Part II

Sources of Nutrients to Grand Haven Stormwater Ponds: Fertilizers, Reclaimed Water, Soils and Sediment

Introduction

As indicated in Part I, stormwater retention and detention ponds are designed to mitigate for changes in the quantity and quality of runoff from a watershed due to development. Integration of stormwater management practices is critical to reduce impacts to downstream water bodies. Unfortunately, even with this infrastructure in place many downstream water bodies are not being sufficiently protected from nutrient loads associated more intensive land use in the watershed. As a result, water bodies downstream from these land uses are being listed as impaired. An impaired water body not only indicates the loss of certain public resource values, but it also triggers a need for additional contaminant reduction actions within the watershed which can be costly. Two ways to reduce the amount of nutrients flowing downstream from a stormwater basin is 1) reduce the amount of nutrients entering the basin and 2) increasing the basins treatment potential. If however a stormwater pond is to meet the aesthetic appeal of a healthy lake or pond without excessive use of algaecides or herbicides then minimizing the introduction of nutrients into the stormwater pond is necessary. The challenge with this "source control" approach is that just about everything in a conventional subdivision is designed to drain to the stormwater pond and therefore everything within the contributing catchment area that could be a source of nutrients must be addressed. In this section of the report three potential sources of nutrients in the watershed of stormwater ponds within the Grand Haven community will be evaluated. These include: Soils, Fertilizers and Reclaimed Water. I will also summarize findings from a survey of sediments collected from the bottom of the twelve study ponds as well as two additional ponds monitored in the lake watch program.

Methods

Upland Soils

Two soil sampling events were conducted in the fall of 2008 and spring of 2009. The first event was conducted by volunteers who collected soils from within common areas throughout the Grand Haven community. This survey also included several residential landscape soils. The second survey targeted individual lots that had not yet been landscaped or had any structure started. Half of the lots had been cleared and fill soil brought in to raise the lot elevation the other half of the lots had not yet been cleared and no fill soil added.

In all instances surface soils were collected to a depth of approximately 6 inches, several soil samples within a one meter area were combined to minimize small scale heterogeneity (see Appendix J for volunteer sampling protocols). Samples were placed in a bag for analysis at the University of Florida Soils Testing Laboratory. Soils analyses that will be reported include pH and Mehlich-1 extractable phosphorus. Mehlich-1 extractable phosphorus is a measure of phosphorus that provides a good estimate of the amount of phosphorous available for plant uptake.

Fertilizer Use

Fertilizer use estimates came directly from Austin Outdoor (commons area landscape contractor) and relate to the common space areas only. Approximately 6.5 acres of turf are fertilized within the common area with a target nitrogen application of 4 lbs N per 1000 sq ft and phosphorous application only as needed based on soil test or tissue test if soil test and plant visual diagnostic do not agree. Fertilizer used by individual homeowners or lawn care companies on private lots are not included in this fertilizer estimate. The amounts used on private lots may be at least equal if not greater than the amount applied to common space areas based on the total acreage of all private lots relative to the 6.5 acres of common space turf.

Reclaimed Water Nutrients

Irrigation water used in most of the common areas of the community is reclaimed water from the Palm Coast Wastewater Reclamation Facility. A monthly log of water volume used by the community and golf course is kept by the Grand Haven Operations Manager and was used to determine the water volume being applied to CDD common areas. According to Austin Outdoor, approximately 13.7 acres (6.5 turf and 7.2 ornamentals and shrubs) of the common area is irrigated. The concentration of nitrogen and phosphorus in the reclaimed water is based on a single measurement collected May 29, 2008 (Appendix J). Unfortunately this is the only concentration data that was available at the time of this report.

Sediment Collection and Analysis

A one time sediment sampling was conducted in January 2010. Sediments were collected within the open water and deepest portions of the stormwater ponds. Sediments were collected from the 12 study ponds as well as pond 28 and W6 which are ponds monitored as part of the LakeWatch monitoring program. There were three sediments samples collected approximately equidistant across the length of the pond (see Figure 1 for example of collection locations on pond 6). On three ponds (ponds 1, 6 and 19), sediments were also collected at three locations on the littoral shelf to see if there were any differences in the sediment composition between the littoral shelf and the deeper areas of the stormwater ponds. Samples were collected from the top 2 inches of sediment using a Ponar dredge.

After collection, sediments were placed on ice and transported to the Wetland Biogeochemistry Laboratory at the University of Florida. Soils were homogenized in the lab and analyzed for moisture content, organic matter content, total phosphorous, total copper and water extractable phosphorus. Digestions and extractions were conducted at the Wetland Biogeochemistry Laboratory and analysis was conducted at the Analytical Research Laboratory.

Figure 1. Example of pond sediment sampling locations (yellow x's) on pond 6 showing equidistant distribution of sampling points along long axis of stormwater pond.

Results and Discussion

Upland Soils

Soils collected from the common space areas within Grand Haven were analyzed for Mehlich-1 extractable phosphorus along with other common soil fertility parameters. Mehlich-1 extractable phosphorus is used to determine the amount of phosphorus that is available to the plant and whether or not an amendment of phosphorus in the form of fertilizer is recommended. As reported from the soil testing laboratory, the actual soil Mehlich-1 extractable phosphorus concentration is placed into one of five nutrient availability classes, very low (<10 mg/L), low (10-15 mg/L) medium(16-30 mg/L), high (31-60 mg/L) and very high(>60). Of the 48 samples collected during the initial survey 37 samples measured high or very high (Figure 2). This data suggest that 77% of the common areas do not require any additional phosphorus to support healthy turf. This data also implies that phosphorous may be leaching from these soils or if soils become saturated and begin to pond water due to irrigation or a storm event, phosphorus may be incorporated in surface runoff.

