Four Corners Water & Sewer District
Odor Study - FINAL Report

October 2022

Prepared for:

Four Corners Water & Sewer District

Prepared by:

Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd, Suite E
Louisville, KY 40223
(502) 253-3443

Four Corners Water & Sewer District
Odor Study - FINAL Report

Table of Contents

Four Corners Water & Sewer District
Odor Study - FINAL Report

Table of Contents (Continued)

Index of Tables

Index of Figures

Appendices

Four Corners Water & Sewer District
Odor Study – FINAL Report

1.0 Introduction

1.1 Background

The Four Corners Water & Sewer District (FCWSD) of Four Corners, MT in Gallatin County has recently designed and put into service a new Water Reclamation Facility (WRF). As part of the implementation of this new WRF, the FCWSD told neighbors that odors from the facility would be minimal. To achieve that, the WRF designers selected biofilter technology to treat air from the Influent Pump Station (IPS) and from the main processes, including the headworks, dewatering building and aerobic digesters. Unfortunately, the existing odor control systems are not mitigating the odors and the FCWSD has been receiving odor complaints.

The FCWSD takes their odor control responsibilities very seriously and want to be good neighbors. Because of this, the FCWSD did their research and got in contact with Webster Environmental Associates (WEA). After discussing the odor problems at the WRF, WEA was retained to perform an Odor Study at the WRF. The work was initiated in May of 2022.

1.2 Objectives

The primary objectives of this odor evaluation are to:

- Characterize the odors in terms of odor detection threshold (DT), H_2S and reduced sulfur compound (RSC) concentrations
- Use the odor data to conduct odor dispersion modeling to determine the WRFs odor footprint within the surrounding community
- Evaluate the condition and the performance of the existing odor control systems
- Gather enough data to develop design criteria for odor control improvements
- Make recommendations for odor control improvements to reduce odors from the WRF

1.3 Four Corners WRF Description

The Four Corners WRF became operational in December 2020. The new facility was designed and put online to provide much-needed capacity to treat wastewater generated by homes and businesses in the growing Four Corners area. As part of the FCWSD long-term plan for handling growth, the new WRF was designed so that it can be incrementally expanded in phases as growth occurs. Major treatment processes include:

- Headworks facility with screening
- Sequencing batch reactors
- Grit removal and dewatering
- Aerobic digestion

Figure 1 shows an aerial of the WRF.

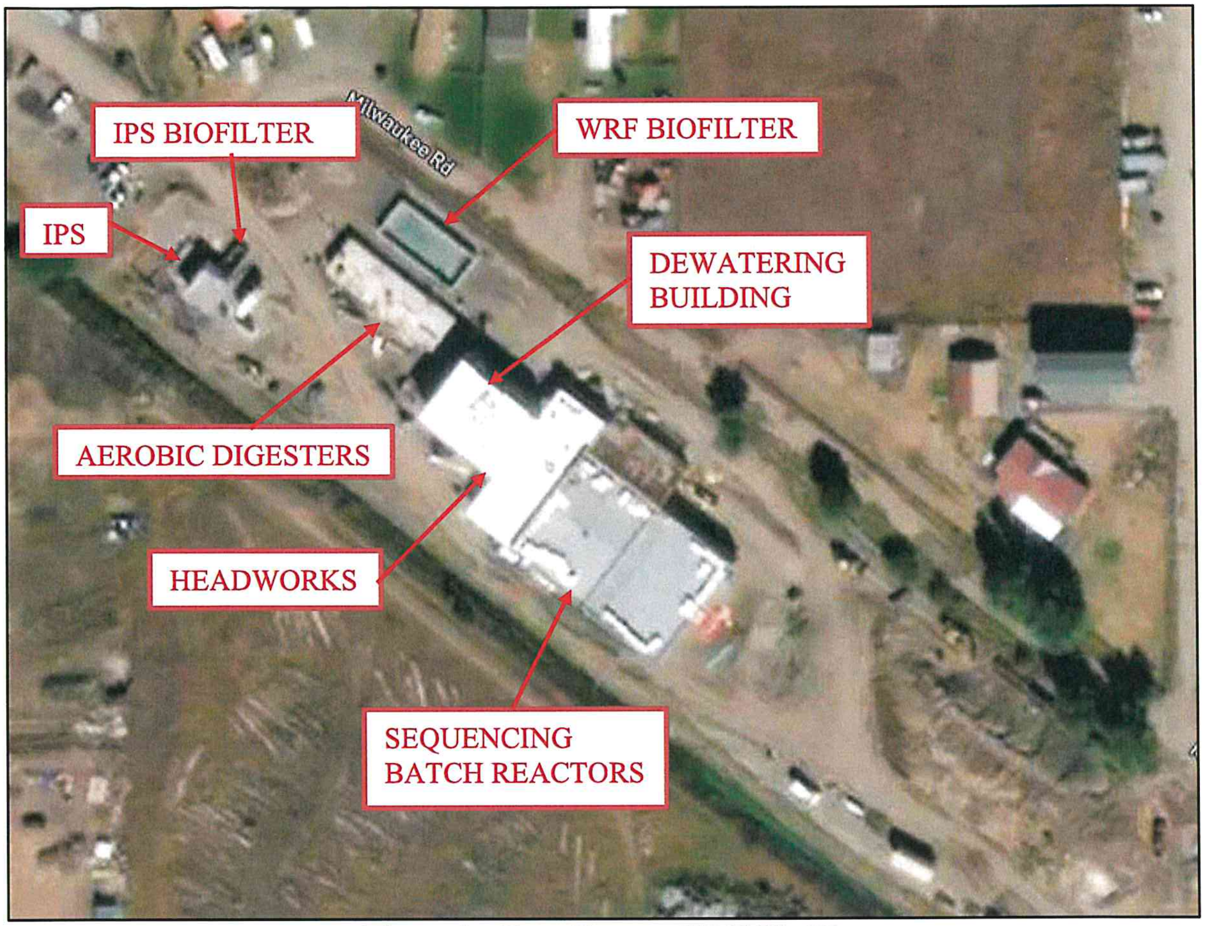


Figure 1 – Four Corners WRF Site Plan

2.0 Odor Generation and Characterization of Odors

2.1 Odor Generation

Odor-producing substances found in domestic wastewater and sludge are small, relatively volatile molecules with a molecular weight of 30 to 150 pounds (lbs) per pound mole. Most of these substances result from the anaerobic decomposition of organic matter containing sulfur and nitrogen. Inorganic gases produced from domestic wastewater decomposition commonly include hydrogen sulfide (H_2S), methyl mercaptan, dimethyl sulfide and other reduced sulfur compounds.

H_2S is the most commonly known and prevalent odorous gas associated with domestic wastewater collection and treatment systems. It is a colorless gas that is heavier than air, has a characteristic rotten egg odor, and is directly corrosive to metals and indirectly corrosive to concrete. H_2S can be oxidized to sulfuric acid, which causes corrosion of concrete, metals and other materials.

Many of the odors detected in wastewater collection and treatment systems result from the presence of sulfur-bearing compounds. A list of the most common malodorous sulfur-bearing compounds is shown in **Table 1**.

The lower the molecular weight of a compound, the higher the volatility and potential for emission to the atmosphere. Substances of high molecular weight are usually not perceptibly odorous and are neither volatile nor soluble. It should be noted that organic chemicals of industrial origin, particularly solvents, are highly volatile as well as odorous and may contribute to overall odor emissions. The presence of turbulent or splashing conditions, such as overflow weirs in grit chambers and primary clarifiers increase the release of volatile odorous molecules. On the other hand, if the wastewater is aerobic and such odorous compounds are not present, such turbulence is beneficial because it promotes reaeration and the addition of dissolved oxygen, and thus prevents formation of odorous compounds associated with anaerobic conditions.

TABLE 1 -ODOROUS SULFUR COMPOUNDS IN WASTEWATER

Compound	Formula	Characteristic Odor	Odor Threshold (ppb)
Hydrogen Sulfide	H_2S	Rotten eggs	0.4
Methyl Mercaptan	CH_3SH	Decayed-cabbage	0.01
Dimethyl Sulfide	CH_3-S-CH_3	Decayed-vegetables	1
Dimethyl Disulfide	CH_3-S-CH_3-S	Decayed-vegetables	2
Dimethyl Trisulfide	$C_2H_6S_3$	Pungent, sulfur-like	0.01
Carbon Disulfide	CS_2	Chloroform	10
Carbonyl Sulfide	COS	Unpleasant, sulfur-like	55

Odor Threshold – lowest concentration at which compound may be detected by a person with an average to above average sense of smell.
ppb – parts per billion
Reference: Design Manual: Odor and Corrosion Control in Sanitary Sewer Systems and Treatment Plants, USEPA/625/1-85/018, October 1985

Perceived odors are often complex mixtures of odorous compounds acting together to create "an odor" which may have characteristics significantly different from each of the individual components which is why odor panel testing is usually performed. Odor panel testing takes this blending of odorous compounds into account and provides the strength and dilute-ability of the odor.

2.2 Odor Panel Procedures

Odor panels involve human panelists who participate in a series of scientifically controlled sensory tests.

Common sensory properties used to characterize odors are:

- Odor detectability reported as Detection Threshold (DT)
- Odor recognition reported as Recognition Threshold (RT)

DT values are used as inputs to the odor dispersion modeling, as discussed later in this report.

A five to six-member odor panel consists of trained personnel who are scientifically screened to determine their smelling acuity to butanol. The odor panel testing, although subjective, is conducted under strictly controlled "clean" conditions to produce statistically valid results.

The odor evaluations were conducted in accordance with ASTM Standard Practice E679-91 (Determination of Odor and Taste Thresholds by a Forced-Choice

Ascending Concentration Series of Limits) and E544-99 (Referencing Suprathreshold Odor Intensity).

The dynamic dilution of odorous emissions is a physical process that occurs in the atmosphere down-wind of the odor source. An individual, or citizen from the community, sniffs the diluted odor. The number of dilutions needed to make the odor emission just detectable is known as the DT. The RT value is the dilution ratio at which the assessor first recognizes the odor's character. For example, an odor panel's response at DT may be "that smells" where the odor panel response at RT may be "that smells like a skunk".

Odor Detectability and Recognition

DT values reported from the odor panel refer to the number of dilutions of an odorous air sample required such that at least half the panel members are able to detect the presence of the odor. RT refers to the number of dilutions of an odorous air sample required before half the panel members are still able to characterize or recognize the odor.

A high DT indicates a strong odor requiring many dilutions to render it undetectable. RT values are always less than DT values because it is easier to detect an odor than identify an odor. The relative magnitude of DT and RT values indicates the relative significance of odors from various odor sources.

2.3 Reduced Sulfur Compound Test Procedures

Reduced sulfur compound testing is performed to specifically identify which compounds are present in the air and in what concentrations. This is important when selecting and sizing potential odor control alternatives. On this project, the air samples were collected in 3-liter Tedlar bags and then shipped to ALS Environmental for analysis. ALS Environmental analyzed the samples for the presence of RSC and other volatile sulfur compounds by direct injection Gas Chromatography / Flame Photometric Detection GC/FPD. The equipment used for this analysis was a Hewlett Packard 5890 Series II Gas Chromatograph/Hewlett Packard FPD Detector. The column used was a HP-VOC 3um film, 105 Meter x 0.53 mm ID. The sample volume injected into the GC/FPD ranged from 0.005 ml to 2.5 ml depending on sample concentrations. Purchased tank standards were used to calibrate for H_2S and to determine other RSC concentrations. When H_2S concentrations were too high to allow concentration estimates of other RSCs, or better detection limits were obtained by GC/MS, their concentrations were estimated by the carbon disulfide response factor from the VOC calibration standard for the GC/MS system.

2.4 Hydrogen Sulfide Measurements

Hydrogen Sulfide (H_2S) can be measured in the field using H_2S analyzers that provide instantaneous readings and/or continuous data logging. Since it is easy to measure, H_2S is often used in wastewater situations as an odor indicator. In many cases, if the H_2S is controlled, the odor problem will be eliminated. H_2S is slightly heavier than air and moderately soluble in water.

H_2S dissolves in water and disassociates in accordance with the following reversible reaction:

$$H_2S \leftrightarrow HS^- + H^+$$

The distribution of the above species is a function of pH, as shown graphically in **Figure 2**. The relative H_2S concentration increases with decreasing pH. Only the dissolved sulfides can escape from the liquid (as H_2S). Hydrogen sulfide is formed under anaerobic or septic (absence of oxygen) conditions.

