Eagles Pointe Copper Sampling Report
Eagles Pointe Golf Club
1 Eagles Pointe Drive
Bluffton, South Carolina

Submitted To:

Beaufort County Public Works
120 Shanklin Road
Beaufort, South Carolina 29906

June 30, 2011

Eagles Pointe Copper Sampling Report

Eagles Pointe Golf Club
Bluffton, South Carolina

TABLE OF CONTENTS

Eagles Pointe Copper Sampling Report

Eagles Pointe Golf Club
Bluffton, South Carolina

Executive Summary

Due to elevated copper concentrations in the Eagles Pointe Golf Club (EPGC) Outfall BMP-Out, expanded sampling efforts were undertaken to determine: 1) if and how applications of copper sulfate affect copper concentrations at EPGC; and 2) if observed concentrations of copper at EPGC are toxic to the aquatic ecosystem. To determine how copper sulfate applications affect copper concentrations, sampling was conducted prior to and after the application of the herbicide at EPGC. The predicted toxicity of copper exiting EPGC through Outfall BMP-Out was determined through the use of HydroQual's Biotic Ligand Model (BLM). The BLM predicts the metal toxicity for data from a specific site based on ambient water conditions.

Based on the findings of the copper sulfate application sampling and BLM, the following conclusions can be made:

- Applications of copper sulfate to the EPGC pond system increases the dissolved copper concentration which remain elevated for approximately 24-hours after application. However, between 48-hours and a week following application, dissolved copper concentrations return to pre-treatment levels.
- The results of the BLM indicate that the observed concentrations of dissolved copper do not exceed the Criterion Maximum Concentration (acute concentration) or Criterion Continuous Concentration (chronic concentration) for the EPGC pond system. Therefore, the model data suggests that the dissolved copper concentrations are not toxic.
- The data suggests the downstream aquatic environment from EPGC would not be negatively impacted by the application of copper sulfate (at levels consistent with application doses deployed during the course of our study perior) if discharge was prevented from leaving the pond system for 24-hours following an application of copper sulfate.

Eagles Pointe Copper Sampling Report

Eagles Pointe Golf Club
Bluffton, South Carolina

1.0 INTRODUCTION AND BACKGROUND

As part of the Beaufort County Stormwater Quality Monitoring Program, quarterly copper samples were collected at the Eagles Pointe Golf Club (EPGC) Outfall BMP-Out. The analytical results for the EPGC outfall, BMP-Out, consistently had concentrations exceeding current regulatory standards, which range from 2.9 to 5.8 micrograms per liter (µg/L) (SCDHEC 2008). Due to high quarterly copper analytical results, monthly sampling was initiated at the two EPGC water outfalls, BMP-Out and Pinckney Colony.

The monthly samples were analyzed for both total and dissolved copper, whereas previous quarterly samples were analyzed for only total copper. The analysis for dissolved copper would provide more insight into the potential toxicity within the aquatic ecosystem, since dissolved copper tends to be more biologically available. However, it is important to note that not all dissolved copper is biologically available, but if dissolved copper concentrations were less than the regulatory standards, the concentrations would not likely be toxic to aquatic organisms. After several months of sampling, the dissolved copper concentrations were noted to be greater than the regulatory standards.

Following these results, a sediment sample was collected from the pond basin adjacent to outfall BMP-Out. The purpose of this sample was to determine if the sediments in the ponds were a source of copper that is washed out during storm events. The analytical result for the sediment sample (Table 1) indicated that the copper concentrations were consistent with normal, background concentrations (Buchman 2008). Therefore, it was determined that the sediments were not a significant source of the observed copper concentrations.

The presumed source of copper in the outfall samples was copper sulfate. Copper sulfate is a very common herbicide used to control aquatic vegetation and algae. Although copper sulfate is used at EPGC and copper concentrations are greater than regulatory standards, two unknowns exist. The first unknown was whether the applications of copper sulfate affected increased copper concentrations in water exiting EPGC. The second unknown was whether the observed dissolved copper concentrations are toxic within the aquatic ecosystem.

To shed light on these issues, two sampling efforts were established. The first sampling

effort was established to determine how copper concentrations are affected by the application of copper sulfate at EPGC. The second sampling effort was established to determine if observed copper concentrations in the water exiting EPGC are toxic. The methods and results of these efforts are described in the sections below.

2.0 SAMPLING ACTIVITIES

2.1 Copper Sulfate Application & Copper Sampling

A sampling protocol was established to determine how copper sulfate applications affect copper concentrations at outfall BMP-Out. Outfall BMP-Out was used because it is the larger of the two outfalls and copper concentrations from this outfall were consistently higher than Outfall Pinckney Colony. Five samples were collected per application of copper sulfate, which are described below:

- Pre-Treatment: sample collected the morning prior to the application of copper sulfate.
- Post-Treatment: sample collected on the same day following the application of copper sulfate.
- 24-Hours: sample collected 24-hours after the application of copper sulfate.
- 48-Hours: sample collected 48-hours after the application of copper sulfate.
- Week: sample collected a week following the application of copper sulfate.

Four total sets of data were collected in conjunction with the applications of copper sulfate. For each set, the first four samples were collected by an employee of EPGC. The dissolved copper samples were filtered and preserved by the University of South Carolina-Beaufort (USC-B). All samples collected by EPGC were stored and refrigerated by USC-B. The Week sample was collected by GEL Engineering and upon retrieval of the stored, filtered samples from USC-B, the samples were analyzed by GEL Laboratories, LLC for both total and dissolved copper.

