AECOM
500 West Jefferson Street
Suite 1800
Louisville, KY 40202
aecom.com

Project name:
MSD Odor Control Master Plan

Project ref:
60644274

To:
Robin Burch
MSD Project Manager
4522 Algonquin Parkway
Louisville, KY 40211

From:
Alex Carciumaru
Brett Wagner
Jackson Allman

Reviewed by:
Amanda Foote
Janet Strickland
Maria DeLuca

Date:
December 13, 2022

Memo

Subject: Technical Memorandum #7A- Morris Forman Water Quality Treatment Center Current Odor Technologies Performance Evaluation

1. Introduction

1.1 Background

In response to receiving a Notice of Violation (NOV) in November 2019 for failure to control odors from the Morris Forman Water Quality Treatment Center (WQTC, Plant) and its collection system, MSD entered into an agreed order with the Louisville Metro Air Pollution Control District (APCD) to develop and implement a phased District-wide Odor Control Master Plan. MSD has contracted AECOM to provide MSD with professional engineering services for the development of Phase I of the Odor Control Master Plan (Odor Control Master Plan), which is focused on the Morris Forman Service Area. MSD also contracted with a public relations firm to increase public engagement and communications during development and implementation of the phased Odor Control Master Plan.

The Morris Forman WQTC, constructed and commissioned in 1958, is currently the largest wastewater treatment plant in the state of Kentucky. Located in the western region of Louisville along the Ohio River, the plant is responsible for treating 120 MGD of dry weather flow and a peak capacity of 350 MGD during wet weather flow conditions.

Despite recent efforts by MSD to reduce odor emissions generated from the Morris Forman WQTC through development and phased implementation of the 2001 Morris Forman Odor Control Master Plan and 2009 follow-up report, the neighboring community has experienced odors leading to a

significant number of complaints, specifically during the summer of 2019. Primary affected residents were in the Chickasaw, California, and Park DuValle neighborhoods.

1.2 Purpose

During the previous phases of the Odor Control Master Plan, AECOM compiled and examined the existing odor control reports and data pertaining to the Morris Forman Water Quality Treatment Center. This memorandum is intended to review historical sampling data and new data collected during the 2020, 2021, and 2022 sampling campaigns to evaluate the performance of odor control systems and technologies within the Morris Forman Water Quality Treatment Center. The main objectives of this report are to:

- Summarize the effectiveness of the following odor control technologies:
    - Biotower Odor Control (BOC)
    - Solids Handling Odor Control (SHOC)
    - Regenerative Thermal Oxidizers (RTOs)
    - Main Equipment Building (MEB) Fugitive Dust Wet Scrubbers
    - MEB Silo Dust Wet Scrubber
- Determine if additional odor control technologies and systems are required within the WQTC
- Incorporate findings from this TM#7A, Morris Forman Water Quality Treatment Center Current Odor Control Technologies Performance Evaluation, into TM#8, New Odor Control Technologies Performance Evaluation, and TM#9, Odor Control Conceptual Design

1.3 Previous Documentation and Implementation Schedule

In accordance with the agreed order, MSD has submitted several documents to APCD to demonstrate ongoing odor control efforts. Table 1 shows MSD's completed and ongoing efforts towards the APCD agreed order.

Table 1: Phase I Master Plan Implementation Schedule

Title		Due Date	Status
TM#1	Morris Forman WQTC Background Document Review	Q1 2021	Completed
TM#2	Collection System Background Document Review	Q2 2021	Completed
TM#3	Pump Stations Background Document Review	Q2 2021	Completed
TM#4	WQTC, Pump Stations and Combined Sewer System Planned Process Modifications	Q1 2021	Completed
TM#5	Current WQTC, Pumping Stations, and Combined Sewer System Odor Impact Evaluation	Q2 2021	Completed
TM#6A, TM#6B, TM#6C	Morris Forman WQTC (TM#6A), Collection System (TM#6B), and Pump Stations (TM#6C) Sampling Phase Results Analysis	Q4 2022	Completed

TM#7A, TM#7B, TM#7C	Morris Forman WQTC Current Odor Technologies Performance Evaluation; Collection System Current Odor Technologies Performance Evaluation; Pump Stations Current Odor Technologies Performance Evaluation	Q4 2022	Completed
TM#8	**New Odor Control Technologies Recommendation**	**Q4 2022**	**Ongoing**
TM#9	**Odor Control Conceptual Design**	**Q4 2022**	**Ongoing**
Odor Control Master Plan Phase I Final Report		**Q4 2022**	**Ongoing***

**- The Final Odor Control Master Plan Phase I Final Report will be a comprehensive document which includes information about the Morris Forman Collection System, WQTC, and selected pump stations.*

Please refer to TM#1, TM#5, and TM#6A for details relating to the data review, odor impact evaluation, and sampling results prior to the development of this report.