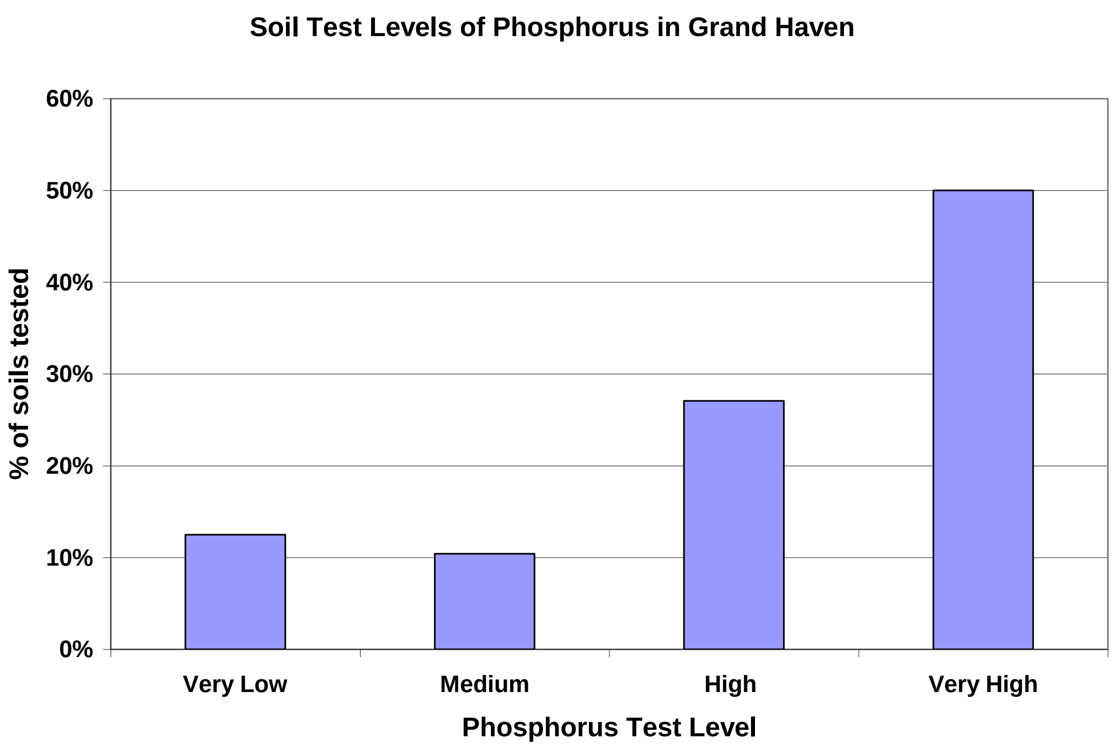
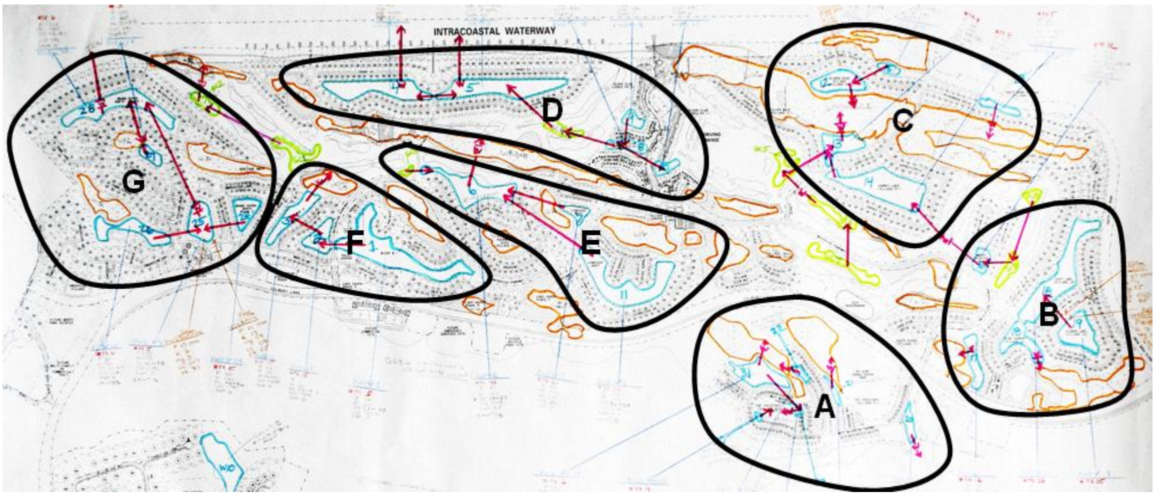


Figure 2 Soil phosphorus test results from initial survey of Grand Haven common areas.

The same soil data plotted in Figure 2 was aggregated into seven regions within the Grand Haven community based generally on stormwater catchment areas. The original intent of this aggregation of samples was to determine if there was a relationship between soils and stormwater pond water quality. There was no relationship found between upland soils data and water column nutrients in stormwater ponds of the same catchment, however data did show that certain regions within the Grand Haven community have soils that are higher in Mehlich-1 extractable phosphorus than others (Figure 3). Soils in catchment B, C, E and F had more soil samples that were classified as High or Very High when compared to catchments A or G that have a number of soils in the Very Low to Moderate category.



Catchment	Very Low	Medium	High	Very High
A	33%	0%	56%	11%
B	0%	14%	29%	57%
C	14%	0%	29%	57%
D	0%	40%	20%	40%
E	0%	0%	0%	100%
F	0%	0%	40%	60%
G	29%	29%	14%	29%
Grand Haven	13%	10%	27%	50%

Figure 3. Soils collected from common space areas aggregated into seven catchments based on common drainage areas with the Grand Haven Community.

The regional variance in Mehlich-1 soil phosphorus concentration suggests either differences in landscape management and therefore different levels of phosphorous application or differences in underlying soil characteristics. Since all common space areas are under the same management regime, it was concluded that differences in underling soil characteristic must be the reason that Mehlich-1 soil phosphorus concentration varied throughout the community. This finding is not surprising since most conventional developments undergo a high degree of soil disturbance during the development process and in low lying areas or areas with high water table there is often a large amount of fill soil brought in to raise the elevation. Most of the fill soil is excavated in areas of the development that will eventually become the stormwater ponds.

