Roseville, MN. It is located north of Lake McCarrons on North McCarrons Boulevard near the intersection with Rice Street (Figure 9-1). The pond is bordered on the north by Elmer Street. A buffer zone around the north and east sides of the pond primarily consists of grass and shrub/tree zones (Figure 9-2). There is an apartment building on the south side of the pond that has parking lots on both the east and west sides, so the pond receives direct runoff from these impervious surfaces. Guptil Pond was monitored in 2007, 2010, 2012, and 2014 (Table 9-1).

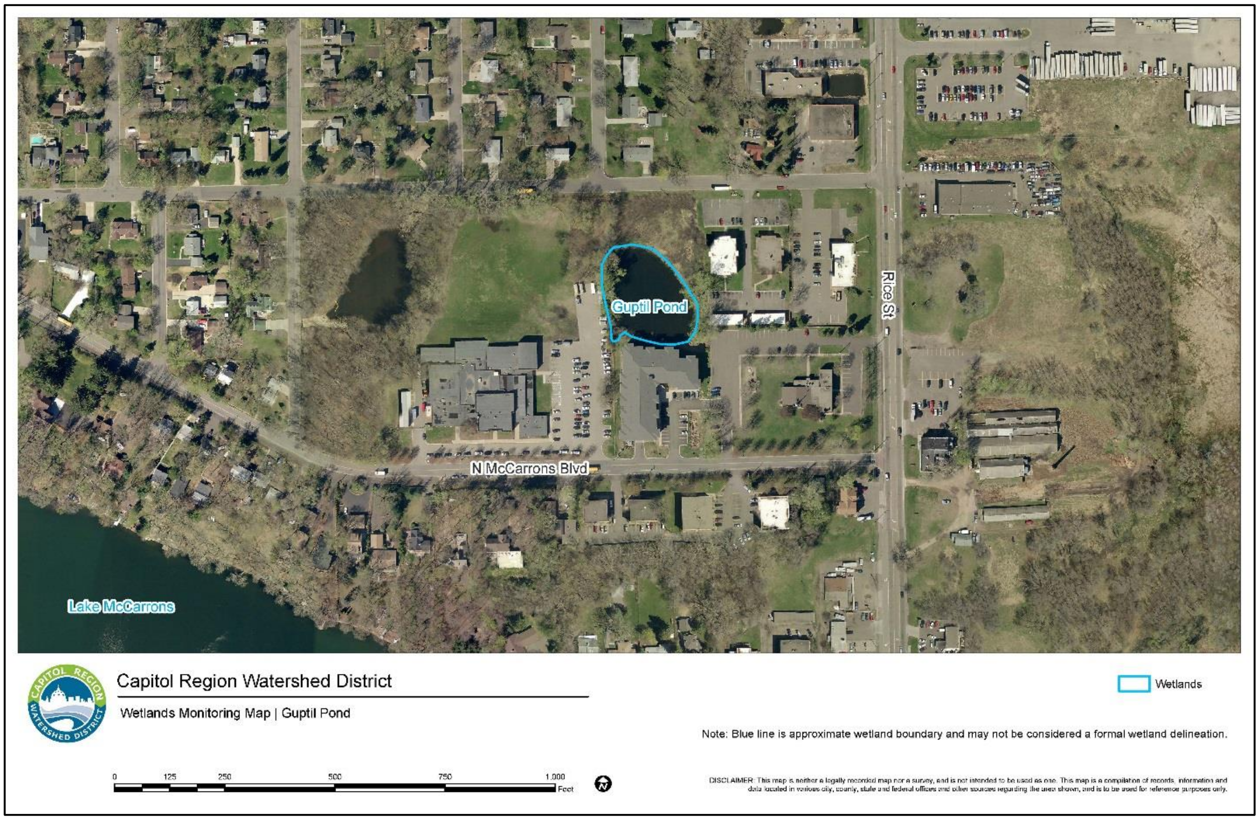

Figure 9-1: Map of Guptil Pond.

Figure 9-2: View of northwest corner of Guptil Pond.

Table 9-1: Dates monitored for Guptil Pond (2007, 2010, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2007	6/22	8/1
2010	7/21	9/9
2012	6/27	9/6
2014	6/26	6/25

9.2 RESULTS

Guptil Pond was first sampled in 2007 while construction was ongoing at the adjacent apartment building, and received a moderately high macroinvertebrate IBI score of 30 (Figure 9-3). In subsequent visits, however, the macroinvertebrate IBI dramatically declined, falling into the poor condition category in 2014 with a score of 18. The number of invertebrate taxa at the site fell from 43 to 35 in 2012, and then to only 31 in 2014 (Table 9-2). There were also declines in chironomid genera, leech, and snail taxa. The only metric that stayed relatively stable from 2007 to 2014 was the proportion of tolerant taxa.

In contrast, the aquatic plant IBI scores remained in the poor condition category for all years monitored, with scores fluctuating between 14 and 18 (Figure 9-3). While there is a lack of diversity in plant genera in Guptil Pond exhibiting low values for the vascular genera, nonvascular genera, Carex cover, and sensitive species metrics, there has not been any persistent litter recorded in any of the years monitored (Table 9-3).

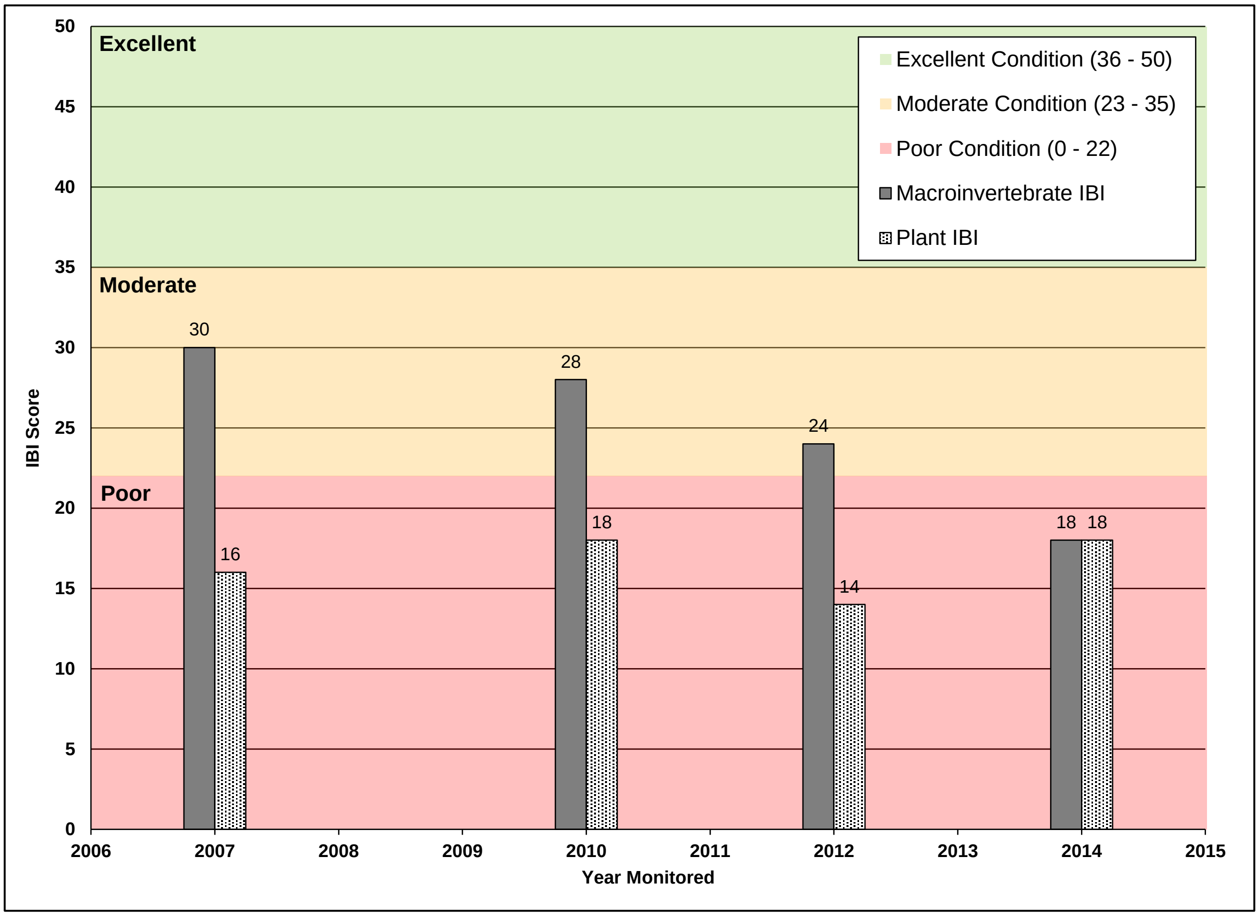

Figure 9-3: Macroinvertebrate and plant IBI scores for Guptil Pond.

Table 9-2: Guptil Pond macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	43	3	43	3	35	1	31	1
2	Odonata taxa	1	1	2	1	0	1	1	1
3	Chironomid genera[a]	9	3	14	5	12	3	4	1
4	Leech taxa	6	5	3	3	3	3	4	3
5	Snail taxa	5	3	1	1	0	1	2	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	3	1	3	1	1	1	2	1
7	Number of intolerant taxa	1	1	3	3	2	1	1	1
8	Tolerant taxa proportion of sample count[a]	56.0%	3	37.2%	5	44.7%	3	49.0%	3
9	Dominate 3 taxa as proportion of sample count[a]	41.8%	5	64.5%	3	51.2%	5	82.0%	1
10	Corixidae proportion of beetles and bugs in AT[b]	8.0%	5	37.1%	3	11.9%	5	3.8%	5
	Total Macroinvertebrate IBI Score		**30**		**28**		**24**		**18**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 9-3: Guptil Pond aquatic plant metric scores/values and total score.

	Plant Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]	4	1	5	1	5	1	5	1
2	Nonvascular genera	0	1	1	3	0	1	0	1
3	Carex cover[a]	0	1	0	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	2	3	0	1	0	1
5	Tolerant taxa proportion	0.40	3	0.57	1	0.60	1	0.83	1
6	Grasslike species (#)[a]	1	1	1	1	0	1	0	1
7	Perennials species (#)[a]	3	1	4	1	4	1	4	1
8	Aquatic guild species (#)	3	1	4	1	4	1	5	3
9	Proportion of dominant 3 taxa cover class	0.85	1	0.76	1	0.84	1	0.65	3
10	Persistent litter	0.0%	5	0.0%	5	0.0%	5	0.0%	5
	Total Plant IBI Score		**16**		**18**		**14**		**18**

a Only native species used in metric calculation.

The physical properties and water chemistry for Guptil Pond are reported in Tables 9-4 and 9-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (medium); TP (medium); Cl- (high); and SO4 (low) (Tables 3-2 and 9-5).

Table 9-4: Sonde data for Guptil Pond (2007, 2010, 2012, 2014).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
08/01/2007 09:20	75.18	6.6	368	2.1	0.18
09/09/2010 10:25	59.99	6.1	157	-	5.75
09/06/2012 10:00	66.02	6.8	169.9	4.7	0.43
06/25/2014 13:50	71.06	7.0	186.5	-	1.82

Table 9-5: Water chemistry data for Guptil Pond (2007, 2010, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
06/27/2007 14:35	-	0.049	0.245	2.1	-	-	85.0	-	-
09/21/2010 10:30	-	0.006 (~)	0.168	1.9	-	-	18.0	0.4 (<)	-
09/06/2012 10:00	-	0.032	0.540	1.3	0.10 (<)	0.10 (<)	11.3	2.5 (<)	26
06/24/2014 09:15	410.0	0.108	-	6.5	0.05 (<)	0.03 (<)	19.9	3.4	-
Average	**410.0**	**0.049**	**0.318**	**3.0**	**0.08**	**0.07**	**33.6**	**2.1**	**26**

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

10 KMART

10.1 BACKGROUND

Kmart wetland is located adjacent to the northwest corner of the Kmart store, west of I-35 E and east of Jackson Street (Figures 10-1 and 10-2). The majority of the surrounding land use is commercial and consists of impervious surfaces.. Kmart wetland was sampled in 2009, 2012, and 2013 (Table 10-1).

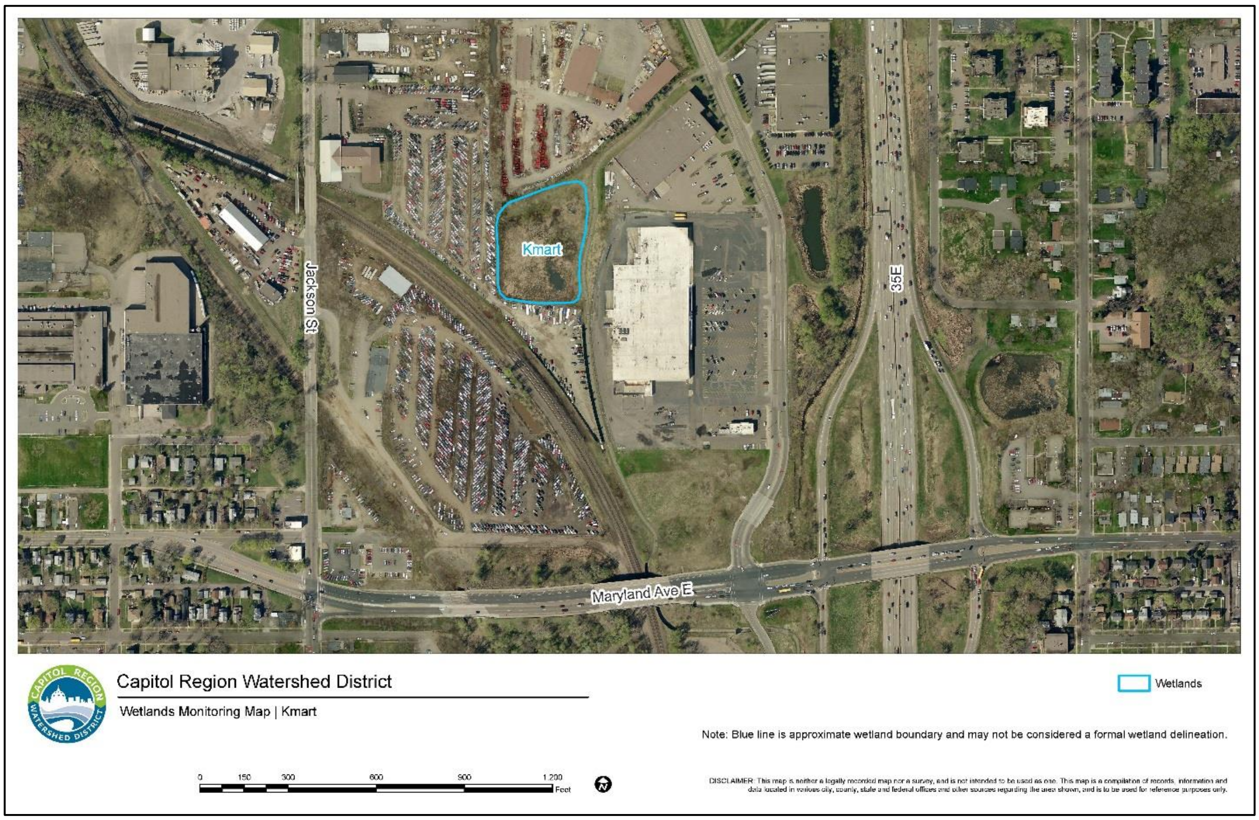

Figure 10-1: Map of Kmart wetland.

Figure 10-2: View of western side of Kmart wetland.

Table 10-1: Dates monitored for Kmart wetland (2009, 2012, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2009	6/23	7/30
2012	6/28	9/5
2013	7/24	7/29

10.2 RESULTS

Over the three years of Kmart macroinvertebrate IBI sampling, the score decreased from 22 in 2009 to 18 in 2012, then increasing to 28 in 2013 (Figure 10-3). These scores moved the macroinvertebrate IBI from the poor condition in 2009 and 2012, to the moderate condition in 2013. One metric contributing to the increase observed is the chironomid genera metric, which increased from 5 when sampling began to 14 during the most recent visit (Table 10-2).

The Kmart plant IBI score received the minimum possible score of 10 in both 2009 and 2012, indicating significant impairment to the plants in the wetland (Figure 10-3). This score increased to 14 in 2013, as a result of decreases in the proportion of dominant species and persistent litter metrics (Table 10-3). The low IBI scores for aquatic plants are a concern and future efforts should be considered to determine what factors are responsible for the consistently low metric scores.

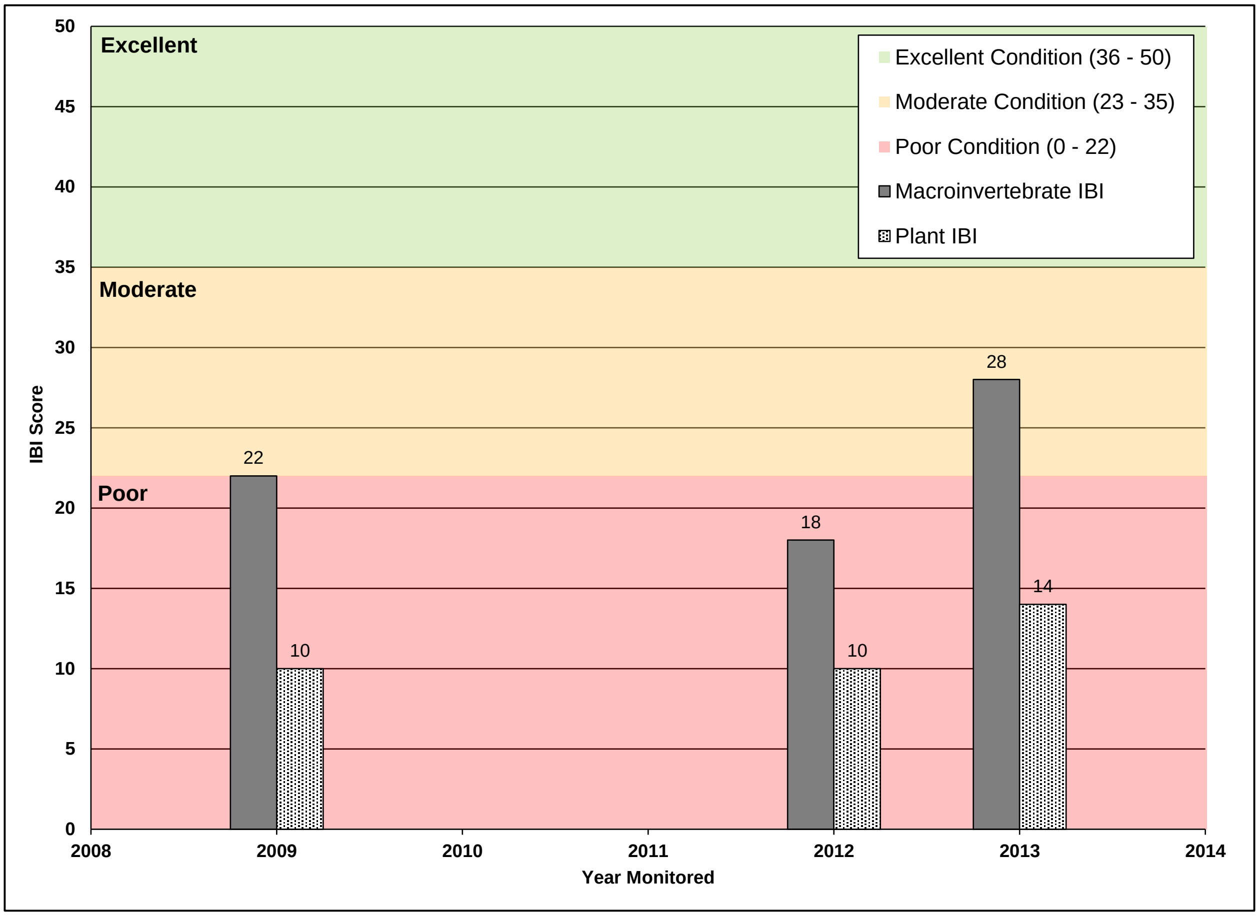

Figure 10-3: Macroinvertebrate and plant IBI scores for Kmart Wetland.

Table 10-2: Kmart macroinvertebrate metric scores/values and total score.

Macroinvertebrate Metrics		2009		2012		2013	
		value	score	value	score	value	score
1	Total invertebrate taxa	38	3	34	1	38	3
2	Odonata taxa	1	1	1	1	1	1
3	Chironomid genera[a]	5	1	9	3	14	5
4	Leech taxa	1	1	2	1	2	1
5	Snail taxa	2	1	1	1	1	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	0	1	2	1	2	1
7	Number of intolerant taxa	0	1	2	1	2	1
8	Tolerant taxa proportion of sample count[a]	4.3%	5	44.0%	3	37.7%	5
9	Dominate 3 taxa as proportion of sample count[a]	49.6%	5	57.3%	3	36.1%	5
10	Corixidae proportion of beetles and bugs in AT[b]	45.8%	3	45.6%	3	0.0%	5
Total Macroinvertebrate IBI Score			**22**		**18**		**28**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 10-3: Kmart aquatic plant metric scores/values and total score.

	Plant Metrics	2009		2012		2013	
		value	score	value	score	value	score
1	Vascular genera[a]	5	1	4	1	7	1
2	Nonvascular genera	0	1	0	1	0	1
3	Carex cover[a]	0	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	0	1	0	1
5	Tolerant taxa proportion	0.67	1	0.83	1	0.56	1
6	Grasslike species (#)[a]	0	1	0	1	0	1
7	Perennials species (#)[a]	2	1	2	1	4	1
8	Aquatic guild species (#)	1	1	2	1	2	1
9	Proportion of dominant 3 taxa cover class	0.83	1	0.81	1	0.58	3
10	Persistent litter	44.4%	1	38.1%	1	32.2%	3
	Total Plant IBI Score		**10**		**10**		**14**

a Only native species used in metric calculation.

The physical properties and water chemistry for the Kmart wetland are reported in Tables 10-4 and 10-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (high); TP (high); Cl- (high); and SO4 (low) (Tables 3-2 and 10-5). Note that individual samples significantly vary by year which alters the total average for each parameter; for example, TP (6.90 mg/L) and TKN (35.0 mg/L) were unusually high in 2011, so the total averages were increased.

Table 10-4: Sonde data for Kmart wetland (2009, 2012, 2013).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
06/25/2009 --:--	72.97	5.9	486	9.0	0.79
07/16/2009 13:10	67.54	6.6	571	10.6	0.95
09/05/2012 11:55	67.82	6.9	784	9.7	0.92
07/29/2013 13:30	-	-	-	-	-

Table 10-5: Water chemistry data for Kmart wetland (2009, 2012, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/16/2009 13:10	-	0.762	-	-	0.05	0.03	81.0	-	-
09/05/2012 11:50	246.0	0.096	1.000	4.8	0.10	0.10	116.0	2.5	116
07/24/2013 11:45	1100.0	0.153	6.900	35.0	0.05	0.03	141.5	4.0	370
Average	**673.0**	**0.337**	**3.950**	**19.9**	**0.07**	**0.05**	**112.8**	**3.2**	**243**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

11 LITTLE CROSBY LAKE

11.1 BACKGROUND

Little Crosby Lake wetland (also previously referred to as Upper Lake) is located in the Mississippi River Floodplain and is part of Crosby Farm Park in the city of Saint Paul (Figure 11-1). It is often confused with Crosby Lake, which is located northeast of Little Crosby Lake. The Crosby Farm Park entrance is located at the intersection of Sheppard Road and Davern Street.

Little Crosby Lake is relatively deep (34 ft at its deepest point) given its small size (8 acres), and has a walking path around the lake with a few spots for visitors to overlook the lake (Figure 11-2). Little Crosby Lake was monitored for only macroinvertebrates in 2008, and twice in 2009 for macroinvertebrates and plants to verify sampling methods (Table 11-1). More information about Little Crosby Lake can be found in the *2014 Lakes Monitoring Report* (CRWD, 2015a).

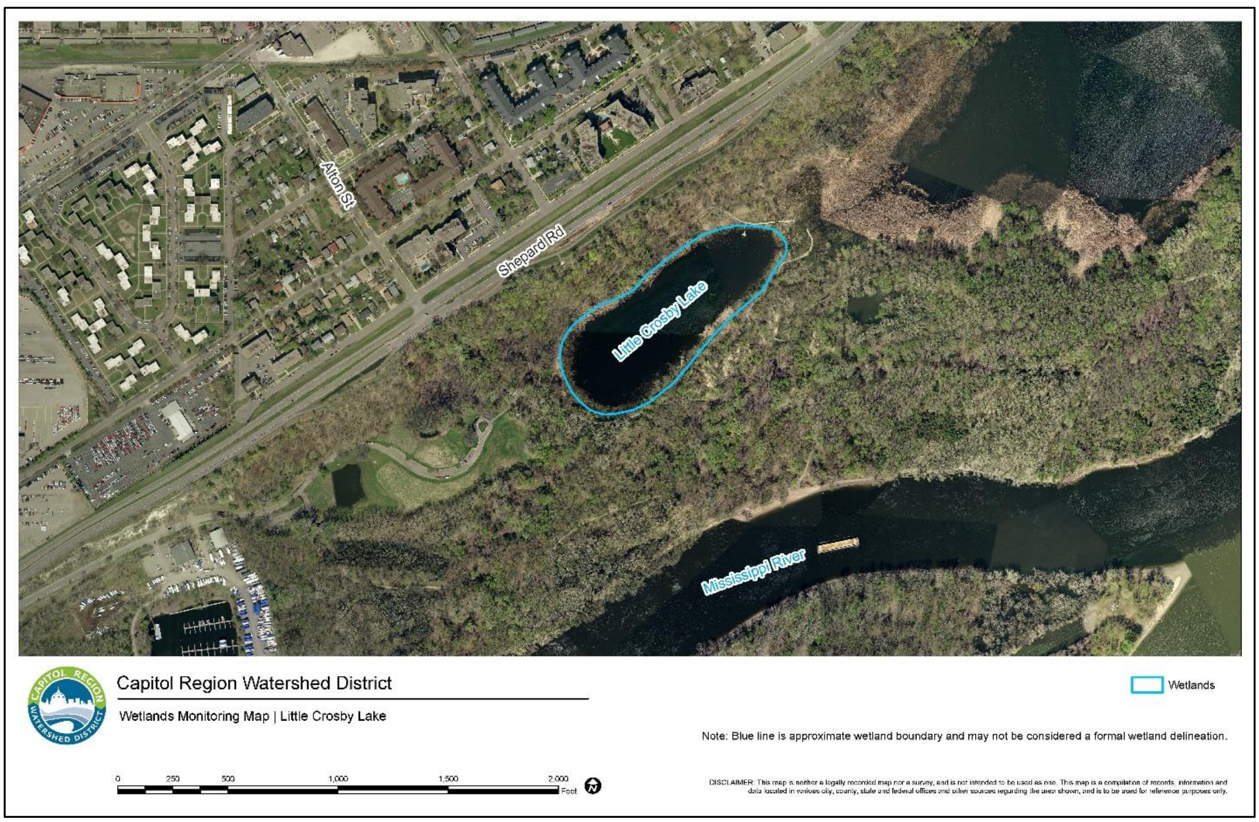

Figure 11-1: Map of Little Crosby Lake.

Figure 11-2: View of north shoreline of Little Crosby Lake.

Table 11-1: Dates monitored for Little Crosby Lake (2008, 2009).

Year Monitored	Macroinvertebrate Date	Plant Date
2008	7/10	
2009	6/30 & 7/8	7/29

11.2 RESULTS

Crosby Lake was assessed for the macroinvertebrate IBI in 2008, and received a moderate score of 24. This site was sampled twice in 2009 (June 30; July 8), and received differing macroinvertebrate IBI scores of 18 and 24, which fell into the poor and moderate categories, respectively (Figure 11-3). The difference in the 2009 macroinvertebrate IBI scoring was due to an increase in odonata taxa, as well as an increase in the ETSD metric (Table 11-2).

The plant IBI was only conducted in 2009 at Little Crosby Lake, but also occurred twice (both on July 29). The plant IBI scores decreased between the two sample dates in 2009, from 20 to 16

(Figure 11-3). Both fell within the poor condition category. This difference in the 2009 plant IBI scoring was due in part to a small decrease in the number of perennial species observed (Table 11-3). Additionally, the proportion of dominant taxa increased.

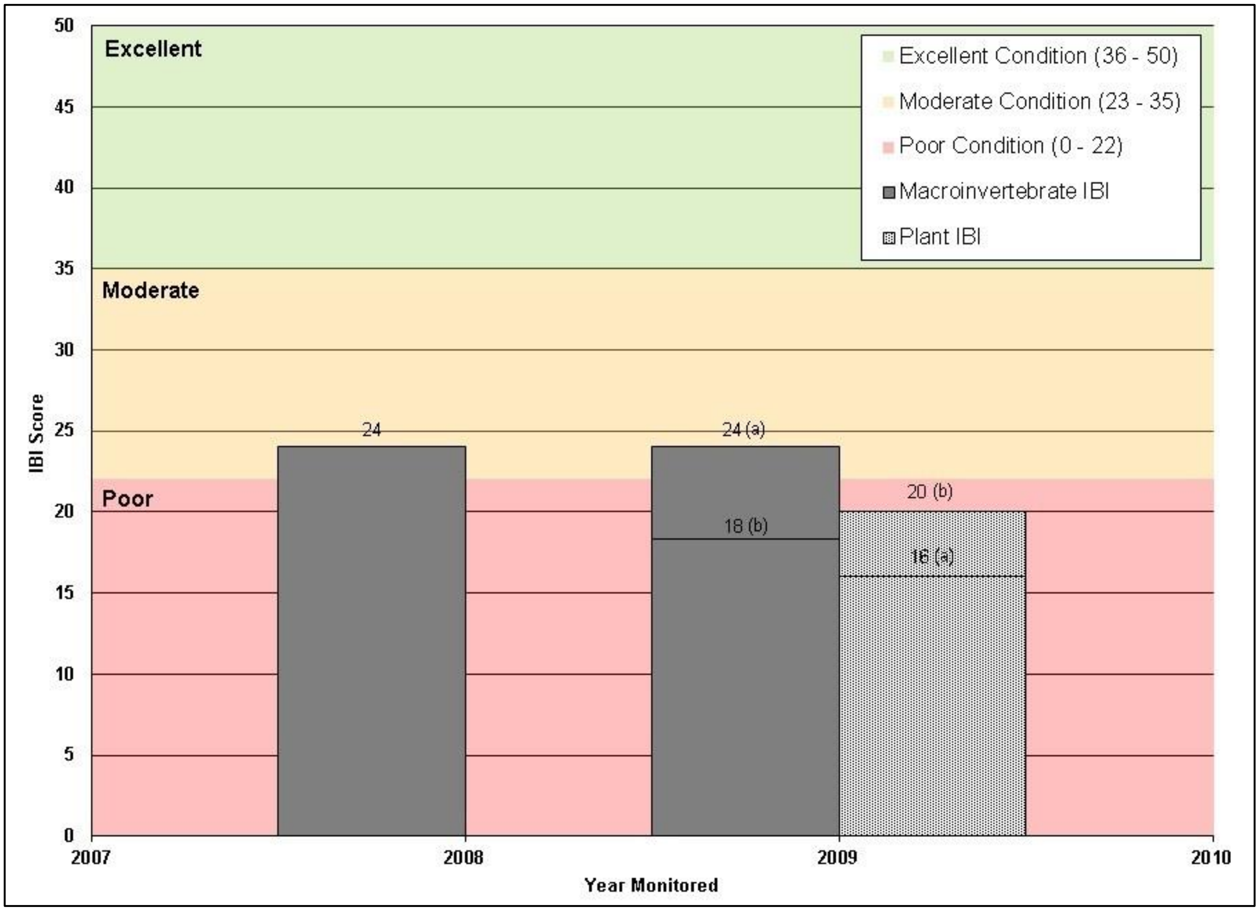

Figure 11-3: Macroinvertebrate and plant IBI scores for Little Crosby Lake; the wetland was monitored two times in 2009, indicated in the figure above as (a) and (b).

