NORTH GRIFFIN REGIONAL DETENTION POND - WETLANDS FILTRATION FOR NON-POINT SOURCE POLLUTION CONTROL AND ABATEMENT

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Abstract. In 1997, the City of Griffin constructed a large regional detention pond in northern Griffin, Georgia to alleviate flooding in the Waterford on Ellis Subdivision. Noting several features in and adjacent to the site, the City applied for and received a Section 319(h) Grant from the Georgia Environmental Protection Division to implement several water quality components in the pond. Using wetland filtration, the North Griffin Regional Detention Pond has proven to be an effective Best Management Practice (BMP) for improving water quality to receiving waters.

INTRODUCTION

On March 10, 2003 the National Pollution Discharge Elimination System (NPDES) Phase II stormwater permits will mandate numerous communities throughout the State of Georgia to look differently at how they manage their stormwater programs. These programs will undertake various approaches to reduce non-point source pollutant loadings to impaired water bodies in an effort to achieve Phase II NPDES compliance and future impending Total Maximum Daily Load (TMDL) restrictions. One community that has taken a proactive approach to stormwater management for non-point source pollution is Griffin, Georgia. The North Griffin Regional Detention Pond (NGRDP) accomplishes two objectives, flood control and water quality enhancement, by incorporating wetland filtration into a regional detention pond. The Consulting Engineers Council of Georgia has recognized the project design and performance success with an engineering excellence award in February 2000 as well as by the Georgia EPD and US EPA Clean Water Act (CWA) Section 319(h) Program as a success story.

PROJECT HISTORY

The City of Griffin was founded in the late 1800's as a cross roads between Atlanta to the north and the city of Macon to the south. The City is located atop a major topographic ridge separating the watersheds leading to the Atlantic Ocean and the Gulf of Mexico. As development grew in response to the needs of local industries, the City's stormwater infrastructure was not able to keep pace with the growth of the community. Now, the system is over 100 years old and in need of extensive maintenance as well as significant improvements.

Significant rainfall events such as Tropical Storm Alberto in 1994 have resulted in extensive flooding of numerous areas of the City. One area that was repeatedly inundated as a result of inadequate stormwater drainage infrastructure is the North Griffin Drainage Basin. This area of the City routinely experienced significant damage to residential structures, inundation of residential streets, severe erosion as well as other safety and environmental concerns. Following implementation of a formal Stormwater Management Program and a Storm Utility in 1997, the City of Griffin began to formulate plans to address the stormwater related problems faced by the citizens of Griffin.

FLOOD CONTROL

The City evaluated the North Griffin Basin and identified an opportunity to construct a regional detention pond to service approximately 180 acres of urbanized Griffin. The regional pond could provide the needed detention for the upstream areas as well as water quality enhancement for a majority of the basin. What emerged was a project to reroute the natural drainage path around the subdivision and discharge the stormwater runoff back into the existing creek downstream of the developed areas. Initially designed as a stormwater runoff quantity control facility, the NGRDP accomplishes its primary flood control objectives by utilizing two major components.

The first component of the facility was designed to solve the initial problem of flooding within the North Griffin Basin. This component consists of a large

drainage channel that diverts and conveys stormwater runoff that previously flowed through and periodically inundated the Waterford on Ellis Subdivision. The channel has enough capacity to route 750 cubic feet of stormwater runoff per second safely around the subdivision and developed areas.

The second component of the facility consists of the main stormwater detention pond area. The NGRDP is able to store approximately 1.5 million cubic feet (34.4 acre-feet) of runoff. Unlike most detention ponds that are designed to discharge water through a single outlet control device, the NGRDP features three separate stormwater discharge control devices. The primary outlet device is a large cast-in-place concrete structure with two ten-inch wide vertical rectangular weirs to control the rate of discharge of stormwater runoff from the facility. A key feature of this device is two large metal plates designed to slide over the weirs to control the rate of discharge. The secondary outlet device consists of a rectangular weir approximately three feet in width set eleven feet above the pond floor. This structure is designed to handle stormwater flows in excess of the 25-year design storm. The device allows higher volumes of runoff to by-pass the forested wetland system and flow directly to the receiving waters via an underground pipe and junction box.

The third component consists of a concrete emergency spillway to protect the integrity of the earthen dam and to convey water safely around the dam in the event that a greater than 100-year storm event occurs.

NON-POINT SOURCE POLLUTION CONTROL

During the design phase of the project, several conditions became apparent that would allow for incorporation of a water quality enhancement component into the pond design. The proposed pond design, the site conditions and the proximity of the forested wetlands area downstream afforded the City an opportunity to evaluate the possibility of using natural filtration systems within the regional detention system. The City revised its design to incorporate wetland plantings within selective areas of the NGRDP and utilization of the downstream wetland areas to naturally filter out pollutants commonly found in stormwater runoff. The wetland species that were selected and planted consisted of Cattail, Bulrush, Pickerel Weed, Soft Rush, Wool Grass, Southern Cutgrass, and Shallow Sedge. These species were selected based on their anticipated ability to breakdown and filter various pollutants that are commonly found in stormwater runoff.