2. Design and Operational Performance Review

2.1 Odor Control System Review

Prior to the development of this report, a detailed review of existing documentation was performed in relation to odor control within the Morris Forman WQTC. Background documentation included previous studies, reports, and field sampling data to gain an understanding of MSD's odor control efforts to date and to investigate current odor conditions in specific areas of the WQTC. Key findings from the background documentation review process for the Morris Forman WQTC can be found in TM#1.

The WQTC is currently equipped with several odor control technologies for the treatment of air generated from various process areas. A summary of the existing odor control technologies is shown in Table 2 which includes the manufacturer, model, number of units, installation year, and associated odor sources.

Table 2: Existing Odor Control Technologies Summary

Odor Control System	Manufacturer/Model	# of Units	Year Installed	Associated Odor Source(s)
(1) BOC	Bioway Purspring 1000	(2)	2007	Aerated Influent Channel
(2) SHOC	Biorem Biofiltair	(2)	2006; Rebuilt in 2011	MEB Dewatering Area[1], Sludge Holding Tanks
(3) RTOs[2]	Gulf Coast Environmental Systems 100-95-RTO	(2)	2022	MEB Dewatering Area, MEB Sludge Drying Area[1]

(4) MEB Acid Scrubbers[2]	Andritz TOP-85 DT-CB/SUMP-VT520'2 OT-DB-SS	(2)	2022	MEB Dewatering Area, MEB Sludge Drying Area[1]
(5) MEB Fugitive Dust Wet Scrubbers[2]	Monroe Environmental DT-3000-SS	(2)	2022	MEB Sludge Drying Area Fugitive Dust
(6) MEB Silo Wet Dust Scrubber[2]	Monroe Environmental DT-1000	(1)	2022	MEB Storage Silos Fugitive Dust

[1]The MEB Dewatering Area and MEB Sludge Drying Area process sludge from the digesters as well as hauled sludge.

[2]The Emergency Dryer Replacement Project was recently completed with the installation of new RTOs, MEB Acid Scrubbers, MEB Fugitive Dust Wet Scrubbers, and MEB Silo Dust Wet Scrubber.

Equipment specifications and reports were evaluated to identify key design parameters for each of the odor technologies which are summarized in Table 3. The project team also compiled previous performance testing results and expected performance parameters to assess the current operational performance. The results from previous sampling events and the most recent sampling in 2020, 2021, and 2022 at the Morris Forman WQTC were used to evaluate the systems performance in the subsequent sections.

Table 3: Existing Odor Control System Design Summary

Odor Control System	Inlet Conditions: Peak Capacity (cfm)	Inlet Conditions: Average/ Peak H_2S Conc. (ppmv)	Inlet Conditions: Average/ Peak Odor Conc. (D/T)	Expected Performance
(1) BOC	20,000	60 / 150	N/A	99% H_2S Reduction or less than 0.1 ppmv outlet concentrations when inlet levels are less than 150 ppmv
(2) SHOC	9,200	150 / 200	< 6,000 / 15,000	99% H_2S Reduction; 80% TRS Reduction
(3) RTOs	10,000	0.359 (average)	1,024,922	99% Removal Efficiency or less than 10 ppmv outlet concentrations
(4) MEB Acid Scrubbers #1	3,000	N/A[1]	N/A[1]	N/A
(5) MEB Acid Scrubbers #2	3,000	N/A[1]	N/A[1]	N/A
(6) MEB Fugitive Dust Wet Scrubbers #1[1]	6,000	N/A[1]	N/A[1]	95% Removal Efficiency
(7) MEB Fugitive Dust Wet Scrubbers #2[1]	6,000	N/A[1]	N/A[1]	95% Removal Efficiency
(8) MEB Silo Dust Wet Scrubber[1]	1,000	N/A[1]	N/A[1]	99.9% Removal of dust 2.0 microns or larger

[1]The data is not available because the inlet sampling was not possible.

N/A= Data not available from previous reports and manufacturer specifications.