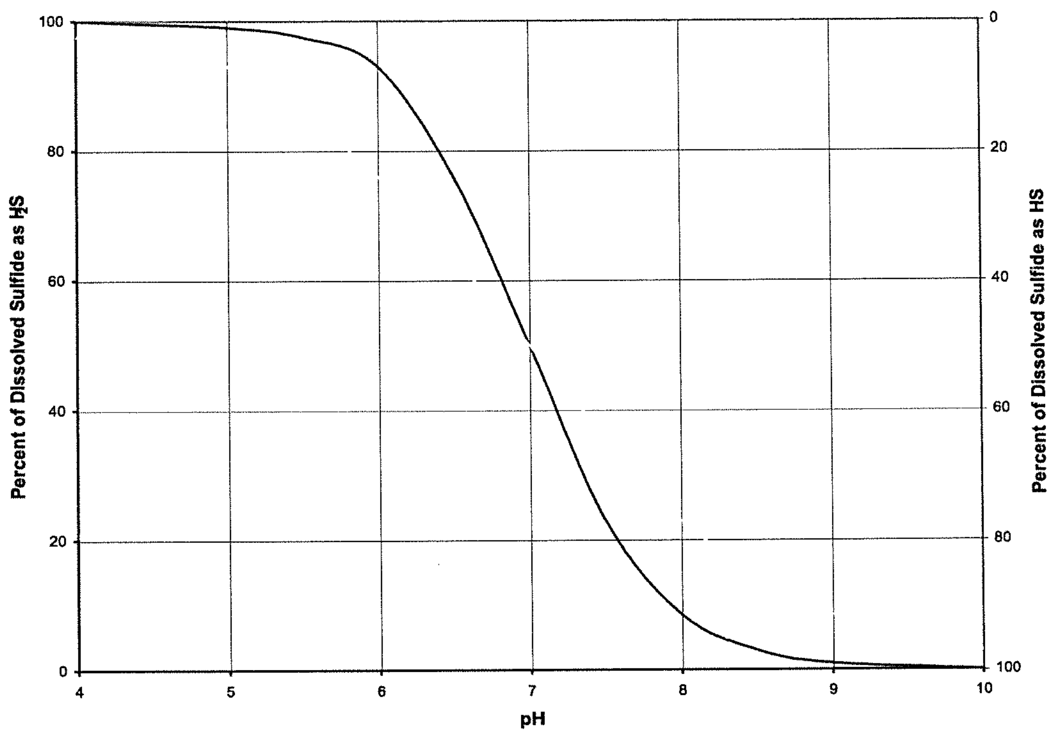


Figure 2
Effects of pH on Distribution of Hydrogen Sulfide in Water

During this evaluation, H_2S was measured using an Arizona Instruments Jerome 631X H_2S analyzer with a range of 0.003 to 50 parts per million (ppm). These measurements are used to identify or confirm odor (and H_2S) sources at the plant. In addition, diurnal H_2S concentrations were logged in six (6) locations during the testing periods using OdaLog H_2S analyzers. Odalogs are less accurate than the Jerome but are capable of measuring higher concentrations and can be deployed in areas with harsh conditions over extended periods of time. The Odalogs were calibrated prior to use on this project and the data was downloaded to a computer and plotted. All of the test results are presented in Section 4 of this report.

3.0 Description of Odor Testing and Modeling

3.1 Overview of Sampling & Testing Program

The comprehensive sampling and testing program, shown in **Table 2**, began on May 16, 2022. On that date, a kickoff meeting was held to discuss the objectives of the study and to give the plant staff an overview of the sampling that would be conducted. Odalog (H_2S) monitors were also installed in pre-determined locations.

From May 25 – 27, 2022 a total of eight (8) samples were collected for odor panel analysis and seven (7) samples were collected for RSC analysis. The odor samples were packaged and shipped by overnight express to St. Croix Sensory, Inc. in Stillwater, MN for odor panel analyses on the following day. The RSC samples were packaged and shipped overnight to ALS Environmental in Simi Valley, CA for RSC analyses.

The weather conditions on the days of sampling were as follows:

May 25th	Sunny with a high of 73°F
May 26th	Sunny with a high of 77°F

Table 2

Sampling and Testing Protocol for Four Corners Water & Sewer District WWTP

Location	Air Sample for Odors	Air Sample for RSCs	$H_2S^{(1)}$	Airflow	Liquid Sulfides	Liquid pH
Headworks	X	X	X	X		
SBR Splitter Box			X			
Dewatering Building	X	X	X	X		
Aerobic Digesters	X	X	X	X		
Biofilter Inlet	X	X	X	X		
Biofilter Outlet	X	X				
IPS Biofilter Inlet	X	X	X	X	$X^{(2)}$	$X^{(2)}$
IPS Biofilter Outlet	X	X				
Gallactic Pump Station	X				X	X

(1) Instantaneous (Inst) test of Odalog (Oda) monitoring continuous for one week.

(2) Liquid sulfides and liquid pH samples collected from the IPS wet well.

3.2 Air Sampling Protocol

Air samples were collected in chemically inert Tedlar bags with a polypropylene access valve. Samples for Odor panel analysis were collected in 10-liter bags and samples for RSC analysis were collected in 3-liter bags. Air samples from point sources such as existing odor control system ductwork, exhaust points or wet wells were collected using the evacuated lung method with a vacuum chamber, sample pump and Tygon tubing as shown in **Figure 3**. New Tygon tubing was used for every source to prevent contamination of the tubing.

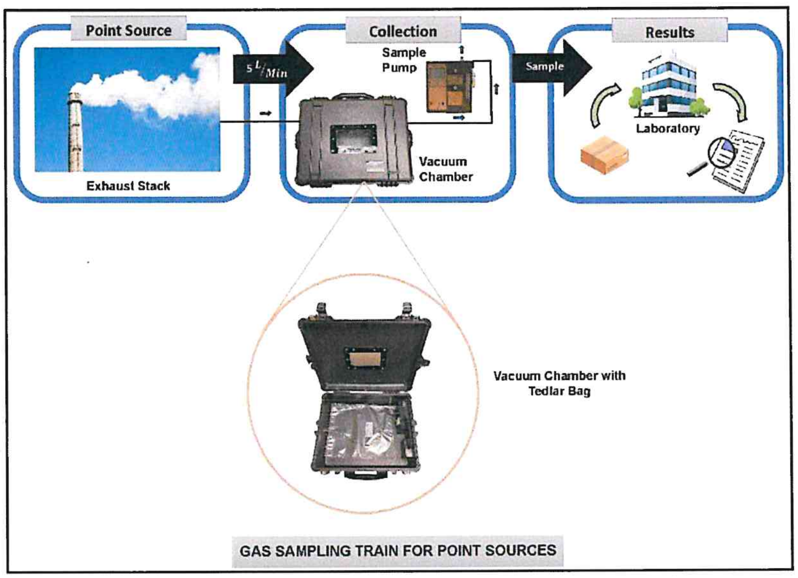
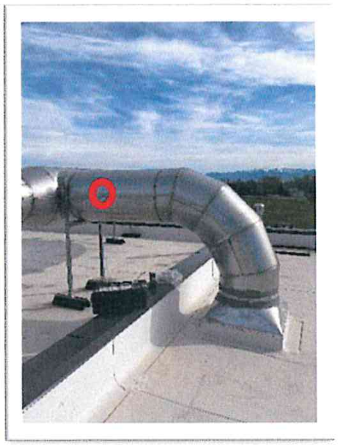


Figure 3 - Gas Sampling Train for Quiescent Surfaces

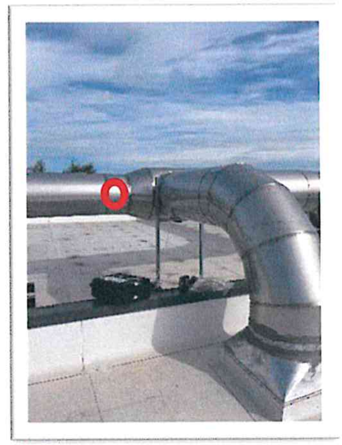
In all cases, the sample container was filled with the sample and then purged to "condition" the container and remove any background container odor prior to collection of the final sample for odor panel analysis.

The air samples were collected from each source and shipped to the laboratories via overnight express courier where they were analyzed the following day.

Figure 4 shows pictures of the locations where samples were collected at the Four Corners WRF.



Dewatering Building Exhaust



Headworks Building Exhaust

Aerobic Digester Exhaust

Biofilter Inlet Duct

Biofilter Media

IPS Biofilter Inlet Duct

Figure 4 - Sampling Locations

IPS Biofilter Outlet

Figure 4 - Sampling Locations (Continued)

3.3 Odor Dispersion Modeling

3.3.1 Description of Modeling

Odor dispersion modeling has been used as a reliable and cost-effective approach for predicting off-site odor impacts from odor sources and evaluating odor mitigation alternatives.

The odor dispersion model is essentially a computer program designed to predict what impact an odor source, or group of odor sources, will have on an area based on a number of factors that are input into the program. The primary inputs include:

- Odor emission rates from individual odor sources
- Odor source dimensions and characteristics
- Historic meteorological data
- Local terrain data

The software used to complete the modeling is Breeze AERMOD v9.0.0.20 Pro Plus Version developed by Trinity Consultants Inc. AERMOD is the preferred EPA model for simulating the impacts of emissions from a variety of sources where a near field (less than 50 km) condition exists.

AERMOD is a comprehensive, steady state Gaussian plume dispersion model that is commonly used for odor assessments as it assumes direct transport from a source to a receptor for every hour of meteorological data, which is designed to yield a conservative result in terms of odor impacts in the community surrounding the facility. The model is used to predict and simulate the dilution of odors from the sources, measured in terms of Detection Threshold (DT) for the maximum hourly value of the year throughout the study area. AERMOD will use the pre-processor program AERMET which processes meteorological data for input to AERMOD.

The modeling in this study uses actual meteorological data from the weather stations at Gallatin Field, MT and Great Falls, MT. The data is the most recent full year surface and mixing height data available, obtained from the Lakes Environmental Consultants, Inc. The data includes the actual hourly meteorological data (wind speed, wind direction, temperature, cloud cover, ceiling height, and mixing height) from every hour of the year.

The information input into the model for this study was Odor Emission Rates (OER) for each odor control system exhaust stack; exhaust stack locations, discharge heights and size; the on-site meteorological conditions from the Boise airport weather station; and digital terrain data. The OER is the Detection Threshold (DT) at the source multiplied by the air flow rate.

3.3.2 Modeling Output

The model output predicts the highest DT level, estimated over the area of analysis. The resulting peak DT levels are shown graphically on odor contour plots. Essentially, the model predicts the number of dilutions in the atmosphere in the downwind DT, or the detection threshold of the odor. In this study, the hourly average DT levels at particular receptor points were converted to peak DT levels by applying a multiplier to account for short exposure to odors (60 seconds). The peak DT is more relevant for odors, since the odor plume meanders and is very transient. Perceived odor complaints are generally related to peak odor levels, as opposed to an hourly average odor level.

Another modeling routine also predicts the frequency of odor events for the areas surrounding the plant. In other words, it predicts the number of times per year odors may be detectable for at least a one-minute period at any point in the study area. For example, a person standing at a point where a frequency of 100 is predicted would be expected to experience an odor that exceeds the selected odor detection threshold 100 times (or during 100 hours) per year. In this study, an odor detection threshold of seven (7) DT has been selected. An odor with a detection threshold of seven dilutions or less may not be detected because it could be overwhelmed by other natural odors in the area such as grass, trees, soil and flowers, or it may not be detectable at all.

3.3.3 Modeling Protocol

The modeling scenarios were completed with the following modeling protocol settings:

- Peak-to-mean multiplier of:

  (Averaging Period / Peak Duration) $^{0.5}$ = (60 min / 60 sec) $^{0.5}$ = **7.75**, based on one hour averaging period, 60 second average peak duration, and 0.5 power factor.
- Elevated terrain option
- Digital local terrain data
- 2022 surface and mixing height meteorological data, collected from the Gallatin Field, MT and Great Falls, MT meteorological stations (nearest available relevant meteorological data)
- Threshold of 7 DT used for the odor frequency modeling

4.0 Presentation and Discussion of Testing Results

4.1 Air Sampling Test Results

A summary of the air testing results for the Four Corners, WRF is provided in **Table 3**. The data includes H_2S concentrations, Detection Thresholds (DT), Recognition Thresholds (RT), and Reduced Sulfur Compound (RSC) concentrations from the locations where this sampling was performed. The complete odor panel and RSC test reports from St. Croix Sensory and ALS Environmental are included in **Appendix A** and **Appendix B**, respectively. The OdaLog charts are included in **Appendix C**.

Within the boundaries of the WRF, the aerobic digesters and the IPS biofilter had the highest DT values. The aerobic digester duct also had high DT values, but this did not show up in the biofilter outlet, likely due to the timing of the samples. While onsite, strong odors seemed to be transient at times. There were times that odors near the biofilter were very strong and other times when there seemed to be no odors.

Overall, the RSC results aside from H_2S were very low. However, the aerobic digesters had high concentrations of Methyl Mercaptan (MM). The MM measured in the aerobic digester was 1,200 ppb. MM has a detection threshold of 0.01 ppb.

Table 3 - Air Testing Results Summary							
	H_2S Field Measurements(1)			Odor Panel Testing		RSC Testing(2)	
Location	Inst. (ppm)	Continuous Peak (ppm)	Continuous Avg. (ppm)	Detection Threshold (DT)	Recognition Threshold (DT)	H_2S (ppb)	MM (ppb)
Headworks Exhaust Duct	0.17	60	0.77	1,500	780	240	6
Screw Press Bldg. Exhaust Duct	0.02	31	0.70	810	430	34	15
Aerobic Digester Exhaust Duct	0.37	386	6.40	11,000	6,500	320	1,200
Biofilter Inlet Duct	0.41	39	1.49	2,200	1,100	170	100
Biofilter Media Bed Outlet	0.02	N/A	N/A	870	470	11	38
IPS Biofilter Inlet Duct	1.40	122	17.35	4,700	2,300	2,000	140
IPS Biofilter Media Bed Outlet	0.56	N/A	N/A	5,800	3,300	1,600	110
Gallactic Pump Station	5.10	N/A	N/A	12,000	6,300	1,600	110
Average =	**1.01**	**638**	**26.71**	**4,860**	**2,648**	**747**	**215**

(1) H_2S Field Measurements were measured and recorded as follows: Instantaneous (Inst.) concentrations were measured directly from each odor sample as they were collected using a Jerome 631X. Continuous concentrations were measured and recorded at specific locations using continuous data loggers from May 17 - 27, 2022.

(2) Laboratory Reduced Sulfur Compound (RSC) results are reported in parts-per-billion (ppb). RSC Abbreviations (odor threshold, ppb): H_2S = hydrogen sulfide (0.4), MM = Methyl Mercaptan (0.01).

(3) N/A = Instrument not deployed in this location.

As shown in **Table 3**, each individual odor source was tested (i.e. the headworks duct) even though that air ultimately goes through the biofilter after combining with air from the dewatering building and the aerobic digesters. This was done to see how each source contributes to the makeup of the air going into the biofilter. However, there is ultimately only three major odor sources at the facility. Those three sources are the WRF Biofilter, the IPS Biofilter and the aerobic digester vent. Air from the aerobic digester is treated by the WRF Biofilter, but not enough air is exhausted to keep the whole structure under negative pressure which results in fugitive emissions from the vent.