2.2 Biotic Ligand Model Sampling

A second sampling protocol was established around the requirements of HydroQual's Biotic Ligand Model (BLM) (HydroQual 2007). The BLM predicts the metal toxicity for data for a specific site based on ambient water conditions. Therefore, by inputting temperature, pH, dissolved organic carbon, major cations (calcium, magnesium, sodium and potassium), anions (chloride and sulfate), alkalinity, and sulfide, the BLM would predict whether measured concentrations of dissolved copper would suggest toxicity in that particular aquatic ecosystem. The sampling and analyses were conducted in accordance with these requirements and in order to

increase confidence in the results, three sets of data were collected and modeled using the BLM software.

3.0 RESULTS

3.1 Copper Sulfate Application and Copper Sampling Results

The results from the four copper sulfate applications and copper sampling are provided in Table 2. Overall, the results indicate that following the application of copper sulfate, dissolved copper concentrations increase and remain elevated for at least 24-hours. After 24-hours, the concentrations decrease and between 48-hours and a week following the copper sulfate application, the dissolved copper concentrations return to pre-application levels.

As noted on Table 2, two results indicated a dissolved copper concentration greater than total copper. These results are anomalous, however, this does not alter the findings.

3.2 Biotic Ligand Model Results

The BLM results are provided in Table 3. Using the parameter data, the BLM predicts the Criterion Maximum Concentration (CMC) and the Criterion Continuous Concentration (CCC). The CMC is the acute value which would likely harm a species if exposed to briefly, while the CCC is the chronic value, which would likely harm a species if exposed for a prolonged period. The BLM also provides the Acute Toxic Units, which is the ratio of copper in the water to the CMC of the sample. Values greater than one are a violation of the CMC and would likely be acutely toxic in that system.

In each of the three data sets the dissolved copper concentrations were greater than the regulatory limit; however, the BLM predicts they are not toxic in the aquatic ecosystem. In each dataset, the observed concentration of dissolved copper was less than the CMC and CCC, while the Acute Toxic Units were less than one.

4.0 CONCLUSIONS

Based on the findings of the copper sulfate application sampling and BLM, the following conclusions can be made:

- Applications of copper sulfate to the EPGC pond system increases the dissolved copper concentration which remain elevated for at least 24-hours after application. Between 48-hours and a week following application, dissolved copper concentrations return to pre-treatment levels.

- The results of the BLM indicate that the observed concentrations of dissolved copper do not exceed the CMC or CCC for the EPGC pond system. Therefore, the model suggests they are not toxic.
- The data suggests the downstream aquatic environment from EPGC would not be negatively impacted by the application of copper sulfate (at current applications rates) if discharge was prevented from leaving the pond system for at least 24-hours following an application of copper sulfate.

5.0 REFERENCES

Biotic Ligand Model Manual, June 2007, HydroQual, Inc.

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration.

South Carolina Department of Health and Environmental Control, April 25, 2008, Water Classifications and Standards Regulation 61-68: Bureau of Water.

FIGURE

GEL Engineering, LLC
a Member of THE GEL GROUP, INC. GEL
P.O. BOX 30712 CHARLESTON, SC 29417
2040 SAVAGE ROAD 29407
(843) 769-7378 FAX (843) 769-7397
WWW.GEL.COM
ENGINEERING ENVIRONMENTAL ANALYTICAL

EAGLES POINTE COPPER SAMPLING REPORT
EAGLES POINTE GOLF CLUB
BLUFFTON, SOUTH CAROLINA

SITE MAP WITH
SAMPLE LOCATION

FIGURE
1

DATE: JUNE 30, 2011

CREATED BY: RCR

APPRV BY: JTW

TABLES

Table 1
Copper Concentrations in Sediment

Eagles Pointe Golf Club
Copper Sampling Report
Bluffton, South Carolina

Sample ID	Concentration
Eagles Pointe Sediment Sample	14,800
Background Concentrations	10,000 - 25,000

Results reported in parts per billion (ppb)

Table 2
Copper Sulfate Application - Copper Sampling Results

Eagles Pointe Golf Club
Copper Sampling Report
Bluffton, South Carolina

	Sample Set 1 - 6/29/2010		Sample Set 2 - 7/20/2010		Sample Set 3 - 8/3/2010		Sample Set 4 - 8/17/2010	
	Total Cu	**Dissolved Cu**	**Total Cu**	**Dissolved Cu**	**Total Cu**	**Dissolved Cu**	**Total Cu**	**Dissolved Cu**
Pre-Treatment	11.5	17.7*	13.4	78.1*	19.3	11.2	11.5	7.6
Post-Treatment	11.9	9.5	27.9	24.1	158.0	65.2	125.0	79.4
24 Hours	38.7	27.1	21.4	14.8	47.7	23.5	31.6	20.9
48 Hours	20.0	16.0	30.8	13.1	184.0	42.1	25.0	15.9
Week	16.2	11.9	32.8	9.9	16.4	11.1	12.4	9.8

All results are reported in micrograms per liter (ug/L)
* These results are anomalous, however, this does not alter the findings.

Table 3
Biotic Ligand Model Results

Eagles Pointe Golf Club
Copper Sampling Report
Bluffton, South Carolina

	May 5 Results (ug/l)	Nov 5 Results (ug/l)	Jan 6 Results (ug/l)
Criterion Maximum Concentration (CMC)	66.15	36.9	45.6
Criterion Continuous Concentration (CCC)	41.08	22.4	28.32
Acute Toxic Units	0.5744	0.3861	0.195
Dissolved Copper (measured in sample)	38.2	13.9	8.89