City of Naples

2019 Update to the City of Naples Stormwater Lakes Management Plan

Prepared for:

City of Naples

Streets & Stormwater Department
295 Riverside Circle
Naples, FL 34102

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.

281 Airport Road South
Naples, Florida 34104

Wood Project No.: 6783193180

September 30, 2019

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AGM	annual geometric mean
Amec	Amec Environment & Infrastructure, Inc.
BMP	Best Management Practices
CFU	colony-forming unit
City	City of Naples
Cu	copper
DO	dissolved oxygen
FDEP	Florida Department of Environmental Protection
FGCU	Florida Gulf Coast University
GIS	Geographic Information System
IFAS	Institute of Food and Agricultural Sciences
µg/L	micrograms per liter
mg/m^3	milligrams per cubic meter
ml	milliliter
NO_x	nitrates + nitrites
NSBB	nutrient separating baffle box
PAH	polynuclear aromatic hydrocarbons
POR	periods of record
SCTL	soil clean-up target levels
SFWMD	South Florida Water Management District
TKN	total Kjeldahl Nitrogen
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorous
TRPH	total recoverable petroleum hydrocarbons
TSS	total suspended solids
USEPA	US Environmental Protection Agency
USGS	US Geographical Service
Wood	Wood Environment & Infrastructure Solutions, Inc.

1.0 Background

Wood Environment & Infrastructure Solutions, Inc. (Wood) was contracted to update the 2012 Stormwater Lakes Management Plan (2012 Lakes Plan) for the City of Naples (City). This update includes a review of previous relevant management plans; an assessment of available stormwater, lake water, and sediment quality data and identification of data gaps based on data needs outlined in the 2012 Lakes Plan; and updated rankings and recommendations for maintaining and restoring stormwater lakes that are owned by the City or used for public stormwater collection and treatment either by plat dedication, dedicated easement, or historical prescriptive use (hereafter referred to as "public" lakes).

1.1 Summary of Previous Lakes Management Documents

The City has two primary management documents related to stormwater lakes. The 2012 Lakes Plan and the 2018 Stormwater Master Plan Update (2018 SMPU). These documents are summarized below.

1.1.1 2012 Stormwater Lakes Management Plan

In 2012, City staff prepared a Proposed Stormwater Lakes Management Plan PowerPoint and an accompanying memorandum (dated 3/12/2012) providing supporting information. The memorandum includes broad water quality improvement strategies and introduces the importance of stormwater lake pollutant removal efficiencies. Collectively, these documents represent the City's 2012 Lakes Plan and are included in Appendix A. Overall water quality pollutant reduction strategies suggested in the 2012 Lakes Plan were: continued water quality sampling to monitor progress towards meeting nutrient criteria and total maximum daily loads (TMDL), source identification and reduction of pollutants, public outreach and partnerships, continued implementation of best management practices, and improving stormwater lake pollutant removal efficiency.

As described in the 2012 Lakes Plan, implementation of these strategies is dependent on several factors, including the specific pollutant issues at a lake, whether a lake receives public drainage, and ownership of the lake. Identifying target pollutants helps determine the appropriate BMPs while knowing lake ownership allows the City to invest public funds on public properties providing public service. In consideration of these factors, and specifically the complex ownership of the stormwater lakes within the City, the 2012 Lakes Plan included four specific stormwater lake improvement strategies:

1. Lead by example and restore and maintain the five public stormwater lakes;
2. Conduct public outreach and enter into partnerships with owners of private lakes that receive public drainage to establish practices and policies to improve stormwater lake water quality (e.g. agreeing to switch from chemical algal treatment such as copper sulphate to aeration and floating islands);
3. Increased regulation and enforcement, including establishment of ordinances for lake maintenance and discharge water quality, could also improve water quality regardless of ownership; and, lastly,
4. Establishment of taxing or special assessment districts.

In order to determine which strategies would be appropriate for the numerous lakes within the City, the 2012 Lakes Plan identified 28 stormwater lakes on the City's inventory and categorized the lakes as follows:

- Tier 1 (public lakes: City- lakes in fee simple ownership or Plat dedication and historical use): These five stormwater lakes are Mandarin Lake (#6), 15th Ave North Lake (#19), Lake Manor (#22), Lowdermilk Lake (#23), and East Lake (#31). These five lakes are on property that is, and has historically been, under City control. The lakes receive drainage from public and private lands.
- Tier II (high priority pollutant loading lakes): Tier II lakes include seven lakes with the highest pollutant loading potential that are privately owned by active or defunct companies, corporations or individuals. These lakes also receive stormwater drainage from both public and private lands.
- Tier III (the remaining inventoried lakes). There were 16 Tier III lakes listed in the 2012 Lakes Plan, all are privately owned with the exception of Lake #17. Ten receive public drainage via inflow pipes within easements and six receive no public drainage input.
- Tier IV for non-inventoried private lakes/systems: Tier IV lakes are privately owned. Although the number of Tier IV lakes is unclear, the city estimated that there are approximately 276 acres of Tier IV lakes within the City of Naples. Ultimately, these lakes treat stormwater and discharge to receiving water bodies or by way of their connection to the City's stormwater system. Many of these lakes and lake systems are within developments that have been permitted by the South Florida Water Management District (SFWMD) and therefore regulated under State rules and regulations enforced by the SFWMD.

The Tiers are summarized below in Table 1, with supplementary information from the 2012 Lakes Plan and information from a study of stormwater lakes efficacy and function [Amec Environment & Infrastructure, Inc. (Amec), 2012]. The 2012 stormwater lake ranking indicates on a scale of 1 to 100, where 1 is the best and 100 is the poorest, the functionality of the stormwater lake. The 2012 ranking was on a relative scale based on the range of treatment performance of 28 City lakes considering the residence time, pollutant removal efficiency estimated by multiple methods, potential for stratification, sediment accumulation, mass loading of pollutants per lake volume, and finally the absolute mass of pollutants discharged. Lake locations are shown in Figure 1.

Table 1. Summary of Stormwater Lakes on the City of Naples Inventory

Lake Name and No.	Ownership [a]	Receives Public Drainage? [a]	Receiving Waterbody [b]	2012 Stormwater Lake Score [b]
Tier I Lakes				
#6 Mandarin Lake	Public	Yes	Gordon River	49
#19 15th Ave North Lake [c]	Public	Yes	Gordon River	17
#22 Lake Manor [c]	Public	Yes	Gordon River	45
#23 Lowdermilk Lake	Public	Yes	Moorings Bay	--
#31 East Lake [c]	Public	Yes	Naples Bay	89
Tier II Lakes (High Priority Pollutant Loading)				
#2 Swan Lake	Private	Yes	Moorings Bay	84
#11 Spring Lake [c]	Undetermined	Yes	Naples Bay	48
#8 North Lake [c]	Undetermined	Yes	Gulf of Mexico	39
#9 South Lake [c]	Undetermined	Yes	Gulf of Mexico	100
#10 Alligator Lake [c]	Undetermined	Yes	Gulf of Mexico	87
#14 Lantern Lake	Private	Yes	Naples Bay	48
#24 Half Moon Lake	Private	Yes	Naples Bay	80
Tier III Lakes (Remaining Inventoried Lakes)				
#1 Devils Lake	Private	Yes	Moorings Bay	31
#3 Colonnade	Private	Yes	Moorings Bay	36
#4 No Name	Private	Yes	Moorings Bay	22
#5 Lake Suzanne	Private	Yes	Moorings Bay	46
#7 No Name	Private	No	Gulf of Mexico	26
#12 No Name	Private	No	Naples Bay	22
#13 No Name	Private	No	Naples Bay	29
#15 Sun Terrace Lake [c]	Private	Yes	Gordon River	24
#16 Thurner Lake [c]	Private	Yes	Gordon River	12
#17 No Name [c]	Undetermined	Yes	Gordon River	17
#20 Forest Lake [c]	Private	Yes	Gordon River	47
#21 Willow Lake [c]	Private	Yes	Gordon River	6
#25 No Name	Private	No	Naples Bay	26
#26 NCH Lake	Private	No	Naples Bay	26
#27 No Name	Private	No	Moorings Bay	--
#28 No Name	Private	No	Naples Bay	55
Tier IV Lakes (Non-Inventoried Private Lakes and Lake Systems)				

Note: [a] City of Naples 2012 Lakes Management Plan
[b] City of Naples Stormwater Quality Analysis, Pollutant Loading and Removal Efficiencies, Amec, 2012
[c] Lakes included in SFWMD permits obtained by the City

The 2012 Lakes Plan also identified five lakes with the least effective pollutant removal efficiencies (Table 2, Amec, 2012). A properly designed stormwater retention lake has the capability of removing pollutants to the following efficiencies:

- Total Nitrogen (TN): 70%
- Total Phosphorus (TP): 95%
- Total Suspended Solids (TSS): 95%

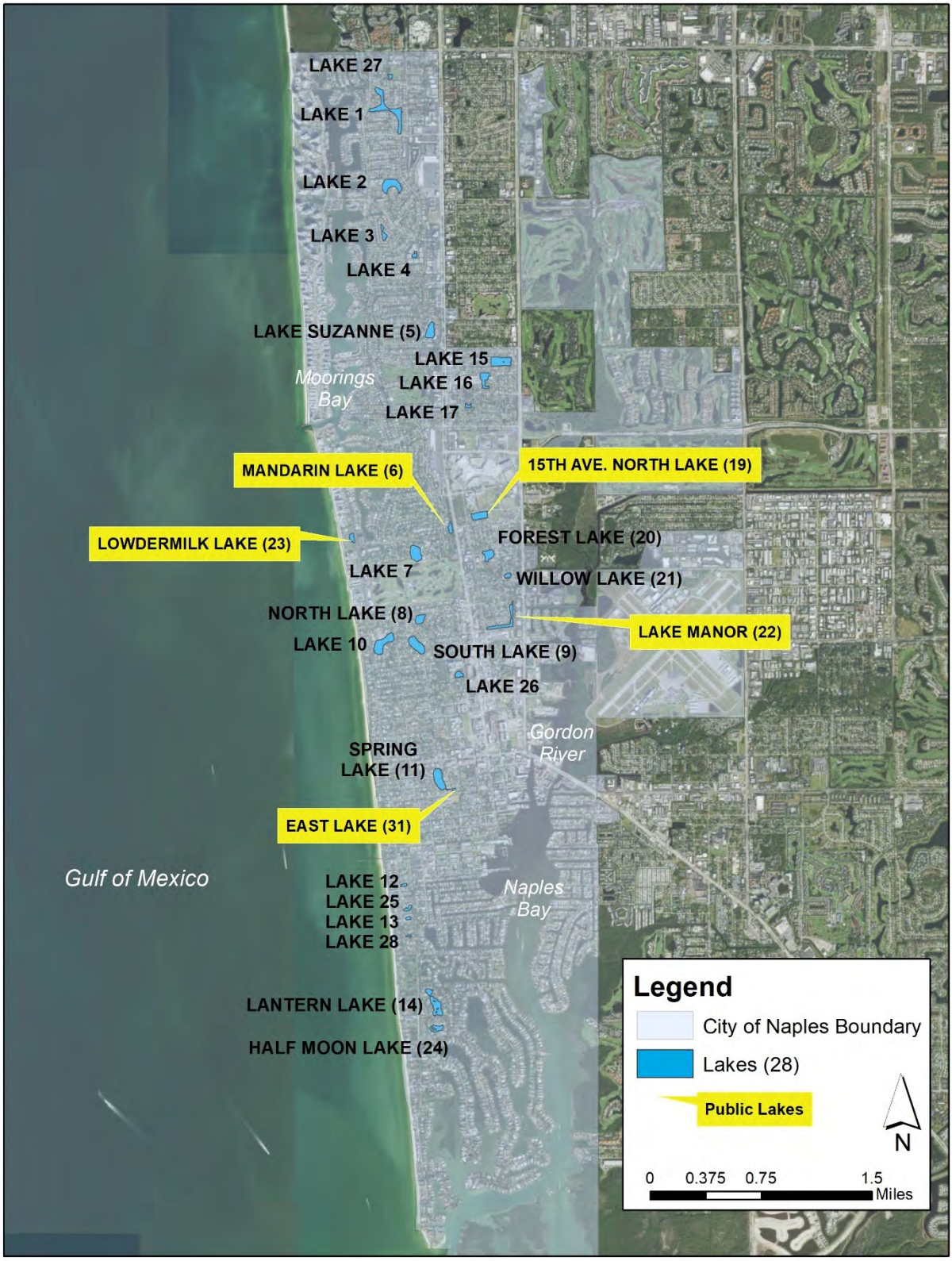
Table 2. Stormwater Lake Pollutant Removal Efficiencies for the Five Most Underperforming Lakes (Amec, 2012)

Lake Name (Lake #)	2012 Lakes Plan Tier	2012 Stormwater Lake Score	Pollutants of Concern [a]	Pollutant Removal Efficiencies (%) [b]			Lake Ownership
				TN	TP	TSS	
South Lake (#9)	II	100	TN, TP	**-123**	**-192**	27	Undetermined
East Lake (#31)	I	89	TN, TP, fecal coliform	**-3**	27	--	Public
Alligator Lake (#10)	II	87	TN, TP, TSS	**-18**	13	**-200**	Undetermined
Swan Lake (#2)	II	84	Copper, fecal coliform	47	69	**-292**	Private
Half Moon Lake (#24)	II	80	TN, TP	**-139**	**-363**	--	Private

Note: [a] TN=total nitrogen, TP=total phosphorus, TSS=total suspended solids
[b] Negative pollutant removal efficiencies are bolded and indicate lakes that are increasing the concentration of the select parameter in stormwater discharge

The 2012 Lakes Plan highlighted recent (at the time) accomplishments at the five Tier I lakes, including dredging at East Lake (#31); vegetative maintenance at East Lake (#31), at 15th Ave North Lake (#19), Lowdermilk Lake (#23), Lake Manor (#22), and Mandarin Lake (#6); and an improved weir at 15th Ave North Lake (#19). Littoral plantings/vegetative islands had been completed at Lake Manor (#22) and East Lake (#31). A fountain was installed at Mandarin Lake (#6) and aeration was in place at Lake Manor (#22). The City also identified specific in-lake improvement technologies for future projects. These specific technologies, which included use of chemical amendments, floating islands, and dredging, were selected by the City because they are common and unlikely to seriously impact plants and wildlife. Included in the 2012 Lakes Plan were estimated removal efficiencies and estimated costs for each technology.

Figure 1. Stormwater Lakes on the City of Naples Inventory



1.1.2 2018 Stormwater Master Plan Update

The City updated its Stormwater Master Plan in 2018. The 2018 SMPU included a summary of previous stormwater lakes reports (City of Naples Stormwater Quality Analysis, Pollutant Loading and Removal Efficiencies by Amec Foster Wheeler from 2012, the 2012 Lakes Plan, the Bathymetry and Sediment Characterization of Lake Manor from 2013, and the City of Naples Semi-annual and Quarterly Stormwater Infrastructure Monitoring from 2013 and 2014). Based on information from these reports and other data reviewed, the 2018 SMPU made the following recommendations for lakes:

- Update the 2012 Lakes Plan with lake restoration and maintenance priorities, as related to pollutant issues at each lake, and develop funding alternatives, including partnership opportunities, that will assist with implementing projects at lakes.
- Develop watershed sub-basin plans that seek to maximize treatment of stormwater for improved water quality while providing a higher level of service as it relates to flood protection.
- Develop public education programs to reduce copper loadings at Devil's Lake and Naples Community Hospital Lake.
- Maintenance of shoreline vegetation and/or construction of littoral shelves (15th Ave North Lake, Mandarin Lake).
- Improve stormwater quality at lake discharge points by implementing nutrient removal stormwater manholes, boxes and control structures where the cost of installation and maintenance achieves a minimum pollutant removal effectiveness.
- In partnership with lakefront property owners, seek to maximize the use of lake aeration systems where the benefits of increased dissolved oxygen (for habitat survival) and lower lake temperatures (to reduce algae blooms) justifies the cost of installation and ongoing maintenance.
- In partnership with lakefront property owners, seek to implement floating islands where the benefits of nutrient removal justifies the cost of installation and ongoing maintenance.

1.2 Recent Projects

The above referenced documents were completed in 2012 and 2018; however, the 2018 SMPU did not include review of all reports generated after 2016. Since 2016, several stormwater lake studies and projects have been, or are being, completed:

- In 2019, Wood completed an engineering report that provides restoration and maintenance alternatives for Spring Lake (#11) and East Lake (#31), along with logistical approaches to executing a project such as dredging. This is considered particularly challenging considering the limited open areas available to dewater dredged material and the very restricted accessibility to and from the lakes. The report also provides strategies for generating revenue for restoration and maintenance projects and these strategies may have application to other City lakes beyond Spring and East lakes. The report is scheduled to be presented concurrently with the 2019 Updated Lake Management Plan.
- Water quality data and analysis for Lake Manor comparing pre versus post 2015 restoration.
- During the stakeholder surveys (Section 3.0), homeowners mentioned the following projects that have been implemented (although no dates were given):
  - Aeration fountains at Swan Lake (#2), Lake #3, Lake #4, Lake Suzanne (#5), Spring Lake (#11), Lake #7, and Forest Lake (#20); and

- The school district dredging Lake #27.
- Biological treatment applications at Spring Lake and Swan Lake.
- Lake fill permits issued that recontour lake banks to create living shorelines that reduce pollutants in stormwater.

2.0 Assessment of Current Conditions and Data Gaps

Wood prepared an updated stormwater lakes water and sediment quality database and incorporated previous stormwater lake assessment information into the review, as described below.

2.1 Water Quality

Each lake considered in this study discharges to one of four receiving waterbodies: Moorings Bay, Gordon River, Naples Bay, or the Gulf of Mexico (Figure 1). Several water quality issues have been recognized among these waterbodies:

- Moorings Bay may potentially contain high levels of total phosphorus, bacteria, and copper (Cardno, 2015; AMEC, 2014). These issues may trigger an impairment listing during FDEP's next assessment cycle (anticipated in 2019).
- Gordon River and Naples Bay are impaired for copper (FDEP, 2019).
- The Gulf of Mexico (Collier County) is impaired for fecal coliform (FDEP, 2019).

Wood compiled the available data to produce a comprehensive water quality database spanning 2010 to 2019. Data spanning multiple years for contaminants of interest (nutrients, TSS, select metals, bacteria, chlorophyll, dissolved oxygen) were available for Devils Lake (#1), Swan Lake (#2), Colonnade (#3), Lake Suzanne (#5), Mandarin Lake (#6), North Lake (#8), South Lake (#9), Alligator Lake (#10), Lantern Lake (#14), Sun Terrace Lake (#15), 15th Ave North Lake (#19), Forest Lake (#20), Lake Manor (#22), Half Moon Lake (#24), NCH Lake (#26), and East Lake (#31). Limited data were available for Lake 4, Thurner Lake (#16), Willow Lake (#21), and Lowdermilk Lake (#23). Data gaps are summarized in Section 2.3 below.

The available water quality data for each lake are visualized in Appendix B. The highest mean contaminant concentrations were observed at the following lakes:

- Chlorophyll-a concentrations were highest at Lakes 24, 8, and 14.
- Copper concentrations were highest at Lakes 26 and 1.
- Fecal coliform concentrations were highest at Lakes 31 and 6.
- Total nitrogen concentrations were highest at Lakes 24 and 8.
- Total phosphorus concentrations were highest at Lakes 24 and 14.
- Total suspended solids concentrations were highest at Lakes 8 and 24.

The following statistically significant ($p<0.05$) temporal trends were found in the observed dissolved oxygen saturations and concentrations of chlorophyll-a, copper, total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), and fecal coliform, beginning 2010 and 2012 and ending in early 2019:

- At Devils Lake (#1), TSS concentrations have trended downward (slope=–0.003 mg l^{-1} d^{-1}; $p=0.002$).
- At Swan Lake (#2), TN concentrations have trended upward (slope<0.001 mg l^{-1} d^{-1}; $p=0.015$) and TSS concentrations have trended downward (slope=–0.002 mg l^{-1} d^{-1}; $p=0.009$).
- At Lake Suzanne (#5), copper concentrations have trended downward (slope=–0.003 µg l^{-1} d^{-1}; $p=0.019$) and DO saturations have trended upward (slope=0.009% d^{-1}; $p=0.029$).

- At South Lake (#9), copper concentrations have trended downward (slope=–0.016 µg l^{-1} d^{-1}; p=0.011).
- At Alligator Lake (#10), TP concentrations have trended upward (slope<0.001 mg l^{-1} d^{-1}; p=0.009).
- At Lantern Lake (#14), TN concentrations have trended upward (slope<0.001 mg l^{-1} d^{-1}; p=0.018).
- At 15th Ave North Lake (#19), TSS concentrations have trended upward (slope=0.003 mg l^{-1} d^{-1}; p=0.016), fecal coliform concentrations have trended downward (slope=–0.95 $(100\ ml)^{-1}$ d^{-1}; p=0.025), and DO saturations have trended upward (slope=0.011% d^{-1}; p=0.040).
- At Forest Lake (#20), chlorophyll-a concentrations have trended downward (slope=–0.079 mg m^{-3} d^{-1}; p=0.009).
- At Lake Manor (#22), DO saturations have trended downward (slope=–.031% d^{-1}; p=0.025) since January 1, 2016 (post-restoration).
- At Half Moon Lake (#24), copper concentrations have trended downward (slope=–0.003 µg l^{-1} d^{-1}; p=0.034), DO concentrations have trended downward (slope=–0.025% d^{-1}; p=0.031).
- At NCH Lake (#26), TP has trended downward (slope< –0.001 mg l^{-1} d^{-1}; p=0.032).
- At East Lake (#31), TN concentrations have trended downward (slope< –0.001 mg l^{-1} d^{-1}; p=0.011).

Water quality trends are considered in the updated rankings (Section 4.0).

2.2 Sediment Quality

In addition to the water quality date summarized above, Wood reviewed the following sediment data and reports:

- AECOM, 2018, City of Naples Stormwater Master Plan Update (2018 SMPU).
- MACTEC, 2008, Water Quality and Sediment Sampling at Spring Lake.
- MACTEC, 2010, Stormwater Lake Maintenance and Improvement Program Report.
- Southwest Florida Aquatic Ecology Group at Florida Gulf Coast University (FGCU), 2013, Bathymetry and sediment characterization of Spring Lake City of Naples, FL.
- Thomas, Serge, 2013, Bathymetry and sediment characterization of Lake Manor, City of Naples, FL. Southwest Florida Aquatic Ecology Group.

The SW Florida Aquatic Ecology Group characterized the sediment of Lake Manor prior to the 2016 dredging of the lake (Thomas, 2013). Sediment was analyzed for chlorides, total Kjeldahl Nitrogen (TKN), TN, Nitrates + nitrites (NO_x), ammonia nitrogen, orthophosphate, TP, total organic carbon, and heavy metals (Al, As, Cd, Cu, Pb, Hg and Zn). Post dredge bathymetric surveys were conducted in April 2019 (Amec Foster Wheeler, 2016).

MACTEC (2008) performed sediment sampling at Spring Lake (Lake 11) with a Ponar dredge at three locations in the lake. The sediment was analyzed for metals (As, Cd, Cr, Cu, Pb, Hg), polynuclear aromatic hydrocarbons (PAHs), and total recoverable petroleum hydrocarbons (TRPH).

MACTEC (2010) measured muck thickness at 28 stormwater lakes in the City of Naples. Based upon the results of the soft sediment thickness measurements, thicker soft sediment was often associated with

inflow structures. Soft sediment thickness of 19 inches or greater was observed at Lake #1NW, Lake #2, Lake #9, Lake #20, Lake #22, and Lake #25.

Florida Gulf Coast University (2013) conducted a bathymetric survey of Lake #11, providing valuable information about the physical characteristics of the lake; the report also includes data on sediment and water quality. The lake was eutrophic (for nitrogen) and sediment samples from 2008 contained concentrations of arsenic, copper, lead, total residual petroleum hydrocarbons, and benzo-a-pyrene that exceeded default soil clean-up target levels (SCTL).

2.3 Data Gaps

As reported in the 2018 SMPU, 15 of the 28 stormwater lakes within the City and all three pump stations were included in the water quality monitoring program; water quality data are not available for all lakes. Of the five public lakes and/or the lakes performing the poorest in pollutant removal, several data gaps were identified:

- Water quality data for Spring Lake (#11) are limited. However, Spring Lake is physically and hydraulically connected to East Lake (#31), which is directly downstream. Spring Lake's water quality is expected to be similar to that of East Lake, which is sampled regularly.
- Water quality data for Lowdermilk Park Lake (#23) are extremely limited, with only one observation of each constituent available (sampled in November 2013). This lake had no reports of algal blooms, fish kills or associated visual or aromatic deficiencies.
- Water quality data for 2014 were extremely limited at many lakes, including Lakes 1, 2, 5, 6, 9, 10, 19, 22, 24, and 31: For most constituents of interest, a single observation of the concentration was available at each lake.

Of the remaining lakes, Lakes 4, 7, Thurner Lake (#16), and Willow Lake (#21) data are limited to samples from 2012 or 2013. The North Lake (#8) data are limited to 2012 and 2017 through 2019.

The dataset contains no water quality data for Lakes 12, 13, 17, 25, 27, and 28.

City staff has indicated that changes in data collection efforts for these private or undetermined lakes were refocused to lakes that the City has clear control over or for which has clear drainage easement rights. Also, water quality sampling periodically continued at lakes that received public stormwater and have or have had notable issues of concern, such as algae, fish kills, etc.

Water quality and sediment/muck data are important to understand pollutants of concern in each lake. These data help scientists and engineers develop programs and projects aimed specifically at reducing pollutants of concern in the lake and upstream. The projects recommended in the previous planning and management documents were based on water quality and sediment/muck data collected. Some of the project recommendations for lakes in the 2018 SMPU should be re-evaluated after data gaps for lakes are filled if policy direction for each lake leads the City to become actively involved with lake management and restoration.

An additional data gap is the lack of recent influent data, which is a key component of the calculation of the 2012 rankings. The 2012 rankings incorporated the following factors: residence time, pollutant removal efficiency, potential for stratification, sediment accumulation, mass loading of pollutants per lake volume, and absolute mass of pollutants discharged. Several of these factors depend on influent concentrations, which have not been monitored since February 2014. Other factors (e.g. residence time)

are determined from the lake volume and flow through. These data have not been updated since 2014 and although the lake depths and volumes may not have changed significantly in some lakes, dredging and construction projects and potential sediment accumulation would affect these values. Recent muck thickness data are also not available.

It is commonly understood that major lake restoration efforts are designed on a case-by-case basis by scientists and engineers. The precursor to design is data collection. While the City has been collecting data for a specific purpose (monitoring), additional data collection would be a critical precursor to engineering and design. The collected data would enable engineers to quantify necessary work and establish a baseline for existing conditions. This baseline data is integral in gauging a project's success (or failure) and cost/benefit.

3.0 Citizen Survey

A citizen survey was administered to gather information about the health and status of specific stormwater lakes from adjacent property owners. The intent of the survey was to gather information on lakes from the people who see them every day. The survey instrument used in the 2018 SMPU (described below) was reviewed prior to design of the current survey instrument.

3.1.1 Previous Survey (2018 SMPU)

Stakeholder involvement was incorporated into the 2018 Stormwater Master Plan Update and included two public meetings, a survey that was available on the City's website to provide input, and two City council workshops that consisted of a 60% meeting of the document and 100% meeting of the document. The survey was available on the City's website through the Survey Monkey service from 2/22/2017 through 7/11/2017. The survey was emailed to homeowner's associations and City Council on March 15, 2017. The survey included questions about the entire City of Naples and city-wide issues, including a focus on the health of Naples Bay, Gordon River, Gulf of Mexico/Naples Beaches, and Moorings Bay.

3.1.2 Lake Survey

The survey instrument used in this Lake Management Plan update is included in Appendix C-1. Definitions of water quality and water quantity and some elements of the questions in this document are from the survey instrument used in the 2018 SMPU. During design of the survey, the instrument used by Gholson et al. (2017 dissertation and 2019 peer-reviewed publication) regarding "Public Perception and Attitudes About Water Resources in Texas" were reviewed.

3.1.3 Results of Lake Survey

The survey instrument was emailed to stakeholders identified by the City. Surveys were sent to 30 stakeholders distributed across 20 lakes (Table 3). Stakeholders are defined as managers of lakes, lakefront property owners, and property owner association managers. Recipients were given the option to complete and return the survey via email or complete the survey with a Wood staff member. As of September 6, 2019, surveys had been completed for 15 lakes. Select survey responses are included in Table 4 and completed surveys are included in Appendix C-2.

Stakeholders ranked Devil's Lake (#1), Swan Lake (#2), Lake Suzanne (#5), Lake 7, and North Lake (#8) water quality as good or good to excellent. Conversely, Alligator Lake (#10), Spring Lake (#11), Forest Lake (#2), and East Lake (#31) were rated as having poor water quality; Lake #12 was rated as having poor but improving water quality. Swan Lake (#2), Colonnade (#3), Lake #4, Lake Suzanne (#5) Mandarin Lake (#6) and Lake #27 were ranked as having good to excellent water quantity. North Lake (#8) water quantity was rated as good but deteriorating. Lake #12 was rated as having poor but improving water quantity.

The majority of stakeholders indicated that they would be interested in supporting or participating in activities that will improve the water quality in the Lake.

In January of 2019, City staff identified an algae bloom in Swan Lake; however, the Swan Lake respondent did not specifically mention algae blooms and ranked the lake as having good or excellent water quality. Wood is awaiting responses from three other stakeholders at the lake.

Table 3. Summary of Stakeholders Contacted and Responses Received for Lake Survey

Lake Number/Name	Number of Stakeholders Contacted	Response Received? [a]
#1 Devils Lake	1	Yes
#2 Swan Lake	4	Yes
#3 Colonnade	2	Yes
#4	1	Yes
#5 Lake Suzanne	1	Yes
#6 Mandarin Lake	1	Yes
#7 No Name	1	Yes
#8 North Lake	1	Yes
#9 South Lake	No contact identified	NA
#10 Alligator Lake	1	Yes
#11 Spring Lake	3	Yes
#12	2	Yes
#13	No contact identified	NA
#14 Lantern Lake	2	Awaiting response
#15 Sun Terrace Lake	No contact identified	NA
#16 Thurner Lake	1	Awaiting response
#17	1	Awaiting response
#19 15th Ave North Lake	1	Awaiting response
#20 Forest Lake	1	Awaiting response
#21 Willow Lake	2	Awaiting response
#22 Lake Manor	Not contacted	NA
#23 Lowdermilk Lake	Not contacted	NA
#24 Half Moon Lake	No contact identified	NA
#25	No contact identified	NA
#26 NCH Lake	2	Awaiting response
#27	1	Yes
#28	No contact identified	NA
#31 East Lake	1	Yes

Note: [a] For Lakes with more than one stakeholder contacted, "Yes" means that at least one survey response was received.

Table 4. Select Survey Responses from Lake Stakeholder Surveys (page 1 of 2)

Lake	Stakeholder Responses					Notes
	Water Quality Rating [a]	Water Quantity Rating [a]	Flooding?	Who is responsible for maintaining the lake?	Interested in supporting or participating in water quality improvement?	
#1 Devils Lake	Good or Excellent	No opinion or don't know	No	not answered	Yes	Stakeholder believes that City of Naples lowers lake levels prior to storm events
#2 Swan Lake	Good or Excellent	Good or Excellent	Yes	Ann Dietz, lakefront property owner champions efforts	Yes	
#3 Colonnade	Fair	Good or Excellent	Yes	Property Owners Association	Yes	
#4 (Hidden Lake)	Fair	Good or Excellent	Yes	Condo association - company maintains - Lake Doctors come out monthly	Maybe	
#5 Lake Suzanne	Good or Excellent	Good or Excellent	Yes	Committee - condo on other lake	Definitely	Stakeholder also mentioned Lake Doctors working at the Lake
#6 Mandarin Lake	Fair	Good or Excellent	Yes	The City	Yes	Stakeholder mentioned concern for algae blooms
#7	Good or Excellent	Fair	No	Steven Duckworth - director and volunteer, Lake Doctors for monthly maintenance	Yes	
#8 North Lake	Good and improving	Good but deteriorating	Yes	City owns and maintains aerators and floating islands	Sure	
#9 South Lake	No contact identified					
#10 Alligator Lake	Poor	Fair	Yes	City of Naples	Yes	
#11 Spring Lake	Poor	Fair	No	City	Yes	
#12	Poor but improving	Poor but improving	Yes	Surrounding homeowners, hired Lake Doctors	--	
#12	Fair	Fair	No	Adjacent property owners pay Lake Doctors	Yes	Stakeholder mentioned concern for algae blooms

Table 4. Select Survey Responses from Lake Stakeholder Surveys (page 2 of 2)

Lake	Stakeholder Responses						Notes
	Water Quality Rating [a]	Water Quantity Rating [a]	Flooding?	Who is responsible for maintaining the lake?	Interested in supporting or participating in water quality improvement?		
#13	No contact identified						
#14 Lantern Lake	Awaiting response						
#15 Sun Terrace Lake	No contact identified						
#16 Thurner Lake	Awaiting response						
#17	Awaiting response						
#19 15th Ave North Lake	Awaiting response						
#20 Forest Lake	Poor	Fair	No	Homeowners	Yes		
#21 Willow Lake	Fair	Fair	No	City of Naples	Yes		Stakeholder mentioned concern for frequent growth of green material floating on surface
#22 Lake Manor	Not contacted						
#23 Lowdermilk Lake	Not contacted						
#24 Half Moon Lake	No contact identified						
#25	No contact identified						
#26 NCH Lake	Awaiting response						
#27	Fair	Good or Excellent	Neighbors have experienced flooding	School District	Yes		
#28	No contact identified						
#31 East Lake	Poor	No opinion or don't know	No	Previously assumed it was City, but was told it was surrounding property owners	Yes		Stakeholder mentioned concern for algae blooms

Note: [a] Possible ratings were: no opinion or don't know, poor, poor but improving, fair, good but deteriorating, good and improving, good or excellent

4.0 Stormwater Lake Rankings

The City's stormwater lakes were ranked in 2012, as described in the 2012 Lakes Plan and Amec (2012), then re-ranked in 2013 to incorporate new information. Wood re-ranked the lakes in 2019 using different data inputs because of the data limitations discussed in Section 2.3.