Table 11-2: Little Crosby Lake macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2008		2009a		2009b	
		value	score	value	score	value	score
1	Total invertebrate taxa	30	1	22	1	29	1
2	Odonata taxa	4	3	2	1	4	3
3	Chironomid genera[a]	8	3	5	1	4	1
4	Leech taxa	0	1	0	1	2	1
5	Snail taxa	2	1	3	1	2	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	3	1	2	1	5	3
7	Number of intolerant taxa	1	1	1	1	1	1
8	Tolerant taxa proportion of sample count[a]	42.7%	3	36.1%	5	22.8%	5
9	Dominate 3 taxa as proportion of sample count[a]	37.6%	5	44.6%	5	51.9%	5
10	Corixidae proportion of beetles and bugs in AT[b]	28.9%	5	69.2%	1	54.2%	3
	Total Macroinvertebrate IBI Score		**24**		**18**		**24**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 11-3: Little Crosby Lake aquatic plant metric scores/values and total score.

Plant Metrics		2008		2009a		2009b	
		value	score	value	score	value	score
1	Vascular genera[a]			7	1	6	1
2	Nonvascular genera			0	1	0	1
3	Carex cover[a]			0	1	0	1
4	Sensitive species (#)[a]			0	1	0	1
5	Tolerant taxa proportion			0.57	1	0.57	1
6	Grasslike species (#)[a]			0	1	0	1
7	Perennials species (#)[a]			6	3	5	1
8	Aquatic guild species (#)			6	3	5	3
9	Proportion of dominant 3 taxa cover class			0.66	3	0.84	1
10	Persistent litter			6.1%	5	9.7%	5
Total Plant IBI Score			**N/A**		**20**		**16**

a Only native species used in metric calculation.

The physical properties and water chemistry for Little Crosby Lake are reported in Tables 11-4 and 11-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (medium); TP (low); Cl- (high); and SO4 (high) (Tables 3-2 and 11-5). To note, Cl- readings are very high for Little Crosby Lake for all years sampled.

Table 11-4: Sonde data for Little Crosby Lake wetland (2008, 2009).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/08/2008 13:33	80.00	-	-	-	-
06/30/2009 10:36	66.50	6.8	933	34.5	3.22
07/02/2009 --:--	67.10	-	871	99.6	9.54
07/08/2009 14:00	84.30	8.7	840	165.0	13.23
07/17/2009 10:45	69.79	8.1	884	92.2	8.20

Table 11-5: Water chemistry data for Little Crosby Lake wetland (2008, 2009).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/15/2008 10:25	5.2	0.017	0.056	1.6	-	-	144.0	15.5	2
07/17/2009 10:45	-	0.005	-	-	0.05	0.03	157.0	-	-
07/17/2009 10:45	-	0.005	-	-	0.05	0.03	167.0	-	-
Average	**5.2**	**0.009**	**0.056**	**1.6**	**0.05**	**0.03**	**156.0**	**15.5**	**2**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

12 POST OFFICE

12.1 BACKGROUND

The Post Office wetland is located southwest of the intersection of Arlington Avenue and Jackson Street, just east of the U.S. Post Office building (Figure 12-1). It is shallow and surrounded on all sides by impervious surfaces with a minimal riparian buffer zone (Figure 12-2). The Post Office wetland was monitored in 2010, 2012, and 2014 (Table 12-1).

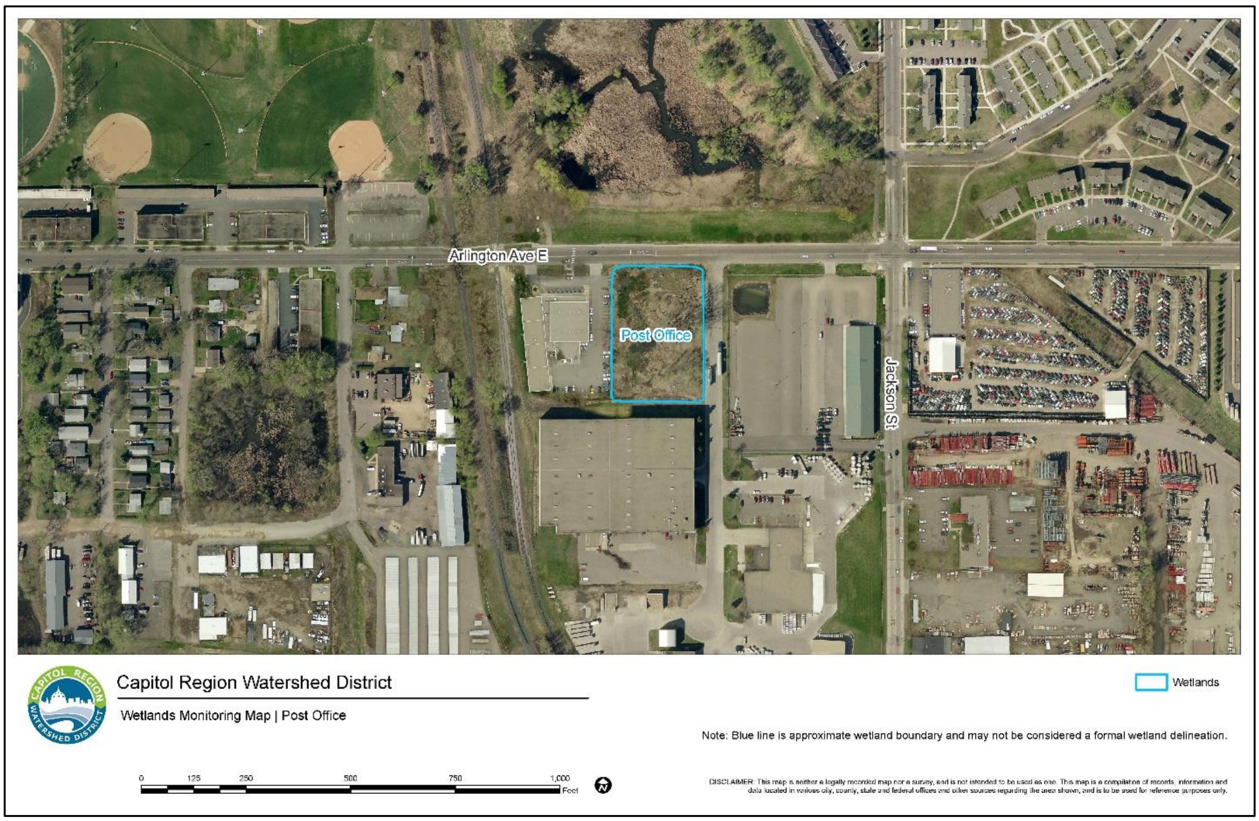

Figure 12-1: Map of Post Office wetland.

Figure 12-2: View of southwest corner of Post Office wetland.

Table 12-1: Dates monitored for Post Office wetland (2010, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2010	7/14	9/14
2012	6/27	9/5
2014	6/26	6/25

12.2 RESULTS

On the first two sampling years in 2010 and 2012, Post Office wetland received moderate invertebrate IBI scores of 26 and 28, respectively (Figure 12-3). Between 2010 and 2012, there were increases observed in the total taxa and odonata taxa (Table 12-2). In 2014, however, the score dropped to 18 in the poor condition category. This was a result of general diversity decreases in all metrics (Table 12-2).

Post Office received poor plant IBI scores for all sample years (Figure 12-3). The only change in metric scores observed between years was within the persistent litter category (Table 12-3). All of the other metrics still received the lowest possible scores. Data shows that the plant community in Post Office wetland is highly degraded with little species diversity or robustness.

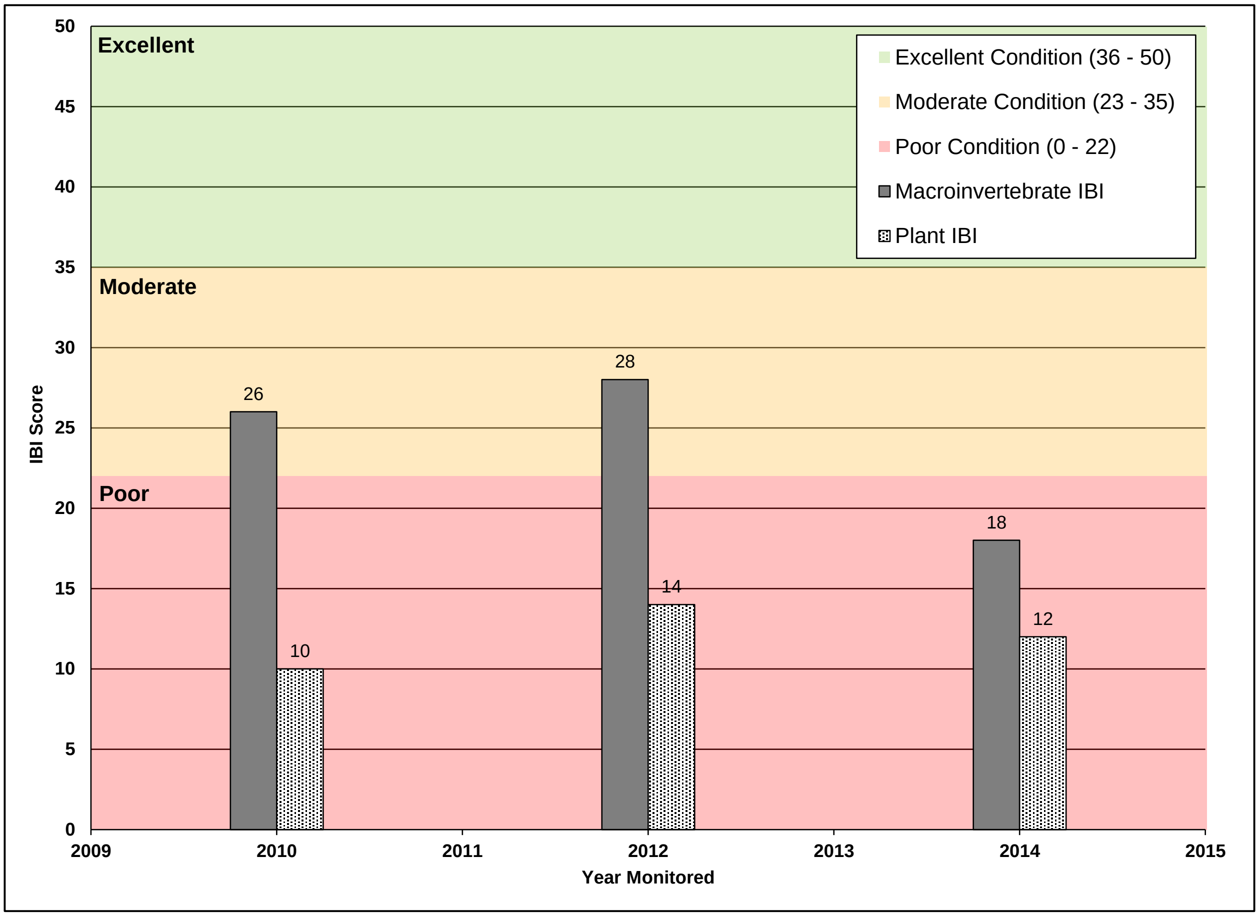

Figure 12-3: Macroinvertebrate and plant IBI scores for Post Office wetland.

Table 12-2: Post Office macroinvertebrate metric scores/values and total score.

Macroinvertebrate Metrics		2010		2012		2014	
		value	score	value	score	value	score
1	Total invertebrate taxa	35	1	41	3	34	1
2	Odonata taxa	2	1	4	3	2	1
3	Chironomid genera[a]	11	3	8	3	4	1
4	Leech taxa	3	3	1	1	2	1
5	Snail taxa	1	1	2	1	3	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	1	1	2	1	2	1
7	Number of intolerant taxa	1	1	2	1	2	1
8	Tolerant taxa proportion of sample count[a]	28.2%	5	40.6%	5	0.4%	5
9	Dominate 3 taxa as proportion of sample count[a]	48.7%	5	50.9%	5	84.9%	1
10	Corixidae proportion of beetles and bugs in AT[b]	10.5%	5	28.1%	5	25.8%	5
Total Macroinvertebrate IBI Score			**26**		**28**		**18**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 12-3: Post Office aquatic plant metric scores/values and total score.

Plant Metrics		2010		2012		2014	
		value	score	value	score	value	score
1	Vascular genera[a]	1	1	2	1	2	1
2	Nonvascular genera	0	1	0	1	0	1
3	Carex cover[a]	0	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	0	1	0	1
5	Tolerant taxa proportion	1.00	1	1.00	1	1.00	1
6	Grasslike species (#)[a]	0	1	0	1	0	1
7	Perennials species (#)[a]	1	1	2	1	1	1
8	Aquatic guild species (#)	1	1	2	1	1	1
9	Proportion of dominant 3 taxa cover class	0.75	1	0.89	1	0.83	1
10	Persistent litter	50.0%	1	10.5%	5	27.8%	3
	Total Plant IBI Score		**10**		**14**		**12**

a Only native species used in metric calculation.

The physical properties and water chemistry for the Post Office wetland are reported in Tables 12-4 and 12-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (high); TP (high); Cl- (high); and SO4 (low) (Tables 3-2 and 12-5). To note, the Cl- concentrations in Post Office wetland are extremely high for all years sampled.

Table 12-4: Sonde data for Post Office wetland (2010, 2012, 2014).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
09/14/2010 10:15	56.70	6.7	1271	-	1.12
09/05/2012 10:20	65.84	7.0	1448	0.9	0.08
06/25/2014 15:00	66.92	-	1386	-	7.00

Table 12-5: Water chemistry data for Post Office wetland (2010, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
09/21/2010 10:15	-	0.005	0.370	4.0	-	-	492.0	1.0	-
09/05/2012 10:15	96.1	0.020	0.560	4.0	0.10	0.10	195.0	2.5	154
06/24/2014 09:10	140.0	0.012	-	3.9	0.05	0.03	141.3	3.4	-
Average	**118.1**	**0.012**	**0.465**	**4.0**	**0.08**	**0.07**	**276.1**	**2.3**	**154**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

13 RESERVOIR WOODS

13.1 BACKGROUND

The Reservoir Woods wetland is located in Reservoir Woods Park in Roseville, MN. The park is bounded by Dale Street on the west and Roselawn Avenue on the north (Figure 13-1). The wetland is located in the center of the park and takes up almost half the land area of the park. The remaining park area is wooded. The buffer zone around the wetland consists of a ring of grasses and forbs on the shoreline and a large wooded zone (Figure 13-2). The east side of the park is bounded by a residential area (where new construction was active for a few years) and Lake McCarrons located farther northeast. Reservoir Woods was monitored in 2007, 2010, 2012, and 2014 (Table 13-1).

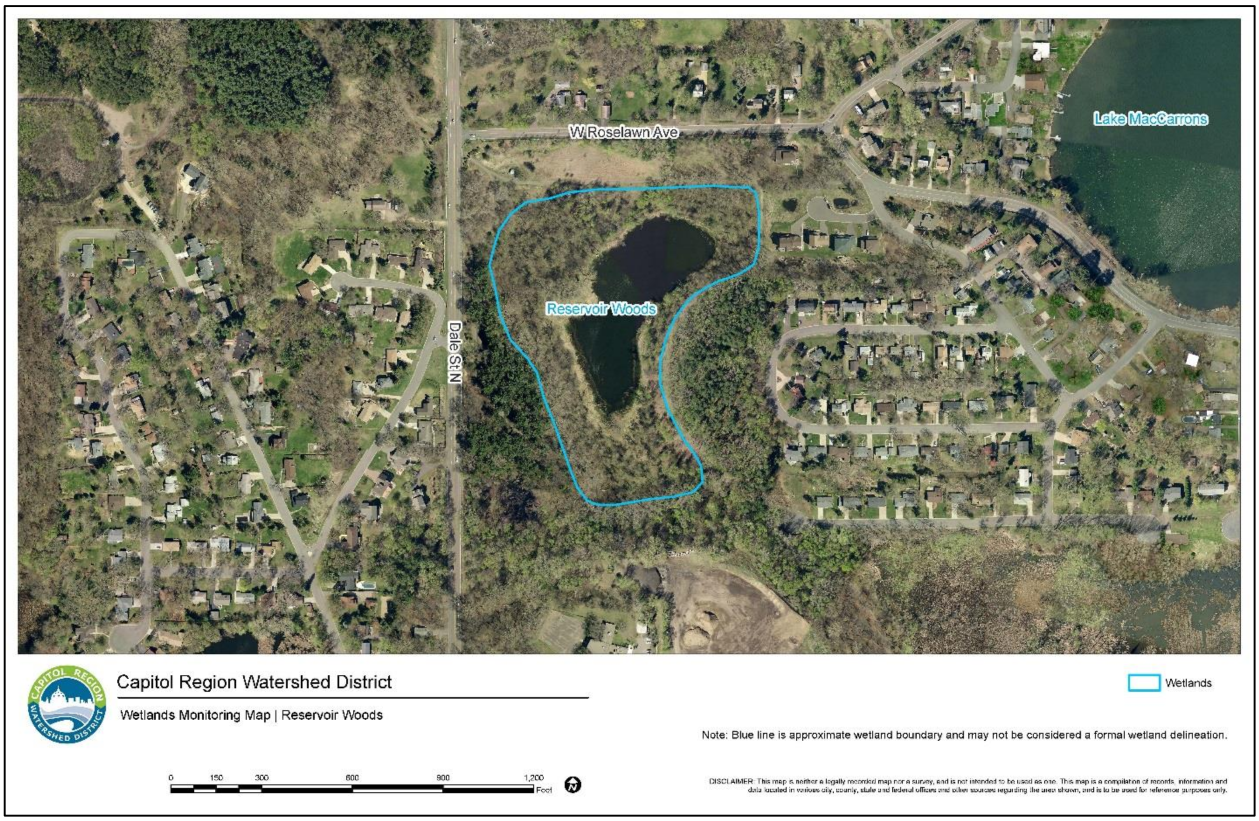

Figure 13-1: Map of Reservoir Woods wetland.

Figure 13-2: View of western side of Reservoir Woods wetland.

Table 13-1: Dates monitored for Reservoir Woods wetland (2007, 2010, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2007	6/28	8/1
2010	7/21	9/9
2012	6/29	9/6
2014	6/26	6/25

13.2 RESULTS

Macroinvertebrate IBI scores for Reservoir Woods fell into the moderate condition category for 2007 and 2010, and in the poor condition category for 2012 and 2014 (Figure 13-3). The 2010 score of 32 was the highest observed. The decline in the macroinvertebrate IBI from 2010 to 2012 was primarily caused by a decrease in chironomid genera, and increases in tolerant taxa and Corixidae (Table 13-2). Total invertebrate taxa also decreased from 50 to 39, although this decrease did not impact the metric score.

Similar to the IBI score for macroinvertebrates, the plant IBI score was the highest in 2010 with a score of 24, which fell within the moderate category (Figure 13-3). In the remaining years, the scores fell within the poor category. The aquatic plant IBI score decreased by 8 points from 2010 to 2012, as a result of declines in 4 metrics, including vascular genera, grasslike species, and perennial species (Table 13-3). Despite these declines, persistent litter levels remained low, earning it the maximum metric score in both years.

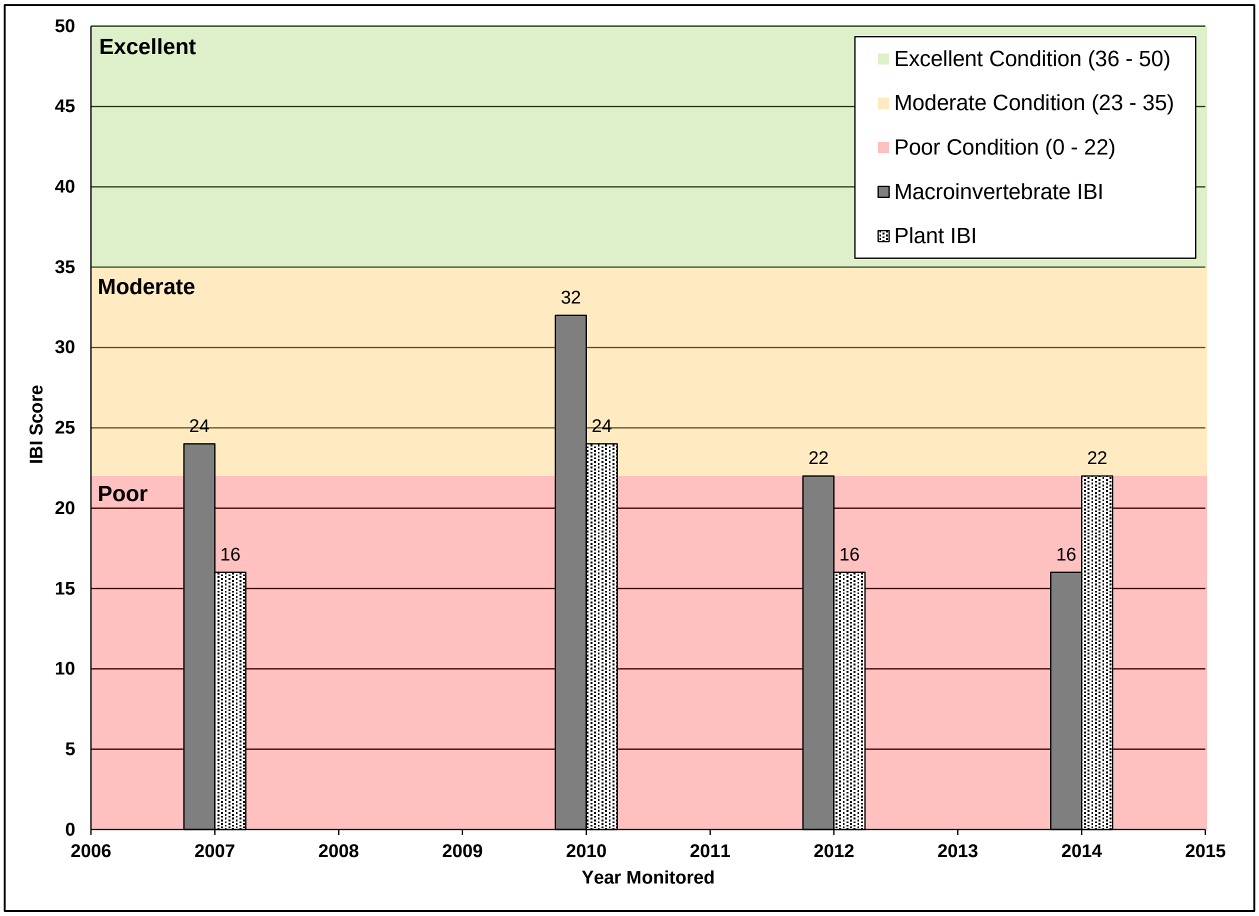

Figure 13-3: Macroinvertebrate and plant IBI scores for Reservoir Woods wetland.

Table 13-2: Reservoir Woods macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	42	3	50	3	39	3	16	1
2	Odonata taxa	1	1	2	1	1	1	0	1
3	Chironomid genera[a]	8	3	14	5	9	3	0	1
4	Leech taxa	3	3	4	3	5	5	5	5
5	Snail taxa	4	3	1	1	2	1	1	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	3	1	5	3	1	1	1	1
7	Number of intolerant taxa	3	3	3	3	2	1	1	1
8	Tolerant taxa proportion of sample count[a]	82.8%	1	38.0%	5	67.6%	3	79.3%	1
9	Dominate 3 taxa as proportion of sample count[a]	83.2%	1	60.9%	3	67.0%	3	93.1%	1
10	Corixidae proportion of beetles and bugs in AT[b]	3.2%	5	20.7%	5	69.2%	1	55.3%	3
	Total Macroinvertebrate IBI Score		**24**		**32**		**22**		**16**

a Metric calculated from dip-net samples only.
b Metric calculated from activity trap samples only.

Table 13-3: Reservoir Woods aquatic plant metric scores/values and total score.

	Plant Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]	5	1	10	3	7	1	11	3
2	Nonvascular genera	0	1	0	1	0	1	0	1
3	Carex cover[a]	1	3	0.1	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	1	1	0	1	0	1
5	Tolerant taxa proportion	0.50	1	0.27	3	0.63	1	0.64	1
6	Grasslike species (#)[a]	2	1	3	3	2	1	1	1
7	Perennials species (#)[a]	5	1	8	3	4	1	8	3
8	Aquatic guild species (#)	2	1	3	1	4	1	5	3
9	Proportion of dominant 3 taxa cover class	0.85	1	0.49	3	0.63	3	0.40	3
10	Persistent litter	5.0%	5	12.5%	5	0.4%	5	0.0%	5
	Total Plant IBI Score		**16**		**24**		**16**		**22**

a Only native species used in metric calculation.

The physical properties and water chemistry for the Reservoir Woods wetland are reported in Tables 13-4 and 13-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (medium); TP (high); Cl- (high); and SO4 (low) (Tables 3-2 and 13-5).

Table 13-4: Sonde data for Reservoir Woods wetland (2007, 2010, 2012, 2014).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
08/01/2007 10:30	79.06	7.1	281	3.8	6.31
09/09/2010 13:39	64.51	6.3	196	-	2.48
09/06/2012 10:35	67.10	-	237.3	2.5	0.23
06/25/2014 11:40	72.32	6.9	175.4	-	2.73

Table 13-5: Water chemistry data for Reservoir Woods wetland (2007, 2010, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
06/27/2007 14:50	-	0.054	0.231	3.2	-	-	39.0	-	-
09/21/2010 11:00	-	0.109	0.296	2.3	-	-	8.0	0.9	-
09/06/2012 10:45	109.0	0.038	0.890	3.8	0.10	0.10	18.9	2.5	31
06/24/2014 10:15	17.0	0.017	-	2.3	0.05	0.03	12.2	2.0	-
Average	**63.0**	**0.055**	**0.472**	**2.9**	**0.08**	**0.07**	**19.5**	**1.8**	**31**

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

14 SHERREN STREET POND

14.1 BACKGROUND

Sherren Street Pond is located northwest of the intersection of Victoria Street and County Road B in Roseville, Minnesota (Figure 14-1). The surrounding land use is mainly residential. Directly surrounding the pond is a buffer of grasses and trees (Figure 14-2). Sherren Street Pond was monitored in 2009, 2011, and 2013 (Table 14-1).

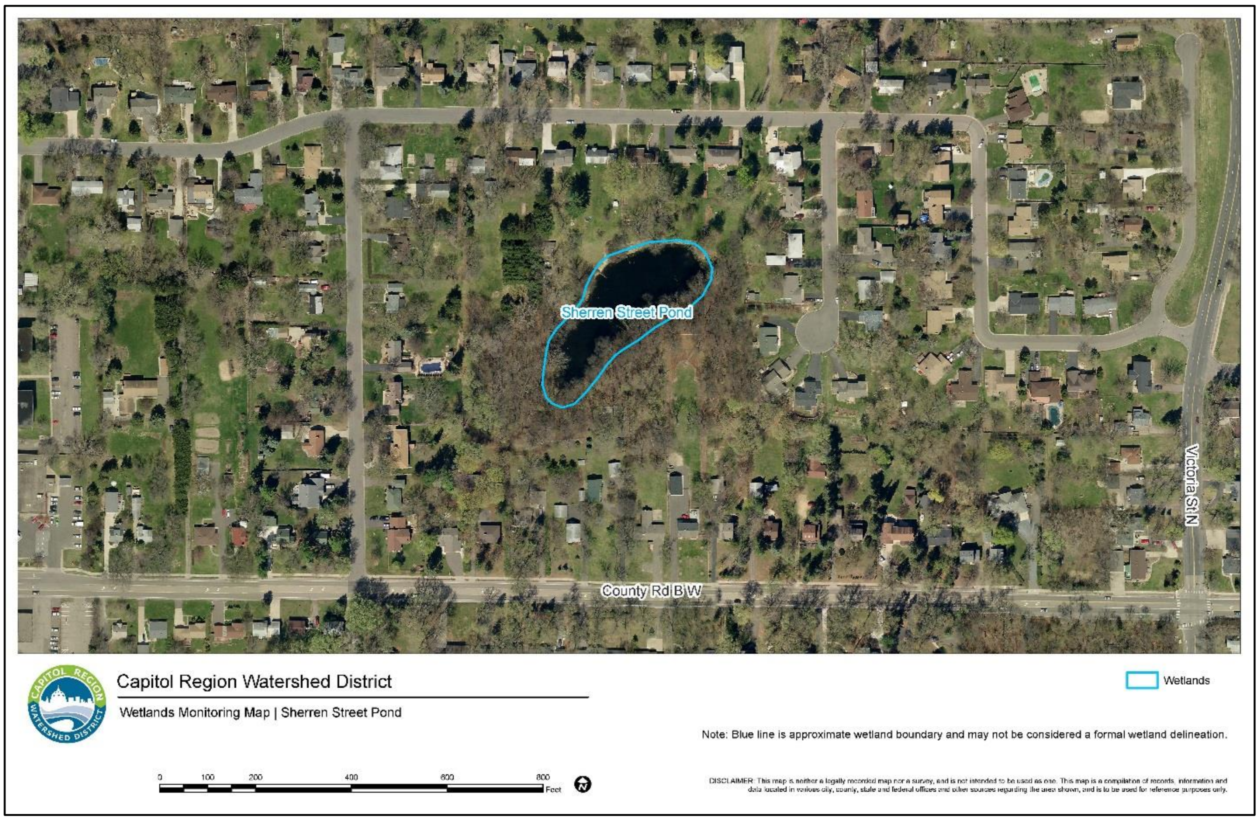

Figure 14-1: Map of Sherren Street Pond.

Figure 14-2: View of northwestern side of Sherren Street Pond.

Table 14-1: Dates monitored for Sherren Street Pond (2009, 2011, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2009	6/30	7/30
2011	7/7	8/16
2013	7/24	7/31

14.2 RESULTS

Macroinvertebrate IBI scores for Sherren Street Pond increased between 2009 and 2013 from 18 to 26, respectively (Figure 14-3). The 2013 IBI score of 26 moved the macroinvertebrate IBI into the moderate condition category. The increase observed between 2009 and 2011 (improving the score from 18 to 22) was the result of multiple changes in metrics. The total number of invertebrate taxa more than doubled, from 20 in 2009 to 41 in 2011, which improved the score from 1 to 3 (Table 14-2). Additionally, improvements were observed in the number of chironomid genera and leech taxa. Increases from 2011 to 2013 were again attributed to increases in chironomid genera, as well as a decrease in tolerant taxa and the dominant taxa proportion.

