WAWASEE AREA CONSERVANCY FOUNDATION
WATER QUALITY SUMMARY REPORT

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Prepared for:

Wawasee Area Conservancy Foundation
P.O. Box 548
Syracuse, Indiana 46567

Prepared by:

DLZ Indiana, LLC
360 Century Building
36 S. Pennsylvania Street
Indianapolis, Indiana 46204-4120
317-633-4120

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WATER QUALITY SUMMARY

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EXECUTIVE SUMMARY

The proposed project involves

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I. PROJECT DESCRIPTION AND PURPOSE

The proposed project involves the summarization of water quality data collected by the Wawasee Area Conservancy Foundation (WACF). The WACF has pulled together information from the 1970's forward from a conglomeration of studies within the Lake Wawasee watershed. The purpose of this project is to provide a summary of the water quality within Lake Wawasee's watershed. The summary is to be concise and is to provide graphical representations.

II. RATIONALE / METHODOLOGY

The data to be analyzed includes:

1) A report conducted in the Summer of 1971 by Cameron E. Gifford, Michael Melampy, William Bishop, and Margaret Hollinger entitled " A Summary of a Chemical and Bacteriological Survey of Lakes Wawasee and Syracuse";
2) A report conducted in the Summer of 1982 by Karl A. Keiper entitled "Chemical and Bacteriological Survey, Lakes Syracuse and Wawasee";
3) Public Water System Reports conducted in August of 1998 by Turner Technologies testing community water for E. Coli;
4) Data from 1989 to 1999, as well as from 2002, by the Indiana Clean Lakes Program; and
5) The Hoosier Riverwatch's Standard Chemical Monitoring Data Sheets from 2000 through 2003 completed by WACF members.

The five data sets highlight the following parameters, respectively:

1) Dissolved oxygen, nitrate, total phosphorus, fecal
2) Temperature, pH, dissolved oxygen, fecal, nitrate, ammonia nitrogen (NH3-N), phosphorus, total phosphorus
3) E. Coli
4) Secchi depth, total phosphorus, chlorophyll a
5) Dissolved oxygen (% saturation), biological oxygen demand (5-day), nitrate, pH, orthophosphate, temperature change, turbidity, fecal or E. coli colonies

A summary of the sampled parameters follows:

Dissolved Oxygen

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration, and as a waste product of photosynthesis. The oxygen is used by plants and animals for respiration and by the aerobic bacteria which consume oxygen during the process of decomposition. When organic matter such as animal waste or improperly treated wastewater enters a body of water, algae growth increases and the dissolved oxygen levels decrease as the plant material dies off and is decomposed through the action of the aerobic bacteria. Dissolved oxygen is essential for aquatic plants and animal life and is one of the best indicators of the health of a water ecosystem. Dissolved oxygen can range from 0-18 mg/L, but most natural water systems require 5-6 mg/L to support a diverse population. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/L, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills.

Nitrate

Nitrate rich effluents discharged into water can degrade water quality by encouraging excessive growth of algae. As decomposition of plant and animal material occurs, dissolved oxygen levels decrease and nitrate levels increase. In addition, bacteria break down large protein molecules into ammonia which combines with oxygen to form nitrates and nitrites. Unpolluted waters usually have a nitrate level below 4 mg/L. In Indiana waters, nitrate-nitrogen levels typically range between 0.9 and 3.15 mg/l, although in areas where land use is predominately agricultural, nitrate concentrations exceeding 10 mg/l are common.

Ammonia

Ammonia is the most reduced form of nitrogen and is found in water where dissolved oxygen is lacking. Ammonia is a product of the microbiological decay of animal and plant protein and can be reused directly to produce plant protein. The presence of ammonia in raw surface waters is generally an indication of domestic pollution. Ammonia is toxic to fish and aquatic organisms, even in very low concentrations. When levels reach 0.06 mg/L, fish can suffer gill damage. When levels reach 0.2 mg/L, sensitive fish like trout and salmon begin to die. As levels near 2.0 mg/L, even ammonia-tolerant fish like carp begin to die. Ammonia levels greater than approximately 0.1 mg/L usually indicate polluted waters. According to the Indiana Administrative Code, maximum (unionized) ammonia concentrations should range between 0 and 0.21 mg/l depending upon temperature and pH.

Phosphorus

Phosphate will stimulate the growth of plankton and aquatic plants which provide food for fish. This increased growth may cause an increase in the fish population and improve the overall water quality. However, if an excess of phosphate enters the waterway, algae and aquatic plants will grow wildly, choke up the waterway and use up large amounts of oxygen. This condition is known as eutrophication or over-fertilization of receiving waters. The rapid growth of aquatic vegetation can cause the death and decay of vegetation and aquatic life because of the decrease in dissolved oxygen levels.

Orthophosphate

Phosphorus is a nutrient that acts as a fertilizer for aquatic plants. When nutrient levels are high, excessive plant and algae growth creates water quality problems. Phosphorus occurs in natural waters in the form of phosphates (PO_4), although over half of the phosphates in lakes, streams, and rivers come from human uses. Phosphate levels higher than 0.03 mg/L contribute to increased plant growth.

Total phosphorus

Ideally, soluble reactive phosphorus concentrations should be 0.01 mg/L or less at spring turnover to prevent summer algae blooms. A concentration of total phosphorus below 0.02 mg/L for should be maintained to prevent nuisance algal blooms. The range for total phosphorus in Indiana waters is quite broad (0.01-0.17 mg/l) with a state average of 0.09 mg/l. A level of 0.03 mg/l is generally thought to indicate eutrophication potential. The State of Indiana does not currently have a water quality standard for phosphorus.

Fecal

Fecal coliform are bacteria found in the intestinal tracts of warm blooded animals. Its presence is an indication that the feces of warm blooded animals exist in the water. The presence of coliform indicates the potential for other harmful pathogenic organisms, making the water unsuitable for human recreation. In Indiana, the Administrative Code sets the maximum *E. coli* standard at 235 colonies/100 mL in any one sample within a 30-day period.

Temperature

Water temperature is a controlling factor in the rate of metabolic and reproductive activities for aquatic life. A rise in temperature can increase metabolic activity, provide conditions for the growth of disease-causing organisms, and lower the amount of dissolved oxygen. Water temperature is influenced by water flow, streamside vegetation, turbidity, ground water inputs, and water release from industrial activities. Removal of streamside vegetation and stream channeling along roads can raise the water temperature.

pH

The pH of water is a measure of the concentration of hydrogen ions. The pH is measured on a scale from 1 to 14, with 1 being most acidic, 7 neutral, and 14 most basic or alkaline. The pH of water influences many types of chemical reactions. A slight decrease in pH may greatly increase the toxicity of substances such as cyanides, sulfides, and most metals. The solubility of most metals is increased at a lower pH and, therefore, the metals are more available for biological processes. A slight increase in pH may greatly increase the toxicity of pollutants such as ammonia. A pH range of 6.5 to 8.2 is optimal for most organisms. Rapidly growing algae and vegetation remove carbon dioxide (CO_2) from the water during photosynthesis, which can result in a significant increase in pH. Most natural waters have pH values from 5.0 to 8.5.