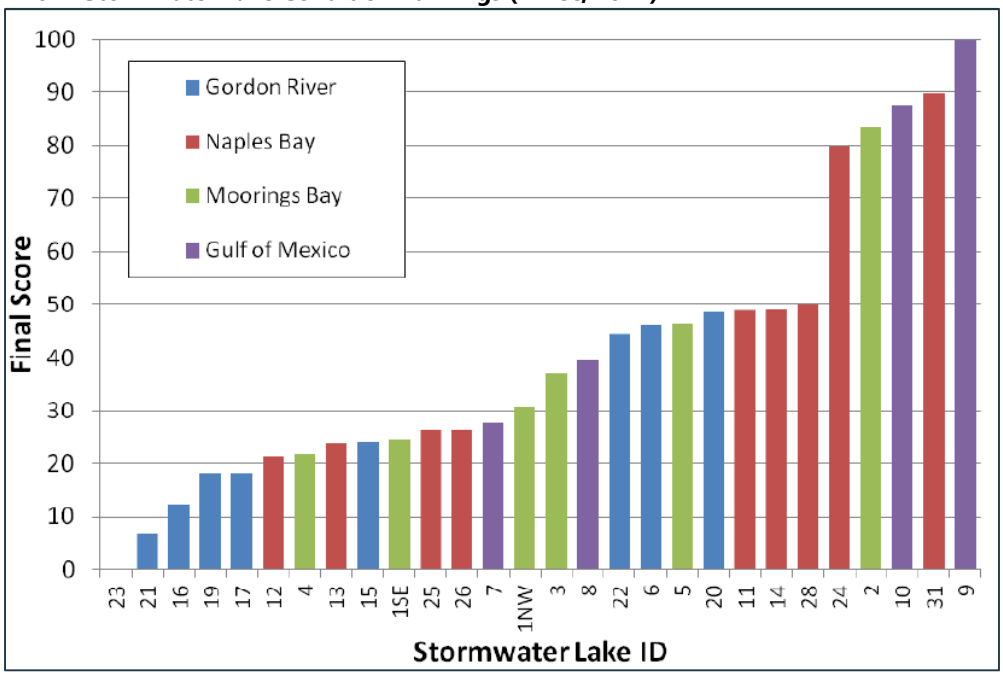
4.1 Rankings from Previous Reports

The stormwater lakes on the City's inventory were ranked in 2012 and presented in the 2012 Lakes Plan using condition assessment calculation. The data incorporated in the 2012 ranking were:

- Residence time
- Predicted and observed removal rates
- Potential for stratification
- Sediment thickness
- Total mass loadings to volumetric capacity
- Concentration comparison
- Total pollutant loading discharged from each stormwater lake

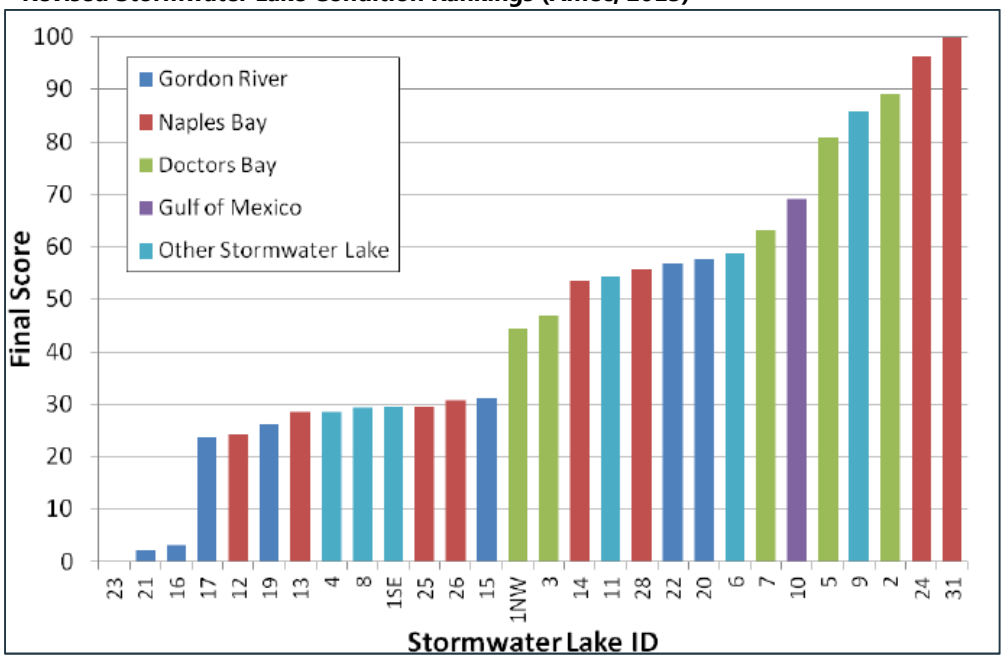
Individual lake indices were calculated for each factor listed above and the lakes were scored against each other by normalizing the indices on a scale of 1 to 100; the scores were averaged to produce a final score. Lower scores indicated lakes in relatively good condition and higher scores indicated lakes in relatively poor condition. Lakes were ranked based on their final score, reproduced below in Figure 2 (Amec 2012). During the 2012 ranking, the worst performing lakes were: South Lake (#9), East Lake (#31), Alligator Lake (#10), Swan Lake (#2), and Halfmoon Lake (#24). Only East Lake (#31) is controlled exclusively by the City.

Figure 2. 2012 Stormwater Lake Condition Rankings (Amec, 2012)



In 2013, the rankings were revised to include new information affecting the loading calculations and removal of TSS from the index. Otherwise, the calculations and data inputs were largely the same as in the 2012 ranking. The revised 2013 scores are reproduced below in Figure 3.

Figure 3. Revised Stormwater Lake Condition Rankings (Amec, 2013)



4.2 Updated Rankings Methods

Wood re-ranked the lakes on the City's inventory using a new ranking methodology that emphasizes water-quality impacts to the lakes' receiving waterbodies (Gordon River, Moorings Bay, Naples Bay, and the Gulf of Mexico) over each lake's own internal water quality. The new ranking methodology reflects changes to the City's water quality monitoring program since 2013 (see Section 2.3): The previous monitoring program collected data at many of the lakes' *inlets and outlets*, enabling estimation of quantities considered in the 2012 and 2013 rankings (e.g., residence times and removal efficiencies). More recently, the monitoring program has emphasized more frequent sampling of water quality at lake *outlets*. As such, the updated ranking methodology emphasizes water quality leaving the lakes, in terms of observed levels of nutrients, metals, pathogens, sediments, and dissolved oxygen.

The lake ranking methodology considers seven water quality constituents observed at 22 lakes for which water-quality data are available (Lakes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 19, 20, 21, 22, 23, 24, 26, and 31):

- Chlorophyll-a (mg/m^3): Chlorophyll-a is an indicator of the amount of algae in surface water—high concentrations of chlorophyll-a can indicate increased algae and degraded water conditions [US Environmental Protection Agency (USEPA) 2016]. The chlorophyll-a numeric nutrient criteria for Moorings Bay, Naples Bay, and the Gulf of Mexico (inshore, near Collier County) are 8.1 µg/L, 4.3 µg/L, and 1.6 µg/L, respectively, expressed as annual geometric means (AGMs), per Florida Statute 62-302.532. The units µg/L and mg/m^3 are equivalent.
- Copper (Cu; µg/L): Copper is used in herbicides and algicides to control nuisance algae and aquatic plants. High concentrations indicate degraded water quality. Copper does not degrade and can

accumulate in lake sediment. At Naples Bay, the Gordon River, and Moorings Bay, the surface water quality standard for copper is ≤ 3.7 µg/L, per Florida Statute 62-302.530.

- Dissolved oxygen saturation (DO; %): Low DO indicates degraded water quality and is unhealthy for fish and other aquatic animals. Low DO can be caused by several factors, including the die-off of aquatic plants and algae [Institute of Food and Agricultural Sciences (IFAS, 2019)].
- Fecal coliform [colony forming units (CFU) per 100 ml]: Fecal coliform is associated with sewage or animal waste [Florida Department of Environmental Protection (FDEP), 2019]; high concentrations indicate degraded water quality. In Naples Bay, the Gordon River, and Moorings Bay, the CFU is not to exceed a median value of 14 with not more than 10% of the samples exceeding or 31, and the CFU should not exceed 800 on any one day (Surface Water Quality Standards Chapter 62-302).
- TN (mg/L): Nitrogen can be introduced to surface water via fertilizer. High concentrations degrade water quality, contribute to algal growth, and lower dissolved oxygen (USEPA, 2013). The TN numeric nutrient criteria for Moorings Bay, Naples Bay, and the Gulf of Mexico (inshore, near Collier County) are 0.85 mg/L, 0.57 mg/L, and 0.29 mg/L, respectively, expressed as annual geometric means (AGMs), per Florida Statute 62-302.532.
- TP (mg/L): Phosphorus can also be introduced to surface water via fertilizer, where high concentrations contribute to algal blooms and degraded water quality [US Geographical Service (USGS)]. The TP numeric nutrient criteria for Moorings Bay, Naples Bay, and the Gulf of Mexico (inshore, near Collier County) are 0.040 mg/L, 0.045 mg/L, and 0.018 mg/L, respectively, expressed as annual geometric means (AGMs), per Florida Statute 62-302.532.
- TSS (mg/L): Total suspended solids are organic and inorganic particles found in the water column. High concentrations of TSS can harm aquatic organisms and indicate degraded water quality (USEPA, 2003).

4.2.1 Data processing

The water quality data were collected by the City between 2010 and 2019, although the periods of record (PORs) vary by constituent and by lake. The ranking also considers lake sediment depth data collected in 2012.

Prior to analysis, the water quality data were cleaned to correct mislabelled units; standardize constituent names, constituent units, and sampling site names across the dataset; and remove misreported values. In addition, we replaced each set of replicate observations (observations made on the same day) with the daily arithmetic mean.

When an analyte was not detected in a sample, the method detection limit—the minimum concentration that can be detected by the analytical method—was recorded as the observed concentration.

DO saturation is a measure of the concentration of oxygen dissolved in water, relative to the maximum concentration that can be dissolved in water at a given temperature, pressure, and salinity (USGS, 2011). The dataset included 194 cases in which temperature and DO concentrations were reported without the corresponding DO saturation values. We imputed these missing DO saturation values using contemporaneous temperature and DO concentration observations and assuming an elevation of 1 m (Moulton, 2018). This method yielded a high Nash-Sutcliffe efficiency (NSE=0.872) when applied to the 724 cases for which contemporaneous temperature, DO concentration, and DO saturation observations

were available (Nash-Sutcliffe, 1970), indicating the calculations used to estimate missing saturation data are approximately correct. The available salinity data were not included in the calculation, because their inclusion yielded a poorer fit to the reported DO saturation values (NSE=0.802).

4.2.2 Ranking methodology

The ranking methodology follows a multi-criteria decision framework, in which weighted *factors* (e.g., water quality parameters) are used to calculate a *score* for each lake (USEPA, 2017). The factors include the seven water quality constituents (see Section 4.2, above) and sediment depth, and each lake's factor values are adjusted to reflect estimated runoff volume from the lake's watershed (as described in the following section). The *weights* assigned to each factor reflect the factors' importance in determining a lake's priority relative to the other lakes. Each lake's score is computed as

$$score_j = \sum_{i=1}^{N} weight_i * factor_i \qquad \textbf{(Equation 1)}$$

for *N* factors at the *j*th lake. We present normalized scores (values between 0 and 100), with 100 representing the relatively highest-priority lake and zero representing the lowest-priority lake, given the specified weighted scheme (described below). Rankings reflect the lakes' relative overall water quality as well as their relative discharge contribution to receiving waterbodies.

A lack of water quality data precluded inclusion of Lakes 12, 13, 17, 25, 27, and 28 in the ranking. Despite data limitations, Lakes 4 and 11 were included in the ranking: These lakes were assigned the scores computed for directly connected lakes (Lakes 3 and 31, respectively).

4.2.2.1 Factors

For each constituent at each lake, we computed the arithmetic mean of observations over the full POR and the arithmetic mean of observations from the past three years (after September 6, 2016). We refer to these values as 'all-time means' and '3-year means,' respectively. The means were normalized on a scale of 0.0 to 1.0, where a value of zero corresponds to the lowest mean concentration across the 22 lakes, and a value of 1.0 corresponds to the highest mean concentration. For each constituent, the normalization effectively transforms means expressed in absolute units (e.g., µg/L) into relative values, in order to eliminate bias introduced by the varying magnitude scales and measurement units across constituents. For consistency, we subtracted the normalized DO saturation values from 1.0, so that a value of 1.0 corresponds to the lowest DO saturation (lowest quality).

In order to account for variability in the lakes' discharge volumes to receiving waterbodies, we adjusted the mean constituent values (concentration or saturation) for each lake by a runoff volume factor, which represents a lakeshed's annual runoff volume as a fraction of the basin's total annual runoff volume. The runoff volume factor was calculated using the Amec (2012) lakeshed annual average runoff volumes (Table 5). Each adjusted mean concentration (or saturation) value was computed as the product of the mean (concentration or saturation) and the runoff volume factor. The intuition is that lakes with larger-volume lakesheds (and therefore greater discharge to a receiving waterbody) should rank more highly than lakes with smaller-volume lakesheds, all else being equal.

Next, we applied linear regression (i.e., ordinary least-squares regression) to determine whether each constituent at each lake showed a statistically significant (α=0.05) linear trend (increasing or decreasing)

over its POR, as given by the regression's estimate of the slope (see also Appendix B and Section 2.1). For each constituent at each lake (except Lake Manor, described below), we used either the runoff-adjusted 3-year mean (if the slope was significant) or the runoff-adjusted all-time mean (if the slope was not significant) as a factor in computing the lake's score. Thus, the selected mean encodes information about the trend, since the difference between the all-time and 3-year means corresponds to the direction and magnitude of the slope. For instance, for a constituent with a significantly increasing trend, the 3-year mean is greater than the all-time mean, and the magnitude of the difference is directly related to the magnitude of the slope. A constituent with a significantly increasing (or decreasing) trend therefore increases (or decreases) the corresponding lake's score, all else being equal. See Appendix B for full results of the trend analysis.

Because Lake Manor (#22) underwent restoration in 2015, we excluded data prior to January 1, 2016 for the purposes of ranking. Thus, the 'all-time' means for Lake Manor represent the means of data collected after restoration (i.e., 2016 or later).

In addition to the means and slopes for each constituent at each lake, we considered the 2012 sediment depth as a factor (Table 6) (Amec, 2012). Lake Manor (#22) sediment depth was not included because this lake was dredged after 2012, and an updated sediment depth measurement was not available.

Table 5. Lakeshed Annual Average Runoff Volumes (Amec, 2012) and Runoff Volume Factors

Sample Location	Runoff Volume (acre-feet)	Runoff Volume Factor	Sample Location	Runoff Volume (acre-feet)	Runoff Volume Factor
1NW	53.52	0.04	15	47.37	0.04
1SE	34.35	0.03	16	9.26	0.01
2	171.23	0.14	17	22.90	0.02
3	25.51	0.02	19	19.65	0.02
4	27.36	0.02	20	32.93	0.03
5	84.47	0.07	21	4.51	<0.01
6	20.71	0.02	22	78.94	0.06
7	19.05	0.02	23	5.60	<0.01
8	38.38	0.03	24	2.23	<0.01
9	19.47	0.02	25	1.28	<0.01
10	16.04	0.01	26	12.45	0.01
11	91.05	0.07	28	2.97	<0.01
12	1.21	<0.01	31	3.75	<0.01
13	8.54	0.01	PW	348.01	0.28
14	12.50	0.01	LL	26.28	0.02
			Total	1241.52	1.00

Table 6. Average Lake Sediment Thickness (in) (Amec, 2012)

Lake	Average Sediment Thickness (in) [a]	Lake	Average Sediment Thickness (in) [a]
#1 Devils Lake	6.07	#15 Sun Terrace Lake	5.29
#2 Swan Lake	9.31	#16 Thurner Lake	1.57
#3 Colonnade	0.60	#17	ND
#4	4.38	#19 15th Ave North Lake	7.50
#5 Lake Suzanne	7.00	#20 Forest Lake	7.40
#6 Mandarin Lake	11.50	#21 Willow Lake	1.67
#7	0.33	#22 Lake Manor	0 [b]

#8 North Lake	2.38		#23 Lowdermilk Lake	0.17
#9 South Lake	8.00		#24 Half Moon Lake	5.00
#10 Alligator Lake	5.00		#25	9.60
#11 Spring Lake	3.50		#26 NCH Lake	0.60
#12	4.00		#27	ND
#13	3.50		#28	12.67
#14 Lantern Lake	6.00		#31 East Lake	ND

Note: [a] ND=no data;
[b] Lake Manor dredged in 2015

4.2.2.2 Weights

For each lake with recent data available (Lakes 1, 2, 3, 5, 6, 8, 9, 10, 14, 15, 19, 20, 22, 24, 26, and 31), the raw score was computed using eight weights corresponding to the eight factors (seven mean constituent values and one sediment depth value for each lake). We applied a weighting scheme that assigned equal weight to each of the seven means (0.135) and a lower weight to sediment depth (0.055). The weights sum to unity (0.135*7 + 0.055 = 1).

Water quality data for several lakes were limited to one or two samples taken in 2012 or 2013 (Lakes 7, 16, 21, and 23). Because these data did not include chlorophyll-a concentrations, we applied a modified weighting scheme to compute the raw scores for these lakes. The modified weighting scheme assigned a weight of 0.160 to each of the six remaining mean constituent values (Cu, coliform, DO, TN, TP, and TSS) and a weight of 0.040 to the sediment depth value for each of these lakes. Again, the weights sum to unity (0.160*6 + 0.040 = 1).

The final scores presented in the ranking (Figure 4) were computed by normalizing the raw scores to a scale of 0 to 100.

4.2.3 Geometric means

We computed annual geometric means (AGMs) for a subset of constituents (chlorophyll-a, Cu, fecal coliform, TN, TP, and TSS) at public lakes (Lakes 6, 19, 22) and at the highest-priority lakes identified in the 2012/2013 reports and in the current ranking. The AGM is computed by raising the product of *n* observations from a given year to the power 1/*n*. AGMs are plotted on a logarithmic scale.

AGM concentrations are not volume-adjusted. Therefore, the lake with the highest AGM concentration value is not necessarily the lake with the greatest water-quality impact on the receiving waterbody.

4.3 Updated Rankings Results

The lakes with the highest-priority rankings—indicating the strongest overall impact on water quality of the receiving waterbody—were Swan Lake (#2), East Lake (#31), Spring Lake (#11), North Lake (#8), and Lake Suzanne (#5). The score for Lake 11 was developed using the best available information (including water quality data collected at Lake 31), since a lack of recent water-quality data precluded calculation of its score using Equation 1. The public lakes ranked 2nd (East Lake #31), 11th (Mandarin Lake #6), 12th (15th Avenue North Lake #19), and 17th (Lowdermilk Lake #23).

In addition to the lake rankings, Wood calculated annual geometric means for TN, TP, chlorophyll-a, Cu, fecal coliform, and TSS at the three public lakes with available data (Figures 5 through 10) and at the

highest-priority lakes: Lakes 2, 31, 8, and 5 (Figures 11 through 16). The AGM concentrations are presented on a logarithmic scale.

Whereas the ranking was structured to prioritize lakes in terms of their overall impact on water quality in receiving waterbodies (i.e., lakes with larger-volume watersheds have a larger impact, all else being equal), the AGM concentrations provide insight into annual water quality dynamics near the outlets of selected lakes. That is, the lake with the highest AGM concentration for a given constituent is not necessarily the lake contributing the greatest constituent load to the receiving waterbody, since the AGMs are not volume-adjusted (for a ranking that emphasizes in-lake water quality, see Figure 17 in Section 5). Below, we discuss several of the AGM concentrations with respect to numerical criteria for Naples Bay, Moorings Bay, and Class II waters. While these criteria provide a relevant basis for comparison, they do not govern water quality at the stormwater lakes.

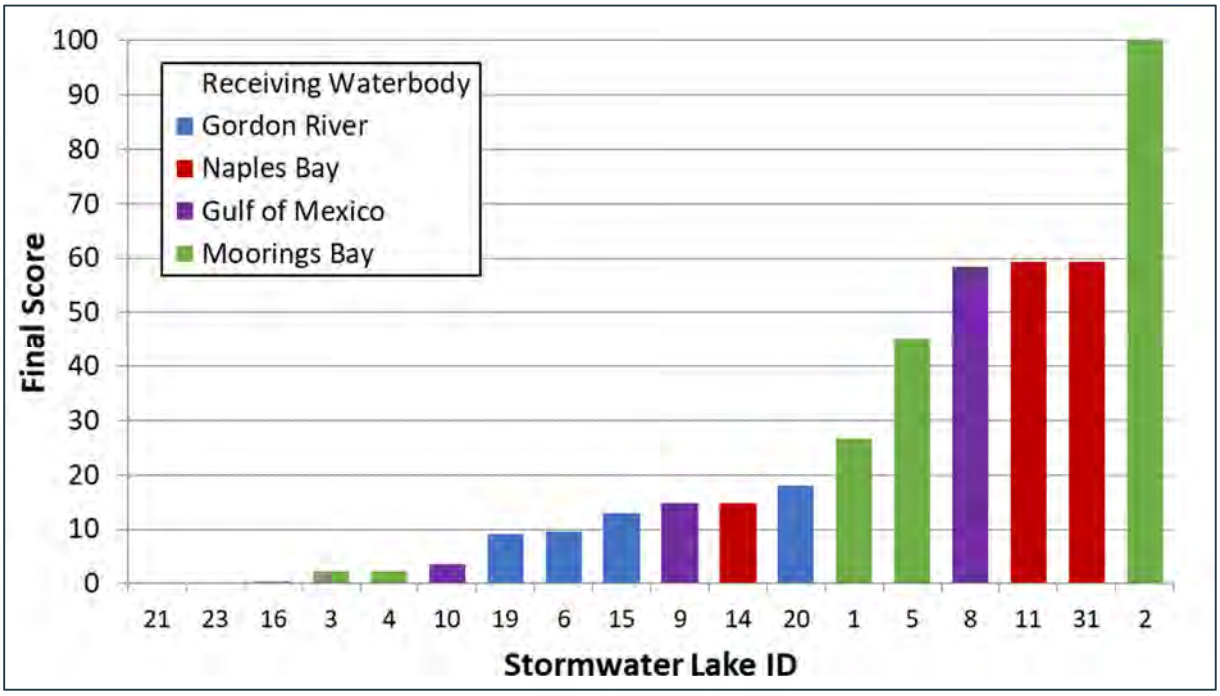
Water quality data from four of the public lakes—Lakes 6, 19, 22, and 31—were adequate to provide meaningful comparisons to numerical criteria governing these lakes' receiving waterbodies (Figures 5 through 10). Lakes 6, 19, and 22 discharge into Gordon River, which flows directly into Naples Bay; Lake 31 discharges to Naples Bay. Among these four public lakes, AGM concentrations of TN and chlorophyll-a consistently remained above the numerical criteria for Naples Bay (0.57 mg/L and 4.3 µg/L, respectively) during their PORs. AGM concentrations for TP at each of the four lakes often exceeded the Naples Bay criterion (0.045 mg/L) during the POR, although the AGMs at Lakes 6, 19, and 22 have decreased in recent years. In 2018, AGM TP concentration at Lake 22 decreased to 0.033 mg/L, below the Naples Bay criterion. In contrast, the AGM TP concentration at Lake 31 has consistently remained relatively high throughout the POR. Regarding copper, AGM concentrations have consistently remained below the numerical criterion (3.7 µg/L), with the exception of Lake 31 at which the concentrations have consistently remained relatively high. In 2014, copper was not detected at Lakes 6, 19, and 22, and the reported concentration (4.0 µg/L) reflects the method detection limit. We present these data with an important caveat: Data for Lakes 6, 19, and 22 in 2014 are limited to one observation date (December 15). Therefore, the 2014 values for these lakes, as shown in Figures 5 through 10, are not likely to be representative of real-world conditions throughout 2014.

Annual geometric mean concentrations for TN, TP, and chlorophyll-a at the three non-public high-priority lakes—Lakes 2, 5, and 8—generally exceeded the numerical criteria corresponding to their respective waterbodies (see above for a description of water quality issues at Lake 31). Lakes 2 and 5 discharge to Moorings Bay, and Lake 8 discharges to the Gulf of Mexico. At Lake 2, AGM concentrations of TN exceeded the criterion for Moorings Bay (0.85 mg/L) in 2012, 2013, and 2015 through 2018; AGM concentrations of TP exceeded the criterion (0.040 mg/L) in 2011 through 2018; AGM concentrations of chlorophyll-a consistently exceeded the criterion (8.1 µg/L) during the POR; and AGM concentrations of copper exceeded the criterion (3.7 µg/L) in 2010 through 2015 and 2017 and 2018. At Lake 5, AGM concentrations of TN, TP, and chlorophyll-a consistently exceeded the Moorings Bay criteria (0.85 mg/L, 0.040 mg/L, and 8.1 µg/L, respectively) during the PORs; and, after substantially exceeding the criterion (3.7 µg/L) for several years, the AGM concentration of copper fell below the criterion in 2016 and exceeded the criterion in 2017 and 2018. At Lake 8, AGM concentrations of TN, TP, and chlorophyll-a substantially exceeded the numerical criteria for the Gulf of Mexico (0.29 mg/L, 0.018 mg/L, and 1.6 µg/L, respectively) during the PORs; and the AGM concentration of copper was below the criterion (3.7 µg/L) in 2017 and above the criterion in 2018. (The data for Lake 8 were limited to 2012, 2017, and 2018.) Again, we present these data with an important caveat: At Lakes 2 and 5, the data for 2014 are limited to one observation date (December 15); at Lake 31, the data for 2014 are limited to one observation date (chlorophyll-a, TN; December 15) or two observation dates (copper, fecal coliform, TP, TSS; February 5 and

December 15). Therefore, the 2014 values for these lakes, as shown in Figures 11 through 16, are not likely to be representative of real-world conditions in 2014.

Because the rankings were influenced by the runoff volume factor (Table 5), the highest-ranking lakes are not necessarily the ones with the poorest overall water quality. That is, the area of each lake's basin was an important factor in determining the rankings. See Figure 17 in Section 5.0 for a ranking based on in-lake water quality without regard to downstream impacts.

Figure 4. 2019 Stormwater Lake Rankings
The rankings emphasize water quality impacts on receiving waterbodies, with scores ranging from zero (lowest priority) to 100 (highest priority). Lakes 4 and 11, for which limited or no water quality data were available, were assigned the scores computed for directly connected lakes (Lakes 3 and 31, respectively). Scores for Lakes 16, 21, and 23 were computed using a modified weighting scheme, due to data limitations (see Section 4.2.2.2 for details). Lakes 12, 13, 17, 25, 27, and 28 were not ranked due to a lack of water quality data. Lake 22 was not ranked, since restoration was completed in 2015.



We also summarized the following data for each lake (Table 7):

- Receiving waterbody
- Details about the lake's connection to receiving waterbody; for example, if it discharges directly to the receiving waterbody and if there are any stormwater lakes upstream
- Whether or not the lake receives public drainage
- Whether or not there is easement access to the lake
- Lake ownership

This qualitative data, in combination with the water quality analyses, will be used in the recommendations and can help with the decision-making process by allowing for the consideration of downstream impacts of projects as well as ease of project implementation and access.

Figure 5. Annual Geometric Mean (AGM) Concentrations of Total Nitrogen (TN) at Public Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative. AGM concentrations for TN at Lake Manor (#22, blue points) decreased following the 2015 restoration project. Data for Lake 23 are limited to one sample in 2013.

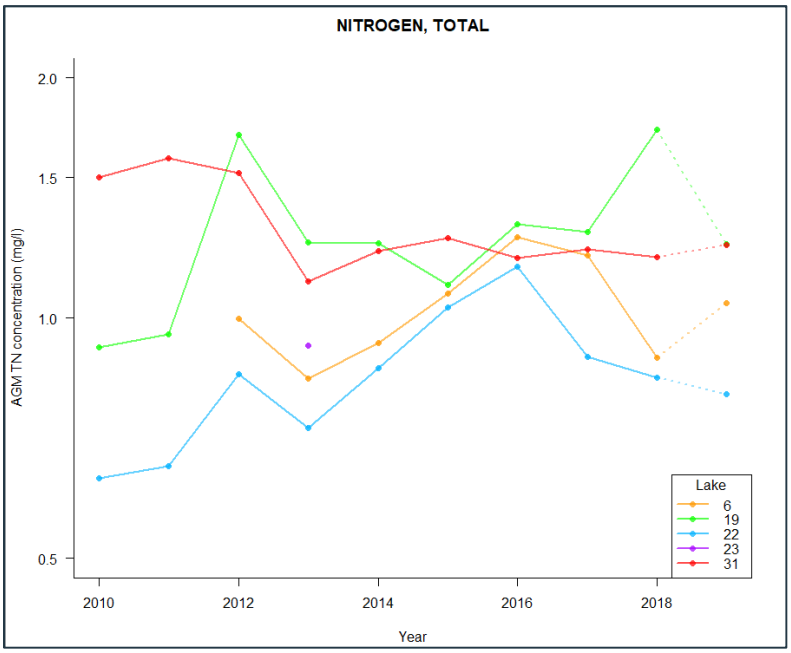


Figure 6. Annual Geometric Mean (AGM) Concentrations of Total Phosphorus (TP) at Public Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative. Data for 2014 are limited to one sample per lake; therefore, the reported mean (and apparent concentration spikes) may not represent actual conditions. Data for Lake 23 are limited to one sample in 2013.

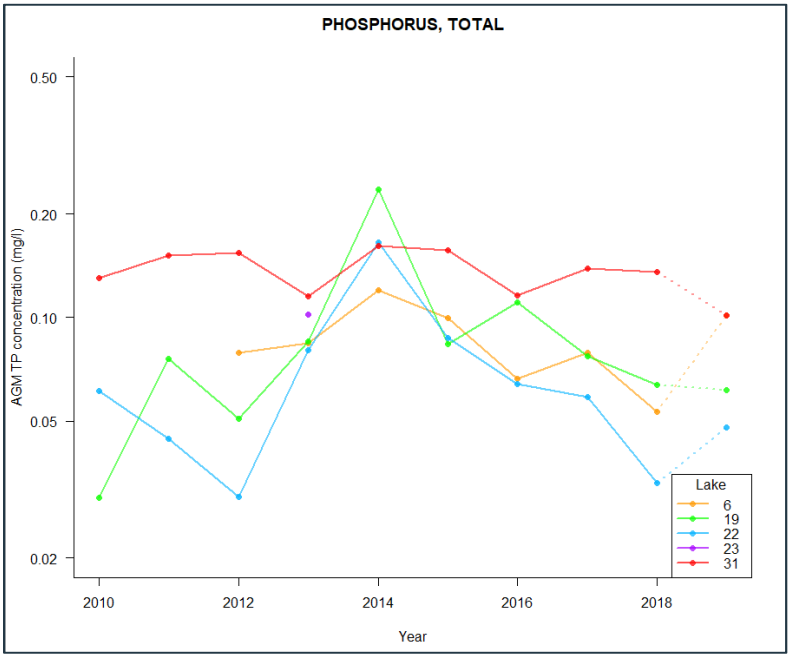


Figure 7. Annual Geometric Mean (AGM) Concentrations of Chlorophyll-a at Public Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative. No data were available for Lake 23.

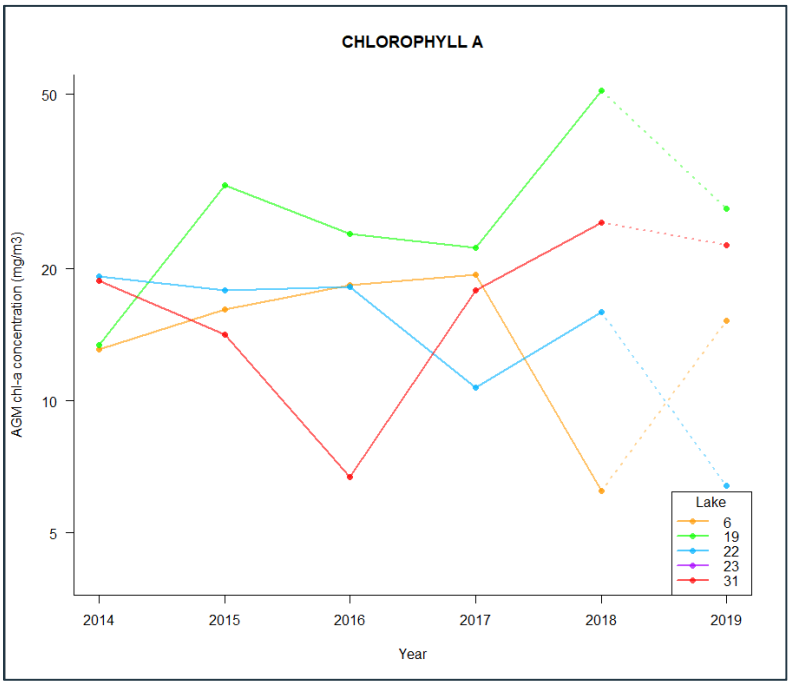


Figure 8. Annual Geometric Mean (AGM) Concentrations of Copper (Cu) at Public Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative. Data for 2014 are limited to one sample per lake; therefore, the reported mean (and apparent concentration spikes) may not represent actual conditions. Data for Lake 23 are limited to one sample in 2013.

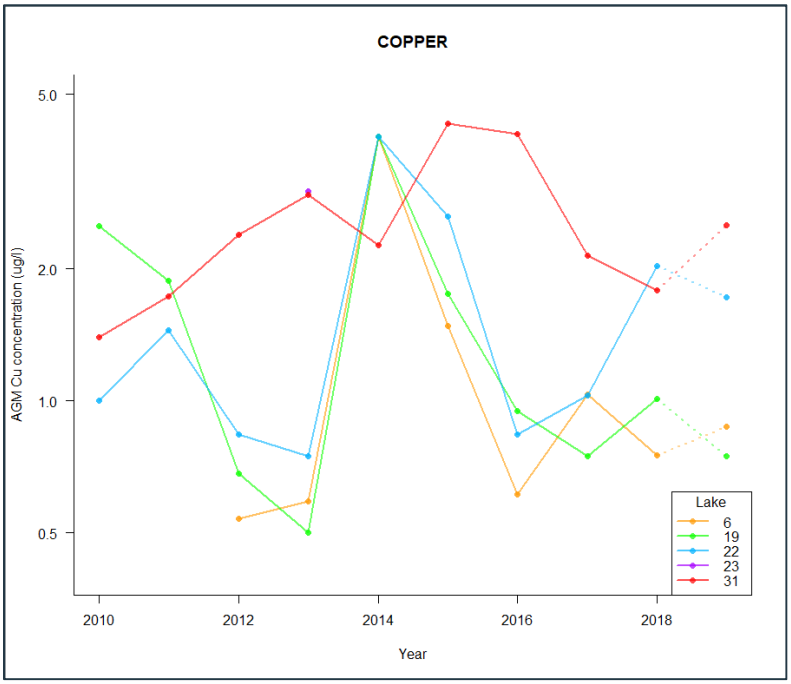


Figure 9. Annual Geometric Mean (AGM) Concentrations of Fecal Coliform Colony-Forming Units (CFUs) at Public Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative. Data for Lake 23 are limited to one sample in 2013.

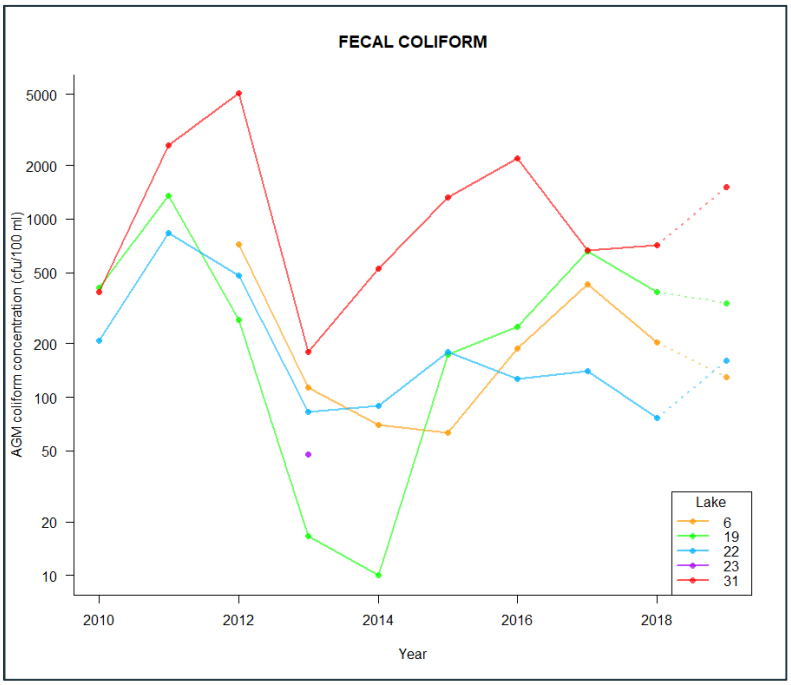


Figure 10. Annual Geometric Mean (AGM) Concentrations of Total Suspended Solids (TSS) at Public Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative. Data for Lake 23 are limited to one sample in 2013.

