Appendix I

M.C. Stiles WWTP Foam Study & Outfall Improvements Work Plan

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Memorandum

To: *City of Memphis Division of Public Works*

From: *CDM*

Date: *December 1, 2010*

Subject: *Stiles WWTP Foam Study and Outfall Improvements Work Plan*

Introduction

The draft NPDES Permit for the M.C. Stiles Wastewater Treatment Plant (WWTP) authorizes discharge of treated wastewater from Outfall 001 with the requirement that "there shall be no distinctly visible floating foam, scum, oil, or other matter contained in the wastewater discharge." While the City has voluntarily taken steps to reduce foaming in its effluent, foam is still observed at times of lower flow in the Mississippi River, both at Outfall 001 and downstream of the outfall. The plant staff has used a defoaming agent since the late 1990s; but this approach does not provide a sustainable, long-term solution to address the root causes of foaming at the plant. CDM has supported the City in evaluating the probable sources and solutions to foaming to provide more beneficial alternatives to addressing the issue. This document provides a summary of the technical analyses conducted to investigate foaming at Outfall 001 and an overall work plan for implementing the proposed solution.

Objectives

The underlying state narrative water quality standards ("WQS") upon which the NPDES permit condition is based does not anticipate that all foam be eliminated from the discharge. For example, where the water quality criterion is for protection of fish and aquatic life, the WQS at 1200-4-3-.03(3)(c) prohibits the discharge of foam "of such size or character that may be detrimental to fish and aquatic life." Similarly, the water quality criteria for:

- industrial water supply at 1200-4-3-.03(2)(e) prohibits the discharge of foam of such size and character that "may impair the usefulness of the water as a source of industrial water supply;"
- recreation at 1200-4-3-.03(4)(c) prohibits the discharge of foam of such size or character that "may be detrimental to recreation;"

- irrigation at 1200-4-3-.03(5)(d) prohibits the discharge of foam of such size or character that "may impair the usefulness of the water for irrigation purpose;"
- livestock watering and wildlife at 1200-4-3-.03(6)(d) prohibits the discharge of foam of such size or character "as to interfere with livestock watering and wildlife;" and
- navigation at 1200-4-3-.03(7)(a) prohibits the discharge of foam of such size or character "as to interfere with navigation."

The City objectives under this consent decree are to assure that any foam that may remain after implementation of the project provided in this work plan be in compliance with the underlying applicable water quality standards.

Background Information

In general, foaming at a wastewater treatment plant could be caused by manmade surfactants or from long-chain fatty, acids, petroleum hydrocarbons, and natural surfactants. Manmade surfactants enter wastewaters mainly by discharge of aqueous wastes from household and industrial laundering and other cleansing operations. Detergents used in cleaning operations may also contain agents known as "builders" to enhance the surfactant effect. Builders lower water hardness by scavenging the calcium and magnesium ions. Typically, some form of sodium phosphate is used; although, in some areas, phosphate is no longer used as an additive due to environmental concerns. As alternatives, other chelating agents are used. It is important to note that the builders that are added to detergents, while enhancing foaming, are not the source of the foaming itself.

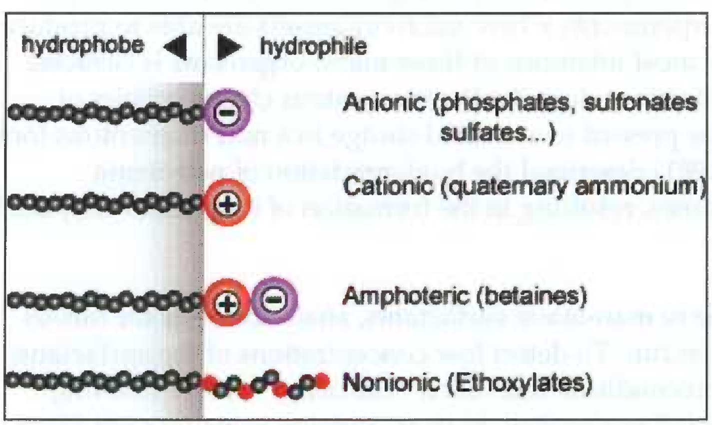

Figure 1
Examples of Surfactant Molecules

A surfactant combines, in a single molecule, a strongly hydrophobic group with a strongly hydrophilic one. These molecules tend to congregate at the interfaces between the aqueous medium and the other phases of the system such as air, oily liquids, and particles; thus imparting their aforementioned properties. The surfactant hydrophobic group, generally, is a hydrocarbon containing 10 to 20 carbon atoms; and the hydrophilic groups are of two types: those that ionize in water and those that do not. The ionic surfactants are further subdivided into two categories: anionic surfactant ion, or negatively charged ions, and cationic ions, which are positively charged. Nonionizing (nonionic) surfactants commonly contain a polyoxyethylene hydrophilic group. Hybrids of these types also exist. Examples of Surfactant Molecules are shown in **Figure 1.**

Quantification and identification of the source of compounds responsible for foam can be challenging. Anionic surfactants are the most prominent surfactants, with an extensive list of producers and trade names. Anionic surfactants account for about two-thirds of the synthetic surfactant production, with linear alkyl sulfonates (LAS) on top of the list. This is why the industry standard for quantification of surfactants is to analyze for methylene blue active substances (MBAS) using LAS as the equivalent standard. This method is useful for estimating the anionic surfactant content of waters and wastewaters, but the possible presence of other types of surfactants must be kept in mind. Cationic surfactants constitute less than .1 of the anionic surfactants and are commonly used for disinfecting, fabric softening, and various cosmetic purposes, rather than for their detersive properties.

At current detergent and water usage levels, the surfactant content of raw domestic wastewater is typically in the range of approximately 1 to 20 mg/L. When present in wastewater treatment systems, surfactants can be problematic. In fact, surfactants can kill microorganisms at concentrations in the 1—5 mg/L range and harm them at even lower concentrations (0.5 mg/L), depending upon the nature of the chemical(s). Surfactants can produce foams directly in a wastewater treatment system or combine with other compounds in the treatment system, resulting in enhanced foam formation. In addition, many surfactants have relatively low biodegradability and may pass through a wastewater treatment plant untransformed.

Surfactants can also be produced from biological activity using various hydrocarbons. The scientific literature describes various experiments where microorganisms are able to produce foaming surfactants from alkanes. The most infamous of these micro-organisms is *Gordonia* (formerly *Nocardia*) *amarae*. Many publications describe the filamentous characteristics of *Nocardia*. However, *Nocardia* can also be present in activated sludge in a non-filamentous form and escape obvious detection. Atlas (1981) described the biodegradation of petroleum hydrocarbons, including branched alkanes, resulting in the formation of long-chain fatty acids (C10 or greater).

To determine if the foam is attributable to man-made surfactants, analytical tests for MBAS and non-ionic surfactants (CTAS) can be run. To detect low concentrations of the surfactants in dilute wastewaters, analysts use a precondition test called "sublation", where foaming chemicals are floated up and concentrated just as they do in an aeration basin (see SM 5540). If results indicate that there is greater than approximately 10 mg/L of either/or a combination of MBAS and CTAS, the chemical mix of the surfactants is most likely the cause of foam. In the case the surfactant class is clearly identified, neutralization of the base charge can be accomplished with a defoaming agent (e.g., such as addition of a cationic defoamer to neutralize anionic surfactants). If, however, results of these tests do not conclusively identify man-made surfactants are the source of foam, additional analysis should be conducted to identify the compounds that compose the foam. Once the chemical composition of the foam and the surfactant concentrations are identified, alternatives for addressing the foam issue may be developed.

Foam Sampling and Results

To determine the source of the foam that is regularly observed at the M.C. Stiles WWTP Outfall 001, this study included a sampling and testing program of the plant process, influent sewer interceptors, and industrial users (IU) discharges, along with a record review of qualitative visual observations of foam. A sample of the foam that forms at the outfall was also collected, concentrated, and submitted for specialized testing at Auburn University. Additionally, the City conducted an IU surfactant survey to gather data for determining the possible sources and causes of the foam. The survey results are provided in **Appendix A**.

Surfactant Sampling and Results

Results of the analytical testing for wastewater samples collected at locations in the WWTP process are provided in **Table 1**. In addition to samples collected throughout the plant, samples were collected from the Mississippi River, upstream of Outfall 001 to determine if these compounds were also present in the receiving stream. If these compounds were present in significant quantities, the hydraulic energy that is imparted to the river as a result of the plant discharge could result in foaming within the river. Samples of concentrated foam were also collected at the clarifiers and Outfall 001 for analysis of the foam itself. Samples were also taken from selected IUs and the three major sewer interceptors entering the plant. These analytical results are summarized in **Table 2**.

Table 1
Sample Results for Anionic (MBAS) and Nonionic (CTAS) Surfactants in M. C. Stiles WWTP and Interceptors

Location	Date	MBAS (mg/L)	CTAS (mg/L)
Mississippi River, Upstream	4 /15/2009	<0.025	N/A
	5 /13/2009	<0.025	<0.5
	7 /29/2009	<0.025	0.36
Lagoon Return	4 /15/2009	0.45	N/A
	5 /12/2009	0.055	<0.5
	7 /22/2009	0.38	<0.5
	7 /28/2009	0.3	0.45
	4 /15/2009	0.45	N/A
	5 /12/2009	0.12	<0.5
	7 /22/2009	0.46	<0.5
Plant Influent	4 /15/2009	1.17	N/A
	5 /12/2009	<0.025	<0.5
	7 /20/2009	0.15	0.7
	7 /28/2009	1.06	0.48
Grit Tank	5 /13/2009	1.39	<0.5
	7 /23/2009	<0.025	<0.5
	7 /28/2009	0.025	0.42
	7 /28/2009	0.7	0.42
Contact Tank-A	4 /15/2009	0.04	N/A
	5 /13/2009	<0.025	<0.5
	7 /23/2009	0.4	<0.5
Contact Tank-B	4 /15/2009	0.04	N/A
	5 /13/2009	<0.025	<0.5
Return Sludge-A	4 /15/2009	<0.025	N/A
Return Sludge-B	4 /15/2009	<0.025	N/A
Secondary Clarifiers	4 /15/2009	0.18	N/A
	5 /13/2009	<0.025	<0.5
	7 /23/2009	<0.025	<0.5
	7 /28/2009	<0.025	0.23
Stabilization Tank-A	5 /13/2009	0.045	<0.5
	7 /23/2009	0.66	N/A
Stabilization Tank-B	5 /13/2009	0.056	<0.5
Effluent at Weir	4 /15/2009	0.18	N/A
	5 /12/2009	<0.025	<0.5
	7 /22/2009	<0.025	<0.5
	7 /28/2009	<0.025	0.4
Effluent at Outfall	5 /12/2009	0.07	<0.5
	7 /22/2009	<0.025	<0.5
	7 /28/2009	0.083	0.35
Foam, Clarifier A	6 /15/2009	1.08	5.6
	8 /10/2009	32.2	14.5
Foam, Outfall	5 /12/2009	0.069	<0.5