In contrast, the aquatic plant IBI sharply declined from 2009 to 2011 (Figure 14-3). Metric scores decreased from 3 to 1 in half of the ten metrics (Table 14-3). The number of vascular genera dropped by over 50 percent, and Carex cover dropped to 0. The plant IBI score increased slightly to 18 in 2013, as a result of an increase in perennial species, and a decrease in the proportion of the dominant three species. Overall, there is little plant species diversity and robustness in the Sherren Street Pond.

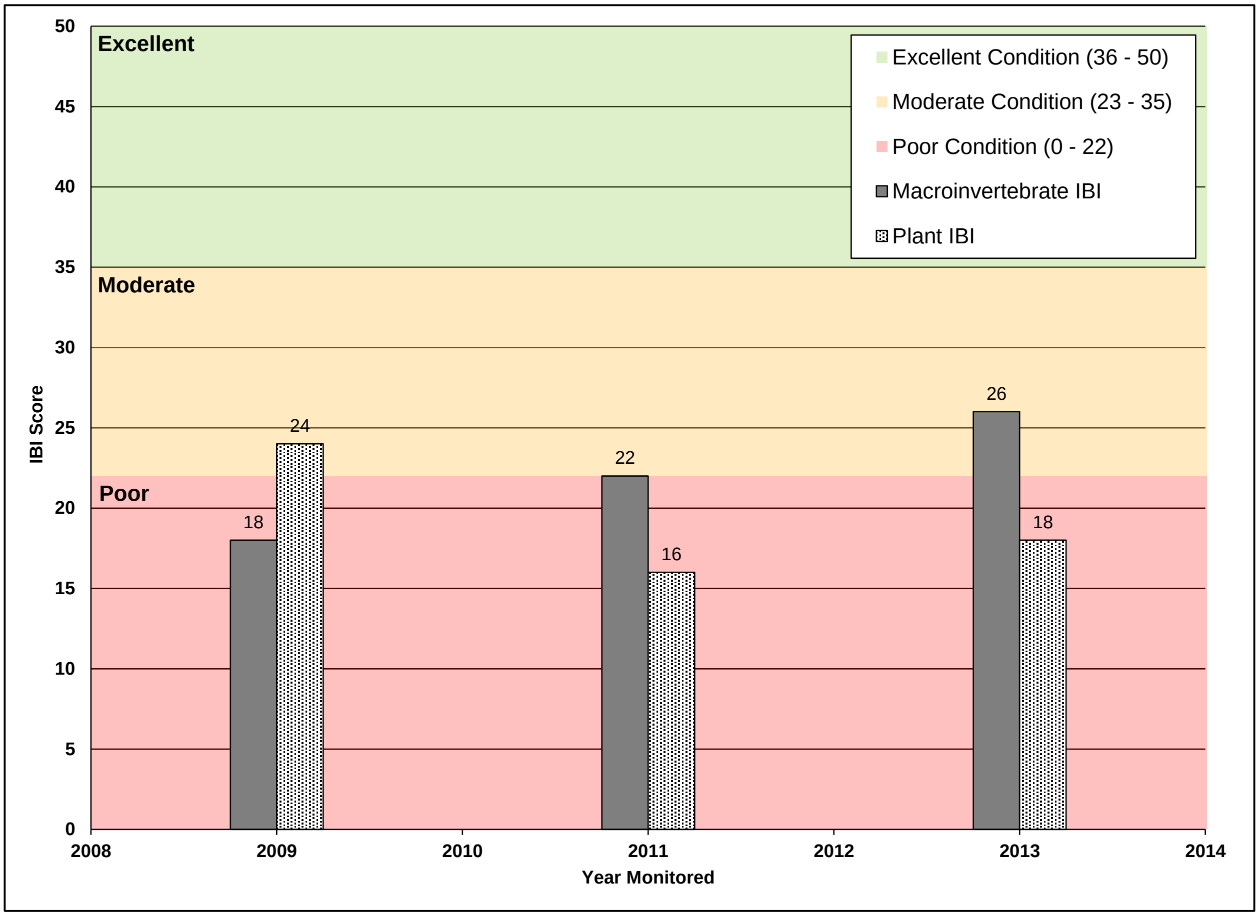

Figure 14-3: Macroinvertebrate and plant IBI scores for Sherren Street Pond.

Table 14-2: Sherren Street Pond macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2009		2011		2013	
		value	score	value	score	value	score
1	Total invertebrate taxa	20	1	41	3	35	1
2	Odonata taxa	0	1	2	1	0	1
3	Chironomid genera[a]	4	1	12	3	17	5
4	Leech taxa	2	1	3	3	2	1
5	Snail taxa	1	1	2	1	0	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	0	1	1	1	1	1
7	Number of intolerant taxa	1	1	1	1	3	3
8	Tolerant taxa proportion of sample count[a]	5.3%	5	47.9%	3	24.0%	5
9	Dominate 3 taxa as proportion of sample count[a]	87.2%	1	67.5%	3	53.1%	5
10	Corixidae proportion of beetles and bugs in AT[b]	8.3%	5	39.6%	3	35.7%	3
	Total Macroinvertebrate IBI Score		**18**		**22**		**26**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 14-3: Sherren Street Pond aquatic plant metric scores/values and total score.

Plant Metrics		2009		2011		2013	
		value	score	value	score	value	score
1	Vascular genera[a]	11	3	5	1	6	1
2	Nonvascular genera	0	1	1	3	0	1
3	Carex cover[a]	0.6	3	0	1	0	1
4	Sensitive species (#)[a]	1	1	1	1	0	1
5	Tolerant taxa proportion	0.33	3	0.71	1	0.57	1
6	Grasslike species (#)[a]	4	3	1	1	1	1
7	Perennials species (#)[a]	8	3	3	1	6	3
8	Aquatic guild species (#)	3	1	4	1	3	1
9	Proportion of dominant 3 taxa cover class	0.69	1	0.78	1	0.67	3
10	Persistent litter	11.5%	5	3.5%	5	0.0%	5
	Total Plant IBI Score		**24**		**16**		**18**

a Only native species used in metric calculation.

The physical properties and water chemistry for Sherren Street Pond are reported in Tables 14-4 and 14-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (low); TP (medium); Cl- (high); and SO4 (low) (Tables 3-2 and 14-5).

Table 14-4: Sonde data for Sherren Street Pond (2009, 2011, 2013).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/02/2009 --:--	64.39	5.5	595	16.0	1.50
07/16/2009 11:10	68.36	5.4	644	64.7	5.86
08/16/2011 10:30	69.98	6.4	108.4	15.9	1.41
07/31/2013 09:05	-	-	-	-	-

Table 14-5: Water chemistry data for Sherren Street Pond (2009, 2011, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/16/2009 11:10	-	0.011	-	-	0.05	0.03	141.0	-	-
08/16/2011 10:30	15.0	0.084	0.187	0.8	0.05	0.03	10.0	0.4	-
07/24/2013 10:00	47.0	0.089	0.338	1.7	0.05	0.03	19.3	0.5	4
Average	**31.0**	**0.061**	**0.263**	**1.3**	**0.05**	**0.03**	**56.8**	**0.5**	**4**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

15 SWEDE HOLLOW

15.1 BACKGROUND

Swede Hollow wetland is located in Swede Hollow Park at the southern end of the Phalen Creek subwatershed, between 7th Street East and Payne Avenue (Figure 15-1). It is surrounded on both sides by bluffs and is fed from the north by a small portion of day-lighted stream, which is the old Phalen Creek stream bed (Figure 15-2). The wetland then drains into the stormwater pipe system. Surrounding land use is primarily dense urban development, with commercial, industrial, and residential areas. Swede Hollow wetland was sampled in 2008, 2009, 2011, and 2013 (Table 15-1).

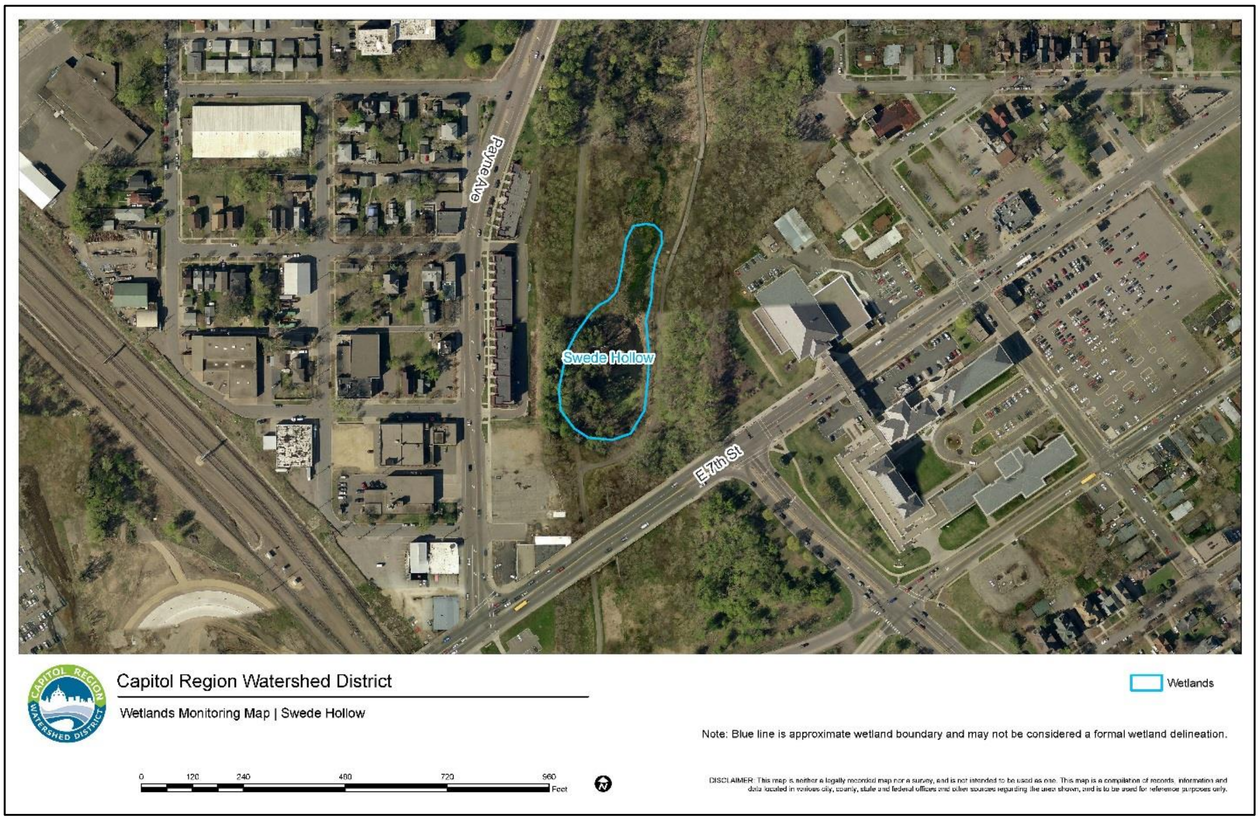

Figure 15-1: Map of Swede Hollow wetland.

Figure 15-2: View of southern shore of Swede Hollow wetland.

Table 15-1: Dates monitored for Swede Hollow wetland (2008, 2009, 2011, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2008	7/8	-
2009	6/16	7/30
2011	7/7	8/16
2013	7/24	7/29

15.2 RESULTS

Swede Hollow was initially assessed for macroinvertebrates in 2008, when it received an IBI score of 10 (Figure 15-3). This score is the lowest score possible and indicates poor wetland condition. In 2009, 2011, and 2013 Swede Hollow Wetland was re-assessed, and macroinvertebrate IBI scores steadily increased to 16, 20, and 24, respectively (Table 15-2). The 2014 score of 24 improved the IBI score to the moderate condition category from the poor condition category. Although Swede Hollow remains in the lower-end of the moderate condition category, the consistent and substantial improvements in macroinvertebrate IBI scores are encouraging and suggest recent improvements in biological quality.

The plant community was only assessed in 2009, 2011, and 2013. In 2009, Swede Hollow received a plant IBI score of 26, placing it in the moderate condition category (Figure 15-3). In 2011, the plant IBI score dropped dramatically to 10, the minimum score possible. In 2011, however, there was no cover class data gathered, so three metrics (carex cover, proportion of dominant 3 taxa, and percent persistent litter) could not be fully calculated and were given a score of 1, the lowest metric score. The resulting annual IBI for 2011, therefore, is lower than the actual value (Table 15-3). Even if these metrics would have received a maximum score of 5, however, the resulting IBI score would still be substantially less than was calculated for 2009. In 2013, the plant IBI increased to 30, once again placing it back within the moderate condition category. This dramatic increase is not only the result of the correct scores for the carex cover, proportion of dominant 3 taxa, and percent persistent litter metrics, but also a result of an increase in vascular genera, and a decrease in the tolerant taxa proportion.

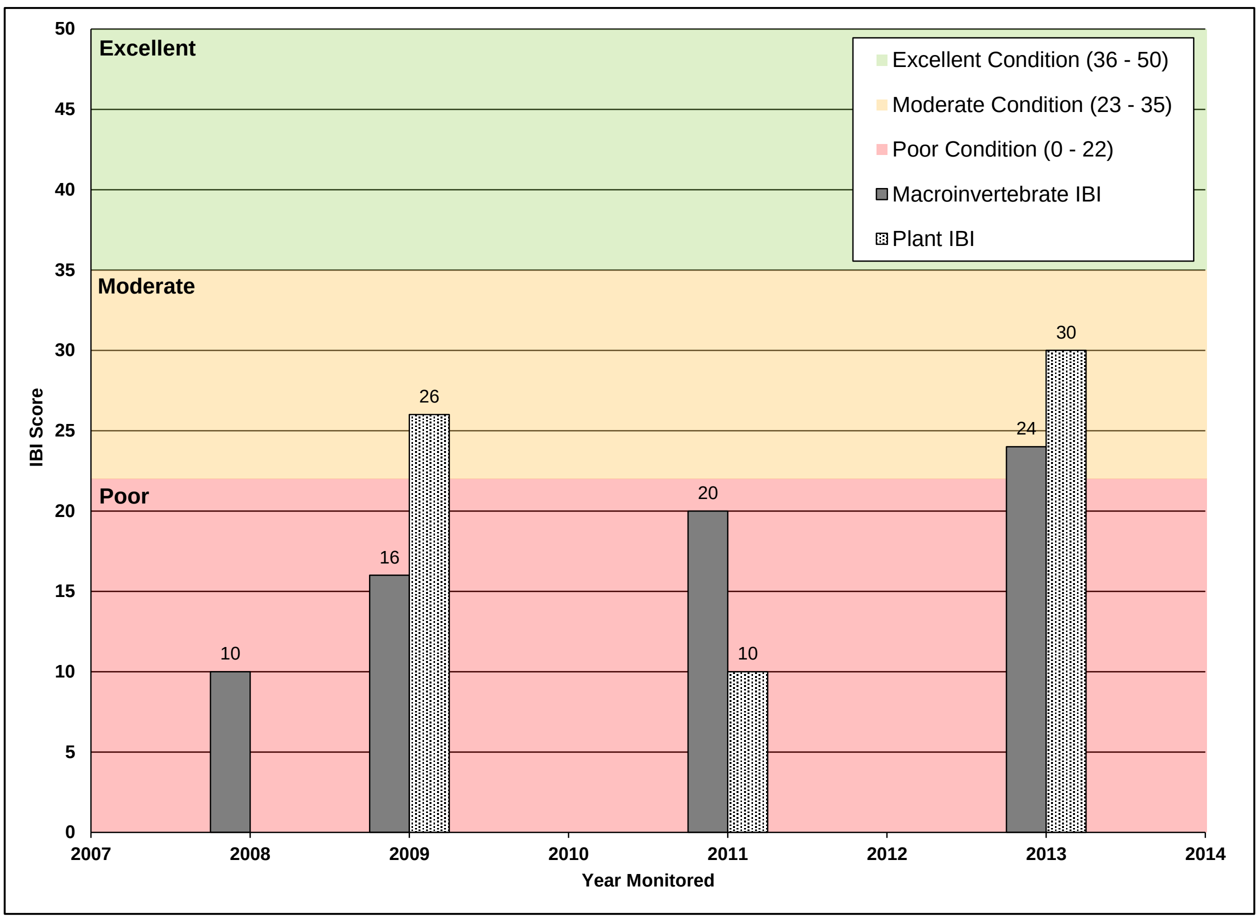

Figure 15-3: Macroinvertebrate and plant IBI scores for Swede Hollow wetland.

Table 15-2: Swede Hollow macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2008		2009		2011		2013	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	13	1	25	1	18	1	28	1
2	Odonata taxa	0	1	1	1	1	1	1	1
3	Chironomid genera[a]	4	1	2	1	5	1	7	3
4	Leech taxa	0	1	2	1	1	1	2	1
5	Snail taxa	2	1	3	1	3	1	4	3
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	0	1	1	1	2	1	2	1
7	Number of intolerant taxa	0	1	0	1	2	1	2	1
8	Tolerant taxa proportion of sample count[a]	75.0%	1	51.7%	3	29.7%	5	28.2%	5
9	Dominate 3 taxa as proportion of sample count[a]	85.4%	1	65.0%	3	67.2%	3	45.5%	5
10	Corixidae proportion of beetles and bugs in AT[b]	77.4%	1	36.4%	3	9.3%	5	53.3%	3
	Total Macroinvertebrate IBI Score		**10**		**16**		**20**		**24**

a Metric calculated from dip-net samples only.
b Metric calculated from activity trap samples only.

Table 15-3: Swede Hollow aquatic plant metric scores/values and total score.

	Plant Metrics	2008		2009		2011		2013	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]			10	3	5	1	16	5
2	Nonvascular genera			1	3	0	1	0	1
3	Carex cover[a]			0.6	3	0	1	3	5
4	Sensitive species (#)[a]			0	1	0	1	1	1
5	Tolerant taxa proportion			0.36	3	0.71	1	0.22	5
6	Grasslike species (#)[a]			3	3	1	1	2	1
7	Perennials species (#)[a]			8	3	4	1	13	3
8	Aquatic guild species (#)			1	1	1	1	2	1
9	Proportion of dominant 3 taxa cover class			0.74	1	0.00	1	0.40	3
10	Persistent litter			4.0%	5	0.0%	1	8.5%	5
	Total Plant IBI Score		**N/A**		**26**		**10**		**30**

a Only native species used in metric calculation.

*No cover class data

The physical properties and water chemistry for Swede Hollow wetland are reported in Tables 15-4 and 15-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (high); TKN (high); TP (high); Cl- (high); and SO4 (high) (Tables 3-2 and 15-5). To note, Cl- concentrations were exceptionally high for all sample events. In addition, the 2011 water quality sample had very high concentrations of TP (4.42 mg/L), TKN (39.0 mg/L), and Cl- (139.0 mg/L), which greatly increased the total averages for those parameters.

Table 15-4: Sonde data for Swede Hollow wetland (2008, 2009, 2011, 2013).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/15/2008 11:00	60.60	7.6	907	84.5	8.28
06/16/2009 14:15	63.30	6.0	1098	56.0	5.40
06/18/2009 --:--	73.00	6.6	1066	18.4	1.60
07/16/2009 11:00	67.94	6.8	1088	12.0	1.12
08/16/2011 --:--	66.02	7.1	1040	3.7	3.50
07/29/2013 09:45	-	-	-	-	-

Table 15-5: Water chemistry data for Swede Hollow wetland (2008, 2009, 2011, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/15/2008 11:00	5.9	0.048	0.123	0.7	-	-	94.0	58.3	5
07/16/2009 13:35	-	0.291	-	-	0.12	0.03	116.0	-	-
08/16/2011 14:30	65.0	0.196	4.420	39.0	0.05	0.03	139.0	47.5	-
07/24/2013 10:15	9.1	0.239	0.483	1.5	0.10	0.03	115.8	45.0	8
Average	**26.7**	**0.194**	**1.675**	**13.7**	**0.09**	**0.03**	**116.2**	**50.3**	**7**

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

16 VICTORIA B

16.1 BACKGROUND

Victoria B wetland is located southwest of the intersection of County Road B and Victoria Street (Figure 16-1). The surrounding land use is mainly residential, and there are many trees in the near vicinity of the open water portion of the wetland (Figure 16-2). Victoria B wetland was sampled in 2009, 2011, and 2013 (Table 16-1).

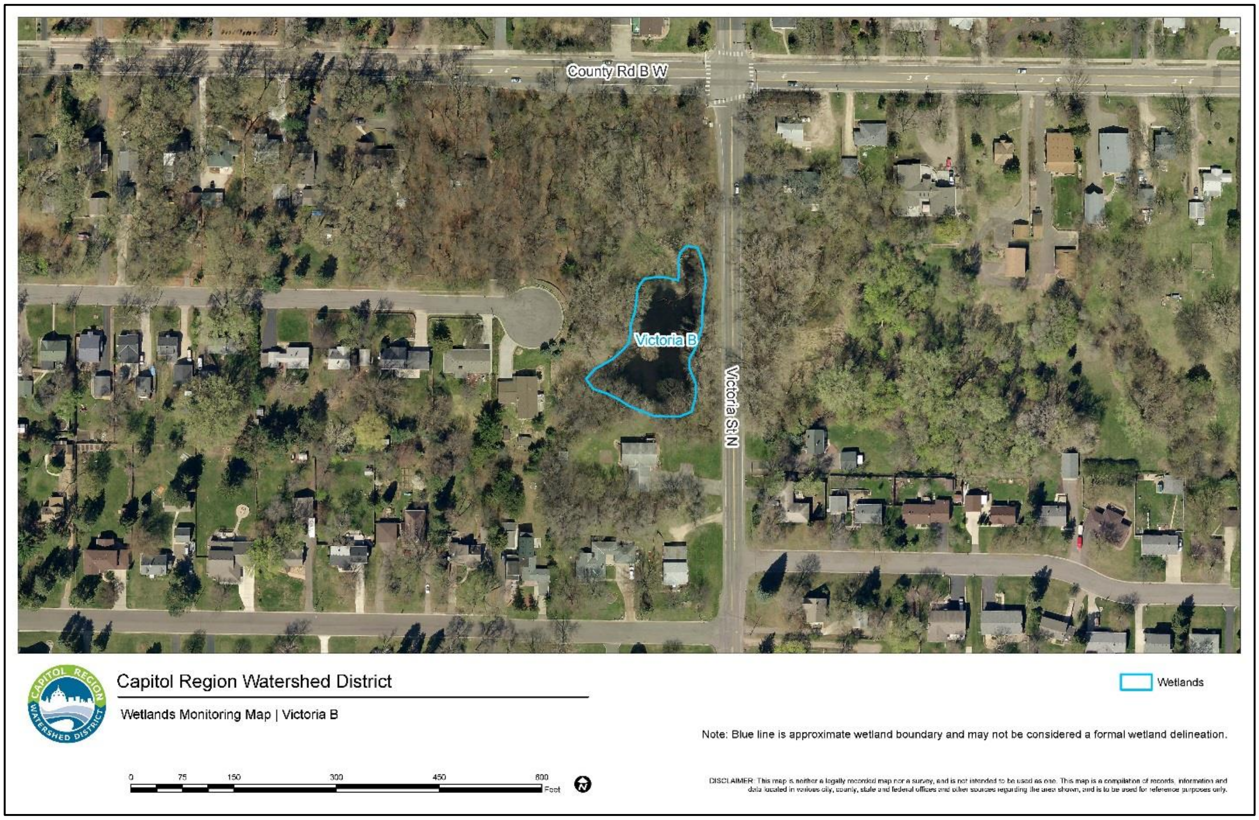

Figure 16-1: Map of Victoria B wetland.

Figure 16-2: View of northeast corner of Victoria B wetland.

Table 16-1: Dates monitored for Victoria B wetland (2009, 2011, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2009	6/22	7/23
2011	7/7	8/16
2013	7/24	7/31

16.2 RESULTS

Victoria B wetland received a macroinvertebrate score of 18 for 2009 and 2011, which is within the poor condition category (Figure 16-3). The invertebrate IBI score then improved to 26 in 2013, moving the IBI score into the moderate condition category. This increase was the result of an increase in total invertebrate taxa, chironomid genera, and intolerant taxa, as well as a decrease in the dominant three taxa proportion (Table 16-2). The chironomid genera metric was of particular importance to note, as the number recorded more than doubled between 2009 and 2011, and doubled again between 2011 and 2013.

The plant IBI score followed the same trend as the macroinvertebrate IBI score: the score in 2009 and 2011 was 14, at the low end of the poor condition category (Figure 16-3). By 2013, however, the plant IBI score more than doubled to 32, which fell within the high end of the moderate condition category. Almost every metric score improved between 2011 and 2013 (Table 16-3).

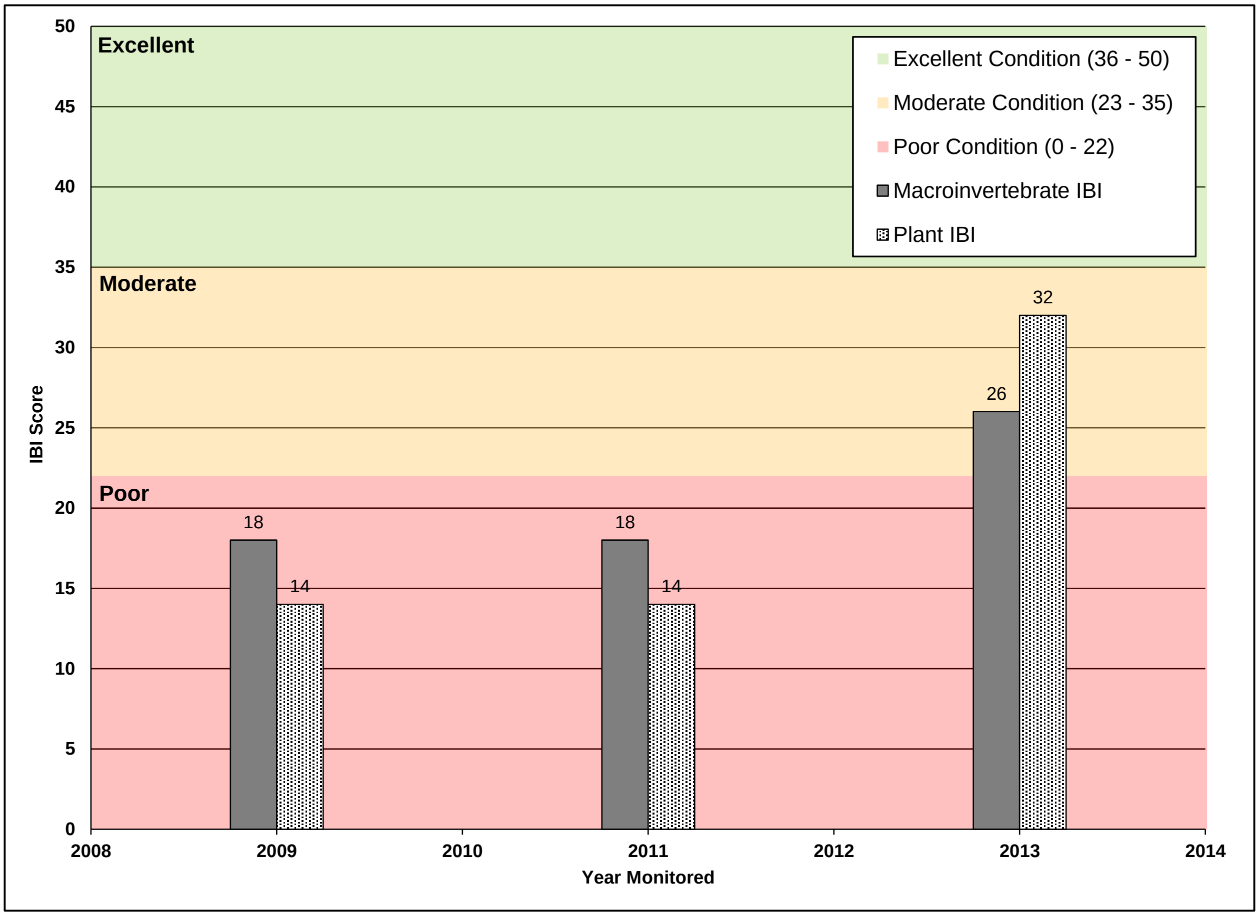

Figure 16-3: Macroinvertebrate and plant IBI scores for Victoria B wetland.

Table 16-2: Victoria B macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2009		2011		2013	
		value	score	value	score	value	score
1	Total invertebrate taxa	35	1	36	1	49	3
2	Odonata taxa	1	1	1	1	2	1
3	Chironomid genera[a]	5	1	11	3	22	5
4	Leech taxa	2	1	2	1	2	1
5	Snail taxa	3	1	3	1	2	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	1	1	2	1	2	1
7	Number of intolerant taxa	2	1	2	1	3	3
8	Tolerant taxa proportion of sample count[a]	9.7%	5	23.8%	5	21.1%	5
9	Dominate 3 taxa as proportion of sample count[a]	45.2%	5	66.5%	3	44.0%	5
10	Corixidae proportion of beetles and bugs in AT[b]	80.8%	1	80.6%	1	84.4%	1
	Total Macroinvertebrate IBI Score		**18**		**18**		**26**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 16-3: Victoria B aquatic plant metric scores/values and total score.

	Plant Metrics	2009		2011		2013	
		value	score	value	score	value	score
1	Vascular genera[a]	5	1	5	1	20	5
2	Nonvascular genera	0	1	0	1	0	1
3	Carex cover[a]	4	5	0	1	5	5
4	Sensitive species (#)[a]	0	1	0	1	2	3
5	Tolerant taxa proportion	0.50	1	0.43	3	0.35	3
6	Grasslike species (#)[a]	1	1	0	1	4	3
7	Perennials species (#)[a]	3	1	4	1	16	3
8	Aquatic guild species (#)	1	1	1	1	1	1
9	Proportion of dominant 3 taxa cover class	0.94	1	0.82	1	0.36	5
10	Persistent litter	75.9%	1	31.8%	3	28.7%	3
	Total Plant IBI Score		**14**		**14**		**32**

a Only native species used in metric calculation.

The physical properties and water chemistry for Victoria B wetland are reported in Tables 16-4 and 16-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (low); TP (medium); Cl- (high); and SO4 (high) (Tables 3-2 and 16-5).

Table 16-4: Sonde data for Victoria B wetland (2009, 2011, 2013).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
06/22/2009 14:45	-	6.0	646	140.0	9.76
07/16/2009 11:30	65.12	6.3	955	17.3	1.62
08/16/2011 09:49	69.44	7.4	524.5	27.3	2.44
07/31/2013 09:50	-	-	-	-	-

Table 16-5: Water chemistry data for Victoria B wetland (2009, 2011, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/16/2009 11:30	-	0.356	-	-	0.05	0.03	88.0	-	-
08/16/2011 09:49	6.8	0.080	0.242	1.0	0.05	0.03	42.0	31.3	-
07/24/2013 11:30	16.0	0.030	0.114	1.1	0.05	0.03	57.9	12.6	5
Average	**11.4**	**0.155**	**0.178**	**1.05**	**0.05**	**0.03**	**62.6**	**22.0**	**5**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

17 VICTORIA-ROSELAWN

17.1 BACKGROUND

Victoria-Roselawn wetland is located immediately to the east of Victoria Street in Roseville, MN, north of Roselawn Ave and south of Parker Ave (Figure 17-1). The wetland has a small portion of open water adjacent to the road, which opens up into a larger body of open water in the central to west portion of the wetland (Figure 17-2). Surrounding land use is primarily residential and parkland. This wetland was sampled in 2009, 2012, and 2014 (Table 17-1).