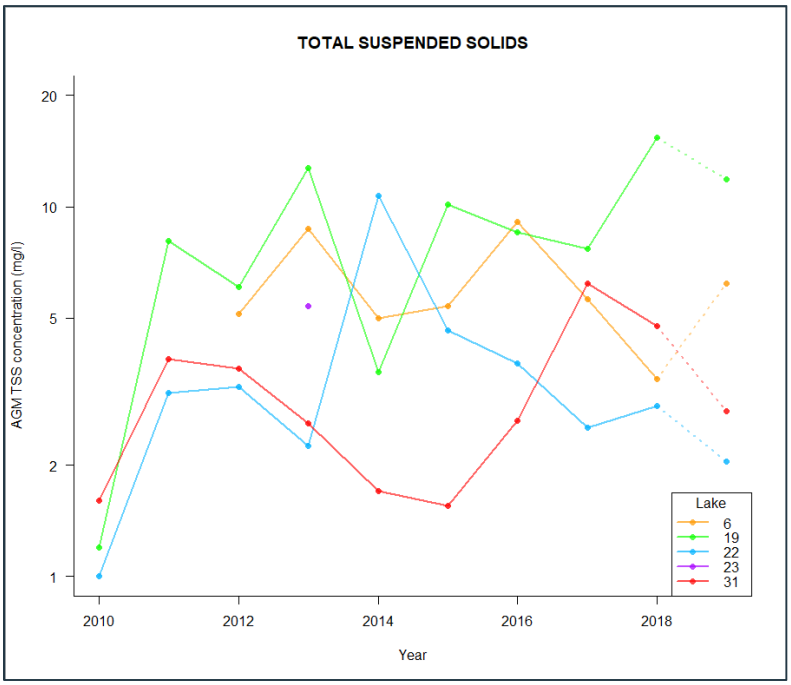


Figure 11. Annual Geometric Mean (AGM) Concentrations of Total Nitrogen (TN) at Priority Lakes, Plotted on a Logarithmic Scale

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative.

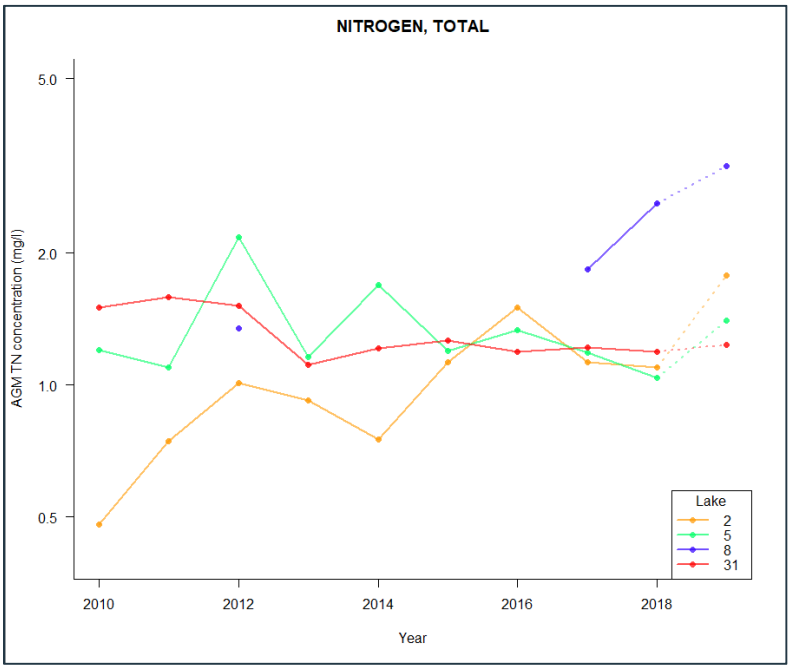


Figure 12. Annual Geometric Mean (AGM) Concentrations of Total Phosphorus (TP) at Priority Lakes, Plotted on a Logarithmic Scale.

Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative.

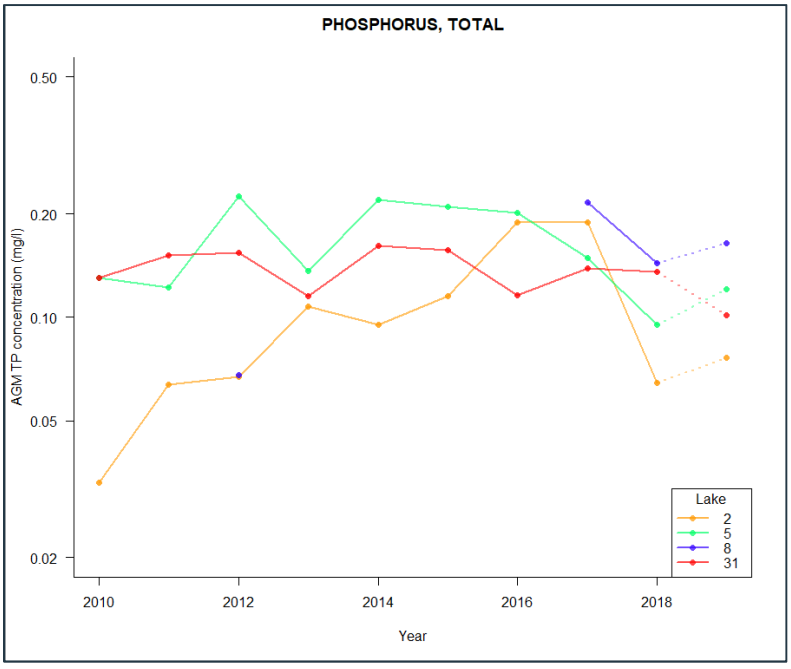


Figure 13. Annual Geometric Mean (AGM) Concentrations of Chlorophyll-a at Priority Lakes, Plotted on a Logarithmic Scale
Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative.

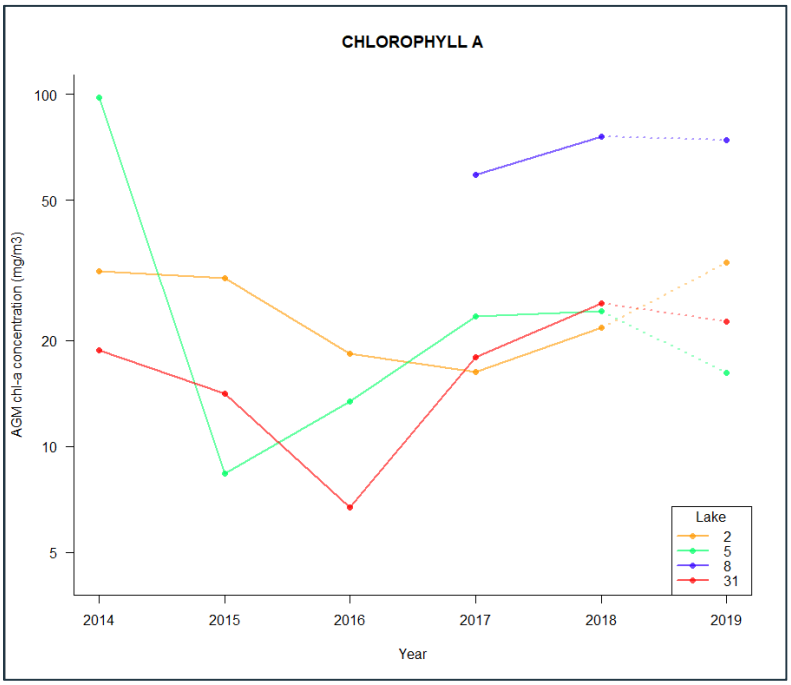


Figure 14. Annual Geometric Mean (AGM) Concentrations of Copper (Cu) at Priority Lakes, Plotted on a Logarithmic Scale
Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative.

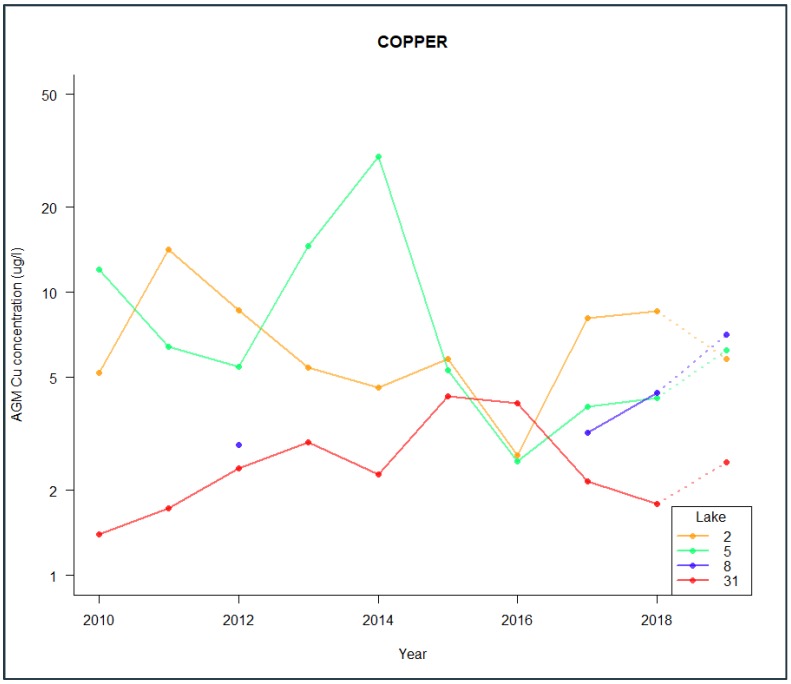


Figure 15. Annual Geometric Mean (AGM) Concentrations of Fecal Coliform Colony-Forming Units (CFUs) at Priority Lakes, Plotted on a Logarithmic Scale
Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative.

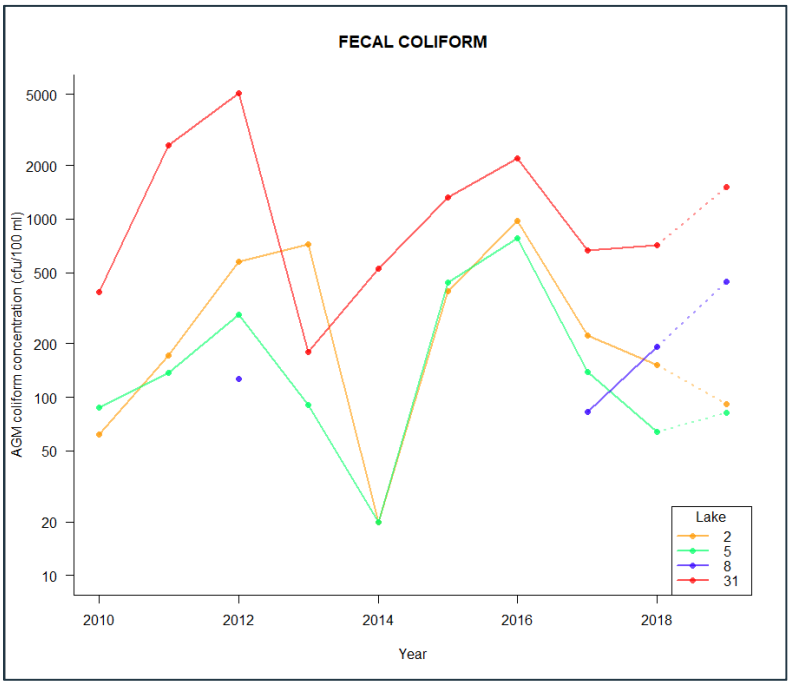


Figure 16. Annual Geometric Mean (AGM) Concentrations of Total Suspended Solids (TSS) at Priority Lakes, Plotted on a Logarithmic Scale
Dotted segments (between the 2018 and 2019 means) indicate that the 2019 means are tentative.

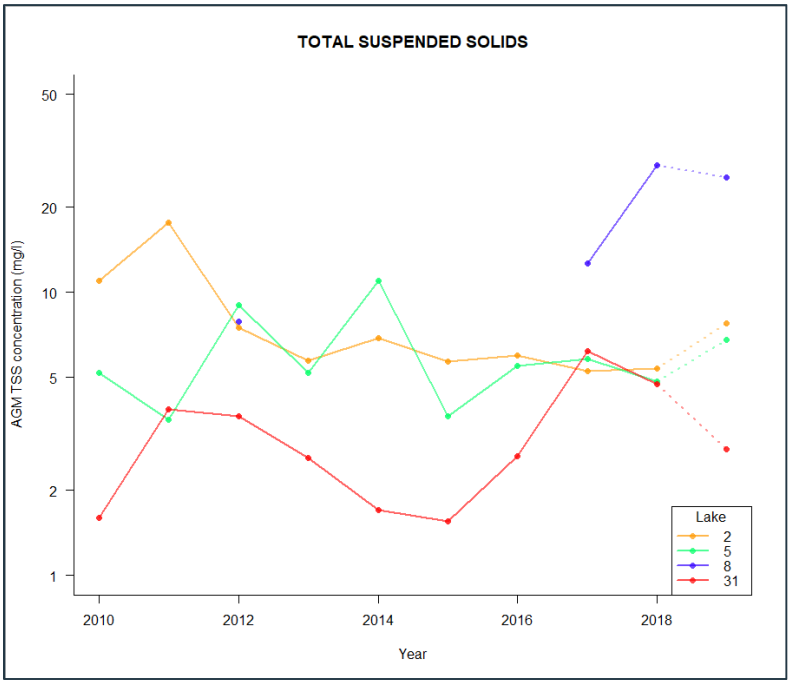


Table 7. Stormwater Lake Receiving Watershed Setting, Ownership, Access, and Rankings Summary (page 1 of 2)

Lake	Receiving Waterbody [a]	Connection to Receiving Waterbody [b]	Upstream Stormwater Lakes [b]	Receives Public Drainage? [c]	Easement Access? [d]	Ownership [c]	2019 Score
#1 Devils Lake	Moorings Bay	Primary	No	Yes	Yes	Private	25
#2 Swan Lake	Moorings Bay	Primary	No	Yes	Yes	Private	100
#3 Colonnade	Moorings Bay	Primary	Yes (Lake #4)	Yes	Yes	Private	0
#4	Moorings Bay	Secondary (via Lake 3)	No	Yes	Yes	Private	0 [e; Lake 3]
#5 Lake Suzanne	Moorings Bay	Primary	No	Yes	Yes	Private	44
#6 Mandarin Lake (public)	Gordon River	Secondary (via Lake 22)	No	Yes	Yes	Public	7
#7	Gulf of Mexico	Quaternary (across golf course and to Gulf of Mexico via Lakes 8, 9, 10)	No	No	Yes	Undetermined	62 [e; 2013 ranking]
#8 North Lake	Gulf of Mexico	Tertiary (via lakes 9 and 10)	Yes (Lake #7)	Yes	Yes	Undetermined	57
#9 South Lake	Gulf of Mexico	Secondary (via Lake 10)	Yes (Lake #8 and Lake #7)	Yes	Yes	Undetermined	13
#10 Alligator Lake	Gulf of Mexico	Primary	Yes (Lakes #9, 8, and 7)	Yes	Yes	Undetermined	1
#11 Spring Lake	Naples Bay	Secondary (via Lake 31)	No	Yes	Yes	Undetermined	58 [e; Lake 31]
#12	Naples Bay	Primary	No	No	No	Private	24 [e; 2013 ranking]
#13	Naples Bay	Primary	No	No	Yes	Private	28 [e; 2013 ranking]
#14 Lantern Lake	Naples Bay	Primary	No	Yes	Yes	Private	13
#15 Sun Terrace Lake	Gordon River	Primary	No	Yes	Yes	Private	11
#16 Thurner Lake	Gordon River	Primary	No	Yes	Yes	Private	3 [e; 2013 ranking]
#17	Gordon River	Primary	No	Yes	Yes	Private	23 [e; 2013 ranking]
#19 15th Ave North Lake (public)	Gordon River	Primary	No	Yes	Yes	Public	7
#20 Forest Lake	Gordon River	Primary	No	Yes	Yes	Private	16

Table 7. Stormwater Lake Receiving Watershed Setting, Ownership, Access, and Rankings Summary (page 2 of 2)

Lake	Receiving Waterbody [a]	Connection to Receiving Waterbody [b]	Upstream Stormwater Lakes [b]	Receives Public Drainage? [c]	Easement Access? [d]	Ownership [c]	2019 Score
#21 Willow Lake	Gordon River	Primary	No	Yes	Yes	Private	2 [e; 2013 ranking]
#22 Lake Manor (public)	Gordon River	Primary	Yes (Lake #6 and Lake #26)	Yes	Yes	Public	9
#23 Lowdermilk Lake (public)	Moorings Bay	*Primary? Geographic Information System (GIS) data incomplete*	No	Yes	N/A	Public	0 [e; 2013 ranking]
#24 Half Moon Lake	Naples Bay	Primary	No	No	Yes	Private	2
#25	Naples Bay	Primary	No	No	No	Private	29 [e; 2013 ranking]
#26 NCH Lake	Naples Bay	Secondary (via Lake 22)	No	No	No	Private	7
#27	Moorings Bay	Secondary (via Lake 1)	No	No	Not in easement research report	Private	not ranked [f]
#28	Naples Bay	Primary	No	No	No	Private	55 [e; 2013 ranking]
#31 East Lake (public)	Naples Bay	Primary	Yes (Lake #11)	Yes	Not in easement research report	Public	58

Note: [a] Amec, 2012. Varying data on receiving waterbody for Lake 26.
[b] Stormwater lake connected directly (primary) or passing through other stormwater lakes prior to reaching receiving waterbody; GIS analysis using Stormwater Pipes and Discharge Direction shapefiles.
[c] City of Naples, 2012.
[d] 2010 Drainage Easement Research by City.
[e] Lakes with data from only 2013 and earlier; score imported from directly connected lake with 2019 score or, if no directly connecting lake, the 2013 score was imported.
[f] Lake #27 was not ranked in either 2012, 2013, or 2019 because of a lack of data.

5.0 Updated Recommendations and Funding Strategies

Water quality improvement can be achieved through a variety of methods. Implementing various Best Management Practices (BMP) is a common way that the water quality within lakes are improved. There are a variety of BMPs that can be implemented, depending on site specific considerations at each lake, including but not limited to type of impairment, available land / access, long term maintenance requirements, and implementation cost.

City Lake Control and Maintenance Responsibilities

The City's lake inventory includes a total of 28 lakes. Of these 28 lakes, five lakes are under direct control of the City. In addition, 20 of these 28 lakes accept discharge from public rights-of-way within the City, and the remaining seven of these 28 lakes do not receive drainage from public rights-of-way, however they do discharge into the City's stormwater collection system. Through the years, there has been some uncertainty regarding the City's ownership, drainage easement access/rights, and lake maintenance responsibilities at various lakes due to a lack of understanding of lake ownership. Due to the nature of the ownership of the lakes, a conversation was held on August 26, 2019 between the City Streets and Stormwater Department, Wood, and the City attorney to discuss the City's ability to act at various lakes. The uncertainty of lake ownership in specific instances can create confusion and challenges when developing recommendations for long term maintenance and/or capital projects.

Each lake is unique when it comes to lake ownership and ongoing maintenance: some lakes are permitted by the SFWMD under a City application for regional SW management; some lakes have been receiving stormwater from the City's stormwater collection and conveyance system for decades and pollutants have been deposited within the lakes. There may be some prescriptive rights related to maintaining certain lakes so they continue to operate for public purpose. In addition, certain lakes may have no one who objects or disputes to City-applied dominion and control over a lake, and if so, the City has more capability to provide maintenance on those lakes for the future.

2012 Plan Implementation Strategy Updates

The following four strategies were outlined in the 2012 Plan, and below are updates and progress made on the strategy implementations that have occurred since 2012.

Strategy #1 Lead By Example:

The City has implemented various capital improvement projects (CIPs) over the last seven years, specifically designed to improve lake water quality. For example, the City completed the Lake Manor Restoration Project which included lake dredging, invasive species removal, structure modifications (curb inlet baskets, trash guard, and mitered end sections), educational signage, pervious asphalt trail and littoral shelf modifications to improve water quality within the lake. The City also presented an agreement with a consultant to the City Council for designing a restoration project for Lake #19 (City controlled lake) to improve Lake #19's water quality. The City Council declined to enter into the Agreement as a result of Council interest to consider reprioritizing lake restoration based on lakes with most significant pollutant levels and health impairments. The City has also been able to implement maintenance programs at Swan and Spring Lakes, through partnerships with property owners of the private lakes, that use biological additives to reduce nutrients and muck.

Strategy #2 Public Outreach and Partnerships

It is recommended that the City continue to implement the robust community outreach program that is currently in place. This is especially important on lakes that are privately owned and maintained, as well as on lakes that receive private drainage and discharge into the City's stormwater conveyance system. This 2019 update to the 2012 Plan included homeowner surveys from adjacent parcels for numerous lakes (see Table 4). Therefore, it is recommended to continue that communication with the point of contacts that have been identified on each lake to further future communication and outreach. Some simple ideas for how to foster those relationships include:

- Quarterly email update on the overall status of the City's stormwater management program, including recommendations for simple implementations at each lake.
- Quarterly 1 page pdf newsletter that can be printed and posted in common areas within each lake community.
- Quarterly 1-page pdf newsletter that can be emailed to the lake contacts for their posting to local community/private social media groups that the community is part of.
- Annual survey to each point of contact with questions regarding the current lake status, programs that need modifications or implementations, questions the community has in regards to maintenance, and suggestions for future water quality improvements.

Strategy #3 Regulation and Enforcement

The City recently funded a Stormwater Master Plan Update (2018), which provided numerous recommendations for stormwater regulation and enforcement (see Section 5.3.6). Please refer to the SMPU for details of progress over the past 7 years, as well as recommendations for future regulation and enforcement.

Strategy #4 Assessment Districts for Stormwater Lake Improvements

Special Assessment Districts were recommended in the 2012 Plan in order to spread project costs over vested parties, where consensus agreements with private lake owners could not be reached. As mentioned above, a meeting was held with the City Attorney to discuss lake control, ownership, and maintenance responsibility and how to proceed with lakes of undetermined control.

The City recently funded an Engineering Study for Spring Lake (2019), which provided funding recommendations on equitable distributions for funding Lake Restoration projects (see Section 6.0).

Recommended BMPs

The following sections include various BMPs typically used within the stormwater community. These methods are accepted in the community without significant health concerns for the public or the lake health.

Community Outreach

As detailed above, all lakes should have a community outreach program in place to encourage responsibility of the lake owners and adjacent landowners to take action where applicable and contribute to enhanced lake quality.

In-Catchment BMPs

Monitoring studies and water quality analysis within the stormwater management industry have proven that upstream catchments draining into the lake can have a large effect on overall lake quality. Therefore, as the upstream runoff water quality improves from the upstream catchment entering the lake, the overall lake health can improve. The following are some in-catchment BMPs that could be implemented in most lakesheds to improve water quality entering the lakes.

- Exfiltration Trenches,
- Curb Inlet Baskets,
- Rain Gardens,
- Vegetated Swales.

Vegetative Maintenance

Removal of invasive species and exotics is key to maintaining healthy vegetation within a lake. Many lakes are currently using the Lake Doctors to manage vegetation within the lakes.

Aerators and Fountains

Lakes that are susceptible to algae blooms and fish kills can benefit from the installation of aeration systems and fountains. These systems oxygenize the water, which reduces the potential for anaerobic conditions. In addition, these systems have the capability to reduce the overall lake temperatures, which can also contribute to a reduction of algae blooms and fish kills.

Littoral Shelf Modifications and/or Plantings

Littoral shelf plantings and modifications would act as a first line of defence to reduce nutrients and runoff from the adjacent lawns from entering the lakes, as well as providing additional nutrient uptake within the lake from the additional littoral shelf plants that are dependent on the available nutrients within the lake. In addition to water quality benefits, littoral shelf modifications of the overly steep areas within the banks would also provide a safety upgrade for the lakes to incorporate a more gradual bank slope (Engineering Study Spring Lake, 2019).

Chemical and/or Mineral Treatment (Aluminum Sulfate, Floc Logs, True Blue, etc.)

Aluminum Sulfate (Alum), Floc Logs and dyes such as True Blue are common chemical/mineral treatments that are applied to lakes to improve the overall lake water quality. The City does not have any current lakes where it has implemented these chemical / mineral treatments though it is a common application, especially in lakes with high phosphorus loads and/or TSS counts.

Reuse for Landscaping Irrigation

Currently, the City has lakes where irrigation systems have been connected into the lake to draw water out of the lake and use as landscape irrigation for adjacent properties. This program creates additional treatment of the lake water quality, as it encourages additional infiltration and treatment of the water through percolation. As long as the fertilizers are being managed in accordance with City recommendations and regulations, this program can be expanded on non-tidal and lakes with low to no salinity to encourage additional nutrient uptake of the lake prior to discharge.

Floating Vegetated Islands

Floating islands provide nutrient uptake from the permanent pool of the wet detention pond. Floating islands generally consist of components of a typical wetland, but instead of a soil medium, the roots are anchored in an inert, floating medium and suspended within the water column. This provides the plants direct access to the soluble, bioavailable nutrients that are within the water column and targeted for removal. The floating root mass also provides an ideal substrate for periphyton growth, which works synergistically with the emergent vegetation to enhance nutrient uptake and sequestration. If designed correctly, this direct interaction between wetland root mass and water column nutrients can provide for very efficient nutrient flux and uptake and represents one of the strengths of these hydroponic systems.

Floating island nutrient removal efficiency can be variable and is highly dependent upon proper installation and maintenance. Researchers at University of Central Florida (Chang, et al., 2012) reported removal of up to 54% of TP, 32% of TN, and 48% of nitrate where the rooting media included *Bold & Gold*™. Researchers from New Zealand have reported about 40% removal of TSS and suspended Cu (Borne, et al. 2013), and more than 50% removal of TN and TP (White and Cousins, 2013).

Several researchers recommend covering 5% or less of the stormwater pond by floating islands. Coverage of less than 5% would result in lesser pollutant removal effectiveness but could still be effective as a secondary treatment alternative when used in conjunction with other BMPs, Engineering Study Spring Lake (2019).

Structural Modifications and Repairs (Shoreline Stabilization, Baffle Boxes, Pipe Upgrades, etc.)

A nutrient separating baffle box (NSBB) is a structural BMP used for water quality treatment at the outfall of storm pipes. The box primarily removes sediment and suspended solids from stormwater. The Type II boxes widely used in South Florida consist of an aluminium screen basket with a horizontal bottom at an elevation below the invert of the influent pipe but above the top of baffles. Incoming flow passes through the screen basket, which captures leaves, trash, and other large materials. In addition to capturing the large sized materials and preventing their passage into the baffle box effluent, the material captured in the screen basket is held above and out of the water column. The purported effect is to reduce or eliminate the leaching that would occur if the captured material were submerged. Since leaching of leaves would release biochemical oxygen demand, nitrogen and phosphorus, removing leaves from the stormwater and holding the captured leaves out of the water column results in a reduction of nutrient loading to the receiving water body.

An evaluation of NSBB based on Suntree technology generally removes 90% TSS, 20% TN and 19% TP from the water being directed to the system (Engineering Study Spring Lake, 2019).

Biological Treatment and/or Bio Augmented Aeration (Organic Muck)

Stagnant water leads to accumulation of harmful and dangerous bacteria, low dissolved oxygen prohibits more beneficial aerobic bacteria from living, muck accumulates faster than the anaerobic bacteria can process it and excess nutrients from fertilizer and run-off add to the cloudiness of the water. Aeration can correct and reverse these problems. When a bio-augmented aeration system is installed and turned on in a water body, a rotation of water begins that forms a doughnut pattern around the diffuser. Water is taken into the bubble stream at the diffuser and moved toward the surface by the rising bubbles.

Introduction of aerobic bacteria will expedite this process and will cause compression of the muck as the bacteria breaks down the organic material. When the Lake bottom is anaerobic, roots and other organic material pile up without being decomposed. This leads to a large collection of organic material that

remains in an undecomposed state until it is slowly broken down by anaerobic bacteria. Anaerobic decomposition is 30 to 40 times slower than aerobic decomposition, and many lakes accumulate organic material due to fertilizer runoff and other contaminates faster than this process occurs. With the introduction of oxygen at the lake bed, aerobic bacteria can take over and decompose muck more quickly. The bacteria that will be introduced to accomplish this are broad spectrum strains of naturally occurring bacteria with the ability to degrade most organic compounds.

Bio-augmented aeration consists of small solar powered aeration systems coupled with biological enhancements such as macro-algae. Bio-augmented aeration is completed in a modular approach, with a typical spacing of approximately 100 feet between aeration systems (Engineering Study Spring Lake, 2019).

There are also products available that are specifically formulated to solely introduce microorganisms and micronutrients into the lakes, which act to reduce the muck build-up on the bottom of the lakes. These products work to digest excess organic matter and consume excess nutrients, in order to improve the overall water quality of the lake and do not need the aeration piece to function, though it does encourage decomposition of the muck quicker.

Dredging (Muck and Sediment)

There are two traditional methodologies for removal of muck sediments, mechanical and hydraulic dredging. Based on the thickness and consistency of the muck, either option can be successful. A hydraulic dredging system for the lake systems are more often recommended though, as a mechanical dredging requires heavy equipment and would not be efficient in removing fine organic sediment. Mechanical dredging also requires a large footprint for dewatering since the material needs ample time to dry for hauling to a disposal area. Hydraulic dredging is a relatively low impact method of sediment removal with few effects on the surrounding environmental system. Hydraulic dredging includes a floating dredge, which essentially acts as a floating vacuum cleaner, and a temporary pipeline to transport the dredged material as a slurry to the dewatering site. The volume of the sediment slurry is greater than the in-situ volume of the sediment. The volume of dredge material can be better controlled with a hydraulic dredge than with mechanical dredging techniques. There are various types of hydraulic dredges available for sediment removal, such as the swing ladder, cutterhead, horizontal auger, plain suction, pneumatic, specialty dredge heads and diver-assisted dredge heads.

Based on past project experience, dredging has shown positive results in the improvement of water quality with Lakes, including City of Naples Lake Manor. That being said, the technology is expensive and requires a large vacant footprint to dewater and dispose of the dredged material (Engineering Study Spring Lake 2019).

Lake Recommendations

There have been numerous previous studies performed for the City over the years that have included recommendations for BMPs for lake water quality improvement. Table 8 below, was prepared to compile previous recommendations indicate which lakes may benefit from specific BMPs, and / or to show which lakes have already implemented site specific BMPs. The following studies were reviewed in preparation of Table 5-1:

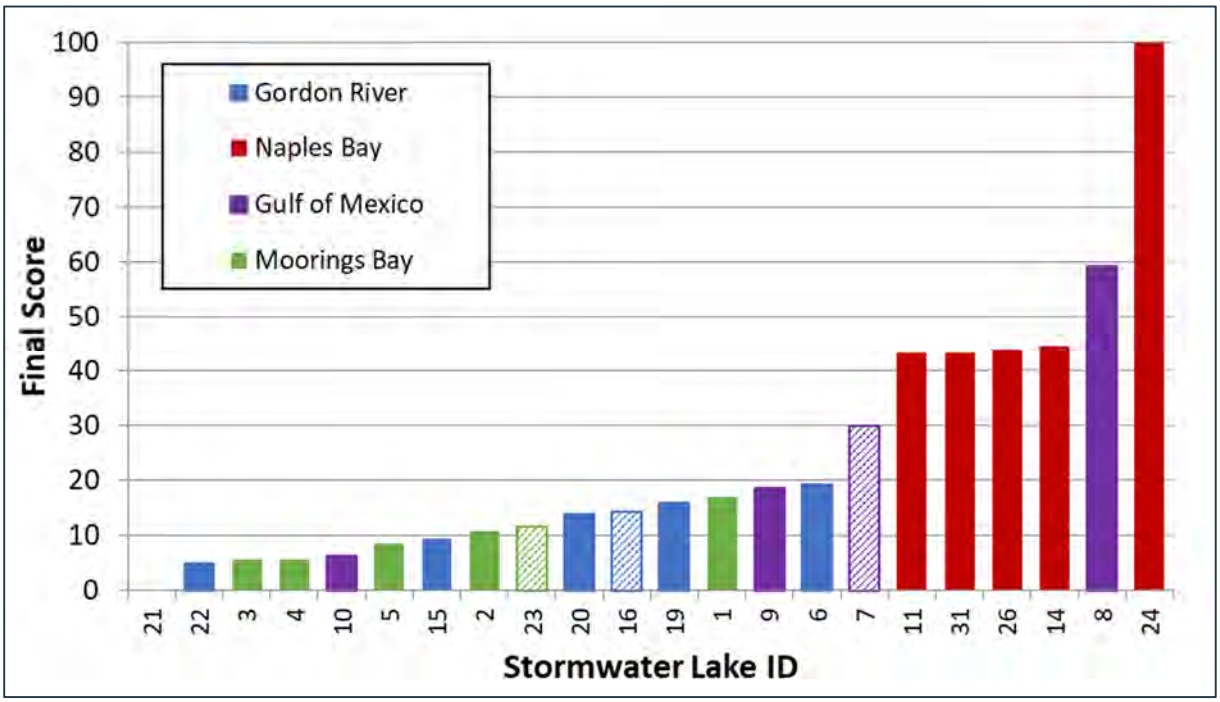
- 2012 Lakes plan
- 2018 SMPU

- 2019 Spring Lake Report (Wood)
- 2019 Homeowner Surveys (Wood)

As shown on the below table, many lakes are already implementing a robust maintenance program, however, there are opportunities to expand the programs and/or perform capital improvement projects. The lakes have been sorted based on publicly controlled versus privately controlled, as well as based on lakes that receive public drainage. In addition, the recommended projects have been categorized into in-lake projects such as vegetation maintenance and floating islands, versus primary projects such as lake dredging.

The lake ranking shown on the table is consistent with the lake ranking provided in Section 4 of this report. As a supplement to the lake ranking performed in Section 4, a secondary ranking was performed specifically related to the project recommendations presented in Table 8. This analysis considered each lake's in-lake water quality only, by computing rankings without adjusting mean concentration (or saturation) values with the runoff volume factor described in Section 4.2.2.1 (the weighting scheme remained the same as described in Section 4.2.2.2). This ranking was primarily performed in order to ensure that any lakes with poor in-lake water quality, regardless of the effects that they may have on receiving waterbodies, would be reviewed for potential project recommendations. The ranking in Figure 17 reflects each lakes' in-lake water quality only and does not account for downstream impacts, with 100 being the worst quality and 0 being the best quality.

Figure 17. Rankings Based on In-Lake Water Quality
This ranking reflects in-lake water quality, without regard for downstream impacts, with scores ranging from zero (best quality) to 100 (worst quality). Lakes 4 and 11 were assigned the scores computed for directly connected lakes (Lakes 3 and 31, respectively). Hatched bars indicate lakes whose scores were computed using a modified weighting scheme, due to data limitations (Lakes 7, 16, 21, and 23). Lakes 12, 13, 17, 25, 27, and 28 were not ranked due to a lack of water quality data.



In addition to the recommendations shown in the table below, all lakes would benefit from continued public education and outreach as well as in-catchment BMPs as described earlier in this section.