Table 2
Sample Results for Anionic (MBAS) and Nonionic (CTAS) Surfactants in Industrial User Discharges

Location	Date	MBAS (mg/L)	CTAS (mg/L)
American Yeast	4 /27/2009	<0.025	3.5
	7 /27/2009	0.14	2.81
Buckeye Technologies	7 /27/2009	0.1	0.34
Cacade Tissue Group	7 /27/2009	0.39	1.64
KTG	4 /27/2009	<0.025	<0.5
	7 /27/2009	<0.025	0.45
PMC Biogenics	5 /19/2009	<0.025	<0.5
Front Street Interceptor	4 /27/2009	0.73	<0.5
	5 /11/2009	0.11	<0.5
	5 /18/2009	0.081	N/A
	7 /20/2009	0.19	<0.5
	7 /27/2009	0.11	0.57
Loosahatchie River Interceptor	4 /27/2009	<0.025	<0.5
	5 /11/2009	0.025	<0.5
	5 /18/2009	0.042	<0.5
	7 /20/2009	0.28	<0.5
	7 /27/2009	0.064	0.64
Wolf River Interceptor	4 /27/2009	0.08	<0.5
	5 /11/2009	0.063	<0.5
	5 /18/2009	0.143	N/A
	7 /20/2009	0.15	<0.5
	7 /27/2009	1.16	0.54
Plant Influent	4 /15/2009	1.17	N/A
	5 /12/2009	<0.025	<0.5
	7 /20/2009	0.15	0.7
	7 /28/2009	1.06	0.48

The reported concentrations of MBAS and CTAS in the wastewater samples, as presented in **Tables 1** and **2**, are well below 10 mg/l and, as such, do not indicate unusually high concentrations of these classes of surfactants present in the plant and/or industrial dischargers. None of the samples had individual or combined concentrations of these classes of compounds in excess of 10 mg/L. While this is not conclusive proof that the chemical mix of surfactants is not the primary cause of foam, it is clear that there is not a single class of surfactant that can be identified. This means that using a base charge neutralization approach may not fully address the foaming at Outfall 001. As a result, additional analyses of the foam in the plant (at clarifier A) were conducted and are presented in **Table 3**.

Table 3
Sample Results from Specialized Surfactant Analyses of Foam from Clarifier A at the M.C. Stiles WWTP

Compound	Fatty Acids	Composition (%)
1	Palmitic acid	15.8
2	Stearic acid	7.2
3	Myristic acid	5.1
4	Oleic acid	16.4
5	Palmitoleic acid	3.8
6	Linoleic acid	2.9
	Quaternary Amines	
7	Didecyl dimethyl ammonium salt	2.2
8	Octyl decyl dimethyl ammonium salt	2.0
9	Dioctyl dimethyl ammonium salt	1.8
10	Benzyldimethyltetradecylammonium chloride	0.5
11	Decyldimethyl ammonium salt	0.6
	Linear Benzylalkylsulfonates (MBAS)	
12	4-sulfophenyl undecanoic acid	6.2
13	4-sulfophenyl octadecanoic acid	3.1
14	4- sulfophenyl octanoic acid	1.6
	Other Compounds	
15	Nonylphenol ethoxylate	1.9

In addition to identification and quantification of specific surfactant compounds, a microscopic inspection of the foam was conducted. This analysis indicated that a moderate amount of bacteria was present in the foam structure. However, these bacteria were not consistent in morphology with known foam producing bacteria. Most likely, the bacteria present in the foam were floated into the foam by surfactant micelles and trapped there. With respect to the specific concentrations of surfactant compounds in the foam sample, compounds 1 to 6, which are long-chain fatty acids, may contribute to foaming problems. Long-chain fatty acids made up 51 percent of the dry weight of the foam; and while fatty acids are not a major source of foaming problems on their own, they often intensify the effects of surfactant-based foam. Fatty acids can also stabilize foam, making it more resistant to typical defoamers. Compounds 7 to 11 are significant products from the common class of surfactants known as quaternary amines and comprised 7.1 percent of the foam (by dry weight). Quaternary amines are commonly utilized in household and industrial cleaning solutions because of their antibacterial action. Quaternary amines are slowly biodegradable under aerobic conditions. Compounds 12 to 14 are linear alkyl benzosulfonates and were detected in the samples at 10.9 percent of the foam by dry weight. These compounds are common household detergents. An additional surfactant, nonylphenol ethoxylate (compound 15), was detected in the sample as well. This compound is also an ingredient in common household detergent and comprised less than 2 percent of the dry weight of the foam.

In summary, the foam that is present on the clarifiers is a mixture of man-made surfactants and fatty acids that likely arise from influent fats, oils, and grease, as well as potentially from grease in the system. The foam is formed by the fatty acids and stabilized by the surfactants. A diverse mixture of common surfactants is present in the samples, indicating a high likelihood that they arise from multiple sources and/or products; and, therefore, reduction or removal of surfactants to the WWTP is impractical as they arise from many sources.

Visual Foam Observations

In the mid-1990s, WWTP management initiated an outfall defoaming program consisting of injecting a 10-percent polydimethylsiloxane solution into WWTP effluent at the existing chlorine contact tank to eliminate or, at least, significantly reduce foaming on the river. In an effort to further decrease foam at Outfall 001, the WWTP started using a double-strength defoaming agent (i.e., a 20-percent polydimethylsiloxane solution) for injection into the WWTP effluent in April 2009.

Observations of foam on the river show that foam originating from Outfall 001 generally remains within approximately 90 yards of the eastern bank of the river. The foam that originates from the WWTP outfall is characterized as frothy and bright white. The foam tends to be unstable and generally dissipates within 0.5 miles of the outfall, even when the defoaming agent is not fed. Observations from the eastern river bank have also shown that dense, yellow-brown foam frequently originates from upstream of the outfall. This foam generally extends across the entire width of the river and does not originate from the outfall. WWTP management believes that a large proportion of the complaints of foam on the river have been due to reports of the dense, yellow-brown foam that originates at some point upstream from the plant. To demonstrate that the upstream-originating foam is different than the foam that is present at Outfall 001, a sample of this yellow-brown foam was collected and sent to Auburn University for specific surfactant testing. Results from this sample analysis are shown in **Table 4**.

In addition to identification and quantification of specific surfactant compounds, a microscopic inspection of the foam indicated that a moderate amount of bacteria and a large amount of silt/clay was present in the foam structure. This material gives the foam the yellowish-brown color when it begins to dry. The bacteria were not consistent in morphology with known foam producing bacteria; and the bacteria, clay, and silt particles that are present in the foam have most likely floated into the foam by surfactant micelles and become trapped.

Table 4
Sample Results from Specialized Surfactant Analyses of Foam from Mississippi River Upstream of Outfall 001

Compound	Fatty Acids	Composition (%)
1	Palmitic acid	12.30
2	Stearic acid	9.60
3	Myristic acid	5.70
4	Oleic acid	11.80
5	Palmitoleic acid	5.00
6	Linoleic acid	3.10
7	Octadecanoic acid methylester	5.80
8	Octadecamide	4.60
9	Dodecanoic acid methyl ester	2.50
10	Tetradecanoic acid methyl ester	3.50
	Quaternary amines	
11	Didecyl dimethyl ammonium salt	0.90
12	Octyl decyl dimethyl ammonium salt	1.10
13	Dioctyl dimethyl ammonium salt	0.70
14	Benzyldimethyltetradecylammonium chloride	0.30
15	Decyldimethyl ammonium salt	0.30
	Linear Benzylalkylsulfonates	
16	4-sulfophenyl undecanoic acid	1.20
17	4-sulfophenyl octadecanoic acid	1.40
18	4- sulfophenyl octanoic acid	1.00
	Other Compounds	
19	Nonyl phenol ethoxylate	0.90

With respect to the specific concentrations of surfactant compounds in the river foam sample, compounds 1 to 10 are long-chain fatty acids which may contribute to foaming problems. The long-chain fatty acids made up 63.9 percent of the dry weight of the foam. These fatty acids likely originate from organic decomposition and re-suspension of sediments. Naturally occurring river and sea foam are comprised of similar fatty acids. Compounds 11 to 15 are significant products from the common class of surfactants known as quaternary amines. They comprised 3.3 percent of the foam by dry weight. These quaternary amines comprise only a small fraction of the foam and are not likely to be the source of the foam. Compounds 16 to 18 are linear alkyl benzosulfonates and were detected by GC-MS in the samples and accounted for 3.6 percent of the foam by dry weight. These compounds are common manmade detergents and are likely present as result of use upstream. Nonylphenol ethoxylate (compound 19), was also detected in the sample but comprised less than 0.9 percent of the foam by dry weight.

In summary, the river foam is comprised mostly of naturally occurring fatty acids and is consistent with naturally occurring river foams. The foam is formed by fatty acids and their methyl esters that arise from fatty acid decomposition. The fatty acids may originate from aerobic biodegradation of petroleum alkanes, vegetable oils, and animal fats. A small, but diverse mixture of common surfactants is present in the samples. The manmade surfactants were a minor component of the foam and are likely the result of upstream discharges.

Alternative Defoaming Agent Demonstration Study

While various analyses and observations were being conducted, the City of Memphis contacted NRP Group to test an alternate, non-silicon based defoaming product to determine its effectiveness compared to the polydimethylsiloxane solution currently being used. Testing was conducted on November 5, 2009.

The NRP product was added at the beginning of the north and south troughs and at the junction box at a dose of 0.05 mg/L. The product was added 30 minutes after the silicone-based product was shut off and, again, 30 minutes later. An additional test was run following a shutoff of all defoaming products for 30 minutes when the NRP product was added again.

A slight visual reduction in the foaming was noted with the NRP product over the current silicone product used at the WWTP. However, the conditions of the river prevented conclusive results. The river was at a high stage, resulting in submergence of the discharge, which prevented the very heavy foaming that typically occurs when the river is at a low stage. The water flowing from the end of the discharge causes additional foaming as a result of the hydraulic release created.

Summary of Foam Evaluations and Recommendations

In summary, the composition of the foam that is present in the M. C. Stiles WWTP and at Outfall 001 is a mixture of man-made surfactants and biologically produced fatty acids that likely arise from sewer users and other grease within the collection system. Foam is formed by fatty acids and is stabilized by surfactants/biosurfactants. A diverse mixture of common surfactants is present, indicating a high likelihood that they arise from multiple sources and/or products.