To investigate the extent to which fill soils may influence Mehlich-1 extractable phosphorus relative to the predevelopment condition, a second soil sampling was conducted. During this sampling soil samples were collected at Grand Haven and Hidden Oaks from two additional locations 1) Fill Soil (cleared lots that had fill added, but no landscaping or structure constructed) and 2) Native soils (lots that had not been cleared, no fill had been added and no landscaping had been conducted). Native soils when compared to fill soils showed dramatically different pH levels with almost a two unit change (Figure 4). Common turf areas and residential turf areas had pH levels similar to that of the fill soil. Mehlich-1 extractable phosphorus concentration also showed a significant increase between native soils and all other soils sampled (Figure 5). The data indicate that there was a 5,450% increase in phosphorous availability between native soils and filled soils even before any fertilizer is applied. An additional increase in phosphorus availability of 4% occurred as a result of common space management practices and phosphorous availability increased an additional 20.3% due to individual yard management practices.

These findings suggests that fill material that was used to raise the elevation of most house lots has a large amount of available phosphorous in it and therefore although this would benefit turf and landscape plants and in most instances eliminate the need for any phosphorus amendments, it also suggest a potentially significant source of phosphorus that may enter the stormwater ponds. These results need to be investigated in more detail and there are differences between potential vectors that connect phosphorus sources to the stormwater ponds (subsurface leaching vs. surface runoff), but the data certainly suggest a large "reservoir" of phosphorus in the soils that are not the result of landscaping practices, but instead the result of initial development activities on the site.

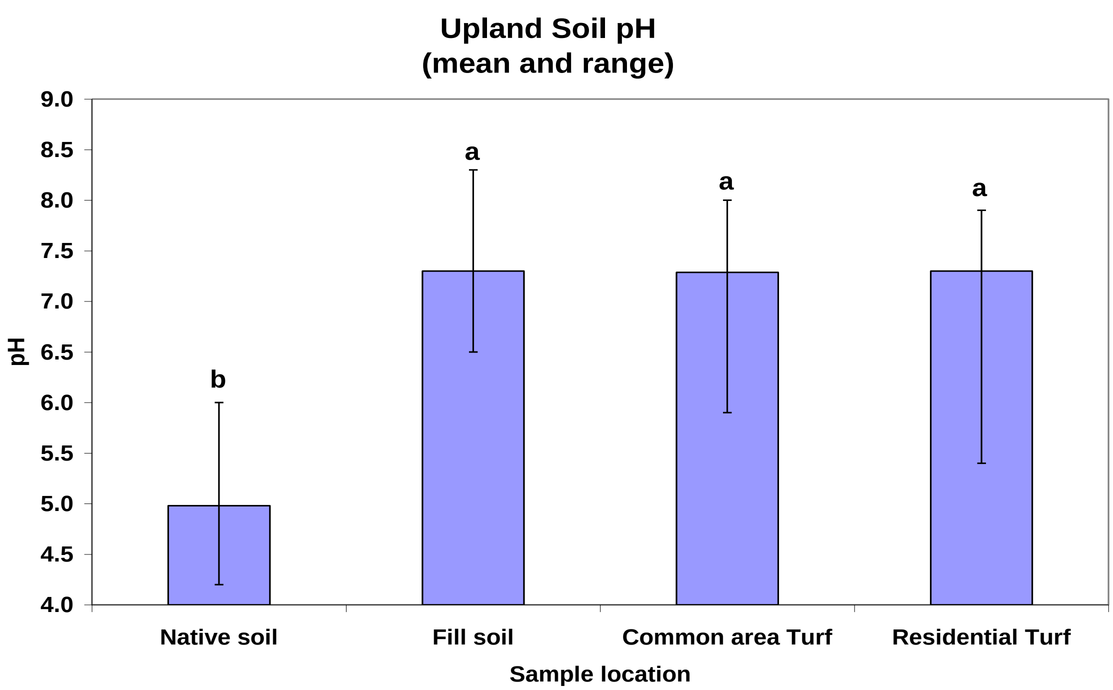


Figure 4 Comparison of soil pH in native soils vs. fill soils under various management regimes. In all cases, fill soils had significantly higher pH values when compared to native soils. Different lower case letters above bar graphs indicate a statistically significant difference between soil types. Graphs with the same letter are not significantly different.

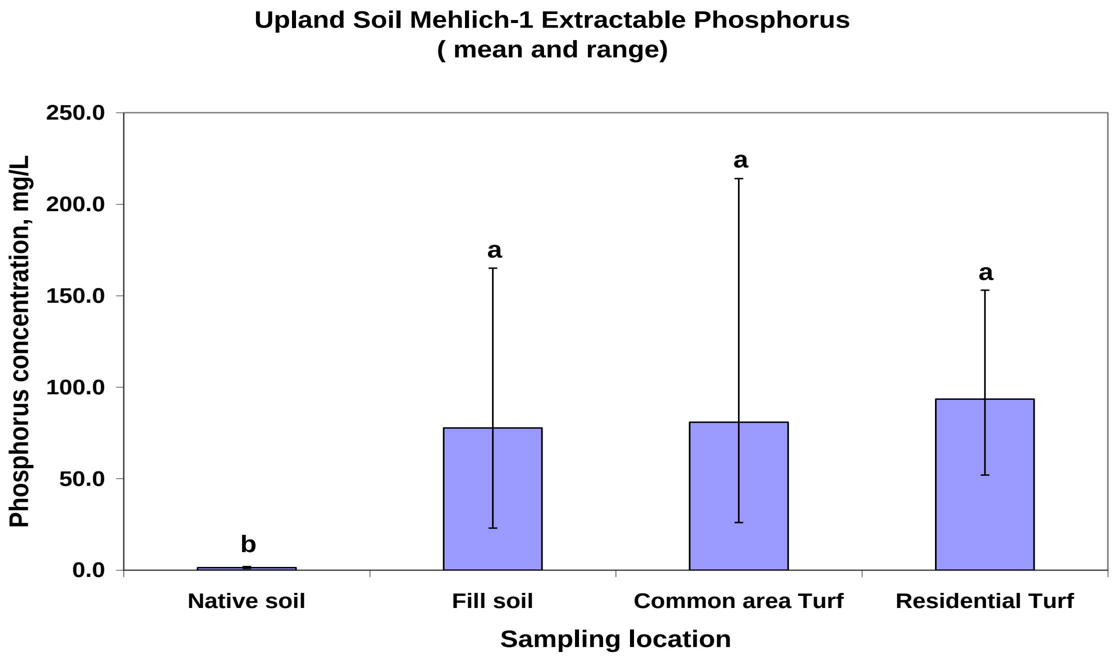


Figure 5 Comparison of Mehlich-1 extractible phosphorus in native soils vs. fill soils under various management regimes. In all cases, fill soils had significantly lower phosphorus concentrations when compared to native soils. Different lower case letters above bar graphs indicate a statistically significant difference with 95% confidence. Graphs with the same letter are not significantly different.