Table 8. Updated Lake Restoration Recommendation (page 1 of 1)

STORMWATER LAKES MANAGEMENT PLAN											
	In-Lake					Primary					
Stormwater Lakes Name	Vegetative Maintenance	Aerators and Fountains	Littoral Shelf Plantings Maintenance	Chemical &/or Mineral Treatment (Aluminum Sulfate, Floc Logs, True Blue, etc.)	Floating Vegetative Islands	Structural Modifications (Shoreline stabilization, baffle boxes, pipe upgrades etc.)	Biological Treatment and/or Bio Augmented Aeration (Organic Muck)	Littoral Shelf Creation / Modifications	Reuse for Landscaping Irrigation	Spot Dredge (Muck & Sediment)	Full Dredge (Muck & Sediment)
#2 Swan Lake	√	√		X		©	©			©	
#31 East Park Lake	√		√		√	√ / ©				√	√
#11 Spring Lake	√	√	X	X	X	©	√	©	D		©
#8 North Lake	X	√	X	X	√	√ / ©		√ / ©	D		©
#5 Lake Suzanne	√	√		X	X	©		©	D		©
#1 Devils Lake	X	X		X		©					©
#20 Forest Lake	X	√ / X	√	X		√ / ©	©	√	√ / ©	©	©
#14 Lantern Lake	X	X	√	X	√	©	©				©
#9 South Lake	X	√		X		√			D		©
#15 Sun Terrace Lake	X			X	√				D		
#6 Mandarin Lake	√ / X	√ / X	X		X	©	©	©	D		©
#19 15th Ave North Lake	√				X	√ / ©		©	D	©	©
#10 Alligator Lake	X	√	√			©		√			
#4 Hidden Lake	√	√							D		
#3 Colonnade Lake	√	√	√			©			√		
#16 Thurner Lake	X								D		
#23 Lowdermilk Lake	√					©					
#21 Willow Lake	√	√		X		©	©		D		
#22 Lake Manor	√	√	√	X	√	©		√		√	
#17	X								D		

©: Recommended Capital Project	From homeowner survey	Indicates Lake Receives Public Watershed
X: Routine Recommendation for Proper Lake Function	From permits	Indicates Public Lake
√: Program or Project in place or completed.	From 2018 SMPU	
D: Additional Data and/or Community Involvement Needed	From 2012 Plan	
	2019 Recommendation	

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Appendix A
2012 Proposed Stormwater Lakes Management Plan

NAPLES CITY COUNCIL AGENDA MEMORANDUM

Workshop Meeting Date: March 19, 2012

Agenda Item:	Prepared By: Gregg R. Strakaluse, P.E. Department: Streets and Stormwater

SUBJECT:
Stormwater Lakes Management Plan

BACKGROUND:
On January 17, 2012, staff presented rationale for continuing stormwater quality monitoring throughout the City. The effort to collect stormwater quality samples in 2011 provided very useful information that enables the City to create pollutant reduction strategies and set specific goals aimed at improving the quality of stormwater that's generated from within City limits. Pollutant reduction strategies presented at the January Workshop include:

1. **Continued Water Quality Sampling to Monitor Progress Towards Meeting Nutrient Criteria & TMDL's**

2. **Source Identification & Reduction of Pollutants**: Through continued stormwater quality sampling, staff will be able to further isolate pollutant sources, identify causes, and work with generators to implement solutions to reduce pollutant loading at the source.

3. **Public Outreach & Partnerships**: Reaching out to neighborhood residents and businesses to share specific information about localized stormwater quality issues empowers individuals to effect change. By developing partnerships, the community has a greater ability to understand specific causes of pollution, create a positive change, and minimize costly downstream pollutant removal technologies that require significant maintenance.

4. **Continued Implementation of Best Management Practices**: This strategy supports City efforts to manage and treat stormwater prior to discharge, including: public education, building codes, swales, detention systems, filter marshes, fertilizer ordinance, stormwater inlet and pipe maintenance, rain gardens, etc.

5. **Improving Stormwater Lake Pollutant Removal Efficiency**: Lakes are one of the most important means by which pollutants are removed from stormwater prior to discharge. Based on the City's 2011 study, stormwater lakes could improve pollutant removal efficiency if they were reconditioned or improved to more closely meet today's design standards for stormwater lakes. The study concluded that lake maintenance and reconditioning, on the average, could increase pollutant removal efficiency by 12% for total nitrogen, 14% for total phosphorus and 16% in total suspended solids.

The goal of this presentation is to expand upon details proposed under Strategy #5: Improving Stormwater Lake Pollutant Removal Efficiency. The attached memorandum dated March 12, 2012 provides a history of the subject, strategies, issues, and solutions.

Reviewed by Department Director	Reviewed by Finance	Reviewed by City Manager
Gregg R. Strakaluse, P.E.	N/A	A. William Moss

City Council Action:

Memo

Streets & Stormwater Department

Streets ● Traffic ● Stormwater

TO: A. William Moss, City Manager

FROM: Gregg R. Strakaluse, Director

DATE: March 12, 2012

SUBJECT: Stormwater Lake Management Plan

The purpose of this memorandum is to provide supplemental information on a proposed Stormwater Lake Management Plan that is scheduled for presentation to City Council on March 19, 2012.

History: In January 1981, a consulting firm working for the City developed an inventory of 23 stormwater lakes throughout the City. These lakes were identified because they are directly connected to the City's drainage system. Other lakes not identified on the inventory also existed at the time of the study but were not included because there was no direct connection to the City's stormwater collection system.

Although the exact history and origin of each stormwater lake is not fully known, all were constructed or expanded in conjunction with residential development. The more recently constructed lakes were developed not only to obtain earthen fill for home foundations, but also as retention for stormwater storage and treatment. Since 1981, significant development has occurred within the City and unincorporated portions of the County have been annexed into the City, thereby adding to the number of lakes within the City.

This year, staff has used the City's Geographic Information System (GIS) mapping data to better quantify lakes within the City limits. While this effort has not yet been finalized, staff has identified over 360 acres of lake surface within the City limits belonging to 70+ different property owners. Most of these stormwater lakes are private and do not connect directly to the City's stormwater system; however, when a large storm brings significant rainfall, all lakes eventually discharge to a receiving water body.

CITY STORMWATER LAKE INVENTORY (2012)

There are 28 lakes identified on the City's inventory. Of the 28 inventoried lakes, 21 receive drainage from public rights-of-way (streets) within the City. Although the remaining seven lakes do not receive public drainage, they do discharge into the City's stormwater collection system. Five of the 28 lakes are owned by the City, 19 are privately owned, and four have "undetermined ownership". All of the privately-owned lakes that receive stormwater from City streets have a drainage easement over them. Properties without clear chain of title have been categorized as "undetermined ownership". In these cases, plat dedications and/or City acceptances were never completed, and ownership typically resorts back to the original owner(s).

Complexity of ownership can create various challenges when developing solutions to improve or restore a lake's ability to remove pollutants from stormwater. In moving forward, staff proposes the following strategies:

Strategy #1 Lead By Example: For the five City-owned stormwater lakes, projects and programs should continue to be funded and implemented by the City to restore and improve each lake's ability to remove pollutants and maintain aesthetic value within its surrounding neighborhood. Within the last five years, the City has spent over $17 million improving its stormwater management system. A portion of this has been spent on projects that have improved conditions at both private and City-owned lakes through: minor dredging, aeration, floating vegetative islands, vegetation harvesting, and increasing water quality volume.

Strategy #2 Public Outreach & Partnerships: For stormwater lakes that receive stormwater from City streets but are owned privately (or ownership is undetermined), staff recommends implementing a comprehensive outreach effort to establish formal partnerships with property owners that establish programs and projects aimed at improving lake performance and appearance. Partnership agreements would identify parties, allocate resources, and establish policies and practices focused on lake maintenance and improved stormwater quality.

For some privately-owned lakes, staff has already established relationships and agreements. For example, Spring Lake (#11) property owners have agreed not to use copper-sulfate to treat algae in exchange for aerators and a fountain installed and operated by the City. At Lantern Lake (#14), property owners have agreed not to use copper-sulfate to treat algae in exchange for aerators and floating vegetative islands. The same is true for Lake #25. These are relatively straight-forward programs. As more significant projects are proposed (such as dredging), partnerships will become more challenging.

Strategy #3 Regulation & Enforcement: At this time, there are no local ordinances that specifically address stormwater lake maintenance. While homeowner associations manage the maintenance of common grounds including lakes, most (if not all) bylaws do not regulate the quality of lake discharges. For those stormwater lakes that are permitted by the South Florida Water Management District, permit conditions for lake maintenance are limited to best management practices and are only checked for compliance as complaints arise. The City of Naples was one of the first to implement a fertilizer ordinance in 2008. Similarly, other ordinances addressing lake maintenance or allowable quality of stormwater discharge could be considered as an option for Citywide compliance with Federal and State pollutant criteria.

Strategy #4 Assessment Districts for Stormwater Lake Improvements: Where consensus and agreement cannot be reached, and where more comprehensive projects are required to restore a lake's ability to remove pollutants, special assessment districts may be considered in order to spread project costs over vested parties.

STORMWATER LAKES: Issues & Solutions

All stormwater lakes on the City's inventory (and most others not inventoried) are classified as wet detention basins. A wet detention basin is a stormwater management facility that includes a permanent pool of water for removing pollutants and additional capacity above the permanent pool for detaining stormwater runoff. Pollutant removal efficiencies for a well-maintained wet detention system are:

- Total Suspended Solids (TSS) = 75 to 85%
- Total Nitrogen (TN) = 37 to 60%
- Total Phosphorus (TP) = 59 to 85%
- Metals = 40 to 80%

In 2011, the City's consultant (AMEC) ranked each City lake against all others within the City's inventory. In addition, some data has been collected for a handful of lakes regarding the water depths and organic muck and sediment thicknesses. The top five poorest performing lakes (in terms of pollutant removal efficiency) are:

LAKE	POLLUTANTS OF CONCERN	POLLUTANT REMOVAL EFFICIENCIES
1. South Lake (#9)	TN, TP	TN = **-123%**, TP = **-192%**, TSS = 27%
2. Lois Selfon (#31)	TN, TP, Fecal Coliform	TN = **-3%**, TP = 27%
3. Alligator Lake (#10)	TN, TP, TSS	TN = **-18%**, TP = 13%, TSS = **-200%**
4. Swan Lake (#2)	Copper, Fecal Coliform	TN = 47%, TP = 69%, Copper = **-292%**
5. Half Moon Lake (#24)	TN, TP	TN = **-139%**, TP = **-363%**

***Negative percentages (in red) indicate lakes that are adding pollutants to stormwater discharge.**

In moving forward, staff has researched various methods for improving a lake's performance in removing pollutants. The following options are more commonly used throughout the country without serious impacts to flora and fauna:

Chemical & Mineral Treatment: There are several chemical and mineral products that have been successfully tested in removing pollutants from stormwater that is eventually discharged from a lake. Such products include aluminum sulfate (alum), floc logs, and dyes. The first two are proven to remove phosphorus from the water column through precipitation, forming a heavier than water particulate known as floc. This floc settles to the lake bottom to create a barrier that retards phosphorus release. Eventually floc must be removed through biological treatment or dredging. Dyes such as True-Blue are nontoxic and water-soluble. They are formulated to reduce sunlight penetration, thereby reducing algae growth and total suspended solids. Caution must be used in the use of dye products because diminished light penetration also limits desired bottom vegetation that helps remove nutrients.

Estimated Cost: Aluminum Sulfate = $275 /ac-ft./month; Flog Logs = $325 /ac-ft./month; True Blue (dye) = $75 /ac-ft./month

Removal Efficiency: 85-95% for TP; >95% for TSS, 35-75% for TN; 60-90% for metals, 90-99% for Fecal Coliform

Biological Applications: Muck at the bottom of a lake is primarily the build-up of organic debris. Fallen leaves, grass clippings, berries, seeds and other organic matter are primary components of muck. Products such as NT-MAX contain a specially formulated range of microorganisms and micronutrients developed for use in biological treatment of ponds and lakes. These microorganisms are specifically designed to reduce organic muck build-up at the bottom of lakes.

Estimated Cost: NewTechBio = $250 /ac-ft./month
Removal Efficiency: 38%+

Aeration: Lakes with deficient dissolved oxygen are prone to algae blooms and fish kills. Aerators are used to add oxygen to the water by forcing air through diffusers anchored at the bottom of a lake. In the summer months, water temperatures rise to very high levels, which promotes algae blooms and fish kills. Aerators are effective at lowering water temperatures by increasing circulation. The use of aerators in lakes reduces the potential for anaerobic conditions.

Estimated Cost: $179 /ac-ft./month (solar); $135 /ac-ft./month (electric) {Aquagenics, Inc.}
Increase in Oxygen Levels: depends on temperature and existing DO levels

Floating Vegetative Islands: Plants are inserted into precut holes of a floating mat that is anchored to the lake bottom so that it stays stationary as it floats on the lake surface. As plants grow, the excess nutrients in the water get stored in plant tissue. Once grown, plants must be removed and new plants inserted into the floating mat.

Estimated Cost: $146 /ac-ft./month (Beemats, Inc.)
Removal Efficiency: 2 - 7% for nutrients (for one 200-sf island per 1.5 acre of lake surface)

Spot Dredge: As inorganic sand and sediment is carried by stormwater to a lake, it typically settles at the bottom of the lake close to the inflow pipe that conveyed it. In several lakes studies, data confirms that sediment build-up has occurred in localized areas of select lakes. In other cases, more data is needed. The cost estimate for spot dredging is based on the localized removal of sediment by mechanical excavation (long-reach excavator) and water-tight trucks which transport material to a disposal facility.

Estimated Cost: Mobilization $110 /cubic yard removed (Kyle Construction, Inc.)
Removal Efficiency: up to 85% for TP; 75-85% for TSS, 37-44% for TN; 40-80% for metals, 90-99% for Fecal Coliform

Full Dredge: Lakes with depths shallower than seven feet are more susceptible to algae blooms and fish kills. Shallow lakes are an indication of accumulated pollutants and do not remove additional pollutant loading nearly as effectively as deeper lakes. In some cases these lakes add pollutants to discharges. The full dredge cost estimate is based on hydraulic pumping of material into a geotube, then transport to a disposal facility.

Estimated Cost: Mobilization = $39,780 + $53.70 /cubic yard removed (Energy Resources, Inc.)
Removal Efficiency: up to 85% for TP; 75-85% for TSS, 37-44% for TN; 40-80% for metals, 90-99% for Fecal Coliform

RECOMMENDATIONS

Table #1 (attached) categorizes stormwater lakes within the City into four tiers. Tier I lakes include the five City-owned lakes that the City has full control over. Tier II lakes include seven of the highest pollutant loading lakes that are either privately-owned or ownership is undetermined. All Tier I and Tier II lakes receive stormwater from both public and private properties. Tier III lakes include the remaining 16 inventoried lakes that are privately-owned; however only ten of the 16 Tier III lakes receive stormwater drainage from City rights-of-way.

Table #1 also includes ten best management practices (BMP's) for maintaining and improving the pollutant removal efficiency of a stormwater lake. Each lake is marked for existing programs (√), needed capital projects (X©) or programs (X), or BMP's requiring additional lake data before a recommendation can be made (DATA). Lastly, annual operations and maintenance cost estimates are provided along with cost estimates for one-time capital improvements.

TIER I LAKES

Staff has identified $69,500 in annual operational and maintenance cost items for Tier I lakes. 43% of this cost (or $29,885) is proposed for new programs and 57% is currently spent on existing programs currently budgeted. Additionally, $236,000 in new capital project costs have been identified for projects associated with spot dredging, major vegetative maintenance, and minor structural repairs at inflow and outfalls. Please note that in 2007, the City spent $66,000 dredging Lake #31 (Lois Selfon Lake). This cost is not accounted for on Table #1. There remain four categories for Lake #23 (Lowdermilk) where additional data is required in order to determine project or program need. **Staff recommends proceeding with the lake management strategies for Tier I lakes as outlined in Table #1.**

TIER II LAKES

Staff has identified $94,300 in annual operational and maintenance cost items. 78% of this cost (or $73,800) is proposed for new programs and 22% is currently spent on existing programs currently budgeted. Additionally, $2,271,500 in new capital project costs have been identified for projects associated with aeration, structural repairs, spot dredging, and full dredging. There remain five categories associated with four lakes where additional data is required in order to determine project or program need.

Since Tier II lakes represent multiple owners, implementation of the recommended projects and programs present significant challenges. The two most daunting are consensus among property owners for implementation of a specific project or program and funding. As previously discussed, the City has already established partnerships with property owners for installing vegetative islands and aerators within private lakes. Still Tier II lakes require additional attention in order to improve each lake's pollutant removal efficiency in perpetuity. Each lake is unique and significant staff time is anticipated for identifying vested interests and developing consensus along with cost sharing options.

Furthermore, significant staff time is anticipated for design and construction management. Existing staffing levels within the Streets & Stormwater Department cannot fully meet the needs that have been outlined for Tier II lakes. I**f it is City Council's desire to proceed with the lake management strategies outlined for Tier II lakes, staff would evaluate additional staff versus contracting with a private management firm in preparation of FY 12-13 Budget.**

TIER III LAKES

Staff has identified $95,500 in annual operational and maintenance cost items. 96% of this cost (or $91,680) is allocated to new programs and 4% is allocated to existing programs currently budgeted by the City. The cost for programs that are currently being implemented by private property owners is not included in this summary. For example, Lake #3 at the Colonnade has a fountain that is currently funded by the property owner's association.

Additionally, $27,500 in new capital project costs have been identified for projects associated with aeration and structural repairs to erosion and pipe. There remain five categories within nine lakes for which additional data is required in order to determine project or program need.

A significant portion of the annual operational and maintenance cost is associated with public outreach at privately-owned and maintained lakes. **Therefore, staff recommends implementing the public outreach portion of the operations and maintenance program ($16,000 per year) in order to impact source reduction efforts and develop consensus and agreements for other recommended capital projects that the City could manage over time.**

TIER I - IV LAKES

Staff does not know the exact number of privately-owned and maintained stormwater lakes outside of the City's inventory list. However, staff has determined that there are approximately 276 acres of additional lakes throughout the City. These stormwater lakes eventually discharge either directly to a receiving water body or to the City's stormwater collection system. Therefore, all contribute to pollutant loading to some degree. All of these lakes are privately-owned. Maintenance varies dramatically among property owners. Staff has identified $73,000 in annual operations and maintenance cost for Tier IV lakes. This cost is associated with public outreach, stormwater quality data collection, and educational materials. **Staff recommends a strong public outreach effort aimed at informing private lake owners about water quality impacts to downstream water bodies and best management practices for long-term lake maintenance.**

REFERENCES

1. Drainage Easement & Lake Ownership Research, City of Naples –City Clerk; April 13, 2010.
2. Citywide Drainage Study; CH2M Hill, January 1981.
3. City of Naples Stormwater Lake Maintenance & Improvement Program; Mactec, Inc., March 2010.

4. City of Naples Stormwater Quality Analysis, Pollutant Loading & Removal Efficiencies; AMEC, Inc., January 2012.
5. Energy Resources, Inc. construction cost estimate, February 8, 2012.
6. Kyle Construction, Inc. construction cost for Lake 31, October, 2007.
7. Current Research & Trends in Alum Treatment of Stormwater Runoff; Harvey H. Harper, Ph.D. and Environmental Research & Design, Inc., unknown date.
8. The Use of Alum for Lake Management; North American Lake Management Society-Position Statement #2; February 26, 2004.
9. Lake Management; North American Lake Management Society.
10. The Effectiveness of Vegetated Floating Mats in Sequestering Nutrients in a Structurally Controlled Waterbody; Professional Service Industries, Inc. (for Lee County Department of Natural Resources); June 17, 2010.
11. NewTechBio, NT-Max Biological Treatment for sludge and organic decay.
12. Aquagenix, Inc.; Aerator Systems, February, 2012.
13. Beemats, Inc.; Floating Vegetative Islands, February 2012.

STORMWATER LAKES MANAGEMENT PLAN

TABLE #1

	Public Outreach & Coordination	Vegetative Maintenance	Litoral Plantings & Vegetative Islands	Aeration	Fountain	Structural Repairs to Erosion, Pipe, etc.	Chemical &/or Mineral Treatment (Water Quality)	Biological Treatment (Organic Muck)	Spot Dredge (Muck & Sediment)	Full Dredge (Muck & Sediment)	Annual Ops & Maintenance Cost	One-Time Capital Cost
Tier I Lakes (City Owned)												
#6 Mandarin Lake	X	√	X		√			X			$ 24,500	$ -
#19 15th Ave North Lake	X	√	X						X©		$ 4,000	$ 82,500
#22 Lake Manor	X	X©	√	√			X		X©		$ 27,500	$ 146,000
#23 Lowdermilk Lake	X	√	DATA	DATA		X©	DATA	DATA			$ 1,000	$ 7,500
#31 Lois Selfon Park Lake	X	√	√							√	$ 12,500	$ -
Tier II Lakes (High Priority Pollutant Loading)										***Subtotal:***	***$ 69,500***	***$ 236,000***
#2 Swan Lake	X	X		X©			X	X	X©		$ 18,700	$ 90,000
#11 Spring Lake	X	√	DATA	√	√		X			X©	$ 16,200	$ 1,527,000
#8 North Lake	X	X	X	√		X©	X			X©	$ 16,700	$ 587,500
#9 South Lake	X	X		X©		X©	X			DATA	$ 11,200	$ 25,000
#10 Alligator Lake	X	X				X©	DATA				$ 5,000	$ 15,000
#14 Lantern Lake	X	X	√	X©		X©	X	X			$ 21,000	$ 27,000
#24 Half Moon Lake	X	√					X	DATA	DATA		$ 5,500	$ -
Tier III Lakes (Remaining Inventoried Lakes)										***Subtotal:***	***$ 94,300***	***$ 2,271,500***
#1 Devils Lake	X	X	DATA	X©			X	DATA	DATA	DATA	$ 11,200	$ 15,000
#3 Colonnade Lake	X	√			√		DATA	DATA	DATA	DATA	$ 1,000	$ -
#4	X	√			√			DATA	DATA	DATA	$ 1,000	$ -
#5 Lake Suzanne	X	X	DATA				X	DATA	DATA	DATA	$ 1,000	$ -
#7 Naples Golf & Beach Club Lake	X	X	DATA				X	DATA	DATA	DATA	$ 8,200	$ -
#12	X	X					DATA	DATA	DATA	DATA	$ 1,000	$ -
#13	X	X					DATA	DATA	DATA	DATA	$ 1,000	$ -
#15 Sun Terrace Lake	X	X					X	DATA	DATA	DATA	$ 17,000	$ -
#16 Thurner Lake	X	X	DATA				DATA	DATA	DATA	DATA	$ 2,000	$ -
#17 County Lake	X	X						DATA	DATA	DATA	$ 2,000	$ -
#20 Forest Lake	X	X		√			X	X			$ 18,300	$ -
#21 Willow Lake	X	√		√		X©	X	X			$ 18,300	$ 7,500
#25	X	X			√	X©	X	X			$ 11,500	$ 5,000
#26 NCH Lake	X	√		√			X	DATA	DATA	DATA	$ 1,000	$ -
#27	X	√		DATA			DATA	DATA	DATA	DATA	$ -	$ -
#28	X	X			√		DATA	DATA	DATA	DATA	$ 1,000	$ -
Tier IV Lakes (Non-Inventoried Private Lakes and Lake Systems)										***Subtotal:***	***$ 95,500***	***$ 27,500***
Citywide Public Outreach	X	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	$ 73,000	$ -

X©: Needed Capital Project
X: Needed Annually for Operations
√: Program or Project in place or completed.
DATA: Additional Data and/or Community Involvement Needed

Proposed Stormwater Lakes Management Plan

March 19, 2012

Presented by:

Gregg Strakaluse, P.E., Streets & Stormwater Director

In Collaboration With: Dr. Mike Bauer, Natural Resources Manager

OVERVIEW

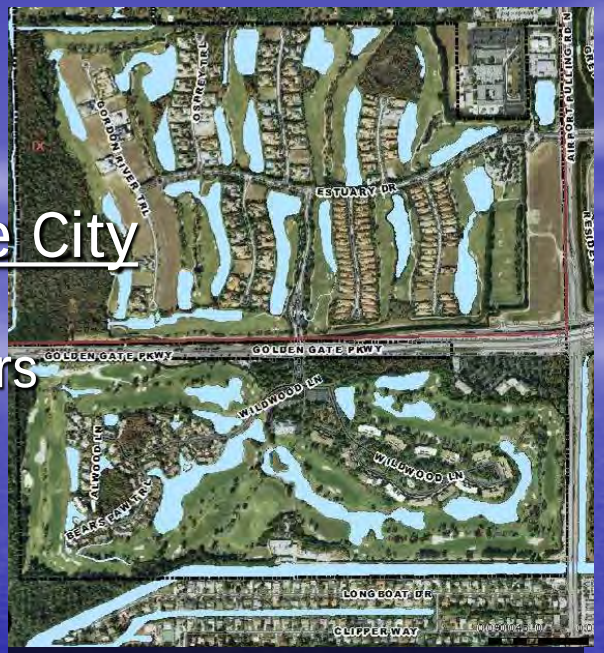
- Background
- Lakes & Lake Groupings
- Lake Improvement Strategy
  - Short-Term Focus
  - Long-Term Focus
- Recommendations
- Questions/Comments

January 2012 Workshop
GOAL: Improving Lake Pollutant Removal Efficiency

- **Recommendation**: In March 2012 present short and long-term strategies that improve pollutant removal efficiencies and estimate cost versus benefit. Continue to monitor water quality within City lakes.

BACKGROUND

- Stormwater Lakes within the City of Naples: 350 acres+
  - 70+ different property owners
- Golf Course Lakes (162 acres.)
  - Royal Poinciana
  - Hole in the Wall
  - Naples Beach Hotel
  - Moorings
- Hospital Lakes (2 acres.)
- Airport Lakes (18 acres.)
- Private Property Owners (206+acres.)
- City (9.07 acres.)(3%)
- Undetermined Owners (17.67 acres.)



The Estuary & Bear's Paw

Goodlette Commons

Existing Lake Inventory

Lake Ownership Summary			
1	PRIVATE	15	PRIVATE
2	PRIVATE	16	PRIVATE
3	PRIVATE	17	PRIVATE
4	PRIVATE	19*	PUBLIC
5	PRIVATE	20	PRIVATE
6*	PUBLIC	21	PRIVATE
7	PRIVATE	22*	PUBLIC
8	UNDETERMINED	23*	PUBLIC
9	UNDETERMINED	24	PRIVATE
10	UNDETERMINED	25	PRIVATE
11	UNDETERMINED	26	PRIVATE
12	PRIVATE	27	PRIVATE
13	PRIVATE	28	PRIVATE
14	PRIVATE	31*	PUBLIC

Receives Public Drainage

No Public Drainage


LAKE 01A
LAKE 01B
LAKE 02
LAKE 03
LAKE 04
LAKE SUZANNE (05)
LAKE 15
LAKE 16
LAKE 17
Gordon River
LAKE 19
LAKE 06
LAKE 23
LAKE 07
FOREST LAKE (20)
41
WILLOW LAKE (21)
NORTH LAKE (08)
LAKE MANOR PARK (22)
LAKE 10
SOUTH LAKE (09)
LAKE 26
Naples Muni
SPRING LAKE (11)
EAST LAKE (31)
Naples Bay
LAKE 12
LAKE 25
LAKE 13
LAKE 28
LANTERN LAKE (14)
HALF MOON LAKE (24)

Lakes Receiving Public Drainage
(Drainage Easements Exist)

Lake Ownership Summary Receiving Public Drainage			
1	PRIVATE	15	PRIVATE
2	PRIVATE	16	PRIVATE
3	PRIVATE	17	PRIVATE
4	PRIVATE	19*	PUBLIC
5	PRIVATE	20	PRIVATE
6*	PUBLIC	21	PRIVATE
8	UNDETERMINED	22*	PUBLIC
9	UNDETERMINED	23*	PUBLIC
10	UNDETERMINED	24	PRIVATE
11	UNDETERMINED	31*	PUBLIC
14	PRIVATE		

Lakes Receiving Public Drainage

City Owned Lakes	
6*	Mandarin Lake
19*	15th Ave N Lake
22*	Lake Manor
23*	Lowdermilk Lake
31*	Lois Selfon Park Lake