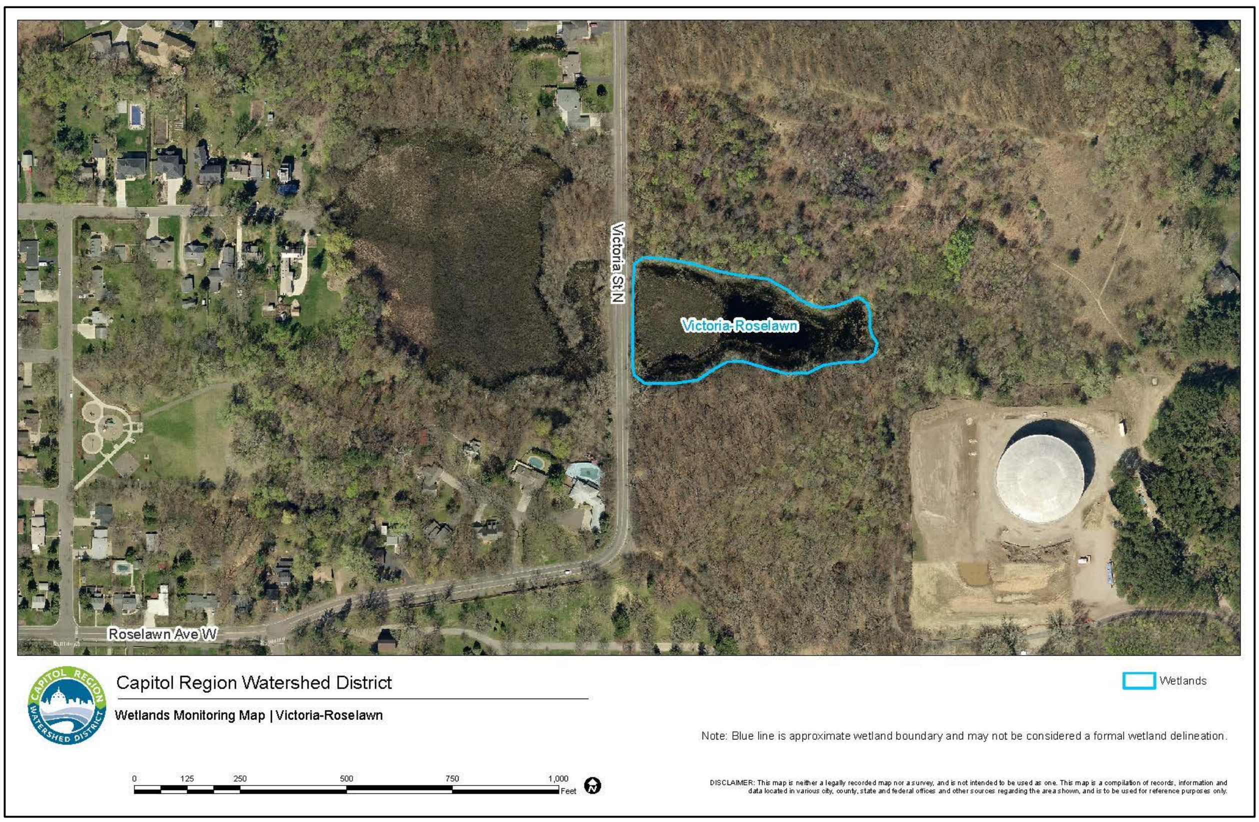

Figure 17-1: Map of Victoria-Roselawn wetland.

Figure 17-2: View towards eastern section of open water in Victoria-Roselawn wetland.

Table 17-1: Dates monitored for Victoria-Roselawn wetland (2009, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2009	6/22	7/23
2012	6/29	9/6
2014	6/26	6/25

17.2 RESULTS

The Victoria-Roselawn wetland received a poor score of 16 in 2009, but improved significantly to a moderate score of 34 when it was sampled in 2012 (Figure 17-3). The 2012 macroinvertebrate IBI score is one of the highest scores observed for all years for all wetlands. The dramatic improvement in the macroinvertebrate IBI score was primarily caused by a nearly 50% decrease in the proportion of dominant taxa (Table 17-2). Additionally, the number of total invertebrate taxa collected more than doubled, from 20 in 2009 to 42 in 2012. The total number of chironomid genera improved markedly during the same time, going from 0 genera detected in

2009 to 9 genera detected in 2012. The decrease in score from 34 to 26 in 2014, however, occurred in a similar but opposite direction as the 2009 to 2012 increase. Decreases in total invertebrate taxa, along with decreases in odonata, chironomid, and intolerant taxa cased the IBI score to drop down to the low end of the moderate condition category.

The plant IBI score remained in the poor condition category for the 2009 and 2012 sampling events, but showed a large increase in score when sampled again in 2014 (Figure 17-3). The increase in score was the result of improvements in almost every metric, including in the number of vascular genera, carex cover taxa, and perennial taxa (Table 17-3).

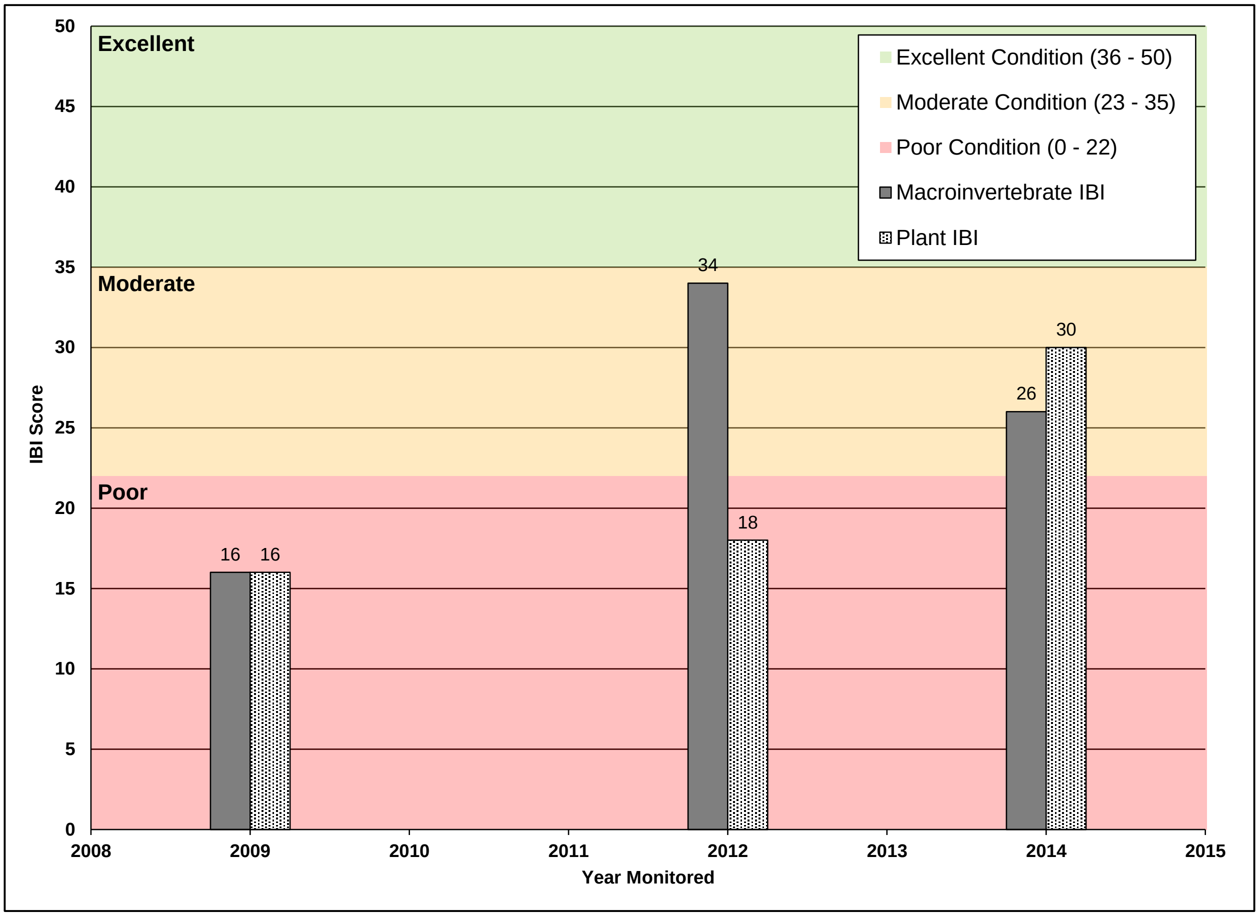

Figure 17-3: Macroinvertebrate and plant IBI scores for Victoria-Roselawn wetland.

Table 17-2: Victoria-Roselawn macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2009		2012		2014	
		value	score	value	score	value	score
1	Total invertebrate taxa	20	1	42	3	23	1
2	Odonata taxa	0	1	4	3	1	1
3	Chironomid genera[a]	0	1	9	3	2	1
4	Leech taxa	3	3	5	5	4	3
5	Snail taxa	0	1	1	1	4	3
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	0	1	4	3	0	1
7	Number of intolerant taxa	0	1	3	3	0	1
8	Tolerant taxa proportion of sample count[a]	8.1%	5	46.9%	3	19.0%	5
9	Dominate 3 taxa as proportion of sample count[a]	91.9%	1	47.8%	5	51.7%	5
10	Corixidae proportion of beetles and bugs in AT[b]	77.2%	1	6.6%	5	1.7%	5
	Total Macroinvertebrate IBI Score		**16**		**34**		**26**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 17-3: Victoria-Roselawn aquatic plant metric scores/values and total score.

Plant Metrics		2009		2012		2014	
		value	score	value	score	value	score
1	Vascular genera[a]	5	1	8	3	15	5
2	Nonvascular genera	0	1	0	1	0	1
3	Carex cover[a]	0.5	3	1	3	3.6	5
4	Sensitive species (#)[a]	0	1	0	1	2	3
5	Tolerant taxa proportion	0.60	1	0.50	1	0.29	3
6	Grasslike species (#)[a]	1	1	1	1	3	3
7	Perennials species (#)[a]	5	1	7	3	15	3
8	Aquatic guild species (#)	3	1	3	1	3	1
9	Proportion of dominant 3 taxa cover class	0.96	1	0.56	3	0.42	3
10	Persistent litter	0.0%	5	36.0%	1	25.3%	3
	Total Plant IBI Score		**16**		**18**		**30**

a Only native species used in metric calculation.

The physical properties and water chemistry for Victoria-Roselawn wetland are reported in Tables 17-4 and 17-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (medium); TP (low); Cl- (high); and SO4 (low) (Tables 3-2 and 17-5).

Table 17-4: Sonde data for Victoria-Roselawn wetland (2009, 2012, 2014).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
06/22/2009 14:00	-	5.5	145	97.0	6.88
07/16/2009 11:30	73.25	6.4	168	142.0	12.35
09/12/2012 09:15	65.84	6.8	136.5	29.6	2.75
06/25/2014 09:00	66.38	6.4	281	-	1.38

Table 17-5: Water chemistry data for Victoria-Roselawn wetland (2009, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/16/2009 11:45	-	0.005	-	-	0.05	0.03	51.0	-	-
09/12/2012 09:15	22.5	0.010	0.140	2.6	0.10	0.10	15.7	2.5	8
06/24/2014 09:00	62.0	0.051	-	1.4	0.05	0.03	47.0	3.6	-
Average	**42.3**	**0.022**	**0.140**	**2.0**	**0.07**	**0.05**	**37.9**	**3.0**	**8**

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

18 VILLA PARK

18.1 BACKGROUND

The Villa Park Wetland System consists of a series of wetland cells and ponds that ultimately drain into Lake McCarrons. The system is within Villa Park, which is bounded on the south by Roselawn Avenue and North McCarrons Boulevard and on the north by County Road B (Figure 18-1). This wetland system is the main stormwater treatment system for the northern part of the McCarrons subwatershed before it drains to Lake McCarrons. Many improvement projects have been performed on the wetland system in the past, such as weir construction and dredging. Survey sites for IBI data collection were chosen in locations where no recent modifications had been made and that best represented the wetland as a whole (i.e. the plant survey plot was not located near recent vegetation restoration sites). Macroinvertebrates were collected from Wet Cell 5 and vegetation was surveyed in the northern portion of Wet Cell 1, with the exception of 2014 when plants were sampled in Wet Cell 5 (Figure 18-2). The Villa Park wetland was monitored in 2007, 2010, 2012, and 2014 (Table 18-1).

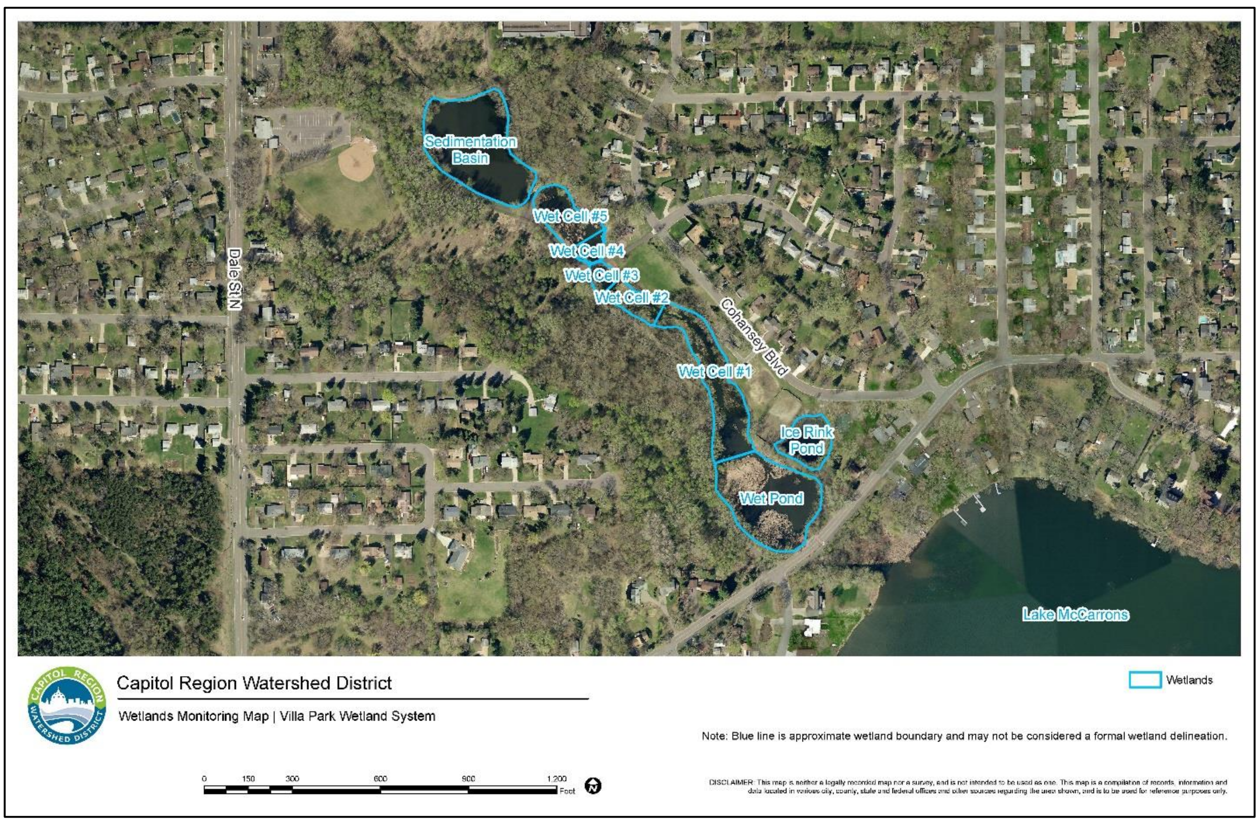

Figure 18-1: Map of Villa Park wetland.

Figure 18-2: View of northwestern shoreline of Wet Cell 5 in Villa Park wetland.

Table 18-1: Dates monitored for Villa Park wetland (2007, 2010, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2007	6/28	8/1
2010	7/12	9/14
2012	6/29	9/6
2014	6/26	6/25

18.2 RESULTS

The macroinvertebrate IBI score was 18 in 2007, indicating a poor biotic community (Figure 18-3). It remained in the poor category in 2010 and 2012, but the score increased to 28 (moderate) in 2014. The biggest improvements between 2007 and 2014 were observed in increases in the chironomid genera and intolerant taxa, as well as decreases in tolerant taxa and the proportion of the dominant three taxa (Table 18-2).

The initial plant IBI score in 2007 was 32, indicating upper-moderate conditions (Figure 18-3). However, the plant IBI scores were lower in the next two assessments, falling into the upper range of the poor condition category. Similar to the macroinvertebrate IBI score, the plant IBI score dramatically increased in 2014 to 34, one of the highest plant scores observed for all years for all wetlands. The 2014 metric scores are all very similar to the 2007 metric scores, with the only exception of an increase in nonvascular genera between 2007 and 2014 (Table 18-3).

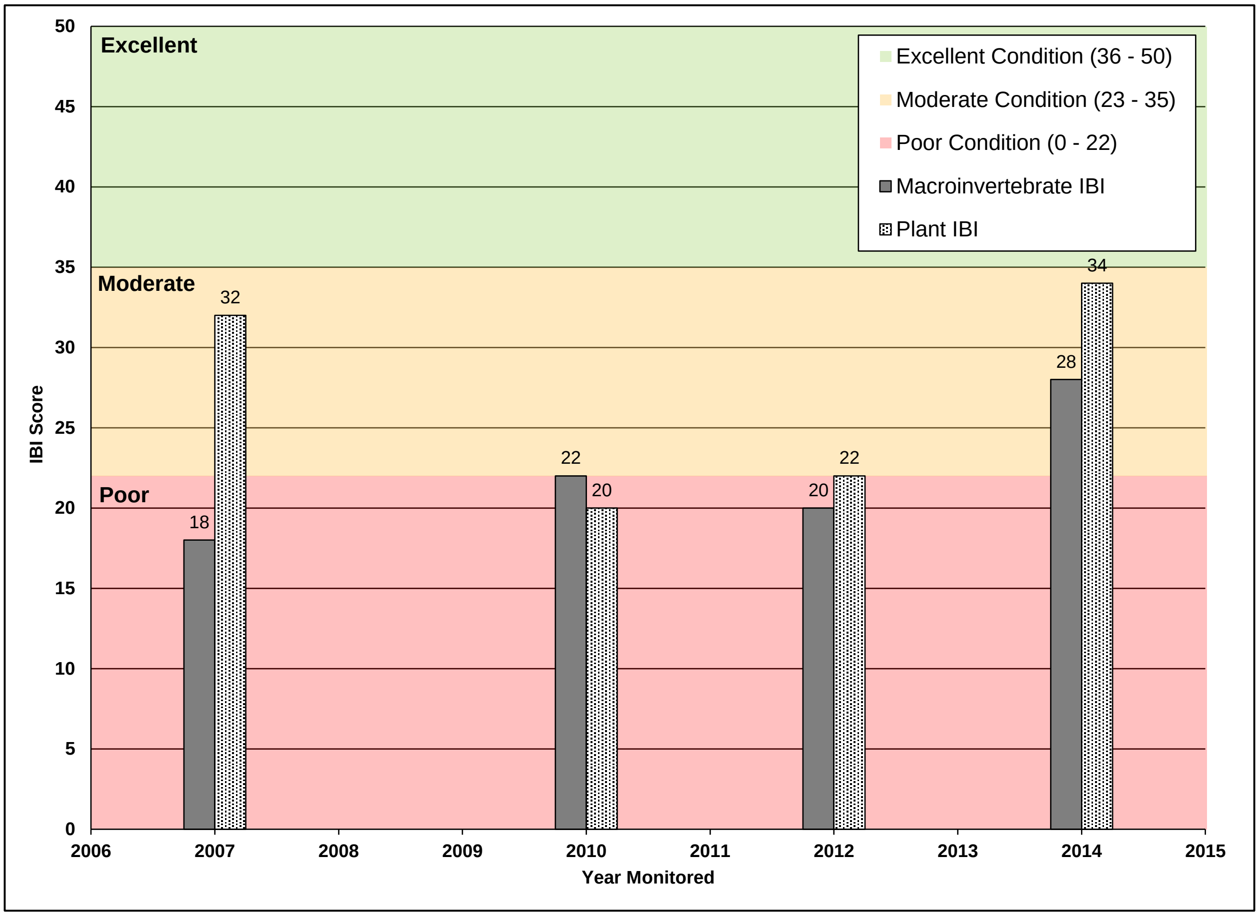

Figure 18-3: Macroinvertebrate and plant IBI scores for Villa Park wetland.

Table 18-2: Villa Park macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	34	1	32	1	36	1	33	1
2	Odonata taxa	3	3	1	1	3	3	3	3
3	Chironomid genera[a]	3	1	8	3	5	1	7	3
4	Leech taxa	4	3	3	3	3	3	3	3
5	Snail taxa	4	3	3	1	4	3	4	3
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	2	1	1	1	2	1	2	1
7	Number of intolerant taxa	1	1	2	1	3	3	3	3
8	Tolerant taxa proportion of sample count[a]	85.5%	1	46.0%	3	82.0%	1	6.0%	5
9	Dominate 3 taxa as proportion of sample count[a]	87.1%	1	71.5%	3	77.2%	1	67.4%	3
10	Corixidae proportion of beetles and bugs in AT[b]	57.4%	3	0.0%	5	44.3%	3	64.7%	3
	Total Macroinvertebrate IBI Score		**18**		**22**		**20**		**28**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 18-3: Villa Park aquatic plant metric scores/values and total score.

	Plant Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]	14	5	11	3	9	3	20	5
2	Nonvascular genera	0	1	0	1	0	1	1	3
3	Carex cover[a]	6	5	0.1	1	1	3	2.3	5
4	Sensitive species (#)[a]	1	1	0	1	0	1	0	1
5	Tolerant taxa proportion	0.31	3	0.46	1	0.50	1	0.67	1
6	Grasslike species (#)[a]	3	3	2	1	2	1	5	3
7	Perennials species (#)[a]	10	3	9	3	8	3	17	3
8	Aquatic guild species (#)	6	3	6	3	4	1	5	3
9	Proportion of dominant 3 taxa cover class	0.38	3	0.39	3	0.55	3	0.32	5
10	Persistent litter	14.1%	5	21.5%	3	3.0%	5	17.4%	5
	Total Plant IBI Score		**32**		**20**		**22**		**34**

a Only native species used in metric calculation.

The physical properties and water chemistry for Villa Park Wetland System are reported in Tables 18-4 and 18-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (high); TKN (medium); TP (high); Cl- (high); and SO4 (medium) (Tables 3-2 and 18-5).

Table 18-4: Sonde data for Villa Park wetland (2007, 2010, 2012, 2014).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
08/01/2007 11:15	77.75	6.7	609	13.3	1.09
09/14/2010 09:36	58.48	6.9	711	-	1.35
09/06/2012 08:45	61.88	7.2	1031	3.1	0.30
06/25/2014 10:30	70.52	7.2	456.5	-	2.61

Table 18-5: Water chemistry data for Villa Park wetland (2007, 2010, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
06/27/2007 14:45[a]	-	0.109	0.362	2.5	-	-	101.0	-	-
09/21/2010 10:50[b]	-	0.064	-	-	0.05	0.03	60.0	5.2	-
09/06/2012 08:45[b]	-	0.270	0.570	1.4	0.10	0.10	149.0	9.5	14
06/24/2014 09:30[a]	12.0	0.152	-	1.6	0.15	0.05	56.0	9.7	-
Average	**12.0**	**0.149**	**0.466**	**1.8**	**0.10**	**0.06**	**91.5**	**8.2**	**14**

[a] *WQ sample taken from Wet Cell #5*
[b] *WQ sample taken from Wet Cell #1*

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

19 WESTERN AVENUE

19.1 BACKGROUND

Western Avenue wetland is located in the city of Lauderdale in the far northwestern part of CRWD. It is just south of Larpenteur Avenue at the intersection of Rose Hill Drive, west of the parking lot behind the furthest set of apartment buildings (Figure 19-1). Surrounding land use is primarily residential. Western Avenue wetland also functions as a stormwater pond, receiving intermittent inflow from the north through a small stream bed. The outlet is a raised concrete overflow pipe, in the southwestern corner of the wetland (Figure 19-2). The Metropolitan Mosquito Control District has worked in the past to control high mosquito populations in this wetland. Western Ave wetland was monitored in 2008, 2011, and 2013 (Table 19-1).

Figure 19-1: Map of Western Ave wetland.

Figure 19-2: View of outlet structure on the southwestern side of Western Ave wetland.

Table 19-1: Dates monitored for Western Ave wetland (2008, 2011, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2008	7/9	7/31
2011	7/7	8/16
2013	7/24	7/31

19.2 RESULTS

The macroinvertebrate IBI score stayed stable with a score of 16 in 2008 and 2011 (Figure 19-3). The score improved to 22 in 2013. All of these scores remained in the poor condition category, indicating a poor biotic condition for the wetland. Even though 2008 and 2011 had the same overall score, metric values fluctuated between the two years, with some metrics improving (e.g., chironomid genera increased) and some degrading (e.g., tolerant taxa increased). The main improvements between 2008/2011, and 2014 were observed in increases in snail taxa, as well as a decrease in the proportion of the dominant three taxa (Table 19-2). The latter was the result of an overall increase in the total invertebrate taxa observed, which did not affect that individual metric score, but did improve the overall diversity of taxa observed in the wetland, which in turn improved the scores of other metrics.

The plant IBI score exhibited the same trend as the macroinvertebrate condition over the same time frame. In 2011, however, there was no cover class data gathered, so three metrics (carex cover, proportion of dominant 3 taxa, and percent persistent litter) could not be fully calculated and were given a score of 1, the lowest metric score. Consequently, the actual wetland plant condition may be higher than calculated. The most recent sampling event exhibited the highest score for the wetland, and improvements were observed in an increase of the number of vascular genera and perennial species, as well as a decrease in the proportion of tolerant taxa (Figure 19-3; Table 19-3).

During the 2008 sample event, it was noted that significant changes in water level may be a source of impairment for this wetland. Additionally, field notes suggested that these fluctuations likely prevent an emergent or shoreline transitional vegetation community from fully developing.

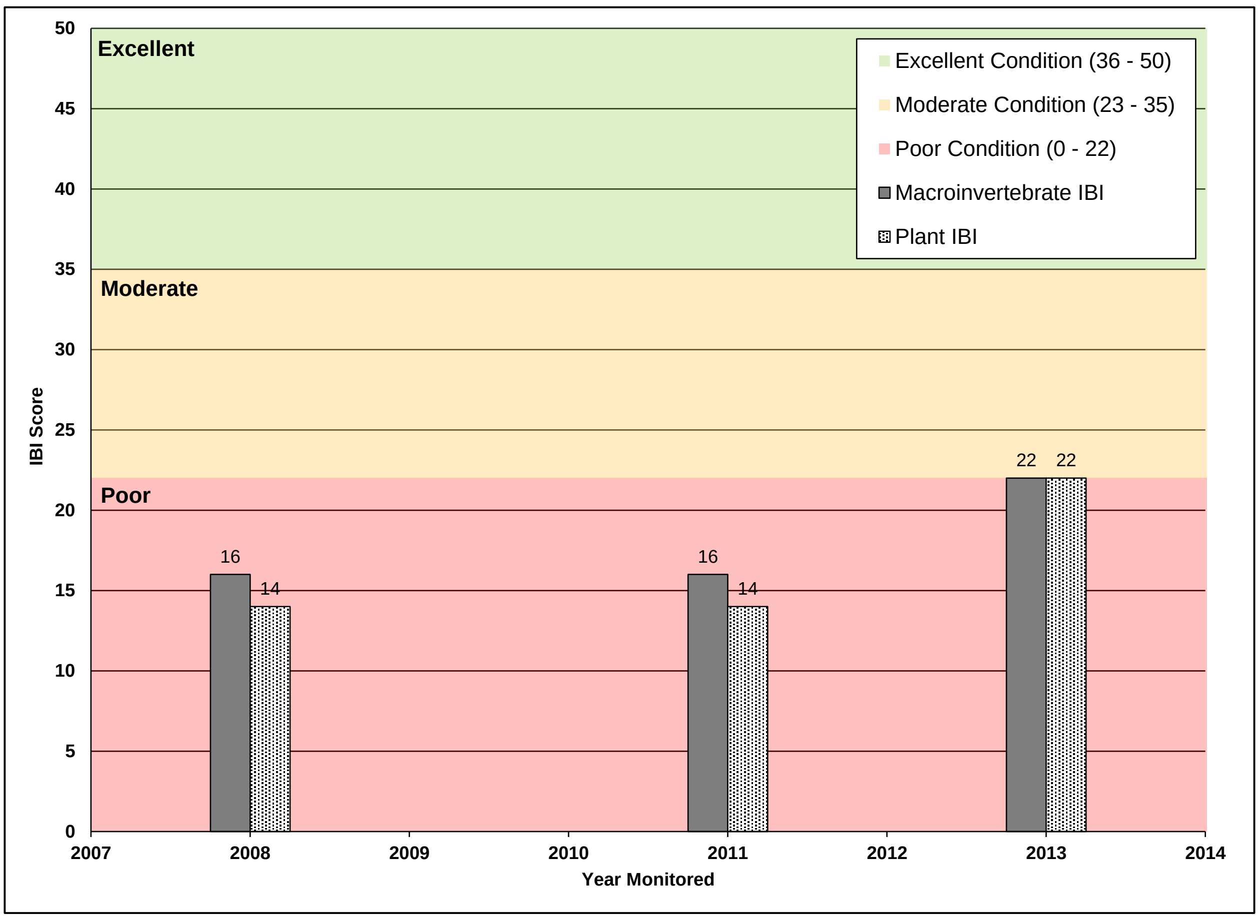

Figure 19-3: Macroinvertebrate and plant IBI scores for Western Ave wetland.

Table 19-2: Western Ave macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2008		2011		2013	
		value	score	value	score	value	score
1	Total invertebrate taxa	8	1	29	1	22	1
2	Odonata taxa	0	1	0	1	0	1
3	Chironomid genera[a]	2	1	9	3	9	3
4	Leech taxa	1	1	2	1	1	1
5	Snail taxa	1	1	1	1	3	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	0	1	1	1	0	1
7	Number of intolerant taxa	0	1	2	1	1	1
8	Tolerant taxa proportion of sample count[a]	5.6%	5	47.5%	3	36.2%	5
9	Dominate 3 taxa as proportion of sample count[a]	94.4%	1	66.2%	3	47.4%	5
10	Corixidae proportion of beetles and bugs in AT[b]	60.0%	3	94.8%	1	45.5%	3
	Total Macroinvertebrate IBI Score		**16**		**16**		**22**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 19-3: Western Ave aquatic plant metric scores/values and total score.