Fertilizer source

Fertilizer use in the common areas during the study period was modified somewhat from previous years in response to recommendations during the January 2008 pond symposium. The modifications changed the nitrogen application rate from 5 pounds per 1000 sq ft. to 4 lbs per 1000 sq ft per year. Actual applications in 2009 were as follows: (data provided by Austin Outdoor)

Application date	Total amount and formulation
March 2009	71 bags (50 lbs. each) of 8-2-12 (N-P-K)
June 2009	71 bags (50 lbs. each) of 10-0-15 (N-P-K)
November 2009	57 bags (50 lbs. each) of 19-0-19 (N-P-K)

This translates into 1180.5 lbs of nitrogen and 71 lbs of phosphorus as phosphate (P_2O_5) or 31.24 lbs as elemental phosphorus.

Converting these numbers to an aerial basis, the fertilizer application rates in 2009 were:

Nitrogen: 4.25 lb. per 1000 sq ft.
Phosphorus: 0.25 lb. per 1000 sq. ft.

Reclaimed Water Volume and Nutrient Load

Reclaimed water is the primary irrigation water used in the common space areas within the Grand Haven community. Approximately 13.7 acres of landscaped area, principally along the roadways is irrigated. The amount of reclaimed water used by the CDD increased from 2005 to 2007 and then decreased in 2008 and 2009 to pre 2005 levels (Table 1). These volumes translate into an average annual irrigation rate of between 113 and 218 inches per year. This amount of irrigation is two to four times greater than the average rainfall for this part of Florida (48.9 inches). Under well-watered conditions, Stewart and Mills (1967) reported that annual water consumption in South Florida for St. Augustine grass and bermudagrass averaged 43 inches/yr over five years. At least part of this consumption need by the turf would be provided by rainfall. Average irrigation requirements for turfgrass in North Florida are on the order of 20–25 inches/yr and 30–35 inches/yr in South Florida (Smajstrla, 1990). Assuming an average irrigation requirement of 35 inches per year, irrigation rates over the past 5 years have been 3-6 times greater than studies would suggest are needed. This also assumes all of the area under irrigation has the same irrigation need. Over half of the irrigated area is not in turf, but instead in ornamentals or shrubs. Studies have shown that most shrubs do not significantly benefit from irrigation after initial establishment.

The nutrient load associated with reclaimed water is considerable. Assuming the single measurement of nutrient concentration in the reclaimed water taken on May 29, 2008 is representative of the concentrations occurring between 2005 and 2009; over 23,920 lbs of nitrogen and 12,480 lbs of phosphorus (as elemental phosphorous) have been applied to the common space area. These amounts are almost twice as much as the amount of nitrogen applied through fertilizer during that period and between 11 and 22 times higher than the amount of phosphorus applied through fertilizer. It is possible that some of the nitrogen applied through the reclaimed water was taken up by vegetation. However, it is likely that little of the added phosphors is taken up by plant material which already had an ample supply of phosphorus in the soil as suggested by the soil test conducted. It is also highly likely that the total volume of irrigation water being applied is increasing the leaching rate of nutrients in the soil and increasing the likelihood of a stormwater runoff event.

Another aspect of nutrients in reclaimed water is that any overspray from the irrigation system or breaks in irrigation heads or lines can result in direct discharge of reclaimed water into the street. Any reclaimed water that lands on an impervious surface is likely to flows down the gutter and into the storm drain, putting high nutrient concentration reclaimed water directly into the stormwater ponds likely stimulating algal growth. As a comparison the 9.2 mg/L total nitrogen concentration and 4.8 mg/L total phosphorus concentration measured in the reclaimed water are 9.2 and 160 times higher than the nutrient concentrations proposed by USEPA to maintain natural lake nutrient levels below which undesirable algal blooms often develop.

Table 1. Reclaimed water volume used for irrigation and associated nitrogen and phosphorus loads. Nutrient concentration applied to all data was 9.2 mg/L total nitrogen and 4.8 mg/L total phosphorus.

Year	Volume used (gallons)	Irrigation Rate (inches per year)	Irrigation Rate (inches per week)	Nitrogen (total lbs.)	Nitrogen (lbs. per 1000 sq ft.)	Phosphorus (total lbs.)	Phosphorus (lbs. per 1000 sq ft.)
2005	52,846,100	142	2.73	4,057	6.80	2,117	3.55
2006	66,693,900	179	3.45	5,121	8.58	2,672	4.48
2007	81,246,300	218	4.20	6,238	10.50	3,255	5.45
2008	68,599,300	184	3.55	5,267	8.83	2,748	4.60
2009	42,167,900	113	2.18	3,238	5.43	1,689	2.83

Pond Sediment Phosphorus and Copper Concentrations

Sediment samples collected in 14 of the stormwater ponds at Grand Haven elevated levels of phosphorus and copper. Phosphorus concentrations ranged from 665 mg/kg (pond 1) to 4,498 mg/kg (pond 3) with ponds 3, 6, 17 and 28 having the highest average concentrations and ponds 1, 2 and W6 and 18A having the lowest concentrations (Figure 6). These average values are a composite of three samples collected within the pond. The lines in the graph that extend above and below each bar indicate the range in phosphorus concentration of the three samples collected. One of the three samples in pond 28 indicated a phosphorus concentration just over 1%