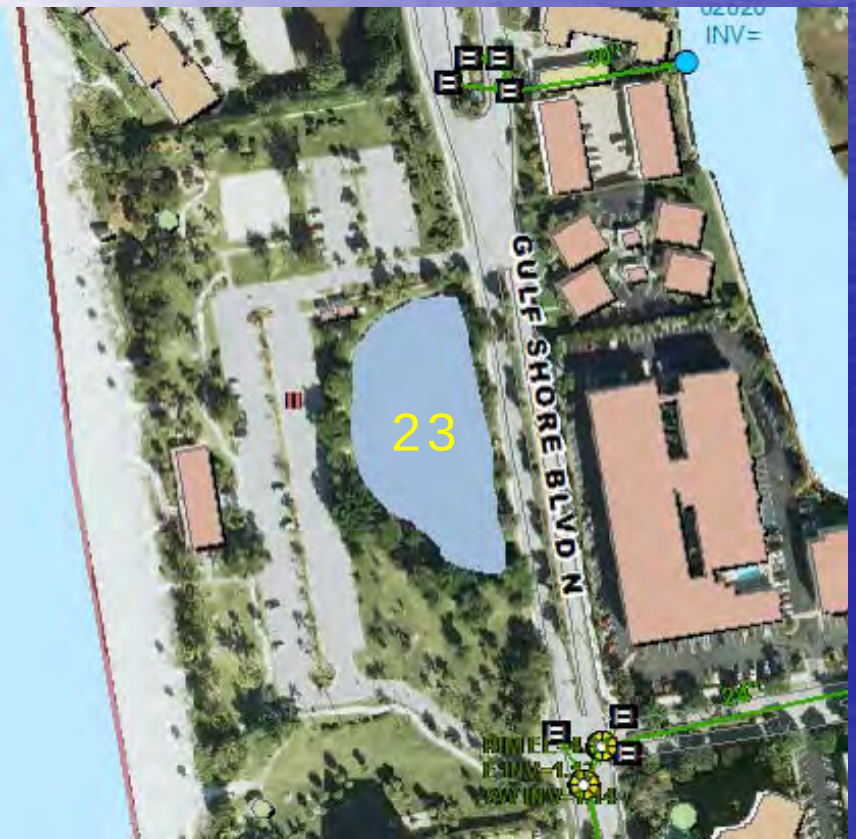
City Owned Lakes

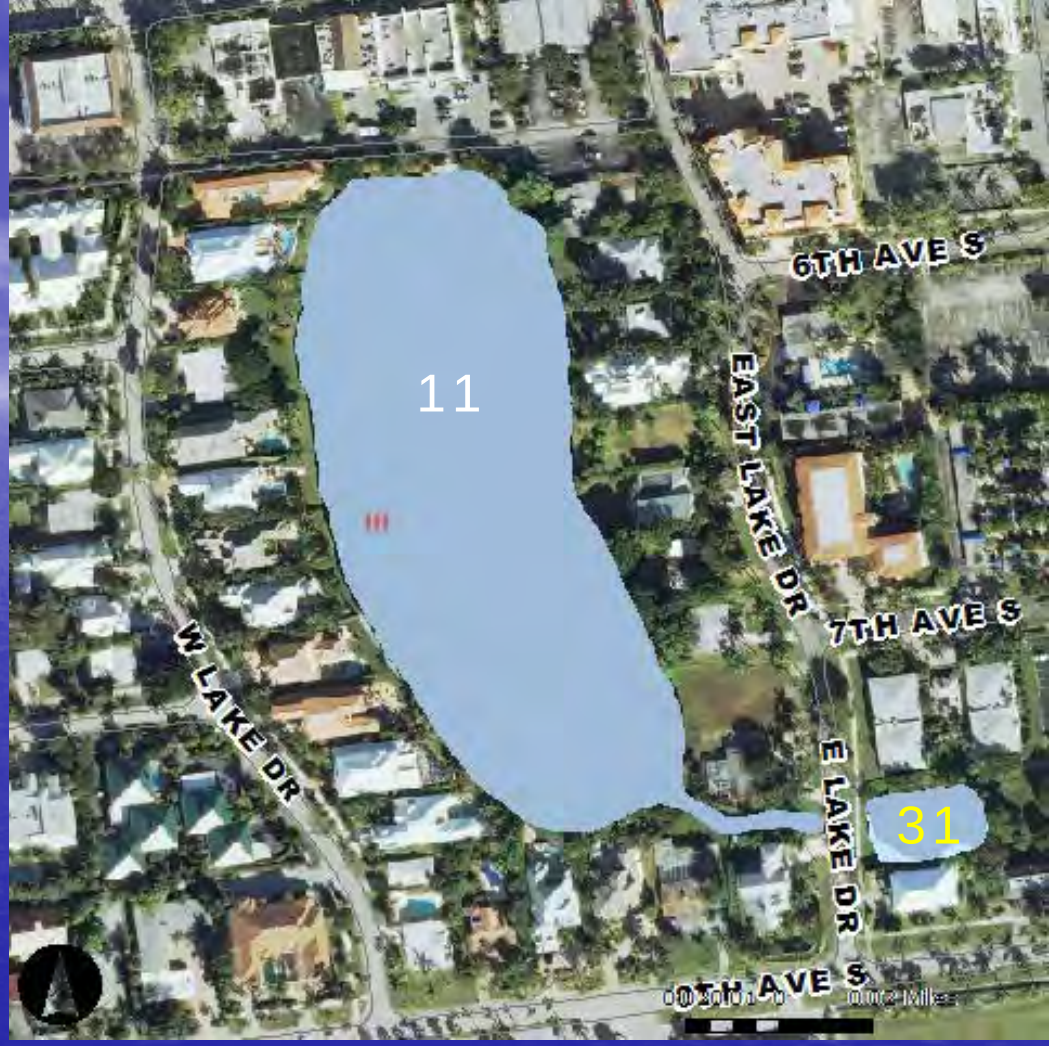
Lake 6: Mandarin Lake

Lake 19: 15th Ave N Lake

Lake 22: Lake Manor

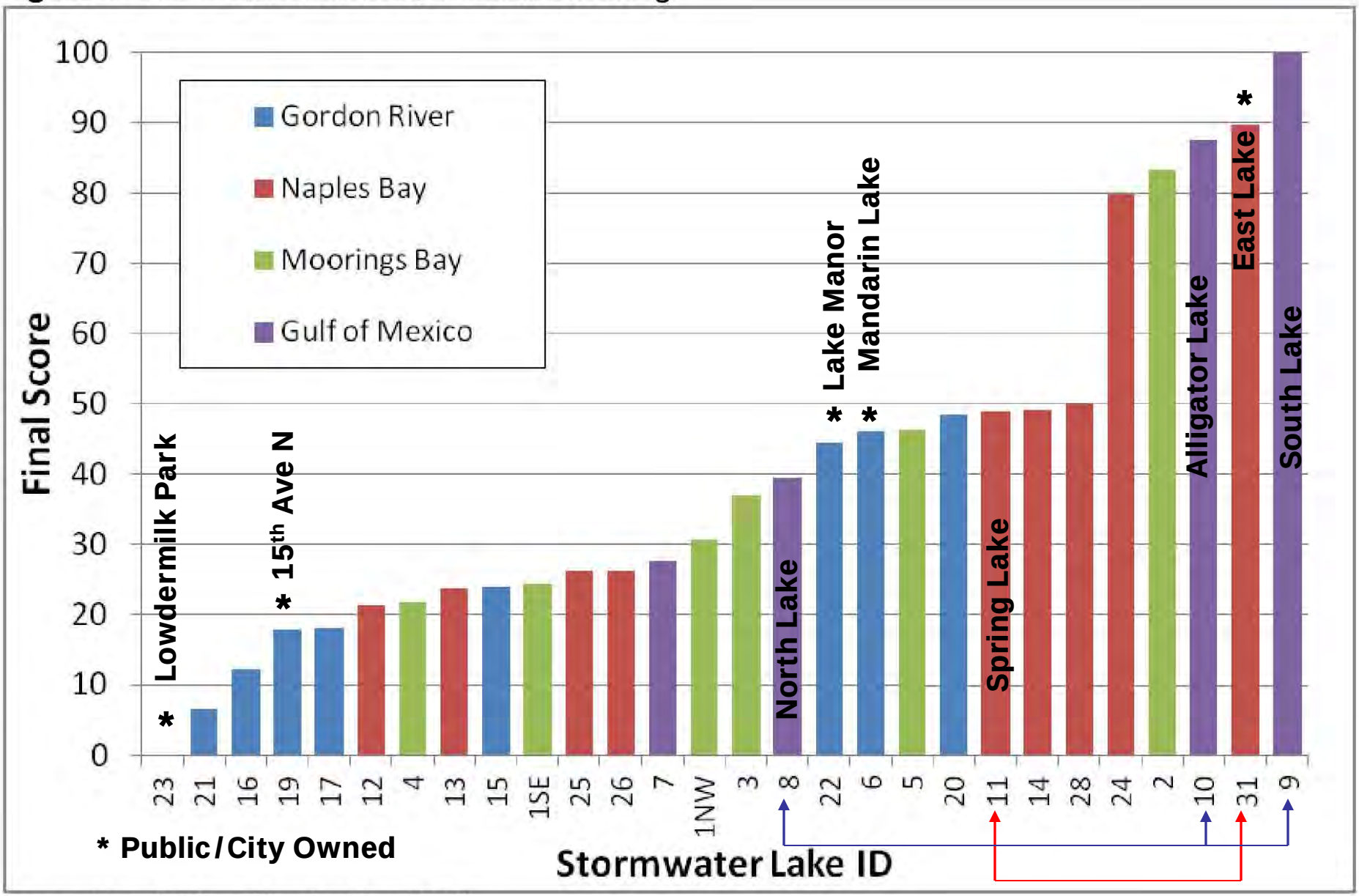
City Owned Lakes





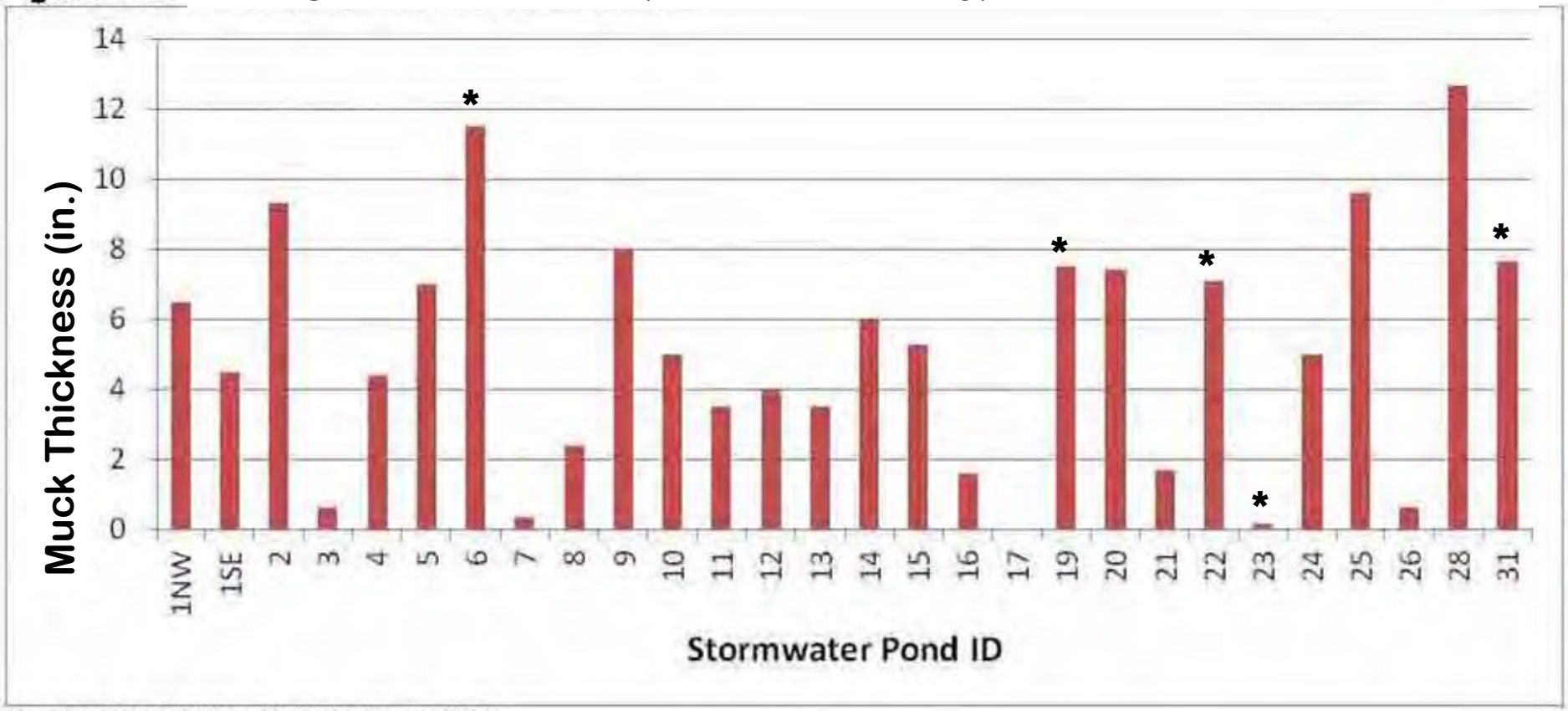
Lake 23: Lowdermilk Lake
Lake 31: Lois Selfon Park (East Lake)

Figure 7-17. Final Stormwater Pond Ranking



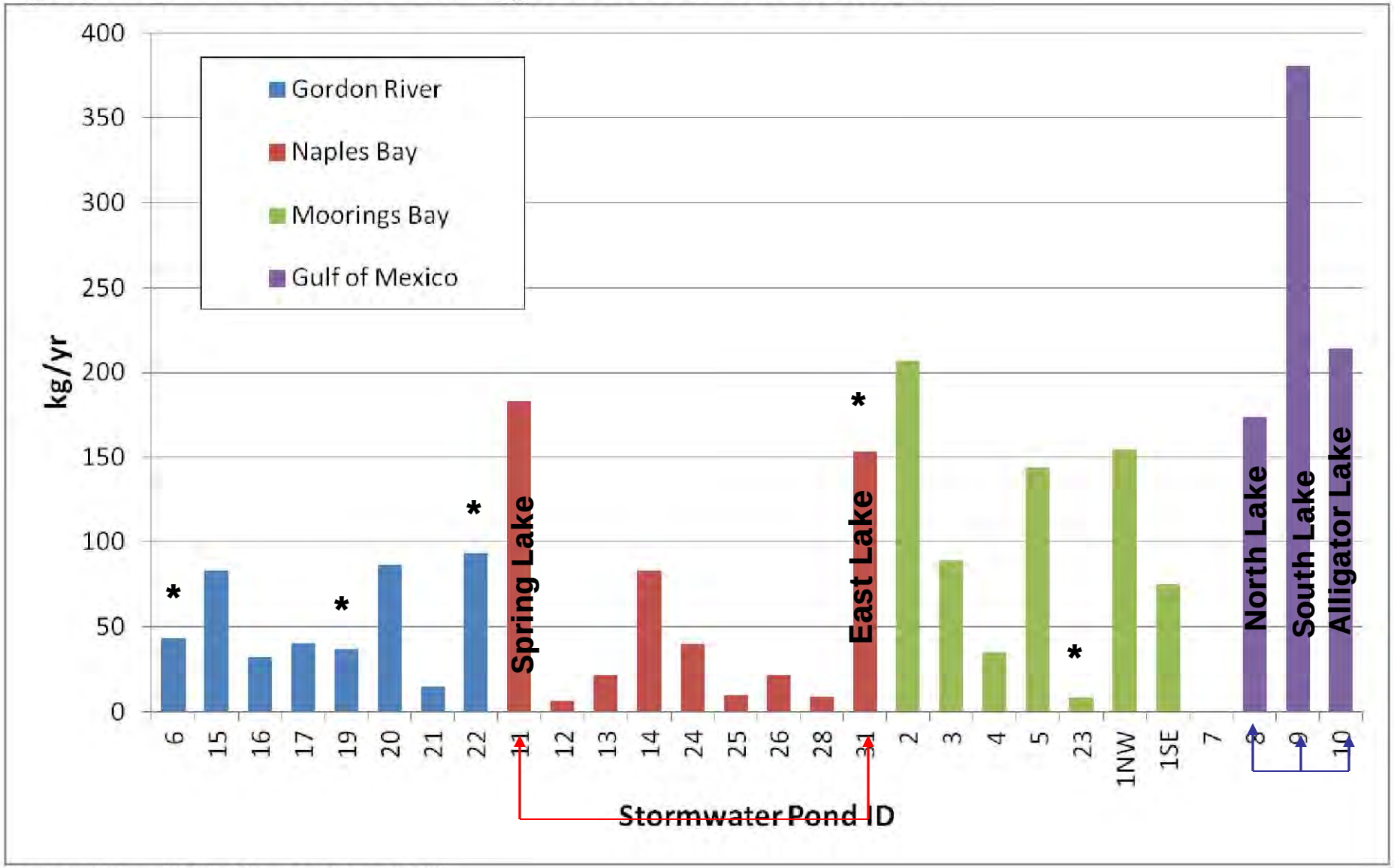
Created by: SCA Checked by: WAT

Figure 7-5. Average Muck Thickness (2009 Mactec Study)



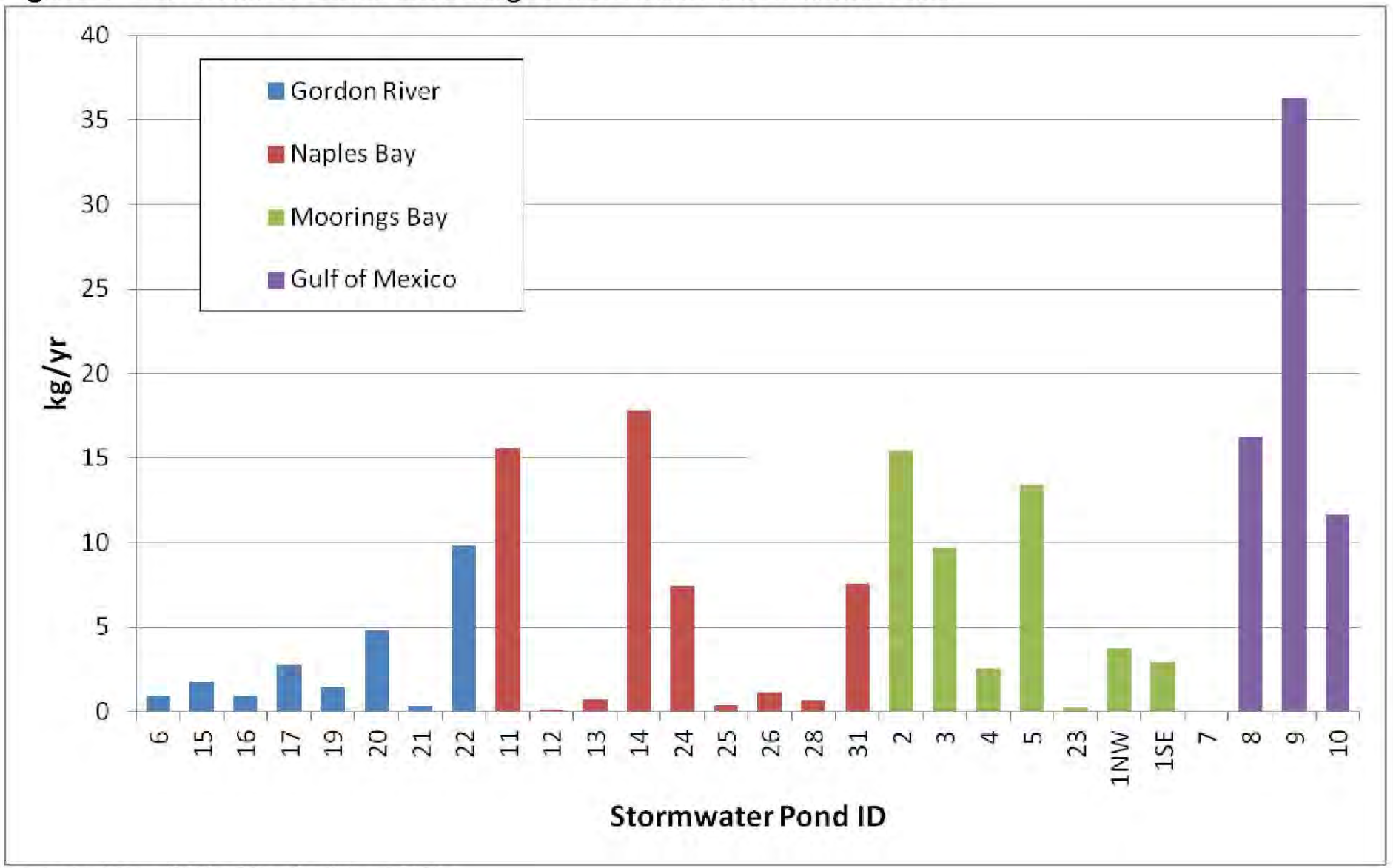
Prepared by: SCA Checked by: TGD

Figure 7-13. Total TN Load Discharged from each Stormwater Lake



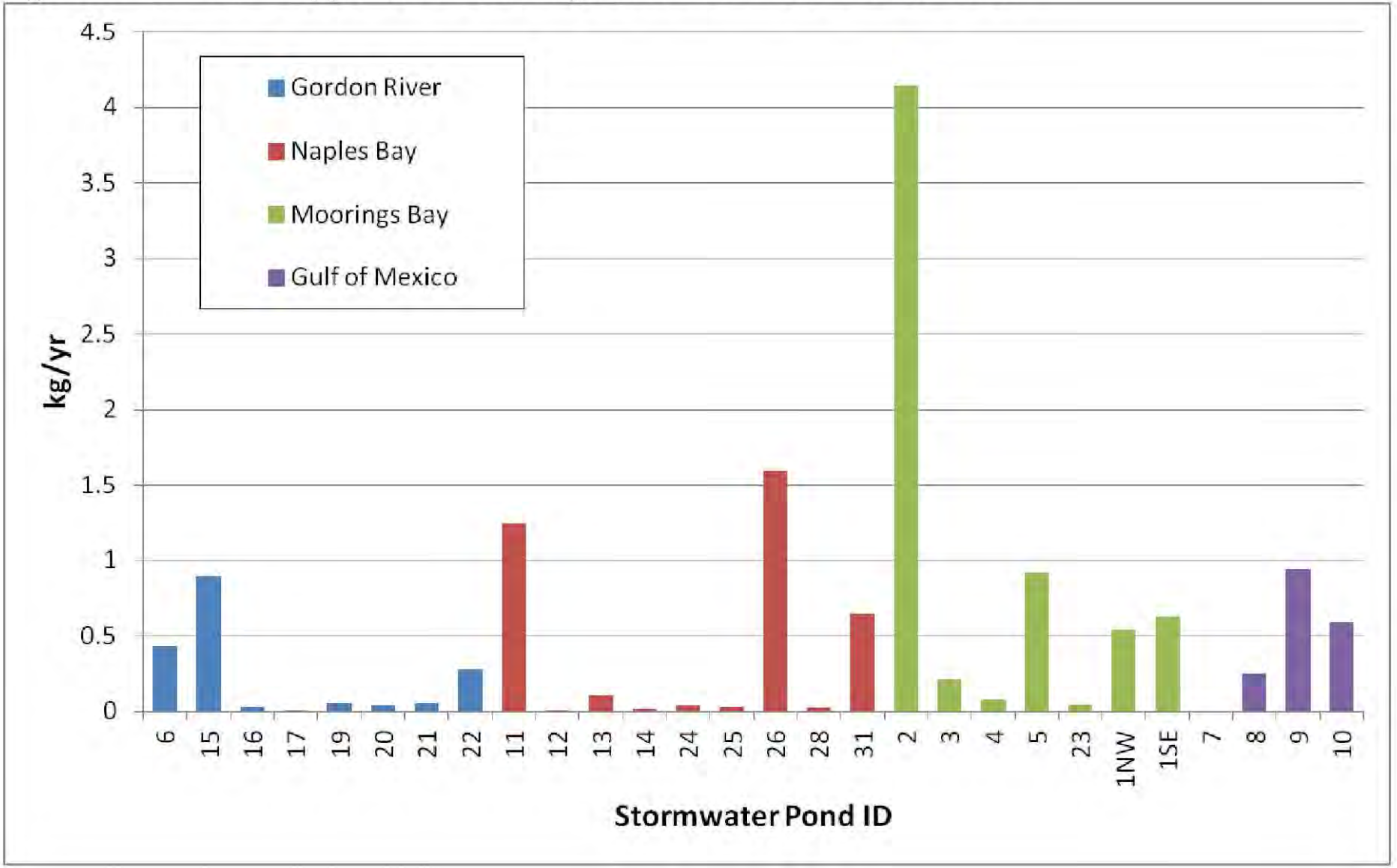
Prepared by: SCA Checked by: TGD

Figure 7-14. Total TP Load Discharged from each Stormwater Lake



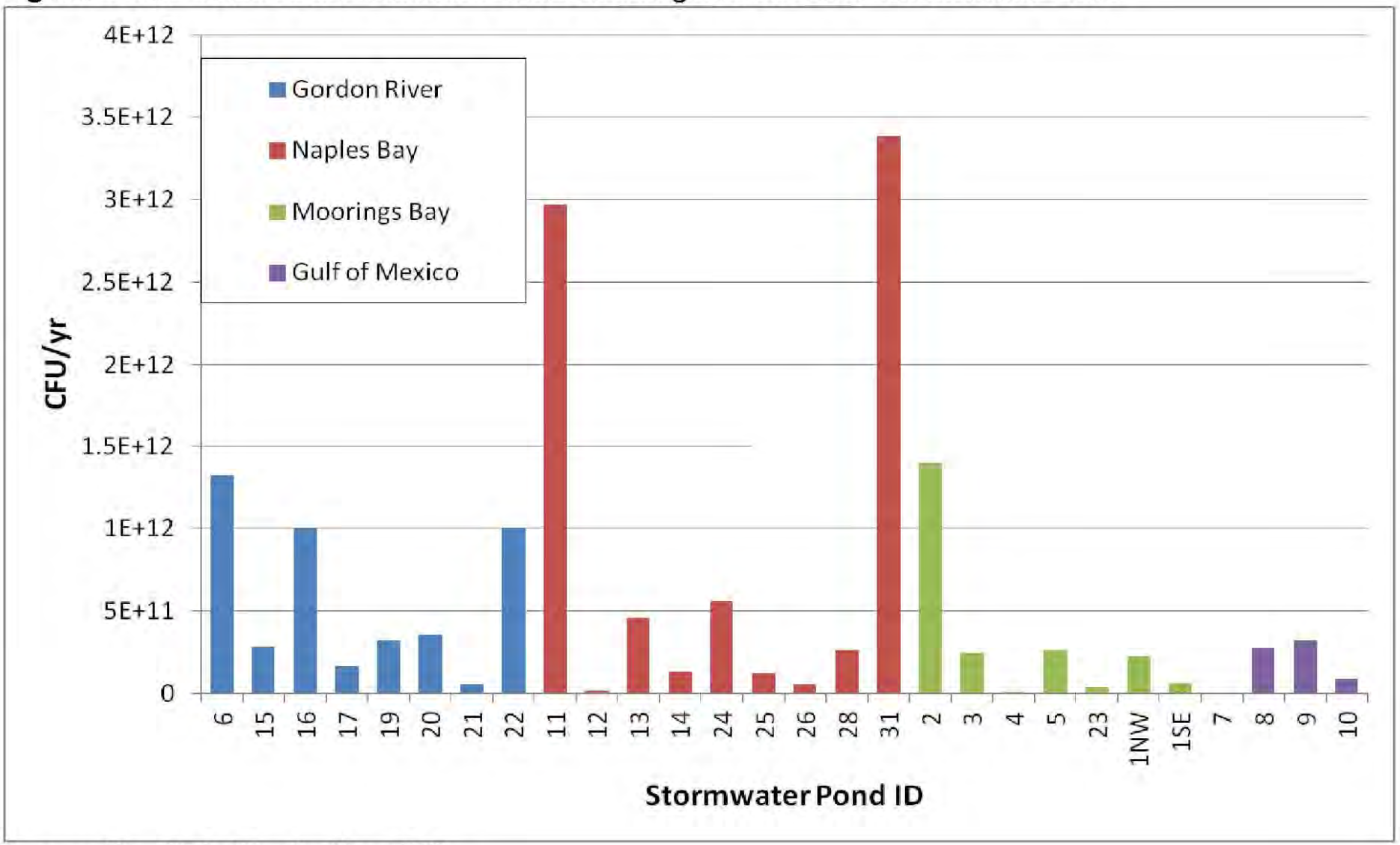
Prepared by: SCA Checked by: TGD

Figure 7-15. Total Copper Load Discharged from each Stormwater Lake



Prepared by: SCA Checked by: TGD

Figure 7-16. Total Fecal Coliform Load Discharged from each Stormwater Lake



Prepared by: SCA Checked by: TGD

Lois Selfon (East Lake)

- Recent Accomplishments:
  - 2007 Dredge
  - Control Structure Installation
  - Vegetative Maintenance & Island
- Needs:
  - Coordination with Spring Lake Actions

Lois Selfon (East Lake)

2007 Dredge Project

Dredging With A Geotube

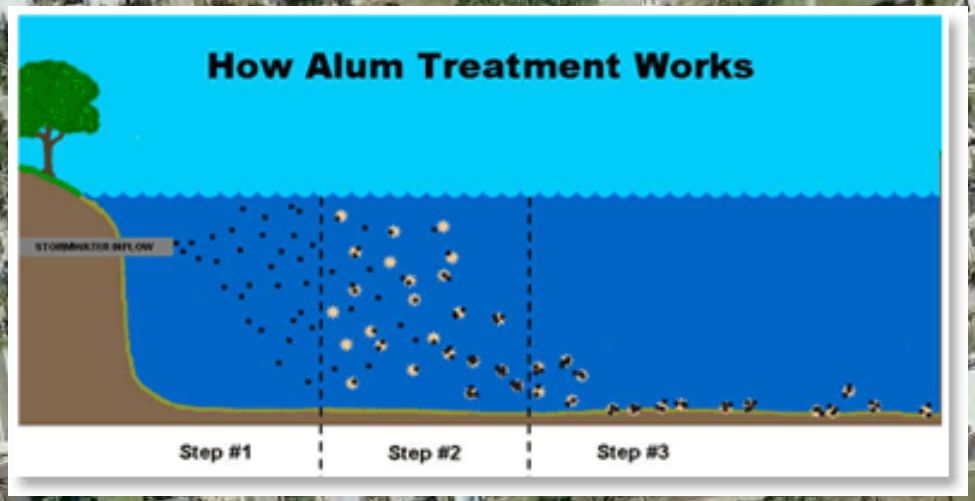
Lake Manor #22

- Recent Accomplishments:
  - Control Structure Improvement
  - Aerators
  - Vegetative Islands

Lake Manor #22

- Needs:
  - Perimeter Vegetative Maintenance
  - Harvest hyacinth and cattails
  - Spot Dredging
  - Mineral Treatment (Alum)

LAKE MANOR (Lake #22)

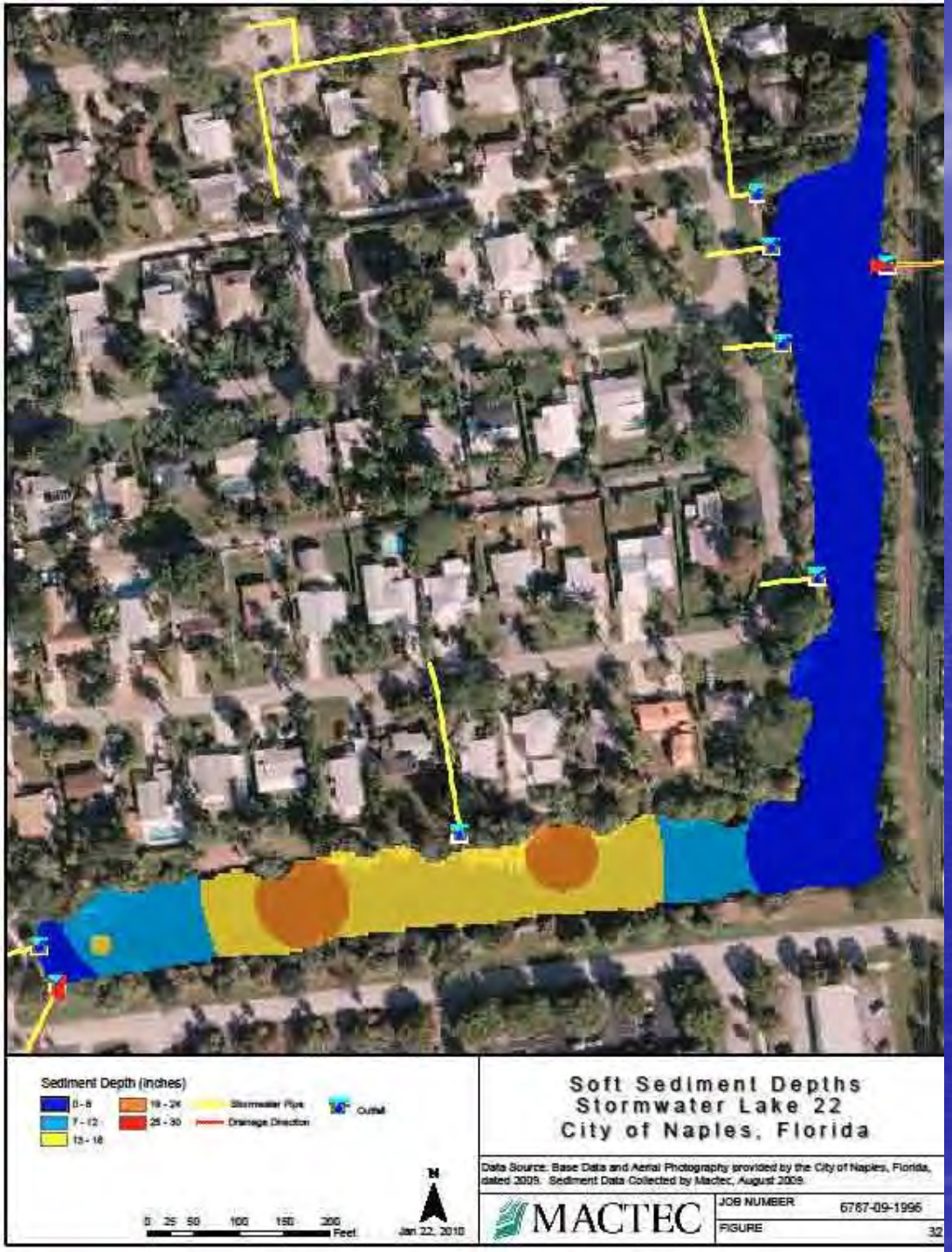


Vegetative Maint. = $7,500/yr

Aluminum Phosphate Application: Year-1
Est. Cost = $12,950/yr

Spot Dredge
EST. 1100 CY @
$110/cy = $121,000

3-Existing Aerators
Cost: $975/yr


Sediment Depth (inches)
0 - 6
7 - 12
13 - 18
19 - 24
25 - 30
Stormwater Pipe
Drainage Direction
Outfall
0 25 50 100 150 200
Feet
N
Jan 22, 2010
Soft Sediment Depths
Stormwater Lake 22
City of Naples, Florida
Data Source: Base Data and Aerial Photography provided by the City of Naples, Florida, dated 2009. Sediment Data Collected by Mactec, August 2009.
MACTEC
JOB NUMBER 6787-09-1996
FIGURE 32

LAKE MANOR (Lake #22)

2011 POLLUTANT LOADING ESTIMATES

TN Loading = 90 kg / year (198 lbs/yr)

56% Removal Efficiency TN

TP Loading = 9.5 kg / year (20.9 lbs/yr)

62% Removal Efficiency TP

TSS Loading = 9 kg/acre-ft/year

92% Removal Efficiency TSS

Cu Loading = 0.27 kg / year (0.59 lbs/yr)

Cu Removal Efficiency = 76%

Fecal Removal Efficiency = 62%

POLLUTANT REDUCTION GOALS

TN Loading = 61.2 kg / year (134.6 lbs/yr)

70% Removal Efficiency TN

TP Loading = 1.25 kg / year (2.8 lbs/yr)

95% Removal Efficiency TP

TSS Loading = 5.63 kg/acre-ft/year

>95% Removal Efficiency TSS

Cu Loading = 0.11 kg / year (0.25 lbs/yr)

Cu Removal Efficiency = 90%

Fecal Removal Efficiency = 99%

*Harvey H. Harper, Ph.D, P.E.

Estimated O & M Cost: $27,500 / year

Estimated Capital Cost: $124,500

15th Ave North Lake #22

- Accomplishments:
  - Improved Weir (Control Structure)
  - Upsized Inflows & Outfall
- Needs:
  - Spot Dredge along 15th Ave N
  - Improved Vegetative Maintenance by Private Property Owners
  - Littoral Plantings Along 15th Ave N

Soft Sediment Depths
Stormwater Lake 19
City of Naples, Florida

Data Source: Base Data and Aerial Photography provided by the City of Naples, Florida, dated 2009. Sediment Data Collected by Mactec, August 2009.

MACTEC

JOB NUMBER 6767-09-1996

FIGURE 31

Lowdermilk Lake #23

- Accomplishments:
  - Excellent Vegetative Maintenance
- Needs:
  - Water Quality Data
  - Bathymetric Data
  - Minor Erosion Repair at Inflow Pipes

Mandarin Lake (#6)

- Accomplishments:
  - Vegetative Maintenance
- Needs:
  - Private Property Owner Vegetative Maintenance
  - Littoral Plantings &/or Vegetative Islands
  - Biological Treatment for Organic Muck

STORMWATER LAKES MANAGEMENT PLAN

TABLE #1

	Public Outreach & Coordination	Vegetative Maintenance	Litoral Plantings & Vegetative Islands	Aeration	Fountain	Structural Repairs to Erosion, Pipe, etc.	Chemical &/or Mineral Treatment (Water Quality)	Biological Treatment (Organic Muck)	Spot Dredge (Muck & Sediment)	Full Dredge (Muck & Sediment)	Annual Ops & Maintenance Cost	One-Time Capital Cost
Tier I Lakes (City Owned)												
#6 Mandarin Lake	X	√	X		√			X			$ 24,500	$ -
#19 15th Ave North Lake	X	√	X						X©		$ 4,000	$ 82,500
#22 Lake Manor	X	X©	√	√			X		X©		$ 27,500	$ 146,000
#23 Lowdermilk Lake	X	√	DATA	DATA		X©	DATA	DATA			$ 1,000	$ 7,500
#31 Lois Selfon Park Lake	X	√	√							√	$ 12,500	$ -
Tier II Lakes (High Priority Pollutant Loading)										***Subtotal:***	***$ 69,500***	***$ 236,000***
#2 Swan Lake	X	X		X©			X	X	X©		$ 18,700	$ 90,000
#11 Spring Lake	X	√	DATA	√	√		X			X©	$ 16,200	$ 1,527,000
#8 North Lake	X	X	X	√		X©	X			X©	$ 16,700	$ 587,500
#9 South Lake	X	X		X©		X©	X			DATA	$ 11,200	$ 25,000
#10 Alligator Lake	X	X				X©	DATA				$ 5,000	$ 15,000
#14 Lantern Lake	X	X	√	X©		X©	X	X			$ 21,000	$ 27,000
#24 Half Moon Lake	X	√					X	DATA	DATA		$ 5,500	$ -
Tier III Lakes (Remaining Inventoried Lakes)										***Subtotal:***	***$ 94,300***	***$ 2,271,500***
#1 Devils Lake	X	X	DATA	X©			X	DATA	DATA	DATA	$ 11,200	$ 15,000
#3 Colonnade Lake	X	√			√		DATA	DATA	DATA	DATA	$ 1,000	$ -
#4	X	√			√			DATA	DATA	DATA	$ 1,000	$ -
#5 Lake Suzanne	X	X	DATA				X	DATA	DATA	DATA	$ 1,000	$ -
#7 Naples Golf & Beach Club Lake	X	X	DATA				X	DATA	DATA	DATA	$ 8,200	$ -
#12	X	X					DATA	DATA	DATA	DATA	$ 1,000	$ -
#13	X	X					DATA	DATA	DATA	DATA	$ 1,000	$ -
#15 Sun Terrace Lake	X	X					X	DATA	DATA	DATA	$ 17,000	$ -
#16 Thurner Lake	X	X	DATA				DATA	DATA	DATA	DATA	$ 2,000	$ -
#17 County Lake	X	X						DATA	DATA	DATA	$ 2,000	$ -
#20 Forest Lake	X	X		√			X	X			$ 18,300	$ -
#21 Willow Lake	X	√		√		X©	X	X			$ 18,300	$ 7,500
#25	X	X			√	X©	X	X			$ 11,500	$ 5,000
#26 NCH Lake	X	√		√			X	DATA	DATA	DATA	$ 1,000	$ -
#27	X	√		DATA			DATA	DATA	DATA	DATA	$ -	$ -
#28	X	X			√		DATA	DATA	DATA	DATA	$ 1,000	$ -
Tier IV Lakes (Non-Inventoried Private Lakes and Lake Systems)										***Subtotal:***	***$ 95,500***	***$ 27,500***
Citywide Public Outreach	X	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	$ 73,000	$ -

X©: Needed Capital Project
X: Needed Annually for Operations
√: Program or Project in place or completed.
DATA: Additional Data and/or Community Involvement Needed

Criteria To Gauge Improvement

- Aesthetics
  - Reduced Algae
  - Vegetative Overgrowth
  - Water Clarity
- Muck/Sediment Thickness Vs. Lake Depth
- Nutrient Levels & Loading
- Copper Levels & Loading
- Fecal Coliform & Enterococcus Levels
- Dissolved Oxygen
- Temperature
- Flora & Fauna

Recommendations
Lakes Management Plan

- **Tier I – IV Lakes**:
  - Data Collection, Source Reduction, Public Outreach, Partnerships & Education
  - Consider Ordinances & Enforcement
  - \+ $73,000 / year {O & M Budget}
- **Tier I Lakes**: City Owned Lakes
  - Additional Data Collection (Lowdermilk Lake)
  - Improve Vegetative Maintenance
  - Expand aeration and floating islands
  - Biological, Chemical, Mineral Applications
  - Spot Dredging
  - Structure repairs at inflow & outfalls
  - \+ $69,500 /yr. {O & M Budget}; + $187,000 Capital

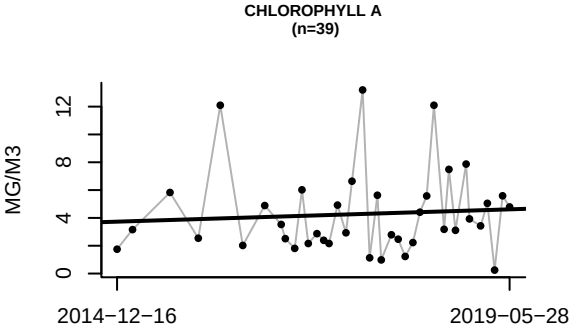
Recommendations
Lakes Management Plan

- **Tier II Lakes (Priority Lakes)**:
  - Public Outreach, Partnerships, Agreements, Assessment Districts
  - Vegetative maintenance, aeration, structural repairs, chemical & biological applications
  - Dredging
  - + $94,300 / year {O & M Budget}
  - + $1,497,000 {Capital}
- **Tier III Lakes**:
  - Public Outreach, Partnerships, Agreements, Assessment Districts
  - Vegetative maintenance, aeration, structural repairs, chemical & biological applications
  - More data is needed to determine dredging needs.
  - + $95,500 /yr. {O & M Budget}; + $25,000+ {Capital}