2.2 BOC Performance Evaluation

MSD conducted performance testing of the BOC system in 2008. The study focused on H_2S and odor removal efficiency, and the performance data results are summarized in Table 4. The 2008 performance testing results showed that average H_2S removal efficiency was approximately 99% between the two BOC units which met the manufacturer expected performance.

As part of the odor control master plan evaluation, odor reduction was also evaluated for impact on the overall MFWQTC system. The odor reduction was generally poor with average odor reduction of 47%. However, the unit is not designed to have a specific target for odor removal. Outlet odor emissions were likely impacted by other non-sulfurous odor compounds, but amines, aldehydes, and VOCs were not sampled during the 2008 performance tests.

Table 4: BOC Performance Data Summary, 2008

	H_2S Concentration (ppb)	Odor Concentration (D/T)
Location	% Reduction	% Reduction
BOC Unit #1	99%	65%
BOC Unit #2	99%	28%
Average:	**99%**	**47%**

NOTE: Only data from sampling day #2 is shown in this table due to an operational error on day #1.

MSD is actively working towards the rehabilitation of the existing BOCs odor control system under the Rehabilitation and Replacement of Primary Sedimentation Basins Project. The proposed process airflow for the new system is estimated at 16,500 cfm. Performance testing will be performed following installation of the new system to confirm the system is meeting design expectations.

2.3 SHOC Performance Evaluation

MSD has conducted several performance tests at the SHOC since the system was commissioned in 2006 and then rebuilt in 2011. The following sampling data was evaluated:

1. Phase 1 Sampling (original construction)
    a. Odor Sampling, July 2008
    b. Reduced Sulphur Compounds (RSC) and H_2S Sampling, September 2008
2. Phase 2 (After re-build)
    a. RSC and H_2S Sampling, November 2012
    b. RSC and H_2S Sampling, April 2013

Table 5 summarizes the results of the SHOC sampling data listed above, including observed outlet RSC concentrations and associated percent (%) reduction at the SHOC units. The Total Reduced Sulfur (TRS) concentration represents the sum of Methyl Mercaptan (MM), Dimethyl Sulfide (DMS), and Dimethyl Disulfide (DMDS).

Table 5: SHOC TRS Performance Data Summary

	Percent Reduction				
	H_2S	MM	DMS	DMDS	TRS
September 2008 (Original SHOC construction)					
SHOC Unit #1	99.9%	99.0%	52.8%	96.1%	93.1%
SHOC Unit #2	99.9%	98.6%	57.4%	84.7%	93.0%
November 2012 (After re-build)					
SHOC Unit #1	99.9%	92.3%	39.7%	63.9%	91.1%
SHOC Unit #2	99.9%	96.9%	41.4%	87.8%	95.9%
April 2013 (After re-build)					
SHOC Unit #1	99.8%	88.4%	86.3%	95.0%	88.9%
SHOC Unit #2	99.8%	99.4%	88.9%	97.0%	95.9%

NOTE:
-H_2S=Hydrogen Sulfide
-MM= Methyl Mercaptan
-DMS= Dimethyl Sulfide
-DMDS= Dimethyl Disulfide
-TRS=Total Reduced Sulfur; Sum of MM, DMDS, and DMS.

Available sampling data shows that the originally constructed SHOC units both met the expected performance target for H_2S percent reduction of 99%, but they had had exceptionally high TRS outlet concentrations. After being rebuilt, they still exceeded the expected performance level of 99% H_2S reduction, 80% TRS reduction. A summary of the observed H_2S and TRS percent reductions versus the expected performance levels provided by the equipment manufacturer is shown in Table 6. Odor was also sampled at the SHOC system in July 2008, but it was not re-sampled after the rebuild. These odor results are likely not representative of the performance after the rebuild and are not shown for clarity.

Table 6: SHOC Observed vs. Target H_2S and TRS % Reduction after Rebuild

	H_2S % Reduction		TRS % Reduction	
Location	Observed	Target	Observed	Target
SHOC Unit #1	99.9%	99%	91.1%-95.9%	80%
SHOC Unit #2	99.9%	99%	88.9%-95.9%	80%

*-Percent removal targets are based on manufacturer performance data for expected performance.

Based on the findings of previous performance data evaluation, the following conclusions were made regarding the existing SHOC system:

- SHOC Unit #2 has shown better operating performance than SHOC Unit #1 in terms of RSC removal.
- 99% H_2S reduction target was met during each performance test for both SHOC units.

- 80% TRS reduction target was met for all performance tests.