In addition to the wetlands species planted in the pond, a large rock check dam was constructed at the point where the channel enters the main pond area. Placement of the rock check dam at the upstream end of the pond dissipates the flow rate/energy of the stormwater runoff resulting in the settling out of sediments/particles within the pond rather than allowing these sediments to be transported to the downstream receiving waters.

ENVIRONMENTAL MONITORING

Following award of the CWA Section 319(h) Grant to incorporate the constructed wetland system into the NGRDP, a monitoring program was designed and implemented in accordance with USEPA and Georgia EPD guidelines. Four locations within the pond system were identified for water quality monitoring. The selected parameters to be monitored consisted of the following:

Laboratory

- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Nitrate Nitrogen (NO_2)
- Nitrite Nitrogen (NO_3)
- Total Kjeldahl Nitrogen (TKN)
- Biochemical Oxygen Demand (BOD_5)
- Total Phosphorus (P)
- Oil and Grease (O&G)
- Total Petroleum Hydrocarbons (TPH)
- Fecal Coliform Bacteria
- Total Copper (Cu)
- Chemical Oxygen Demand (COD)
- Total Lead (Pb)
- Total Zinc (Zn)

In-Situ

- Turbidity
- Dissolved Oxygen (%)
- pH
- Specific Conductance

Each location for testing within the pond system were chosen to give insight into how each of the NGRDP's components were able to reduce non-point source pollutant loadings to the downstream receiving waters.

Sample Location 1 was positioned at the upper most portion of the main drainage channel where a majority of the contributing runoff volume enters the NGRDP system. By characterizing the stormwater runoff at this location, the City is able to quantify the pollutant levels present within the stormwater runoff entering the pond from the 180-acre basin.

Sample Location 2 was positioned at the primary outlet control device of the main detention area which routes a majority of the storm events (i.e. less than the 25 year storm). Utilizing this location the City is able to estimate the removal efficiency of the main drainage channel with its rock-lined channel and the main detention pond area with its constructed wetlands.

Sample Location 3 was positioned at the outlet point of the pond system immediately downstream of the forested wetland system that the primary outlet device discharges to. By characterizing stormwater runoff at this point, the removal efficiency for the entire system is estimated for the inflow runoff from locations 1 and 4.

Location 4 was added to the monitoring program to characterize a small volume of runoff that enters the site between the outfall of the primary outlet control device from the pond (Sample Location #2) and the downstream discharge point for system (Sample Location #3). The combination of stormwater runoff discharge from the NGRDP outlet and the flow from Location #4 comprise the inflow to the existing forested wetlands system and ultimately the downstream discharge point (Sample Location #3). The basin area upstream of Sample Location #4 has undergone significant development within the last 12 months (4 quarters). As a result, highly variable monitoring data has been reported especially with regard to TSS, TDS and turbidity. It will likely take several more sampling events to establish more consistent data with regard to Sample Location #4. As stated above, this flow volume only represents a small volume of flow into the NGRDP system and its impact is still being evaluated.

POLLUTANT REMOVAL EFFECTIVENESS

Entire NGRDP System

The City collects and analyzes samples from the four locations identified above on a quarterly basis.

Table 1. Average Pollutant Concentrations by Location

Constituent	1998 Atlanta Regional Mean	Sample Location 1	Sample Location 2	Sample Location 3	Sample Location 4
Laboratory Analysis					
Total Suspended Solids (mg/L)	191	50.0	29.4	36.7	246.3
Total Dissolved Solids (mg/L)	160	32.4	57.8	50.7	116.8
Nitrate Nitrogen (mg/L)	-	0.39	0.26	0.17	0.07
Nitrite Nitrogen (mg/L)	-	0.03	0.06	0.04	-
Nitrate/Nitrite Nitrogen (mg/L)	0.77	0.39	0.33	0.23	0.10
Biochemical Oxygen Demand (mg/L)	7.3	9.5	7.0	6.0	7.0
Total Phosphorus (mg/L)	0.26	0.20	0.12	0.10	0.18
Total Kjeldahl Nitrogen (mg/L)	1.3	4.53	1.65	1.76	2.39
Chemical Oxygen Demand (mg/L)	43.0	52.0	43.1	31.9	52.8
Oil & Grease (mg/L)	NLD	6.0	11.0	-	5.0
Total Petroleum Hydrocarbons (mg/L)	NLD	-	-	-	-
Fecal Coliform (no/100mL)	2,015	25,457	15,960	8,169	9,829
Total Copper (mg/L)	0.018	-	-	-	0.03
Total Lead (mg/L)	0.03	-	-	-	0.06
Total Zinc (mg/L)	0.11	0.13	0.10	0.07	0.06
In-Situ Analysis					
Turbidity (NTU)	26	120	69	130	203
Dissolved Oxygen (% saturation)	NLD	79.9%	71.0%	77.4%	64.9%
PH	6.62	6.74	6.77	6.63	6.27
Specific Conductance (mS/cm)	NLD	0.04	0.06	0.04	0.05

Note: Several parameters that are being monitored are consistently reported as below laboratory detection limits by the laboratory and are not shown in the table.