Biological Oxygen Demand

Biochemical Oxygen Demand (BOD) is a measure of the quantity of dissolved oxygen used by bacteria as they break down organic wastes. High BOD levels indicate that large amounts of organic matter are present in the stream. In slow-moving and polluted waters, much of the available dissolved oxygen is consumed by bacteria, robbing other aquatic organisms of the dissolved oxygen needed to live.

Turbidity

Turbidity is the measurement of the relative clarity of water. Turbid water is cloudy and is caused by suspended and colloidal matter such as clay, silt, organic, and inorganic matter, and microscopic organisms (algae). Turbidity should not be confused with color, since darkly colored water can still be clear and not turbid. Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances that can be caused by boat traffic and abundant bottom feeding fish.

Secchi Depth

Secchi disk is a measurement of water clarity. Water clarity is affected by two main factors: algae and suspended sediments. Sediments may be introduced into the water by either runoff from the land or from sediments already on the bottom of the lake. Algae are a natural component of the food chain in lakes. Algae are microscopic plants, which grow like plants do; they need sufficient light and nutrients to survive. When there are too many nutrients in the lake, the algae multiply enough to cause a decrease in water clarity. Other factors that may affect the reading will be the color of the water, wind, waves, and sunlight.

Some lakes have a natural brown color. The color is not an indication of pollution or suspended sediments, but of tannic acids produced by decaying plants. Light does not penetrate as deeply in these darkened waters, so these brown lakes will generally have fewer algae than clear lakes.

Secchi disk transparency readings can give a rough estimate of the depth to which oxygen can support fish and other aquatic life. Generally the Secchi disk depth times 1.7 is the depth to which light can penetrate. For example, if the Secchi disk reading was 10 feet, then light can penetrate to a depth of approximately 17 feet. If light can penetrate this far, then there is enough light to support an algal population. The *photic zone* is defined as the vertical depth of a lake that has enough light to support plant growth.

Chlorophyll *a*

Chlorophyll *a* is the photosynthetic pigment that causes the green color in algae and plants. The concentration of chlorophyll *a* present in the water is directly related to the amount of algae living in the water. Excessive concentrations of algae give lakes an undesirable “pea soup” appearance.

An analysis method was developed based upon the sampling locations and parameters from the available data. The developed methodology included:

- Analysis of the combination of data from the 70s and 80s for corresponding sampling locations
- Analysis of the data from the Indiana Clean Lakes Program
- Analysis of the E. coli data from the public water system testing sites
- Analysis of the Hoosier Riverwatch sampling data

III. RESULTS

A. 70s and 80s

Both studies from the 1970s and 1980s sampled similar locations across Lake Wawasee and Syracuse Lake. The studies were conducted to determine the degree and rate of eutrophication in the lakes. In the 1970s, the samples were concentrated along the shore areas and in channels. Mid-lake areas were sampled for comparison. The study concluded that both lakes were not in immediate danger of excessive eutrophication. The dissolved oxygen levels were high and nitrogen and phosphorus were subject to fluctuation but remained low. The channels were generally in worse condition than the shore areas. The channels subject to human use or areas where the streams and channels merged with open water generally had high nitrogen and phosphorus levels and lower levels of dissolved oxygen.

The study in the 1980s collected samples from surface water 4 to 12 inches deep. Overall, the study found that the chemical samples were in line for the lakes but the bacteria levels exceeded those for human health.

In comparing the two studies, fourteen sampling sites coincided with one another. The sampling results for the fourteen locations were combined to compare the corresponding parameters of dissolved oxygen, nitrate, total phosphorus, and fecal coliform. Four graphical representations, one for each parameter, are contained in Appendix B.

The analysis revealed that:

- Dissolved oxygen levels were consistently high aside from at Cedar Point where the 1970s reading fell below 5 mg/L but rebounded in the 1980s to 9 mg/L.
- Nitrate levels were high in the 1970s compared to the 1980s. However, the nitrate levels in the 1970s and 1980s were below the 4 mg/L level indicating the waters were unpolluted.
- Total phosphorus was higher in the 1980s than in the 1970s. The level of phosphorus in the 1980s throughout the sampling sites indicated the potential for eutrophication. Within the 1980 study, it was noted that the levels were not unexpected for the time of year and were thought to be attributed to sediments, organic materials, or waste materials. In the 1970's, Marineland Gardens and Enchanted Hills indicated the potential for eutrophication.
- Fecal coliform levels varied throughout the sampling locations as well as between the two studies. The highest reported value was listed as being >200 col/100 mL. With the state standard being a maximum of 235 col/100 mL for a sample during a 30 day period, it is not known if the standard was exceeded. However, no one sampling site was listed as having a reading of >200 col/100 mL from both studies. Thus in most cases, the high fecal coliform level was not repetitive. The levels are of concern and noted as such in the 1980s study.

B. Indiana Clean Lakes Program

The Indiana Clean Lakes Program initiated a volunteer monitoring program in 1989 with goals of:

- Identifying long-term water quality trends in lakes
- Involving citizens in the active stewardship of their lakes
- Providing opportunities for citizens to learn more about lakes

Within the monitoring program, secchi depth, phosphorus, and chlorophyll a samples have been taken for Lake Wawasee. The gathered data for Lake Wawasee includes a summary from 1989 to 1999 as well as for 2002, when the samples were available. Generally four to five samples were taken each year for total phosphorus and chlorophyll a while anywhere from 8 to 20 secchi disk reading were taken annually. The data reported the annual maximum and minimum readings and the mean value of the July and August samples for each year for the three parameters where available.

In reviewing the reported data, graphical representations, as shown in Appendix C, were formulated to interpret the mean secchi depth, mean total phosphorus, and mean chlorophyll a from 1989 to 1999. The mean data throughout the years was plotted and a trendline developed. Based upon the developed trendlines:

- Secchi depth decreased throughout the years from around 10.5 to 7 and most recently in 2002, the average depth decreased further to 5.9
- Total phosphorus was steady from 1992 to 1999 around 25 and the 2002 value decreased slightly to 21
- Chlorophyll a increased throughout 1992 to 1999 from 1 to 2.8 and most recently in 2002 the value reported a decrease to 2.1

Lake Wawasee has a maximum depth of 77 feet and a mean depth of 22 feet.