	Plant Metrics	2008		2011		2013	
		value	score	value	score	value	score
1	Vascular genera[a]	3	1	7	1	6	1
2	Nonvascular genera	0	1	0	1	0	1
3	Carex cover[a]	0	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	0	1	0	1
5	Tolerant taxa proportion	0.66	1	0.33	3	0.22	5
6	Grasslike species (#)[a]	1	1	0	1	0	1
7	Perennials species (#)[a]	3	1	6	3	6	3
8	Aquatic guild species (#)	1	1	1	1	1	1
9	Proportion of dominant 3 taxa cover class	1.00	1	0.00	1	0.61	3
10	Persistent litter	0.0%	5	0.0%	1	0.0%	5
	Total Plant IBI Score		**14**		**14**		**22**

a Only native species used in metric calculation.

*No cover class data

The physical properties and water chemistry for Western Avenue wetland are reported in Tables 19-4 and 19-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (high); TKN (medium); TP (medium); Cl- (high); and SO4 (medium) (Tables 3-2 and 19-5).

Table 19-4: Sonde data for Western Ave wetland (2008, 2011, 2013).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/15/2008 12:10	70.10	6.3	253	7.3	0.65
08/16/2011 08:49	67.82	7.1	527.4	15.4	1.40
07/31/2013 08:15	-	-	-	-	-

Table 19-5: Water chemistry data for Western Ave wetland (2008, 2011, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/15/2008 12:10	3.0	0.061	0.136	0.7	-	-	43.0	5.1	6
08/16/2011 08:49	8.0	0.085	0.374	1.6	0.21	0.04	85.0	10.4	-
07/24/2013 09:15	19.0	0.147	0.440	2.6	0.05	0.03	105.0	13.9	34
Average	**10.0**	**0.098**	**0.317**	**1.6**	**0.13**	**0.04**	**77.7**	**9.8**	**20**

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

20 WILLIAM STREET POND

20.1 BACKGROUND

William Street Pond is located southeast of the intersection of Elmer Street and William Street just northeast of Lake McCarrons in Roseville, MN (Figure 20-1). The pond is a stormwater retention basin that collects stormwater from the surrounding residential subwatershed, and discharges overflow to Lake McCarrons. Improvements to the pond in 2011 included the installation of a SAFL baffle at the pond inlet to reduce the energy of the flow entering the pond, dredging sediment to improve storage capacity, and installing two iron-enhanced sand filters along the northwest and southwest shorelines to reduce the amount of phosphorus in the overflow to the lake. CRWD currently monitors the pond level, as well as the water quality of the pond and the water leaving the filters (Figure 20-2). William Street Pond was monitored for macroinvertebrates and plants in 2010, 2012, and 2014 (Table 20-1).

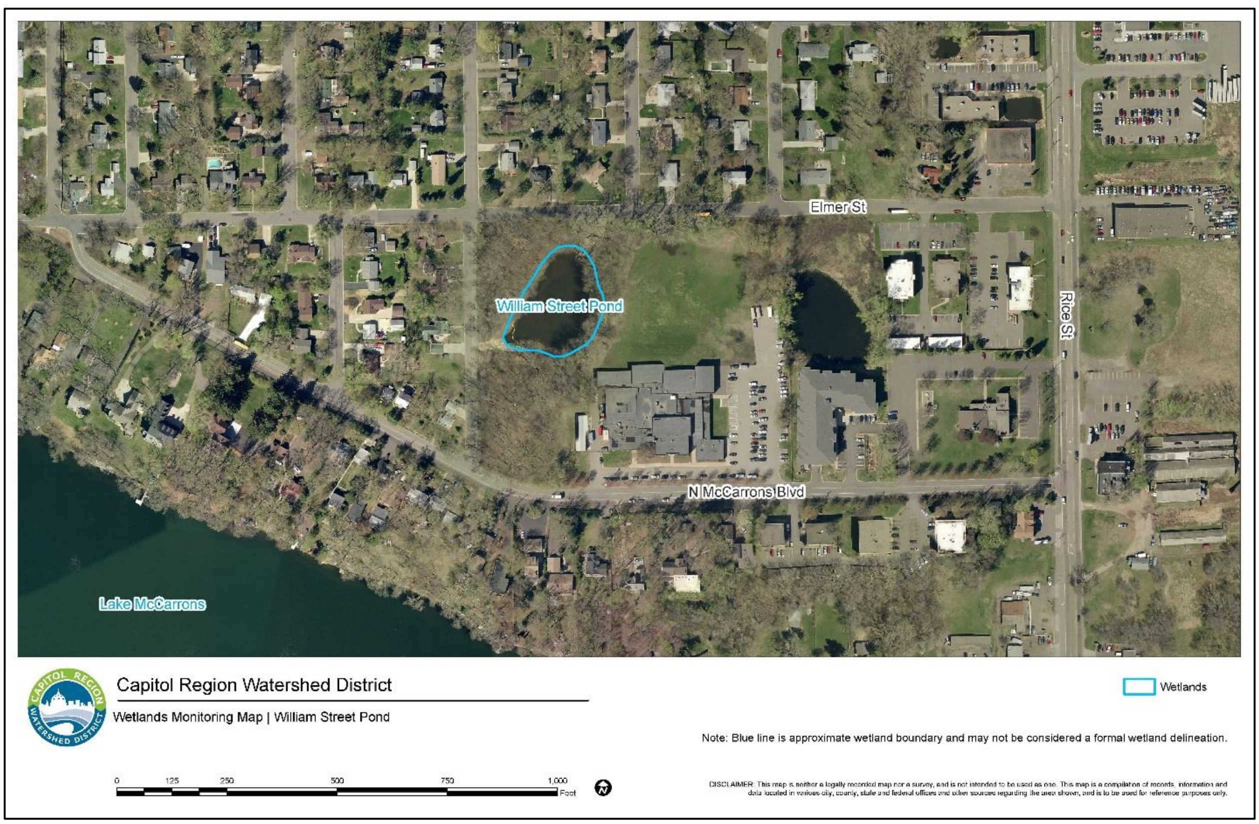

Figure 20-1: Map of William Street Pond.

Figure 20-2: View of staff gauge on south shore of William Street Pond.

Table 20-1: Dates monitored for William Street Pond (2010, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2010	7/21	9/9
2012	6/27	9/5
2014	6/26	6/25

20.2 RESULTS

Macroinvertebrate IBI scores for all years scored in the poor condition category. The overall score improved from 16 to 20 between 2010 and 2012, then dropped to 14 in 2014 (Figure 20-3). One distinct fluctuation that was a driver of these fluctuating scores was the number of chironomid genera, increasing from 6 to 17 between 2010 and 2012, then falling to only 2 genera observed in 2014 (Table 20-2). The majority of the scores remained at 1 for all years monitored. One higher quality aspect of the macroinvertebrate condition at William Street Pond is the consistently low proportion of tolerant taxa observed.

The aquatic plant IBI score was 14 for both 2010 and 2012, improving dramatically to 28 in 2014 (Figure 20-3). In 2010 and 2012, all metrics but one received a score of 1, the lowest possible score. The exception to this was in the persistent litter category which received a score of 5 for both years. In 2014, large improvements were observed in the number of vascular genera, carex cover species, grasslike and perennial species, as well as a reduction in the tolerant taxa proportion (Table 20-3).

The improvements to William Street Pond in 2011 included repairing the buffer area along the southwestern and southern shorelines of the pond, in which native plants were established after construction of the iron-enhanced sand filters. The introduction of these plants could be part of the reason such dramatic improvement was observed in the plant IBI score in 2014, after more plants along the shoreline were further established.

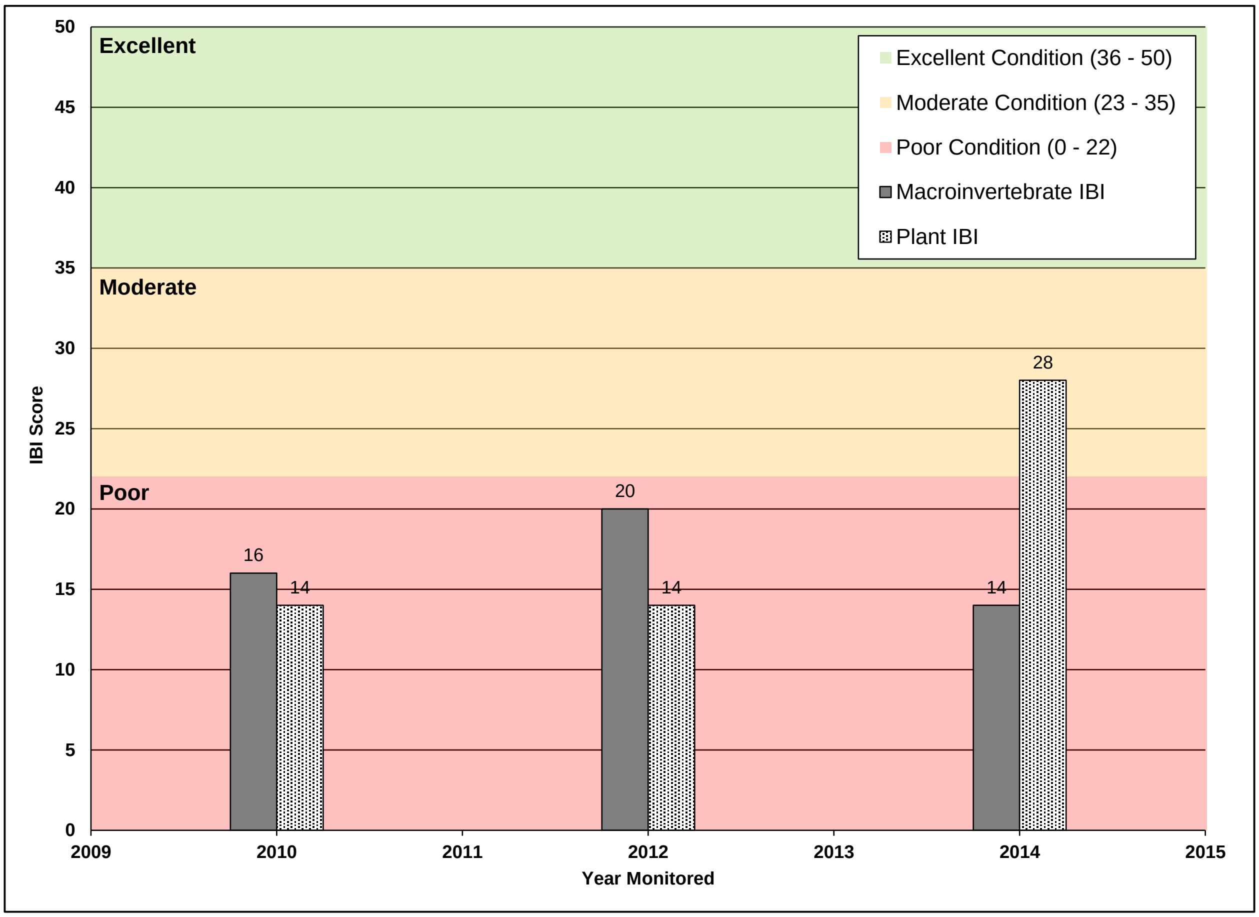

Figure 20-3: Macroinvertebrate and plant IBI scores for William Street Pond.

Table 20-2: William Street Pond macroinvertebrate plant metric scores/values and total score.

Macroinvertebrate Metrics		2010		2012		2014	
		value	score	value	score	value	score
1	Total invertebrate taxa	22	1	33	1	15	1
2	Odonata taxa	0	1	0	1	0	1
3	Chironomid genera[a]	6	1	17	5	2	1
4	Leech taxa	1	1	2	1	1	1
5	Snail taxa	2	1	1	1	1	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	0	1	0	1	0	1
7	Number of intolerant taxa	1	1	1	1	0	1
8	Tolerant taxa proportion of sample count[a]	16.2%	5	6.1%	5	14.0%	5
9	Dominate 3 taxa as proportion of sample count[a]	62.3%	3	86.2%	1	84.0%	1
10	Corixidae proportion of beetles and bugs in AT[b]	84.5%	1	57.0%	3	67.5%	1
Total Macroinvertebrate IBI Score			**16**		**20**		**14**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 20-3: William Street Pond aquatic plant metric scores/values and total score.

Plant Metrics		2010		2012		2014	
		value	score	value	score	value	score
1	Vascular genera[a]	4	1	2	1	13	3
2	Nonvascular genera	0	1	0	1	0	1
3	Carex cover[a]	0	1	0	1	9	5
4	Sensitive species (#)[a]	0	1	0	1	0	1
5	Tolerant taxa proportion	0.67	1	1.00	1	0.36	3
6	Grasslike species (#)[a]	0	1	0	1	5	3
7	Perennials species (#)[a]	3	1	2	1	11	3
8	Aquatic guild species (#)	2	1	2	1	3	1
9	Proportion of dominant 3 taxa cover class	0.89	1	1.00	1	0.42	3
10	Persistent litter	0.0%	5	0.0%	5	11.1%	5
	Total Plant IBI Score		**14**		**14**		**28**

a Only native species used in metric calculation.

The physical properties and water chemistry for William Street Pond are reported in Tables 20-4 and 20-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (high); TKN (medium); TP (high); Cl- (high); and SO4 (low) (Tables 3-2 and 20-5).

Table 20-4: Sonde data for William Street Pond (2010, 2012, 2014).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
09/09/2010 09:55	59.49	6.1	199	-	0.46
09/06/2012 09:40	67.46	7.1	162.3	2.8	0.24
06/25/2014 14:10	69.80	7.0	338.5	-	1.29

Table 20-5: Water chemistry data for William Street Pond (2010, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
09/21/2010 10:37	-	0.020	-	-	0.05	0.03	21.0	1.6	-
09/06/2012 09:40	26.7	0.026	0.440	1.0	0.10	0.10	19.5	2.5	7
06/24/2014 09:50	15.0	0.101	-	3.7	0.05	0.03	44.4	7.36	-
Average	**20.9**	**0.049**	**0.440**	**2.4**	**0.07**	**0.05**	**28.3**	**3.8**	**7**

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

21 WILLOW RESERVE

21.1 BACKGROUND

Willow Reserve wetland is a large wetland in Saint Paul located north of Maryland Ave between Arundal Street and Farrington Street, just northeast of Loeb Lake (Figure 21-1). It is located on the Trout Brook Stormwater Interceptor downstream from Como Lake and provides a large storage basin to reduce peak flows and allow settling time for pollutant removal (Figure 21-2). It is currently preserved for bird and wildlife habit but also serves a water quality/quantity function as well. Willow Reserve was monitored for macroinvertebrates and plants in 2007, 2010, 2012, and 2014 (Table 21-1).

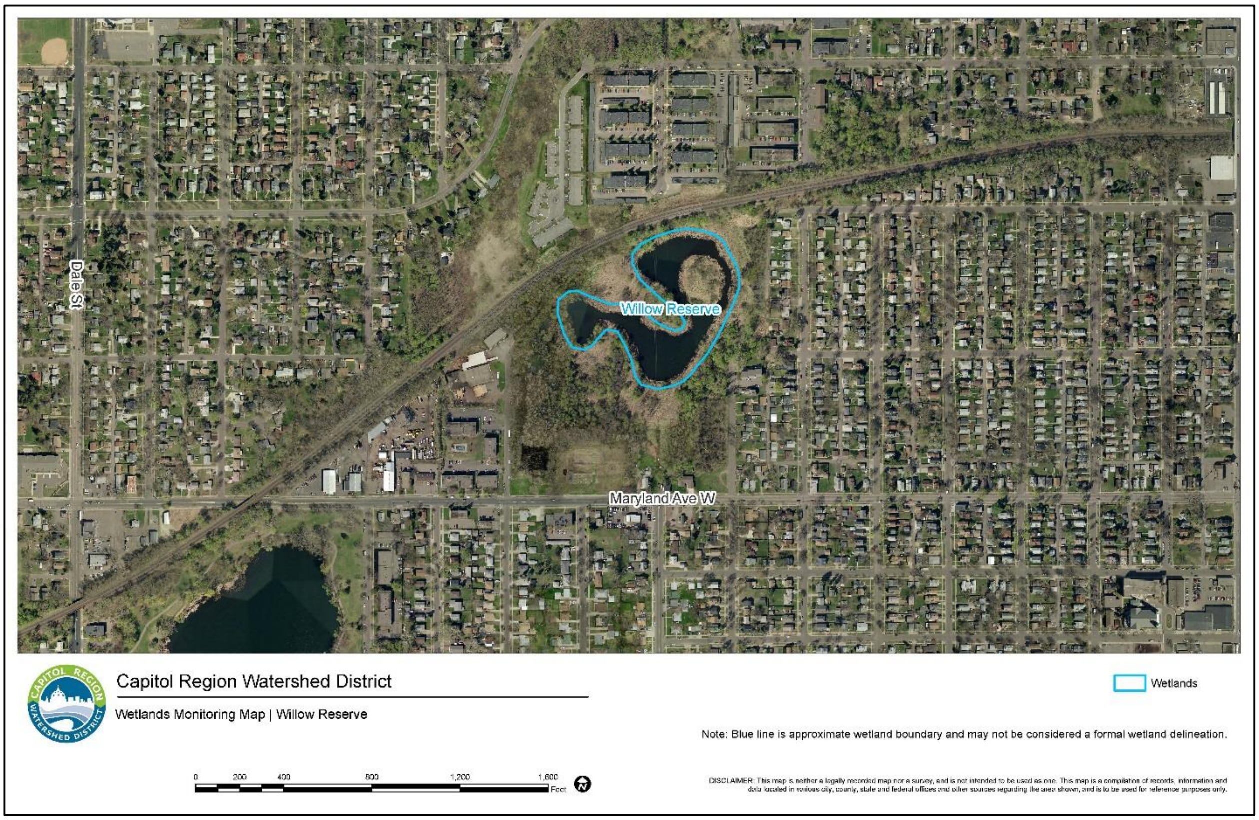

Figure 21-1: Map of Willow Reserve wetland.

Figure 21-2: View of southern shoreline of eastern portion of Willow Reserve wetland.

Table 21-1: Dates monitored for Willow Reserve wetland (2007, 2010, 2012, 2014).

Year Monitored	Macroinvertebrate Date	Plant Date
2007	6/15	7/31
2010	7/21	9/21
2012	6/29	9/6
2014	6/26	6/26

21.2 RESULTS

Macroinvertebrate scores increased steadily from 2007 (18) to 2012 (32) moving it from the poor condition category in 2007 to the moderate condition category in 2010 and 2012 (Figure 21-3). During this time, there was a significant increase in the total invertebrate taxa and chironomid genera counted, as well as increases in leech and snail taxa (Table 21-2). Decreases in the tolerant taxa proportion and proportion of dominant three taxa contributed to the increase in score as well. It fell back into the poor condition category in 2014, however, with a score of 16 where the majority of metric scores decreased.

In contrast, the plant IBI exhibits consistently poor scores (Figure 21-3). The score of 20 in 2007 was the highest score observed, falling to 16 for the remaining three years of monitoring. There was no cover class data available in year 2012, however, so three metrics (carex cover, proportion of dominant 3 taxa, and percent persistent litter) could not be fully calculated and were given a score of 1, the lowest metric score. The resulting annual IBI for 2011, therefore, is lower than the actual value (Table 21-3). In general, Willow Reserve wetland has low plant species diversity and robustness.

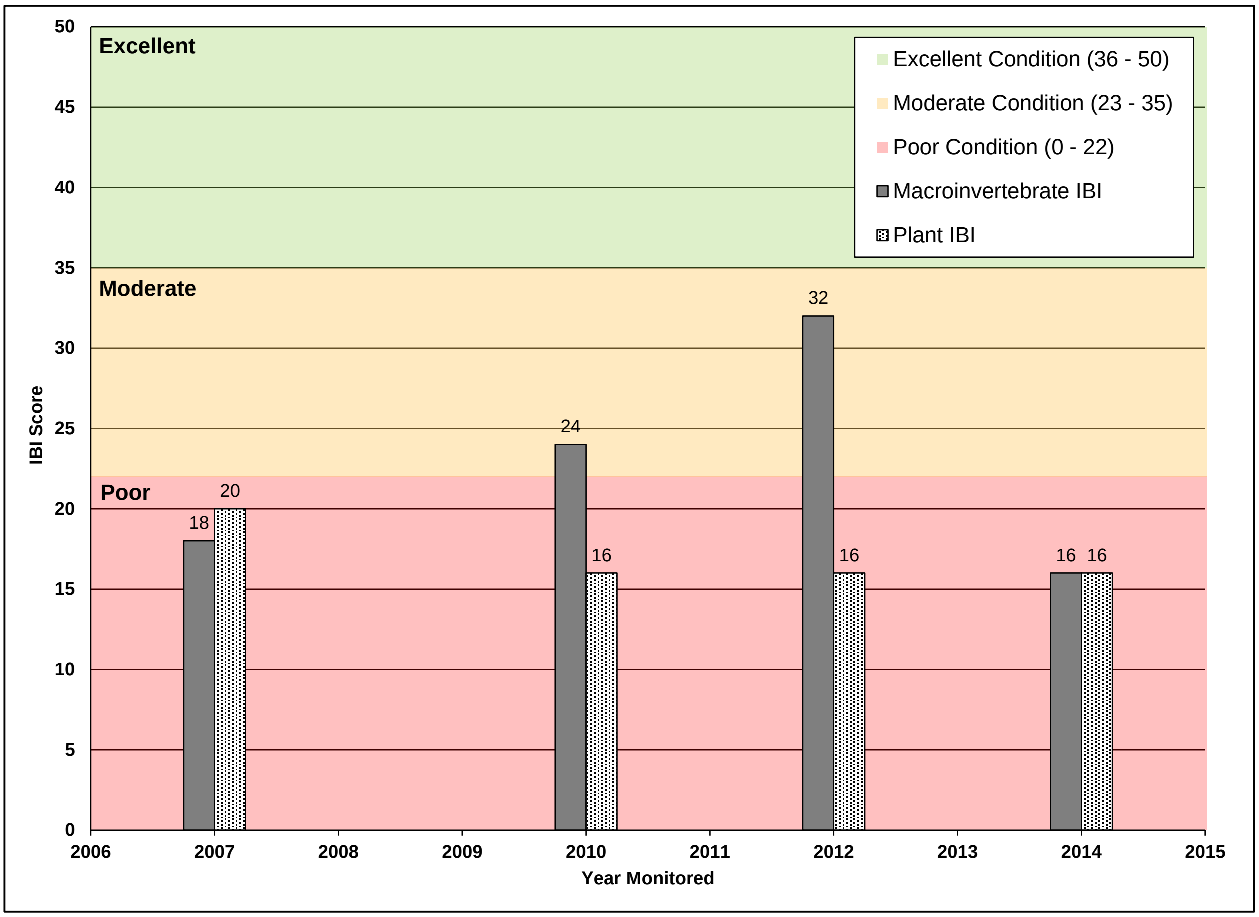

Figure 21-3: Macroinvertebrate and plant IBI scores for Willow Reserve wetland.

Table 21-2: Willow Reserve macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Total invertebrate taxa	31	1	41	3	52	5	20	1
2	Odonata taxa	1	1	2	1	2	1	0	1
3	Chironomid genera[a]	0	1	10	3	16	5	0	1
4	Leech taxa	3	3	4	3	7	5	3	3
5	Snail taxa	4	3	4	3	7	5	5	3
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	2	1	3	1	1	1	1	1
7	Number of intolerant taxa	0	1	2	1	2	1	1	1
8	Tolerant taxa proportion of sample count[a]	81.8%	1	47.1%	3	68.6%	3	72.2%	1
9	Dominate 3 taxa as proportion of sample count[a]	92.5%	1	75.7%	1	52.9%	5	85.6%	1
10	Corixidae proportion of beetles and bugs in AT[b]	3.0%	5	7.5%	5	89.4%	1	54.6%	3
	Total Macroinvertebrate IBI Score		**18**		**24**		**32**		**16**

a Metric calculated from dip-net samples only.

b Metric calculated from activity trap samples only.

Table 21-3: Willow Reserve aquatic plant metric scores/values and total score.

	Plant Metrics	2007		2010		2012		2014	
		value	score	value	score	value	score	value	score
1	Vascular genera[a]	8	3	6	1	7	1	7	1
2	Nonvascular genera	0	1	0	1	0	1	0	1
3	Carex cover[a]	0	1	0	1	0	1	0	1
4	Sensitive species (#)[a]	0	1	0	1	0	1	0	1
5	Tolerant taxa proportion	0.70	1	0.75	1	0.25	5	0.78	1
6	Grasslike species (#)[a]	0	1	0	1	1	1	0	1
7	Perennials species (#)[a]	6	3	4	1	6	3	6	3
8	Aquatic guild species (#)	5	3	4	1	1	1	3	1
9	Proportion of dominant 3 taxa cover class	0.62	3	0.50	3	0.00	1	0.50	3
10	Persistent litter	32.6%	3	14.9%	5	0.0%	1	20.0%	3
	Total Plant IBI Score		**20**		**16**		**16**		**16**

a Only native species used in metric calculation.

*No cover class data

The physical properties and water chemistry for Willow Reserve wetland are reported in Tables 21-4 and 21-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (high); TP (medium); Cl- (high); and SO4 (low) (Tables 3-2 and 21-5).

Table 21-4: Sonde data for Willow Reserve wetland (2007, 2010, 2012, 2014).

Sample Date/Time	Water Temperature (^oF)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/31/2007 09:35	78.48	6.7	570	1.0	0.08
09/21/2010 09:45	61.07	6.8	335	-	3.02
09/06/2012 08:50	65.84	6.9	281	2.0	0.20
06/26/2014 07:55	66.02	6.8	633	-	3.31

Table 21-5: Water chemistry data for Willow Reserve wetland (2007, 2010, 2012, 2014).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
06/27/2007 14:05	-	0.018	0.445	4.7	-	-	72.0	-	-
09/21/2010 09:45	-	0.016	0.154	1.3	-	-	28.0	1.7	-
09/12/2012 08:50	153.0	0.020	0.250	4.0	0.10	0.10	18.1	2.5	26
06/24/2014 08:30	43.0	0.044	-	2.3	0.05	0.03	32.8	9.2	-
Average	**98.0**	**0.025**	**0.283**	**3.1**	**0.08**	**0.07**	**37.7**	**4.4**	**26**

Actual number less than value (<)

Estimated concentration above the method detection limit and below the reporting limit (~)

22 WOODVIEW MARSH

22.1 BACKGROUND

Woodview March is a large wetland that is bounded on the southern edge by Larpenteur Avenue in between Dale and Rice Street, and located southeast of Lake McCarrons (Figure 22-1). It is located within Tamarack Park in Roseville MN, and most of the open water portion of the wetland is surround by tree cover (Figure 22-2). Surrounding land use is primarily residential and green space. Woodview Marsh was monitored for macroinvertebrates and plants in 2007 and 2013 (Table 22-1).

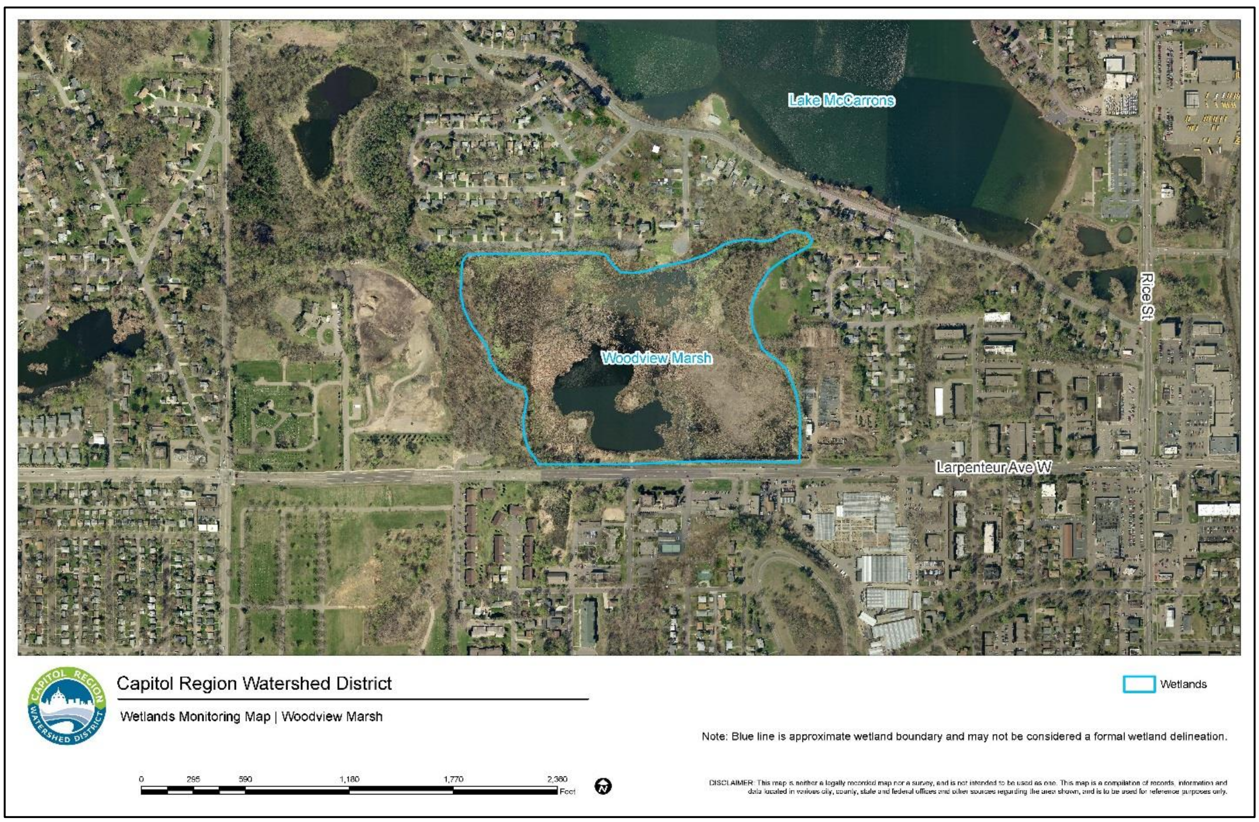

Figure 22-1: Map of Woodview Marsh.

Figure 22-2: View of northeastern shore of Woodview Marsh.

Table 22-1: Dates monitored for Woodview Marsh (2007, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2007	6/22	8/1
2013	7/24	7/29

22.2 RESULTS

The macroinvertebrate IBI score of 28 for Woodview Marsh in 2007 places this wetland in the mid-range of the moderate condition category (Figure 22-3). The score drops to the poor condition in 2013 with a score of 22. The major drivers behind this drop in score were a decrease in total invertebrate taxa, odonatan taxa and taxa within the ETSD metric (Table 22-2). Also contributing to this drop in score was an increase in Corixidae specimens observed. Interestingly, during this same time period, the number of chironomid genera increased which increased this metric score.

The plant IBI score of 26 also places the wetland in the moderate condition category, but contrary to the macroinvertebrate trend, the plant IBI increases between 2007 and 2013 to a score of 34 (Figure 22-3). This is caused by an increase in vascular genera and aquatic guild species, as well as a decrease in the proportion of the dominant three taxa and persistent litter (Table 22-3).