Through December 2000, ten sampling events had been conducted between September 1997 and December 2000. Table 1 shows average concentrations of the pollutants detected at the three primary monitoring locations (upstream, detention pond outlet, and downstream) with the NGRDP system.

By studying the results of the testing program between Sample Locations 1 and 3, one can observe that the detention pond, constructed wetlands and forested wetlands are having a positive impact on water quality through the reduction of pollutant loadings to the downstream receiving waters.

MAIN DETENTION POND

In late 1999, the City implemented another monitoring program to evaluate rainfall-runoff relationships in key areas of the City. Using one of these monitoring devices at the NGRDP, the City has been able to accurately monitor the discharge rates leaving the main detention pond. Utilizing the data gathered, the City has been able to develop rainfall-runoff relationships for the drainage basin.

The pollutant loading for the detention pond relative to the entire basin could be computed by using this relationship and the data gathered in the water quality-monitoring program. The pollutant load reduction calculations for the detention pond are summarized in Table 2.

The City is in the process of conducting water quality and quantity modeling studies citywide. The data compiled from these studies will be utilized to calculate pollutant removal efficiencies for the NGRDP system with respect to the entire watershed as well.

PROJECT FUNDING

The project was a result of a collaboration of national, state, county, and city governmental agencies working in conjunction with water resource professionals. The City of Griffin made the decision to implement a comprehensive stormwater management program in the mid 1990's. In 1996, the citizens of Griffin and Spalding County voted to implement a Special Purpose Local Optional Sales Tax (SPLOST) to fund various stormwater and transportation improvement projects. Utilizing funds from the SPLOST, the City was able to fund land acquisition as well as a majority of the construction of the main detention pond and drainage channel. In 1997, the City undertook an innovative approach to funding their future stormwater management program needs by implementing Georgia's first Stormwater Utility. The utility generates over $1 million per year in revenue specifically for stormwater related projects and improvements. The utility has also enabled the City to successfully seek out and secure state and federal funds by emphasizing the City's commitment to stormwater management. The NGRDP received a CWA Section 319(h) Grant from the United States Environmental Protection Agency (USEPA) and the Georgia EPD to fund the water quality enhancement

Table 2. Constructed Wetlands Pollutant Removal Efficiency

Constituent	Location 1 (inflow)		Location 2 (pond outlet)		Removal Calculations	
	Concentration	Loading	Concentration	Loading	Loading Removal	Removal Efficiency
Total Suspended Solids	50.00 mg/L	20,919 lb/yr	29.4 mg/L	12,290 lb/yr	8,629 lb/yr	41.3%
Nitrate Nitrogen	0.39 mg/L	162 lb/yr	0.3 mg/L	107 lb/yr	55 lb/yr	34.1%
Nitrate/Nitrite Nitrogen	0.39 mg/L	163 lb/yr	0.3 mg/L	138 lb/yr	25 lb/yr	15.4%
Biochemical Oxygen Demand	9.50 mg/L	3,975 lb/yr	7.0 mg/L	2,929 lb/yr	1,046 lb/yr	26.3%
Total Phosphorus	0.20 mg/L	82 lb/yr	0.1 mg/L	50 lb/yr	33 lb/yr	39.6%
Total Kjeldahl Nitrogen	4.53 mg/L	1,895 lb/yr	1.7 mg/L	690 lb/yr	1,204 lb/yr	63.6%
Chemical Oxygen Demand	52.00 mg/L	21,756 lb/yr	43.1 mg/L	18,043 lb/yr	3,713 lb/yr	17.1%
Total Zinc	0.13 mg/L	56 lb/yr	0.1 mg/L	43	13 lb/yr	22.8%

construction components and environmental monitoring tasks associated with the project. Utility revenues were utilized as matching funds in accordance with the grant program requirements.

SUMMARY

Throughout the State of Georgia, numerous water bodies have become impaired as a result of point source and non-point source pollutants. Accordingly, the Georgia EPD has restricted the ability of municipal and county governments to discharge wastewater plant effluent and untreated stormwater runoff to downstream receiving waters. Only recently have municipalities and counties begun to analyze and quantify the potential impacts of these impaired water bodies on the community's quality of life and economic growth potential. The City of Griffin has taken a proactive approach to address these issues by successfully implementing stormwater management BMPs such as the NGRDP. Although each of the NGRDP's components are not unique unto themselves, it was the combination of the traditional stormwater runoff quantity and quality control BMPs into a comprehensive system that make the NGRDP an award winning non-point source pollution and flood control facility. This project shows that incorporation of a water quality enhancement component into a traditional regional detention pond system can be accomplished cost effectively. The City of Griffin believes that this project will provide valuable data for other government entities, engineering designers, and environmental regulators to evaluate the feasibility of using regional detention ponds as a viable stormwater management BMP. The City of Griffin is confident that implementation of a comprehensive water resources management program will ensure future economic growth and quality of life for the community and its surrounding areas.

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