When a biofilter is designed and operated properly, they will be very effective odor control systems. Biofilters will effectively remove 90%, or more, of odors and 99% of H_2S. **Table 4** shows how the existing biofilters performed during the onsite testing.

Table 4 - Odor Control Removal Efficiencies			
	Inlet Odor (DT)	Outlet Odor (DT)	Removal Efficiency (%)
WRF Biofilter	2,200	870	60%
IPS Biofilter	4,700	5,800	-23%

During the onsite testing, smoke testing was conducted. A smoke test is performed by lighting a smoke bomb and inserting it directly into the inlet of the biofilter. The smoke test is used to show the empty-bed residence time (EBRT) of the biofilter and also to show how well the air distribution across the media bed is. The EBRT is simply the amount of contact time that the air has with the media. The larger the EBRT, the more time the air is in contact with the media which results in better removal efficiencies, but also larger biofilter footprint. An organic biofilter, such as the existing biofilters at the WRF typically have an EBRT of 60 seconds. The smoke test results for both biofilters are shown in **Table 5**.

Table 5 - Biofilter Smoke Test Results		
	EBRT (seconds)	Air Distribution Across Media Bed (%)
WRF Biofilter	15	60
IPS Biofilter	20	50

The smoke test results showed that the EBRT's of the WRF Biofilter and the IPS Biofilter were 15 seconds and 20 seconds, respectively. Based on calculations using the measured airflow into each biofilter, the footprint of each biofilter and media volume in each biofilter, the EBRT for each should be 60 seconds. An EBRT of 15 – 20 seconds is one of the main reason why the performance of each biofilter is so poor. Additionally, the air distribution is very poor across both biofilters. The air distribution ranged from 50 – 60 % for both biofilters. What this means is that air is only being distributed across 50 – 60% of the entire media bed. There is a lot of unused media in both biofilters due to the design of the air distribution system.

4.2 Odor Emission Rates

The potential for off-site odors from the WRF was evaluated in this report by calculating "Odor Emission Rates" (OER), which is the product of DT multiplied by exhaust air flow rate. The OER data is also used in the air dispersion modeling to predict off-site odors from individual sources as well as combined sources.

The following methods were used to determine the air exhaust flow rates (cfm) from the sampled sources at the WRF.

1. Rated capacity or measured air flow rate of blowers or exhaust fans.
2. Calculation of the surface air emissions from the biofilters based on surface area of the source and the measured airflow of the inlet duct.

Table 6 presents the results of the odor emission rate calculations for all odor sources evaluated during the odor testing. The data includes the surface area of the source, air flow rate, DT, resulting odor emission rate (OER), and the percentage of the total OER for each of the processes evaluated during the testing. The OER inventory may be used as a preliminary method for considering the potential for off-site odors from the individual processes, prior to odor dispersion modeling. The OER takes into account the odor strength at the source (DT) and the amount of air flow exhausting the odorous air into the atmosphere.

Table 6 - Odor Emission Rates

Location	Surface Area (ft^2)	Air Flow Rate [(1)] (cfm)	Detection Threshold (DT)	Odor Emission Rate (D/T x cfm)	Percentage of Total
WRF Biofilter	1,500	9,000	1,200	10,800,000	51.28%
IPS Biofilter	500	1,200	5,800	6,960,000	33.05%
Aerobic Digester Vent	0.35	300	11,000	3,300,000	15.67%
			Total Plant Sources =	**21,060,000**	**100%**

The WRF Biofilter, which treats air from the headworks, dewatering building and aerobic digester was found to have the highest OER of all the odorous sources that were tested, which accounted for approximately 51% of the total OER from the plant. The IPS Biofilter, which treats air from the influent pump station wet well, was found to have the second highest OER during the testing period, accounting for a total of about 33% of the total OER. Even though air from the aerobic digester is being pulled into the WRF Biofilter, it is not enough air to keep the four (4) tanks under a negative pressure. The aerobic digester vent is at the opposite end of the structure from the intake and it is releasing odorous air. Therefore, it is estimated that the aerobic digesters account for approximately 16% of the total OER from the WRF. The three (3) odor sources in **Table 4** account for 100% of the odors at the WRF.

5.0 Evaluation of Proposed Odor Control Alternatives

5.1 General

The most effective way to prevent off-site odor emissions at the Four Corners WRF is to capture and treat the foul air in an air treatment system. As previously discussed, there are two existing biofilters at the WRF that treat foul air from the following sources:

- Influent Pump Station Biofilter
  - Airflow – 1,200 cfm, as measured during testing
  - Sources – Influent Pump Station
- WRF Biofilter
  - Airflow – 9,000 cfm, as measured during testing
  - Sources – headworks, dewatering building, aerobic digesters

Both biofilters were constructed and put into service when the WRF was constructed in December 2020. The overall condition of each biofilter is good. Therefore, WEA is focusing on reusing the existing biofilters at the WRF for the odor control alternatives and not evaluating alternative technologies. Biofilters, when designed and maintained properly, are very effective. Reusing the biofilter structures already in place should save FCWSD a substantial amount of money.

5.2 Preliminary Odor Control Design Criteria

In order to adequately size the odor control system, airflows from each source were calculated, along with anticipated inlet H_2S concentrations. Depending on the process, design airflow rates can be based on air changes per hour (AC/hr), airflow per square foot, or blower capacity. Airflows for this analysis were calculated by using the AC/hr for each source and then backing into a number by using the measured airflow from each source. The continuous H2S monitoring values shown in **Table** 3, and also in the Odalog charts in **Appendix** C, are how the H_2S values were determined for the preliminary design criteria. Airflows and inlet H2S concentrations were determined as follows:

WRF Biofilter

Airflow – 9,000 cfm total
- Headworks Building Exhaust – 3,400 cfm
- Dewatering Building Exhaust – 4,000 cfm
- Aerobic Digester Exhaust – 1,600 cfm

H_2S Removal Efficiency
- Inlet – 15 ppm average/60 ppm peak
- Outlet – 99% removal

IPS Biofilter

Airflow – 1,200 cfm total

H_2S Removal Efficiency
- Inlet – 30 ppm average/150 ppm peak
- Outlet – 99% removal

5.3 Odor Control Alternatives Descriptions and Costs

A total of two (2) odor control alternatives were developed and evaluated with respect to cost and effectiveness. This section provides a description of each alternative as well as an estimated capital and operating cost for each (see **Table 7** on the following page).

Section 6 will present the results of the odor dispersion modeling which is used to evaluate each alternative with respect to mitigation of offsite odors.

TABLE 7 FOUR CORNERS WRF ODOR CONTROL ALTERNATIVES COST COMPARISON CAPITAL AND ANNUAL COSTS		
Capital Costs	**Odor Control Alternative 1**	**Odor Control Alternative 2**
WRF Biofilter System Equipment[1]	$395,000	$595,000
IPS Biofilter System Equipment[1]	$175,000	$275,000
Ductwork & Supports	$40,000	$40,000
Media Removal & Disposal	$30,000	$30,000
Biofilter Modifications	$30,000	$30,000
WRF Biofilter Concrete Coatings	$94,000	$94,000
IPS Biofilter Concrete Coatings	$17,480	$17,480
Mechanical & HVAC	$20,000	$20,000
Electrical	$20,000	$20,000
Equipment Installation (20%of Equipment Cost)	$122,000	$182,000
Total Capital Costs[2]	**$943,480**	**$1,303,480**
Annual Operating Costs		
Water ($/yr)	**$4,791**	**$4,791**
Cost per gallon ($/gal)	0.00525	0.00525
Estimated Usage (gal/day)	2,500	2,500
Maintenance[3]	**$15,560**	**$21,560**
Total O&M Costs	**$20,351**	**$26,351**
Amortized Capital Costs (4% Interest, 20 yrs)	**$69,423**	**$95,912**
Total Estimated Annual Cost	**$89,774**	**$122,263**

Notes:

1. Equipment costs are budgetary estimates obtained from biofilter manufacturer. See **Appendix D**.
2. Engineering fees are not included in the estimate.
3. Annual maintenance costs based on 2% of odor control equipment costs plus 2 hours of labor/week/odor control system @ $40/hr.

<u>Alternative 1</u> – Rehab existing biofilters with engineered media

- **Cost: $943,000 capital, $90,000/yr O & M**
- Remove and dispose of existing organic wood chip media
- Install a humidification chamber upstream of the biofilter
- Demolish existing air distribution piping system
- Coat biofilter concrete with 100% solids polyurethane coating
- Replace existing air distribution system with new, improved air distribution flooring system such as BacTee, Hahn, or equal. See **Appendix E**.
- Install engineered biofilter media
- Install irrigation system for biofilter media bed with water control cabinet
- Install dampers on each duct exhausting air from an odor source for balancing

<u>Alternative 2</u> – Rehab existing biofilters with engineered media & covers

- **Cost: $1.3 million capital, $122,000/yr O & M**
- Remove and dispose of existing organic wood chip media
- Install a humidification chamber upstream of the biofilter
- Demolish existing air distribution piping system
- Coat biofilter concrete with 100% solids polyurethane coating
- Replace existing air distribution system with new, improved air distribution flooring system such as BacTee, Hahn, or equal. See **Appendix E**.
- Install engineered biofilter media
- Install irrigation system for biofilter media bed with water control cabinet
- Install covers over the biofilters and exhaust air through an exhaust stack
- Install dampers on each duct exhausting air from an odor source for balancing

6.0 Odor Dispersion Modeling Results

See **Section 3.3.2** for explanation of Peak DT and Frequency figures.

6.1 Existing Conditions Model

The "Existing Conditions Model" was used to predict odor concentrations during worst case conditions. This model utilized odor data obtained from the onsite testing that was conducted in May 2022. This alternative predicts the odor impact that all significant existing plant processes combined are having on the surrounding community.

Figures 5 & 6 show the Peak DT and Odor Frequency contour maps associated with the conditions that are predicted to exist during warm weather conditions.

Figure 5
Existing Conditions Frequency Contours (Worst Case Conditions)

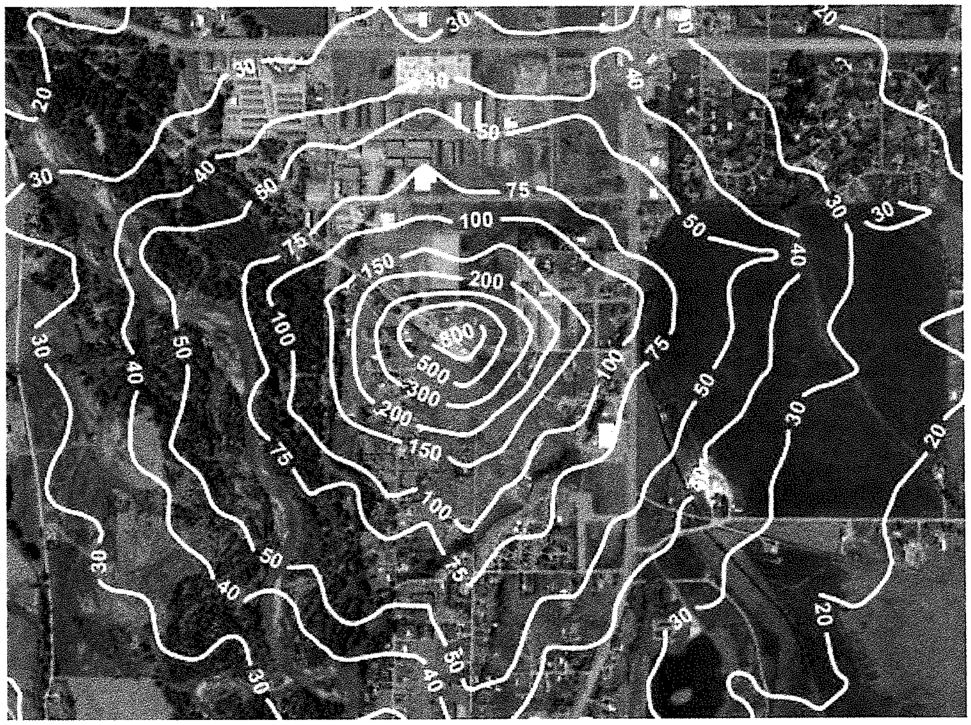


Figure 6
Existing Conditions Peak DT
Contours (Worst Case
Conditions)

The "Existing Conditions" model shows that the odor DT can exceed 800 offsite and be as high as 300 – 500 in the residential areas to the south and southwest of the WRF. The frequency contours show that odors from the plant could be detectable offsite 1,500 times per year and more than 500 – 1,000 times per year in the residential area to the south and southwest of the WRF. To the northwest, the model predicts that an odor event could occur up to 50 times per year, nearly 1-mile away.

6.2 Odor Control Alternative 1 Model

The "Odor Control Alternative 1 Model" predicts the odor impact of implementing the odor control measures described in **Section 5.3**.

Figures 7 & 8 show the Peak DT and Odor Frequency contour maps for this scenario.