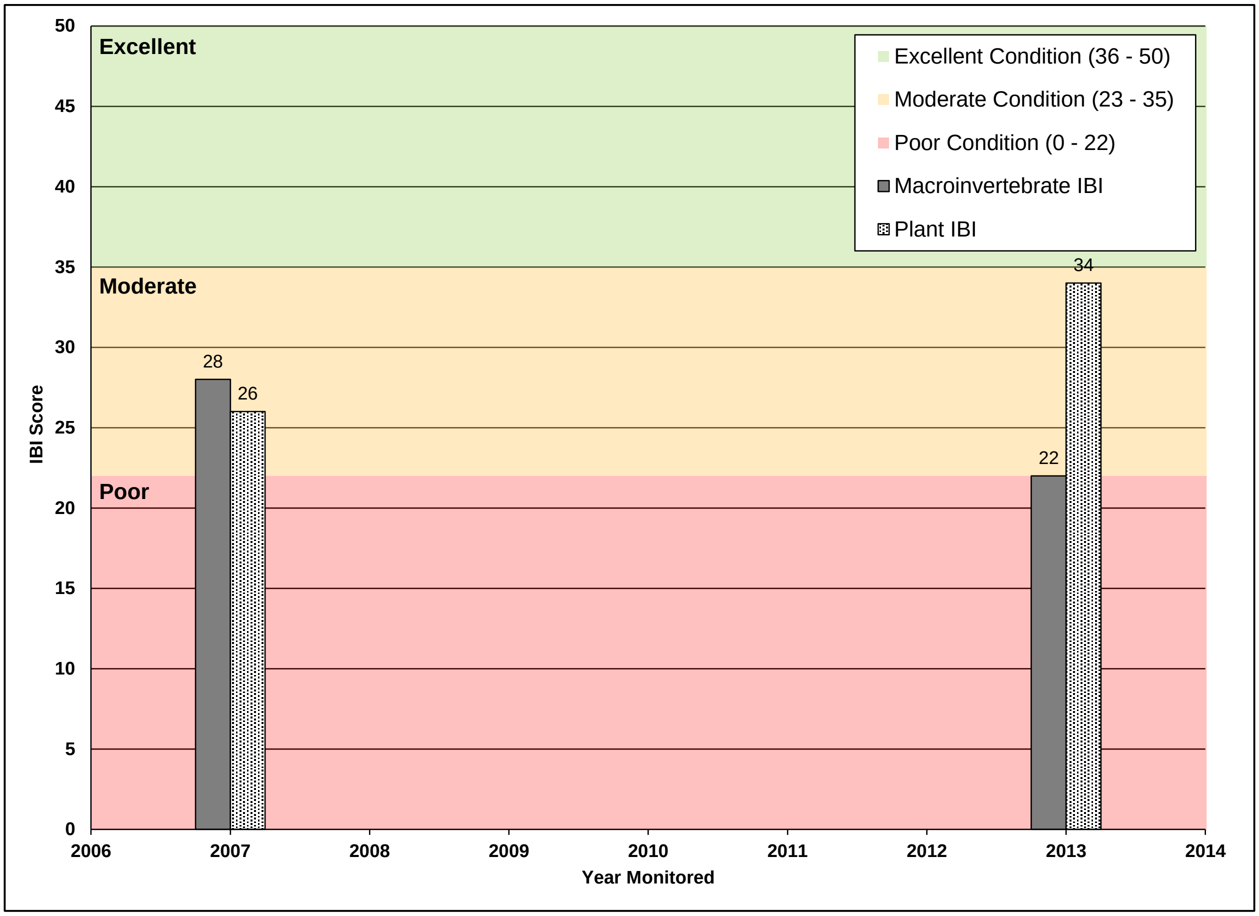

Figure 22-3: Macroinvertebrate and plant IBI scores for Woodview Marsh.

Table 22-2: Woodview Marsh macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2007		2013	
		value	score	value	score
1	Total invertebrate taxa	55	5	39	3
2	Odonata taxa	4	3	0	1
3	Chironomid genera[a]	13	3	17	5
4	Leech taxa	6	5	3	3
5	Snail taxa	3	1	2	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	5	3	2	1
7	Number of intolerant taxa	1	1	2	1
8	Tolerant taxa proportion of sample count[a]	74.9%	1	69.8%	1
9	Dominate 3 taxa as proportion of sample count[a]	79.4%	1	73.0%	3
10	Corixidae proportion of beetles and bugs in AT[b]	1.5%	5	61.3%	3
	Total Macroinvertebrate IBI Score		**28**		**22**

a Metric calculated from dip-net samples only.
b Metric calculated from activity trap samples only.

Table 22-3: Woodview Marsh aquatic plant metric scores/values and total score.

Plant Metrics		2007		2013	
		value	score	value	score
1	Vascular genera[a]	12	3	19	5
2	Nonvascular genera	0	1	0	1
3	Carex cover[a]	6.5	5	7	5
4	Sensitive species (#)[a]	3	3	3	3
5	Tolerant taxa proportion	0.31	3	0.39	3
6	Grasslike species (#)[a]	4	3	4	3
7	Perennials species (#)[a]	11	3	17	3
8	Aquatic guild species (#)	3	1	5	3
9	Proportion of dominant 3 taxa cover class	0.48	3	0.32	5
10	Persistent litter	35.5%	1	25.7%	3
	Total Plant IBI Score		**26**		**34**

a Only native species used in metric calculation.

The physical properties and water chemistry for Woodview Marsh are reported in Tables 22-4 and 22-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (high); TP (medium); Cl- (high); and SO4 (low) (Tables 3-2 and 22-5).

Table 22-4: Sonde data for Woodview Marsh (2007, 2013).

Sample Date/Time	Water Temperature (^{o}F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
08/01/2007 13:40	89.17	7.8	546	65.1	4.77
07/29/2013 14:34	-	-	-	-	-

Table 22-5: Water chemistry data for Woodview Marsh (2007, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
06/27/2007 15:05	-	0.013	0.120	1.9	-	-	90.0	-	-
07/24/2013 15:15	160.0	0.046	0.550	5.6	0.05	0.03	44.3	0.6	45
Average	**160.0**	**0.030**	**0.335**	**3.8**	**0.05**	**0.03**	**67.2**	**0.6**	**45**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

23 ZITTELS

23.1 BACKGROUND

Zittels wetland is located near the intersection of Rice Street and Roselawn Avenue East and is bounded along its southeast border by the Soo Line Railroad track (Figure 23-1). The wetland has moderate tree cover, extending outside of the wetland boundary, and the open water portion of the wetland has high algae growth in the summer (Figure 23-2). Surrounding land use is primarily commercial and green space. Zittels wetland was monitored in 2009 and 2013 (Table 23-1).

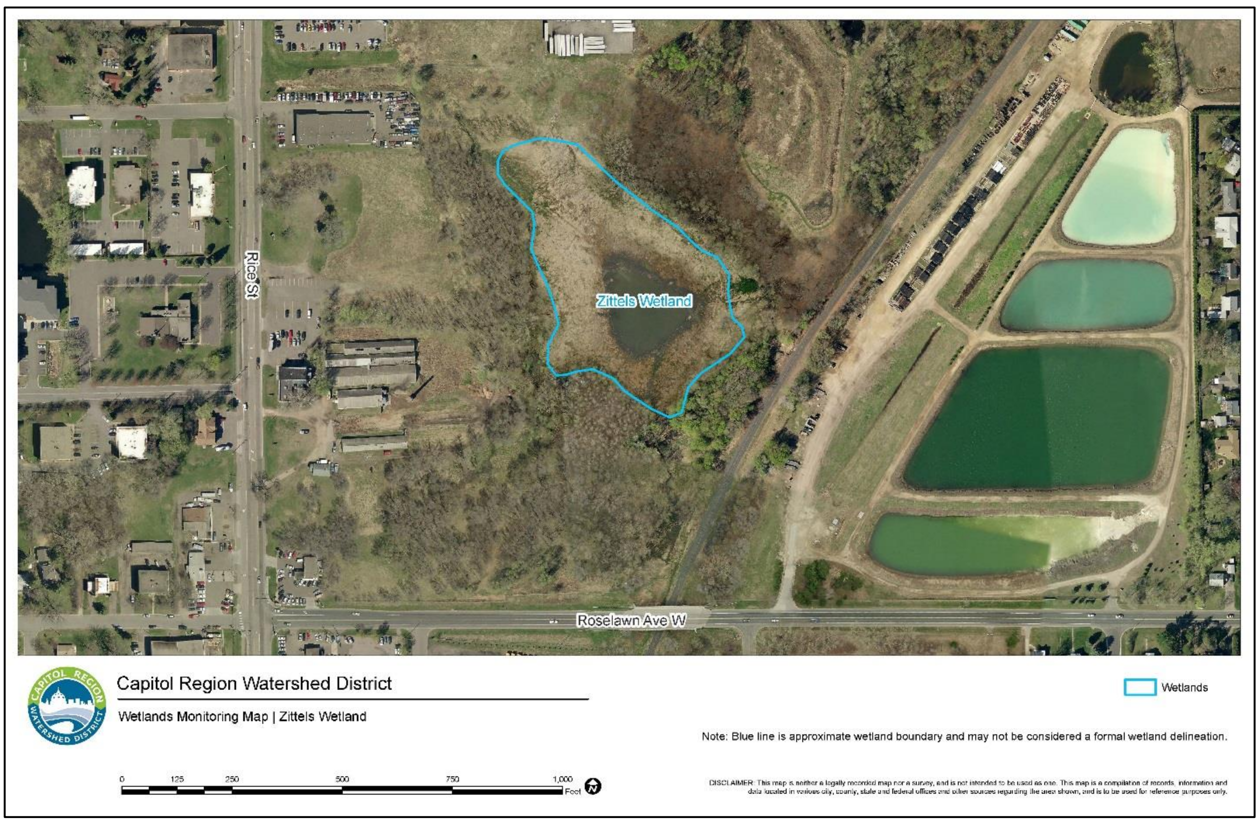

Figure 23-1: Map of Zittels wetland.

Figure 23-2: View of eastern shoreline in Zittels wetland.

Table 23-1: Dates monitored for Zittels wetland (2009, 2013).

Year Monitored	Macroinvertebrate Date	Plant Date
2009	6/30	7/30
2013	7/24	7/29

23.2 RESULTS

Zittels wetland scored within the moderate condition category in 2009 with a score of 26, which dropped to the poor condition category in 2013 with a score of 22 (Figure 23-3). This was largely the result of an increase in tolerant taxa, proportion of the dominant three taxa, and Corixidae specimens (Table 23-2). Interestingly, during this same period of time, the overall diversity of the total macroinvertebrate taxa increased, and the chironomid genera increased from 0 to 18.

In contrast to the metric scores for the macroinvertebrate IBI, the plant IBI score of 12 placed 2009 in the poor condition category (Figure 23-3), and all but one metric received the minimum score (Table 23-3). Also contrary to the macroinvertebrate IBI, the plant IBI doubled between 2009 and 2013, to a score of 24. This improved the scoring to the moderate condition category. This increase is attributed to an increase in vascular genera and carex cover species, as well as a reduction in the proportion of the dominant three taxa and persistent litter.

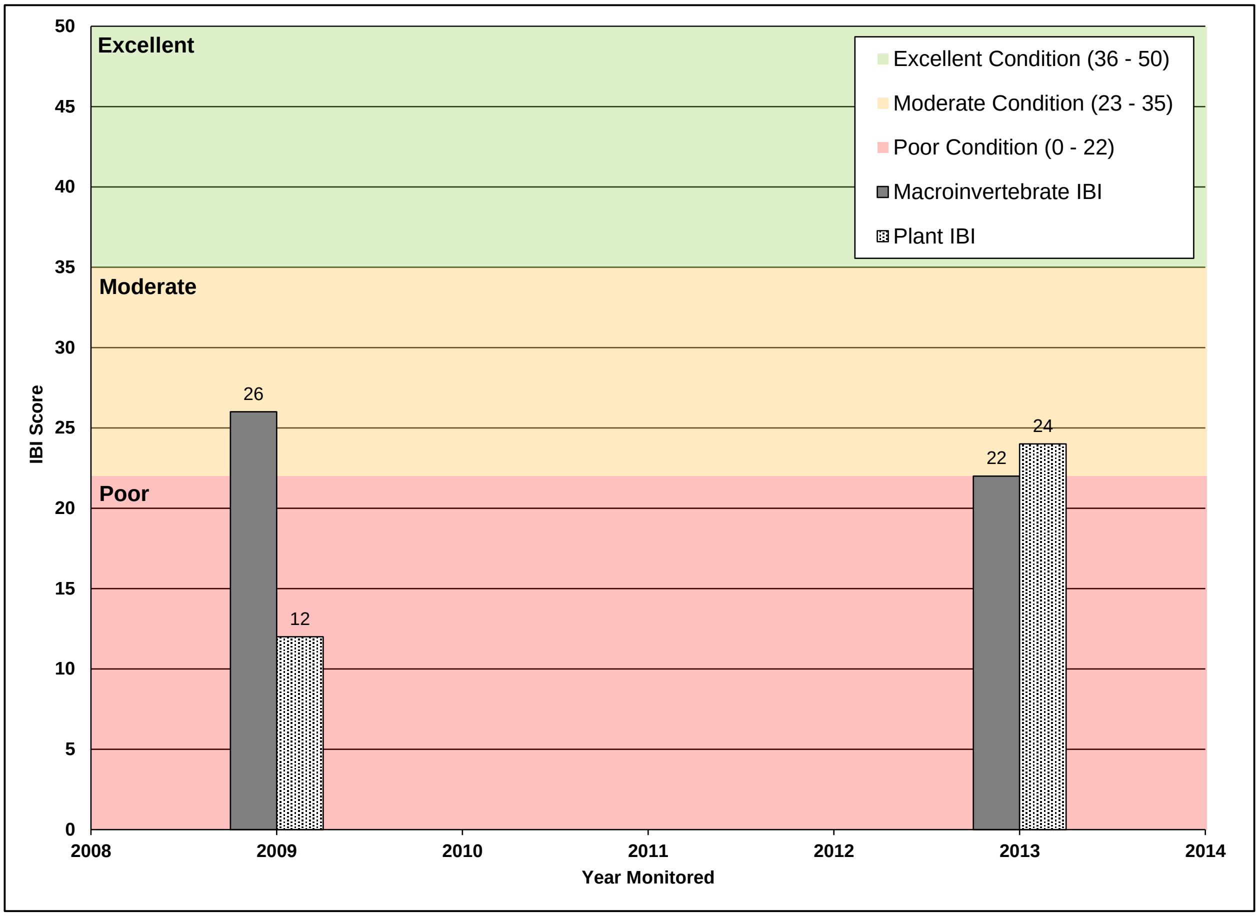

Figure 23-3: Macroinvertebrate and plant IBI scores for Zittels wetland.

Table 23-2: Zittels macroinvertebrate metric scores/values and total score.

	Macroinvertebrate Metrics	2009		2013	
		value	score	value	score
1	Total invertebrate taxa	33	1	46	3
2	Odonata taxa	3	3	0	1
3	Chironomid genera[a]	0	1	18	5
4	Leech taxa	3	3	4	3
5	Snail taxa	3	1	3	1
6	ETSD metric: # genera mayflies, caddisflies; presence of fingernail clams, dragonflies	3	1	1	1
7	Number of intolerant taxa	1	1	3	3
8	Tolerant taxa proportion of sample count[a]	40.0%	5	74.7%	1
9	Dominate 3 taxa as proportion of sample count[a]	53.3%	5	75.7%	1
10	Corixidae proportion of beetles and bugs in AT[b]	4.3%	5	57.8%	3
	Total Macroinvertebrate IBI Score		**26**		**22**

a Metric calculated from dip-net samples only.
b Metric calculated from activity trap samples only.

Table 23-3: Zittels aquatic plant metric scores/values and total score.

Plant Metrics		2009		2013	
		value	score	value	score
1	Vascular genera[a]	3	1	9	3
2	Nonvascular genera	0	1	0	1
3	Carex cover[a]	0	1	3	5
4	Sensitive species (#)[a]	0	1	0	1
5	Tolerant taxa proportion	0.80	1	0.67	1
6	Grasslike species (#)[a]	0	1	2	1
7	Perennials species (#)[a]	2	1	6	3
8	Aquatic guild species (#)	3	1	4	1
9	Proportion of dominant 3 taxa cover class	0.74	1	0.42	3
10	Persistent litter	21.7%	3	13.9%	5
	Total Plant IBI Score		**12**		**24**

a Only native species used in metric calculation.

The physical properties and water chemistry for Zittels wetland are reported in Tables 23-4 and 23-5. Physical and chemical properties of the water recorded from the Sonde can be dependent upon the date in which it was recorded due to seasonal variability. Additionally, attributes such as pH, SC, and DO can differ naturally because of the complexity of wetland systems (MPCA, 2005). According to MPCA (2015) for the Mixed Wood Plain (MWP) ecoregion, the averages for all years sampled of the following chemical parameters fall into Stressor Level Categories (relative to other regional reference sites): NO3+NO2 (low); TKN (high); TP (high); Cl- (high); and SO4 (low) (Tables 3-2 and 23-5).

Table 23-4: Sonde data for Zittels wetland (2009, 2013).

Sample Date/Time	Water Temperature (°F)	pH	Specific Conductivity (µS/cm3)	DO (%)	DO (mg/L)
07/02/2009 --:--	66.15	8.2	805	71.0	6.52
07/16/2009 12:45	75.00	8.5	1020	132.6	11.18
07/29/2013 13:45	-	-	-	-	-

Table 23-5: Water chemistry data for Zittels wetland (2009, 2013).

Sample Date/Time	Chl-a (µg/L)	Ortho-P (mg/L)	TP (mg/L)	TKN (mg/L)	NO3 (mg/L)	NO2 (mg/L)	Cl- (mg/L)	SO4 (mg/L)	Turbidity (NTU)
07/16/2009 12:45	-	0.071	-	-	0.05	0.03	216.0	-	-
07/24/2013 13:25	570.0	0.083	6.340	43.0	0.05	0.03	59.2	1.9	850
Average	**570.0**	**0.077**	**6.340**	**43.0**	**0.05**	**0.03**	**137.6**	**1.9**	**850**

(light blue)	Actual number less than value (<)
(grey)	Estimated concentration above the method detection limit and below the reporting limit (~)

24 CONCLUSIONS & RECOMMENDATIONS

24.1 CONCLUSIONS

The IBI results for 20 wetlands sampled in CRWD show a range of conditions, reflecting the many impacts of urbanization on wetland health. From 2007 – 2014, all of the sampled wetlands were assessed as either poor or moderate condition. None of the sampled wetlands received an excellent condition rating. These IBI assessments and results have allowed the District to determine the baseline condition of area wetlands based on at least two years of macroinvertebrate and aquatic plant sampling (with the exception of Alta Vista and Exxon-Mobil wetlands, which were only monitored once).

The 2007 – 2014 wetland IBI results showed several outcomes. For all years and all wetlands monitored for macroinvertebrates, there were 27 sampling events that scored in the moderate condition, as opposed to 31 sampling events that scored within the poor condition category. Conversely, for all years and all wetlands monitored for aquatic plants, there were only 15 sampling events that scored in the moderate condition category, and 41 sampling events that scored in the poor condition. Therefore, macroinvertebrate communities showed more diversity and less impact than the plant communities in the CRWD wetlands that were sampled.

Arlington-Jackson and Woodview Marsh were the only two wetlands that scored in the moderate condition category for both IBIs for their historical averages (having been surveyed four and two times, respectively), indicating relatively high wetland health (Tables 4-1 and 4-2). Of the four times that Arlington-Jackson was sampled, it fell within the moderate condition category for both IBIs in 2007, 2012, and 2014. Woodview Marsh scored in the moderate condition for both IBIs in 2007, but not in 2013. In 2013 and 2014, Arlington-Jackson, Swede Hollow, Victoria B, Victoria-Roselawn, and Villa Park all scored in the moderate condition category for both IBIs. These results signify which wetlands are of higher quality in recent years, as well as which wetlands are of the highest quality historically.

In contrast, 9 of the 20 wetlands scored in the poor category for both plant and macroinvertebrate historical IBIs, indicating poor wetland health (Tables 4-1 and 4-2). These 9 wetlands are: Kmart, Western Ave, William Street Pond, Cottage Ave, Swede Hollow, Willow Reserve, Little Crosby Lake, Victoria B, and Sherren Street Pond. The remaining wetlands scored in the poor or moderate condition categories for either IBI.

Water chemistry samples (NO3+NO2, TKN, TP, Cl-, and SO4) from each CRWD wetland were reported and evaluated using MPCA Stressor Level Categories (low, medium, high) for the Mixed Wood Plain ecoregion. Using this method of evaluation, chloride was the most significant stressor, with every wetland receiving a “high” category for average annual chloride concentration results. While chloride ranked as “high” for every wetland, the other parameters and their associated category varied by individual wetlands (e.g. "low" NO3+NO2 and "high" TP, or vice-versa). TKN and TP were generally "medium" stressor level categories. NO3+NO2 and SO4 were generally "low" stressor level categories. Swede Hollow was the only wetland to receive "high" stressor categories for all parameters, indicating very poor water quality in this wetland system.

In general, the gathering of baseline wetland IBI data and water quality data showed that wetlands within CRWD are highly impacted with lower species diversity and robustness. These impacts are likely due to watershed stressors introduced by intense urbanization, including the effects of surrounding land uses, stormwater inputs, and the lack of habitat connectivity. Data showed that the balance of the macroinvertebrate and plant communities varied by wetland, so further analysis should evaluate each wetland on an individual basis in order to better understand biotic diversity, stressors, and overall wetland health.

24.2 RECOMMENDATIONS

The goal of the CRWD wetland monitoring program is to establish baseline quality conditions of major wetlands in District and to document their health using IBI assessments in order to better understand each wetland's condition and to inform future wetland management decisions. It is recommended that the baseline wetland data reported herein be utilized to meet those goals. Additionally, this report can be used to better understand and define the services provided by CRWD wetlands, including: the biological function of wetlands; environmental services provided by wetlands; and the human health value of wetlands.

The data reported herein may also be utilized in the District planning process to answer the following questions:

1. Would any CRWD wetland(s) benefit from maintenance or restoration?

2. How does CRWD want to manage District wetlands?
    a. For biological function, environmental services, human health, or all?
    b. What are priority management strategies?

3. How can CRWD better manage wetlands to help achieve the District's overall goal of protecting, managing, and improving the water resources of CRWD?

Finally, it is recommended that CRWD continue wetland monitoring efforts to assist in answering questions regarding the management of District wetlands.

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APPENDIX A:
MPCA MACROINVERTEBRATE COMMUNITY SAMPLING PROTOCOL FOR DEPRESSIONAL WETLAND MONITORING SITES

MACROINVERTEBRATE COMMUNITY SAMPLING PROTOCOL FOR DEPRESSIONAL WETLAND MONITORING SITES

I. PURPOSE

To describe the methods used by Minnesota Pollution Control Agency's (MPCA) Biological Monitoring Program to collect macroinvertebrate community information at wetland monitoring sites for the purpose of assessing water quality and developing biological criteria.

II. SCOPE/LIMITATIONS

This procedure applies to all monitoring sites for which an integrated assessment of water quality is to be conducted. An integrated assessment involves the collection of biological (macroinvertebrate and plant) and chemical data to assess wetland condition.

III. GENERAL INFORMATION

Sites may be selected for assessment for a number of reasons including: 1) sites randomly selected for condition monitoring as part of the Environmental Monitoring and Assessment Program (EMAP), 2) sites selected for the development and calibration of biological criteria (e.g., Index of Biological Integrity), and 3) sites selected to evaluate a suspected source of pollution.

IV. ACTION STEPS

A. Field Sampling

For sampling wetland macroinvertebrate assemblages a seasonal index period of June - early July is preferred, this can be earlier if spring temperatures are unusually high that year. In previous wetland work, Minnesota Pollution Control Agency (MPCA) researchers found that some of the invertebrates were too immature to identify when sampled in May, especially the dragonfly nymphs. The sampling window was therefore moved forward to June. In stream invertebrate work, the sampling is done in September to ensure base flow conditions, and to obtain a relatively high percentage of mature larval invertebrates. This approach does not work for wetlands because: a) the wetlands may be dry or unsampleable later in the field season, and b) the wetlands will be heavily colonized by invertebrates which have immigrated into them from other waterbodies. In the latter situation, the invertebrate community in September may be less reflective of the water quality of the wetland itself than the invertebrate community in early summer.

Currently the MPCA has emphasized depressional wetlands in their development of invertebrate indices of biotic integrity (IBI). Depressional wetlands can be stratified into nearshore emergent (shore to 1 m water depth), deep emergent (> 1m water depth), and open water submergent vegetation zones. The MPCA has focused on the nearshore emergent vegetation zone for developing the invertebrate index of biological integrity. In this zone there is a high richness and abundance of invertebrates, including the large predatory insects, due in part to the decomposing vegetation and diverse vegetative microhabitats which occur in this zone. Sampling is conducted in areas that are representative of the wetland emergent zone. However, field partitioning of the wetland for invertebrate sampling as above may need to be modified as the MPCA expands assessment to other wetland types (e.g., riparian, forested).

Sampling of invertebrates by the MPCA Biological Unit is restricted to macroinvertebrates, excluding ostracods and the smaller microinvertebrates which are not retained by a U.S. Standard No. 30 sieve (28 meshes per inch, 0.595 mm openings). Macroinvertebrates are collected in the field using two sampling techniques: dip nets and activity traps. Previous MPCA projects (e.g., Helgen et al. 1993) demonstrated that dip net sampling captures the greatest richness of invertebrates, but the actively swimming or night-active predators may be under-collected by this method. Therefore, activity traps are placed in the wetland for two days to collect the active swimmers (see details below). Previous work by MPCA (Helgen et al. 1993) has shown reduced taxa richness in benthic, or bottom samples taken with core tubes and subsequently this method of sampling is not currently in use.

Dip Net Sampling
Two samples are collected from each wetland using a heavy-handled D-frame aquatic dip net with a 600 micron mesh size (Wildlife Supply Company). The two samples are taken in different areas within the same general location of the nearshore emergent vegetation zone and are not intended to be replicates, but rather are done to sample the wetland more widely. Ultimately, the data from the two samples are combined for purposes of calculating IBI metric scores. Each dip net sample consists of two dipnetting efforts composited into one sample. Each effort consists of sweeping the dip net strongly a few times (3 -5 depending on the density of the vegetation), reaching outward and pulling towards the body in a rapid motion. Each sweep should be through the water column and vegetation downwards to near the bottom. If mud is scraped into the net, the sample should be discarded and the sampling effort must be repeated in an area away from the previous netting, after the net has been cleaned out.

A method utilized by MPCA reduces the amount of time associated with separating invertebrates from the vegetation that invariably gets swept into the dip net. This method involves the placement of the entire dip net contents on top of a framed ½ inch hardware cloth screen set over two small pans (Coleman cooler style) containing sieved water (Figure 1). The frame is placed so no open screen area projects beyond the pans of water below. This frame and pan setup is placed into a larger plastic pan (tote tray) which can be floated on the water. Over a period of ten minutes the vegetation is spread apart on the hardware cloth to allow the invertebrates to drop or crawl out into the pans below. After ten minutes a second dipnetting effort is done in a nearby area, the vegetation from the first dip net effort is removed, and the second net's contents are placed on the cleared screen. The spreading process is repeated for about 10 minutes, after which the vegetation is again discarded.

After both sweeping efforts are completed, the contents in the two small pans are poured through a 200 micron nytex nylon net sieve to drain out the water. The sieve is made with 15 cm length of 4" diameter PVC pipe with the net glued on one end with a ring of the PVC. The 200 micron sieve is used to retain the chironomids dislodged from the vegetation. The contents of the sieve is back-flushed with 100% alcohol with a strong squirt-bottle into a sample jar, thus combining the two dip net efforts into one dip net sample. The goal is to end up with 80% alcohol final concentration. Care must be taken to represerve samples containing a large catch of invertebrates, or to divide the sample between two jars (sample #, jar 1 of 2, jar 2 of 2). The jar should have not more than 1/3 volume of invertebrates to alcohol. Sixteen-ounce plastic jars with foam or polypropylene seals are useful for preservation in the field. Labels made with India ink or pencil on 100% cotton paper or other material known to survive the preservatives are placed within the jar. Any label placed on the outside of the jar is only for convenience in managing samples.

Activity Trap Sampling
The activity traps work as passive funnel traps to collect organisms that swim into the funnel and pass through the neck into the bottle. Made from clear 2-liter plastic beverage bottles obtained from the manufacturer free of labels or opaque parts, the traps are nearly invisible underwater. The top of the bottle is cut cleanly with a hot wire at the shoulder and inverted into the bottle. The bottle traps used by the MPCA are designed with four two inch grooves cut in to the funnel edge by a hot wire to allow the funnel to snap into the bottle opening without the use of clips or visible straps (Figure 2). The traps are supported on a 4 ft ½" dowel, or a 4 ft fiberglass electric fence post, and attached with a flexible half section of 3" thin wall PVC pipe which allows raising or lowering the activity trap on the dowel (Figures 2 & 3).

Ten activity traps are placed in each wetland for two consecutive nights within the nearshore emergent vegetation zone. The ten activity traps are set out in pairs with each trap in a pair located approximately 3 - 4 meters apart. In the shallowest water (15 cm) the traps are placed just under the surface of the water, but

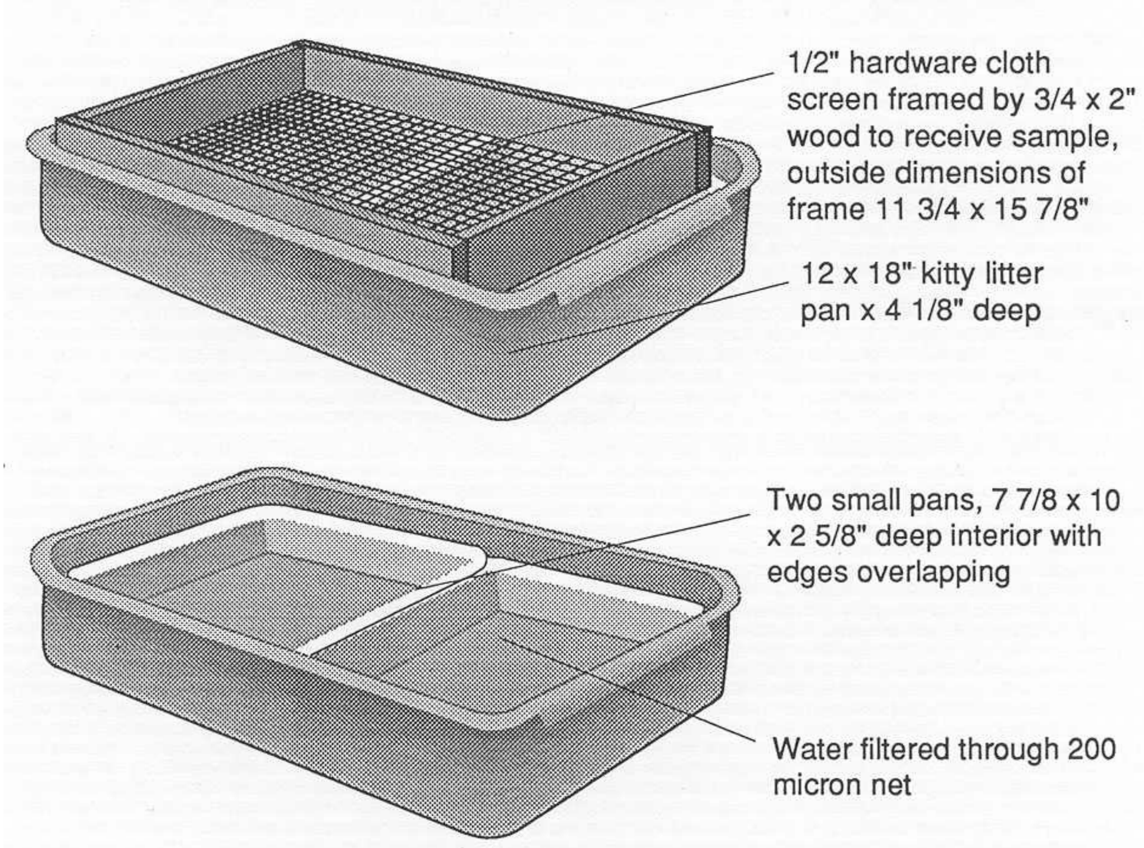

Figure 1. Diagram of hardware cloth and tray apparatus for separating invertebrate specimens from vegetation collected in dip net samples.

should not be resting on the bottom to avoid filling the bottletrap with sediment. In deeper water (> 50 cm) traps are placed horizontally about 15 - 20 cm under the surface. Traps are not placed at the deeper edge of the vegetation in the open water area because capture efficiency goes down as the water gets deeper. The traps are backfilled with water leaving no air bubbles inside in order to reduce predation within the trap. The wingnut should be tightened enough so the trap remains horizontal (see Figure 3a).

