DEVELOPMENT OF AN S.S.O. MITIGATION PLAN: WHAT WE CAN LEARN FROM THE FIELD

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Abstract. Wastewater collection and conveyance systems have long been a neglected component of many municipal wastewater systems, due to a lack of funding and management focus. Increased population growth has resulted in increased wastewater flows. Aging systems may not have hydraulic capacity to receive the increased flows due to a large volume of Infiltration and Inflow (I/I) and lack of periodic maintenance. This may result in a Sanitary Sewer Overflow (SSO) to receiving waters. With the implementation of the Total Maximum Daily Load (TMDL) program and watershed protection programs, SSO events have received increased attention from regulatory agencies. Utilities are required to record the events and estimate the volume of the spills as they occur. The purpose of the evolving Capacity, Management, Operations, and Maintenance (CMOM) program is to minimize SSO events by requiring that each wastewater utility develop a comprehensive program. A response plan is still needed, however, a response plan to address the negative impacts of SSO events to receiving waters.

Fulton County, Georgia (the county in which the bulk of the City of Atlanta is located), operates a 45-million gallons per day (MGD) wastewater system consisting of 16 sewersheds, 5 treatment plants, 45 pump stations, over 300 miles of pipelines, and over 42,000 manholes. The system primarily serves residents in the unincorporated portions of the County in areas to the north and south, effectively bisected by the city limits of Atlanta, which operates a separate system. The County is currently developing several action plans in response to CMOM requirements. These include development of a comprehensive sewer system collection system model and master plan, implementation of a comprehensive maintenance program, replacement or rehab of key conduits, and upgrades at pump stations. It is the goal of the County to become more proactive in terms of its activities instead of reactive; however, again a response plan was needed, and in fact required for SSOs.

MACTEC assisted Fulton County in developing a procedure for responding to SSO events in isolated water bodies such as lakes and wetlands. This methodology uses a simple series of charts to simplify the calculation of carbonaceous and nitrogenous Biochemical Oxygen Demand (BOD). The process takes as an input the volume of the water body and the volume of the spill, and estimates the size and schedule of run times for aeration equipment deployed in response to the SSO event. Several iterations of this procedure were developed to simplify the method in application in the field. MACTEC developed and conducted a series of training classes with Fulton County's sewer collection system personnel. Despite technological and learning differences, the sewer collection system personnel provided valuable feedback on the method and on the state of the system. As the CMOM program evolves, it will be important to consider some of the lessons learned from operational personnel to ensure effective implementation.

INTRODUCTION

Fulton County (County) has an extensive sewage collection and treatment system located in two distinct geographic areas. The entire sewage collection system consists of approximately 1,600 miles of sewer lines with about 42,000 manholes. In North Fulton, there are approximately 1,070 miles of sewer lines and 30,000 manholes. In South Fulton, there are approximately 530 miles of sewer lines and 12,000 manholes. This includes sewage collection systems for various cities and towns within Fulton County that are owned and maintained by the County.

Besides the collection system, the County owns and operates five wastewater treatment facilities, Big Creek, Johns Creek and Little River in North Fulton; and Camp Creek and Little Bear Creek in South Fulton. The County generates approximately 49.4 million gallons per day (MGD) of wastewater; 37.1 MGD of this flow is treated at

County-owned wastewater treatment facilities, and the remaining 12.3 MGD is treated at wastewater facilities belonging to neighboring jurisdictions, such as R.L. Sutton in Cobb County, R.M. Clayton and Utoy Creek in the City of Atlanta, and R.L. Jackson in Clayton County. The County's wastewater treatment facilities also treat approximately 15.9 MGD from cities within Fulton County and neighboring counties. In addition, the County maintains 40 wastewater pump stations, 26 in North Fulton and 14 in South Fulton.

In the past, Fulton County has experienced several events related to overflows of the sanitary system. In response to these overflow events and ongoing maintenance needs, Fulton County has prepared an action plan. The action plan addresses the need for a quick and effective response to potential complaints concerning the collection system. The plan is a long-range strategy for improving and optimizing the complaint response and investigation program for the sewage collection system and other public works units. SSOs of more than 10,000 gallons to waters of the State are tracked and reported to the Georgia Environmental Protection Division (EPD). Those spills that occur in lakes and wetlands may require pumping and/or aeration to mitigate the effects of the spill. The following is a summary of the response procedures major SSO events.