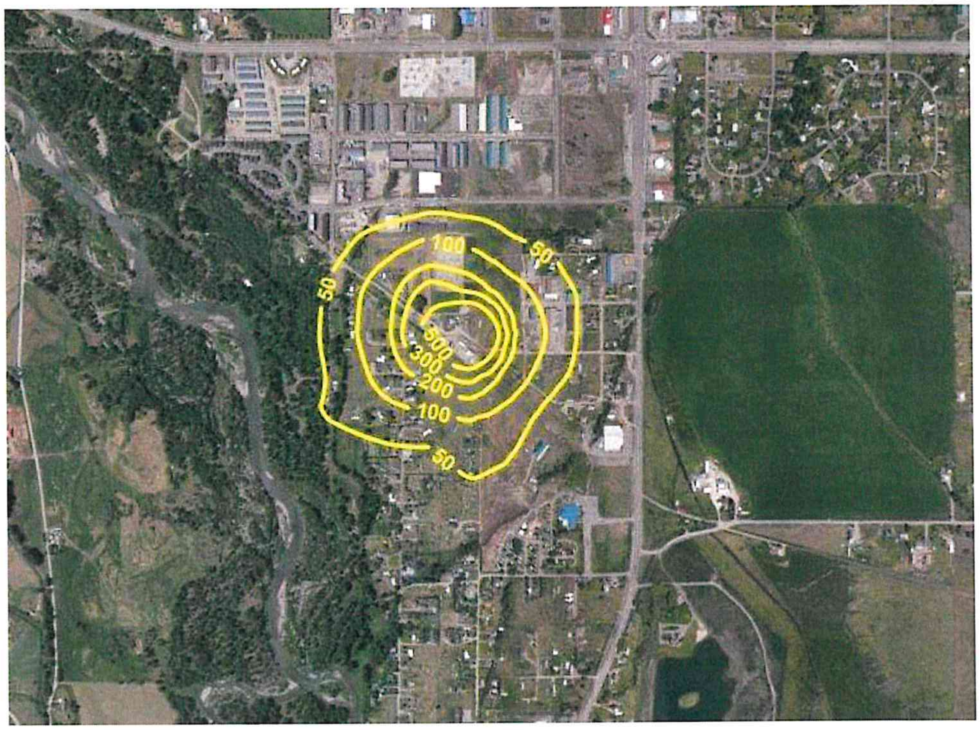


Figure 7
Odor Control Alternative 1
Frequency Contours

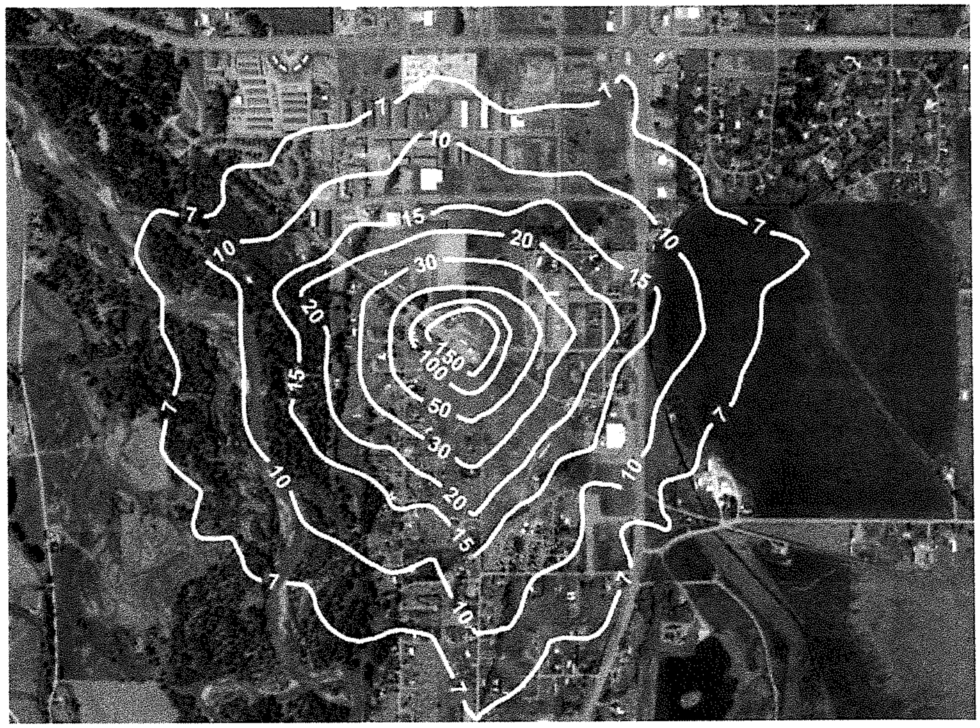


Figure 8
Odor Control Alternatives 1
Peak DT Contours

The model predicts that implementing Odor Control Alternative 1 will result in offsite Peak DT of 150, shown in **Figure 8**, which results in a >81% reduction in peak odors from the WRF. The model predicts odors from the plant could be detectable (>7 DT) offsite during up to 500 events per year near the plant as shown in **Figure 7**. This results in a 67% reduction in odor events from the WRF.

6.3 Odor Control Alternative 2 Model

The "Odor Control Alternative 1 Model" predicts the odor impact of implementing the odor control measures described in **Section 5.3**.

Figures 9 & 10 show the Peak DT and Odor Frequency contour maps for this scenario.

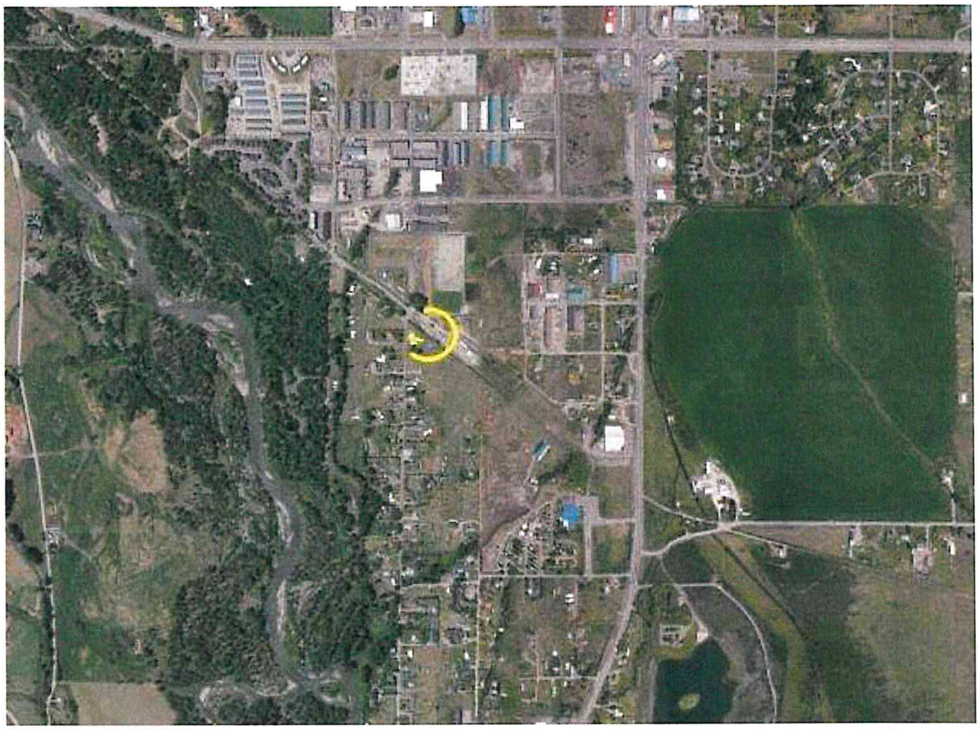


Figure 9
Odor Control Alternative 2
Frequency Contours

Figure 10
Odor Control Alternatives 2
Peak DT Contours

The model predicts that implementing Odor Control Alternative 2 will result in offsite Peak DT of 8, shown in **Figure 10**, which results in a 99% reduction in peak odors from the WRF. The model predicts odors from the plant could be detectable (>7 DT) offsite only one time per year near the plant as shown in **Figure 9**. This results in a >99% reduction in odor events from the WRF.

7.0 Summary & Conclusions

The following is a summary of the primary conclusions from the odor study and odor dispersion modeling study:

1. The existing conditions at the WRF have a major impact on the community, as shown in **Figures 5 & 6**. Currently, odor from the WRF could be detected nearly 1-mile away with the right weather conditions.

2. The onsite sampling and testing revealed that the existing biofilters are not performing well and are the main contributors to the offsite odors from the WRF.

3. The biofilters are sized to provide a 60 second EBRT, but the existing air distribution system in each biofilter are not adequately distributing the air across the media bed. Air is short-circuiting a majority of the media bed resulting in very short EBRT's. The smoke test revealed that an estimated 40 – 50% of the media beds are not being used. The short EBRT's do not allow the biofilters to perform as intended. The image below shows the WRF biofilter media bed during one of the smoke tests performed. The smoke is very heavy to the middle/right side of the biofilter and is not coming up through the media around the first 3 – 4 ft of the perimeter of the whole biofilter.

A similar smoke test was performed on the IPS biofilter and the results showed that the majority of the air is going to the northern most cell. The southern most cell is the original biofilter cell that was designed and constructed with the WRF. The northern most cell was an addition. The air distribution systems in each cell are completely different from one another. The northern most cell utilizes and air plenum beneath the media and provides better air flow, explaining why the majority of the air is flowing through that cell instead of seeing an even distribution.

4. The existing biofilters do not have humidification chambers or irrigation systems to irrigate the media bed. Biofilter media has to be wetted properly in order for the biology to grow, thrive and perform the way it is supposed to. When the media is dry, the biology cannot thrive and the biofilter will have poor performance.

5. Visually, the biofilter structures appear to be in good condition and are not suffering from corrosion. The condition of the concrete beneath the media should be verified.

6. The aerobic digester structure only has one air intake. This single intake is not providing even airflow across the four (4) aerobic digester tanks. The vent for the aerobic digester is on the opposite end of the structure from the intake. Because of this, fugitive emissions are escaping from the digesters, contributing to the offsite odors from the WRF.

7. The odor control ductwork does not have any balancing dampers to allow the system to be balanced to get the desired airflow from each odorous source.

8. The sequencing batch reactors were tested and were not shown to be a big source of odors.

9. The scope of this study was limited to the WRF. The collection system associated with the WRF was not included in this evaluation. However, the Galactic Pump Station was tested for H_2S and odor. At the time of testing, the H2S concentration was >5 ppm and the odor panel analysis showed an odor of 12,000 DT. This site could be a contributor to any odor complaints that may come from the nearby residents to the pump station.

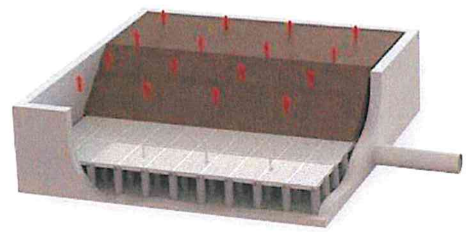
7.0 Recommendations

The follow Recommendations are made based on the results of the testing, modeling results, cost analysis and discussions with the FCWSD.

1. WEA recommends the FCWSD to implement ***Odor Control Alternative 2 for an estimated capital cost of $1.3 million***. Both alternatives evaluated will greatly reduce the odors coming from the WRF. However, Odor Control Alternative 2 nearly reduces all odor events outside of the WRF boundaries, according to the modeling results. Unlike the organic media being used now, which has to be replaced every ~3 years, the engineered media is guaranteed by the manufacturer for 10 years. As discussed previously, the alternative includes the following:

    - Remove and dispose of existing organic wood chip media
    - Install a humidification chamber upstream of the biofilter. There are different ways to humidify the air prior to entering the biofilter. This should be worked out during the design phase of the biofilter upgrades.
    - Demolish existing air distribution piping system
    - Coat biofilter concrete with 100% solids polyurethane coating

- Replace existing air distribution system with new, improved air distribution flooring system such as BacTee, Hahn, or equal. See **Appendix E**. Below is an image of this type of biofilter flooring system along with a depiction of how a biofilter should be designed around the air distribution system.



  The air distribution should be upgraded in both biofilters. For the IPS biofilter the air distribution system should be the same in both biofilter cells to ensure proper airflow and even distribution.

- Install engineered biofilter media
- Install irrigation system for biofilter media bed with water control cabinet
- Install covers over the biofilters and exhaust air through an exhaust stack for better dispersion
- Install dampers on each duct exhausting air from an odor source for balancing

Covering the biofilter and exhausting through an exhaust stack versus an open media bed will provide better dispersion of the treated air into the atmosphere. An example of a covered biofilter with an exhaust stack is shown in the picture below. Additionally, a covered biofilter will provide some form of climate control for the biofilter irrigation. Biofilter irrigation needs and freeze concerns should be verified during the design of the odor control improvements.

2. An interim recommendation would be to regularly irrigate the biofilter media beds. Media irrigation should become part of the daily routine at the WRF until the odor control improvements are implemented.

3. These recommendations are based on the existing conditions that were tested at the WRF. While the onsite testing was being conducted, new aerobic digesters were being constructed to increase the WRF's treatment capacity. This odor study showed that the existing aerobic digesters are a big contributor to odors coming from the WRF. To ensure that the new aerobic digesters are not a source of odors, the FCWSD should accommodate for approximately 1,600 cfm of air to be pulled from the digesters, or 400 cfm per tank. This will likely require modifications to the existing fan, or replacement of the existing fan, to accommodate the additional capacity. The additional airflow into the WRF Biofilter will lower the EBRT to ~45 seconds, which is still an acceptable EBRT based on the results of the onsite testing.

Appendix A – St. Croix Sensory, Inc.
Odor Panel Results

St. Croix Sensory, Inc.

Odor Evaluation Report

Report Number: **2214604**
Project Name: **FCWSD Odor Study**

Samples Collected: **5/25/22**
Samples Received: **5/26/22**
Samples Evaluated: **5/26/22**

Report Prepared For: **Webster Environmental Associates, Inc.**
13121 Eastpoint Park Blvd, Ste. E
Louisville, KY 40223

Report Prepared By: **St. Croix Sensory, Inc.**
1150 Stillwater Boulevard North
Stillwater, MN 55082 U.S.A
1-800-879-9231
stcroix@fivesenses.com

Data Release Authorization:

Michelle Harty
Laboratory Manager

Reviewed and Approved:

Michael A. McGinley, P.E.
Laboratory Director

St. Croix Sensory is ISO/IEC 17025:2017 Accredited

Perry Johnson Laboratory Accreditation, Inc.
Certificate No.: L20-534

Accreditation No.: 81047
Initial Accreditation Date: 19 May 2014

Odor Evaluation Report

St. Croix Sensory, Inc.