After the required two-night period the traps can be collected by slightly loosening the wingnut in order to rotate the trap to a vertical position and slide it up the dowel by slightly compressing the dowel clamp. Then the funnel is removed and the contents of the trap are poured through the 200 micron sieve. The trap is squirted with tap water and the inside is rubbed to dislodge leeches and other invertebrates. Specimens attached to both faces of the funnel opening are also considered part of the sample. These dislodged specimens are then added to the contents of the sieve. The second trap of the pair is collected and its contents are poured into the same sieve. The sieve is back-flushed into a sample jar with 100% alcohol to a final concentration of 80%. Care must be taken to represerve samples having a large catch of invertebrates, or divide the sample between multiple jars (sample #, jar 1 of 2, jar 2 of 2, etc.). The jar should have not more than 1/3 volume of invertebrates to alcohol. Sixteen-ounce plastic jars with foam or polypropylene seals are useful for preservation in the field. Labels with India ink or pencil on 100% cotton paper or other material known to survive the preservatives are placed within the jar. Any label placed on the outside of the jar is only for convenience in managing samples.

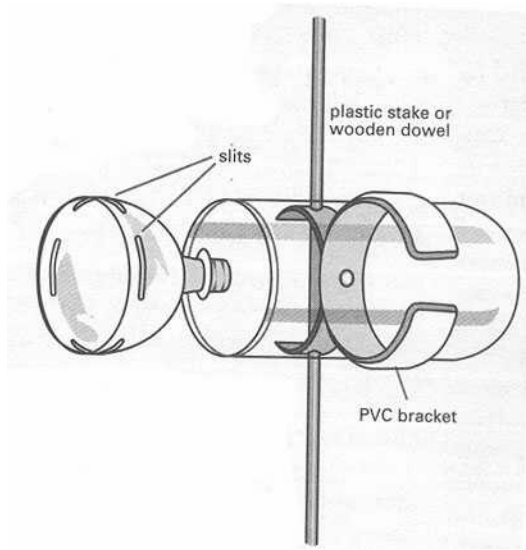

Figure 2. Activity trap design illustrating adjustable PVC bracket and funnel grooves.

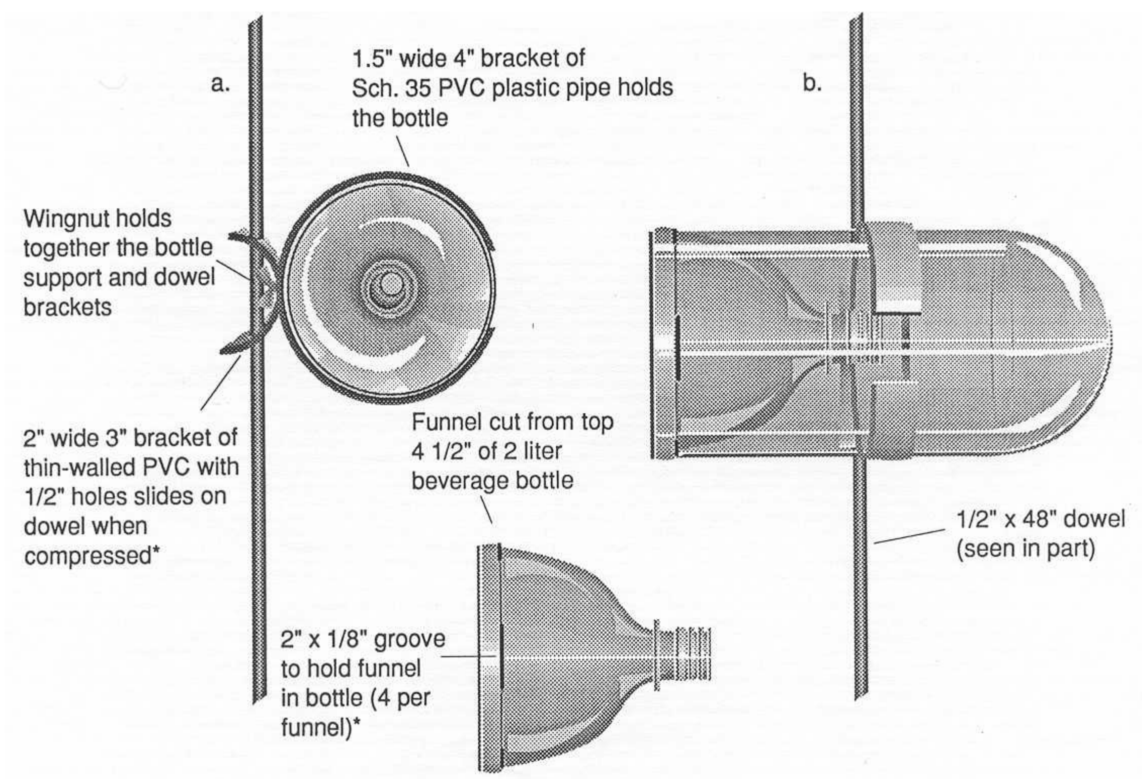

Figure 3. Activity trap design illustrating a) view into funnel and b) lateral view.

B. Sample Storage and Maintenance

All preserved samples are kept in a hazardous materials room. They are checked within a week of field sampling and then periodically for adequate preservative volume, and represerved with 80% alcohol as necessary. For samples that require additional alcohol the lids are tightened or replaced in order to prevent further evaporation.

C. Sample Processing

A combination of dissecting microscopes and compound microscopes are used for sorting and identifying macroinvertebrates in the laboratory. At MPCA there is one Olympus SZX microscope, one Olympus SZH, two Olympus SZ40 microscopes, and one Olympus BX40 compound microscope. The procedures for sorting invertebrates from dip net and activity trap samples are outlined in Table1.

Sample Identifications
Organisms are identified to the lowest possible taxonomic level. Typically this is to the genus level though often it is to the species level, at a minimum they will be identified to the taxonomic level as designated for each group in Table 2. Once specimens are sorted according to the guidelines listed in Table 2, identifications are then made for each specimen within the sorted groups. Identifying all the specimens in a

Table 1. Sorting protocol for dip net and activity trap macroinvertebrate samples.

Procedure	Comments
1) Note start time and site information on to data sheets.	Check/retain inner label.
2) Pour the sample into sieve and rinse with tap water.	Collect, cover, and save alcohol for re-preservation
3) Backflush sample with water to glass picking tray. Tray should be placed over grid transparency upon light box.	Generally, sample is large, and must be separated into two or more efforts to accommodate picking and accuracy.
4) Fill glass tray slightly (1 cm) with water. This helps to separate organisms from debris.	Gentle stirring/probing sample also helps dislodge critters from debris.
5) Using forceps, pick entire sample to sorting trays, jars, and petri dishes according to taxa list (Table 2). Be sure to keep record of separate taxa on mechanical counter. Properly fill in lab sheets.	Pick, count, and visually ID according to taxa List (Table 2). A magnifying lamp may be beneficial for small organisms and juveniles.
6) Specimens may then be combined in general groups (dragons/damsels, snails/sphaeriidae, etc.) and placed into vials/jars with proper labeling for later identification. Preserve in 80% ethanol.	Grouping conserves resources. Label should contain site, date, collector, and sample type written in pencil on cotton stock.
7) Replace original label and sample remnant to sample jar. Backflush using 80% alcohol and fill using previously saved alcohol.	Be sure to check prior alcohol for strength.
8) Note end time on datasheet. Calculate total time.	Calculate in hourly increments.

group (e.g., dragonflies) at the same time facilitates proper designations (e.g., species or genus) by allowing comparisons of closely related taxa. References containing the taxonomic keys for identifications are provided in Appendix A. Where ambiguity exists, specimens will be set aside for identification by an independent invertebrate taxonomist (also see *Reference Collection* section).

Table 2. Invertebrate taxa list indicating which groups are counted and identified for each sample type (dip net or activity trap) and the taxonomic resolution for each group.

	Activity Trap		**Dip Net**		**Identify to**
Group	**Total**	**Picked**	**Total**	**Picked**	
[3] Amphipoda (Ad)	x	x	x	x	Genus
[3, 4] Amphipoda (Juv, < 3mm)	x		x		Lowest Level
Anisoptera (Larvae)	x	x	x	x	Genus
Anostraca	x	x	x	x	Genus
[2] Chironomidae (Larvae)			x	x	*
[2] Chironomidae (Larvae, < 3mm)			x		*
Coleoptera (Ad)	x	x	x	x	Genus
Coleoptera (Larvae)	x	x	x	x	Genus
[3] Conchostraca	x		x	x	Genus
[1] Corixidae (Ad)	x	x	x	x	Genus
[1, 3, 4] Corixidae (Juv.)	x		x		Family
Diptera (Larvae)	x	x	x	x	Genus
Ephemeroptera (Larvae)	x	x	x	x	Genus
Gastropoda (Ad)	x	x	x	x	Species
[3] Gastropoda (Juv.)	x		x		Genus
Hemiptera (Ad)	x	x	x	x	Genus
Hemiptera (Juv.)	x	x	x	x	Lowest level
Hirudinea (Ad)	x	x	x	x	Species
Hirudinea (Juv.)	x	x	x	x	Lowest level
Isopoda (Ad)	x	x	x	x	Genus
Isopoda (Juv.)	x	x	x		Lowest level
Lepidoptera (Larvae)	x	x	x	x	Genus
Malacostraca	x	x	x		Family
Megaloptera (Larvae)	x	x	x	x	Genus
[1, 3] Neoplea (Ad & Juv.)	x		x		Genus
[3] Sphaeriidae (Ad & Juv.)	x		x	x	Family
Trichoptera (Larvae)	x	x	x	x	Genus
Zygoptera (Larvae)	x	x	x	x	Genus

[1] Represents Corixidae & Neoplea which were counted/recorded separately from other Hemiptera.
[2] Chironomidae Ids are done on dip net samples only. Estimate abundance of chironomids in activity traps.
[3] Represents groups that may be counted within the glass tray.
[4] Represents group that may be sub-sampled in high numbers.
* Identifications made by Dr. Len Ferrington (University of Minnesota).

Reference Collection
A macroinvertebrate reference collection is maintained for each project at the MPCA Biomonitoring Laboratory (St Paul Office). This collection consists of specimens of each type of macroinvertebrate that has been collected for individual projects conducted by MPCA staff. A few specimens of each taxon are placed in vials or small jars which are labeled inside for the taxon, date, and collection site. This collection will be reviewed by other biologists to confirm the identifications for each project. Specimens for which the identification is uncertain will be reviewed by other biologists with expertise in the particular group.

D. Quality Assurance

At least ten percent of the sites for each project are sampled twice, either on the same date or within a week in an area that is equally representative of the wetland as was first selected for sampling. At least ten percent of the samples are repicked. If organisms were missed, the entire set of samples is repicked. At least ten percent of the picked samples will be reviewed by a qualified invertebrate biologist to verify identifications. In addition, the reference collection from the project will be reviewed by a qualified invertebrate biologist to verify identifications. Chironomidae will be identified by a specialist in the taxonomy of the group (Dr. Len Ferrington, University of Minnesota).

Data is recorded on standard hard copy lab and field data sheets (see Appendix B for examples). These data sheets and field notebooks will be copied and stored in a separate place. In addition, data from each project will be stored and maintained within a Microsoft® Access database that resides on the MPCA network drives and is normally backed up each night.

Following data input all entries are completely proofed before data analysis begins.

E. Literature Cited

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Appendix A: Taxonomic References for Identifying Invertebrates

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Appendix B: Field and Lab Data Sheets

MPCA Wetland Monitoring Program

WETLAND INVERTEBRATE VISIT FORM

Wetland Name:		**Date:**
Field Number:	**County:**	**Crew:**

COORDINATES	LATITUDE	LONGITUTDE	TYPE OF GPS
Field GPS:	______°______’ ____.____“	______°______’ ____.____“	□ 2D □ 3D

GPS TIME	PDOP	ROV. FILE #

BOTTLE TRAP PLACEMENT	DIPNET SAMPLE
□ **Bottle Traps Placed** **TIME:** Traps place by: **DATE:**____/____/____ **TEMP:**	□ **D-net Sample Taken** **TIME:** D-net taken by: **DATE:**____/____/____ **TEMP:**
Number of Bottle Traps Placed: ________	**Number of D-nets Taken:** ________

BOTTLE TRAP RETRIEVAL

Bottle Trap Sample #	# Jars per Sample
__________	__________
__________	__________
__________	__________
__________	__________
__________	__________

D-net Sample #	# Jars per Sample
__________	__________
__________	__________

SAMPLE SITE INFORMATION

Wetland Bottom: Firm Soft Mucky Help!!

Comments:

BT’s Had	None	Few	Some	Many
Tadpoles				
Minnows				

Salamander larvae--__________

Salamander adults--__________

Frog adults --------__________

Aquatic Veg:	None	Sparse	Moderate	Dense
Submerged				
Emergent				

Shoreline Veg: Grassy Shrubs Wooded Other

Comments:

Fish Species	Number

Weather: Sunny Partly-Cloudy Overcast Windy Calm Rainy

PHOTOGRAPHIC DOCUMENTATION

Looking left from BT’s: Frame Seg. # /

Looking opposite shore from BT’s: Frame Seg. # /

Looking right from BT’s: Frame Seg. # /

DIRECTIONS TO WETLAND / COMMENTS

WATER CHEMISTRY

DEPARTMENT OF HEALTH SAMPLES	FIELD MEASURMENTS
☐ Turbidity, 1 125ml, ** DO THIS FIRST **	☐ PH -----------------
☐ TSS and Chloride, 1 liter general	☐ Conductivity ------
☐ Calcium and Magnesium, 1 250 ml metals ☐ Preserved with HNO_3	☐ Field Turbidity ----
☐ Nitrogen and Phosphorus, 1 250 ml nutrient ☐ Preserved with H_2SO_4	☐ Water Temp--------
CHLOROPHYLL WATER/FILTER ----to be chilled in cooler, filtered and sent to MDH	

☐1 Liter amber glass bottle (or 1 liter general)

***Volume filtered--------------------------------

SKETCH OF WETLAND

Include roads used to access site, most convenient vehicle parking, location of bottle traps, location of dipnetting, any other relevant info.

Dipnet ID Sheet Pg 1			Analyzed By:		Date analyzed:	
Site Name and #:				ID Time DN1:	ID Time DN2:	
Sample Collection Date:			Count		Count	
Odonata	Genus		DN-1	Notes/jar/vial	DN-2	Notes/jar/vial
Dragonflies						
Damselflies						
Trichoptera (Caddisflies)						
	Genus		DN-1	Notes/jar/vial	DN-2	Notes/jar/vial
Ephemeroptera (Mayflies)						
	Genus	species	DN-1	Notes/jar/vial	DN-2	Notes/jar/vial
Hirudinea (Leeches) For Glossiphonidae try to identify species.						
	Genus	species	DN-1	Notes/jar/vial	DN-2	Notes/jar/vial
Gastropoda (Snails) Try to identify to species. Counts are given for mature specimens (3-4 whorls)						
	Genus	species	DN-1	Notes/jar/vial	DN-2	Notes/jar/vial

APPENDIX B: MPCA AQUATIC PLANT COMMUNITY SAMPLING PROCEDURE FOR DEPRESSIONAL WETLAND MONITORING SITES

AQUATIC PLANT COMMUNITY SAMPLING PROCEDURE FOR DEPRESSIONAL WETLAND MONITORING SITES

I. PURPOSE

To describe and document the standard operating procedure (SOP) used by the Minnesota Pollution Control Agency's (MPCA) Biological Monitoring Program to collect aquatic plant community information at depressional wetland monitoring sites for the purpose of assessing water quality and developing biological assessment criteria.

II. SCOPE/LIMITATIONS

The following SOP applies to all depressional wetland monitoring sites for which an integrated assessment of water quality is to be conducted. An integrated depressional wetland assessment involves the collection of biological (macroinvertebrate and plant) and chemical data to assess wetland condition. The MPCA defines depressional wetlands as wetlands that occur within a shallow depression in the landscape that are not directly associated with streams (i.e., riparian wetland) or lakes (i.e., lacustrine fringe wetland); have a semi-permanent to permanent flooding regime (i.e., not temporarily flooded wetland or vernal pool); and have predominantly emergent marsh to shallow open water (aquatic) vegetation types (Eggers and Reed 1997). This combination of water regime and vegetation communities corresponds to U.S. Fish and Wildlife Service (US FWS) Circular 39 wetland types 3, 4, and 5 (Shaw and Fredine 1956).

III. GENERAL INFORMATION

Sites may be selected for assessment for a number of reasons including: 1) sites randomly selected for ambient condition monitoring, 2) sites selected for the development and calibration of biological criteria, 3) sites selected to evaluate a suspected source or result of pollution impacts, and 4) wetland management/restoration/remediation effectiveness monitoring. Although the reasons for monitoring a site may vary, the aquatic plant sampling protocol described in this document applies to all MPCA wetland monitoring sites unless otherwise noted.

IV. PERSONEL REQUIREMENTS

A. Field Crew Leader: The field crew leader must be a professional aquatic biologist with a good knowledge of the Minnesota wetland flora. He or she must have a minimum of a Bachelors degree in aquatic biology, botany, or a closely related field; and have a minimum of six months field experience in wetland plant sampling and plant identification. Field crew leaders should also be proficient with map reading and orienteering; using both Global Positioning System (GPS) and compass.

B. Field Assistant/Intern: The field assistant/intern must have at least one year of college education and an interest in aquatic biology. Coursework in environmental, natural resource, and/or biological science is preferred.

C. General Qualifications: All personnel conducting this procedure must have the ability to perform rigorous physical activity in an outdoor setting; be capable of lifting up to 50 lbs. of sampling equipment; be able to travel up to four nights per week during the summer months; and maintain a positive attitude within a team setting.

V. RESPONSIBILITIES

A. Field Crew Leader: The field crew leader is responsible for implementing the action steps of the procedure and ensuring that the data generated meets the standards and objectives of the Biological Monitoring Program and the MPCA. In addition, the field crew leader is responsible for planning sampling activities and ensuring that MPCA policies are followed during all sampling activities.

B. Field Assistant/Intern: The field assistant/intern is responsible for implementing the action steps of the procedure; including the maintenance, stocking, and storage of sampling equipment, data collection, and data recording.

VI. TRAINING

All personnel will receive instruction from a trainer designated by the program manager. Major revisions in this protocol require that all personnel that apply this procedure on behalf of the MPCA Biological Monitoring Unit be re-trained in the revised protocol by experienced personnel. The field crew leader will provide additional instruction to the field assistant/intern and will be responsible for monitoring the performance of the field assistant/intern throughout the field season.

VII. ACTION STEPS

A. Equipment Check: Before heading out into the field, check all equipment and supplies necessary to complete this procedure is present and in proper working condition (Table 1).

B. Field Sampling: The wetland vegetation biological assessment techniques employed by the MPCA (i.e., Index of Biological Integrity; Gernes and Helgen 2002, Genet et al. 2006) require data on the different kinds of plants growing in a wetland and how abundant those plants are. The vegetation sampling technique described in this procedure is adapted from what is known as releve sampling. Releve sampling was developed by Braun-Blaunquet in Europe and is currently being used by the Minnesota Department of Natural Resources (DNR) County Biological Survey and Natural Heritage Programs (Almendinger 1987). Essentially, releve sampling relies on the observer to select areas within the desired community that are representative of the overall community composition to place a sampling plot where plant data can be quantified.

Table 1. Equipment List-This table identifies all the equipment needed to complete the MPCA wetland vegetation sampling protocol.

Equipment	Purpose	Operation Check
Personal Data Assistant (PDA)	-Field data recording device	-Software function -Date and time -Associated cords and devices
Global Positioning System (GPS)	-Navigation and sample location recording	-Date and time -Correct coordinate system and datum -Associated cord
Laptop Computer	-Downloading and data storage -GIS applications	-Software function -Associated cords and devices -Power inverter
Digital Camera	-Photographic site documentation	-Memory card(s) -Associated cords -Date and time
Cell Phone	-Communication	-Associated cord
4-8Rechargeable AA Batteries & Charger	-Spare batteries for GPS and digital camera	
Site Files and Maps	-Site location information	
Paper Data Sheets & Clipboard	-Backup in case of PDA failure	
Field Notebook	-Recording misc. notes, backup for recording data	
6 Tall Garden Stakes	-Sampling plot corner posts, 2-spares	
4 50 m Measuring Tapes	-For laying out sampling plots, 2-spares	
Chest Waders	-To keep field workers dry	
Raingear	-To keep field workers dry	
Field Guides	-Aid with plant identification	
Hand Lens	-Aid with plant identification	
1-2 Gallon Size Plastic Bags	-For collecting plant specimens	

Table 1. Equipment List-Continued.

Equipment	Purpose	Operation Check
Cooler with Ice	-Short term preservation of water quality samples (*see Wetland Water Chemistry SOP*) and plant specimens	
Plant Press with Newsprint, Blotters, & Cardboard	-For pressing plant specimens	
Wax Paper	-Aid with pressing aquatic plant specimens	
Shallow Pan	-Aid with pressing aquatic plant specimens	
Compass	-Navigation & sampling plot layout	
Pencils	-For recording data	
Permanent Marker	-For labeling bags & water samples (*see Wetland Water Chemistry SOP*)	
First-Aid Kit	-Emergency medical care	

Since 2001, the MPCA has been collecting field plant data using a hand held Personnel Data Assistant (PDA). This has reduced the amount of time recording data in the field, increased data quality control, and also reduced the time needed to produce sample results. Field data sheets continue to be maintained, however, as a backup to the PDA and are included at the end of this SOP. The MPCA is currently using Trimble Recon™ PDAs with a custom data recording application adapted from the field data sheets and built-in GPS receivers.

B.1. Record visit information: Upon arrival at a site begin recording visit information on the Visit Data Sheet (*attached at the end of this SOP*) or PDA. Record the **Site Name**, **Date**, **Surveyor Name**, and **Arrival Time** immediately. Also, document weather conditions in the **Weather Notes** space.

Throughout the remainder of the visit (i.e., during or following vegetation sampling), record other visit or site level data as appropriate. Document any site photographs in the **Photo Information** section. Record the **Camera Make and Model** used for the visit and the **Photo Number** reported from the camera and any associated **Photo Notes** for each photograph taken. Collect water chemistry measurements and samples (*see Depressional Wetland Water Chemistry SOP*), and record information in the **Water Chemistry** section. Also during the visit, conduct a site stressor verification assessment. Do this by walking around the margin of the wetland, noting any anthropogenic stressors that may be impacting the wetland. Complete the **Habitat Alteration**, **Hydrologic Modification**, and **Sedimentation** checklists in the **Site Stressor Verification** section as you proceed. Site stressor information is necessary for developing a Human Disturbance Score (HDS; Gernes and Helgen 2002) for the site. A brief site stressor assessment may have been completed during the initial site reconnaissance (*see Wetland Site Reconnaissance SOP*). The purpose of the site stressor verification during vegetation sampling is to assess the wetland more thoroughly and add to any information gathered during the site reconnaissance. Finally, record the **Leave Time** (site departure time) when all of the data have been collected.

B.2. <u>Determine the major plant communities in the wetland</u>: The releve sampling method relies on the observer finding a 'representative' location in the wetland that best characterizes the vegetation of the entire wetland to place the sampling plot(s). The first step in this procedure then is to determine what the major plant communities in the wetland are. This can be done by finding an area where the entire wetland can be viewed or by walking around the margin of the wetland.

B.3. <u>Establish the sample location</u>: After the major plant communities have been identified, determine a location where the sampling plot(s) can be placed that would best capture or represent the vegetation types found in the wetland. Typically, this is at the emergent/aquatic vegetation interface (Figure 1). If the wetland has predominantly emergent vegetation, locate the sample plot(s) in the wettest location of the wetland. If there is not an extensive emergent community present, locate the sampling plot(s) where the emergent community should be.

B.4. <u>Determine the plot size and shape</u>: Over the course of the development of wetland vegetation monitoring at the MPCA, the sampling methods have evolved to better characterize wetland vegetation and increase the performance of the assessment indicators. Because of this evolution, a variety of sampling plot sizes and shapes have been, and continue to be, employed with this procedure. Historically, the MPCA used a single large sampling plot to characterize an entire wetland. The size of the plot was standard (100 m^2), but the shape was either square (10 m x 10 m) or rectangular (5 m x 20 m). The 10 m x 10 m plot was used when a wide and well developed emergent vegetation fringe was present. The 5 m x 20 m plot was employed when only a narrow emergent vegetation fringe was present to better capture the emergent/aquatic vegetation interface. More recently, the MPCA has investigated alternative sample techniques. During the 2003 field season, a methods comparison was undertaken comparing the use of the large single plot versus a set of four small (5 m x 5 m) plots sampling technique (Genet et al. 2005). In this scenario the four small plots survey the same area (100 m^2) and together are considered to be a single wetland vegetation sample. The four small plot technique was found to approximately double IBI precision in the North Central Hardwood Forest Ecoregion (Figure 2) and it was decided that it should be adopted as the primary MPCA sampling method. IBI development data for the Northern Lakes and Forest Ecoregion was collected using the four small plot technique in 2004. The same sampling comparison performed in the Northern Glaciated and Western Cornbelt Plains Ecoregions,

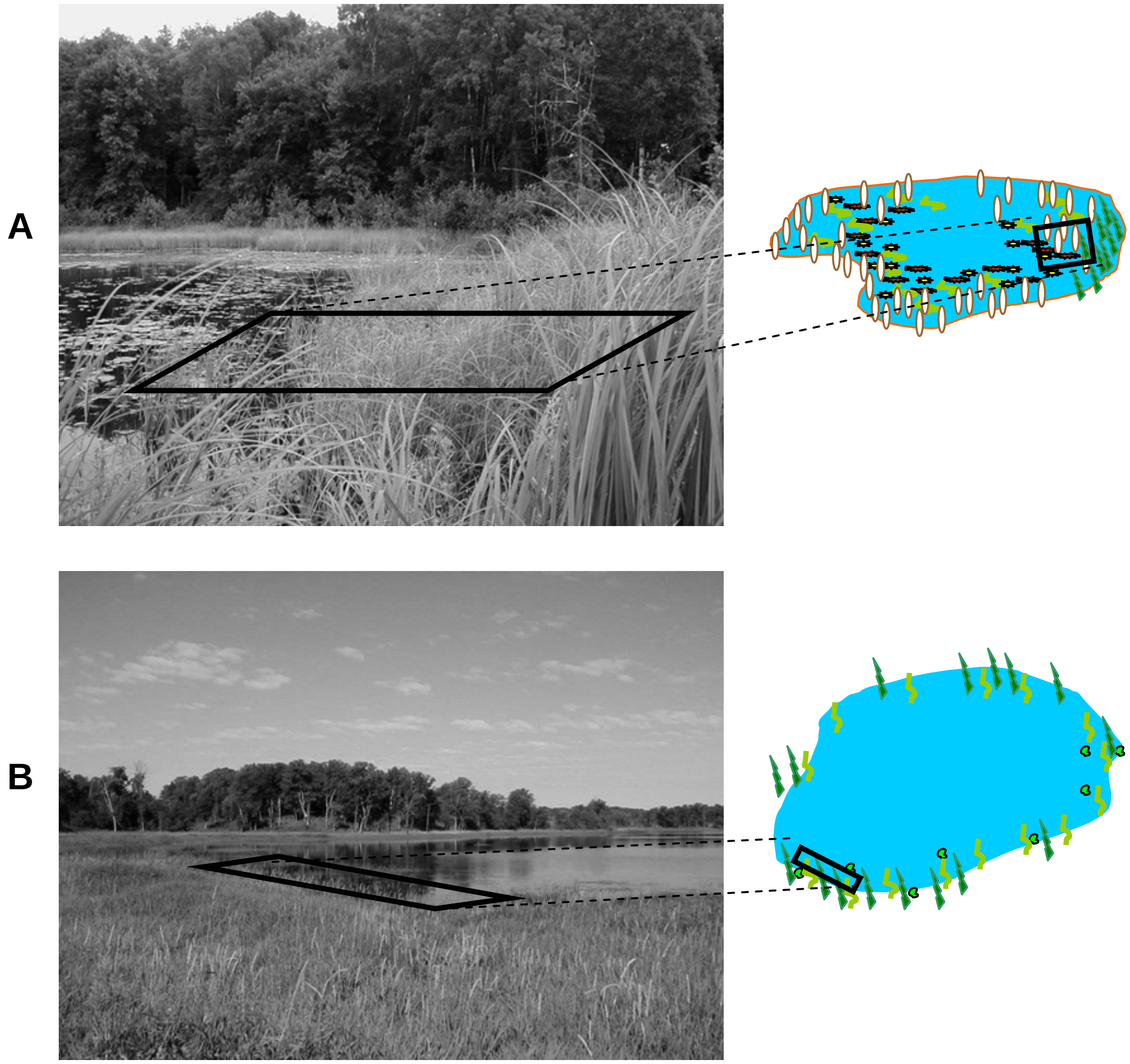

Figure 1. Hypothetical lay-out of a 10 m x 10 m (A) and a 5 m x 20 m (B) plot in two wetlands. In wetland A there is a relatively wide and diverse emergent wetland fringe. Wetland B, on the other hand, has a very narrow emergent fringe. In the diagrams on the right the symbols represent different vegetation communities. In both cases the plots are located at the emergent/aquatic vegetation interface to capture as many of the different vegetation types as possible.

however, did not improve IBI precision (Genet et al. 2006). The MPCA will continue to compare alternate sampling techniques, as we expand and refine wetland biological monitoring.