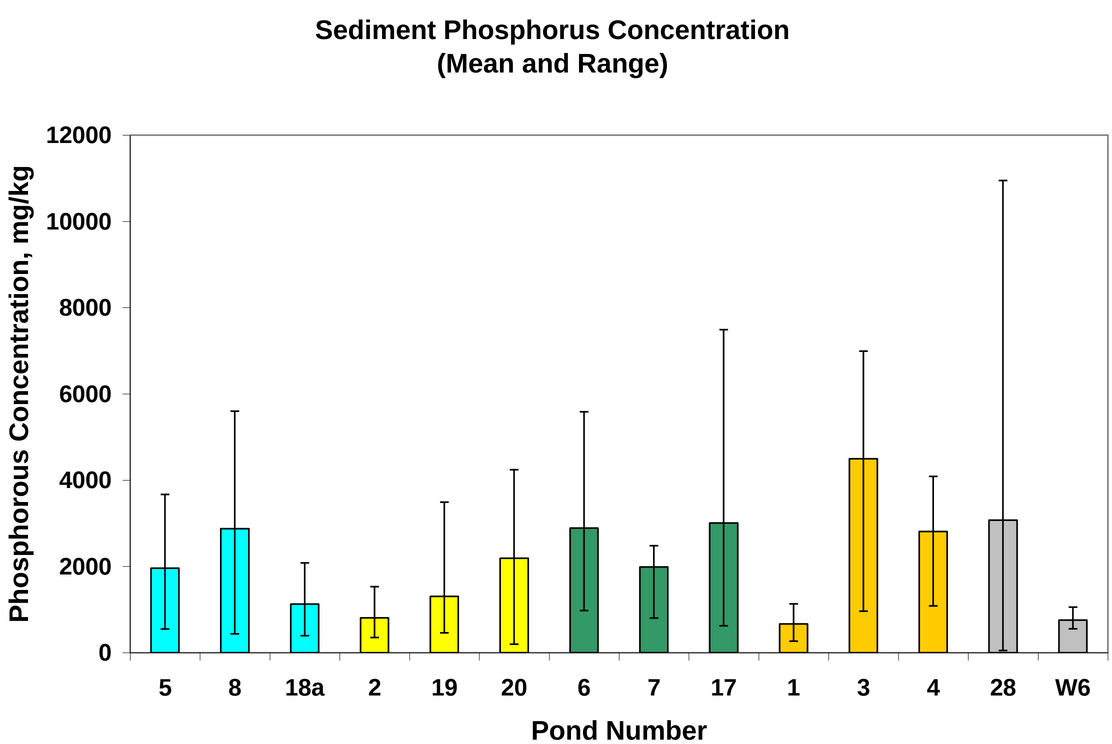


Figure 6 Average and range of pond sediment Total Phosphorous concentration. Different colors indicate study pond treatments; blue – copper sulfate, yellow – aeration with microbes, green – LSP, orange – SAV and grey – LakeWatch monitored ponds.

Although total phosphorous concentrations indicate how much phosphorus is present in the sediment, it does not indicate how likely the phosphorus is to be released into the water column. Similar to Mehlich-1 extractable phosphorous, water extractable phosphorus can be used to measure the relative availability of phosphorus in the sediment and is a measure of how easily the phosphorus in the sediment could be released into the interstitial pore spaces and eventually into the over lying water column. Water extractable phosphorus concentrations tended to mirror the total phosphorus concentration, however some ponds such as pond 8 had lower extractable phosphorus relative to its total phosphorus concentration and pond 19 had higher extractable phosphorous relative to total phosphorous concentration (Figure 7). Differences in the release rate of phosphorus and the total phosphorus concentration can be influenced by numerous sediment and water column variables including the organic matter content (Figure 8).

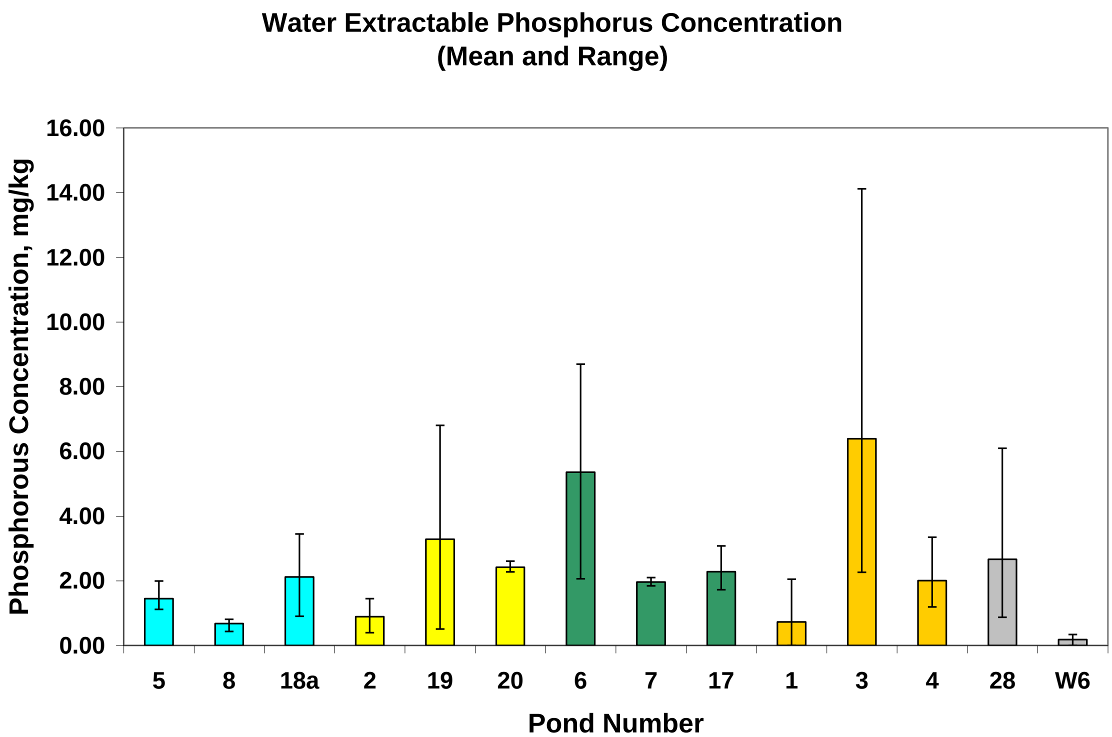


Figure 3 Water Extractable Phosphorus Different colors indicate study pond treatments; blue – copper sulfate, yellow – aeration, green – LSP, orange – SAV and grey – LakeWatch monitored ponds.