2.4 MEB Odor Control Systems Performance Evaluation

The RTOs, MEB Acid Scrubbers, MEB Fugitive Dust Wet Scrubbers, and MEB Silo Dust Wet Scrubber were installed and commissioned as part of the Emergency Dryer Replacement Project for the MEB. Vapor sampling was conducted in Summer 2022 as a part of the Odor Control Master Plan at the following locations:

- RTO #1 Inlet
- RTO #1 Outlet
- RTO #2 Inlet
- RTO #2 Outlet
- Fugitive Dust Wet Scrubber #1 Outlet
- Fugitive Dust Wet Scrubber #2 Outlet
- Silo Dust Wet Scrubber Outlet
- MEB Exhaust

The preliminary results for key odor compounds in the RTOs are summarized in Table 7. Sampling data shows that both RTOs demonstrated significant odor reduction with RTO #1 reducing the odor D/T by 99% and RTO #2 by 98%. However, the outlet odor values were still high. For odor to not be detected in the community, the odor concentration must be below a target threshold of 20 D/T along the WQTC fence line. The Odor Control Master Plan will evaluate if the odor threshold from the RTOs is exceeded.

Interestingly, the measured concentrations of odor causing compounds appeared to increase after RTO treatment. As a result, methyl mercaptan and dimethyl disulfide concentrations were higher than their respective reference concentrations reported in TM#6A for both units. These workplace and environmental references were used to identify elevated concentrations of odorous compounds and were used as a reference for comparison only. RTO #1 also exceeded the concentration reference for ammonia. The percent reductions for these compounds were therefore reported as 0% since the concentrations increased from the inlet to the outlet.

RTO #1 and #2 had similar flow rates which differed by 200 cfm on average. RTO #1 generally performed better than RTO #2 for all measured parameters except for ammonia which was 10 times more concentrated in RTO #1 than in RTO #2. The large variance in ammonia concentrations suggests that additional performance evaluation for the RTOs may be required.

The following conclusions were made for the RTO system based on the preliminary sampling:

- RTO #1 performed better than RTO #2 for all measured parameters except for ammonia.
- Both RTOs showed an odor D/T reduction of at least 98%.
- Both RTOs had elevated methyl mercaptan and dimethyl disulfide concentrations, and RTO #1 also had an elevated ammonia concentration, when compared to guidance limits.

- Percent reductions of odor compounds were reported as 0% because their concentrations increased from the inlet to the outlet.

Table 7: RTO #1 and RTO #2 Preliminary % Reduction

	RTO #1	RTO #2
Sampling Parameter	% Reduction (Avg)	% Reduction (Avg)
Flow Rate (cfm)	N/A	N/A
Odor (D/T)	99%	98%
Hydrogen Sulfide (ppmv)	0%	0%
Methyl Mercaptan (ppmv)	0%	0%
Dimethyl sulfide (ppmv)	0%	0%
Dimethyl disulfide (ppmv)	0%	0%
Trimethylamine (ppmv)	0%	0%
Ammonia (ppmv)	0%	0%

NOTE:
The % reduction for hydrogen sulfide, methyl mercaptan, dimethyl sulfide, dimethyl disulfide, trimethylamine, and ammonia is 0% to signify an increase in their concentrations from the inlet to the outlet of the RTOs.

Percent reductions of odor compounds were not able to be calculated for the Silo Dust Wet Scrubber, Fugitive Dust Wet Scrubber, and MEB Exhaust sampling locations because inlet sampling was not possible.

Air dispersion modeling will be used to determine if the odor from the Silo Dust Wet Scrubber, Fugitive Dust Wet Scrubber, and MEB Exhaust exceed 20 D/T at critical odor receptors along the WQTC fence line. Results of this evaluation will be provided in the Odor Control Master Plan.

Multiple odor compounds also exceeded their reference concentrations. Methyl mercaptan was elevated at the Silo Dust Wet Scrubber Outlet and Fugitive Dust Wet Scrubber Outlets. Dimethyl sulfide concentrations were elevated at both Fugitive Dust Wet Scrubber Outlets. Ammonia also exceeded its reference concentration at the Fugitive Dust Wet Scrubber Outlet #1 under average concentrations and at the Silo Dust Wet Scrubber Outlet under peak concentrations.