Ultimately, the sampling plot technique used to develop IBIs in the various Ecoregions of the state needs to be used for consistent application. The single large (100 m^2) plot size should be used for sampling in the North Central Hardwood Forest, Western Corn Belt, and Northern Glaciated Plains Ecoregions (Figure 2). The four small (5 m x 5 m) plot technique should be used in the

Northern Lakes and Forest Ecoregion. Depressional wetland IBIs have not yet been developed or adapted for the Red River Valley, Northern Minnesota Wetlands, and Driftless Area Ecoregions.

Once a representative plot location has been identified choose either the single sample plot or the four small plot sampling technique based on which Ecoregion in the state the wetland occurs (Figure 2). If the single plot technique is to be used, determine which plot shape (square or rectangular) is appropriate. As a general rule, only use the 5 m x 20 m rectangular plot shape when the emergent vegetation fringe is < 5 m wide from the upland boundary to the aquatic vegetation/open water boundary.

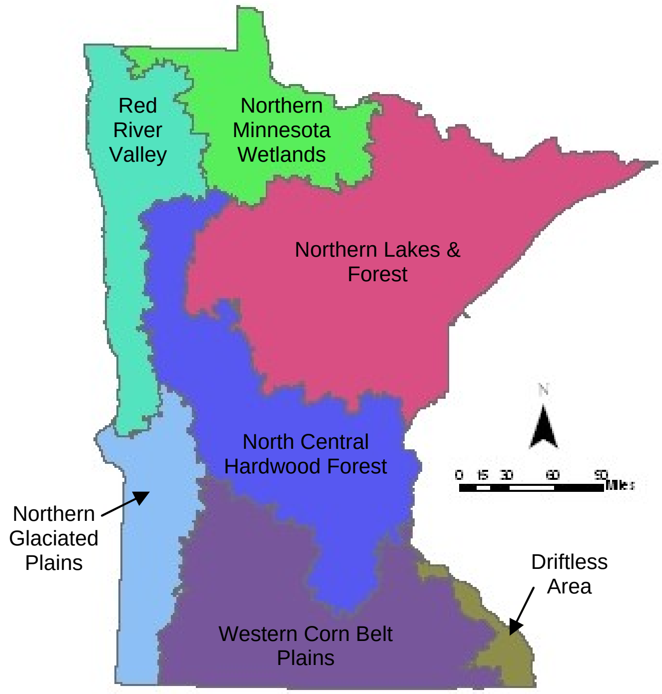

Figure 2. Level III Ecoregions in Minnesota (Omernik 1987). Use the 100 m^2 plot size in the North Central Hardwood Forest, Western Corn Belt Plains, and Northern Glaciated Plains Ecoregions and multiple 25 m^2 plots in the Northern Lakes and Forest Ecoregion.

B.5. Lay-out the plot: To lay-out a plot, first pick a point to be corner #1 and plant one tall gardening stake (Table 1) to mark the corner. Using a tape measure (Table 1), mark off the first side of the plot, according to the dimensions of the determined plot shape, holding the tape measure away from your body and walking outside of the plot area to avoid excessive trampling of the vegetation inside the plot. Stake this point (corner #2). Turn 90 degrees using a compass or best visual judgment, and measure out the second side to corner #3. Repeat these steps, establishing corner #4 and enclosing the plot with four sides. Adjust the corners and sides if necessary. The plot should capture the emergent/aquatic vegetation interface (Figure 1); therefore, a portion of the plot should be in each vegetation type.

B.6. Record releve information: Once a plot, or releve, has been established, begin recording releve level data in the Releve Data Sheet (*attached at the end of this SOP*) or PDA. If using the Releve Data Sheet, establish the **Releve Number** (this is done automatically in the PDA). The releve number consists of the date and time of the beginning of the releve and should have the following format: month/day/year-hours:minutes:seconds. Record the **Site Name**, **Surveyor's Name**, and **Date**. Determine the **Releve Result,** or use category of the data. A releve is: **Reportable** if the data in that releve will be used for the primary assessment for the site; **Replicate** if the data will be used to determine IBI variance (Genet et al. 2005), for QA/QC purposes, or for secondary assessment; and **Nonreportable** if the data will not be used for any assessment purposes or if the sampling procedures were unable to return a reliable sample. If the **Nonreportable** data use category is selected, document the reason the data should not be used for wetland assessment. Record the **Releve Shape**. If the releve is 5 m x 5 m, also record a **Sample** letter (beginning with A) and **Subsample** number (beginning with 1) for the releve. The **Sample** letter is needed to group multiple 5 m x 5 m plots (i.e., subsamples) together into groups of four. Determine and record the **Average**, **Maximum**, and **Minimum Water Depth** (cm) within the releve. Estimate the percent cover the genus ***Carex*** and **Open Water** occupies in the plot. **Open Water** is defined as standing water that does not have emergent or floating vegetation shading it. Record the approximate position of the releve with a handheld Global Positioning System (GPS) unit. Save the waypoint in the GPS with a file name that consists of the **Site Name** and the **Sample** and **Subsample** indicators (if necessary). If the site was named prior to 2003, use the first six characters of the site name and sample and subsample indicators (if necessary). If the site was named using the year/county/wetland number coding system adopted in 2003 and currently used, record the **GPS File Name** according to the following format: 2 digit year, first four letters of the county, 2 digit wetland number, sample letter (if necessary), and subsample number (if necessary).

Example: the **GPS File Name** for the third 5 m x 5 m plot of the second set of plots (sample) in the site named 04CASS011 should be- 04CASS11B3. If any photographs of the releve are taken, record the appropriate **Photo Info** in the space provided.

B.7. Identify plants within the plot: Next, inventory the plants within the plot. This is done by 'walking the plot' (Figure 3). Begin in corner #1 and walk just inside the plot toward corner #2. Identify and record plants to the lowest

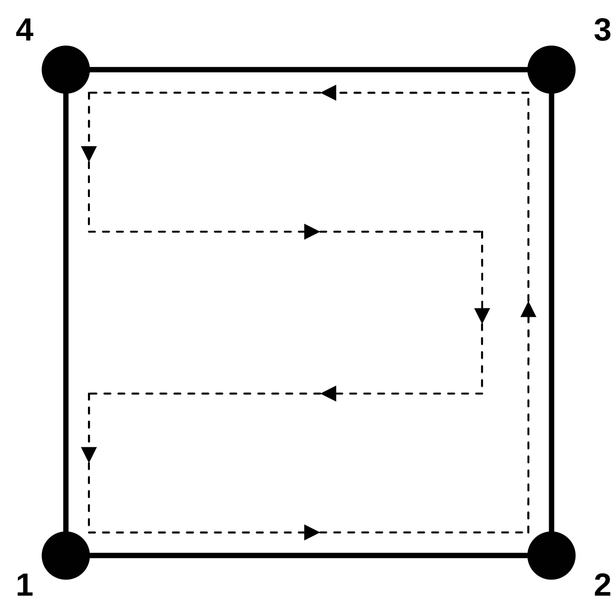

Figure 3. Walking the plot. Begin at corner #1 and follow the arrows until the entire plot has been observed.

taxonomic division possible in the **Species Info** section as you proceed. Continue around sides 2 and 3. After passing corner #4 go about 1/3 of the way of the remaining side of the plot and cut through to the opposite side to observe the vegetation in the interior. Once on the opposite side, proceed down another 1/3 of that side and cut through the plot again. Return to corner #1. In very dense emergent vegetation it may be necessary to do a third interior path to be able to observe the entire plot. For the 5 m x 20 m plot shape, 4-5 interior paths may be necessary to complete the plant inventory.

Record a **Reliability** code (Table 2) for each plant encountered to indicate the level of identification confidence. If there are multiple higher level taxonomic identifications in the same plot belonging to the same group, use the **tsnGroup** space to differentiate individual species (*see B.9*). If a plant is collected to be identified in the laboratory, mark the **Collected** box for that plant.

Table 2. Identification reliability codes.

Reliability Code	Description
7	Unknown
6	cf Genus
5	Genus certain
4	cf species
3	species complex
2	species certain
1	cf var/subsp.
0	variety/subsp. certain

B.8. Estimate cover: For each plant taxa encountered in the plot, estimate the percent cover (proportion of the plot area occupied by the taxa) using the cover class (**CC**) scheme given in Table 3.

B.9. Unknown plants: All plants encountered in the plot should be identified to its lowest taxonomic division possible. When a plant cannot be reliably identified to species in the field, the plant should be recorded using a standard naming convention and be collected for identification later in a laboratory.

The following notation convention should be used to record unknown plants: 1) the scientific name of the lowest known taxonomic division of the plant (e.g., Genus, Family, etc), and 2) a number corresponding to the number of different unknown plants from that taxonomic division encountered in a particular plot. Record the taxonomic division in the **Species Name** column and the number in the **tsnGroup** column.

Example: if one were to encounter an unknown species of the genus *Carex*, *Carex* should be recorded as the **Species Name** and a 1 should be recorded in the **tsnGroup** space. If a different unknown species of *Carex* is encountered in the same plot, the **Species Name** should be recorded as *Carex* and a 2 should be recorded in the **tsnGroup** space.

Table 3. Cover Classes and corresponding ranges of percent cover.

Cover Class (CC)	Percent Cover Range
8	95-100%
7	75-94%
6	50-74%
5	25-49%
4	10-24%
3	5-9%
2	2-4%
1	1%
0.5	0.1-0.9%
0.1	single/few

All unknown plants should be collected, pressed, and dried for positive identification in the laboratory. In the field, collect as much material as necessary, or possible, to facilitate identification of the plant and place in a plastic bag. Label the bag with: 1) the site name, 2) sample and subsample identifiers (if necessary), 3) plant unknown name (i.e., **Species Name** and **tsnGroup** number recorded), 4) date, and 5) collector name. Upon returning to the vehicle, immediately place collection bags into a cooler with ice and keep specimens cool until they can be pressed. Collected specimens must be pressed within 24 hours of collection.

It is unnecessary to collect a specimen for the same unknown taxa in each plot, if multiple plots are to be sampled at the same site, as long as the field crew leader is certain that the taxa is the same species and the naming convention is consistently applied at the site. For example, an unknown species of *Carex* is observed and collected in the first sampling plot. The very same *Carex* is observed in a replicate plot of the same site. It is not necessary to make an additional specimen collection if the crew leader is certain that it is the same species.

C. <u>Data and Equipment Security</u>: Immediately after each day of field sampling, the following actions must be taken to secure the data collected during field sampling and maintain sampling equipment for further use:

C.1. <u>Download Data</u>: Download any and all field data from the PDA, GPS, and digital camera onto the hard drive of the laptop computer. Make an additional copy of these files onto a portable memory source (e.g., ‘memory stick’, CD) to back up the files. Delete data as necessary on the individual units to reduce duplicate copies of data from downloading the same data multiple times.

C.2. <u>Press Collected Plant Specimens</u>: Specimens must be pressed within 24 hours of collection. Press specimens with a standard plant press that has cardboard ventilators, blotter paper, and newsprint. Each specimen should be placed in an individual piece of newsprint and labeled with the same label as the collecting bag (*see B.9*). Array the plant so that stems and leaves and any flowering or fruiting material are separated and clearly visible. Aquatic plants may require floating in a tray filled with water and arrangement on wax paper.

C.3. <u>Ship Water Chemistry Samples</u>: *See Depressional Wetland Water Chemistry SOP*.

C.4. <u>Equipment Assessment and Maintenance</u>: Assess and maintain sampling equipment as necessary. Clean soiled sediment tubes (*See Depressional Wetland Water Chemistry SOP*). Recharge any flat batteries. Organize, update, and maintain site files and maps. Dry and repair waders as necessary. Acquire fresh ice for cooler.

VIII. QUALITY ASSURANCE AND QUALITY CONTROL

Compliance with this procedure will be maintained through annual internal reviews. Technical personnel will conduct periodic self-checks by comparing their results with other trained personnel. Calibration and maintenance of equipment will be conducted according to the guidelines specified in the manufacturer's manuals.

In addition to adhering to the specific requirements of this sampling protocol and any supplementary site specific procedures, the minimum QA/QC requirements for this activity are as follows:

A. <u>Control of deviations</u>: Deviation shall be sufficiently documented to allow repetition of the activity as performed.

B. <u>QC samples</u>: Ten percent of sites sampled in any given year are re-sampled as a means of determining sampling error and spatial variability.

C. <u>Verification</u>: The field crew leader will conduct periodic reviews of field personnel to ensure that the procedures detailed in this SOP are being followed.

IX. LITERATURE CITED

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MPCA WETLAND VEGETATION VISIT DATA SHEET

Version 2.2 5/2006

Visit Information

Site Name:	Date:	Surveyors Name:	Arrival Time: Leave Time:

Weather Notes:

Site Notes:

Photo Information

Camera Make & Model:	Photo Number(s):	Photo Notes:

Water Chemistry

Field Measurements

	Reportable (A)	Replicate (B)
Temperature (C)	______	______
pH	______	______
Specific Conductivity	______	______
Dissolved Oxygen	______	______
Time of Measurement:	______	______

Water Grab Samples

Reportable (A)	Replicate (B)		Reportable (A)	Replicate (B)	
☐	☐	Turbidity (1:125 ml)	☐	☐	Calcium, Magnesium (1:500 ml)
☐	☐	Color (1:125 ml)	☐	☐	Preserved with HNO3
☐	☐	Chloride, Sulfate, TOC (1L general)	☐	☐	Nitrogen, Phosphorus (1:250 ml)
			☐	☐	Preserved with H2SO4

Sediment

Reportable (A)	Replicate (B)	
☐	☐	Sediment Sample

Water Chemistry Notes:

Site Stressor Verification

Habitat Alteration

(within wetland & 50 m of surrounding upland)

Checklist:

Wetland	Upland	
☐	☐	Mowing
☐	☐	Excessive herbivory
☐	☐	Shrub removal
☐	☐	Removal of woody debris
☐	☐	Removal of emerg. veg.
☐	☐	Vehicle use
☐	☐	Livestock hooves
☐	☐	Cultivation
☐		Microtopography altered
	☐	Tree plantation
	☐	Tree removal

Sedimentation

Checklist:

- ☐ Sediment deposits/plumes
- ☐ Eroding banks/slopes
- ☐ Turbid water column
- ☐ Soil disturbance in immediate upland (e.g., construction, cultivation)

Hydrologic Modification

Checklist:

- ☐ Ditch *inlet* *outlet* *both*
- ☐ Tile Drain # _____ *if multiple*
- ☐ Dredging
- ☐ Weir/Dam Type:__________
- ☐ Grading/Filling (in or near wetland)
- ☐ Stormwater input/culvert #_______*if multiple*
- ☐ Dike, berm or levee ______% of wetland edge
- ☐ Road or RR bed _____% of wetland edge
- ☐ Unnatural connection to other waterbody
- ☐ Source water change
- ☐ Drainage
- ☐ Dewatering in or near wetland
- ☐ Point source (non-stormwater)

Stressor Verification Notes

Sketch of Wetland

N

MPCA WETLAND VEGETATION RELEVE DATA SHEET

Version 2.2 5/2006

Releve Info

Releve Number:	Releve Result (circle one): Reportable Replicate Nonreportable
Site Name:	Releve Shape (circle one): 10 x 10 5 x 20 5 x 5
Surveyors Name:	Sample (letter): / Subsample (number; for 5 x 5 plot):
GPS File Name:	Water Depth (cm): Minimum ________ Average ________ Maximum _________
Photo Info: Camera Make & Model: Photo Number(s):	*Carex* Cover (%): _________ Open Water (%): _________
Releve Notes:	

Reliability Code

Code	Description
7	Unknown
6	cf Genus
5	Genus certain
4	cf species
3	species complex
2	species certain
1	cf var/subsp.
0	variety/subsp. certain

Cover Class (CC)

CC	Range
8	95-100%
7	75-94%
6	50-74%
5	25-49%
4	10-24%
3	5-9%
2	2-4%
1	1%
0.5	0.1-0.9%
0.1	single/few

Species Info

Species Name	tsn Group	Reliability	CC	Collected	Notes
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
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				☐	
				☐	
				☐	
				☐	
				☐	
				☐	

Species Info

Species Name	tsn Group	Reliability	CC	Collected	Notes
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
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APPENDIX C: MCES LAB PARAMETERS

Table A-1: Analysis Method, Reporting Limit, and Holding Times for Water Chemistry Parameters Analyzed by Metropolitan Council Environmental Services.

Parameter	Abbreviation	Method	Reporting Limit	Holding Time
Cadmium	Cd	MET-ICPMSV_5	0.0002 mg/L	180 days
Calcium	Ca	CA-MSV	1 mg/L	180 days
Carbonaceous BOD, 5 day	CBOD	BOD5_5	0.2 mg/L	48 hours
Chloride	Cl	CHLORIDE_AA_3	0.5 mg/L	28 days
Chlorophyll-a	Chl-a	CLA-TR-CS	1.0 ug/L	30 days
Chromium	Cr	MET-ICPMSV_5	0.00008 mg/L	180 days
Copper	Cu	MET-ICPMSV_5	0.0003 mg/L	180 days
Hardness	Hardness	HARD-TITR_3	N/A	28 days
Lead	Pb	MET-ICPMSV_5	0.0001 mg/L	180 days
Magnesium	Mg	MG-MSV	1 mg/L	180 days
Nickel	Ni	MET-ICPMSV_5	0.0003 mg/L	180 days
Nitrate as N	NO3	N-N_AA_4	0.01 mg/L	28 days
Nitrite as N	NO2	N-N_AA_4	0.003 mg/L	28 days
Nitrogen, Ammonia	NH3	NH3_AA_3	0.005 mg/L	28 days
Nitrogen, Kjeldahl, Total	TKN	NUT_AA_3	0.03 mg/L	28 days
Orthophosphate as P	Ortho-P	ORTHO_P_1	0.005 mg/L	48 hours
pH at 25 Degrees C	pH	pH by electrochemical pH probe	N/A	N/A
Phosphorus, Dissolved	Dissolved P	P-AV	0.02 mg/L	28 days
Phosphorus, Total	TP	NUT_AA_3	0.02 mg/L	28 days
Sulfate	SO4	SO4-IC	0.15 mg/L	28 days
Total Dissolved Solids	TDS	TDS180_1	5 mg/L	7 days
Total Suspended Solids	TSS	TSSVSS_3	N/A	7 days
Turbidity	Turbidity	TRB-NTRUN2	1 NTRU	48 hours
Volatile Suspended Soilds	VSS	TSSVSS_3	N/A	7 days
Zinc	Zn	MET-ICPMSV_5	0.0008 mg/L	180 days

APPENDIX D:
CRWD WETLAND WATER CHEMISTRY

Alta Vista

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/16/2009 12:15	-	-	0.014	-	-	-	-	0.05	0.03	-	-	-	25	21	-	64	36.0	-	-	-	-	-	-	-	-	-	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Arlington-Jackson

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
06/27/2007 14:30	-	-	0.008	-	0.100	-	0.8	-	-	-	-	-	16	5	-	80	40.0	-	-	-	-	-	-	-	-	-	-
08/16/2011 13:10	9.6	8.6	0.007	-	0.015	-	0.6	0.15	0.03	-	-	-	3	1	-	116	67.0	-	-	-	-	-	-	-	-	15.9	-
09/05/2012 10:45	-	3.2	0.015	-	0.100	0.080	1.0	0.32	0.10	0.35	2	190	9	-	-	97	36.8	-	-	-	-	-	-	-	-	19.4	-
06/24/2014 09:30	9.4	6.3	0.018	0.035	-	0.020	0.9	0.08	0.03	-	-	328	5	2	-	164	88.4							-	-	33.4	3.7

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Cottage Ave

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/15/2008 11:35	10.0	8.8	0.066	-	0.257	-	1.6	-	-	-	12	-	6	4	-	184	85.0	-	-	-	-	-	-	-	-	3.5	-
08/16/2011 12:31	1000.0	1100.0	0.028	-	3.450	-	23.0	0.05	0.03	-	-	-	610	250	-	142	71.0	-	-	-	-	-	-	-	-	0.8	-
09/05/2012 09:10	-	336.0	0.020	-	0.200	0.090	1.7	0.10	0.10	0.10	25	392	61	-	-	197	94.6	-	-	-	-	-	-	-	-	2.5	-
06/24/2014 08:45	430.0	390.0	0.047	0.059	-	0.020	3.9	0.05	0.03	-	-	177	432	148	-	104	31.1							-	-	1.4	4.1

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Exxon-Mobil

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/24/2013 09:00	34.0	31.0	0.019	0.042	0.158	0.020	1.4	0.05	0.03	-	6	283	18	14	-	174	61.3	0.00020	0.00018	0.00055	0.00033	0.00100	0.00290	-	-	4.9	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Guptil Pond

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
06/27/2007 14:35	-	-	0.049	-	0.245	-	2.1	-	-	-	-	-	27	21	-	68	85.0	-	-	-	-	-	-	-	-	-	-
09/21/2010 10:30	-	-	0.006	-	0.168	-	1.9	-	-	-	-	-	99	40	-	52	18.0	-	-	-	-	-	-	-	-	0.4	-
09/06/2012 10:00	-	-	0.032	-	0.540	0.140	1.3	0.10	0.10	0.10	26	117	49	-	-	71	11.3	-	-	-	-	-	-	-	-	2.5	-
06/24/2014 09:15	550.0	410.0	0.108	0.138	-	0.040	6.5	0.05	0.03	-	-	133	477	263	-	68	19.9							-	-	3.4	4

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Kmart

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/16/2009 13:10	-	-	0.762	-	-	-	-	0.05	0.03	-	-	-	26	17	-	106	81.0	-	-	-	-	-	-	-	-	-	-
09/05/2012 11:50	-	246.0	0.096	-	1.000	1.800	4.8	0.10	0.10	0.10	116	412	259	-	-	186	116.0	-	-	-	-	-	-	-	-	2.5	-
07/24/2013 11:45	1200.0	1100.0	0.153	0.182	6.900	2.110	35.0	0.05	0.03	-	370	495	1,710	820	-	220	141.5	0.00200	0.03270	0.08850	0.07040	0.03550	0.48900	-	-	4.0	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Little Crosby Lake

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/15/2008 10:25	6.0	5.2	0.017	-	0.056	-	1.6	-	-	-	2	-	1	1	-	156	144.0	-	-	-	-	-	-	-	-	15.5	-
07/17/2009 10:45	-	-	0.005	-	-	-	-	0.05	0.03	-	-	-	2	2	-	96	157.0	-	-	-	-	-	-	-	-	-	-
07/17/2009 10:45[a]	-	-	0.005	-	-	-	-	0.05	0.03	-	-	-	7	3	-	182	167.0	-	-	-	-	-	-	-	-	-	-

[a] *Duplicate Sample Collected*

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Post Office

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
09/21/2010 10:15	-	-	0.005	-	0.370	-	4.0	-	-	-	-	-	53	26	-	596	492.0	-	-	-	-	-	-	-	-	1.0	-
09/05/2012 10:15	-	96.1	0.020	-	0.560	0.930	4.0	0.10	0.10	0.10	154	734	620	-	-	477	195.0	-	-	-	-	-	-	-	-	2.5	-
06/24/2014 09:10	170.0	140.0	0.012	0.028	-	0.040	3.9	0.05	0.03	-	-	526	180	68	-	256	141.3							-	-	3.4	2.8

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Reservoir Woods

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
06/27/2007 14:50	-	-	0.054	-	0.231	-	3.2	-	-	-	-	-	14	9	-	84	39.0	-	-	-	-	-	-	-	-	-	-
09/21/2010 11:00	-	-	0.109	-	0.296	-	2.3	-	-	-	-	-	9	6	-	80	8.0	-	-	-	-	-	-	-	-	0.9	-
09/06/2012 10:45	-	109.0	0.038	-	0.890	0.320	3.8	0.10	0.10	0.10	31	175	67	-	-	97	18.9	-	-	-	-	-	-	-	-	2.5	-
06/24/2014 10:15	22.0	17.0	0.017	0.044	-	0.020	2.3	0.05	0.03	-	-	100	9	7	-	56	12.2							-	-	2.0	3.2

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Sherren Street Pond

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/16/2009 11:10	-	-	0.011	-	-	-	-	0.05	0.03	-	-	-	40	24	-	50	141.0	-	-	-	-	-	-	-	-	-	-
08/16/2011 10:30	16.0	15.0	0.084	-	0.187	-	0.8	0.05	0.03	-	-	-	2	1	-	34	10.0	-	-	-	-	-	-	-	-	0.4	-
07/24/2013 10:00	48.0	47.0	0.089	0.120	0.338	0.020	1.7	0.05	0.03	-	4	70	9	6	-	36	19.3	0.00020	0.00021	0.00036	0.00010	0.00052	0.00200	-	-	0.5	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Swede Hollow

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/15/2008 11:00	7.2	5.9	0.048	-	0.123	-	0.7	-	-	-	5	-	10	3	-	384	94.0	-	-	-	-	-	-	-	-	58.3	-
07/16/2009 13:35	-	-	0.291	-	-	-	-	0.12	0.03	-	-	-	7	2	-	216	116.0	-	-	-	-	-	-	-	-	-	-
08/16/2011 14:30	63.0	65.0	0.196	-	4.420	-	39.0	0.05	0.03	-	-	-	6,200	2600	-	548	139.0	-	-	-	-	-	-	-	-	47.5	-
07/24/2013 10:15	13.0	9.1	0.239	0.233	0.483	0.210	1.5	0.10	0.03	-	8	561	44	15	-	420	115.8	0.00020	0.00092	0.00450	0.00440	0.00200	0.01490	-	-	45.0	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Victoria B

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/16/2009 11:30	-	-	0.356	-	-	-	-	0.05	0.03	-	-	-	20	9	-	196	88.0	-	-	-	-	-	-	-	-	-	-
08/16/2011 09:49	5.2	6.8	0.080	-	0.242	-	1.0	0.05	0.03	-	-	-	9	4	-	248	42.0	-	-	-	-	-	-	-	-	31.3	-
07/24/2013 11:30	19.0	16.0	0.030	0.055	0.114	0.020	1.1	0.05	0.03	-	5	224	15	11	-	138	57.9	0.00020	0.00039	0.00220	0.00078	0.00130	0.00480	-	-	12.6	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Victoria-Roselawn

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/16/2009 11:45	-	-	0.005	-	-	-	-	0.05	0.03	-	-	-	60	38	-	50	51.0	-	-	-	-	-	-	-	-	-	-
09/12/2012 09:15	-	22.5	0.010	-	0.140	0.076	2.6	0.10	0.10	0.10	8	115	16	-	-	46	15.7	0.00008	0.00100	0.00100	0.00190	0.00130	0.00590	12.2	3.8	2.5	-
06/24/2014 09:00	66.0	62.0	0.051	0.064	-	0.060	1.4	0.05	0.03	-	-	235	14	8	-	134	47.0	-	-	-	-	-	-	-	-	3.6	3.7

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Villa Park

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
06/27/2007 14:45[a]	-	-	0.109	-	0.362	-	2.5	-	-	-	-	-	21	16	-	262	101.0	-	-	-	-	-	-	-	-	-	-
09/21/2010 10:50[b]	-	-	0.064	-	-	-	-	0.05	0.03	-	-	-	45	19	-	172	60.0	-	-	-	-	-	-	-	-	5.2	-
09/06/2012 08:45[b]	-	-	0.270	-	0.570	0.250	1.4	0.10	0.10	0.10	14	594	23	-	-	403	149.0	-	-	-	-	-	-	-	-	9.5	-
06/24/2014 09:30[a]	17.0	12.0	0.152	0.173	-	0.380	1.6	0.15	0.05	-	-	264	19	8	-	142	56.0	-	-	-	-	-	-	-	-	9.7	3.0

[a] *WQ sample taken from Wet Cell #5*
[b] *WQ sample taken from Wet Cell #1*

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Western Avenue

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/15/2008 12:10	3.3	3.0	0.061	-	0.136	-	0.7	-	-	-	6	-	4	2	-	80	43.0	-	-	-	-	-	-	-	-	5.1	-
08/16/2011 08:49	12.0	8.0	0.085	-	0.374	-	1.6	0.21	0.04	-	-	-	226	48	-	142	85.0	-	-	-	-	-	-	-	-	10.4	-
07/24/2013 09:15	22.0	19.0	0.147	0.159	0.440	0.520	2.6	0.05	0.03	-	34	374	125	22	-	170	105.0	0.00020	0.00340	0.00620	0.00370	0.00360	0.02570	-	-	13.9	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

William Street Pond

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
09/21/2010 10:37	-	-	0.020	-	-	-	-	0.05	0.03	-	-	-	13	10	-	76	21.0	-	-	-	-	-	-	-	-	1.6	-
09/06/2012 09:40	-	26.7	0.026	-	0.440	0.086	1.0	0.10	0.10	0.10	7	93	18	-	-	51	19.5	-	-	-	-	-	-	-	-	2.5	-
06/24/2014 09:50	17	15	0.101	0.132	-	0.21	3.7	0.05	0.03	-	-	212	27	22	-	108	44.4	-	-	-	-	-	-	-	-	7.36	9.8

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Willow Reserve

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
06/27/2007 14:05	-	-	0.018	-	0.445	-	4.7	-	-	-	-	-	175	94	-	202	72.0	-	-	-	-	-	-	-	-	-	-
09/21/2010 09:45	-	-	0.016	-	0.154	-	1.3	-	-	-	-	-	10	8	-	164	28.0	-	-	-	-	-	-	-	-	1.7	-
09/12/2012 08:50	-	153.0	0.020	-	0.250	0.100	4.0	0.10	0.10	0.10	26	172	31	-	-	128	18.1	0.00008	0.00100	0.00210	0.00240	0.00090	0.01290	35.8	9.4	2.5	-
06/24/2014 08:30	45.0	43.0	0.044	0.073	-	0.020	2.3	0.05	0.03	-	-	281	12	9	-	168	32.8							-	-	9.2	5.2

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Woodview Marsh

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
06/27/2007 15:05	-	-	0.013	-	0.120	-	1.9	-	-	-	-	-	22	18	-	126	90.0	-	-	-	-	-	-	-	-	-	-
07/24/2013 15:15	190.0	160.0	0.046	0.068	0.550	0.390	5.6	0.05	0.03	-	45	283	230	142	-	176	44.3	0.00020	0.00500	0.00660	0.01190	0.00250	0.02170	-	-	0.6	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)

Zittels

Sampling Date / Time	Chl-a (trichromatic) µg/L	Chl-a (pheophytin) µg/L	Ortho-P mg/L	Dissolved P mg/L	Total P mg/L	NH3 mg/L	TKN mg/L	NO3 mg/L	NO2 mg/L	NO2+NO3 mg/L	Turbidity NTU	TDS mg/L	TSS mg/L	VSS mg/L	pH -	Hardness mg/L	Cl mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Ca mg/L	Mg mg/L	SO4 mg/L	CBOD-5Day mg/L
07/16/2009 12:45	-	-	0.071	-	-	-	-	0.05	0.03	-	-	-	10	6	-	108	216.0	-	-	-	-	-	-	-	-	-	-
07/24/2013 13:25	830.0	570.0	0.083	0.113	6.340	0.160	43.0	0.05	0.03	-	850	241	5,840	3,160	-	116	59.2	0.00390	0.05560	0.10800	0.41500	0.06710	0.44200	-	-	1.9	-

Actual number less than value (<)
Estimated concentration above the method detection limit and below the reporting limit (~)