Questions / Comments

Appendix B
Water Quality Trend Plots

Site: Lake 1



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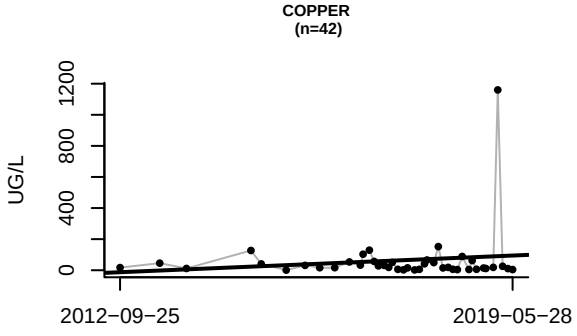

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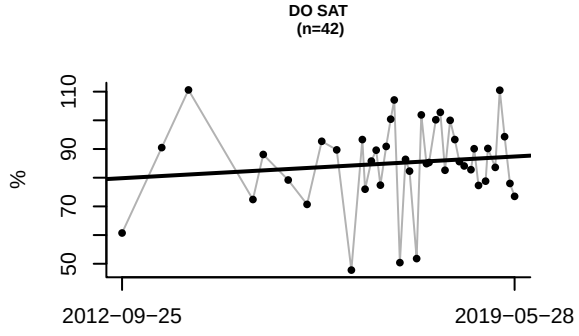
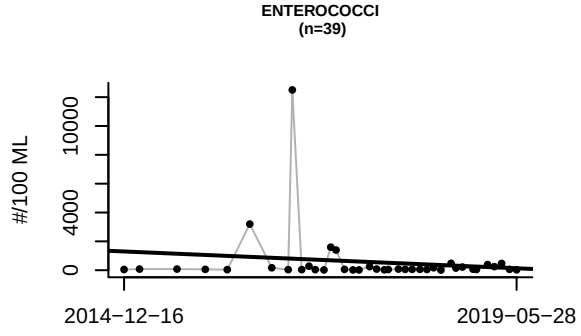
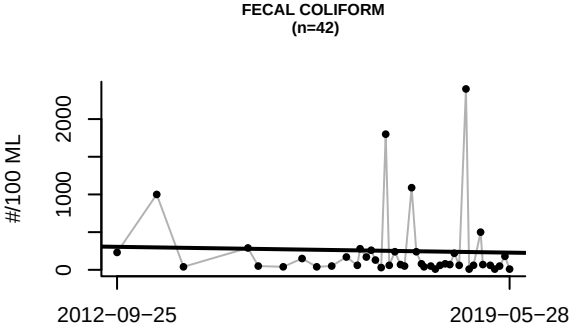


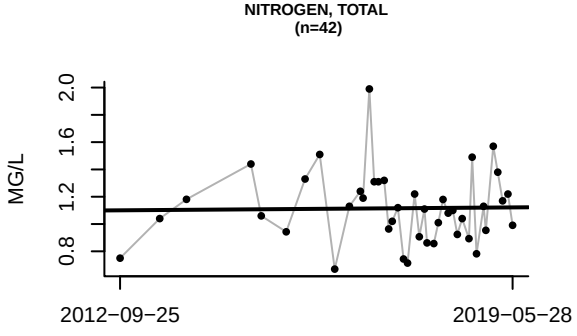
R2=0.02; m=3e−03 %/day; pval=0.431



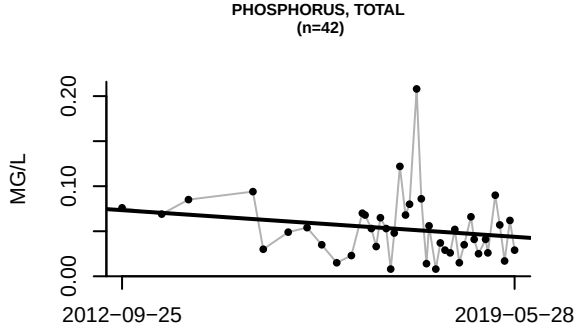
R2=0.02; m=−0.718 #/100 ML/day; pval=0.363



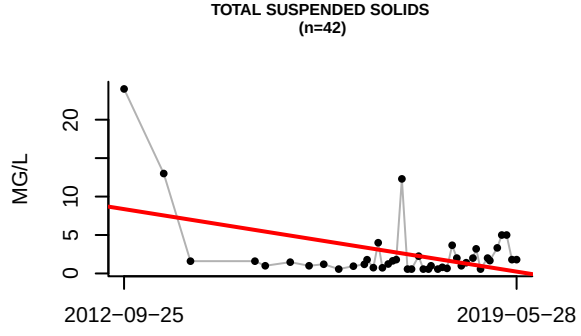
R2=0; m=−0.032 #/100 ML/day; pval=0.808



R2=0; m=0 MG/L/day; pval=0.902

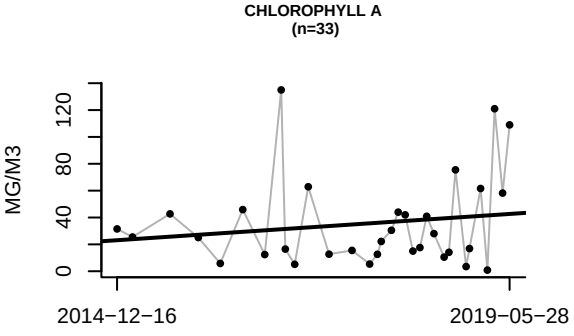


R2=0.04; m=0 MG/L/day; pval=0.209

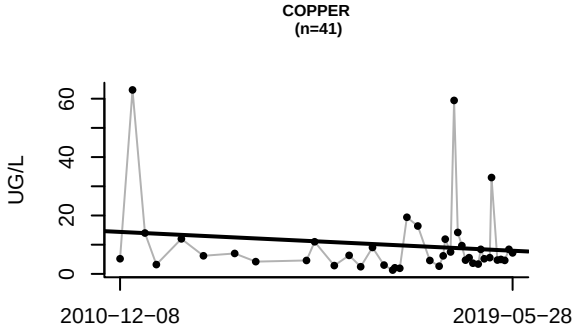


R2=0.21; m=−3e−03 MG/L/day; pval=2e−03

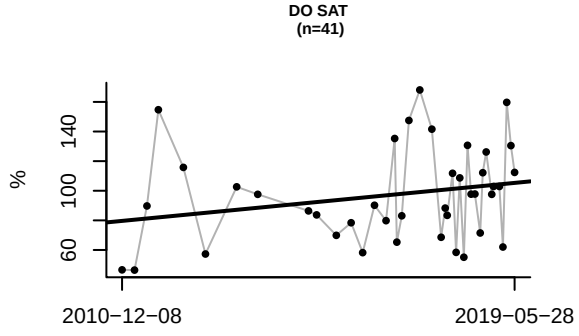
Site: Lake 2



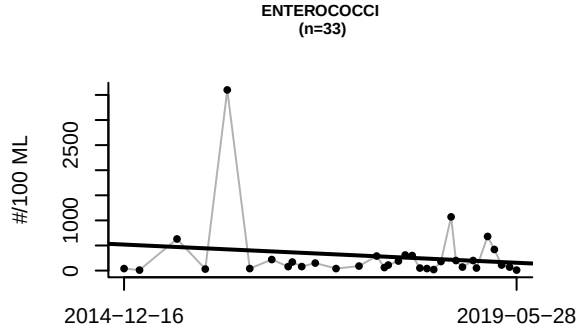
R2=0.03; m=0.012 MG/M3/day; pval=0.361



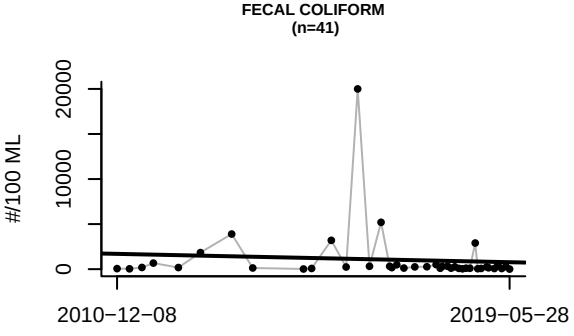
R2=0.02; m=−2e−03 UG/L/day; pval=0.359



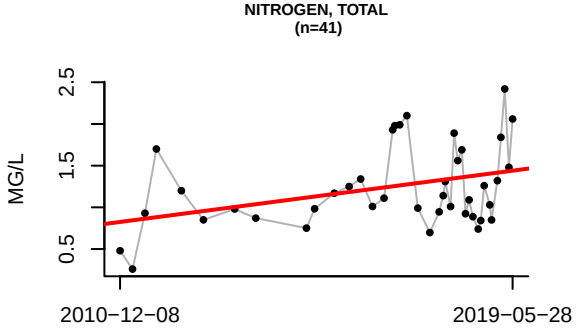
R2=0.06; m=8e−03 %/day; pval=0.127



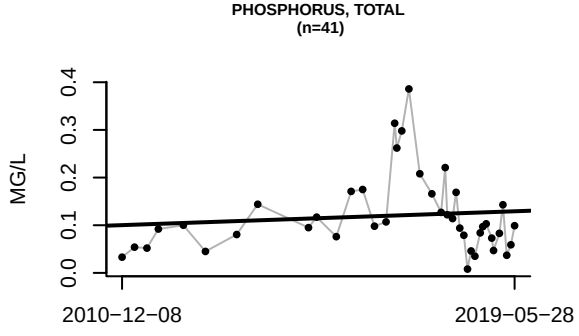
R2=0.03; m=−0.224 #/100 ML/day; pval=0.369



R2=0.01; m=−0.299 #/100 ML/day; pval=0.595



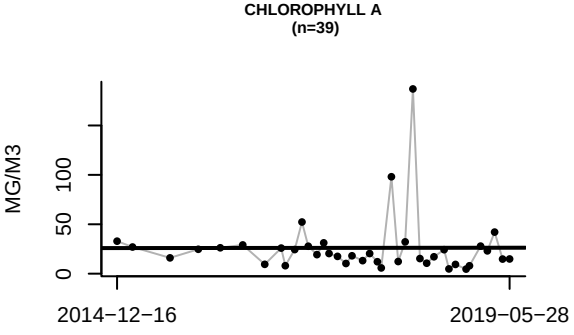
R2=0.14; m=0 MG/L/day; pval=0.015



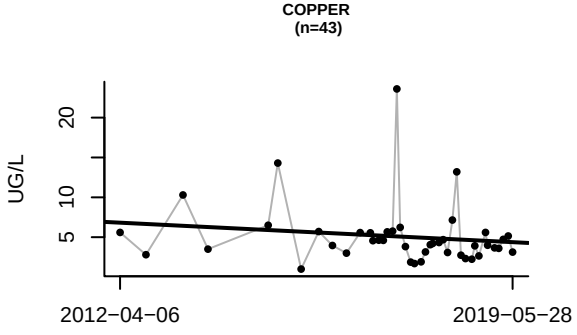
R2=0.01; m=0 MG/L/day; pval=0.508

R2=0.16; m=−2e−03 MG/L/day; pval=9e−03

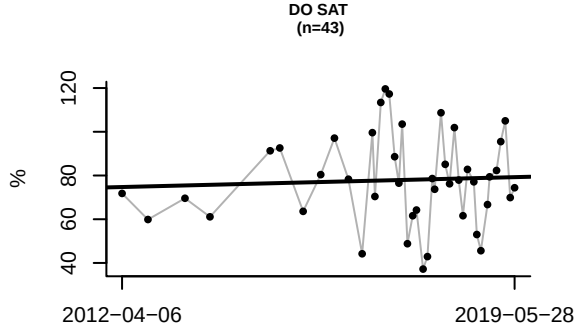
Site: Lake 3



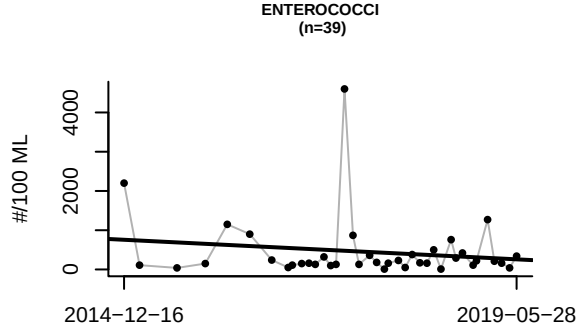
R2=0; m=0 MG/M3/day; pval=0.986



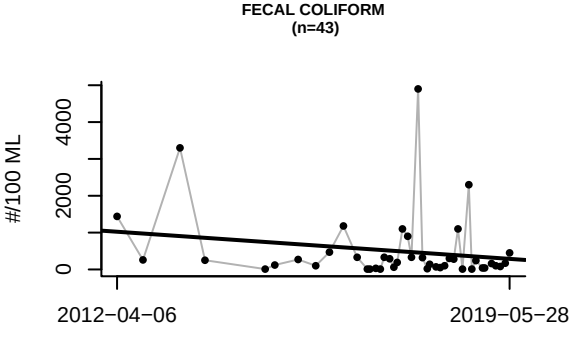
R2=0.02; m=−1e−03 UG/L/day; pval=0.323



R2=0; m=2e−03 %/day; pval=0.729



R2=0.03; m=−0.307 #/100 ML/day; pval=0.323



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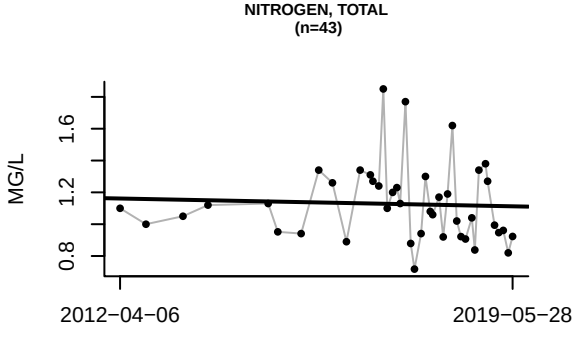
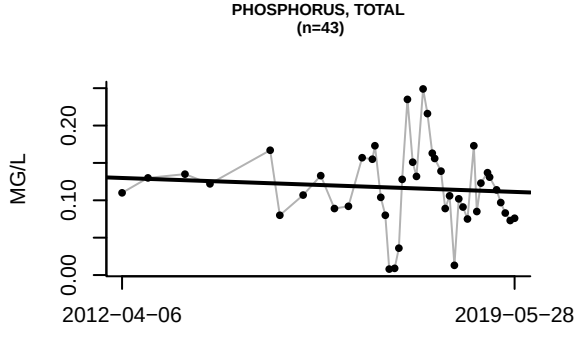
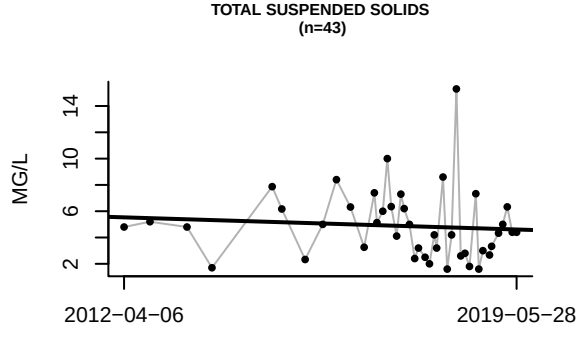


R2=0; m=0 MG/L/day; pval=0.747

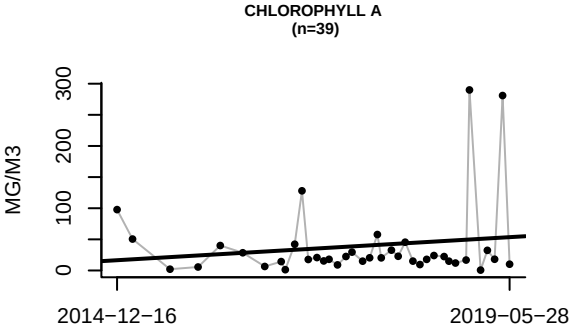


R2=0.01; m=0 MG/L/day; pval=0.575

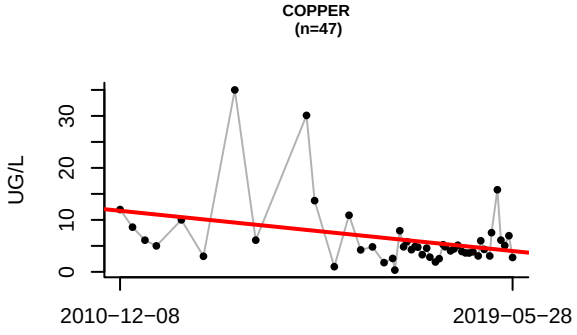


R2=0.01; m=0 MG/L/day; pval=0.585

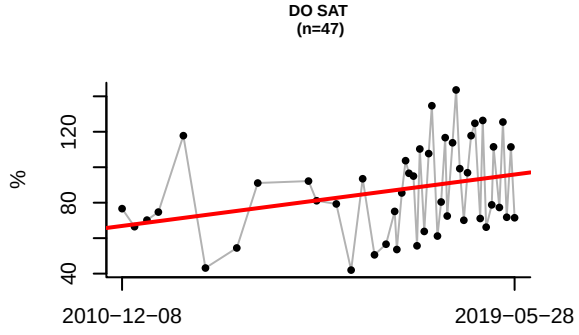
Site: Lake 5



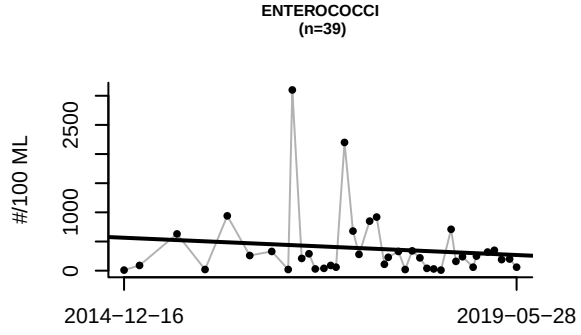
R2=0.02; m=0.023 MG/M3/day; pval=0.348



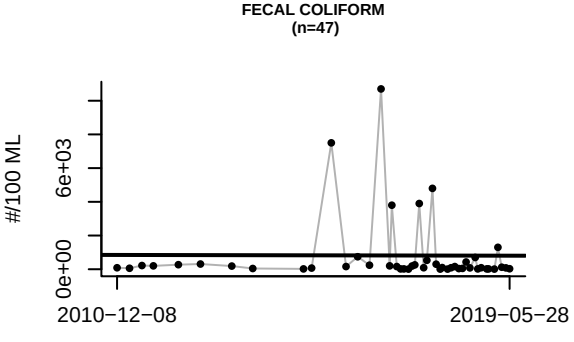
R2=0.12; m=−3e−03 UG/L/day; pval=0.019



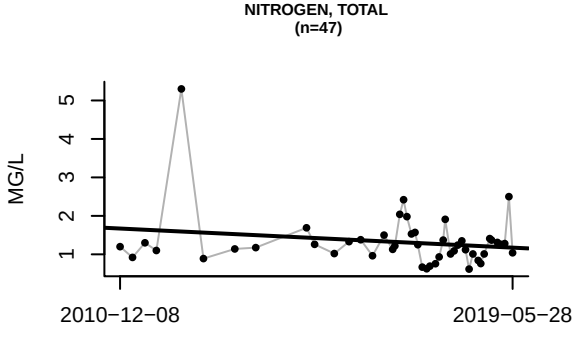
R2=0.1; m=9e−03 %/day; pval=0.029



R2=0.02; m=−0.182 #/100 ML/day; pval=0.434



R2=0; m=−0.014 #/100 ML/day; pval=0.968



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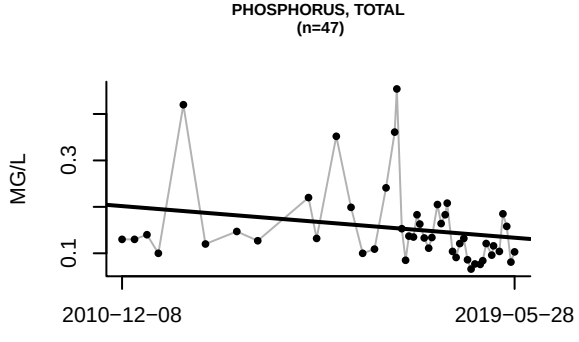
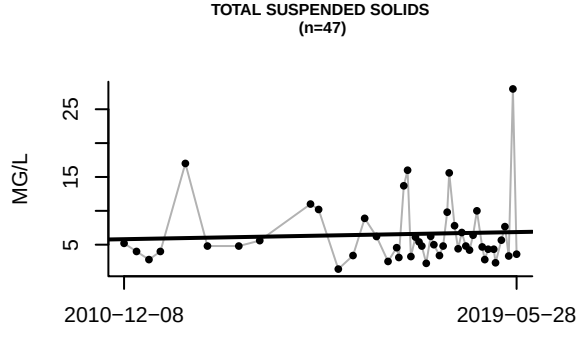
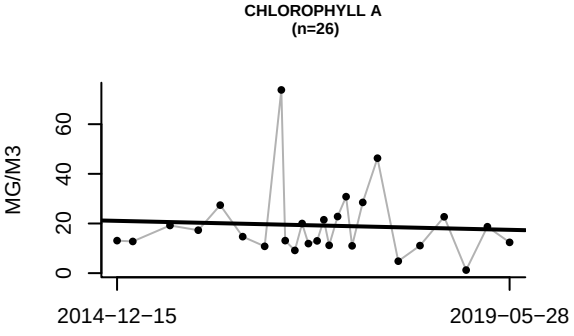


R2=0.05; m=0 MG/L/day; pval=0.132

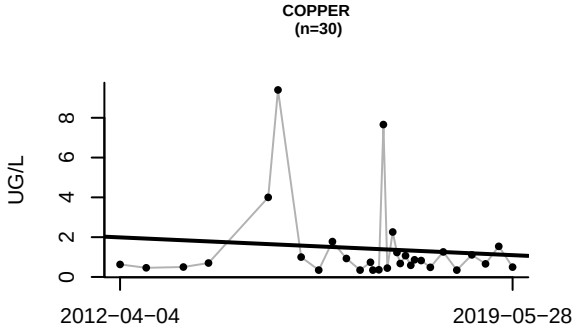


R2=0; m=0 MG/L/day; pval=0.687

Site: Lake 6



R2=0; m=−2e−03 MG/M3/day; pval=0.752



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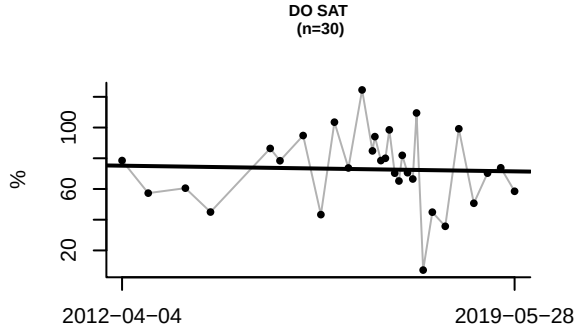
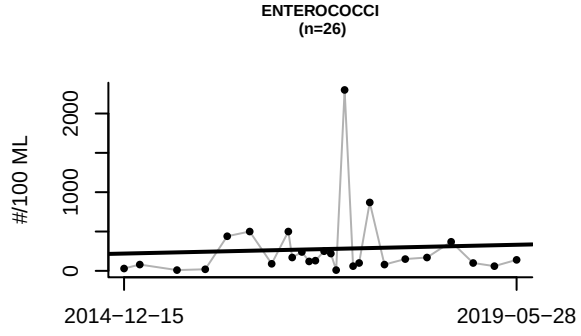
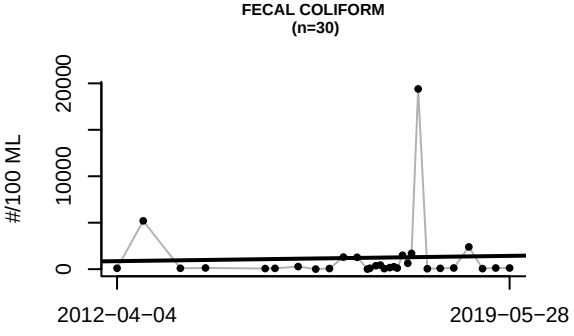


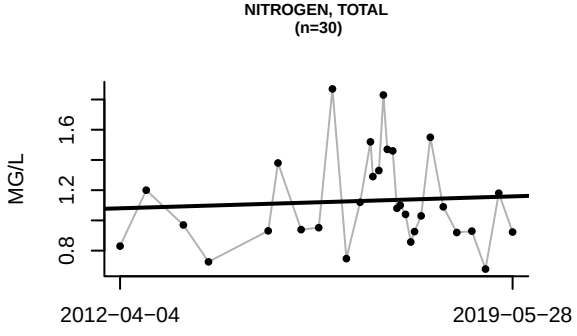
R2=0; m=−1e−03 %/day; pval=0.84



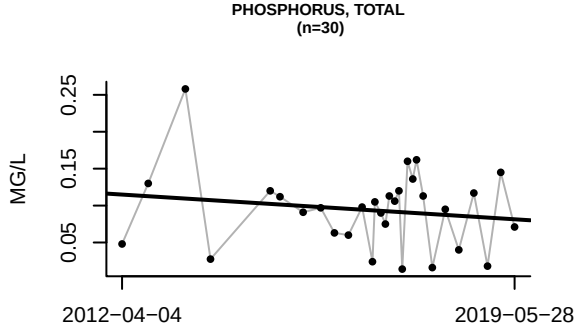
R2=0; m=0.069 #/100 ML/day; pval=0.757



R2=0; m=0.218 #/100 ML/day; pval=0.833



R2=0; m=0 MG/L/day; pval=0.732



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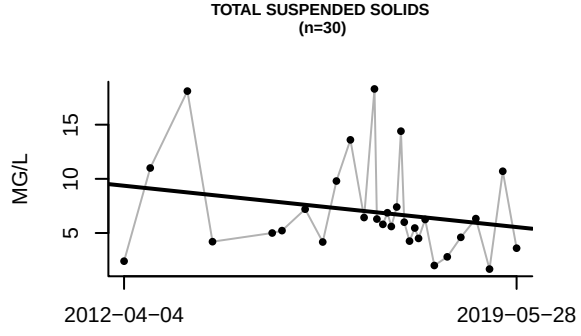
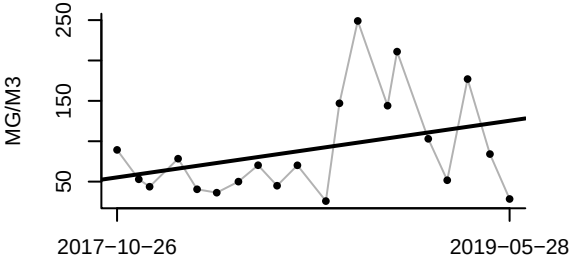


R2=0.05; m=−1e−03 MG/L/day; pval=0.234

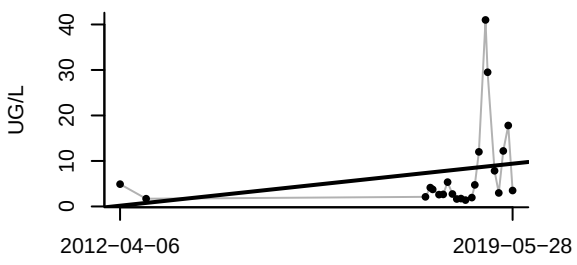
Site: Lake 8

CHLOROPHYLL A
(n=20)



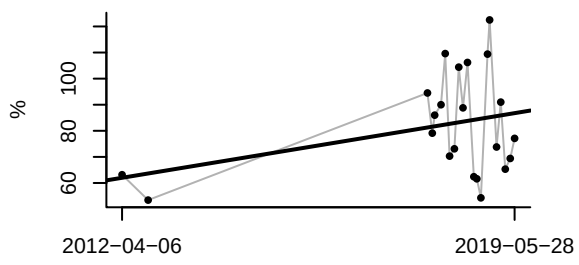
R2=0.12; m=0.121 MG/M3/day; pval=0.135

COPPER
(n=22)



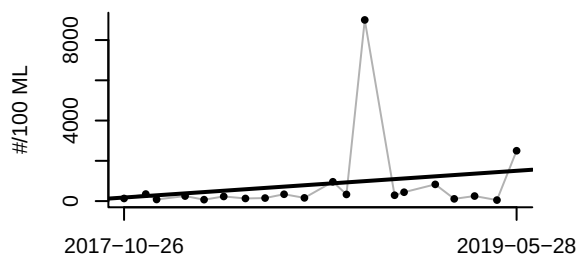
R2=0.06; m=4e−03 UG/L/day; pval=0.281

DO SAT
(n=22)



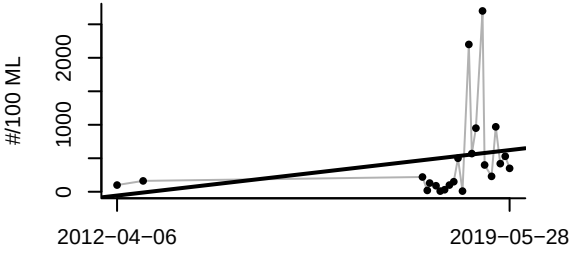
R2=0.11; m=0.01 %/day; pval=0.136

ENTEROCOCCI
(n=20)



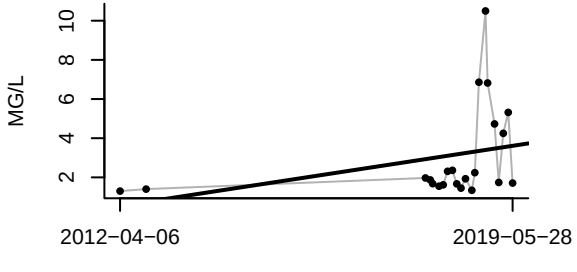
R2=0.04; m=2.291 #/100 ML/day; pval=0.379

FECAL COLIFORM
(n=22)



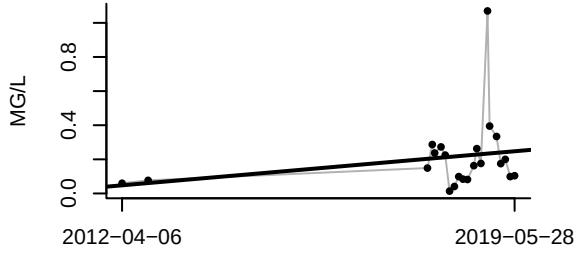
R2=0.06; m=0.26 #/100 ML/day; pval=0.254

NITROGEN, TOTAL
(n=22)



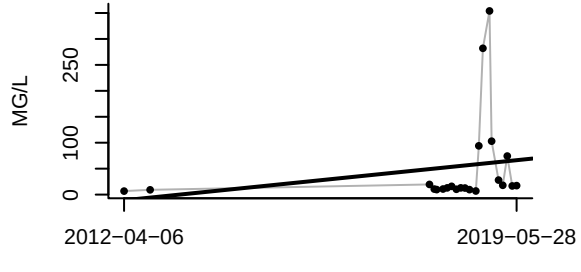
R2=0.11; m=1e−03 MG/L/day; pval=0.132

PHOSPHORUS, TOTAL
(n=22)



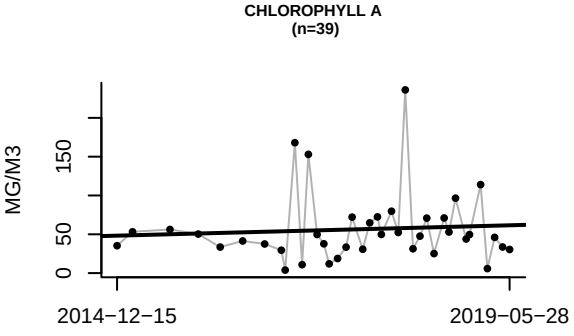
R2=0.06; m=0 MG/L/day; pval=0.283

TOTAL SUSPENDED SOLIDS
(n=22)

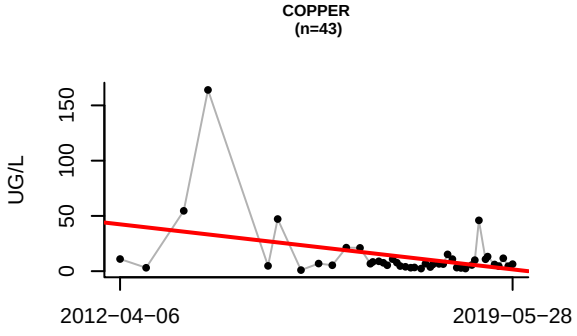


R2=0.05; m=0.03 MG/L/day; pval=0.325

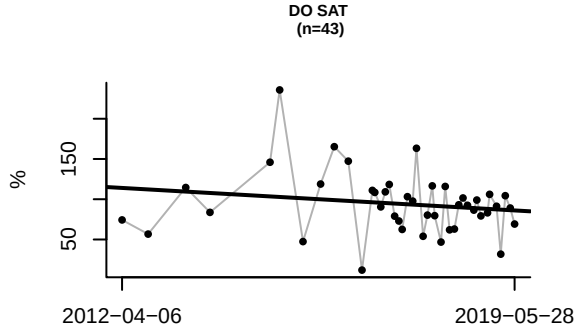
Site: Lake 9



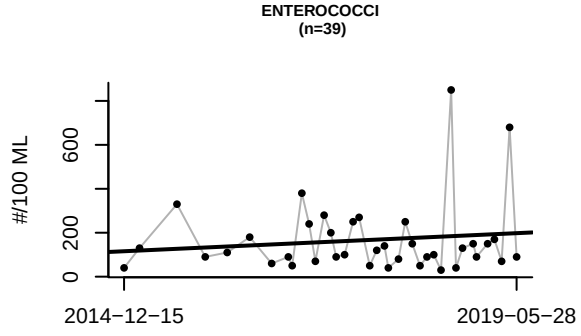
R2=0.01; m=8e−03 MG/M3/day; pval=0.641



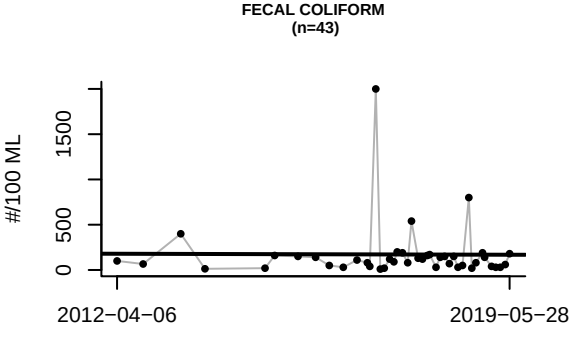
R2=0.15; m=−0.016 UG/L/day; pval=0.011



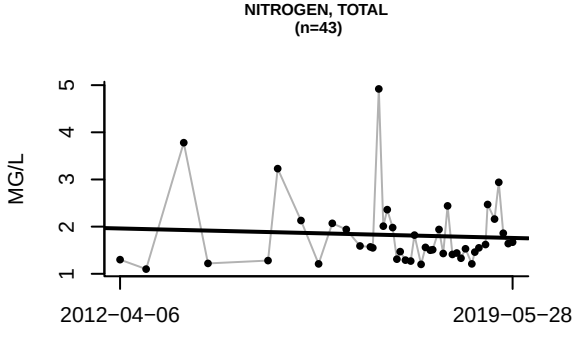
R2=0.03; m=−0.011 %/day; pval=0.253



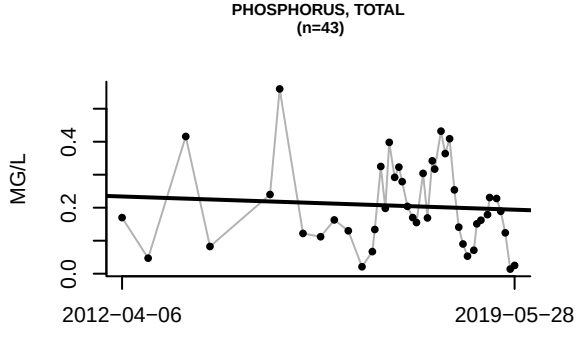
R2=0.02; m=0.051 #/100 ML/day; pval=0.43