Client: Webster Environmental Associates, Inc.
Project Name: **FCWSD Odor Study**
Report Number: **2214604**
Samples Evaluated: **5/26/22**

#	Field No.	Sample Description	DT	RT	I	HT	DR	Comments
1	1	Influent Pump Station	4,700	2,300	---	---	---	
2	2	Gallactic Pump Station	12,000	6,300	---	---	---	

Odor Detection Threshold Testing (Evaluations) conducted in compliance with and under all conditions specified or required by ASTM E679 and EN13725 unless noted in report "Comments" column. The Client Chain of Custody (COC) attached to the Odor Evaluation Report provides information that may include sampling location(s), methods, and/or environmental conditions during sampling. Client, designated agents, and/or reviewers provide interpretation of results based on sampling conditions.

DT - Detection Threshold as determined by ASTM E679 and EN13725. The Practical Detection Limit (PDL) of DT is 12, based on the nominal lowest dilution presentation ratio of 8. Result is dimensionless dilution ratio at which half the assessors detect the diluted air as different from the blank air. Odor Units (OU) or Odor Units per cubic meters (OU/m3) are commonly used as pseudo-units.

RT - Recognition Threshold as determined by ASTM E679 and EN13725. Result is dimensionless dilution ratio at which half the assessors recognize a character in the diluted odorous air. Odor Units (OU) or Odor Units per cubic meter (OU/m3) are commonly used pseudo-units.

I - Perceived odor intensity as determined by ASTM E544. Intensity is expressed as average reported scale value on 10pt n-butanol in water static scale.

HT – Hedonic Tone value. Average rating of assessors' opinion of odor pleasantness on scale of -10 (most unpleasant) to +10 (most pleasant).

DR – the slope of the dose-response relationship of odor intensity with dilution (persistency of odor).

Attachments

St. Croix Sensory, Inc.

CHAIN OF CUSTODY RECORD FOR ODOR SAMPLES

9|2|0|7|8

Client: Webster Environmental			Sampled By: Lee Blakeman			Odor Evaluations Requested: (X)				Page 1 of 1	
Project Name: FCWSD Odor Study			Sampling Date: 5-25-22							For Laboratory use Only	
Comments:						Odor Concentration* (Detection & Recognition Threshold)	Odor Intensity* (PPM 1-Butanol)	Odor Characterization (Hedonic Tone & Descriptors)	Odor Persistency ("Dose-Response")	Odor Evaluation Report No. 2214604	
Line No.	Field No.	Sample Description		Sample Time	Field H_2S (ppm)					Laboratory Sample No. LN	FN
1	(1)	Influent Pump Station		2:20p	1.4	X					
2	2	Gallactic Pump Station		3:20p	5.1	X					
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Transmittal	Relinquished By	Date	Time	Accepted By	Date	Time	Comments & Exceptions Noted
Number of Shipping Boxes 1	Lee Blakeman	5-25-22	4:30p				
	Received at St. Croix Sensory Laboratory			[signature]	5/26/22	10:30 AM	

*Odor Concentration: ASTM E679-04 & EN13725:2003 and Odor Intensity: ASTM E544-10

St. Croix Sensory, Inc. • 1150 Stillwater Blvd. N. • Stillwater, MN 55082 U.S.A. • Tel:800-879-9231 • Fax:651-439-1065 • Email:reports@fivesenses.com • Web:www.fivesenses.com

LAB COPIES WHITE & YELLOW   CLIENT COPY PINK

St. Croix Sensory, Inc.

Odor Evaluation Report

Report Number: 2214702

Project Name: FCWSD Odor Study

Samples Collected: 5/26/22

Samples Received: 5/27/22

Samples Evaluated: 5/27/22

Report Prepared For: Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd, Ste. E
Louisville, KY 40223

Report Prepared By: St. Croix Sensory, Inc.
1150 Stillwater Boulevard North
Stillwater, MN 55082 U.S.A
1-800-879-9231
stcroix@fivesenses.com

Data Release Authorization:

Michelle Harty
Laboratory Manager

Reviewed and Approved:

Michael A. McGinley, P.E.
Laboratory Director

St. Croix Sensory is ISO/IEC 17025:2017 Accredited

Perry Johnson Laboratory Accreditation, Inc.
Certificate No.: L20-534

Accreditation No.: 81047
Initial Accreditation Date: 19 May 2014

Odor Evaluation Report

St. Croix Sensory, Inc.

Client: Webster Environmental Associates, Inc.
Report Number: 2214702
Project Name: FCWSD Odor Study
Samples Evaluated: 5/27/22

#	Field No.	Sample Description	DT	RT	I	HT	DR	Comments
1	1	Headworks Exhaust	1,500	780	---	---	---	
2	2	Dewatering Building Exhaust	810	430	---	---	---	
3	3	Aerobic Digester Exhaust	11,000	6,500	---	---	---	
4	4	Biofilter Inlet	2,200	1,100	---	---	---	
5	5	Biofilter Outlet	870	470	---	---	---	
6	6	IPS Biofilter Outlet	5,800	3,300	---	---	---	

Odor Detection Threshold Testing (Evaluations) conducted in compliance with and under all conditions specified or required by ASTM E679 and EN13725 unless noted in report "Comments" column. The Client Chain of Custody (COC) attached to the Odor Evaluation Report provides information that may include sampling location(s), methods, and/or environmental conditions during sampling. Client, designated agents, and/or reviewers provide interpretation of results based on sampling conditions.

DT - Detection Threshold as determined by ASTM E679 and EN13725. The Practical Detection Limit (PDL) of DT is 12, based on the nominal lowest dilution presentation ratio of 8. Result is dimensionless dilution ratio at which half the assessors detect the diluted air as different from the blank air. Odor Units (OU) or Odor Units per cubic meters (OU/m3) are commonly used as pseudo-units.

RT - Recognition Threshold as determined by ASTM E679 and EN13725. Result is dimensionless dilution ratio at which half the assessors recognize a character in the diluted odorous air. Odor Units (OU) or Odor Units per cubic meter (OU/m3) are commonly used pseudo-units.

I - Perceived odor intensity as determined by ASTM E544. Intensity is expressed as average reported scale value on 10pt n-butanol in water static scale.

HT – Hedonic Tone value. Average rating of assessors' opinion of odor pleasantness on scale of -10 (most unpleasant) to +10 (most pleasant).

DR – the slope of the dose-response relationship of odor intensity with dilution (persistency of odor).

Attachments

St. Croix Sensory, Inc.

CHAIN OF CUSTODY RECORD
FOR ODOR SAMPLES

Page 1 of 1

Client: Webster Environmental
Sampled By: Lee Blakeman
Project Name: FCWSD Odor Study
Sampling Date: 5-26-22
Comments:

Odor Evaluations Requested: (X)

For Laboratory use Only — Odor Evaluation Report No. 2214702

Line No.	Field No.	Sample Description	Sample Time	Field H_2S (ppm)	Odor Concentration* (Detection & Recognition Thresholds)	Odor Intensity* (PPM 1-Butanol)	Odor Characterization (Hedonic Tone & Descriptors)	Odor Persistency ("Dose-Response")	Laboratory Sample No. LN	FN
1	1	Headworks Exhaust	9:10A	0.17	X					
2	2	Dewatering Bldg. Exhaust	9:20 A	0.018	X					
3	3	Aerobic Digester Exhaust	10:30 A	0.37	X					
4	4	Biofilter Inlet	10:50A	0.41	X					
5	5	Biofilter Outlet	1:50 P	0.017	X					
6	6	IPS Biofilter Outlet	2:20 P	0.56	X					
7										
8										
9										
10										
11										
12										

Transmittal	Relinquished By	Date	Time	Accepted By	Date	Time	Comments & Exceptions Noted
Number of Shipping Boxes 1	Lee Blakeman	5-26-22					
	Received at St. Croix Sensory Laboratory			[signature]	5/27/22	10:00	

*Odor Concentration: ASTM E679-04 & EN13725:2003 and Odor Intensity: ASTM E544-10

St. Croix Sensory, Inc. • 1150 Stillwater Blvd. N. • Stillwater, MN 55082 U.S.A. • Tel:800-879-9231 • Fax:651-439-1065 • Email:reports@fivesenses.com • Web:www.fivesenses.com

LAB COPIES WHITE & YELLOW CLIENT COPY PINK

Appendix B – ALS Environmental Reduced Sulfur Compound Testing Lab Results

ALS Environmental
2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T +1 805 526 7161

right solutions.
right partner.

LABORATORY REPORT

June 10, 2022

Lee Blakeman
Webster Environmental Associates
13121 Eastpoint Park Blvd., Suite E
Louisville, KY 40223

RE: FCWSD Odor Study / 781

Dear Lee:

Enclosed are the results of the samples submitted to our laboratory on May 27, 2022. For your reference, these analyses have been assigned our service request number P2202363.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

ALS | Environmental

By Sue Anderson at 8:28 am, Jun 10, 2022

Sue Anderson
Project Manager

ALS Environmental
2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T +1 805 526 7161

right solutions.
right partner.

Client:	Webster Environmental Associates	Service Request No:	P2202363
Project:	FCWSD Odor Study / 781		

CASE NARRATIVE

The samples were received intact under chain of custody on May 27, 2022 and were stored in accordance with the analytical method requirements. The first two samples were received past the recommended holding time. The analysis was performed as soon as possible after receipt by the laboratory and the data flagged to indicate the holding time exceedance. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Sulfur Analysis

The samples were analyzed for twenty sulfur compounds per ASTM D 5504-12 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan. This method is included on the laboratory's NELAP scope of accreditation, however it is not part of the DoD-ELAP accreditation.

Sample Aerobic Digester (P2202363-003) was received with insufficient hold time remaining to complete the analysis within the recommended limit. The analysis was performed as soon as possible after receipt by the laboratory and the data flagged to indicate the holding time exceedance.

ALS Environmental
2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T +1 805 526 7161

right solutions.
right partner.

CERTIFICATIONS, ACCREDITATIONS, AND REGISTRATIONS

Agency	Web Site	Number
Alaska DEC	http://dec.alaska.gov/eh/lab.aspx	17-019
Arizona DHS	http://www.azdhs.gov/preparedness/state-laboratory/lab-licensure-certification/index.php#laboratory-licensure-home	AZ0694
Florida DOH (NELAP)	http://www.floridahealth.gov/licensing-and-regulation/environmental-laboratories/index.html	E871020
Louisiana DEQ (NELAP)	http://www.deq.louisiana.gov/page/la-lab-accreditation	05071
Maine DHHS	http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/labCert.shtml	2018027
Minnesota DOH (NELAP)	http://www.health.state.mn.us/accreditation	1776326
New Jersey DEP (NELAP)	http://www.nj.gov/dep/enforcement/oqa.html	CA009
New York DOH (NELAP)	http://www.wadsworth.org/labcert/elap/elap.html	11221
Oregon PHD (NELAP)	http://www.oregon.gov/oha/ph/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	4068-008
Pennsylvania DEP	http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx	68-03307 (Registration)
PJLA (DoD ELAP)	http://www.pjlabs.com/search-accredited-labs	65818 (Testing)
Texas CEQ (NELAP)	http://www.tceq.texas.gov/agency/qa/env_lab_accreditation.html	T104704413-19-10
Utah DOH (NELAP)	http://health.utah.gov/lab/lab_cert_env	CA016272019-10
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C946

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Webster Environmental Associates
Project ID: FCWSD Odor Study / 781

Service Request: P2202363

Date Received: 5/27/2022
Time Received: 10:10

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	ASTM D 5504-12 - Sulfur Bag
Headworks Exhaust	P2202363-001	Air	5/26/2022	09:10	X
Dewatering Exhaust	P2202363-002	Air	5/26/2022	09:20	X
Aerobic Digester	P2202363-003	Air	5/26/2022	10:30	X
Biofilter Inlet	P2202363-004	Air	5/26/2022	10:50	X
Biofilter Outlet	P2202363-005	Air	5/26/2022	13:50	X
IPS Biofilter Outlet	P2202363-006	Air	5/26/2022	14:20	X

Air - Chain of Custody Record & Analytical Service Request

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Page 1 of 1

P2202363

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No.