C. <u>E. Coli Testing</u>

WACF provided results for a total of seven data samples that were collected and analyzed for E. coli levels. Turner Technologies took the following samples on August 2, 1998 around 3:00PM:

1) a kitchen tap sample where the water originated from a private well at Pier 759
2) a community access point at the Lilly Property, East
3) a community access point at the Lilly Property, West
4) a community access point at the Lilly Property, Center
5) a community access point at Sandbar 3
6) a community access point at Sandbar 2
7) a community access point at Sandbar 1

All samples measured less than 10 col/100 mL except at the Lilly property, center location where the sample measured 30 col/100 mL. Based upon a satisfactory and unsatisfactory level, all seven samples had test results indicating the samples to be satisfactory. Overall, the public water system reports indicate that E. coli was not of concern

D. <u>Hoosier Riverwatch</u>

Hoosier Riverwatch is a state-sponsored water quality monitoring initiative sponsored by the Indiana Department of Natural Resources, Division of Soil Conservation in cooperation with Purdue University Agronomy Department. The program was started in 1994 to increase public awareness of water quality issues and concerns by training volunteers to monitor stream water quality. Hoosier Riverwatch collaborates with agencies and volunteers to:

- Increase public involvement in water quality issues through hands-on training of volunteers in stream monitoring and cleanup activities.
- Educate local communities about the relationship between land use and water quality
- Provide water quality information to citizens and governmental agencies working to protect Indiana's rivers and streams.

WACF began monitoring the waters within the Lake Wawasee watershed in 2000. WACF monitors, Lake Wawasee, Syracuse Lake, Turkey Creek, Dillon Creek, Knapp Lake, and Harper Lake.

31 samples were reported at 17 different locations.
Nine locations were sampled more than once and 8 were sampled once
7 locations at wawasee (15 samples), 3 at Syracuse (5 samples), 7 se of lake (11 samples)

IV. PROJECT CONCLUSIONS

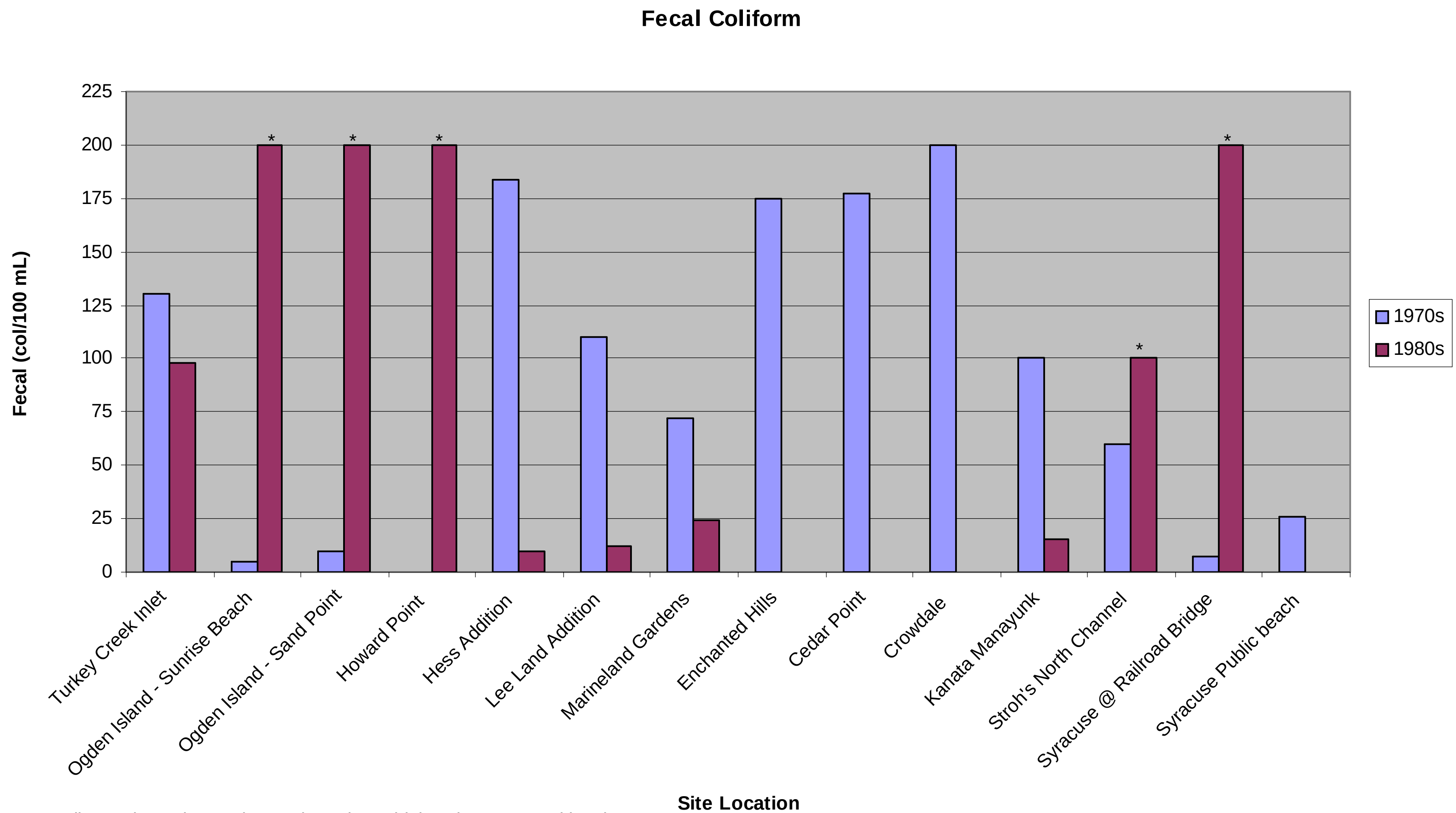
The overall project purpose is to provide a.