METHODS

The Fulton County Standard Operating Procedure, or SOP (DPW 2002) outlines a mandatory procedure to be followed for major SSO events. A major spill is defined as:

(1) A discharge from a Publicly Owned Treatment Works (P0TW) which exceeds the weekly average permitted effluent limit for Biological Oxygen Demand (BOD5) or Total Suspended Solids (TSS) by 50% or more for any one day;

(2) A discharge of raw sewage in excess of 10,000 gallons that reaches waters of the State;

(3) A discharge of raw sewage that results in a "fish kill".

A legal notice must be published d within seven (7) days after the date of the major spill. The notice shall, as a minimum, include the following:

a. The date of the major spill,
b. The location of the spill,
c. The name of the receiving waters,
d. The estimated volume discharged, and
e. The corrective action taken to mitigate this spill and prevent similar future occurrences.

A monitoring program is required subsequent to the SSO event. The monitoring program is required for at least one year and includes the following parameters:

a. Dissolved Oxygen
b. Fecal Coliform bacteria
c. pH
d. Temperature

The monitoring frequency is once a day for the first seven (7) days, once a week for the next three (3) weeks and once a month for the next eleven (11) months. The results are then provided to the Georgia EPD and all downstream public agencies using the affected waters as a source of public water supply. Downstream counties, municipalities, and public agencies whose public water supply is within 20 miles of the affected area are also notified.

SSO events within rivers and streams most often do not require containment or treatment because of natural dilution due to flushing. However, for SSOs events that spill into isolated bodies of water such as lakes and wetlands, a mitigation strategy must be performed to lessen the impact of the spill. If feasible, the spill should be contained and removed and conveyed to a wastewater treatment plant. Often this is not viable due to the size of the spill and the inaccessibility of the spill location. Another mitigation strategy is to provide supplemental aeration treatment so that the Biochemical Oxygen Demand (BOD) of the spilled volume is reduced. Computing the amount of aeration is a multi-step process. MACTEC, formerly LAW Engineering, developed methodology based upon water quality modeling kinetics of carbonaceous and nitrogenous BOD (LAW 2002). BOD at time *t*, is estimated from the following relationship from Chapra (1997):

$$L_t = L_u\left(1 - e^{-kt}\right) \qquad \textbf{(1)}$$

Where:

L_t = BOD at time t
L_u = Ultimate BOD
k = Constant

The power requirements for providing the required aeration volume is determined form the following relationship from Metcalf and Eddy (1991):

$$N = N_o\left(\left(B * CT - CL\right)/C_{s,20}\right) * a * 1.024^{(T-20)} \qquad \textbf{(2)}$$

Where:

N = Pounds of oxygen transferred per Hp-day at ambient conditions

N_o = Pounds of oxygen transferred per Hp-day in tap water at 20ºC and Zero Dissolved Oxygen (DO)
B = Salinity-surface tension correction. In this case $B = 1$
CT = Oxygen saturation concentration at conditions, [mg/L]
CL = Oxygen concentration in water body, [mg/L]
$C_{s,20}$ = Oxygen saturation concentration at 20ºC in tap water, [mg/L]
a = Oxygen correction factor for type of wastewater and low speed aerators
T = Temperature, [ºC]

For spills into lakes or wetlands, the aeration procedures outlined in the SOP shall be followed. These are summarized as:

a. Estimate the size of the spill. This is typically done by approximating the flow rate using either the Manning Equation of relationships for partially full pipe with a depth measurement, or determining the volume of the spill by multiplying by the length of time of the spill. Typically, the diameter of a pipe is used, and/or the depth (for when the pipe is not flowing full) and the time frame in order to estimate the size of the spill volume.
b. For spills of less than 1,000,000 gallons and for spills into water body sizes of between 1 to 10 acres, initiate an aeration schedule based upon Tables 1 through 6 of the Corrective Action Plan (DPW 2002); Table 1 is provided to illustrate how the method is used.