ALS Contact:

Company Name & Address (Reporting Information): Webster Environmental, 13121 Eastpoint Park Blvd., Louisville, KY 40223

Project Name: FCWSD Odor Study

Project Number: 781

Project Manager: Lee Blakeman

P.O. # / Billing Information: Same as Company Address

Phone: 502-253-3443

Fax:

Email Address for Result Reporting: lee.blakeman@odor.net

Sampler (Print & Sign): Lee Blakeman [signature]

Analysis Method: Reduced Sulfurs RSC

Comments e.g. Actual Preservative or specific instructions

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Reduced Sulfurs RSC		Comments
(1) Headworks Exhaust	1	5-26-22	9:10 A					3L	X		
(2) Dewatering Exhaust	2	5-26-22	9:20 A					3L	X		
(3) Aerobic Digester	3	5-26-22	10:30 A					3L	X		
(4) Biofilter Inlet	4	5-26-22	10:50 A					3L	X		
(5) Biofilter Outlet	5	5-26-22	1:50 P					3L	X		
(6) IPS Biofilter Outlet	6	5-26-22	2:20 P					3L	X		

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____ Units: ____

Chain of Custody Seal: (Circle)
INTACT BROKEN ABSENT

Project Requirements (MRLs. QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
[signature]	5-26-22	3:50 P	[signature]	5-27	1010

Cooler / Blank Temperature ____ °C

ALS Environmental

Sample Acceptance Check Form

Client: Webster Environmental Associates Work order: P2202363

Project: FCWSD Odor Study/781

Sample(s) received on: 5/27/22 Date opened: 5/27/22 by: KYLE.WOODIN

Note: This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	No	N/A
1	Were **sample containers** properly marked with client sample ID?	☒	☐	☐
2	Did **sample containers** arrive in good condition?	☒	☐	☐
3	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
4	Did **sample container labels** and/or tags agree with custody papers?	☒	☐	☐
5	Was **sample volume** received adequate for analysis?	☒	☐	☐
6	Are samples within specified holding times?	☒	☐	☐
7	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☐	☐	☒
8	Were **custody seals** on outside of cooler/Box/Container?	☐	☒	☐
	Location of seal(s)? ______ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
9	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☐	☐	☒
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☐	☐	☒
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☐	☒
10	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
11	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P2202363-001.01	1 L Zefon Bag					
P2202363-002.01	1 L Zefon Bag					
P2202363-003.01	1 L Zefon Bag					
P2202363-004.01	1 L Zefon Bag					
P2202363-005.01	1 L Zefon Bag					
P2202363-006.01	1 L Zefon Bag					

Explain any discrepancies: (include lab sample ID numbers):

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **Headworks Exhaust**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P2202363-001

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes: **H3**

Date Collected: 5/26/22
Time Collected: 09:10
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 11:00
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**330**	7.0	**240**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**12**	9.8	**6.0**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
H3 = Sample was received and analyzed past holding time.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Webster Environmental Associates**
Client Sample ID: **Dewatering Exhaust**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P2202363-002

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes: **H3**

Date Collected: 5/26/22
Time Collected: 09:20
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 11:24
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**47**	7.0	**34**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**29**	9.8	**15**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	**16**	13	**6.4**	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
H3 = Sample was received and analyzed past holding time.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **Aerobic Digester**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P2202363-003

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes: **H1**

Date Collected: 5/26/22
Time Collected: 10:30
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 12:02
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**450**	7.0	**320**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**2,300**	9.8	**1,200**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	**1,100**	13	**440**	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	**260**	9.6	**67**	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
H1 = Sample analysis performed past holding time. See case narrative.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **Biofilter Inlet**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P2202363-004

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

Date Collected: 5/26/22
Time Collected: 10:50
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 10:37
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**230**	7.0	**170**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**200**	9.8	**100**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	**100**	13	**41**	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	**44**	9.6	**11**	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **Biofilter Outlet**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P2202363-005

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

Date Collected: 5/26/22
Time Collected: 13:50
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 12:21
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**15**	7.0	**11**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**75**	9.8	**38**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	**75**	13	**30**	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	**40**	9.6	**11**	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **IPS Biofilter Outlet**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P2202363-006

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

Date Collected: 5/26/22
Time Collected: 14:20
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 12:54
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**2,200**	7.0	**1,600**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**210**	9.8	**110**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	**42**	13	**17**	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	**33**	9.6	**8.7**	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **Method Blank**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P220527-MB

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

Date Collected: NA
Time Collected: NA
Date Received: NA
Date Analyzed: 5/27/22
Time Analyzed: 07:06
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE / DUPLICATE LABORATORY CONTROL SAMPLE SUMMARY

Client: **Webster Environmental Associates**
Client Sample ID: **Duplicate Lab Control Sample**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202363
ALS Sample ID: P220527-DLCS

Test Code: ASTM D 5504-12
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 5/27/22
Volume(s) Analyzed: NA ml(s)

CAS #	Compound	Spike Amount LCS / DLCS ppbV	Result LCS ppbV	Result DLCS ppbV	% Recovery LCS	% Recovery DLCS	ALS Acceptance Limits	RPD	RPD Limit	Data Qualifier
7783-06-4	Hydrogen Sulfide	989	949	1,010	**96**	**102**	72-122	6	18	
463-58-1	Carbonyl Sulfide	1,050	1,010	1,000	**96**	**95**	72-121	1	17	
74-93-1	Methyl Mercaptan	1,050	1,120	1,160	**107**	**110**	74-127	3	18	

ALS Environmental
2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T +1 805 526 7161

right solutions.
right partner.

LABORATORY REPORT

June 10, 2022

Lee Blakeman
Webster Environmental Associates
13121 Eastpoint Park Blvd., Suite E
Louisville, KY 40223

RE: FCWSD Odor Study / 781

Dear Lee:

Enclosed are the results of the sample submitted to our laboratory on May 27, 2022. For your reference, this analysis has been assigned our service request number P2202364.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

ALS | Environmental

By Sue Anderson at 8:34 am, Jun 10, 2022

Sue Anderson
Project Manager

ALS Environmental
2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T +1 805 526 7161

right solutions.
right partner.

Client: Webster Environmental Associates
Project: FCWSD Odor Study / 781

Service Request No: P2202364

CASE NARRATIVE

The sample was received intact under chain of custody on May 27, 2022 and was stored in accordance with the analytical method requirements. The sample was received past the recommended holding time. The analysis was performed as soon as possible after receipt by the laboratory and the data flagged to indicate the holding time exceedance. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the sample at the time of sample receipt.

Sulfur Analysis

The sample was analyzed for twenty sulfur compounds per ASTM D 5504-12 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan. This method is included on the laboratory's NELAP scope of accreditation, however it is not part of the DoD-ELAP accreditation.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

ALS Environmental
2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T +1 805 526 7161

right solutions.
right partner.

CERTIFICATIONS, ACCREDITATIONS, AND REGISTRATIONS

Agency	Web Site	Number
Alaska DEC	http://dec.alaska.gov/eh/lab.aspx	17-019
Arizona DHS	http://www.azdhs.gov/preparedness/state-laboratory/lab-licensure-certification/index.php#laboratory-licensure-home	AZ0694
Florida DOH (NELAP)	http://www.floridahealth.gov/licensing-and-regulation/environmental-laboratories/index.html	E871020
Louisiana DEQ (NELAP)	http://www.deq.louisiana.gov/page/la-lab-accreditation	05071
Maine DHHS	http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/labCert.shtml	2018027
Minnesota DOH (NELAP)	http://www.health.state.mn.us/accreditation	1776326
New Jersey DEP (NELAP)	http://www.nj.gov/dep/enforcement/oqa.html	CA009
New York DOH (NELAP)	http://www.wadsworth.org/labcert/elap/elap.html	11221
Oregon PHD (NELAP)	http://www.oregon.gov/oha/ph/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	4068-008
Pennsylvania DEP	http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx	68-03307 (Registration)
PJLA (DoD ELAP)	http://www.pjlabs.com/search-accredited-labs	65818 (Testing)
Texas CEQ (NELAP)	http://www.tceq.texas.gov/agency/qa/env_lab_accreditation.html	T104704413-19-10
Utah DOH (NELAP)	http://health.utah.gov/lab/lab_cert_env	CA016272019-10
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C946

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Webster Environmental Associates

Service Request: P2202364

Project ID: FCWSD Odor Study / 781

Date Received: 5/27/2022

Time Received: 10:10

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	ASTM D 5504-12 - Sulfur Bag
Influent Pump Station	P2202364-001	Air	5/25/2022	14:25	X

Air - Chain of Custody Record & Analytical Service Request

Page 1 of 1

P2202364

ALS
2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No.:
ALS Contact:

Company Name & Address (Reporting Information): Webster Environmental, 13121 Eastpoint Park Blvd. Louisville, KY 40223

Project Name: FCWSD Odor Study

Project Number: 781

Project Manager: Lee Blakeman

P.O. # / Billing Information: Same as Company Address

Phone: 502-253-3443

Fax:

Email Address for Result Reporting: lee.blakeman@odor.net

Sampler (Print & Sign): Lee Blakeman [signature]

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Analysis Method: RSC	Analysis Method	Comments e.g. Actual Preservative or specific instructions
(1) Influent Pump Station		5-25-22	2:25p					3L	X		

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____ Units: ____

Chain of Custody Seal: (Circle) INTACT BROKEN ABSENT

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
[signature]	5-25-22	4:30 P	[signature]	5-27	1010

Cooler / Blank Temperature ____ °C

ALS Environmental
Sample Acceptance Check Form

Client: Webster Environmental Associates	Work order: P2202364
Project: FCWSD Odor Study / 781
Sample(s) received on: 5/27/22	Date opened: 5/27/22	by: KYLE.WOODIN

Note: This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	No	N/A
1	Were **sample containers** properly marked with client sample ID?	☒	☐	☐
2	Did **sample containers** arrive in good condition?	☒	☐	☐
3	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
4	Did **sample container labels** and/or tags agree with custody papers?	☒	☐	☐
5	Was **sample volume** received adequate for analysis?	☒	☐	☐
6	Are samples within specified holding times?	☒	☐	☐
7	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☐	☐	☒
8	Were **custody seals** on outside of cooler/Box/Container?	☐	☒	☐
	Location of seal(s)? ______ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
9	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☐	☐	☒
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☐	☐	☒
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☐	☒
10	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
11	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P2202364-001.01	1 L Zefon Bag					

Explain any discrepancies: (include lab sample ID numbers): ______

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Webster Environmental Associates**
Client Sample ID: **Influent Pump Station**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202364
ALS Sample ID: P2202364-001

Test Code: ASTM D 5504-12
Instrument ID: Agilent 7890A/GC22/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes: **H3**

Date Collected: 5/25/22
Time Collected: 14:25
Date Received: 5/27/22
Date Analyzed: 5/27/22
Time Analyzed: 12:13
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	**2,800**	7.0	**2,000**	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	**270**	9.8	**140**	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	**75**	13	**30**	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	**34**	9.6	**8.8**	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
H3 = Sample was received and analyzed past holding time.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Webster Environmental Associates**
Client Sample ID: **Method Blank**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202364
ALS Sample ID: P220527-MB

Test Code: ASTM D 5504-12
Instrument ID: Agilent 7890A/GC22/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

Date Collected: NA
Time Collected: NA
Date Received: NA
Date Analyzed: 5/27/22
Time Analyzed: 07:19
Volume(s) Analyzed: 1.0 ml(s)

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE / DUPLICATE LABORATORY CONTROL SAMPLE SUMMARY

Client: **Webster Environmental Associates**
Client Sample ID: **Duplicate Lab Control Sample**
Client Project ID: **FCWSD Odor Study / 781**

ALS Project ID: P2202364
ALS Sample ID: P220527-DLCS

Test Code: ASTM D 5504-12
Instrument ID: Agilent 7890A/GC22/SCD
Analyst: Gilbert Gutierrez
Sample Type: 1 L Zefon Bag
Test Notes:

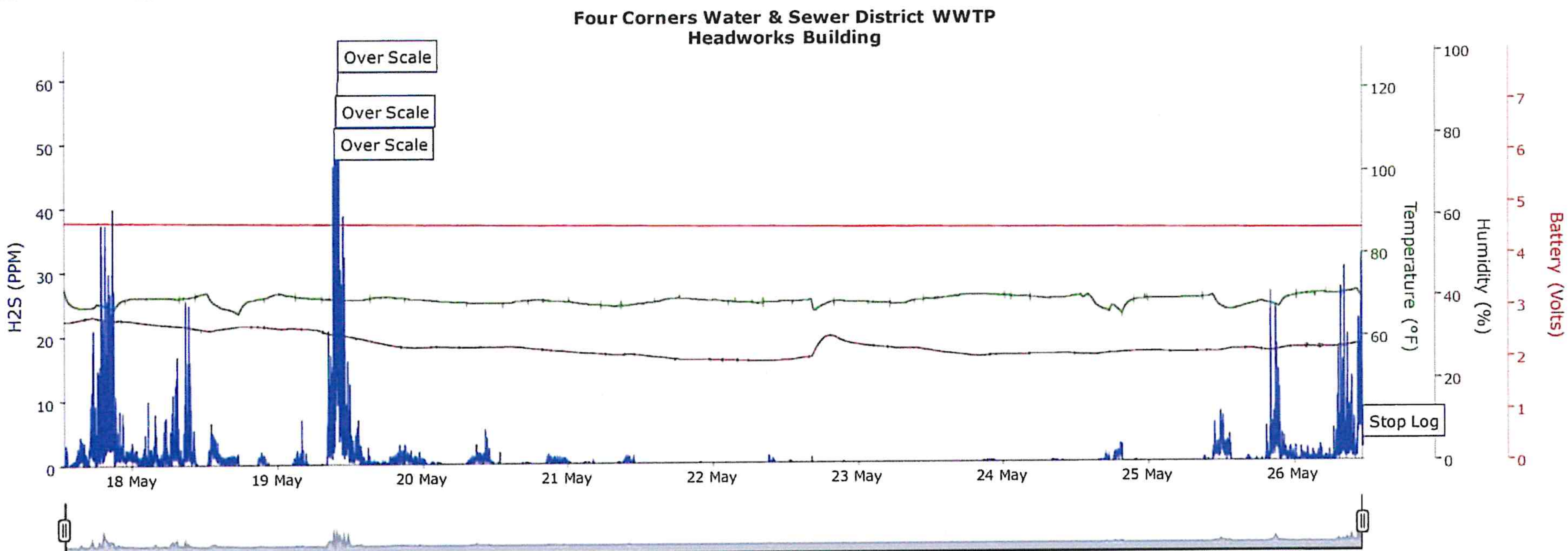
Date Collected: NA
Date Received: NA
Date Analyzed: 5/27/22
Volume(s) Analyzed: NA ml(s)

CAS #	Compound	Spike Amount LCS / DLCS ppbV	Result LCS ppbV	Result DLCS ppbV	% Recovery LCS	% Recovery DLCS	ALS Acceptance Limits	RPD	RPD Limit	Data Qualifier
7783-06-4	Hydrogen Sulfide	989	1,020	1,070	**103**	**108**	72-122	5	18	
463-58-1	Carbonyl Sulfide	1,050	1,010	991	**96**	**94**	72-121	2	17	
74-93-1	Methyl Mercaptan	1,050	1,170	1,160	**111**	**110**	74-127	0.9	18	