APPENDIX A

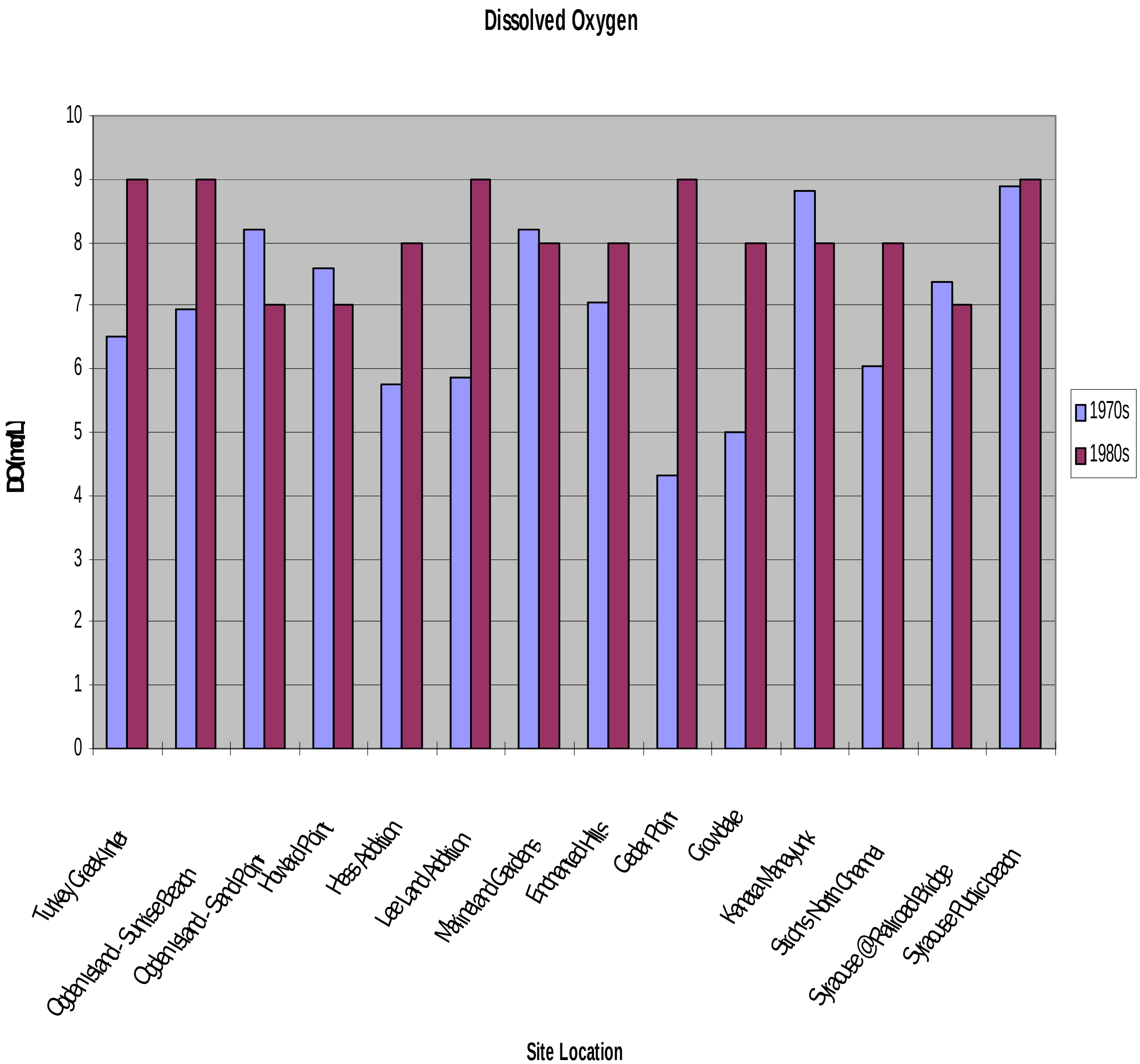
Data Sets

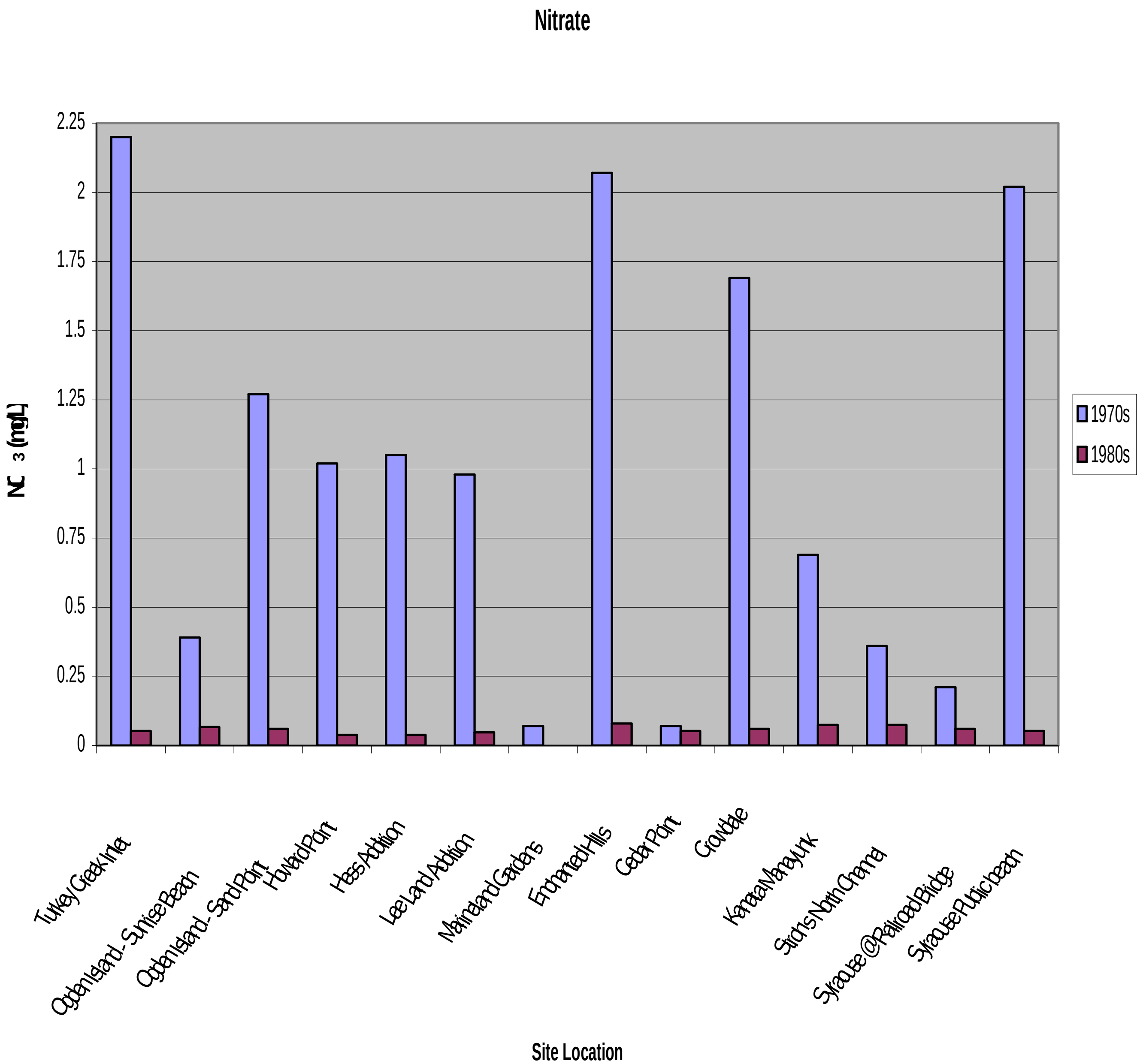
APPENDIX B

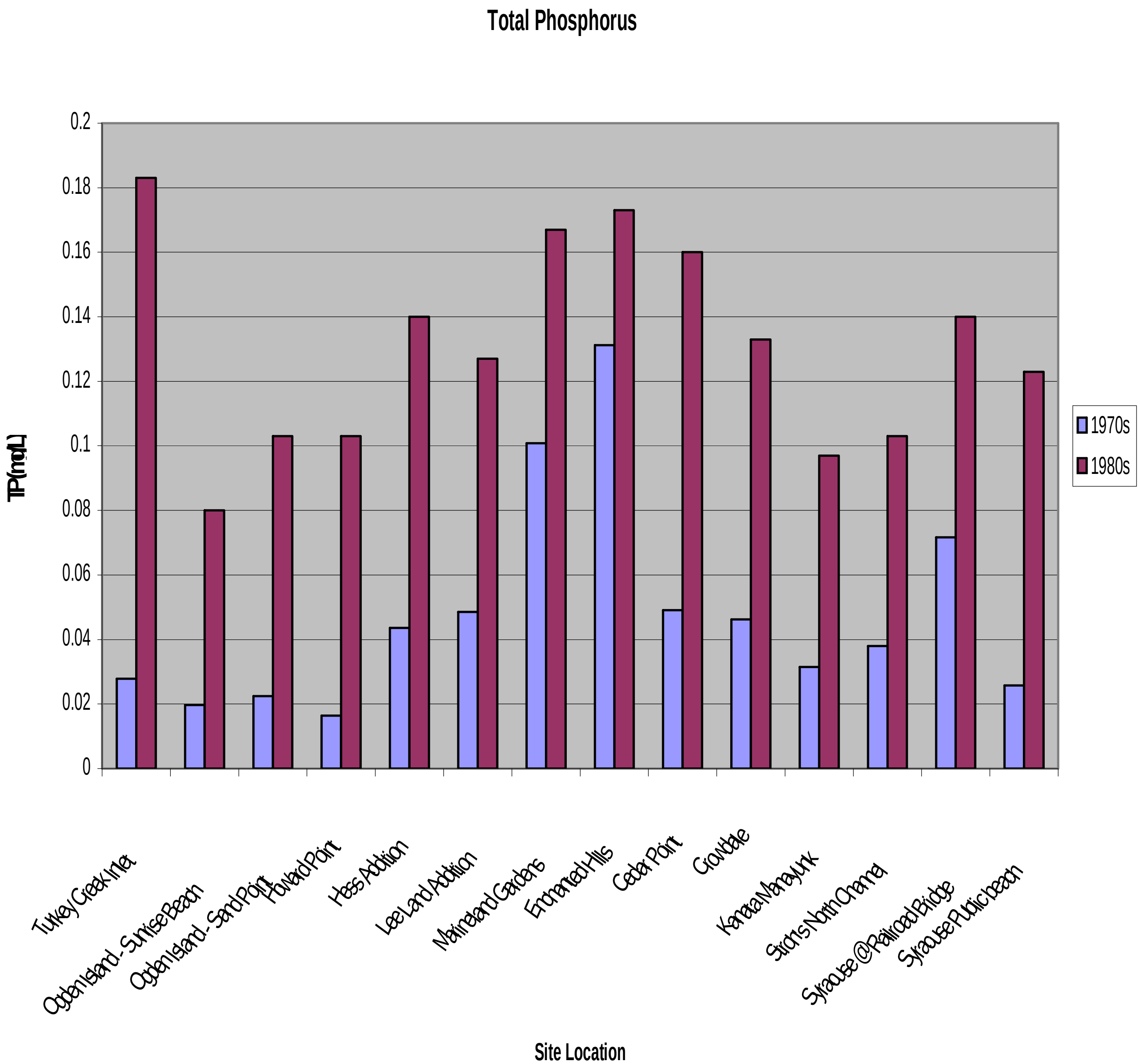
Analysis of the 1970s and 1980s Data



* Reading estimated; sample may have been higher than reported level

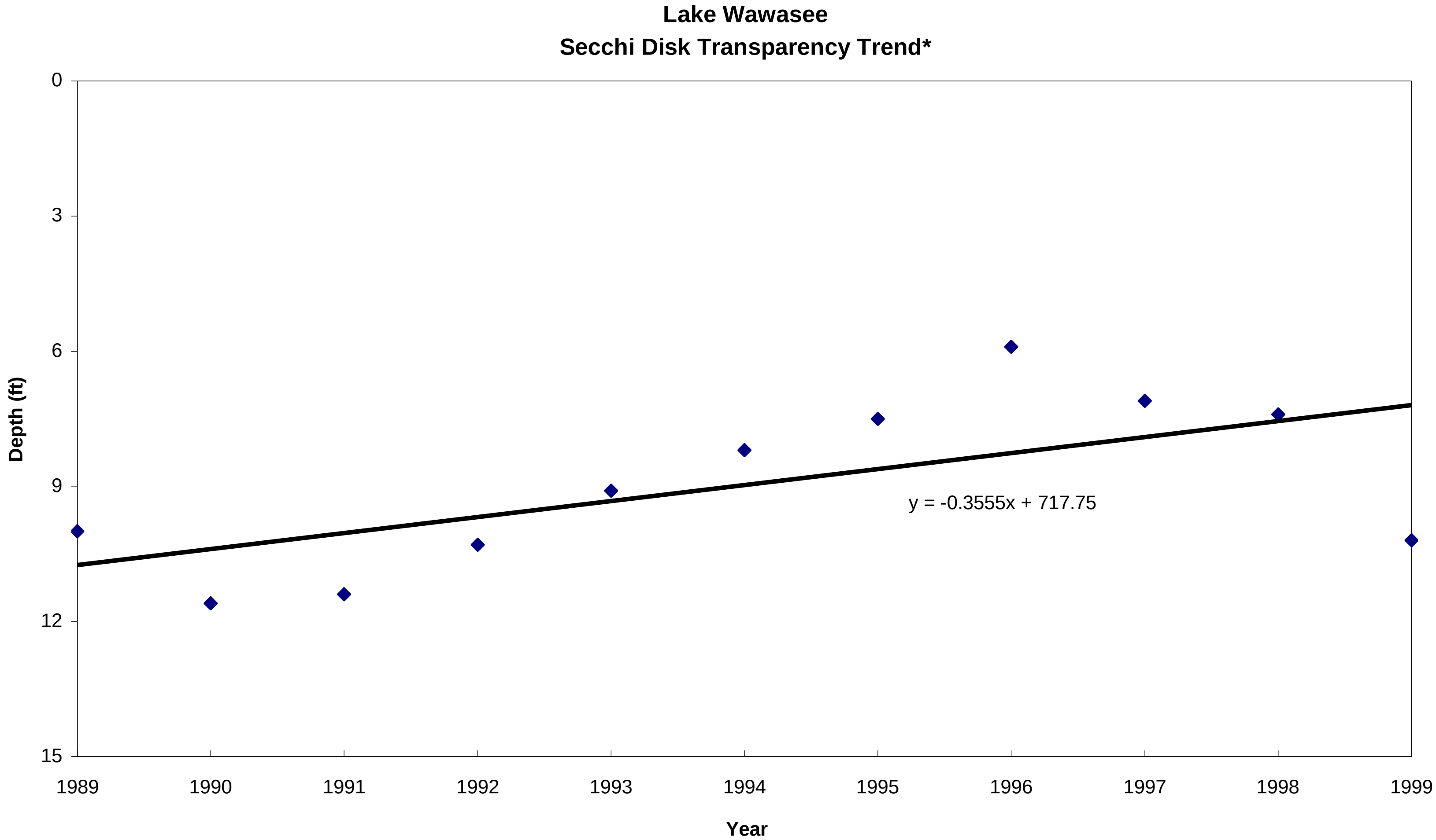

Dissolved Oxygen
DO (mg/L)
10
9
8
7
6
5
4
3
2
1
0
1970s
1980s
Turkey Creek Inlet
Ogden Island - Sunrise Beach
Ogden Island - Sand Point
Howard Point