Removal and/or reduction of hydraulic drops at the chlorine contact basin and outfall that allow energy and air to be imparted into water would reduce foaming. Addressing the large hydraulic drops to the discharge would make anti-foaming agents effective (if necessary at all) and would eliminate most of the foaming at Outfall 001.

Due to the difficulty of identifying and eliminating all the surfactant and fatty acids discharging to the plant, the recommended solution is to address the foaming by restructuring the outfall structure to remove the large hydraulic drops responsible for air entrainment. Based on a preliminary review of the existing outfall, a redesign or reconfiguration of the existing outlet structure is anticipated to relieve the air entrainment and release of the air at the outfall causing the existing foaming. Recommendations of this study are to move forward with the design of the outfall reconfiguration and construction of a new outfall structure.

Existing Outfall Structure

Effluent from the plant has an energy grade line well above the invert elevation of 224 feet, which must dissipate roughly 10 to 40 feet of head at or before its discharge to the river. Currently, most of the foam is generated at the primary outfall vertical drop, situated at the top of the river bank, and there is little horizontal distance between the drop structure and outlet for foam bubbles to rise and be purged before discharging. When the river level is below an elevation of 197 feet, the drop structure to the river acts hydraulically as an open channel, preventing submergence that is hydraulically favorable for eliminating air entrainment.

Currently, effluent flows over a broad-crested weir in the chlorine contact basin into either an 84-inch primary or secondary overflow outfall pipe. From the chlorine contact basin at Station 0+00, the primary outfall pipe slopes downward to an invert elevation of 210 feet at Station 1+55, then continues at a reduced slope to an invert elevation of 209 feet at Station 3+49. Here, flow empties into a vertical drop structure adjacent to the Mississippi River bank where the outfall structure has a free-fall drop to an invert elevation of 190 feet. This free-fall entrains a significant amount of air, much of which is released up the vertical shaft, leaving a significant residue of foam to discharge into the river. Down gradient of the drop structure, flow continues within the primary 84-inch pipe which extends another 54 feet to Station 4+18, where its crown intersects the concrete mat bank revetment. Effluent flows into the river through an 8-foot-wide headwall structure at an invert elevation of 190 feet.

The secondary outfall pipe, which is used only at high Mississippi River water levels, currently slopes from Station 0+00, within the chlorine contact basin at an invert elevation of 224 feet, to Station 1+15 at an invert elevation of 221 feet. The pipe terminates at a headwall structure located approximately 200 feet from the shoreline. Any effluent that must be diverted through this secondary pipe flows through a 200-foot earthen drainage ditch, approximately at grade, to the bank of and into the river.

In the vicinity of the river outlet, the river bank is lined with heavy rip-rap, at an embankment side slope of approximately 3H:1V. The top elevation of the lined bank is 220 feet. The rip-rap lining continues down slope to an approximate elevation of 180 feet. At the location of the outfall, the Mississippi River is about 2,400 feet wide and has a maximum depth of 55 feet, based on the average recorded depth of 194 feet over the past 10 years.

Mississippi River Water Elevations

Development of alternative outfall configurations to address foam formation depends upon the ability to remove major hydraulic drops in the outfall structure, as well as the submergence of the outfall structure in the Mississippi River. Thus, understanding the variability of water elevations in the river are critical to developing, evaluating, and selecting the best alternative to meet the objectives of reducing foam formation.

The past 10 years of historical Mississippi River flow and depth data were obtained and reviewed. In that period, the average Mississippi River water elevation at the City of Memphis has been 194.4 feet. Seasonal low-water levels were been between 175 – 180 feet during that period. However in the most recent years the river elevation has been closer to 180 – 182 feet. The high-water level in the river within the past 10 years was 222 feet, recorded in April and May of 2002.

The past 10 years of Mississippi River data are shown in **Figure 2.** This data indicates that there are significant differences in the amount of time that an outfall would be entirely or partially submerged, based on alternative elevations at 190, 180, and 175 feet. As previously discussed, submergence is not the primary mode of foam reduction, but does provide a secondary mechanism for minimizing foam formation. Submergence also provides improved dispersion of effluent flow, which may improve compliance with other discharge permit standards.

Based on historical river data, a proposed outfall alternative at 190 feet would be partially submerged 62-percent of the time with the outfall being entirely submerged 41-percent of the time, or 150 days of the year. In comparison, proposed outfall structures at 180 feet and 175 feet would be partially submerged 96 and 99.6 percent of the time, respectively; and each alternative would be totally submerged 70 and 87 percent of the time, respectively. This equates to a submergence of 256 and 317 days, at elevations 180 feet and 175 feet, respectively. The 180-foot outfall alternative would provide an additional 100 plus days annually over the 190-foot alternative. The 175-foot outfall elevation provides an additional 60 days of submergence over the 180-foot alternative. This information regarding the number of days of outfall submergences for several alternatives will be used in a feasibility evaluation that will also consider constructability and cost with the alternative effectiveness, which includes consideration of the annual submergence of the outfall structure.

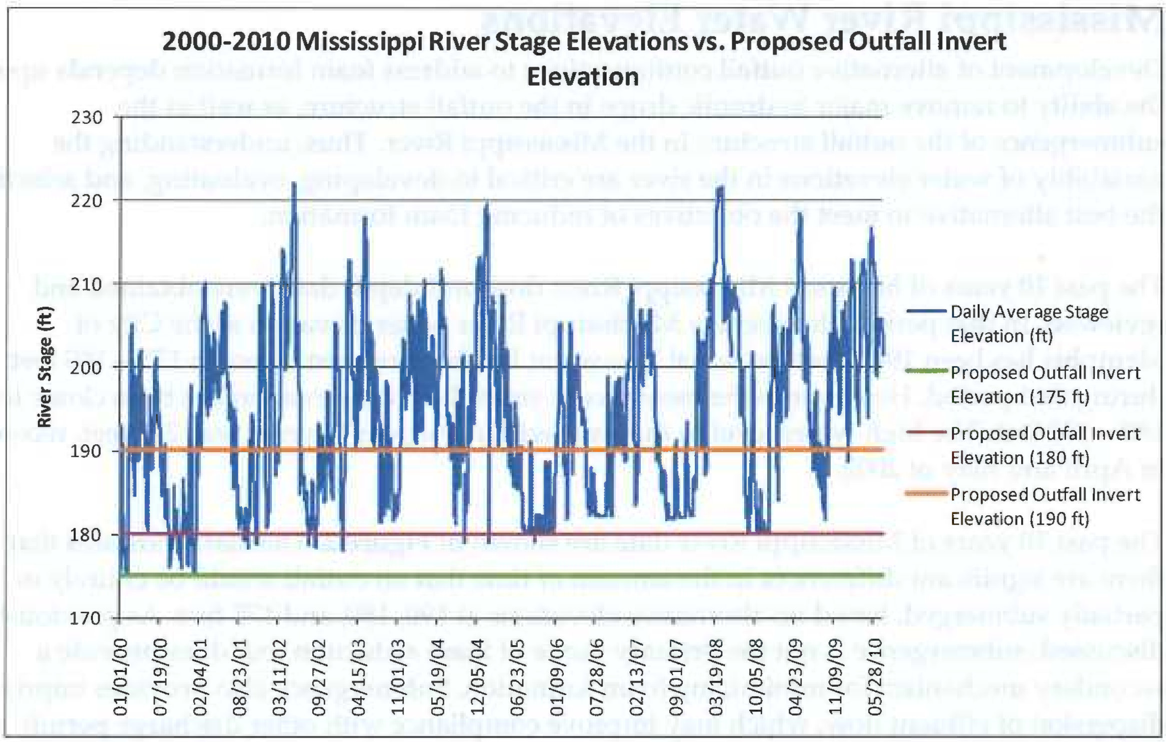

Figure 2
10-year Historical Mississippi River Data vs. Proposed Outfall Elevations

Alternative Outfall Designs

Five alternative layouts to the existing piping and drop structure were evaluated to address the hydraulic issues associated with air entrainment and foaming issues. The plan for addressing foam control is to adapt and extend the secondary outfall pipeline using one of the following alternatives. This approach will allow the existing primary outfall to remain in service throughout construction of a modified outfall structure. The alternatives that will be evaluated for feasibility, cost, constructability, and effectiveness include the following:

- Construct a non-vertical drop structure with discharge through a portal in the bank at an invert elevation of 190 feet.
- Construct a non-vertical drop structure with discharge through a portal in the bank at an invert elevation of 180 feet.
- Construct a non-vertical drop structure with discharge through a short diffuser located approximately 150 feet from the bank at an invert elevation of 175 feet

- Construct a non-vertical drop structure with discharge through a diffuser approximately 1,000 feet long, extending across the deepest part of the river, at and/or under an elevation of 150 feet. This option was quickly eliminated after discussions with the US Army Corps resulted in concerns due to its presence within a ship channel that routinely needs maintenance dredging, as well as the problems of sand waves propagating over the diffuser alignment.

- Utilize a mechanical energy dissipater in place of the reconfiguration of the existing piping and outfall structure.

Alternatives Evaluation

For each of the alternatives, a new design could employ the existing 84-inch pipeline at the secondary outfall. Using and extending the secondary pipeline for these alternatives would allow construction to proceed without interrupting operation of the primary outfall. Upon completion and commissioning of any alternative, the existing outlet would be reconfigured as the secondary emergency outfall.

The non-vertical drop structure mentioned in all alternatives, except for the energy dissipater, would replace the vertical drop structure in the primary pipeline. This existing drop structure is considered to be the major hydraulic drop that causes air entrainment and subsequent foaming. The non-vertical drop would consist of a steep (about 6H:1V) portion of the extended secondary pipeline, from invert elevation 221 feet at station 110+00 to one of the alternative discharge elevations (190 feet, 180 feet, or 175 feet) at Station 350+00, where Station 0+00 is the outlet from the chlorine contact tank. At Station 350+00, a tee of the same diameter as the outlet pipeline would be used, with the stem of the tee rising vertically to several feet above grade. This tee stem would function as an air release for bubbles and foam generated where the effluent in the partially full, steeply sloping pipe enters the full-flowing pipe.

Alternative 1 – Non-vertical Drop Structure, Discharge at 190 Feet

The first alternative provides for effluent discharge through a portal in the river bank at an invert elevation of 190 feet. This option would allow discharge into the River at the same elevation as the existing outfall. Therefore, there would be portions of the year that the outfall would not be submerged. Outfall submergence is not essential, because the primary reduction of foam would result within the flatter portion of piping, with release of the air and foam at the rising vertical tee; however, submergence of the outfall structure is an additional source of foam dissipation. This alternative also has the advantage that construction would be adjacent to the shoreline, evading the river cross section and any dangers of outall burial by sand waves or damage by impact from river traffic. Due to the required depth of the outfall piping, this alternative would require the least excavation and site work, and would be the least expensive of the three outfall reconfiguration options (Alternatives 1, 2 and 3).