Table 1. Estimated Aeration Time and Horsepower Requirements for Various Spill Volumes Using a Water body size of 1 acres, 6-foot in depth (6 Acre-Feet, 10 M lbs)

Cumulative Aerator size, hp	**1**	**2**	**4**	**6**	**10**	**70**
Gal/spill	**10,000**	**25,000**	**50,000**	**75,000**	**100,000**	**1,000,000**
0	7.6	9.5	9.5	9.5	7.6	10.9
1	7.6	9.5	9.5	9.5	7.6	10.9
2	7.6	9.5	9.5	9.5	7.6	10.9
3	13.3	16.6	16.6	16.6	13.3	19.0
4	11.1	13.8	13.8	13.8	11.1	15.8
5	9.5	11.9	11.9	11.9	9.5	13.5
6	6.7	8.4	8.4	8.4	6.7	9.5
7	4.7	5.9	5.9	5.9	4.7	6.7
8	3.3	4.1	4.1	4.1	3.3	4.7
9	2.3	2.9	2.9	2.9	2.3	3.3
10	1.6	2.1	2.1	2.1	1.6	2.4
11	1.2	1.5	1.5	1.5	1.2	1.7
12	0.8	1.0	1.0	1.0	0.8	1.2
13	0.6	0.7	0.7	0.7	0.6	0.8
14	0.4	0.5	0.5	0.5	0.4	0.6
15	0.3	0.4	0.4	0.4	0.3	0.4
16	0.2	0.3	0.3	0.3	0.2	0.3
17	0.1	0.2	0.2	0.2	0.1	0.2
18	0.1	0.1	0.1	0.1	0.1	0.1
19	0.1	0.1	0.1	0.1	0.1	0.1
20	0.0	0.1	0.1	0.1	0.0	0.1
21	0.0	0.0	0.0	0.0	0.0	0.1
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0

Note: For spill volumes in excess of 1,000,000 gallons, a different procedure must be used. For example, a 50,000-gallon spill will require a 4-hp aerator (or four 1-hp aerators) to be operated on days 0 to 2 at 9.5 hours, day 3 at 16.6 hours, day 4 at 13.8 hours, day 5 at 11.9 hours, then slowly decreasing to 0.0 as shown in Table 1 at day 21

Then select the column based upon the spill volume. Above the column is a suggested aeration requirement, in terms of cumulative horsepower. Any combination of aerators with the sum of their individual horsepower totaling this amount should achieve the results suggested in this column. The daily hourly schedule of required aeration to degrade the spill is given in the following rows. Discontinue aeration and remove the aeration equipment when the hourly schedule indicates no further aeration is required.

c. For spills greater than 1,000,000 gallons, and for water bodies substantially smaller or larger than the 1 to 10 acre sizes, a more general procedure must be followed, based upon the relationships found in equations 1 and 2. Due to space limitations, details are omitted here, but will be presented at the conference.

d. Raw sewage overflow to a wetland area presents additional issues. If there are sufficient open pools, the SSO response would be similar to that for a pond. The necessary course of action would be to follow the monitoring program. Naturally low DO of a wetland area may be lowered for a period of time, but should recover as the wetland area processes the spill. However, accessible, isolated small spills in wetlands may be candidates for pumping and removal and or aeration to be decided on a case-by-case basis.

Initially, a more detailed analysis of the spill response methodology was performed; changes were recommended by DPW in order to simplify the procedure and match the technical skill levels of the operational personnel. The above spill response procedure was taught in two separate sessions to the staff. Feedback received indicated a partial understanding of the procedure by most attendees, with a few of those present understanding most of the document.

CONCLUSIONS

A spill response methodology has been developed that estimates aeration requirements following a major SSO spill. This procedure provides a means for operational personnel to use simplified charts to facilitate complex calculations in the field. Although a determined effort was made to gear the method to the DPW staff, there still remained significant gaps in the understanding of the procedure.

Operational personnel are responsible for the field implementation of much of the new CMOM requirements. As these new regulations are phased in, it will be important to provide as much involvement and training of these personnel as possible in order to make CMOM programs effective and successful.

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