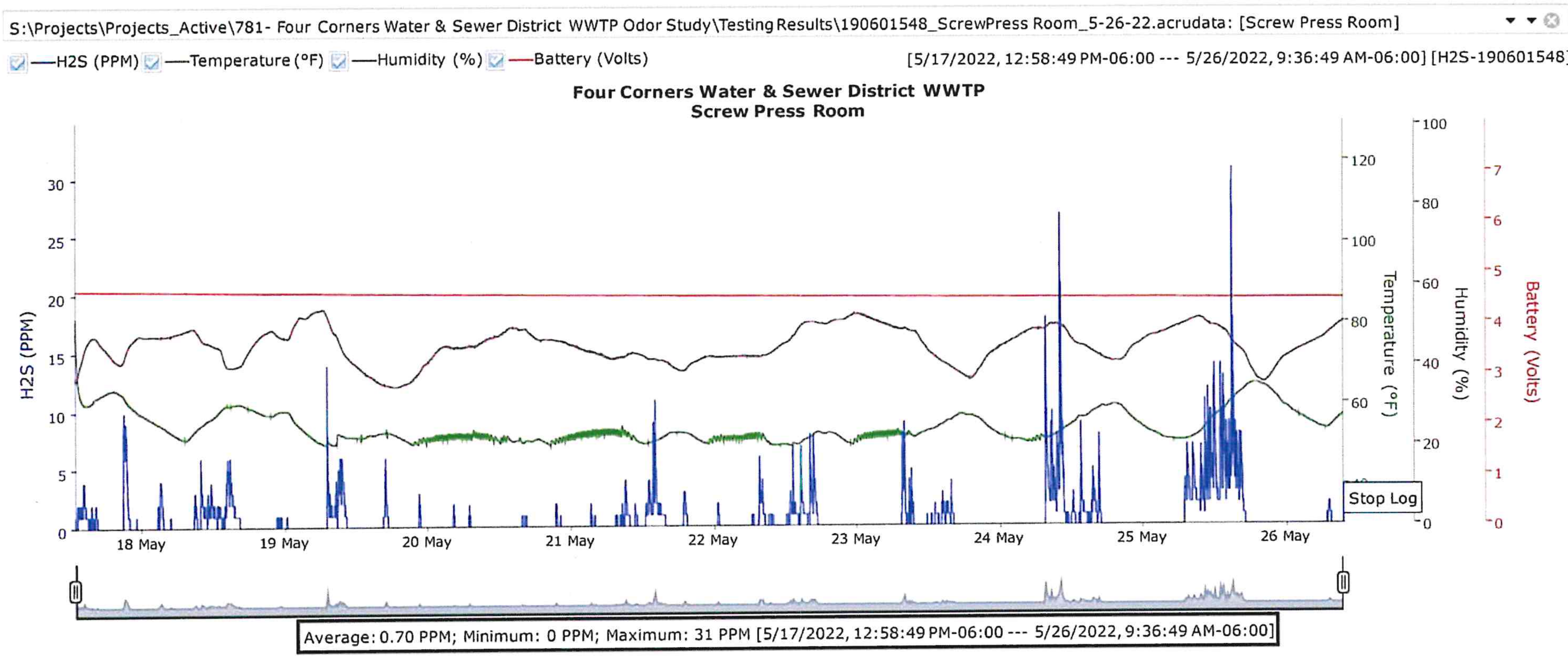
Appendix C – Odalog Charts

S:\Projects\Projects_Active\781- Four Corners Water & Sewer District WWTP Odor Study\Testing Results\200602907_HeadworksBuilding_5-26-22.acrudata: [Headworks Building]

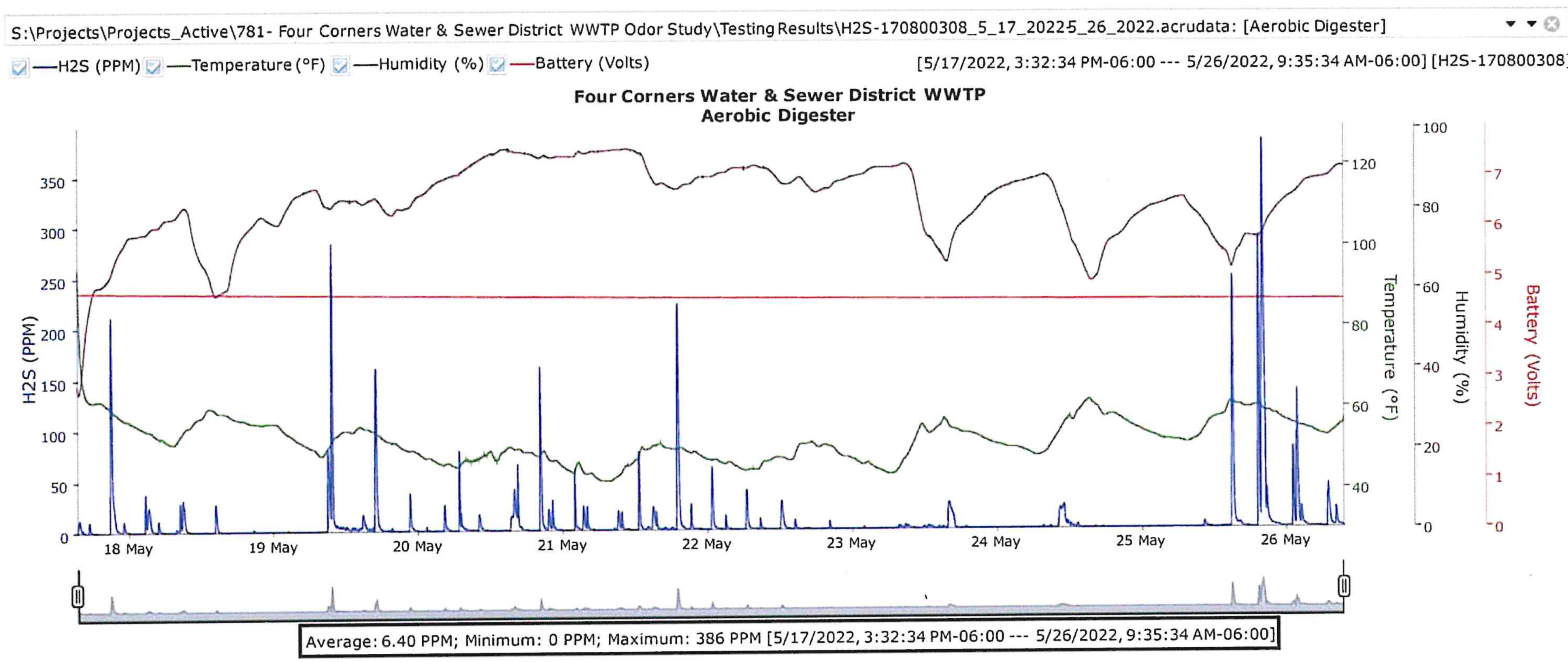
—H2S (PPM) —Temperature (°F) —Humidity (%) —Battery (Volts) [5/17/2022, 12:50:01 PM-06:00 --- 5/26/2022, 11:27:01 AM-06:00] [H2S-200602907]

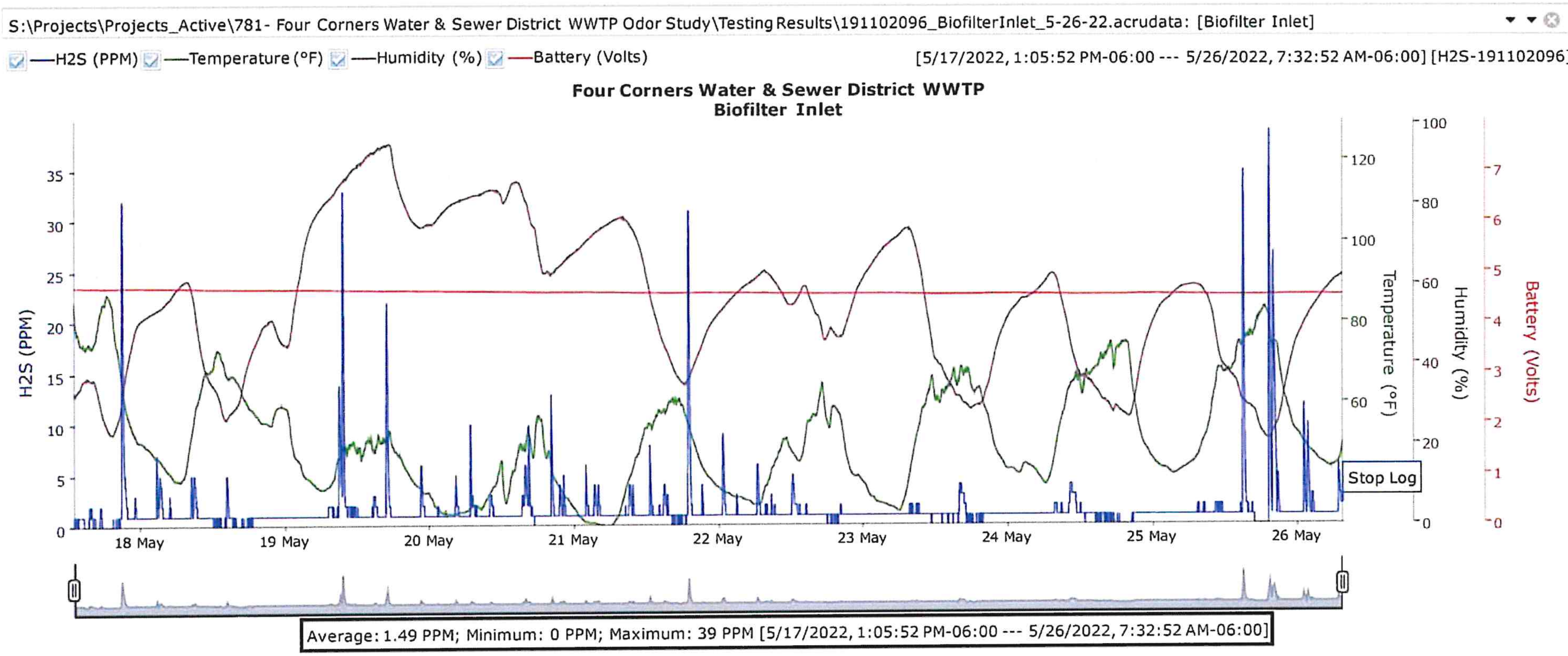


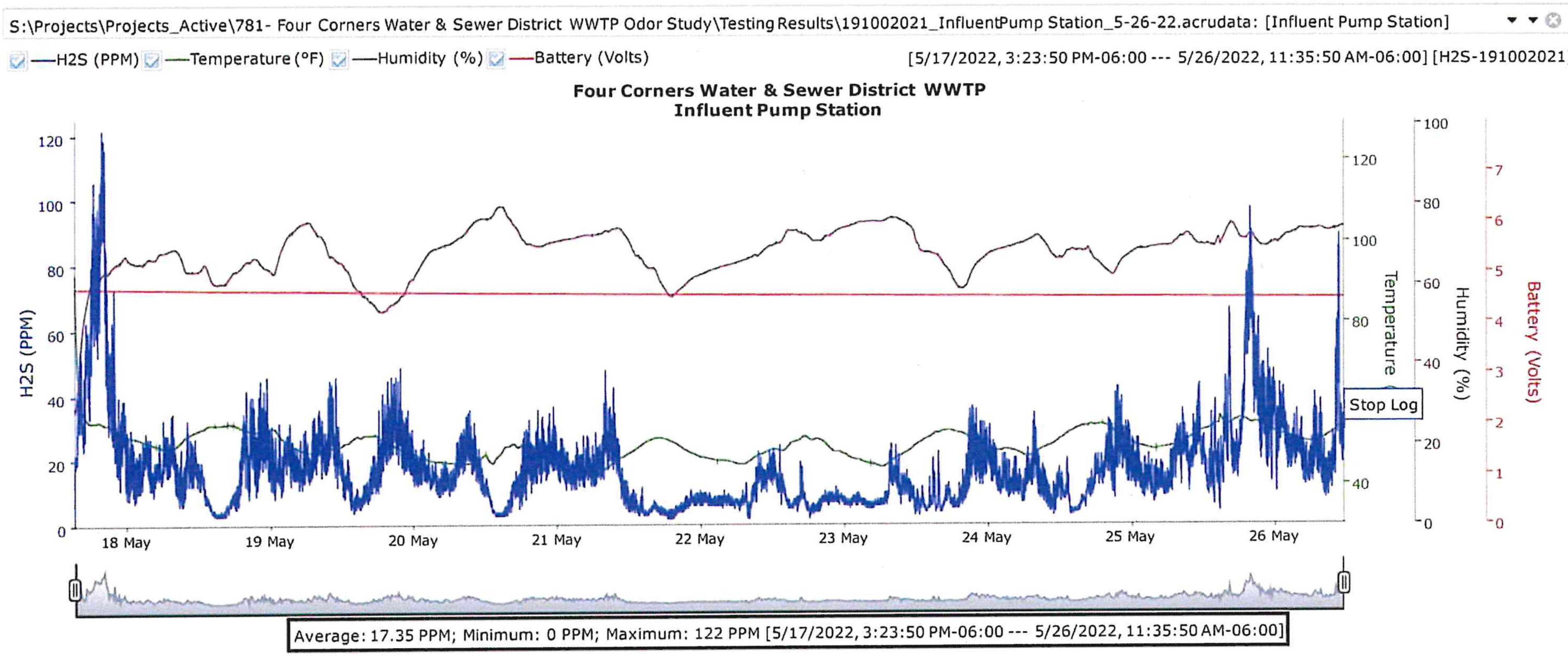
Average: 0.77 PPM; Minimum: 0 PPM; Maximum: 60 PPM [5/17/2022, 12:50:01 PM-06:00 --- 5/26/2022, 11:27:01 AM-06:00]



S:\Projects\Projects_Active\781- Four Corners Water & Sewer District WWTP Odor Study\Testing Results\190601548_ScrewPress Room_5-26-22.acrudata: [Screw Press Room]
—H2S (PPM) —Temperature (°F) —Humidity (%) —Battery (Volts)
[5/17/2022, 12:58:49 PM-06:00 --- 5/26/2022, 9:36:49 AM-06:00] [H2S-190601548]
Four Corners Water & Sewer District WWTP
Screw Press Room
H2S (PPM)
Temperature (°F)
Humidity (%)
Battery (Volts)
18 May
19 May
20 May
21 May
22 May
23 May
24 May
25 May
26 May
Stop Log
Average: 0.70 PPM; Minimum: 0 PPM; Maximum: 31 PPM [5/17/2022, 12:58:49 PM-06:00 --- 5/26/2022, 9:36:49 AM-06:00]