Hess Addition
Lee Land Addition
Mainland Gardens
Enchanted Hills
Cedar Point
Crowdale
Kanata Manayunk
Strichs North Channel
Syracuse @ Railroad Bridge
Syracuse Public beach
Site Location


Nitrate
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
NO3 (mg/L)
1970s
1980s
Turkey Creek Inlet
Ogden Island - Sunrise Beach
Ogden Island - Sand Point
Howard Point
Hess Addition
Lee Land Addition
Mainland Gardens
Enchanted Hills
Cedar Point
Syracuse @ Railroad Bridge
Syracuse Public beach
Site Location

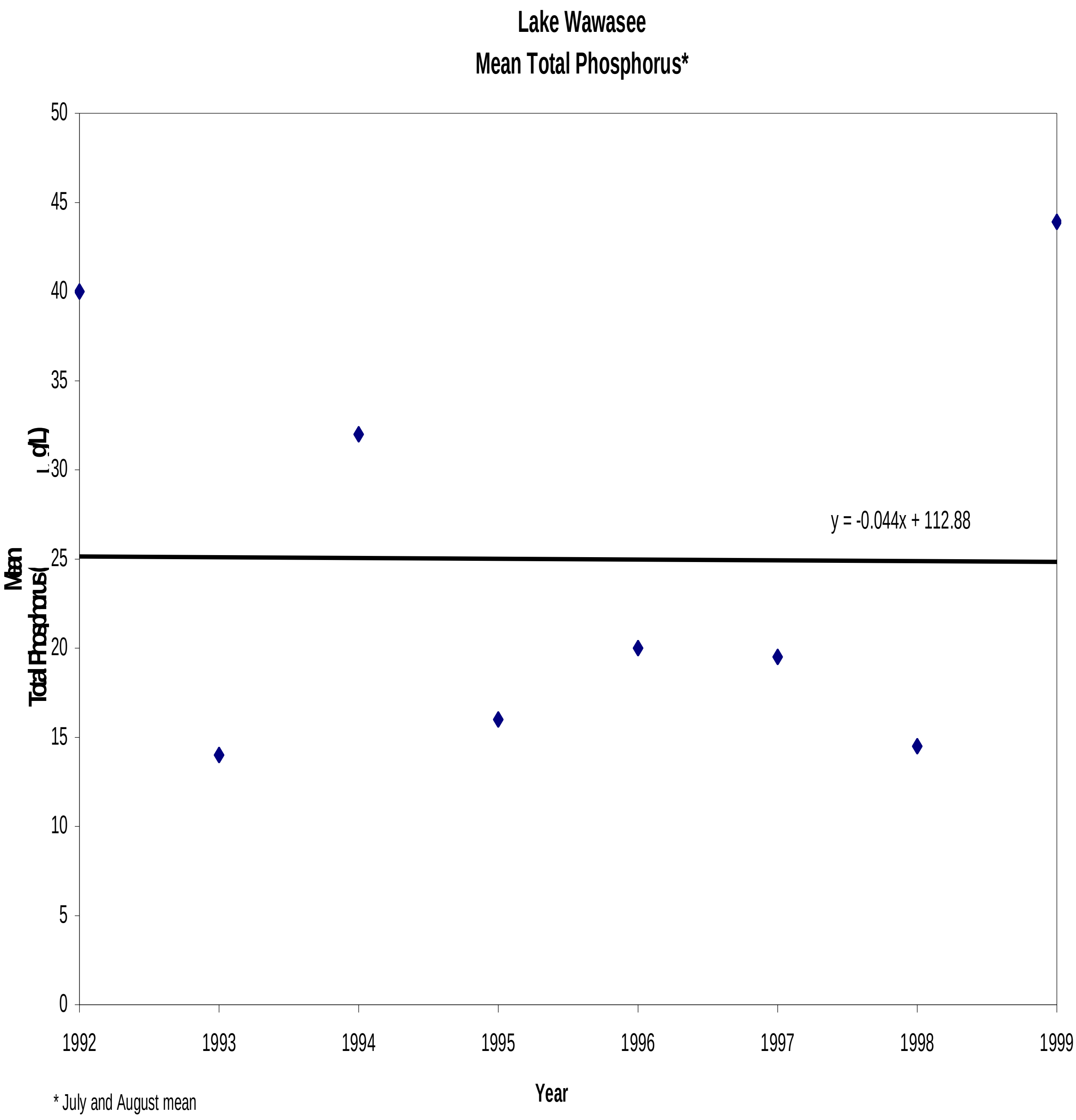

Total Phosphorus
TP (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1970s
1980s
Turkey Creek Inlet
Ogden Island - Sunrise Beach
Ogden Island - Sand Point
Howard Point
Hess Addition
Lee Land Addition
Marineland Gardens
Enchanted Hills
Cedar Point
Crowdale
Kanata Manayunk
Strohs North Channel
Syracuse @ Railroad Bridge
Syracuse Public beach
Site Location