Alternative 2 – Non-vertical Drop Structure, Discharge at 180 Feet

The second alternative provides for effluent discharge through a portal in the river bank at an invert elevation of 180 feet. This option would also be constructed adjacent to the banks, thus avoiding the danger of burial by sand waves or damage by river traffic. Compared with the present outlet, this alternative would significantly reduce foam, but would have submergence during a greater portion of the year, which could provide a greater level of foam dissipation throughout the year. In addition, the greater depth of submergence will also allow for greater mixing of the effluent, extending the plume a slightly greater distance from the shore than a free-fall plume. Due to the additional 10 feet of depth required for the construction of the effluent pipeline, this option would require additional excavation and site work.

Alternative 3 – Non-vertical Drop Structure, Discharge at 175 Feet

This outfall reconfiguration option includes extending the outfall piping to an elevation of 175 feet — approximately 150 feet from the shore. Due to the extension into the river and the requirement of the multi-port diffuser, this option is a difficult option to construct and would have a significantly higher cost. This alternative also is subject to significant risk of damage from river traffic, including freight transport and dredging operations. Sand waves would also be a concern and could have significant impacts on plant operations and maintenance activities and costs. Although the outfall would be submerged a greater percentage of the year, the disadvantages of operations, in addition to the complex excavation (deeper on the plant site and open trenching of the river bed) required for construction of this alternative eliminate it from further consideration.

Alternative 4 – Non-vertical Drop Structure with Discharge Through Diffuser at 1,000 feet from Shore

This alternative involves the construction of a non-vertical drop structure with discharge through a diffuser, approximately 1,000 feet long, extending across the deepest part of the river at and/or under an elevation of 150 feet. After preliminary discussions with the US Army Corps, this option was quickly eliminated due to concerns over the presence of a diffuser structure within a busy navigation channel. The diffuser would require significant, routine maintenance in addition to potential dredging responses to sand wave propagation over the diffuser alignment.

Alternative 5 – Mechanical Energy Dissipater

The final alternative includes installation of an energy dissipater on the existing outfall. As an alternative to the sloping-pipe configuration recommended above, the vortex energy dissipater, which has been studied extensively in hydraulic laboratories at St. Anthony Falls, Iowa Institute of Hydraulic Research, Caltech, and other research institutions, was evaluated for its applicability to the reduction of the foam at the M.C. Stiles WWTP outfall. A typical design resulting from physical model studies is shown in **Figure 3**. The dimensions shown in black, in inches, are the dimensions in a physical model that have been demonstrated to be successful in dissipating hydraulic head with a minimum of attendant foaming; the design flow rate in this model was 3.5 cubic feet per second (cfs) (2.3 mgd) , while the peak discharge in the model was 4.85 cfs (3.2 mgd).

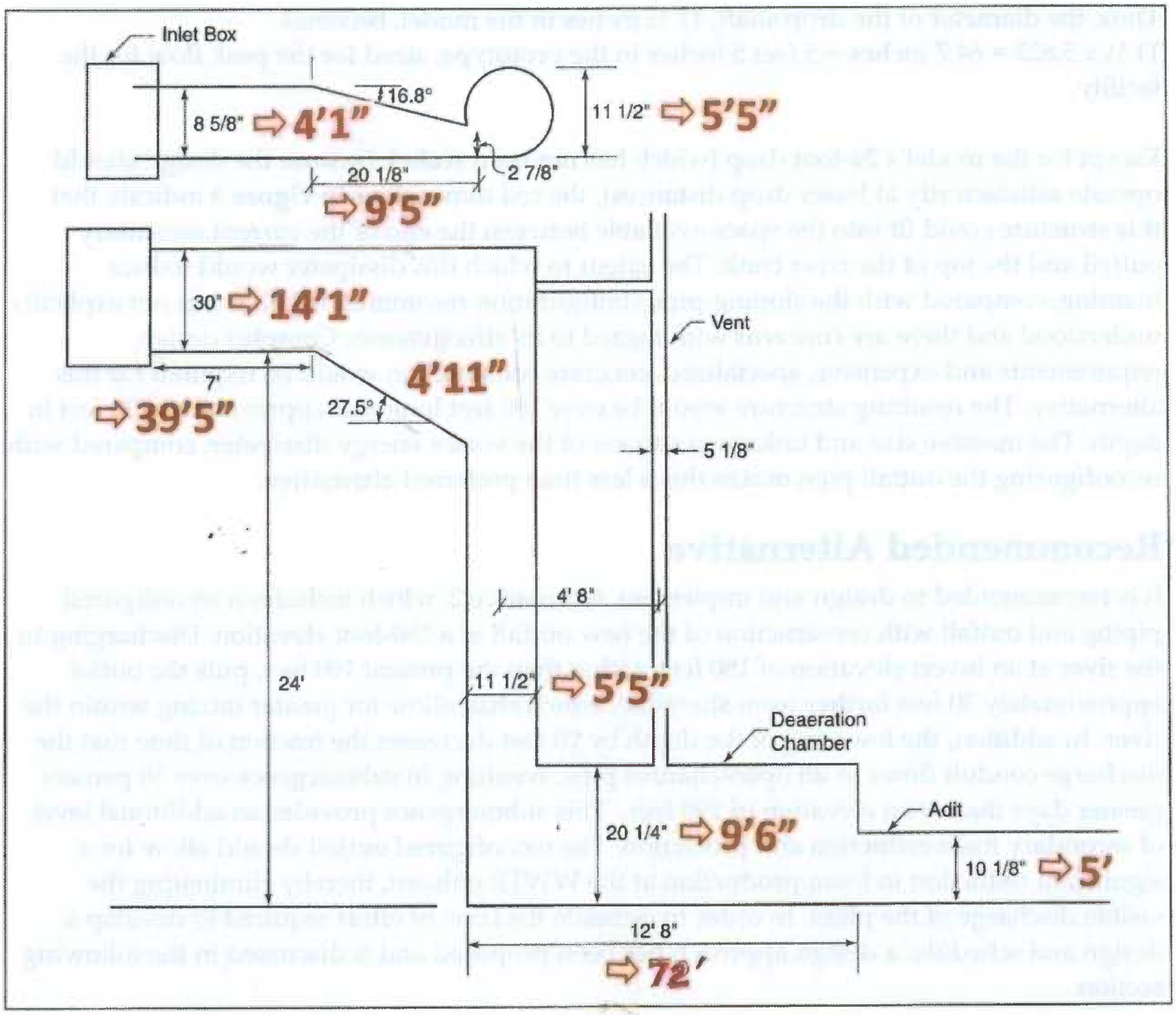

Figure 3
A Vortex Drop Structure Design Based on Physical Modeling

The dimensions shown in red, in feet and inches, have been scaled to pass a design peak flow of 235 mgd (364 cfs) to address the peak flow at the M. C. Stiles WWTP. The scaling was conducted using a Froude scaling ratio and was determined as follows:

$$L_{prototype}/L_{model} = (Q_{prototype}/Q_{model})\ 0.4 = (364/4.85)\ 0.4 = 5.625.$$

Thus, the diameter of the drop shaft, 11 ½ inches in the model, becomes 11 ½ x 5.625 = 64.7 inches = 5 feet 5 inches in the prototype, sized for the peak flow for the facility.

Except for the model's 24-foot drop (which has not been scaled, because the design should operate satisfactorily at lesser drop distances), the red dimensions in **Figure 3** indicate that this structure could fit into the space available between the end of the current secondary outfall and the top of the river bank. The extent to which this dissipater would reduce foaming, compared with the sloping-pipe configuration recommended above, is not explicitly understood and there are concerns with regard to its effectiveness. Complex design requirements and expensive, specialized, concrete construction would be required for this alternative. The resulting structure would be over 100 feet long and approximately 20 feet in depth. The massive size and unknown success of the vortex energy dissipater, compared with reconfiguring the outfall pipe makes this a less than preferred alternative.

Recommended Alternative

It is recommended to design and implement Alternative 2, which includes a reconfigured piping and outfall with construction of the new outfall at a 180-foot elevation. Discharging to the river at an invert elevation of 180 feet, rather than the present 190 feet, puts the outlet approximately 30 feet farther from shoreline, which shall allow for greater mixing within the river. In addition, the lowering of the depth by 10 feet decreases the fraction of time that the discharge conduit flows as an open-channel pipe, resulting in submergence over 30 percent greater days than at an elevation of 190 feet. This submergence provides an additional level of secondary foam reduction and protection. The reconfigured outfall should allow for a significant reduction in foam production at the WWTP effluent, thereby eliminating the visible discharge of the plant. In order to estimate the level of effort required to develop a design and schedule, a design approach has been proposed and is discussed in the following section.

Design Approach

Based on the preliminary evaluations, the proposed new design will extend the existing secondary outfall pipe to a new outfall elevation of 180 feet. The new outfall will dissipate energy via a hydraulic jump in a gently sloping pipe, rather than in a vertical drop structure.

While this Alternative will not completely eliminate air entrainment, the jump will create far less foam than a vertical free-fall. This approach will also provide a generously adequate distance after the jump to allow foam bubbles to collect at the top of the pipe and be vented, instead of continuing to the river and being discharged with the effluent. The layout of the preferred Alternative lowers the discharge invert from the current 190 feet to 180 feet, resulting in a discharge point about 30 feet further off shore than the current outfall structure. The proposed outfall would include the following physical constraints (note, however, that during detailed design the optimum sizes, locations, invert elevations, etc. will be determined and may vary somewhat from the conceptual configuration presented below):

- The existing headwall on the secondary outfall pipe, at Station 1+15 and invert 221 feet, would be removed.
- The existing 84-inch secondary outfall would be extended from Station 1+15 and invert 221 feet, sloping down to an invert elevation of 180 feet.
- From the toe of the outfall slope, the outfall conduit would continue horizontally at invert 180 feet to a point under the top of the river bank, about 350 feet from the chlorine contact basin.
- An 84-inch vertical vent shaft would be provided, intersecting the horizontal outfall pipe.
- From Station 3+57 feet, the horizontal outfall pipe would be continued to its intersection with the concrete-mat-revetted river bank, at Station 4+60, invert 180 feet. Flow would be released to the river in a headwall structure identical to the existing structure.

For the layout, bubble velocity rise will be considered in determining the horizontal distance between the bottom of the slope and the vent shaft. Research by Wu and Gharib (2002) has been used to calculate these dimensions which are presented in **Table 5**.