The organic matter content of the sediment is a direct measure of the amount of organic matter that has accumulated in the surface sediments of the ponds as a result of primary productivity within the pond, import of organic matter from the watershed and reduced decomposition rates under flooded conditions. Ponds 3, 4, 8, and 20 had the highest organic matter content and ponds 1, 2, 18A and 19 had the lowest organic matter content.

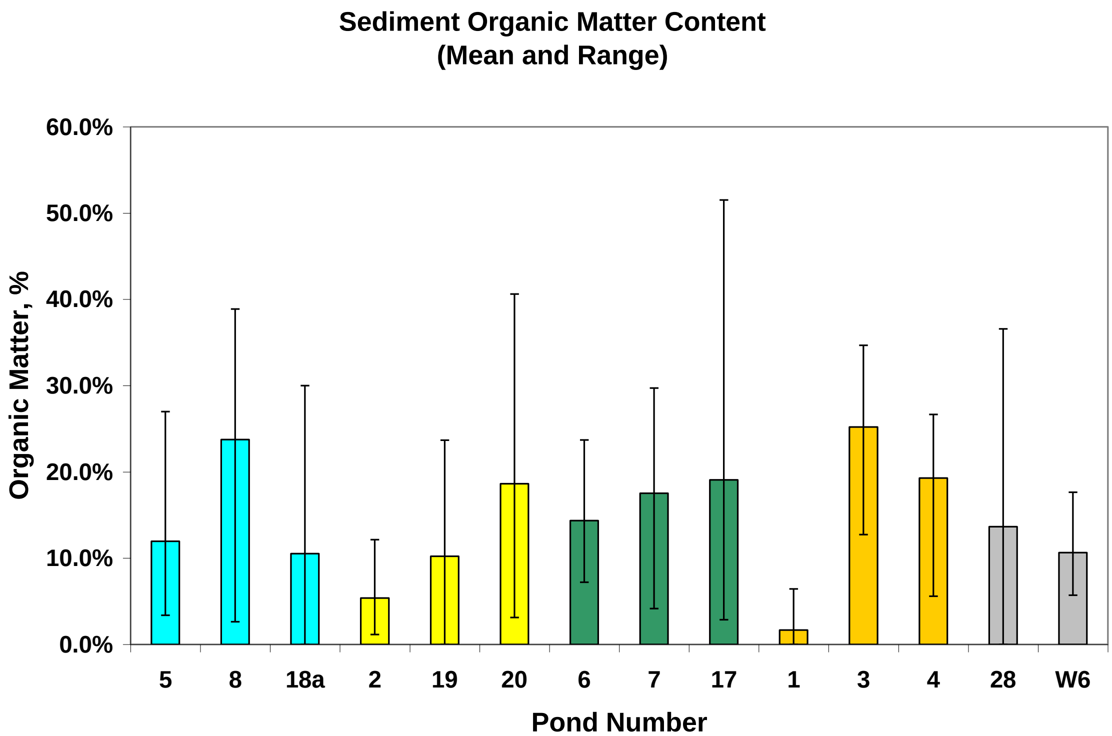


Figure 8 Average and range of sediment organic matter content. Different colors indicate study pond treatments; blue – copper sulfate, yellow – aeration, green – LSP, orange – SAV and grey – LakeWatch monitored ponds.

Total copper concentrations in pond sediments ranged from 17.6 mg/kg (pond W6) to 2,388 mg/kg (pond 20) (Figure 9). For reference the average value for 50 wet retention pond sediments reported by Schueler and Yousef (1994) in the mid Atlantic region was 2 - 173 mg/kg. Copper applied as copper sulfate is used as an algaecide and is toxic to algae. Copper is also used to control invertebrate parasites on fish in aquariums and the aquaculture industry. Thresholds for sediment toxicity of copper are difficult to determine without taking into account sites specific variables including pH, alkalinity, lignin exchange sites and a host of other variables as well as the sensitivity of the aquatic organism of interest. Table 2 provides various effect ranges and thresholds of sediment copper concentration reported by USEPA (1997)

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Table 2. Various effect ranges and thresholds of sediment copper (USEPA 1997)

Metal	ER-L[a]	ER-M[b]	AET-L[c]	AET-H[d]	TEL[e]	PEL[f]	FDA[g]
Pb	46.7	218	450	660	30.2	112	**1.3**
Zn	150	410	410	1600	124	271	–
Cu	34	270	390	1300	18.7	108	–
Cd	1.2	9.6	5.1	9.6	0.676	4.21	**3.0**

[a] Effects range – low value.
[b] Effects range – median value.
[c] Apparent effects threshold – low value.
[d] Apparent effects threshold – high value.
[e] Threshold effects level.
[f] Probable effects level.
[g] Food & Drug Administration Guidance/Action/Tolerance level for fish tissue concentration.

Sources of copper found in the stormwater pond sediments could be native in the sediment parent material, sourced from stormwater runoff, or an accumulation of copper added during copper sulfate algaecide treatments. As a way to determine which of these sources is most likely to explain the elevated levels of copper in the sediments I looked at the relationship between the sediment copper concentration and the number of copper sulfate treatments applied between 2006 and 2009. Since heavy metals are often associated with organic matter and there was a range in organic matter content in the stormwater pond sediments, I normalized the sediment copper concentrations by the organic matter content and plotted those values against the number of copper sulfate treatments per pond. Figure 10 indicates that 83 % of the copper sulfate concentration in the sediments is likely explained by the number of copper sulfate treatments that have been applied.

