TECHNICAL SUMMARY

Determination and Treatment of Substances in Runoff in a Controlled Highway System (Cross Lake)

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ABSTRACT

Beginning in November 1996, a flowmeter/sampler was installed at the inlet to the concrete lined holding pond (hereafter referred to as the Cross Lake holding Pond). Initially 9 runoff events were monitored. Additional funding was obtained in 1997. Runoff entering the holding pond from the Cross Lake bridge as a result of 77 separate rainfall events was measured and logged between 1996 and 1999. Rainfall amounts on the bridge were logged using a recording rain gage. Initially, discrete samples (for contaminant analysis) were collected at points on the runoff hydrograph. However, experience over time demonstrated that flow weighted composite samples generally produced equally good results with far less laboratory effort and expense. The samples collected were analyzed for COD, TSS, NH_3, TKN, NO_3, TPH, and oil and grease. Some later samples of the pond contents were analyzed for heavy metals. Using the flow and pollutant concentration data, it was possible to calculate pollutant loads (lbs) entering the pond. In 1998, a flowmeter/sampler similar to the one at the inlet was installed at the pond outlet. With this additional equipment, it was possible to measure the volume leaving the pond when it was drained and collect flow weighted samples for pollutant analysis. As a result pollutant loads leaving the pond could be computed. Knowing the mass of a contaminant entering and leaving the pond during a specific time period allowed the efficiency of the pond in removing that pollutant to be computed. Results show that the pond is quite effective in removing sediment and those pollutants commonly associated with sediment, such as COD, phosphorus and heavy metals. Removal of TKN, ammonia and nitrate also occurred but to a lesser and more erratic extent.

INTRODUCTION

The impetus for this project has it's origins in section 303(d) of the Clean Water Act (CWA) of 1972. As described by Houck, *[1],* the CWA, which was originally predicated on state programs to achieve water quality standards, was overhauled in 1972. The revised CWA required national technology standards for point source dischargers. These technology provisions of the act worked. Industrial pollution plummeted; rates of wetland loss slowed, and in some regions even reversed; and municipal waste loadings, the subject of $128 billion in public funding for treatment works, dropped by nearly 50 percent while the populations served were doubling. However, according to Houck, the country's waters are not now appreciably cleaner. The problem is that those sources of pollution <u>not initially regulated</u> by the CWA have increased to the point where they have erased the gains point source reduction. These remaining sources of contamination are commonly referred to as diffuse or non-point sources of pollution. A good example of the effects of non-point contamination is the 8000 square mile "dead zone" at the mouth of the Mississippi. Here the marine environment has become too anaerobic for most higher life forms to exist. The cause of this dead zone is commonly believed to be runoff from agricultural land, most of which comes from above the confluence of the Mississippi with the Ohio, more than 975 miles away. Houck points out that just about every state in the union has similar problems caused by agriculture, logging or some other industry which creates non-point pollution. Fortunately or unfortunately, depending on one's viewpoint, one provision of the original CWA which was retained when it was revised in '72 was section 303(d). Section 303(d) provided a structure for water quality based regulation of waters that remained contaminated after the implementation of the technology based provisions of the CWA. States would identify those waters which remained contaminated and develop total maximum daily loads (TMDLs) which, if enforced, could be expected to bring these remaining waters into compliance. These TMDLs would then be allocated to discharge sources via permits and state water quality plans. If the states did not do this, EPA would.
However, the states did not do it and neither did EPA until a series of court cases in the late 1980s and early 1990s caught EPA and the states by surprise. Eclipsed by more imperative provisions of the new CWA, this provision had lain dormant for 20 years. A wave of litigation followed, compelling states to prepare listings of impaired waters and develop schedules for TMDLs. Ironically, the reason 303(d) was retained from the original CWA was precisely because both the states and those industries responsible for both point and non-point pollution wanted it. They wanted it because of it's water quality based provisions and it's primary reliance on the states and localities for implementation. As part of it's attempt to meet the requirements of 303(d), the EPA is now requiring states to develop best management practices (BMPs) for use in mitigating non-point contamination. This project examines the use of holding ponds as a best management practice for reducing pollutant flux from roadways.