Table 5
Calculated Horizontal Distance between the Bottom of the Slope and the Vent Shaft

Q, mgd	B, ft	X, ft	(X – 115), ft	Slope Tangent = (221-180)/(X-115)	Slope for Jump, Degrees
80	69	281	166	0.247	13.9
135	116	234	119	0.345	19.0
235	202	148	33	1.24	51.2

In **Table 5**, the position of the toe of the slope, X feet from the WWTP, is 350 feet – B feet. The tangent of the slope is the vertical drop from elevation 221 to 180, or 41 feet, divided by the horizontal run of the slope, which is X feet – 115 feet — the location of the end of the current secondary outfall. This provides for a variety of layout options which are illustrated, in profile, in **Figure 4**. Three alternative slopes are shown in red, dark red, and violet. The vent pipe (violet) extends vertically to just above grade (green) at Station 350. The B distance is from the toe of the slope to the vent pipe.

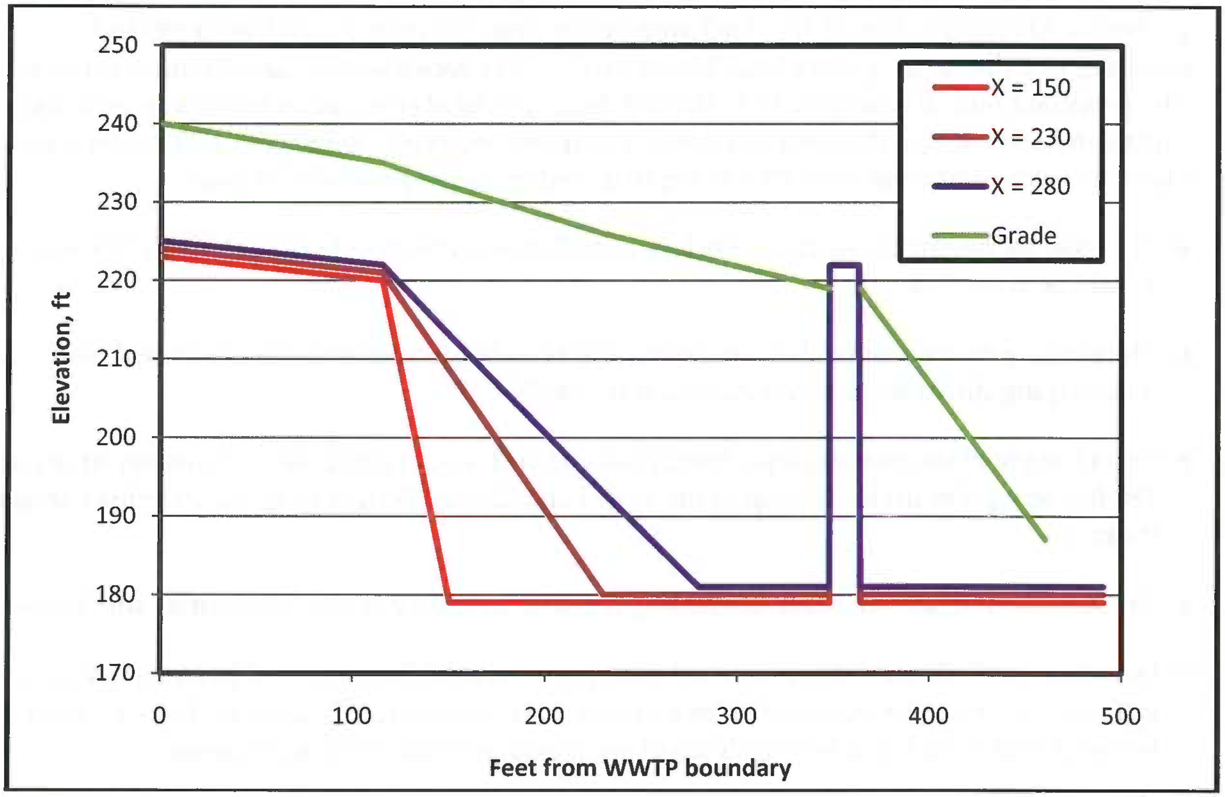

Figure 4
Pipe Invert Profiles for Various Values of Slope Toe Location X

Layout

Figure 4 provides a schematic of three configurations of the proposed alternative which would be buried beneath the shore grade and the revetted embankment (green line). All three layout configurations use the existing 84-inch secondary outfall line from the WWTP boundary at elevation 224 feet to a point 115 feet from the chlorine contact basin at elevation 221 feet (<115, 221>). All configurations slope downward to an invert elevation of 180 feet and continue horizontally at the invert elevation of 180 feet until intersecting a vertical vent pipe under the top of the bank at <350, 180>, then emerging through the river bank at <470, 180>, 500 feet from the chlorine contact basin.

The differences in these layouts are primarily in the slopes employed between the end of the existing 84-inch secondary outfall pipe at <115, 221> and the bottom of the slope at <X, 180>. A description of the differences among these layout options is provided below:

- **X = 150 ft (red line).** This provides the greatest distance, B, from the toe of the slope to the vent pipe (B = 200 ft), for adequate time for bubbles to rise to the top of the pipe and escape up the vent pipe even at the peak flow rate of 235 mgd. However, the slope of 50 degrees is the steepest, and the volume of excavation required would be the greatest, at about 7,000 cu yd.

- **X = 230 ft (dark red line).** This provides a B of 116 feet from the toe of the slope to the vent pipe, for adequate time for bubbles to rise to the top of the pipe and escape up the vent pipe at the permitted flow rate of 135 mgd. The slope would be 19 degrees, and the volume of excavation required would be slightly less than 6,000 cu yd.

- **X = 280 ft (violet line).** This provides the shortest distance, B, from the toe of the slope to the vent pipe (B = 70 ft), for adequate time for bubbles to rise to the top of the pipe and escape up the vent pipe, but is only designed at the current dry-weather flow rate of about 80 mgd. However, the slope of 14 degrees is the gentlest. The volume of excavation required would be the least, at just over 5,000 cu yd.

The excavation, bubble-rise distance, B, and slope quantities for these three alternatives are compared graphically in **Figure 5**.

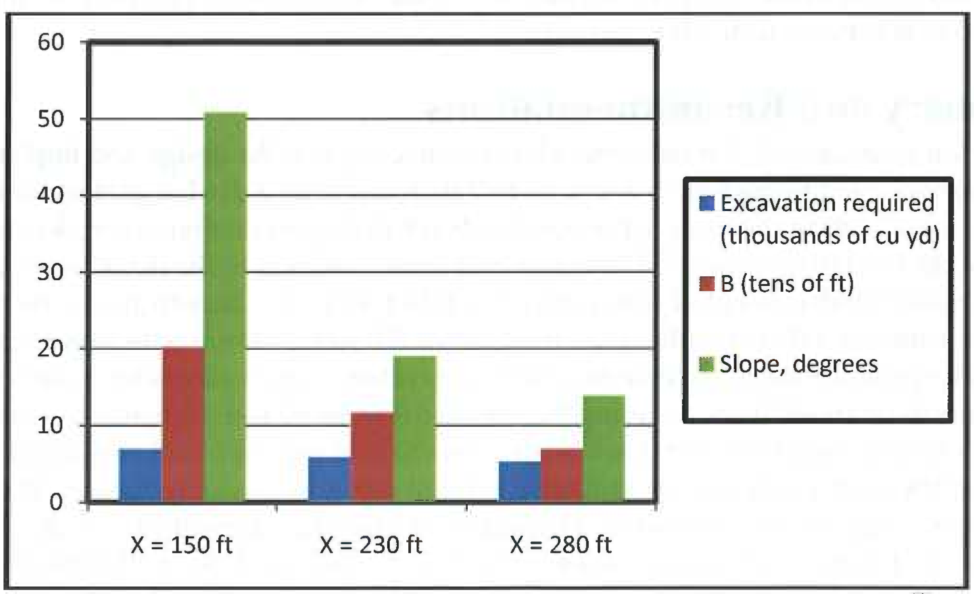

Figure 5
Comparative Effects of Various Values of Slope Toe Location, X

Among these alternatives, the required excavation varies a relatively small amount.

The B values are estimates of the distance required to let entrained air bubbles rise to the top of the pipe, and are conservative because:

- The bubble rise velocity, U, of 10 cm/sec applies to bubbles 1 mm in diameter, whereas most bubbles will be larger, with faster rise velocities.
- B was calculated assuming that all bubbles will need to rise throughout the entire pipe diameter, D, whereas the bubbles generated in the hydraulic jump on the slope will initially be distributed throughout the pipe cross-section.
- Except at very low river levels, the hydraulic jump causing bubble entrainment will occur some distance up the slope. Therefore, in addition to the horizontal distance, B, from the toe of the slope to the vent pipe, there will be a distance on the slope from the jump location to the toe of the slope for bubbles to rise toward the top of the pipe.

These points are somewhat offset by the fact that bubble rise will be slightly hindered by the turbulence of the flow in the pipe, tending to stir some of the rising bubbles downward.

All the slopes used in these three arrangements should engender less air entrainment than a vertical free-fall plunge, but in general, the gentler the slope the less air entrainment is to be expected. The arrangement in which X = 150 ft has a slope of 50 degrees, which is much greater than those of the other two layouts — 19 and 14 degrees, respectively — and may be expected to entrain considerably more air.

Summary and Recommendations

As previously discussed, the recommendation is to complete the design and implementation of Alternative 2 – construction of a new outfall structure with a discharge elevation of 180 feet. As noted, during the design, precise details regarding the configuration, location and sizing of the modified outfall will be made, and some variation to the details can be expected, however the overall concept of Alternative 2 will be followed. Discharging to the river at an invert elevation of 180 feet, rather than the present 190 feet, puts the outlet approximately 30 feet farther from the shoreline than the existing structure, which allows for greater mixing within the river. In addition, lowering the outfall depth by 10 feet decreases the fraction of time that the discharge conduit flows as an open-channel pipe opposed to being submerged by over 30 percent, providing an additional level of secondary foam reduction. The recommended layout for Alternative 2 includes a design that aligns the toe of the outfall slope at X = 230 feet from the chlorine contact basin. This provides a slope of 19 degrees, which is much gentler than that for the steepest layout option, still providing a bubble rise distance that is adequate for average flows of 135 mgd. These recommendations will allow for a significant reduction in foam formation in the outfall structure and the visible foam at the outfall into the Mississippi River.

Proposed Schedule

Based on the recommended alternative for improvements to the outfall structure and piping at the Stiles WWTP, the following proposed schedule is included for the implementation of the project from design through commissioning and startup. The total estimated time for a full operating system is anticipated to be 28 months. A schedule by major task is included for reference in **Figure 6**.