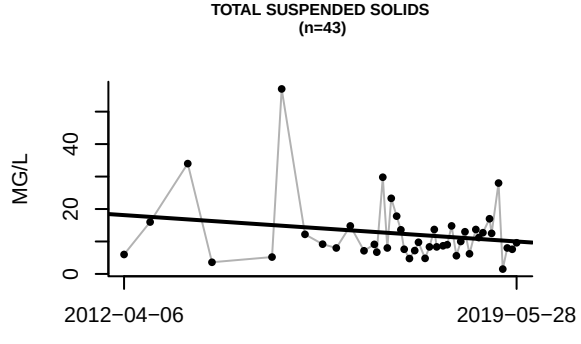
R2=0; m=−4e−03 #/100 ML/day; pval=0.958



R2=0; m=0 MG/L/day; pval=0.671



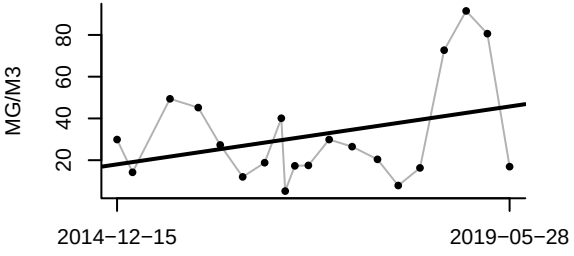
R2=0.01; m=0 MG/L/day; pval=0.62



R2=0.04; m=−3e−03 MG/L/day; pval=0.185

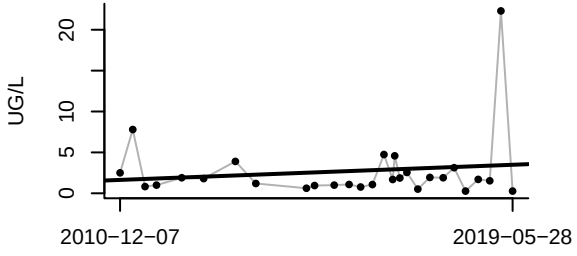
Site: Lake 10

CHLOROPHYLL A (n=20)



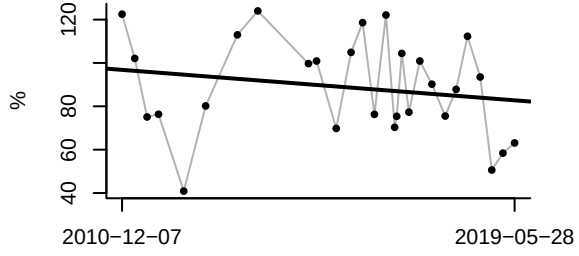
R2=0.11; m=0.017 MG/M3/day; pval=0.148

COPPER (n=28)



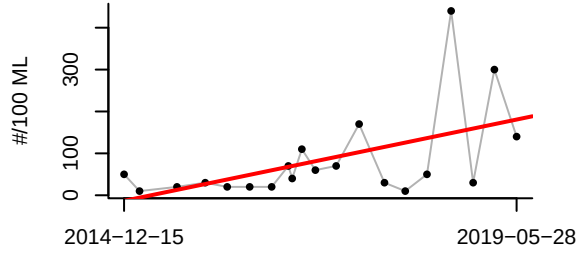
R2=0.02; m=1e−03 UG/L/day; pval=0.489

DO SAT (n=28)



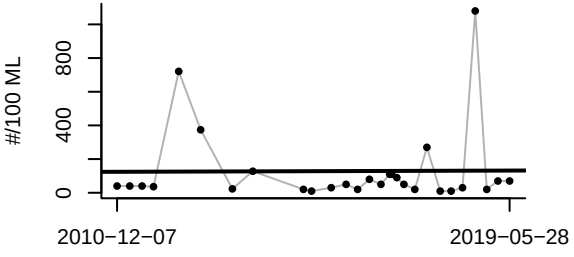
R2=0.04; m=−5e−03 %/day; pval=0.328

ENTEROCOCCI (n=20)



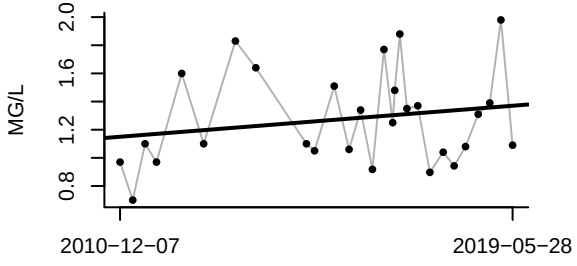
R2=0.28; m=0.119 #/100 ML/day; pval=0.017

FECAL COLIFORM (n=28)



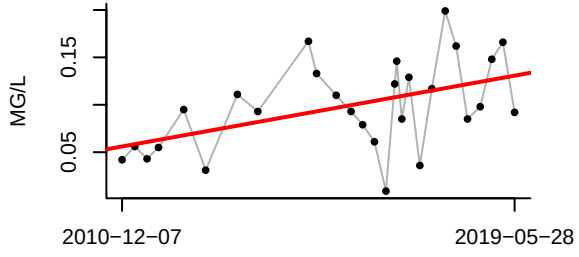
R2=0; m=2e−03 #/100 ML/day; pval=0.961

NITROGEN, TOTAL (n=28)



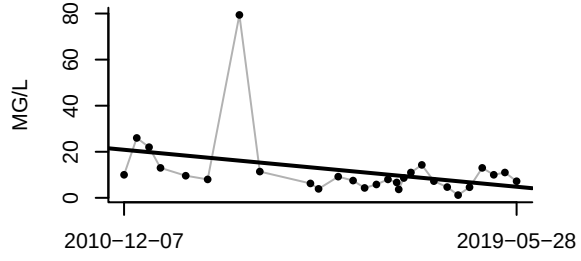
R2=0.04; m=0 MG/L/day; pval=0.299

PHOSPHORUS, TOTAL (n=28)



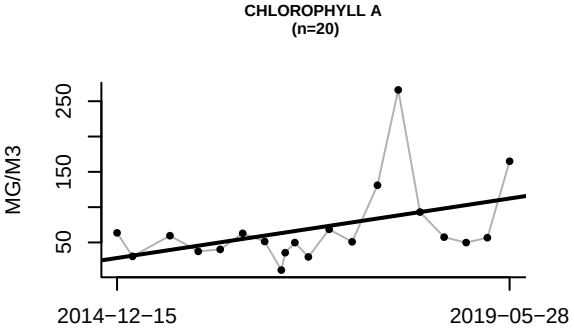
R2=0.24; m=0 MG/L/day; pval=9e−03

TOTAL SUSPENDED SOLIDS (n=28)

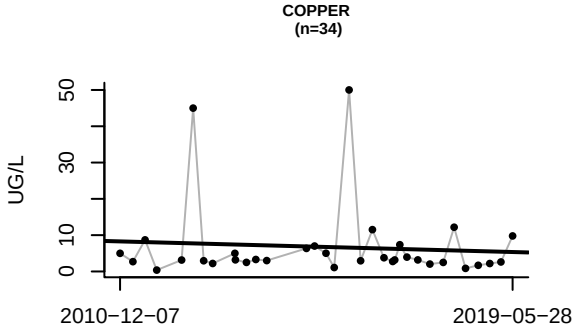


R2=0.12; m=−5e−03 MG/L/day; pval=0.071

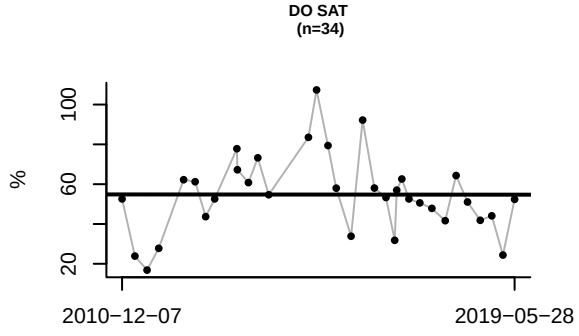
Site: Lake 14



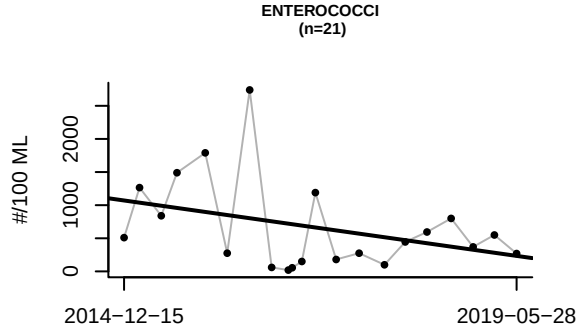
R2=0.19; m=0.052 MG/M3/day; pval=0.058



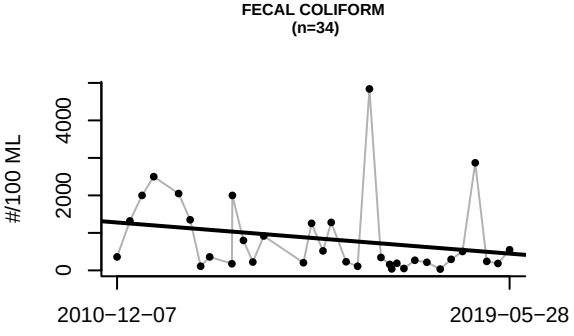
R2=0.01; m=−1e−03 UG/L/day; pval=0.649



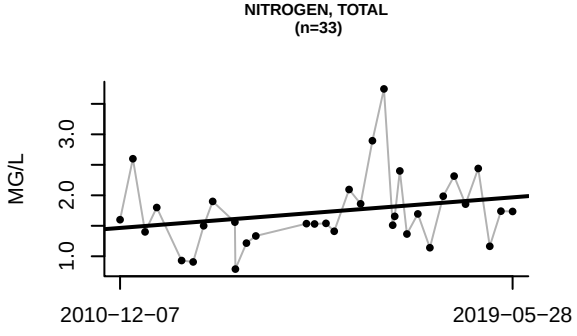
R2=0; m=0 %/day; pval=0.992



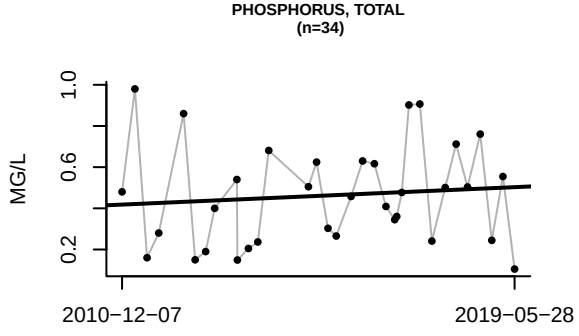
R2=0.13; m=−0.515 #/100 ML/day; pval=0.103



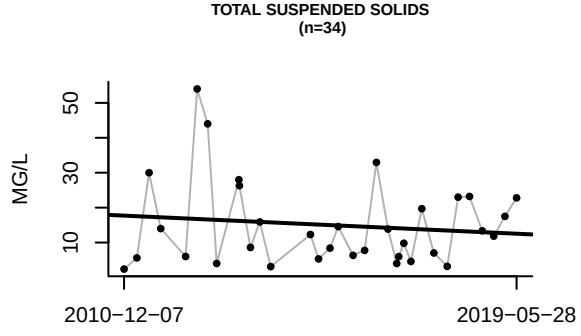
R2=0.06; m=−0.268 #/100 ML/day; pval=0.178



R2=0.06; m=0 MG/L/day; pval=0.159

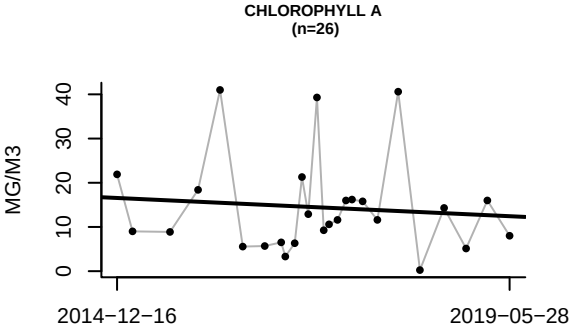


R2=0.01; m=0 MG/L/day; pval=0.558

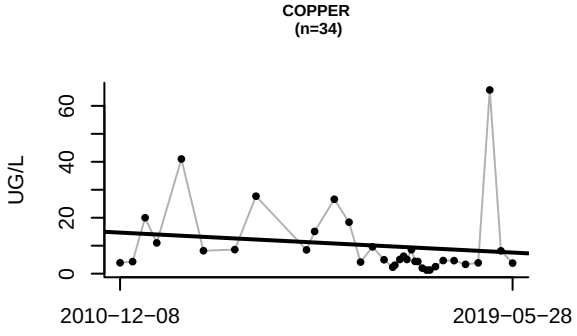


R2=0.02; m=−2e−03 MG/L/day; pval=0.474

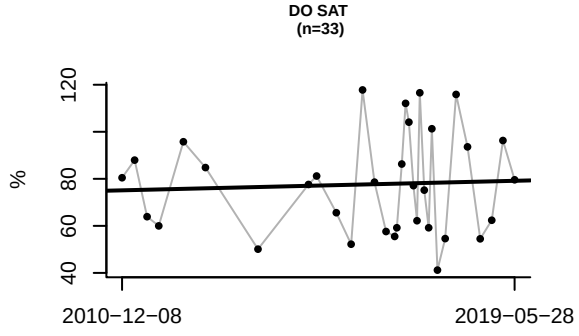
Site: Lake 15



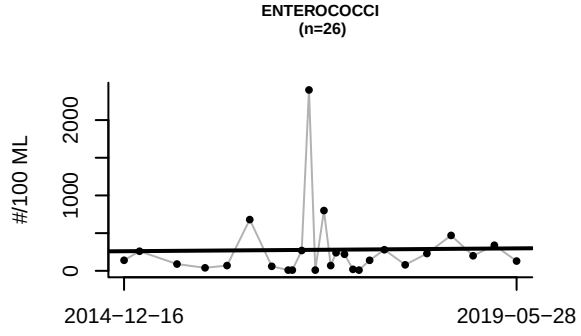
R2=0.01; m=−3e−03 MG/M3/day; pval=0.634



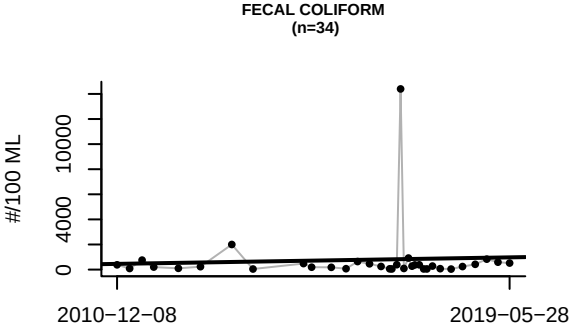
R2=0.02; m=−2e−03 UG/L/day; pval=0.375



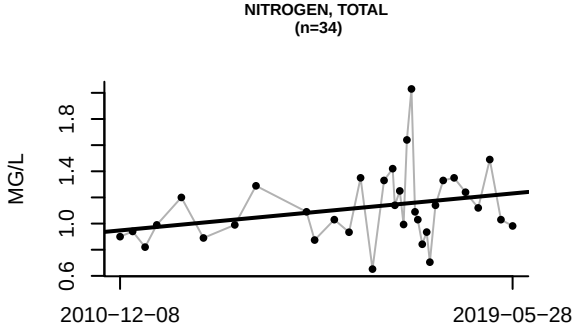
R2=0; m=1e−03 %/day; pval=0.764



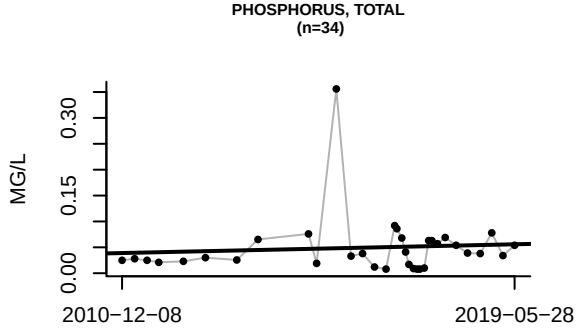
R2=0; m=0.023 #/100 ML/day; pval=0.921



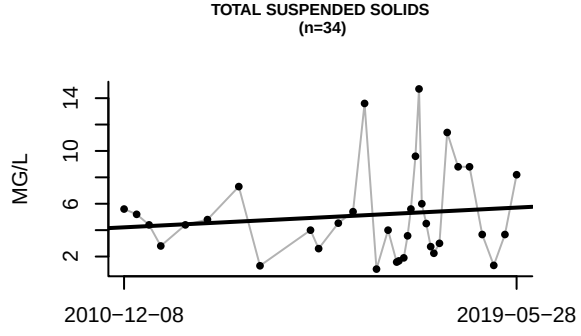
R2=0; m=0.168 #/100 ML/day; pval=0.731



R2=0.09; m=0 MG/L/day; pval=0.089

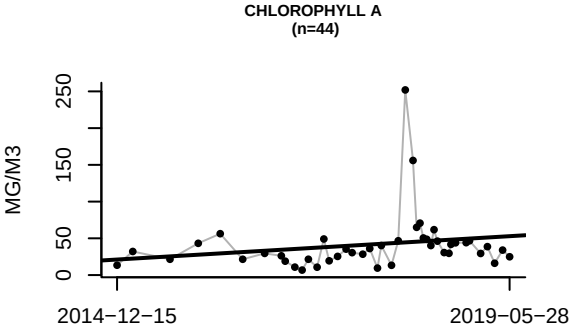


R2=0.01; m=0 MG/L/day; pval=0.645

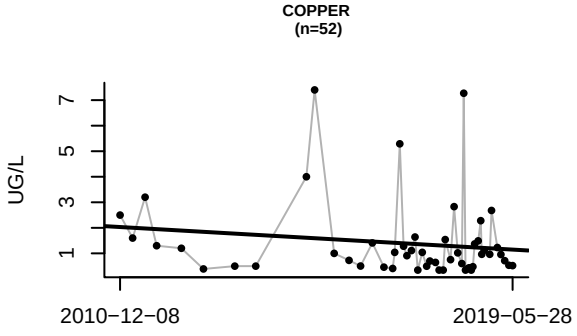


R2=0.02; m=0 MG/L/day; pval=0.478

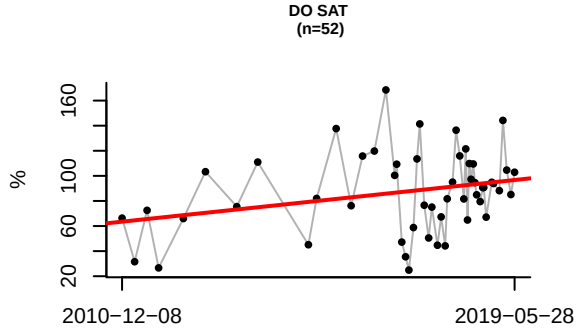
Site: Lake 19



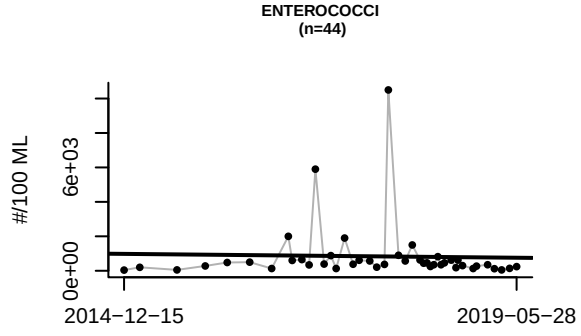
R2=0.04; m=0.02 MG/M3/day; pval=0.193



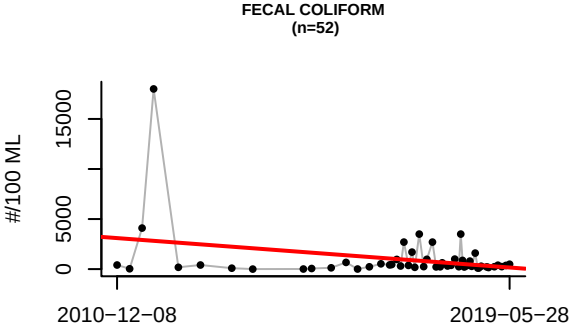
R2=0.02; m=0 UG/L/day; pval=0.269



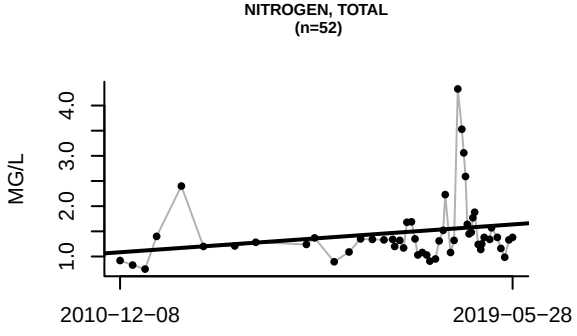
R2=0.08; m=0.011 %/day; pval=0.04



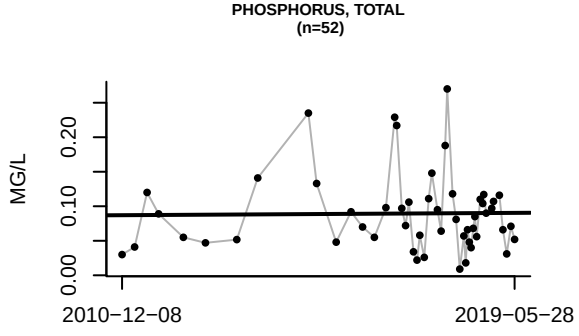
R2=0; m=−0.138 #/100 ML/day; pval=0.834



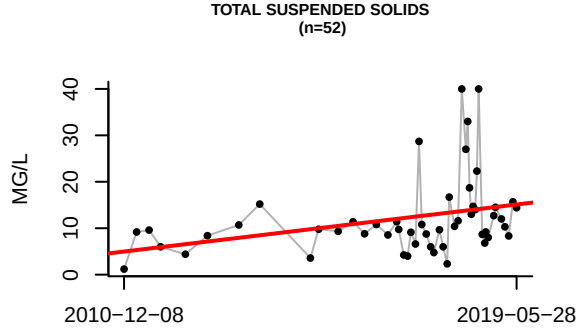
R2=0.1; m=−0.95 #/100 ML/day; pval=0.025



R2=0.05; m=0 MG/L/day; pval=0.102

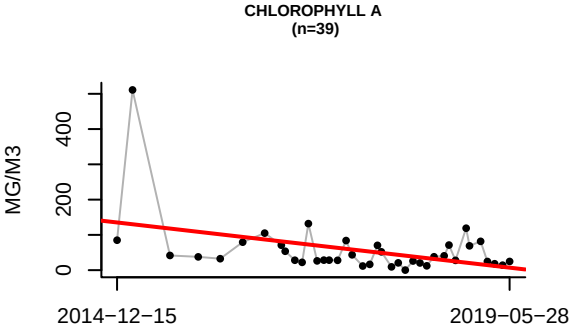


R2=0; m=0 MG/L/day; pval=0.909

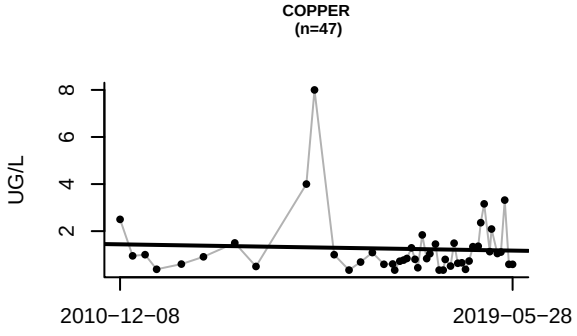


R2=0.11; m=3e−03 MG/L/day; pval=0.016

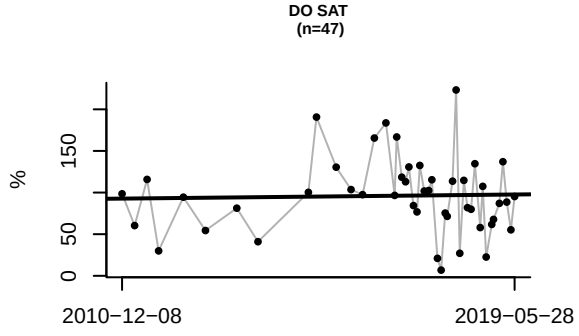
Site: Lake 20



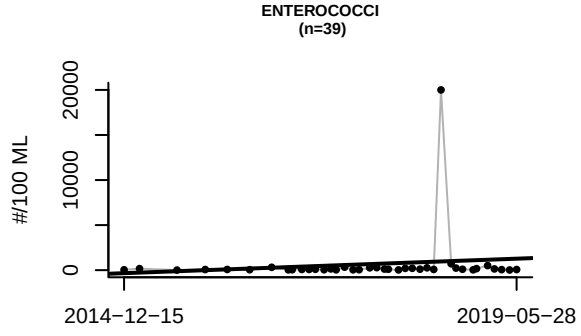
R2=0.17; m=−0.079 MG/M3/day; pval=9e−03



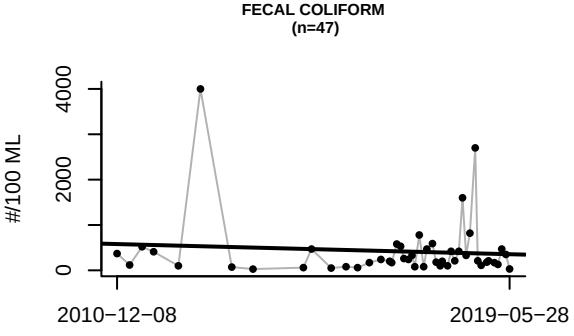
R2=0; m=0 UG/L/day; pval=0.699



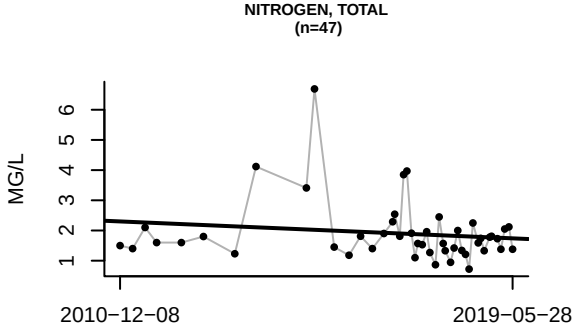
R2=0; m=2e−03 %/day; pval=0.839



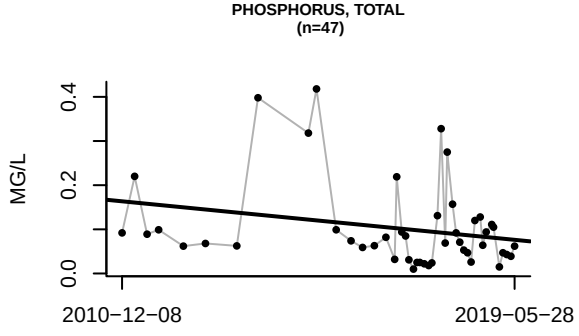
R2=0.02; m=0.989 #/100 ML/day; pval=0.422



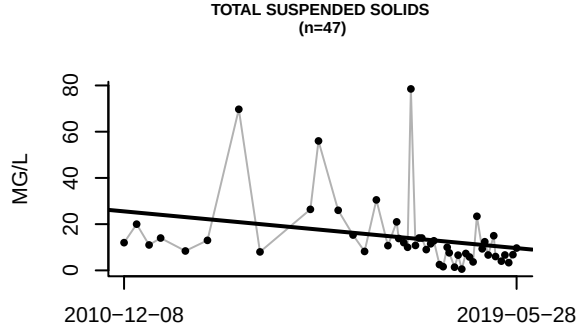
R2=0.01; m=−0.072 #/100 ML/day; pval=0.546



R2=0.02; m=0 MG/L/day; pval=0.305



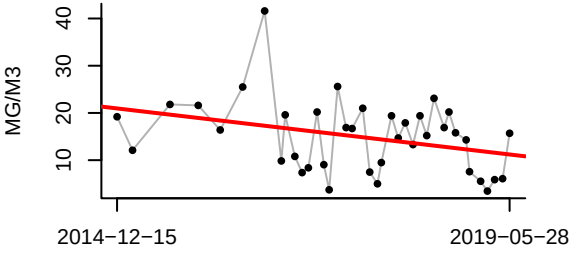
R2=0.06; m=0 MG/L/day; pval=0.091



R2=0.08; m=−5e−03 MG/L/day; pval=0.054

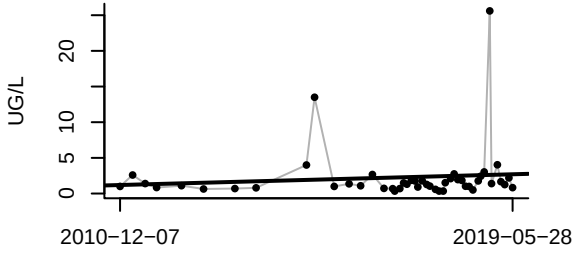
Site: Lake 22

CHLOROPHYLL A
(n=39)



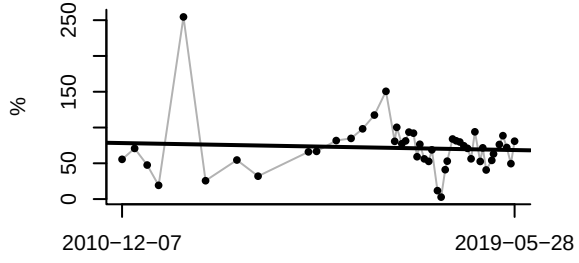
R2=0.11; m=−6e−03 MG/M3/day; pval=0.037

COPPER
(n=47)



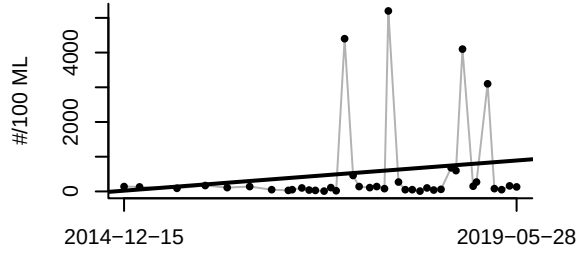
R2=0.01; m=0 UG/L/day; pval=0.48

DO SAT
(n=47)



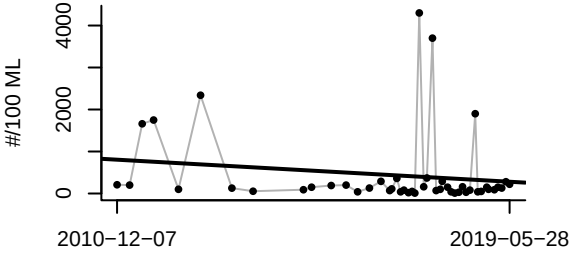
R2=0.01; m=−3e−03 %/day; pval=0.63

ENTEROCOCCI
(n=39)



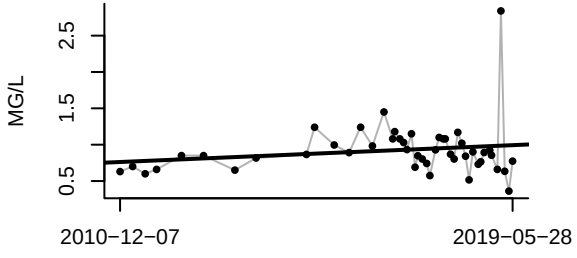
R2=0.03; m=0.535 #/100 ML/day; pval=0.278

FECAL COLIFORM
(n=47)



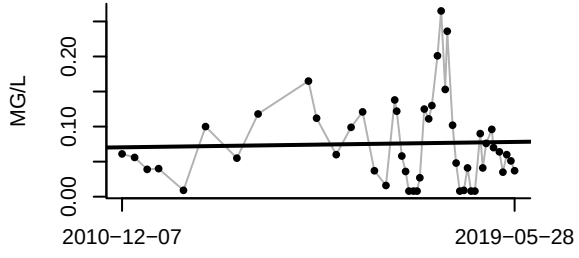
R2=0.03; m=−0.17 #/100 ML/day; pval=0.282

NITROGEN, TOTAL
(n=47)



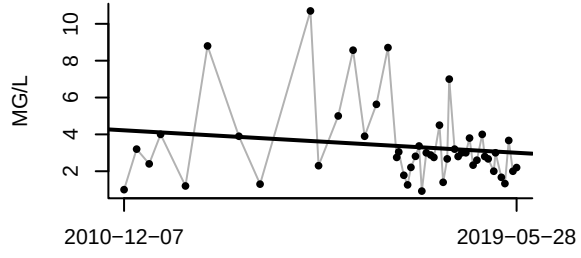
R2=0.03; m=0 MG/L/day; pval=0.222

PHOSPHORUS, TOTAL
(n=47)



R2=0; m=0 MG/L/day; pval=0.812

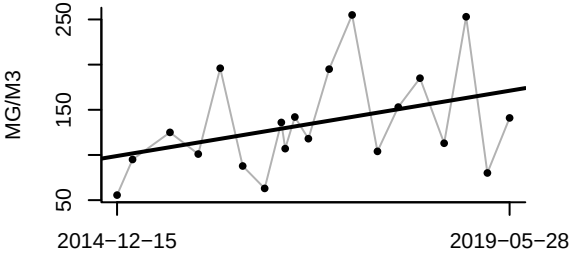
TOTAL SUSPENDED SOLIDS
(n=47)



R2=0.02; m=0 MG/L/day; pval=0.289

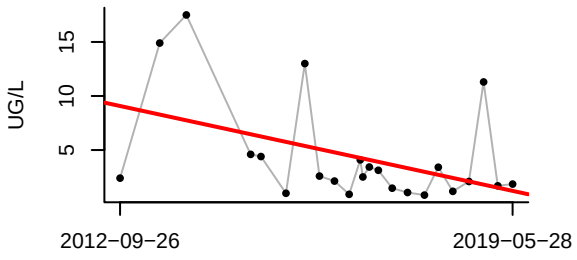
Site: Lake 24

CHLOROPHYLL A (n=20)



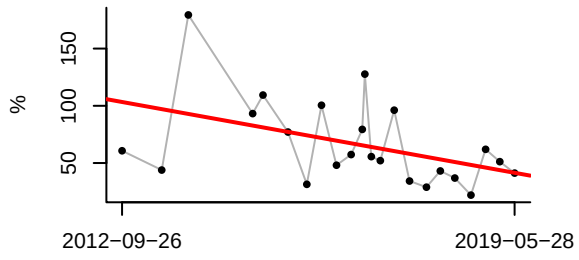
R2=0.14; m=0.044 MG/M3/day; pval=0.1

COPPER (n=23)



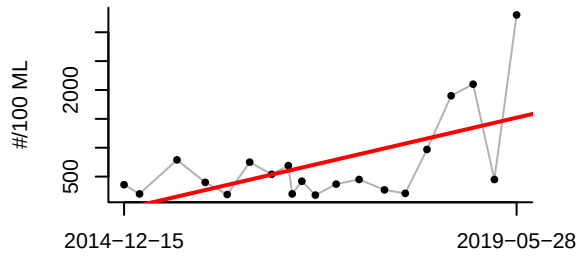
R2=0.2; m=−3e−03 UG/L/day; pval=0.034

DO SAT (n=23)