APPENDIX C

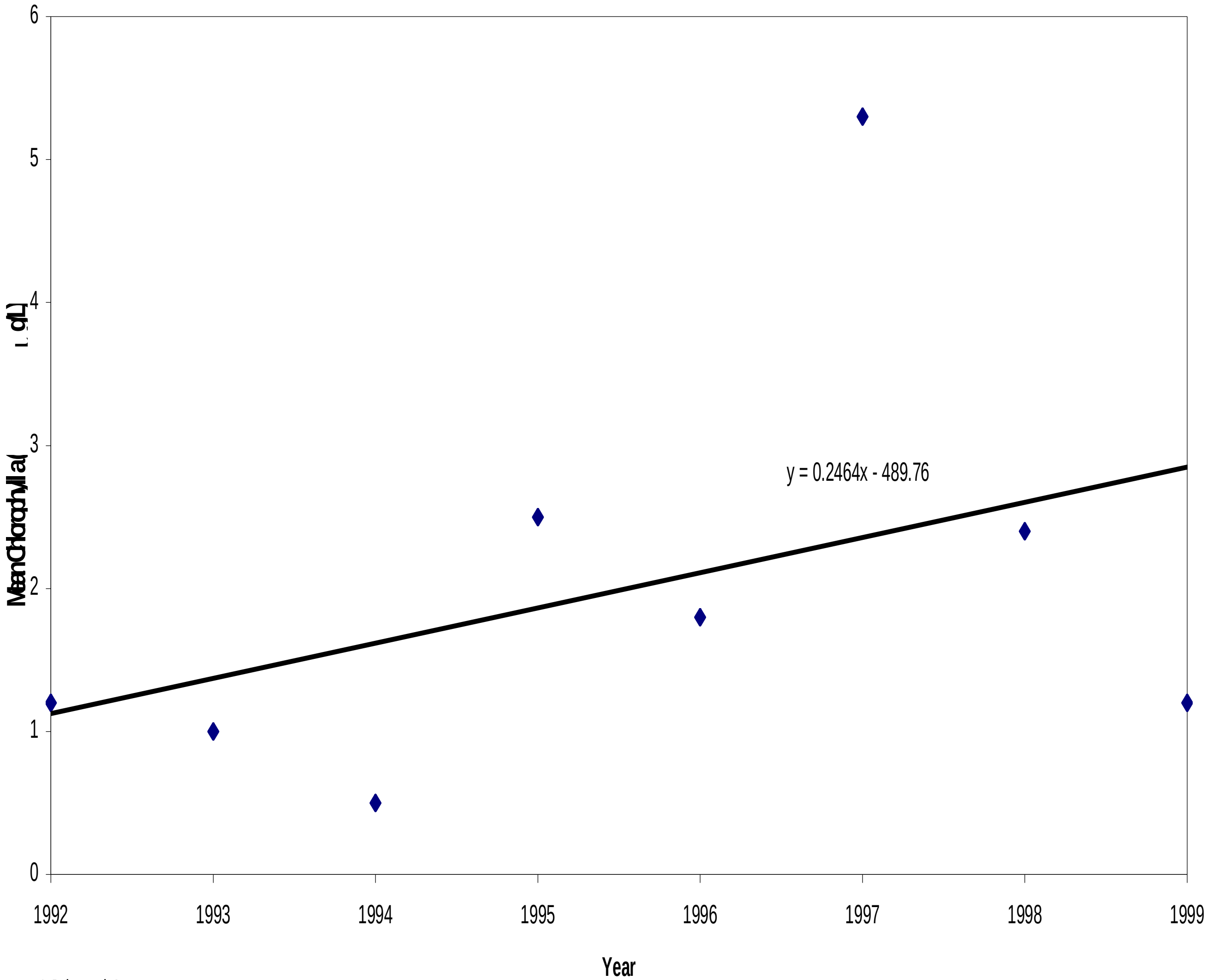
Analysis of the Indiana Clean Lakes Program Data



* July and August mean


Lake Wawasee
Mean Total Phosphorus*
Mean
Total Phosphorus (µg/L)
50
45
40
35
30
25
20
15
10
5
0
y = -0.044x + 112.88
1992
1993
1994
1995
1996
1997
1998
1999
Year
* July and August mean