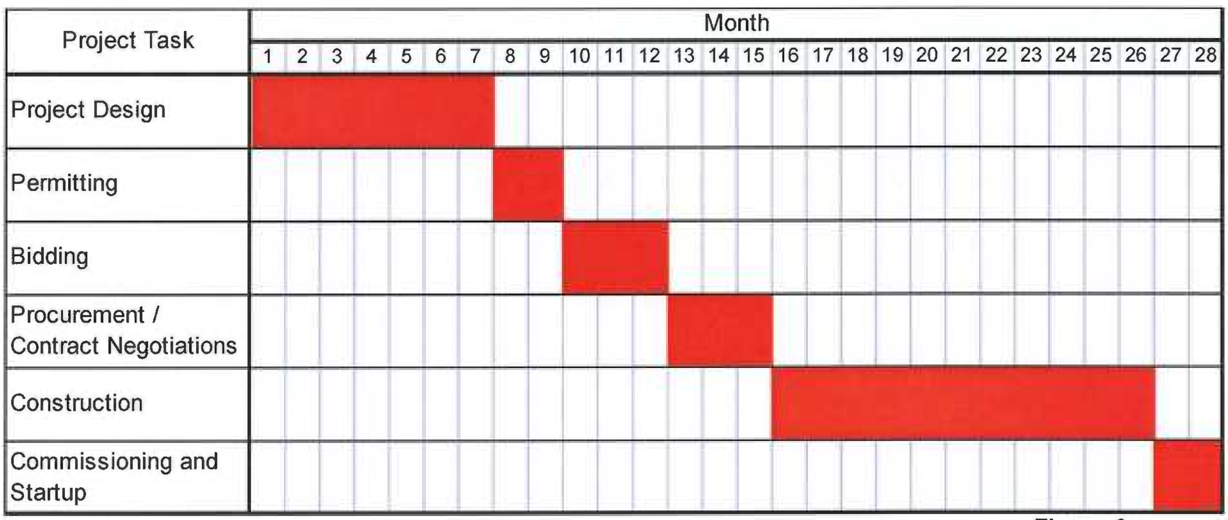

Figure 6
Outfall Improvements Implementation Proposed Schedule

References

Wu, M-M, and M. Gharib, "Experimental Studies on the Shape and Path of Small Air Bubbles Rising in Clean Water," J. Physics of Fluids vol 14 no. 7, July 2002.

Drawings G-72, "Primary and Secondary Outfall Pipes: Plan and Profile," and G-74, "Plant Effluent Line: Outfall Details," both by Ellers, Reeves, Fanning and Oakley, Inc./Consoer Townsend & Associates, August 1972.

APPENDIX A
INDUSTRIAL USER SURFACTANT SURVEY

Permit Number	Facility Name	Fac Street Address	Fac City	Fac Zip Code	Fac Phone Number	Interceptor	Facility Info_Notes	Product Name	Prod Chem Name	Product Family Name	Product Type or Class	Prod Manufacturer	Manufacturer Address	Manufacturer City	Manufacturer Zip Code	Manufacturer Phone	Product Info_Notes
N-FS3-102	Allied Graphics, Inc.	806 Walnut Street	Memphis	38106	901-774-5502	Front Street		V7310 Developer		Inorganic Salt		MacDermid	5210 Phillip Lee Drive, SW	Atlanta	30336	800-348-7201	
N-FS3-102	Allied Graphics, Inc.	806 Walnut Street	Memphis	38106	901-774-5502	Front Street		W6230 Defoamer	Proprietary Mixture	Inorganic/Organic Mixture		MacDermid	5210 Phillip Lee Drive, SW	Atlanta	30336	800-348-7201	
N-FS3-102	Allied Graphics, Inc.	806 Walnut Street	Memphis	38106	901-774-5502	Front Street		W6410-L	Proprietary Mixture	Organic Mixture		MacDermid	5210 Phillip Lee Drive, SW	Atlanta	30336	800-348-7201	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Accentuate II		Liquid Laundry Starch		Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Bannish II	000935	Liquid Antichlor		Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Detergent #27	000575	Liquid Laundry Detergent		Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Dober Base Oil		Liquid Solvent Based Laundry		Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Dober-Brite	000514			Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Fabristat		Disinfectant		Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS3-159	Ameripride Services, Inc.	800 Vance Avenue	Memphis	38126	901-647-3129	Front Street		Super Reduce	000927			Dober Chemical Corp	14461 South Waverly Ave	Midlothian, IL	60445	708-388-7700	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Ajax Quik Solv Spray Cleaner				Colgate-Palmolive Co.	191 East Hanover	Morristown, NJ	07960-3151	800-432-8226	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Alki-Foam	AKF1, AKF5, AKF55			Sporlan Division of	206 Lange Drive	Washington, MO	63090	636-239-1111	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Lemon Fresh Pine-Sol All-Purpose		Clear yellow liquid with citrus odor		Clorox Professional Products Co.	1221 Broadway	Oakland, CA	94612	510-271-7000	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Clean Air Purge III				Waterbury Companies,	PO Box 640	Independence, LA	70443		
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Oxy Power Multi-Purpose		Household Cleaning		S.C. Johnson & Son, Inc.		Racine, WI	53403-2236	800-725-6737	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Misty Bolex		Toilet Cleaner		Amrep, Inc.	990 Industrial Park	Marieta, GA	30062	770-422-2071	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		GOJO Natural Orange Pumice Hand		Hand Cleaner		GOJO Industries, Inc.	One GOJO Planza, Suite 500	Akron, OH	44311	330-255-6000	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Husky 702 No Rinse Damp Mop Cleaner				Canberra Corp	3610 Holland-Sylvania	Toledo, OH	43615	419-841-6616	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Husky 325 T/N/A Bowl and Bathroom Cleaner		Bathroom Cleaner		Canberra Corp	3610 Holland-Sylvania	Toledo, OH	43615	419-841-6616	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Husky 705 Extra Heavy-Duty Stripper		Wax Stripper		Canberra Corp	3610 Holland-Sylvania	Toledo, OH	43615	419-841-6616	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Husky 1020 Fast Drying High Gloss		Floor Wax		Canberra Corp	3610 Holland-Sylvania	Toledo, OH	43615	419-841-6616	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Oakite Chlor-Tergent	3480			Oakite Products Inc.	50 Valley Road	Berkeley Heights, NJ	07922	908-464-6900	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		BCA 5390 Terminator		Heavy Duty Finish		Water's Edge Technologies,	111-3 Edwards Road	Byhalis, MS	38611	662-838-4013	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Softsoap Liquid Hand		Hand Cleaner		Colgate-Palmolive	191 East Hanover	Morristown, NJ	07960-3151	800-432-8226	
N-FS2-114	Conwood Company, LLC	46 Keel Avenue	Memphis	38107	901-248-1806	Front Street		Orange Energy, Pine-		All Purpose Cleaner		Clorox Sales Company	1221 Broadway	Oakland, CA	94612	510-271-7000	
N-WS3-156	Onyx Medical Corporation	152 Collins Street	Memphis	38112	901-323-6699	Wolf River	Facility only reported that they use Simple Green	Simple Green									
N-FS1-145	Owen Corning	704 Corrine Avenue	Memphis	38107	901-575-2010	Front Street		533 Release Agent			Liquid Release Agent	Ridgeland Chemical, Inc.	P.O. Box 1087	La Grange Park, IL	60526	847-593-0468	

Permit Number	Facility Name	Fac Street Address	Fac City	Fac Zip Code	Fac Phone Number	Interceptor	Facility Info_Notes	Product Name	Prod Chem Name	Product Family Name	Product Type or Class	Prod Manufacturer	Manufacturer Address	Manufacturer City	Manufacturer Zip Code	Manufacturer Phone	Product Info_Notes
N-NW5-175	Penn A Kem, LLC	3324 Chelsea Avenue	Memphis	38108	901-320-4040	Wolf River		Link Lotion Liquid			Hand Soap	Stearns Packaging	4200 Sycamore	Madison, WI	53704-0216	608-246-5150	
N-NW5-175	Penn A Kem, LLC	3324 Chelsea Avenue	Memphis	38108	901-320-4040	Wolf River		SC-200		Janitorial		Spartan Chemical	1110 Spartan Drive	Maumee, OH	43537	800-537-8990	
N-WN3-188	Safety Quip, Inc.	4950 Getwell Road	Memphis	38118	901-452-7040	Wolf River	Facility reports that they mix 3 ounces of Rediform in 5 gallons of	Rediform	Formaldehyde Solution			Redi Chem of Texas	20905 Hwy 71, West	Spicewood, TX	78669	800-634-2540	
N-FS3-168	United Rubber Die Service, Inc.	P.O. Box 160	Memphis	38101	901-774-5973	Front Street	Facility reports that they mix approximately 1/2 gallon of W6410-L into 55 gallons of water every	W6410-L		Organic Mixture	Proprietary	MacDermid	5210 Phillip Lee Drive, SW	Atlanta, GA	30336	800-348-7201	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Foremost 2153-ES Wonder Cleaner				Delta Foremost Chemical	3915 Air Park Street	Memphis	38118	901-363-4340	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Ajax Oxygen Bleach				Colgate-Palmolive	191 East Hanover	Morristown, NJ	07960-3151	800-432-8226	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Bleach									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Blue Grass Cleaner									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Brillo Pads									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Cormatic/Ultima Hand Soap			Lotion/Cleanser	Georgia-Pacific Consumer	133 Peachtree Street, NE	Atlanta, GA	30303	866-435-5647	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Dial Soap		Mixture	Liquid Antimicrobial	The Dial Corporation	15101 North Scottsdale	Scottsdale, AZ	85254-9934	888-468-6673	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Foam Rug Cleaner									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Formula 505	0505		Alkaline Cleaner	Cello Professional	1354 Old Post Road	Havre de Grace, MD	21078	410-939-1234	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		GOJO Hand Cleaner									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Ivory Classical Bar	15157069			Procter & Gamble		Cincinnati, OH	45202	800-395-9960	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Jiffy Clean	5226		Disinfectant Aerosol	Cello Professional	1354 Old Post Road	Havre de Grace, MD	21078	410-939-1234	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Joy Detergent		Liquid Hand Dishwashing		Procter & Gamble	5299 Spring Grove	Cinncinnati, OH	45217-1087	800-436-1569	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Kutol Shower Shampoo									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Lava Soap									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Economy Pine APC	1174		Liquid Cleaning	Cello Professional	1354 Old Post Road	Havre de Grace, MD	21078	410-939-1234	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Shower Saver Soap									
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Switer Bolw Cleaner Disinfectant	1695		Acid Cleaner	Cello Professional Products	1354 Old Post Road	Havre de Grace, MD	21078	410-939-1234	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Soft Soap	1924	Liquid Soap Formulation	Mosturizing Hand Soap	Colgate-Palmolive	191 East Hanover	Morristown, NJ	07960-3151	800-432-8226	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Tide Laundry Detergent			Granulated Laundry	Proctor & Gamble	5299 Spring Grove Avenue	Cinncinnati, OH	45217-1087	800-436-1569	
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		X-14 Cleaner									