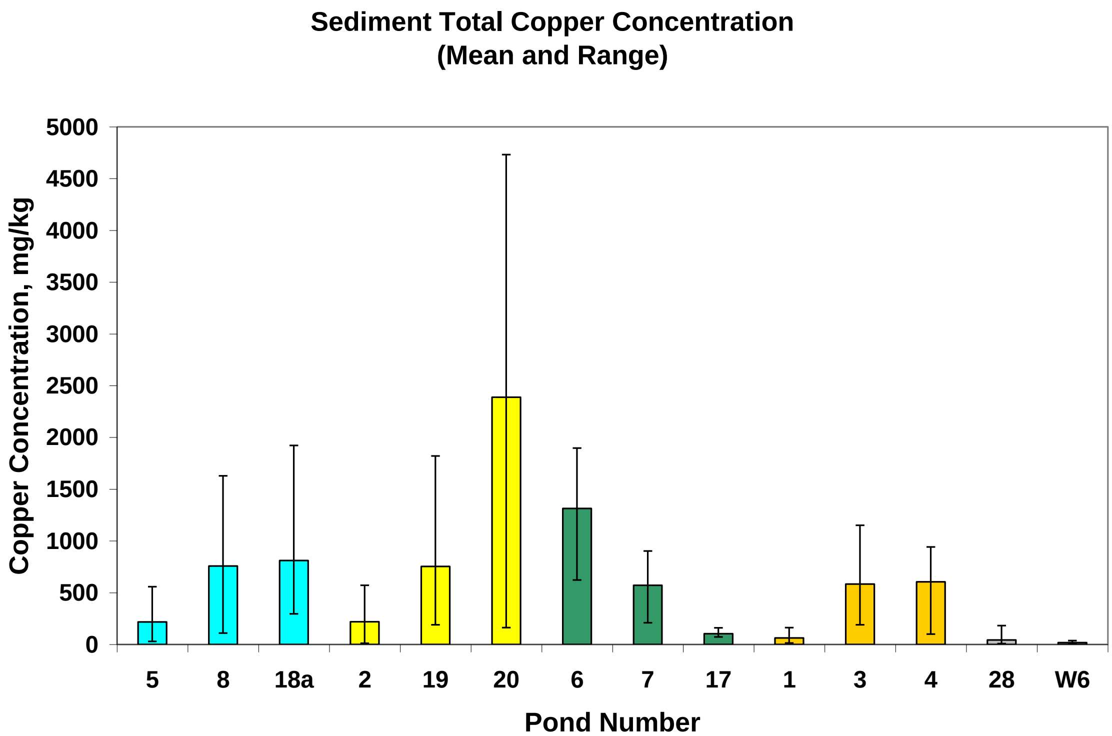

Figure 9 Average and range of Stormwater pond sediment copper concentration. Different colors indicate study pond treatments; blue – copper sulfate, yellow – aeration, green – LSP, orange – SAV and grey – LakeWatch monitored ponds.

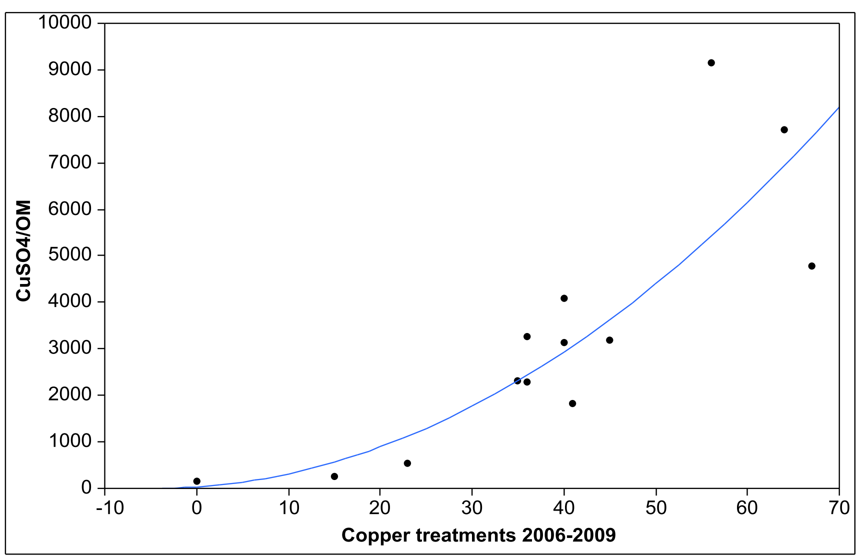

Figure 10. Relationship between sediment total copper concentration normalized for organic matter content and the number of copper sulfate treatments applied between 2006 and 2009. Note – Y axis should read sediment total copper concentration/organic matter concentration, mg/kg

References

Schueler, T. And Y.L. Yousef, 1994. “Pollutant Dynamics of Pond Muck,” Watershed Protection Techniques, Volume 1, Number 2. Summer 1994.

Smajstrla, A. G. (1990). Agricultural field scale irrigation requirements simulation (AFSIRS) technical manual. Gainesville, FL: University of Florida Agricultural and Biological Engineering Department.

Stewart, E. H. & Mills, W. C.. (1967). Effect of Depth to Water Table and Plant Density on Evapotranspiration Rate in Southern Florida. Transactions of the ASAE 10(6), 746–747.

U.S. Environmental Protection Agency. 1997 The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. EPA 823-R-97-006, September, 1997.

Appendix J

Volunteer Soil Sampling Protocols

Soil Sampling Protocol

The objective of this soil sampling is to better understand the amount of nutrients already available in the soils and then use this information to guide future fertilizer applications so that fertilizers are being applied based on potential limitations to plants not generic application rates. This sampling will focus on the common areas as well as individual homeowners who would like to participate.