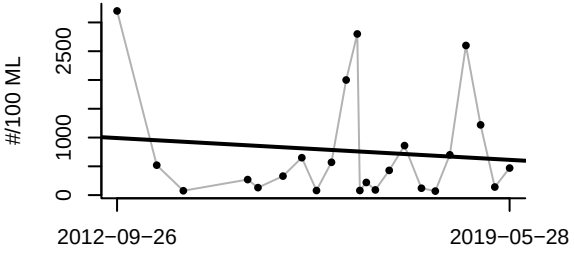
R2=0.2; m=−0.025 %/day; pval=0.031

ENTEROCOCCI (n=20)



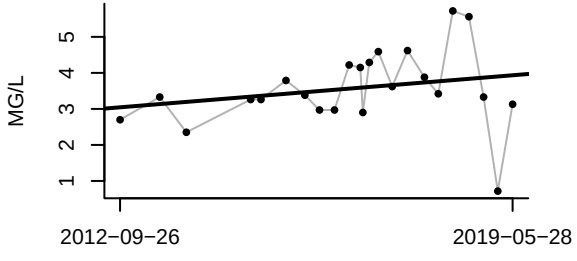
R2=0.34; m=0.972 #/100 ML/day; pval=7e−03

FECAL COLIFORM (n=23)



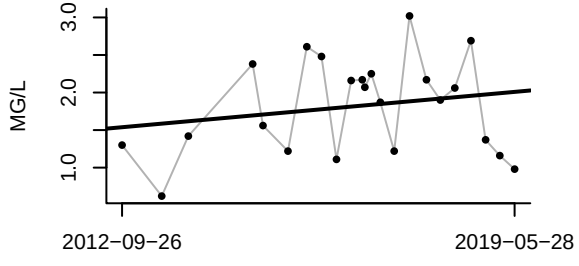
R2=0.01; m=−0.155 #/100 ML/day; pval=0.621

NITROGEN, TOTAL (n=23)



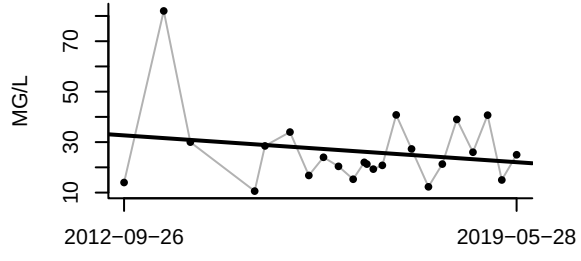
R2=0.05; m=0 MG/L/day; pval=0.289

PHOSPHORUS, TOTAL (n=23)



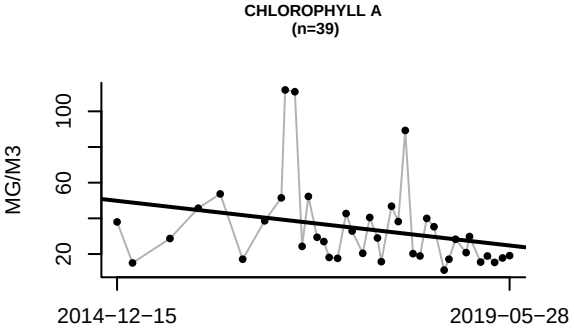
R2=0.04; m=0 MG/L/day; pval=0.352

TOTAL SUSPENDED SOLIDS (n=23)

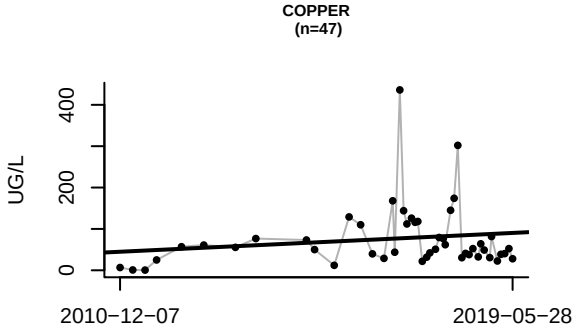


R2=0.04; m=−4e−03 MG/L/day; pval=0.374

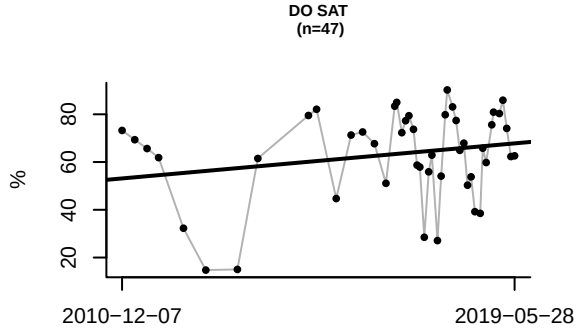
Site: Lake 26



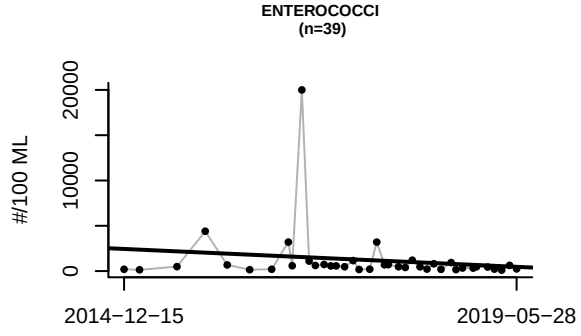
R2=0.08; m=−0.015 MG/M3/day; pval=0.088



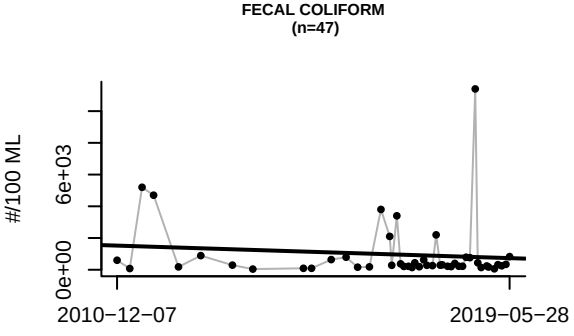
R2=0.03; m=0.015 UG/L/day; pval=0.267



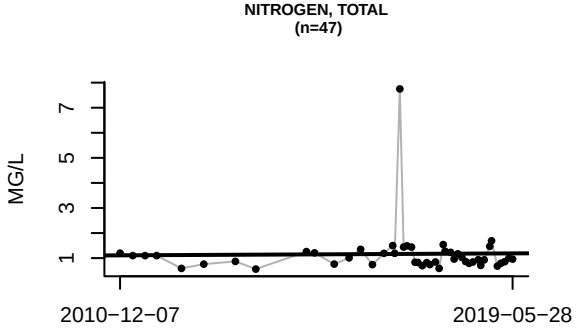
R2=0.05; m=5e−03 %/day; pval=0.133



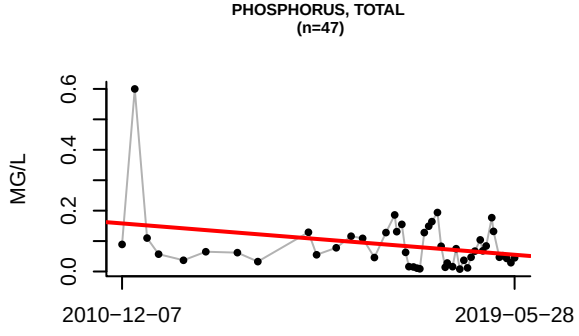
R2=0.03; m=−1.216 #/100 ML/day; pval=0.327



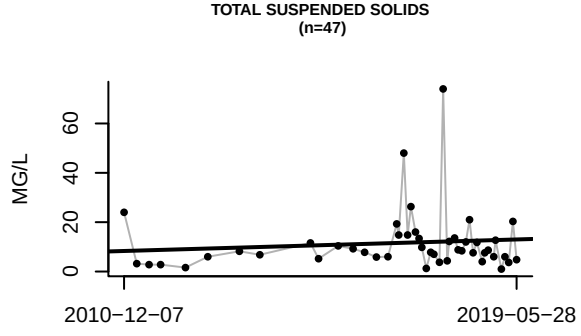
R2=0.01; m=−0.255 #/100 ML/day; pval=0.448



R2=0; m=0 MG/L/day; pval=0.887

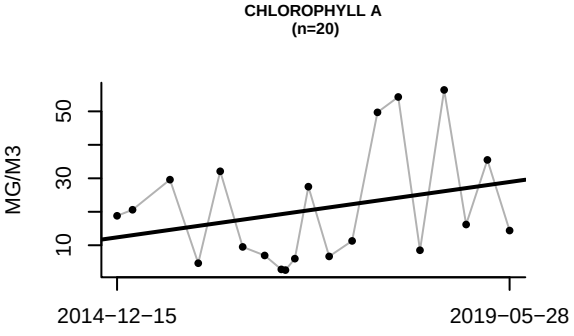


R2=0.1; m=0 MG/L/day; pval=0.032

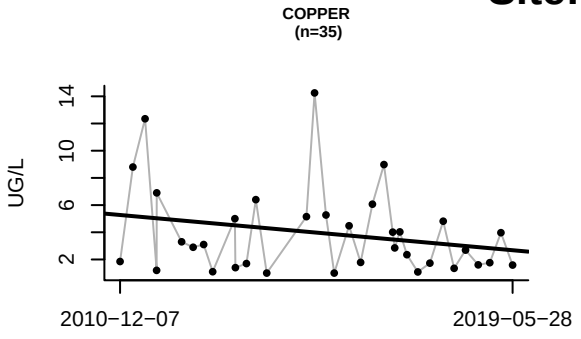


R2=0.01; m=2e−03 MG/L/day; pval=0.479

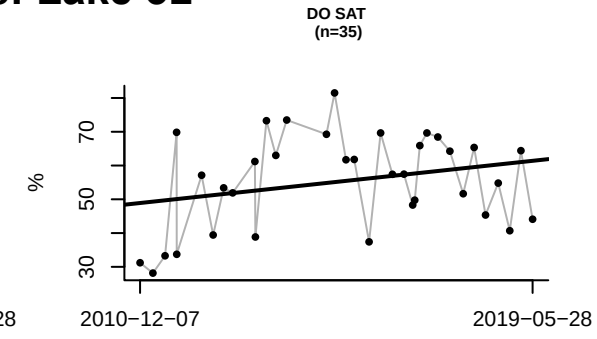
Site: Lake 31



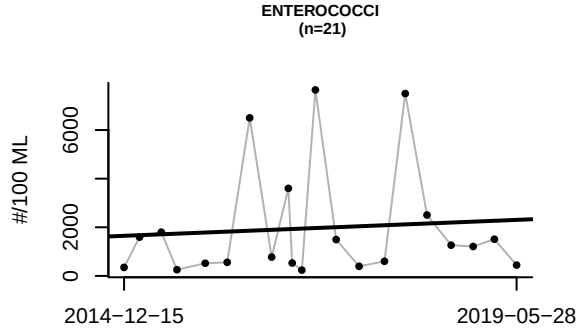
R2=0.08; m=0.01 MG/M3/day; pval=0.225



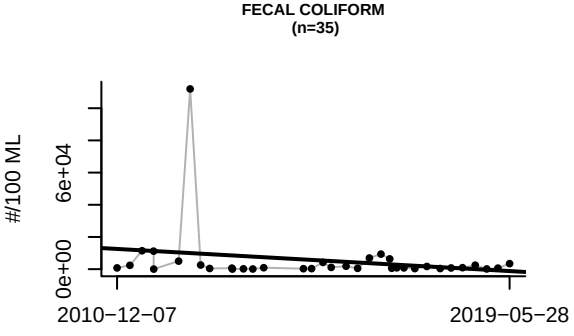
R2=0.06; m=−1e−03 UG/L/day; pval=0.155



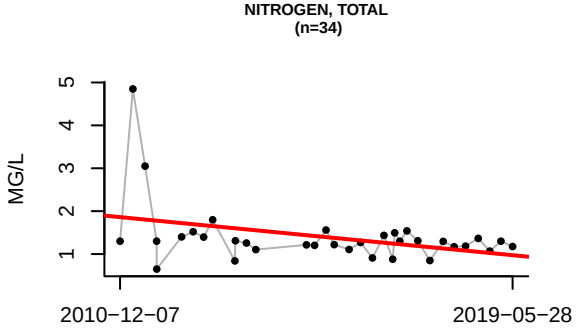
R2=0.07; m=4e−03 %/day; pval=0.113



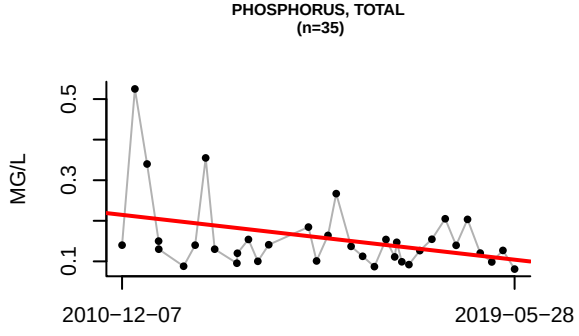
R2=0.01; m=0.403 #/100 ML/day; pval=0.717



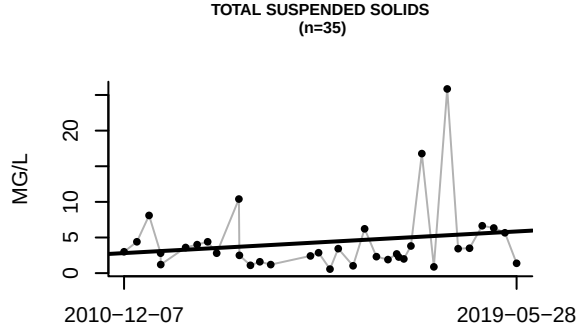
R2=0.05; m=−4.442 #/100 ML/day; pval=0.201



R2=0.14; m=0 MG/L/day; pval=0.028



R2=0.14; m=0 MG/L/day; pval=0.028



R2=0.04; m=1e−03 MG/L/day; pval=0.278

Appendix C-1
Stakeholder Lake Status Survey Instrument

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: _____

Resident Name: _____

Resident Address:_____

1. Who is responsible for maintaining the Lake?

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

3. Why do you think the water quality is good/bad?

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

6. What do you think should be done to improve the water quality in the Lake?

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

9. Why do you think the lake is/is not functioning as it should?

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

14. What do you think should be done to improve the water quantity in the Lake?

Additional Comments

Please provide any additional comments here:

Appendix C-2
Completed Stakeholder Lake Status Surveys

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Yucca Lake

Resident Name: Art Neuman

Resident Address: 480 Yucca Rd

1. Who is responsible for maintaining the Lake?
Steven Dellinath - Director Volunteer Lake Doctors, aerating system - monthly maintenance $350/yr = 11 residents

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

3. Why do you think the water quality is good/bad?
No vultures eating dead fish, have had issues in the past w/ algae bloom

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two) wildlife, aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
hiring Lake docs + added aerating system
-WQ samples to local conservancy ~40 yrs ago used to dive in the lake

6. What do you think should be done to improve the water quality in the Lake?
Littoral zone plantings

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
yes

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the **overall** quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

9. Why do you think the lake is/is not functioning as it should?

Functioning typically – rises in rain, drops in drought

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

NO – no ones

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

City of Naples – utilities? checks inlet a few times/yr

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

N/A

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO

14. What do you think should be done to improve the water quantity in the Lake?

NO

Additional Comments

Please provide any additional comments here:

Doesn't want city to take over maintenance of the lakes

RCP pipe goes to drain inlet – maybe connected to SW system? Maybe tied into beach club lake?

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Willow Lake

Resident Name: Andrew Hjorteas

Resident Address: 1211 8th Terrace N., Naples, FL 34102

1. Who is responsible for maintaining the Lake?
   The City of Naples, I believe.

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

3. Why do you think the water quality is good/bad?
   Appears that we get frequent, large growths of green stuff that floats on the surface.

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
   Wildlife + aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
   No.

6. What do you think should be done to improve the water quality in the Lake?
   Unsure.

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
   Yes.

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

9. Why do you think the lake is/is not functioning as it should?

See answer to # 3.

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

I have seen high levels, but they seem to subside relatively quickly. I haven't seen it close to our house.

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

See answer to # 4.

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

No.

14. What do you think should be done to improve the water quantity in the Lake?

Unsure.

Additional Comments

Please provide any additional comments here:

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Swan Lake

Resident Name: Michael Williams

Resident Address: 536 Turtle hatch rd

1. Who is responsible for maintaining the Lake?

unknown - Ann Dietz runs amateur group of maintainers

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwoter ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

3. Why do you think the water quality is good/bad?

plenty of ducks fish + turtles

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

plant life, aesthetics
↑
very little in lake

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

aerating system, hired a company - Ann knows name for various maintenance

6. What do you think should be done to improve the water quality in the Lake?

can't answer, good quality

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

yes

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public thraugh flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Starmwater runoff also infiltrates the groundwoter system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

9. Why do you think the lake is/is not functioning as it should?
takes care of water during intense rain events

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?
Bottom of yard and then retreats

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?
City - change level of sluice

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)
none

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.
NO

14. What do you think should be done to improve the water quantity in the Lake?
NO -

Additional Comments

Please provide any additional comments here:

9 inlets
who owns the lake? => difficult to know

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Spring Lake / East Lake

Resident Name: Jamie Bottalla

Resident Address: 658 7th Ave S., Naples, FL 34102

1. Who is responsible for maintaining the Lake?
I assumed the City of Naples would be responsible for maintaining the lake, but was told it is surrounding property owners.

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	(2)	3	4	5	6	7

3. Why do you think the water quality is good/bad?
I think the water quality is bad because of the algae blooms. Those blooms cause foul odors and poor air and water quality.

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two) My main concerns are for wildlife as well as air quality for humans. Next would be my concern aesthetically how the pond looks and smells.

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
I contacted Andrew Holland w/the City of Naples to find out who is responsible for condition of lake. He put me in contact with a property owner John McClarry who said they hired a company to help take care of lake the best they could.

6. What do you think should be done to improve the water quality in the Lake?
Run off from pesticides and fertilizers is main cause for algae blooms so we need to somehow manage that. Also maintaining some of the natural plants that help filter the lake is necessary.

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
Yes, I highly recommend the entire City of Naples reduce their use of pesticides and fertilizers and I would be willing to help.

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
(1)	2	3	4	5	6	7

9. Why do you think the lake is/is not functioning as it should? Someone recently repaired a filter that was in the middle of the lake which seems to be helping. As far as if the lake is properly "functioning" I am not sure.

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen? I have not experienced flooding of the lake, but the water levels have been very high at times. Certain areas adjacent to the lake have flooded during storms. Areas such as parking lots, roads, and lawns.

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake? I am not sure.

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two) Areas that concern me are ponding in nearby roadside swales, and any potential property damage.

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe. I am uncertain how individuals can improve water quantity of a lake. Before I moved into my property I think a drain was installed in our parking lot in a attempt to help with flooding, but other then that I don't know how we can effect water levels.

14. What do you think should be done to improve the water quantity in the Lake? Perhaps additional drains need to be installed around the city of Naples in areas that are prone to flooding.

Additional Comments

Please provide any additional comments here:

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Spring Lake

Resident Name: John McGarry (Jane)

Resident Address: 6411 W Lake Drive 34102

1. Who is responsible for maintaining the Lake?
   City claims is orphan – not city or resident believes it is the city

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	(2)	3	4	5	6	7

3. Why do you think the water quality is good/bad?
   very bad, actual cancerous matrials in lake, oils, heavy metals, fecal matter

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
   concerned about all – recreation + aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
   yes- monthly treatments for algae, installed fountain for aeration, microbe treatment

6. What do you think should be done to improve the water quality in the Lake?
   should be dredged – dying lake – needs new bottom, remove carcinogens + heavy metals over 100 Acres draining to lake

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
   absolutely

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

9. Why do you think the lake is/is not functioning as it should?

N/A unknown

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

NO, NO

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

maybe the city

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

yes - microbe treatments should reduce sludge @ bottom

14. What do you think should be done to improve the water quantity in the Lake?

yes - dredged

Additional Comments

Please provide any additional comments here:

was original city water source for 50 yrs, until 1950 then other aquifers developed, started using Spring lake for drainage

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: North Lake

Resident Name: Pete Have

Resident Address: 400 – 7th Ave N

1. Who is responsible for maintaining the Lake?
   City? Bounded by city property

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	(6)	7

3. Why do you think the water quality is good/bad?
   10-15 yrs ago Algae from March-Summer
   New water circulators help movement + no algae
   but concerned about growth of weeds

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
   plant life, aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
   used to pump fresh water, not for 30 yrs
   NA

6. What do you think should be done to improve the water quality in the Lake?
   if weeds are affecting WQ - needs to be taken care of
   have called city 3x

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
   sure

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals ond pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	(5)	6	7

9. Why do you **think** the lake is/is not functioning as it should?

connected to drainage system of nearby golf course
saltwater fish seen in lake

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

just up to road during hurricanes, approached house during hurricane

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

overflow of the lake, ponding

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO

14. What do you think should be done to improve the water quantity in the Lake?

u NO – reasonable functionality

Additional Comments

Please provide any additional comments here:

concerned about runoff
have ~~seen~~ deteriorated along 7th Ave
in the past 10 yrs

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: ~~Lincoln Barefoot~~ Mandarin Lake

Resident Name: Lincoln Barefoot

Resident Address: 1450 Mandarin Rd, Naples, FL 34102

1. Who is responsible for maintaining the Lake?

The city, but the only do it there is an issue

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (conals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

3. Why do you think the water quality is good/bad?

it doesn't seem like the city is doing anything to treat the water, no movement or aeration. There have been 2 algal blooms in the last 5 years, city contracted outside group to mitigate

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

aesthetics + recreation - fishing

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

NO

Follow city imposed fertilization schedule

6. What do you think should be done to improve the water quality in the Lake?

add aerators or plants to help clean the water e.g. pond lilies, more proactive approach to management - takes multiple calls for an issue to be addressed

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

yes

Barefoot Mandarin

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

9. Why do you think the lake is/is not functioning as it should?

Drains + holds water when it needs to

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

yes + yes - only in extreme weather - hurricane Irma

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

N/A

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

N/A

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

N/A

14. What do you think should be done to improve the water quantity in the Lake?

N/A

Additional Comments

Please provide any additional comments here:

Resident wishes the city would be more proactive w/ mgmt instead of reactive

Barefoot Manatarin

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Lake Suzanne

Resident Name: Bill oppenheimer

Resident Address: 698 Mooring Line drive – doesn't live on Lake

1. Who is responsible for maintaining the Lake?

   committee – condo on other lake

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

3. Why do you think the water quality is good/bad?

   Lake Doctors – there are fish

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

   aesthetics, wildlife

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

   Lake Doctors, oxygenator/fountain

6. What do you think should be done to improve the water quality in the Lake?

   unknown, only runoff coming in
   unknown if outflow structure is structurally sound

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

   Definitely

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

9. Why do you think the lake is/is not functioning as it should?

Owner of condo for 20 years, seems to function as designed

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

came up high during hurricane – flooded streets – didn't approach buildings

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO – NO mechanical way
would like to have ability to lower lake

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

road flooding, building flooding

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO

14. What do you think should be done to improve the water quantity in the Lake?

would like to be able to control levels of the lake

Additional Comments

Please provide any additional comments here:

will send contact info
for head of lake committee

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Lake 32

Resident Name: Tom Eastman

Resident Address: Seagate School

1. Who is responsible for maintaining the Lake?

School District – Maintenance Dept – Grounds Supervisor Mendez

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

3. Why do you think the water quality is good/bad?

Fertilizers coming in, city parks on school district site.

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

plant life, aesthetics
↑ affects storage + flooding

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

Mow bank, in compliance with permits

6. What do you think should be done to improve the water quality in the Lake?

State of water quality unknown, reduce input of fertilizers + chemicals

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

yes

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often manoged by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwoter runoff also infiltrotes the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

9. Why do you think the lake is/is not functioning as it should?

Only problem is when drains are clogged or outfall pipes are clogged or vegetation is overgrown

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

Neighbors have experienced flooding - years ago, city was notified

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO - no mechanism for this

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

building flooding + property damage, overflow of lake

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe. School district dredged lake b/c of torpedo grass and cleaned out outfalls, try to reduce plant growth

14. What do you think should be done to improve the water quantity in the Lake?

Maintain amount of vegetation, may need to dredge again in the future

Additional Comments

Please provide any additional comments here:

Maya - if an assessment wants to be made w/ recommended management practices he is open to that and meeting someone for a site visit + review

City of Naples Lakes Management Plan Update –Survey Instrument

The intent of this survey instrument is to collect information from City of Naples residents about the stormwater lakes bordering/adjacent to their homes. The data collected will be used in the Lakes Management Plan Update.

Lake Name: Lawrence Gentz Lake 17

Resident Name: ↓

Resident Address: 2515 Royal Palm Ct.

1. Who is responsible for maintaining the Lake?
   25 years ago - City, told that it is responsibility of homeowners property line does not include lake

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

unknown

3. Why do you think the water quality is good/bad?

   Not sure, no fish anymore, only ducks used to be a bird sanctuary

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

   wildlife, aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

   NO

6. What do you think should be done to improve the water quality in the Lake?

   clean the filth out of it – no one has touched it

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

   NO

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you **think** the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

9. Why do you think the lake is/is not functioning as it should?

yes, good

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

NO - swale + barrier

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

N/A - good through hurricanes

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO

14. What do you think should be done to improve the water quantity in the Lake?

unknown

Additional Comments

Please provide any additional comments here:

"absurd that the city expects homeowners to take care of this pond"

City of Naples Lakes Management Plan Update –Survey Instrument

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Lake Name: NUMBER 12

Resident Name: ROY & LINDA KEITH

Resident Address: 139 15TH AV. S.

1. Who is responsible for maintaining the Lake? AS FAR AS I KNOW WE (THE HOME OWNER THAT LIVE AROUND LAKE) ARE AND HAVE BEEN MAINTAINING THE POND.

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	(3)	4	5	6	7

3. Why do you think the water quality is good/bad?
THE WATER LOOKS TO BE OF A POOR QUALITY. IN YEARS PAST THERE HAS BEEN SOME ODOR BUT THE LAST YEAR OR TWO WE HAVE NOT NOTICED THE ODOR.

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two) AESTHETICS AND WILD LIFE

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
YES, YES, YES... WE HIRED "THE LAKE DOCTORS" TO MAINTAIN AND TRY TO IMPROVE THE WATER QUALITY

6. What do you think should be done to improve the water quality in the Lake?

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
YES

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	(3)	4	5	6	7

9. Why do you think the lake is/is not functioning as it should?
OUR LAKE IS TILED OUT TO THE BAY. THE CITY HAS PUT FLAPS THAT CAN BE LOWERED OR RAISED. I'M THINK THEY ARE NOT BEING MANAGED PROPERLY.

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen? YES... DURING HURRICANE IRMA

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake? NO

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)
PONDING & FLOODING

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.
?

14. What do you think should be done to improve the water quantity in the Lake?
I FEEL THE CITY SHOULD PARTICIPATE IN HELP US REGULATE TO CULVERTS CONNECTING OUR POND TO THE BAY

Additional Comments

Please provide any additional comments here:

City of Naples Lakes Management Plan Update –Survey Instrument

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Lake Name: LAKE 12

Resident Name: STEVEN T (TERRY) CLONTZ

Resident Address: 1441 GULF SHORE BLVD S.

1. Who is responsible for maintaining the Lake?
OWNERS OF PROPERTY ADJACENT TO THE LAKE HAVE BEEN FUNDING LAKE DOCTORS TO TREAT THE LAKE FOR ALGAE AND MUCK REDUCTION. CITY OF NAPLES MAINTAINS FLOATING ISLAND.

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

3. Why do you think the water quality is good/bad?
THERE IS A LAYER OF MUCK ON THE BOTTOM OF the LACK. AND THE LAKE IS CONNECTED TO NAPLES BAY. BRACKISH.

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
AESTHETICS & WILDLIFE

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
YES. WE HIRED LAKE DOCTORS ABOUT 5 YEARS AGO

6. What do you think should be done to improve the water quality in the Lake?
REDUCTION of MUCK AND SHORELINE MTCE/MGMT

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
YES

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

9. Why do you think the lake is/is not functioning as it should?

THE LAKE IS TIDAL

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

NO

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NOT NECESSARY, AS THE LAKE IS CONNECTED VIA TWO CULVERTS TO NAPLES BAY.

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

PONDING

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NOT NECESSARY (See 11.)

14. What do you think should be done to improve the water quantity in the Lake?

NOT NECESSARY (See 11.)

Additional Comments

Please provide any additional comments here:

City of Naples Lakes Management Plan Update –Survey Instrument

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Lake Name: Hidden Lakes

Resident Name: Mike Campbell

Resident Address: 788 Parkshore Naples 34103

1. Who is responsible for maintaining the Lake?
Condo association – company maintains – Lake Docs come out monthly

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

3. Why do you think the water quality is good/bad?
Fish present – thriving
Anhinga + ducks

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
recreation, plant life

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
yes – $8k water aerator, + Lake Doctors

6. What do you think should be done to improve the water quality in the Lake?
nothing

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
Maybe

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

9. Why do you think the lake is/is not functioning as it should?

yes - pass through with weir helps control levels

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

yes - irma - weir was covered w/ debris did not

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

Maintenance Supervisor

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

building flooding + property damage; plugged exit tube

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO

14. What do you think should be done to improve the water quantity in the Lake?

NO - pass through

Additional Comments

Please provide any additional comments here:

N/A

City of Naples Lakes Management Plan Update –Survey Instrument

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Lake Name: Forest Lakes

Resident Name: Tim Packard

Resident Address: 1169 10th Ave N 34102

1. Who is responsible for maintaining the Lake?
   Homeowners

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff ond stormwater ponds. As starmwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you **think** the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	(2)	3	4	5	6	7

3. Why do you think the water quality is good/bad?
   Need fountain to help clear lake out, current bubblers doing nothing, used to be crystal clear
   Muscovey ducks

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
   wildlife, recreation

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
   Keep it clean, volunteer efforts to weed
   2 bubblers for aeration – pumps + solar panels on his property

6. What do you think should be done to improve the water quality in the Lake?
   Dredge, limestone boulders, add fountain

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
   absolutely

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

9. Why do you think the lake is/is not functioning as it should?
homeowners can use water for irrigation

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?
NO | NO

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?
catch basin for emergency spillway

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

Algae, bad quality, grass sediments

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe. should allow neighbors across the street to use water for irrigation

14. What do you think should be done to improve the water quantity in the Lake?

Additional Comments

Please provide any additional comments here:

wants to be able to shoot the Muscovey Ducks

City of Naples Lakes Management Plan Update –Survey Instrument

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Lake Name: DEVILS LAKE

Resident Name: RAYMOND BERNIER

Resident Address: 477 DEVILS LANE

1. Who is responsible for maintaining the Lake?

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

3. Why do you think the water quality is good/bad? GOOD

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two) ALL THE ABOVE

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe. NO

6. What do you think should be done to improve the water quality in the Lake? WEED FERTILIZING

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts. YES

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	7

9. Why do you think the lake is/is not functioning as it should?

IT'S OK.

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

NO

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO - CITY NAPLES DOES

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

IN 25 YEARS WE NEVER HAD A PROBLEM.

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

I REMOVE COCONUTS PLASTIC ETC ON FRONTAGE OF LAKE

14. What do you think should be done to improve the water quantity in the Lake?

Additional Comments

Please provide any additional comments here:

I WOULD LIKE TO SEE LAKE MEMBERS TAKE MORE INTEREST WITH THEIR LAWN PEOPLE TO CLEAN THE PORTIONS OF LAKE PROPERTY

City of Naples Lakes Management Plan Update --Survey Instrument

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Lake Name: Colonade impoundment

Resident Name: Ed Monroe

Resident Address: 259 Colonade Circle 34103

1. Who is responsible for maintaining the Lake?

POA - regular fleet maintenance program,

Specific Water Quality Questions treat for invasives + insects - 2x per year

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

3. Why do you think the water quality is good/bad?

because receive flow from other ponds

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)

plant life, aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.

added aeration fountains, plants in littoral zone maintained 3x/wk

6. What do you think should be done to improve the water quality in the Lake?

No idea

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.

absolutely

Monroe
Colonade

Specific Water Quantity Questions

Water Quantity refers to the amount of starmwater runoff that is praduced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	4	5	6	(7)

9. Why do you think the lake is/is not functioning as it should?

Movement of watw helps maintain level in the lake

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

yes, NO, IRMA – watw level over bulkhead, receded in a number of hours

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO – 3ft well

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

recovery time,

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO – tried to increase well to 4ft + stormwatw team made them remove structure

14. What do you think should be done to improve the water quantity in the Lake?

Nothing

Additional Comments

Please provide any additional comments here:

Saltwatw intrusion into the bay, landscaping irrigated from the lake, tested 2x per wk for salinity (meter)

6 yrs ago
high tide > 3 ft → potential breach

Manvee Colorado

City of Naples Lakes Management Plan Update –Survey Instrument

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Lake Name: Alligator Lake –

Resident Name: Karen VanArsdale

Resident Address: 305 S Lake Dr. N 34102

1. Who is responsible for maintaining the Lake?
   City of Naples

Specific Water Quality Questions

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff and stormwater ponds. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

2. Do you think the overall water quality in the Lake is good/healthy or bad/unhealthy?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	(2)	3	4	5	6	7

3. Why do you think the water quality is good/bad?
   Lived on Lake for 33 years, used to flow out to gulf but put in a weir – affected salinization, huge fish kill aerators now in lake, so many dead fish – blizzard problem

4. When it comes to Water Quality, which items concern you most about the Lake: wildlife, plant life, aesthetics (how water bodies look and smell), recreation (fishing, swimming, boating, etc)? (Please select two)
   Fish life – tarpon, snook dying off
   aesthetics

5. Have you or your neighbors done anything to improve the water quality in the Lake? If yes, please describe.
   NO

6. What do you think should be done to improve the water quality in the Lake?
   have environmental person checking quality of the lake – salinity, oxygen, etc

7. Are you interested in supporting or participating in activities that will improve the water quality in the Lake? E.g. by reducing use of fertilizers or volunteering for things like littoral plant maintenance efforts.
   yes – have planted things, don't use fertilizer

Specific Water Quantity Questions

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes, ponds, ditches, canals and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates the groundwater system.

8. Do you think the overall quantity of water in the Lake is functioning as it should?

No Opinion/ Don't Know	Poor	Poor, but improving	Fair	Good, but deteriorating	Good, and improving	Good or excellent
1	2	3	(4)	5	6	7

9. Why do you think the lake is/is not functioning as it should?

Don't know status now, has historically been saturating lawn more often, new flood levels

10. Have you experienced flooding of the Lake? Has the water approached your house? If yes to either question, when did this happen?

yes over the years but haven't noticed since Dec. 2018

Lake saturated ground around house & killed 50 yr old tree

11. **For private lakes only:** Do you have someone designated to lower lake levels prior to storm events to increase water capacity of the lake?

NO – could remove cover over the well

12. Which items concern you most about the Lake? Overflow of the lake, ponding in nearby roadside swales, flooding depth, flooding recovery time, building flooding & property damage. (Please select two)

① flooding depth, ② overflow of the lake

13. Have you or your neighbors done anything to improve the water quantity in the Lake? If yes, please describe.

NO

14. What do you think should be done to improve the water quantity in the Lake?

Nothing to be done – wants to break the well

Additional Comments

Please provide any additional comments here:

Alligator Lake is unique

Appendix D
Updated Stormwater Lakes Management Plan PowerPoint Presentation