Performance between the Fugitive Dust Wet Scrubber Outlets was varied. Outlet #2 had a larger peak and average flow rate than Outlet #1. Outlet #2 had a larger odor D/T value and trimethylamine concentration, and outlet #1 had larger hydrogen sulfide, methyl mercaptan, dimethyl sulfide, dimethyl disulfide, and ammonia concentrations. The ammonia concentration in Outlet #1 was 10 times more concentrated than in Outlet #2.

The following conclusions were made for the Silo Dust Wet Scrubber, Fugitive Dust Wet Scrubber, and MEB Exhaust based on the preliminary sampling:

- Fugitive Dust Wet Scrubber Outlet #2 performed better than Outlet #1 for all measured parameters except for odor and trimethylamine.

Methyl mercaptan concentrations were high at the Silo Dust Wet Scrubber Outlet and Fugitive Dust Wet Scrubber Outlets. Dimethyl sulfide concentrations were high at both Fugitive Dust Wet Scrubber Outlets. Ammonia was also elevated at the Fugitive Dust Wet Scrubber Outlet #1 under average concentrations and at the Silo Dust Wet Scrubber Outlet under peak concentrations.

3. Conclusions and Recommendations

3.1 Conclusions

Available performance data was compiled and evaluated for each existing odor control system at the WQTC. Table 8 summarizes available performance data from previous reports including average H_2S, odor and TRS removal efficiency for each existing odor control system. A performance rating was included to indicate whether each performance efficiency target was met.

Performance data showed that the BOC and SHOC systems met manufacturer performance targets in terms of H_2S removal. Both systems had relatively high outlet odor concentrations measured at the source, but air dispersion modeling will be performed to determine if these systems exceed 20 D/T at the Morris Forman WQTC fence line. The RTOs met the odor removal target in Unit 1, and Unit 2 missed the target by 1%. The 10 ppmv max outlet concentration was also met for all compounds except for ammonia in Unit 1. Percent removal could not be calculated for the Silo Dust Wet Scrubber, but average concentrations were elevated for odor, methyl mercaptan, and ammonia (peak). Percent removal could also not be calculated for the Fugitive Dust Wet Scrubber, but concentrations were elevated for odor, methyl mercaptan, and dimethyl disulfide for both units.

The most recent odor results will be used in the air dispersion model to determine the odor impact at and beyond the Morris Forman WQTC fence line. Following model completion, recommendation for future odor control improvements will be provided in the Odor Control Master Plan.

Table 8: Current Odor Technologies Performance Evaluation Summary

Odor Control System	Odor Conc. % Reduction	H_2S Conc. % Reduction	TRS Conc. % Reduction	Performance Rating(s)
(1) BOC	Unit 1: 65% Unit 2: 28%	Unit 1: 99.4% Unit 2: 99.5%	N/A	• Odor Removal: Poor • H_2S Removal: Meets target removal efficiency (99% reduction)
(2) SHOC	N/A	Unit 1: 99.8-99.9%[3] Unit 2: 99.8-99.9%[3]	Unit 1: 88.9-91.1%[3] Unit 2: 95.9%[3]	• H_2S Removal: Meets target removal efficiency (99% reduction) • TRS Removal: Meets target removal efficiency (80%)
(3) RTO	Unit 1: 99% Unit 2: 98%	Unit 1: 0%[1] Unit 2: 0%[1]	Unit 1: 0%[1] Unit 2: 0%[1]	• Odor Removal: Met target for Unit 1 but not for Unit 2 (99% reduction) • 10 ppmv max outlet concentration: Met target for all compounds except for ammonia in Unit 1
(4) Silo Dust Wet Scrubber	N/A[2]	N/A[2]	N/A[2]	• Elevated odor, methyl mercaptan, and ammonia (peak) concentrations.
(5) Fugitive Dust Wet Scrubber	N/A[2]	N/A[2]	N/A[2]	• Elevated odor, methyl mercaptan, and dimethyl disulfide concentrations for both units. Ammonia concentration high for Unit 1.

NOTE:

[1] 0 % reduction was used to show that the outlet concentration was greater than the inlet concentration

[2]The data is not available because the inlet sampling was not possible

[3]Only data after the SHOC 2012 rebuild is presented.

3.2 Recommendations

The following action items are proposed to improve the odor removal efficiency of the existing units:

- Evaluate options for upgrading the current SHOC and BOC odor control technologies, if determined necessary.
- Evaluate options for the BOC system under the Primary Sedimentation Basin Rehabilitation project.
- Predict community impact from the odor process sources by using air dispersion modelling and assess whether MSD's target odor concentration of 20 D/T at the fence line is exceeded.