Permit Number	Facility Name	Fac Street Address	Fac City	Fac Zip Code	Fac Phone Number	Interceptor	Facility Info_Notes	Product Name	Prod Chem Name	Product Family Name	Product Type or Class	Prod Manufacturer	Manufacturer Address	Manufacturer City	Manufacturer Zip Code	Manufacturer Phone	Product Info_Notes
N-WS3-158	Velsicol Chemical, LLC	1199 Warford Street	Memphis	38108	901-324-4401	Wolf River		Window Cleaner			Cello 1104	Cello Professional Products,	1354 Old Post Road	Havre de Grace, MD	21078	410-939-1234	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Simple Green			Cleaner/Degreaser	Sunshine Makers, Inc.	15922 Pacific Coast Highway	Huntington Harbour, CA	92649	800-228-0709	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		VF-77T Liquid Compound	Proprietary Blend	Mixture	Tumbler Lubricant	Vibra Finish Company	8411 Seward Road	Hamilton, OH	45011	513-870-6300	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Phosphoric Acid			Part Cleaner	GE Analytical Instruments, Inc.	6060 Spine Road	Boulder, CO	80301	303-444-2009	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Amibrite-100 S.S. Brite Dip			Part Cleaner	Sur-Fin Chemical Corp.	1530 Spence Street	Los Angeles, CA	90023	213-262-8108	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		EPS 4000	Proprietary	Mineral Acid Mixture	Electropolish	Electro Polish Systems	5678 North Brown Deer Road	Brown Deer, WI	53223	414-357-8445	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Oaktite 90			Part Cleaner	Oaktite Products, Inc.	675 Central Avenue	New Providence, NJ	07974	800-526-4473	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Cleaner Catalogue No. 3-720			Part Cleaner	Miltex Instrument Co., Inc.	700 Hicksville Road	Bethpage, NY	11714	516-349-0001	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		CitriSurf 2210	STS-2210		Specialty Cleaner	Stellar Solutions, Inc.	4511 Prime Parkway	McHnery, IL	60050	847-854-2800	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Citrisurf 2250	STS-2250		Specialty Cleaner	Stellar Solutions, Inc.	4511 Prime Parkway	McHnery, IL	60050	847-854-2800	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Auto-Chlor A0150	A0150040		Laundry Detergent	Auto-Chlor System	746 Poplar Avenue	Memphis, TN	38105	800-477-3693	
N-WN5-143	Engineered Medical Systems, LLC	3325 Appling Road	Bartlett	38133	901-380-5552	Wolf River		Auto-Chlor MS0300009	4273815		Machine Rinse Aid Plus	Auto-Chlor System	746 Poplar Avenue	Memphis, TN	38105	800-477-3693	
N-WS4-180	Methodist Healthcare - Laundry Service Center	2655 Chelsea Avenue	Memphis	38108	901-323-2574	Wolf River	Facility is commercial laundry that uses laundry surfactants at a reported rate of 6 ounces per 100 pounds of soiled linen, with a water	Power Blast			Laundry Detergent	Gurther Industries, Inc.	15475 South LaSalle Street	South Holland, IL	60473	708-331-2550	
N-WS4-180	Methodist Healthcare - Laundry Service Center	2655 Chelsea Avenue	Memphis	38108	901-323-2574	Wolf River	Facility is commercial laundry that uses laundry surfactants at a reported rate of 6 ounces per 100 pounds of soiled linen, with a water	Power Jolt			Laundry Detergent Alkali	Gurther Industries, Inc.	15475 South LaSalle Street	South Holland, IL	60473	708-331-2550	

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N-WS4-180	Methodist Healthcare - Laundry Service Center	2655 Chelsea Avenue	Memphis	38108	901-323-2574	Wolf River	Facility is commercial laundry that uses laundry surfactants at a reported rate of 6 ounces per 100 pounds of soiled linen, with a water	NDT Conditioner			Water Conditioner	Gurther Industries, Inc.	15475 South LaSalle Street	South Holland, IL	60473	708-331-2550	
N-WS4-180	Methodist Healthcare - Laundry Service Center	2655 Chelsea Avenue	Memphis	38108	901-323-2574	Wolf River	Facility is commercial laundry that uses laundry surfactants at a reported rate of 6 ounces per 100 pounds of soiled linen, with a water	NDT Sour Plus			Liquid Laundry Sour	Gurther Industries, Inc.	15475 South LaSalle Street	South Holland, IL	60473	708-331-2550	
N-WS4-180	Methodist Healthcare - Laundry Service Center	2655 Chelsea Avenue	Memphis	38108	901-323-2574	Wolf River	Facility is commercial laundry that uses laundry surfactants at a reported rate of 6 ounces per 100 pounds of soiled linen, with a water	NDT Softener			NDT Softner	Gurther Industries, Inc.	15475 South LaSalle Street	South Holland, IL	60473	708-331-2550	
N-FS4-173	Happy Day Laundry and Cleaners	1649 Union Avenue	Memphis	38104	901-274-0246	Front Street	Facility did not submit MSDS, but only that	Tide Laundry Detergent									
N-WN5-172	Gyrus ENT, LLC	2925 Appling Road	Bartlett	38133	901-373-0219	Wolf River		Foam Clean Assure			Foaming Antibacterial	Triple S	2 Executive Park Drive	Billercia, MA	01862	800-323-2251	Ingredients were not listed
N-WN5-172	Gyrus ENT, LLC	2925 Appling Road	Bartlett	38133	901-373-0219	Wolf River		Pine-Sol		Clear Amber Liquid with		Clorox Professional	1221 Broadway	Oakland, CA	94612	510-271-7000	
N-WN5-172	Gyrus ENT, LLC	2925 Appling Road	Bartlett	38133	901-373-0219	Wolf River		AFBC Topmost			Disinfectant Cleaner	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-352-7278	
N-WN5-172	Gyrus ENT, LLC	2925 Appling Road	Bartlett	38133	901-373-0219	Wolf River		AF315			Neutral PH Disinfestant/Deoderant/Deter	Beico Corporation	1001 Brown Avenue	Toledo, OH	42507	419-241-2156	
N-WN5-172	Gyrus ENT, LLC	2925 Appling Road	Bartlett	38133	901-373-0219	Wolf River		Sinple Green All Purpose				Sunshine Makers, Inc.	15922 Pacific Coast Highway	Huntington Harbour, CA	92649	800-228-0709	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Floorstar Glaze Restorer 2			Floor Care	Servce Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38120	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	GOJO Green Certified Foam Hand Cleaner				GOJO Industries, Inc.	One GOJO Plaza, Suite 500	Akron, OH	44311	330-255-6000	No Ingredients listed
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	CEB74405 Premium Foam Soap				Corporate Express	1 Environmental Way	Broomfield, CO	80021	888-238-6329	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Odorgo Room Deodorant Pro				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38120	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Shine-Up Lemon	04441		Furniture Care	Johnson Diversey	2401 Bristol Circel	Oakville, Ontario	L6H 6P1	800-668-3131	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Floor Star Power Strip Finish			Floor Stripper	Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	

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N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Floor Star Premium 25 Finish				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for Floors				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for GPC				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for Oxidizing Cleaner				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for Restrooms				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	No ingredients listed.
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for Scrub & Shine			Polish	Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for Floor Finish Remover DS				Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Green for Floor Finish			Floor Finish	Service Master Clean	860 Ridge Lake Blvd.	Memphis, TN	38118	800-756-5656	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Sodium Hydroxide	50% NaOH		Process Chemical	Ideal Chemical	PO Box 18698	Memphis, TN	38181-0699	901-363-7720	
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Phosphoric Acid	75% H3PO4	Nutrient Grade	Process Chemical	ICL Performance Products, LP		Carondelet (St Louis), MO			
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Sodium Hypochlorite Solution	12.5% Sodium Hypochlorite		Process Chemical	Brenntag Mid-South, Inc.	1405 Highway 136 West	Henderson, KY	42420-0020	270-830-1200	Water Treatment Chemical
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	EliminеX	Chlorinated High Alkaline Liquid Cleaner		Foaming Drain Cleaner	Suma/Johnson Diversey	2401 Bristol Circle	Oakvile, Ontario	L6H 6P1	800-668-3131	Used in process area
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Roubaix			Liquid General Purpose Cleaner	JohnsonDiversey	2401 Bristol Circle	Oakvile, Ontario	L6H 6P1	800-668-3131	Used to clean Package Room
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Divosan			Non-Foaming Liquid Peroxyacetic	JohnsonDiversey	2401 Bristol Circle	Oakvile, Ontario	L6H 6P1	800-668-3131	Sanitizer used in process room
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	IO Pucks			Drain Cleaner and Deodorant	JohnsonDiversey	2401 Bristol Circle	Oakvile, Ontario	L6H 6P1	800-668-3131	Drain cleaner used in process room
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Diton B	Chlorinated Cleaner			JohnsonDiversey	3630 East Kemper Road	Cincinnati, OH	45241-2046		Used for Packaging Room Cleanup
N-WO1-140	American Yeast Corporation	2405 North Second Street	Memphis	38127	901-358-4788	Direct Discharge to Plant	Faciliy is located directly adjacent to	Divosan MH VT11			Disinfestant	JohnsonDiversey					Used for process cleanup
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		4027ES Smotthy Body				Delta Foremost	3915 Air Park Street	Memphis, TN	38118	901-363-4340	No ingredients lists
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		Boraxo Powdered Hand Soap	Mixture			The Dial Corporation	15101 North Scottsdale Road	Scottsdale, AR	85254-9934	888-468-6673	
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		Clean by Peroxy	0035		Janitorial	Spartan Chemical	110 Spartan Drive	Maumee, OH	43537	800-537-8990	Used for cleaning
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		NABC Non-Acid Disinfestant Bathroom			Janitorial	Spartan Chemical Campany, Inc.	110 Spartan Drive	Maumee, OH	43537	800-537-8990	