The Cross lake site
Cross Lake Bridge on I-220, spans Cross Lake in Shreveport, Louisiana. Cross Lake serves as the potable water supply for Shreveport, a city of approximately 200,000 persons. I-220 is the bypass around Shreveport from I-20 which is the longest Interstate highway in the country and, as a result, I-20 is very heavily traveled. During construction of the bridge, concern was expressed over the possibility of an accident on the bridge contaminating the City's water supply. As a result of this concern, DOTD agreed to modify the bridge to include a "closed" drainage system and to construct a concrete lined holding pond on the east bank of Cross Lake to contain the runoff. Thus, the Cross Lake bridge is, in effect, a closed catchment and all the runoff from it drains to a holding pond. This is a rather unique situation and offers the opportunity to examine the usefulness of such holding

ponds in reducing pollutant flux from roadways.
Runoff, held in the pond, is periodically released into wetlands which drain to 12-mile Bayou. The average detention time in the pond is highly variable, but it is estimated to be between 5 and 10 days. Over the last 10-15 years, Cross lake has been the subject of numerous news articles relating to both water quality as well as it's hydrologic characteristics. In addition, the lake and the dam at the outlet have been involved in at least one lawsuit related primarily to flooding of surrounding property. Aside from the research described in this report, no scientific articles in refereed publications were found concerning non point contamination effects on Cross Lake. However, there has been research dealing with pollution from roadways as well as the use of holding basins as a best management practice for controlling it.

OBJECTIVE

1. Determine a correlation between traffic flow and water runoff quality for this bridge and similar settings,
2. Determine the relationship between water runoff quality from the bridge and effluent quality from the detention pond. Develop a predictive relationship for similar settings, and
3. Develop recommendations for further investigation,

Objective 1 could not be met because of difficulties encountered in obtaining traffic data. While traffic counters were installed in early November of 1996, traffic data could not be obtained from DOTD until early 1999, just before the project ended, when the Principal Investigator and/or his students was given permission to download the traffic counters. However, the small amount of traffic data obtained at the start of the study (1996) suggested ADT values at or just above 30,000 vehicles per day. More recent data indicate ADT values of about 33,000 vehicles per day.

SCOPE

The initial scope of work, developed jointly by personnel from DNR and LTRC concentrated on sampling the quantity and quality of flow <u>entering</u> the basin. Nine runoff events were sampled and analyzed during November and December of 1996. Then, the budget was increased to $340,000 and the sampling period extended until early 1999. In addition, $45,000 was received from NCHRP Proect 25-12. With these additional funds, the project proceeded along two fronts for a time. A second sampler was installed at the pond outlet which allowed mass balance calculations to be carried out on the liquid volume and pollutant mass entering and leaving the pond. This allowed the efficiency of the pond to be quantified. Concurrently, analysis of runoff events entering the pond continued centering on several areas: 1) The nature of the contaminants, form and concentration, 2) Relationships, if any, which existed between contaminants entering the pond and characteristics of the rainfall events which produced them, and 3) The extent to which the "first flush" phenomenon occurred at this site.
From January 1998 through June 1999, the project concentrated on measuring efficiency of the pond in removing conventional water pollution constituents such as BOD, COD, TSS, and nutrients. Also, during this time Louisiana Tech purchased a computer controlled atomic absorption spectrophotometer which is used to measure the concentration of metals. Because of the minimal additional cost to the project, some samples of pond contents, both liquid and deposited sediment, were collected and analyzed for a suite of heavy metals.

METHODOLOGY

The Cross Lake bridge is 10,000 feet long. It may be considered completely impervious with a surface area of approximately 880,000 square feet. The bridge presumably has a closed drainage system and all runoff is conveyed to a concrete lined holding pond located at the east end of the bridge. An American Sigma series 950 flowmeter/sampler measured and logged the runoff flow rate entering the pond. In addition, it could be programmed to collect samples across the runoff hydrograph. A recording rain gauge, mounted on top of the sampler enclosure, recorded rainfall amounts over time in increments of .01". The pond itself has an average surface area of 40,000 square feet with a maximum depth of 6 to 8 feet depending on location. The pond bottom slopes to toward the outlet.

CONCLUSIONS

1. Holding ponds such as that at Cross Lake can be very effective (mean TSS removal 85 percent) in removing sediment and sediment bound contaminants such as heavy metals from runoff.
2. Holding ponds are relatively simple, low maintenance systems which could be employed as a best management practice (BMP) at a number of DOTD facilities and be a major factor in reducing non-point contamination at existing DOTD facilities such as district offices and maintenance yards.
3. Holding ponds appear to be a simple and relatively inexpensive way of complying with upcoming federal and state mandates regarding export of non-point contamination from DOTD facilities.

RECOMMENDATIONS

1. Institute a program to clean the holding pond regularly.

2. Repair leaks in the Cross Lake bridge drainage system. This will protect the lake and allow for better quality data to be collected should additional research be carried out on the bridge. Recent information from local DOTD personnel indicates this may be in progress.

3. Erect some type of structure near the outlet of the pond to help minimize contaminant losses due to scour when the pond is emptied.

4. Investigate the economic and technical feasibility of similar systems at other DOTD facilities.