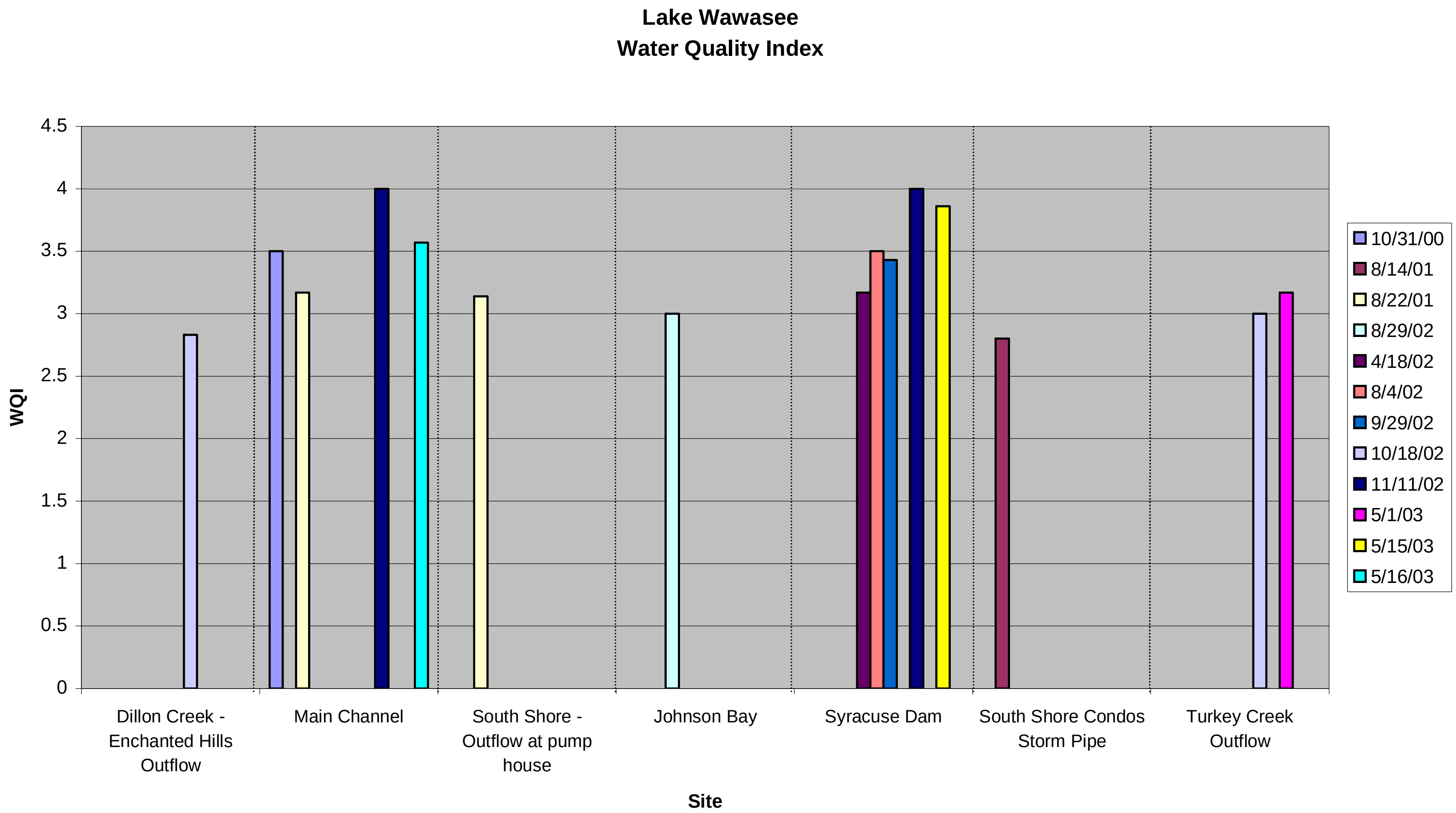
Lake Wawasee
Mean Chlorophyll a*

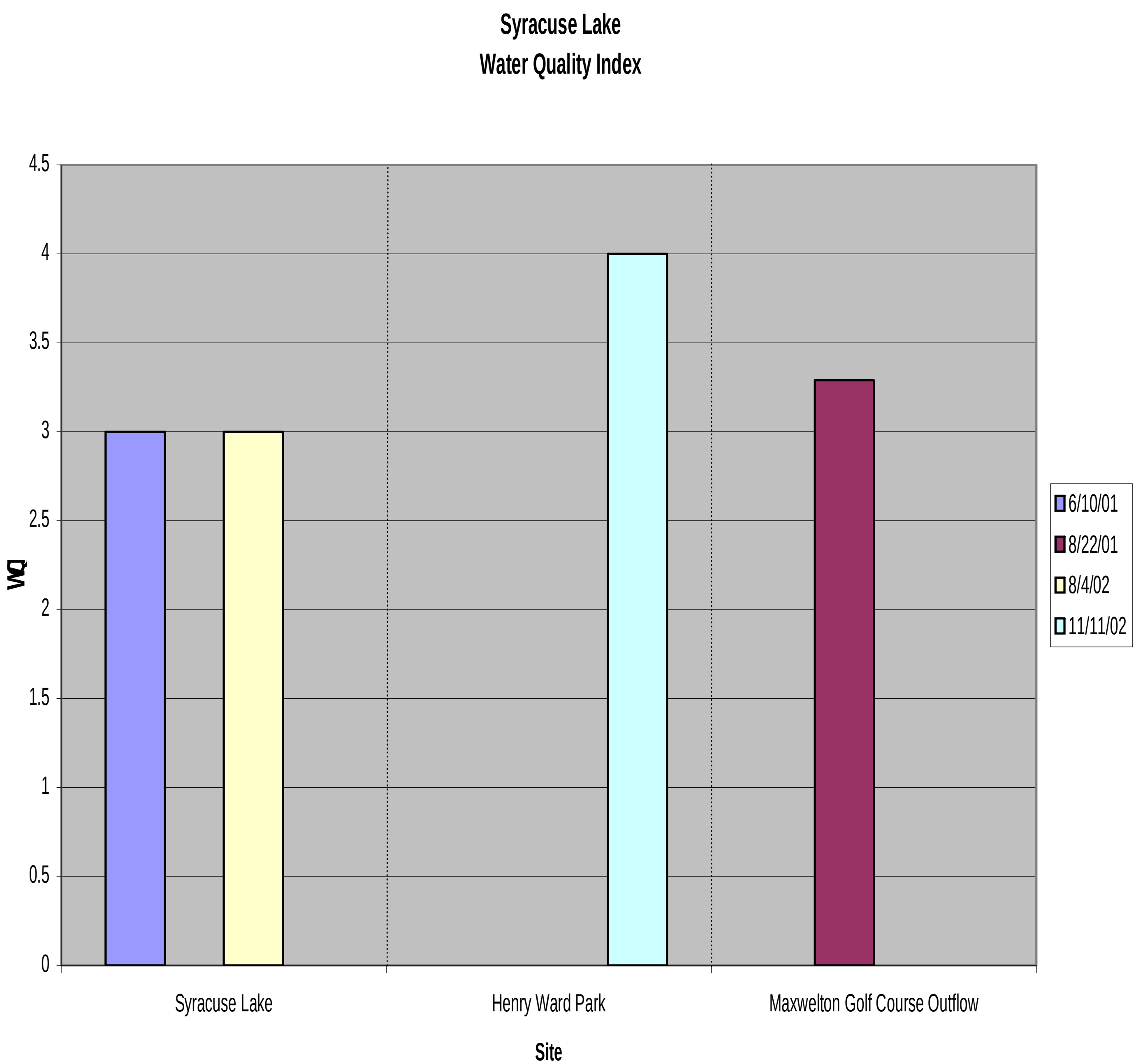


* July and August mean

APPENDIX D

Analysis of the Hoosier Riverwatch Data


Lake Wawasee
Water Quality Index
WQI
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Dillon Creek - Enchanted Hills Outflow
Main Channel
South Shore - Outflow at pump house
Johnson Bay
Syracuse Dam
South Shore Condos Storm Pipe
Turkey Creek Outflow
Site
10/31/00
8/14/01
8/22/01
8/29/02
4/18/02
8/4/02
9/29/02
10/18/02
11/11/02
5/1/03
5/15/03
5/16/03


Syracuse Lake
Water Quality Index
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
WQ
Syracuse Lake
Henry Ward Park
Maxwelton Golf Course Outflow
Site
6/10/01
8/22/01
8/4/02
11/11/02

APPENDIX XXX

Analysis of XXXX