In Common Space Areas

Sampling within the common area will be used to guide HOA management of these areas to minimize impacts to stormwater retention basins. An initial survey of water quality data in the ponds suggests some differences within the Grand Haven development and therefore the area has been divided up into seven “catchments”. Each catchment represents a sort of watershed or common contributing area for stormwater runoff. We would like to collect seven soil samples within common spaces of each of the seven catchments. Where exactly to sample within the catchment will be based on local knowledge. The goal is to collect soils that are “representative” of the area. Therefore, based on your understanding of the catchment, select seven representative areas and conduct you’re sampling there. If all common areas are similar within the catchment then distribute your sampling spatially. If you are unfamiliar with the area then survey the area first to get a better feeling of where to sample. For each sampling site we will collect a composite of three to five subsamples to reduce small scale spatial variability.

Sample site description

Once you have decided upon a sampling site fill out the following information and conduct the sampling based on the methods described. First photograph the general area where the soils are being collected. This photo should capture the location of the soil sampling area as well as the general landscape of the area. Describe the general area where the three soil samples will be collected. Identify features such as the type of vegetation, is the vegetation in a swale or on a raised mound. Is the vegetation in the open sun or in the shade? Is the area irrigated etc?

Sampling methodology

Label the sampling bag with the following information

- Closest street address
- Date
- How many subsamples are in the bag
- Person(s) who conducted sampling

Once you have labeled the bag collect the sample as follows

- Dig a hole in the shape of a triangle approximately 6” deep
- Remove a 1-2” thick slab of soil 6” deep along one side of the triangle
- Cut a 3-4” wide section of soil out of the center of the slab
- Cut off the top layer of turf but stay above the visible soil layer.
- Leave the roots and rhizomes
- Place sample in the labeled bag
- Fill the hole back in

- Collect 3 to 5 subsamples from the general area. Collect 3 samples if they all look somewhat similar, collect 5 samples if they look very different.
- Place the bags in a cool dry location out of direct sunlight. (inside the house in the air conditioning is optimal).
- Contact Steve Davidson or me to let me know that the sampling in your area has been completed. (clarkmw@ifas.ufl.edu)

<u>On Individual Yards</u>

We would also like to collect soils from individual yards. This is strictly on a volunteer basis, but the information will be very useful to determine if there are differences between the common space areas and homeowner landscapes. For those of you willing to participate, the sampling protocol is similar, but there are a few differences.

If you have a landscape that is greater than 50% turf

Collect five "composite" soil samples equally distributed within the turf area.

If you have a landscape that is less than 50% turf

Collect three composite samples within the turf area and put into one bag and collect three composite samples within the other landscaped area and put those in a separate bag. Photograph and describe the general soil sampling area as noted above.

Sampling methodology

Label the sampling bag with the following information

- Closest street address
- Date
- How many subsamples are in the bag
- Type of landscape (turf or other)
- Person(s) who conducted sampling

Once you have labeled the bag collect the sample as follows

- Dig a hole in the shape of a triangle approximately 6" deep
- Remove a 1-2" thick slab of soil 6" deep along one side of the triangle
- Cut a 3-4" wide section of soil out of the center of the slab
- Cut off the top layer of turf but stay above the visible soil layer.
- Leave the roots and rhizomes
- Place sample in the labeled bag
- Collect 3-5 additional samples from the same general area. Collect few samples if they all look somewhat similar, collect more samples if they look very different.
- Place the bags in a cool dry location out of direct sunlight. (inside the house in the air conditioning is optimal).
- Contact Steve Davidson or me to let me know that the sampling in your area has been completed. (clarkmw@ifas.ufl.edu)

Appendix K

Reclaimed Water Nutrient Analysis

Advanced Environmental Laboratories, Inc.

Advanced Environmental Laboratories, Inc
528 S. North Lake Blvd, Suite 1016
Altamonte Springs, FL 32701
Phone: (407)937-1594
Fax: (407)937-1597

ANALYTICAL RESULTS

Workorder: A0802422 WWTP

Lab ID: **A0802422001** Date Received: 5/29/2008 12:15 Matrix: Water
Sample ID: **Plant Effluent** Date Collected: 5/29/2008 07:55

Sample Description Location

Parameters	Results Units	Qual	DF	Adjusted PQL	Adjusted MDL	Analyzed	Lab
Analysis Desc: Total Nitrogen,Calculated,Water	Analytical Method: Calculation						
Total Nitrogen	**9.2 mg/L**		1	0.070	0.070	6/9/2008 17:33	A
Total Organic Nitrogen	**0.34 mg/L**		1	0.070	0.070	6/9/2008 17:33	A
WET CHEMISTRY							
Analysis Desc: Ammonia,E350.1,Water	Analytical Method: EPA 350.1						
Ammonia	**4.3 mg/L**		10	0.80	0.43	6/2/2008 11:25	T
Analysis Desc: TKN,E351.2,Water	Preparation Method: EPA 351.2 Analytical Method: EPA 351.2						
Total Kjeldahl Nitrogen	**4.6 mg/L**		5	0.40	0.35	6/9/2008 17:33	T
Analysis Desc: Orthophosphate,E365.1,Water	Analytical Method: EPA 365.1						
Orthophosphate	**4.5 mg/L**		5	0.028	0.022	5/30/2008 10:14	T
Analysis Desc: Nitrate+Nitrite,SM4500NO3F,W	Analytical Method: SM 4500NO3-F						
Nitrate + Nitrite	**4.6 mg/L**		1	0.20	0.072	6/10/2008 14:54	T
Analysis Desc: Total Phosphorus,E365.4,Analysis	Preparation Method: EPA 365.4 Analytical Method: EPA 365.4						
Total Phosphorus (as P)	**4.8 mg/L**		5	1.0	0.080	6/9/2008 18:03	T

Lab ID: **A0802422002** Date Received: 5/29/2008 12:15 Matrix: Water
Sample ID: **Plant Influent** Date Collected: 5/29/2008 07:50

Sample Description Location

Parameters	Results Units	Qual	DF	Adjusted PQL	Adjusted MDL	Analyzed	Lab
Analysis Desc: Total Nitrogen,Calculated,Water	Analytical Method: Calculation						

CERTIFICATE OF ANALYSIS