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N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		Pine-Sol			Cleaner	The Clorox Company	1221 Broadway	Oakland, CA	94612	510-271-7000	
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		Formost 1663 Ram Drain Opener				Delta Foremost Chemical	3915 Air Park Street	Memphis, TN	38118	901-363-4340	
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		Foremost 4038 ES Grit Blitz				Delta Foremost	3915 Air Park Street	Memphis, TN	38118	901-363-4340	No ingredients listed
N-WS1-119	Nex Air, LLC	1211 North McLean Blvd.	Memphis	38108	901-729-5550	Wolf River		Professional Lysol Brand Diinfectant Foam Cleaner			Aerosol Disifectant Cleaner	Reckitt Benckiser North America, Inc.	399 Interpace Parkway	Parsippany, NJ	07054-0225	703-527-3887	
N-WS4-104	Southern Cotton	2782 Chelsea Avenue	Memphis	38108	901-454-7315	Wolf River		EC Expo	Proprietary Mixture			Ideal Chemical and Supply	4025 Air Park Street	Memphis	38181-0698	901-363-7720	
N-WS4-104	Southern Cotton	2782 Chelsea Avenue	Memphis	38108	901-454-7315	Wolf River		Foamer A	Mixture			G.S. Robins and Company	126 Chouteau Avenue	St. Louis, MO	63102	314-621-5155	All ingredients are listed as
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Razor's Orange A-Peel				Razor Chemical Company, Inc.	1305 North Hills Blvd., #119	North Little Rock, AR	72114	501-771-2800	General Cleaning and Disinfection
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Citrus Breeze II				Razor Chemical	1305 North Hills Blvd., #119	North Little Rock, AR	72114	501-771-2800	General Cleaning and Disinfection
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		BioVex				Bio-Cide International, Inc.	2845 Broce Drive	Norman, OK	73072	800-323-1398	General Cleaning and Disinfection
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Eco-Star Detergent I				Ecolab, Inc.	370 North Wabash Street	St. Paul, MN	55102	800-553-8683	Laundry Service
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Eco-Star Destainer									Laundry Service
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Eco-Star Builder C NP				Ecolab, Inc. Textile Care Division	370 North Wabash Street	St. Paul, MN	55102	800-553-8683	Laundry Service
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Tri-Star So Fresh				Ecolab, Inc.	370 North Wabash Street	St. Paul, MN	55102	800-553-8683	Laundry Service
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Eco-Star Sour VII									Laundry Service
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Solid Powder			Solid High Caustic Warewash	Ecolab, Inc.	370 North Wabash Street	St. Paul, MN	55102	800-553-8683	Kitchen Dishwashing
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Lime-A-Way									Kitchen Dishwashing
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Jet Dry	Mixture of surfactants of 5%			Ecolab, Inc.	370 North Wabash Street	St. Paul, MN	55102	800-553-8683	Kitchen Dishwashing
N-FS2-153	Criminal Justice Center, Shelby County	201 Poplar Avenue	Memphis	38103	901-545-2422	Front Street		Clear Foaming Antimicrobial Soap			Hand Soap	Action Chemical		Memphis, TN	38101	901-522-8783	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Redi Steamy Concentrate			Extraction Cleaner	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-363-7278	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Liberate			Very Aggressive No-	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-363-7278	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		PDF Speedway	Aqueous Solution of Glycol Ethers		Cleaner						
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Best Impressions			Metal Interlocked	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-363-7278	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Glass Shine			Glass and Surface	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-363-7278	

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N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Fiber Pro Red and Brown Out			Tanin Treatment and	Betco Corporation	1001 Brown Avenue	Toledo, OH	43607	419-241-2156	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Sure Cure			Water Based Urethane	Betco Corporation	1001 Brown Avenue	Toledo, OH	43607	419-241-2156	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Refresh Gel Deodorant			Deodorant	Fresh Products	4010 South Avenue	Toledo, OH	43615	419-531-9741	No Ingredients listed
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Lavender Lotion Wash			Sanitizer	Triple S	2 Executive Park Drive	Billerca, MA	01862	800-323-2251	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Conquer			Liquid Bateria / Digester /	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-363-7278	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Clorox Hand Sanitizing Spray			Cleam Alcohol Solution with Fresh, Clean	The Clorox Company	1221 Broadway	Oakland, CA	94612	510-271-7000	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Hard as Nails			Hard Film Floor Finish	Betco Corporation	1001 Brown Avenue	Toledo, OH	43607	419-241-2156	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Dura Scrub			Liquid Cream Cleanser	Topmost Chemical	PO Box 18913	Memphis, TN	38118	901-363-7278	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Rest Stop			Acid Free RTU Disinfectant Restroom	Betco Corporation	1001 Brown Avenue	Toledo, OH	43607	419-241-2156	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Whallop			Cleaner	Drummond American	600 Coporate Woods	Vernon Hills, IL	60061	847-913-9313	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Magic Clean			Cleaner	Central Kentucky	129 Lee Oak Drive	Hodgenville, KY	42748		
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Enviro-Kleen Industrial Degreaser/Cleaner			Emulsified Detergent-Dispersant	Coastline, Inc.		Toledo, OH & Chicago, IL		800-553-3644	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Recon Plate Cleaner	Glycol Compound		Mild Detergent Wash	Rycoline Products, Inc.	5540 Northwest	Chicago, IL	60630	773-775-6755	
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		877 Plate Finisher			Plate Gum, for industrial use	Eastman Kodak	343 State Street	Rochester, NY	14650	800-242-2424	Used for plate gum
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Auto Wash 265		Detergent	Ultra Low VOC Blanket &	RBP Chemical Technology,					
N-FS2-137	Commercial Appeal, The	495 Union Avenue	Memphis	38103	901-529-2455	Front Street		Prosall Sterling			Stainless Steel Cleaner	Chase Products					
N-LS3-146	Runyon Industries	4300 Millington Road	Memphis	38127	901-353-4484	Loosahatchie River		Heavy Duty Degreaser		Alkaline	430	KO Manufacturing,	PO Box 3574	Springfield, MO	65808	417-866-8000	
N-LS3-146	Runyon Industries	4300 Millington Road	Memphis	38127	901-353-4484	Loosahatchie River		WT-Antifoam 41	Proprietary Mixture	Polydimethylsiloxane		Ideal Chemcial and Supply	4025 Air Park Street	Memphis, TN	38181	901-363-7720	
N-LS3-146	Runyon Industries	4300 Millington Road	Memphis	38127	901-353-4484	Loosahatchie River		Soft Soap									
N-LS3-146	Runyon Industries	4300 Millington Road	Memphis	38127	901-353-4484	Loosahatchie River		Pine-Sol									
N-LS3-146	Runyon Industries	4300 Millington Road	Memphis	38127	901-353-4484	Loosahatchie River		Cascade Dishwashing Powder									
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		MIT 1032		Proprietary Blend		Southwest Engineers	39478 Highway 190 East	Slidell, LA	70461	985-643-1117	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Procor 2032				Southwest Engineers					
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Chemex 3801 Aintiseptic Hnad Cleaner				Chemex, Inc.	1357 Hiestan Place	Memphis, TN	38104	901-272-2431	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Pathways Solid Drain Sanitizer			Sanitizer	Ecolab, Inc.	370 N. Wabasha Street	St. Paul, MN	55102	800-352-5326	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		J-11			100% Plant Extract	Biocatalyst Corp	Rt. 1, Box 336A	Campbellsburg, KY	40011	800-551-9545	

Permit Number	Facility Name	Fac Street Address	Fac City	Fac Zip Code	Fac Phone Number	Interceptor	Facility Info_Notes	Product Name	Prod Chem Name	Product Family Name	Product Type or Class	Prod Manufacturer	Manufacturer Address	Manufacturer City	Manufacturer Zip Code	Manufacturer Phone	Product Info_Notes
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		ZEP FS AMINE Z			Sanitizer, Disinfectant, Deodorizer	Zep, Inc.	1310 Seaboard Industrial Blvd.	Atlanta, GA	30318	877-428-9937	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Purity FG WO White Mineral Oil 15, 35, 90				Petro-Canada					
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Sodium Hypochlorite Sanitizer & Cleaner				Innophos	PO Box 8000 / 259 Prospect Plains Road	Cranbury, NJ	08512	609-495-2495	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Hot Stuff		Alkaline Detergent	Cleaning Compound	Power Cleaning Equipment,	2549 Lamar Avenue	Memphis	38114	901-743-7303	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		SANI-T-10 / 1210.4800			Janitorial	Spartan Chemical Company, Inc.	1110 Spartan Drive	Maumee, OH	43537	800-537-8990	
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Sparchlor Chlorinated Sanitizer /			Janitorial	Spartan Chemical Company, Inc.					
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		High Acid Cleaner FP			Janitorial	Spartan Chemical Company, Inc.					
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Caustic Cleaner FP / 3189			Janitorial	Spartan Chemical Company, Inc.					
N-WS3-120	Fineberg Packing Company		Memphis		901-458-2622	Wolf River		Chlorinated Degreaser			Janitorial	Spartan Chemical Company, Inc.					
N-FS2-171	Crothall Laundry	245 South Camilla	Memphis	38104	901-521-7140	Front Street		Mikro-Quat			Quaternary Detergent	Ecolab, Inc.					
N-FS2-171	Crothall Laundry	245 South Camilla	Memphis	38104	901-521-7140	Front Street		Kindet			Commercial Liquid Laundry	Ecolab, Inc.					
N-LN2-112	Osmose, Inc.	152 Collins Street	Millington	38053	901-357-1703	Loosahatchie River		Ancocide 4050 / 1t2z		Bromonated Cyanoacetami		Chem-Aqua, Inc.	PO Box 152170	Irving, TX	75015		
N-LN2-112	Osmose, Inc.	152 Collins Street	Millington	38053	901-357-1703	Loosahatchie River		Ancool 3190 / 46TZ		Phosphate and Polymer		Chem-Aqua					
N-LN2-112	Osmose, Inc.	152 Collins Street	Millington	38053	901-357-1703	Loosahatchie River		Mr. Clean			Liquid All-Purpose	Procter & Gamble, Inc.	PO Box 355, Station "A"	Toronto, Ontario	M5W I C5	800-465-2945	
N-LN2-112	Osmose, Inc.	152 Collins Street	Millington	38053	901-357-1703	Loosahatchie River		Softsoap Clear Liquid Hand Soap			Formulated Liquid Hand Soap	Colgate-Palmolive Company	300 Park Avenue	New York, NY	10022		
N-LN2-147	Lemm Services, Inc. - Memphis Transloading	1280 Big Orange Road, Suite 200	Cordova	38018	901-624-1325	Loosahatchie River		Clorox Regular Bleach				The Clorox Company	1221 Broadway	Oakland, CA	94612	510-271-7000	
N-LN2-147	Lemm Services, Inc. - Memphis Transloading	1280 Big Orange Road, Suite 200	Cordova	38018	901-624-1325	Loosahatchie River		Pine-Sol Brand Cleaner			Clear Amber Liquid with Characteristic Pine Odor	Uline	2200 South Lakeside Drive	Waukegan, IL	60085		
N-LN2-147	Lemm Services, Inc. - Memphis Transloading	1280 Big Orange Road, Suite 200	Cordova	38018	901-624-1325	Loosahatchie River		Tide Liquid Laundry Detergent				Proocter & Gamble	5299 Spring Grove Avenue	Cincinnati, OH	45217		

Appendix J

State Projects