S:\Projects\Projects_Active\781- Four Corners Water & Sewer District WWTP Odor Study\Testing Results\H2S-170800308_5_17_20225_26_2022.acrudata: [Aerobic Digester]
H2S (PPM)
Temperature (°F)
Humidity (%)
Battery (Volts)
[5/17/2022, 3:32:34 PM-06:00 --- 5/26/2022, 9:35:34 AM-06:00] [H2S-170800308]
Four Corners Water & Sewer District WWTP
Aerobic Digester
18 May
19 May
20 May
21 May
22 May
23 May
24 May
25 May
26 May
Average: 6.40 PPM; Minimum: 0 PPM; Maximum: 386 PPM [5/17/2022, 3:32:34 PM-06:00 --- 5/26/2022, 9:35:34 AM-06:00]


S:\Projects\Projects_Active\781- Four Corners Water & Sewer District WWTP Odor Study\Testing Results\191102096_BiofilterInlet_5-26-22.acrudata: [Biofilter Inlet]
—H2S (PPM) —Temperature (°F) —Humidity (%) —Battery (Volts)
[5/17/2022, 1:05:52 PM-06:00 --- 5/26/2022, 7:32:52 AM-06:00] [H2S-191102096]
Four Corners Water & Sewer District WWTP
Biofilter Inlet
H2S (PPM)
0
5
10
15
20
25
30
35
Temperature (°F)
60
80
100
120
Humidity (%)
0
20
40
60
80
100
Battery (Volts)
0
1
2
3
4
5
6
7
18 May
19 May
20 May
21 May
22 May
23 May
24 May
25 May
26 May
Stop Log
Average: 1.49 PPM; Minimum: 0 PPM; Maximum: 39 PPM [5/17/2022, 1:05:52 PM-06:00 --- 5/26/2022, 7:32:52 AM-06:00]



S:\Projects\Projects_Active\781- Four Corners Water & Sewer District WWTP Odor Study\Testing Results\191002021_InfluentPump Station_5-26-22.acrudata: [Influent Pump Station]
H2S (PPM)
Temperature (°F)
Humidity (%)
Battery (Volts)
[5/17/2022, 3:23:50 PM-06:00 --- 5/26/2022, 11:35:50 AM-06:00] [H2S-191002021]
Four Corners Water & Sewer District WWTP
Influent Pump Station
H2S (PPM)
Temperature
Humidity (%)
Battery (Volts)
Stop Log
18 May
19 May
20 May
21 May
22 May
23 May
24 May
25 May
26 May
Average: 17.35 PPM; Minimum: 0 PPM; Maximum: 122 PPM [5/17/2022, 3:23:50 PM-06:00 --- 5/26/2022, 11:35:50 AM-06:00]

Appendix D – Biofilter Budgetary Proposals

Lee Blakeman

From: Dean Parker <dparker@biorem.biz>
Sent: Monday, August 15, 2022 2:14 PM
To: Lee Blakeman
Subject: RE: Four Corners, MT Biofilter

Follow Up Flag: Follow up
Flag Status: Flagged

Lee,

Here are some budget numbers including commissioning and freight for the equipment requested. Please review and let me know if you have any questions.

Headworks Biofilter:

- Airflow = 9,000 cfm
- Media Volume @ 50 sec. EBRT = 7,500 cu. ft.
- Average Inlet H2S = 15 ppm
- Peak Inlet H2S = 60 ppm

Quote based on supplied equipment requested below: $395,000

IPS Biofilter:

- Airflow = 1,100 cfm
- Media Volume @ 60 sec. EBRT = 1,100 cu. ft.
- Average Inlet H2S = 30 ppm
- Peak Inlet H2S = 150 ppm

Quote based on supplied equipment requested below: $175,000

I've attached pictures of both biofilters.

To reiterate, can you provide me with a quote that includes the following:

- Engineered Media for both biofilters
- Media support structure (preferably BacTee, or equal)
- Humidification Chamber for both biofilters
- Irrigation for both biofilters
- Water control panel for both biofilters

Dean Parker
Regional Sales Manager
BIOREM
experience. integrity. performance.

Phone: (585) 455-0129

From: Lee Blakeman <lee.blakeman@odor.net>
Sent: Thursday, August 11, 2022 4:29 PM
To: Dean Parker <dparker@biorem.biz>
Subject: RE: Four Corners, MT Biofilter

The Headworks Biofilter is 60'x25'.

The IPS Biofilter is actually two (2) cells that make up the biofilter and each cell is 8'x17'.

Thanks,

Lee Blakeman, P.E.
Project Manager
Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd.
Office: 502-253-3443
Cell: 502-724-9772

From: Dean Parker <dparker@biorem.biz>
Sent: Thursday, August 11, 2022 4:23 PM
To: Lee Blakeman <lee.blakeman@odor.net>
Subject: RE: Four Corners, MT Biofilter

Lee,

Can you give me the dimensions of each biofilter bed please?

Dean Parker
Regional Sales Manager

Phone: (585) 455-0129

From: Lee Blakeman <lee.blakeman@odor.net>
Sent: Thursday, August 11, 2022 4:11 PM
To: Dean Parker <dparker@biorem.biz>
Subject: RE: Four Corners, MT Biofilter

I think using the humification chamber as a first-stage biotrickling filter is a good option.

Thanks,

Lee Blakeman, P.E.
Project Manager

Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd.
Office: 502-253-3443
Cell: 502-724-9772

From: Dean Parker <dparker@biorem.biz>
Sent: Thursday, August 11, 2022 4:01 PM
To: Lee Blakeman <lee.blakeman@odor.net>
Subject: RE: Four Corners, MT Biofilter

Lee,

At either loading a single stage engineered media biofilter will have the potential of acidifying the media bed. Our recommendation would be to put a small humidifier (biotrickling filter) in front of the biofilter to ensure proper odor removal. These loadings seem high for Montana but if you did the testing it is likely correct.

Let me know how you want to proceed.

Dean Parker
Regional Sales Manager

BIOREM
experience. integrity. performance.

Phone: (585) 455-0129

From: Lee Blakeman <lee.blakeman@odor.net>
Sent: Thursday, August 11, 2022 3:53 PM
To: Dean Parker <dparker@biorem.biz>
Subject: RE: Four Corners, MT Biofilter

Dean,

The loading may be slightly inflated, but back in May when I did my testing and monitoring the average was ~20 ppm and peaks were ~120 ppm. With some adjustments based on higher summer temps, I anticipate 30 ppm as the average and 150 ppm as the peak.

Thanks,

Lee Blakeman, P.E.
Project Manager
Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd.
Office: 502-253-3443
Cell: 502-724-9772

From: Dean Parker <dparker@biorem.biz>
Sent: Thursday, August 11, 2022 3:43 PM
To: Lee Blakeman <lee.blakeman@odor.net>
Subject: RE: Four Corners, MT Biofilter

Lee,

Are those loadings on the ISP biofilter accurate? I need to talk with one of my design guys to see if this is viable with just a single stage biofilter.

Dean Parker
Regional Sales Manager

BIOREM
experience. integrity. performance.

Phone: (585) 455-0129

From: Lee Blakeman <lee.blakeman@odor.net>
Sent: Wednesday, August 10, 2022 4:58 PM
To: Dean Parker <dparker@biorem.biz>
Subject: Four Corners, MT Biofilter

Dean,

I am working on a study for a wastewater treatment plant in Four Corners, MT, just outside of Bozeman. This facility already has two (2) biofilter in place that utilize organic media. The problem is that they have major air distribution problems and are seeing less than 20 seconds of EBRT. On top of that their loadings, specifically the spikes, are a little bit higher than I think they should be. Neither biofilter has a humidification chamber or irrigation system, so that definitely does help either. I was hoping you could provide me a quote to provide engineered media, media support structure for air distribution, humidification chamber, irrigation system and water control panels for both biofilters.

Here is the criteria:

Headworks Biofilter:

- Airflow = 9,000 cfm
- Media Volume @ 50 sec. EBRT = 7,500 cu. ft.
- Average Inlet H2S = 15 ppm
- Peak Inlet H2S = 60 ppm

IPS Biofilter:

- Airflow = 1,100 cfm
- Media Volume @ 60 sec. EBRT = 1,100 cu. ft.
- Average Inlet H2S = 30 ppm
- Peak Inlet H2S = 150 ppm

I've attached pictures of both biofilters.

To reiterate, can you provide me with a quote that includes the following:

- Engineered Media for both biofilters
- Media support structure (preferably BacTee, or equal)
- Humidification Chamber for both biofilters
- Irrigation for both biofilters
- Water control panel for both biofilters

Feel free to give me a call with any questions. This project is pretty important to this plant and they plan to make the improvements pretty quickly. I appreciate all of the support you've been giving me lately.

Thanks,

Lee Blakeman, P.E.
Project Manager
Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd.
Office: 502-253-3443
Cell: 502-724-9772

Lee Blakeman

From: Joe Getz <Joe.Getz@ecs-env.com>
Sent: Wednesday, August 17, 2022 11:25 AM
To: Lee Blakeman
Cc: joe.getz-O35069494-47LY6A1@mailbox.insight.ly
Subject: RE: Four Corners, MT Biofilter

Lee,

Thanks for sending the drawings along!

Please see below in RED and let me know if there are any questions.

Headworks Biofilter:

- Airflow = 9,000 cfm
- Media Volume @ 50 sec. EBRT = 7,500 cu. ft.
- Average Inlet H2S = 15 ppm
- Peak Inlet H2S = 60 ppm
  - Engineered Media
    - 7,500 ft3 of BioPure
  - Media support structure (preferably BacTee, or equal)
    - 1,500 ft2 of BacTee/Hahn Flooring
    - 1,500 ft2 of geonetting
  - Humidification Chamber
    - ~6'Ø FRP humidification chamber
  - Irrigation system, including:
    - PVC piping
    - Spray nozzles
  - Water control panel, including:
    - Basket strainer
    - Pressure gauges
    - Valving, etc.
  - Freight/Startup

- Budgetary price - $325,000

IPS Biofilter:

- Airflow = 1,100 cfm
- Media Volume @ 60 sec. EBRT = 1,100 cu. ft.
- Average Inlet H2S = 30 ppm
- Peak Inlet H2S = 150 ppm
  - Engineered Media
    - 1,100 ft3 of BioPure
  - Media support structure (preferably BacTee, or equal)
    - 236 ft2 of BacTee/Hahn Flooring
    - 236 ft2 of geonetting
  - Humidification Chamber

        - ~2'Ø FRP humidification chamber
    - Irrigation system, including:
        - PVC piping
        - Spray nozzles
    - Water control panel, including:
        - Basket strainer
        - Pressure gauges
        - Valving, etc.
    - Freight/Startup

- Budgetary Price - $162,000

Regards,

Joe Getz

Regional Sales Manager

ECS Municipal

Cell: (610) 442-7025

Industry Leading Air Pollution Control Systems

From: Lee Blakeman <lee.blakeman@odor.net>
Sent: Wednesday, August 17, 2022 10:43 AM
To: Joe Getz <Joe.Getz@ecs-env.com>
Subject: RE: Four Corners, MT Biofilter

Good morning, Joe. Hopefully it was a good getaway!

The Headworks Biofilter is 60'x25'. The walls are 6' tall. See attached drawing.

The IPS Biofilter is actually two (2) cells that make up the biofilter and each cell is 8'x17'.

Thanks,

Lee Blakeman, P.E.
Project Manager
Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd.
Office: 502-253-3443
Cell: 502-724-9772

From: Joe Getz <Joe.Getz@ecs-env.com>
Sent: Wednesday, August 17, 2022 9:52 AM
To: Lee Blakeman <lee.blakeman@odor.net>
Subject: RE: Four Corners, MT Biofilter

Lee,

I apologize. I was off on Thursday and Friday of last week as we took the kids on a quick little getaway to New River Gorge National Park in WV for some rafting and site seeing...I'm just now getting to this.

Easy enough to put some numbers together for you, but I'm hoping you have dimensions of the existing BF structures, which will help me put more accurate costing/pricing together for the media support structure. I'm also super curious about how deep the BF structures are? Most of the time, I've only seen organic media be ~3-5 ft deep, and I don't want to provide a quote for 7,500 ft3 of media (for the headworks system) if the basin/structure itself can only hold like half of that...

Let me know.

Regards,

Joe Getz
Regional Sales Manager
ECS Municipal
Cell: (610) 442-7025

Industry Leading Air Pollution Control Systems

From: Lee Blakeman <lee.blakeman@odor.net>
Sent: Wednesday, August 10, 2022 4:59 PM
To: Joe Getz <Joe.Getz@ecs-env.com>
Subject: Four Corners, MT Biofilter

Joe,

I am working on a study for a wastewater treatment plant in Four Corners, MT, just outside of Bozeman. This facility already has two (2) biofilter in place that utilize organic media. The problem is that they have major air distribution problems and are seeing less than 20 seconds of EBRT. On top of that their loadings, specifically the spikes, are a little bit higher than I think they should be. Neither biofilter has a humidification chamber or irrigation system, so that definitely does help either. I was hoping you could provide me a quote to provide engineered media, media support structure for air distribution, humidification chamber, irrigation system and water control panels for both biofilters.

Here is the criteria:

Headworks Biofilter:
- Airflow = 9,000 cfm
- Media Volume @ 50 sec. EBRT = 7,500 cu. ft.
- Average Inlet H2S = 15 ppm
- Peak Inlet H2S = 60 ppm

IPS Biofilter:
- Airflow = 1,100 cfm
- Media Volume @ 60 sec. EBRT = 1,100 cu. ft.
- Average Inlet H2S = 30 ppm
- Peak Inlet H2S = 150 ppm

I've attached pictures of both biofilters.

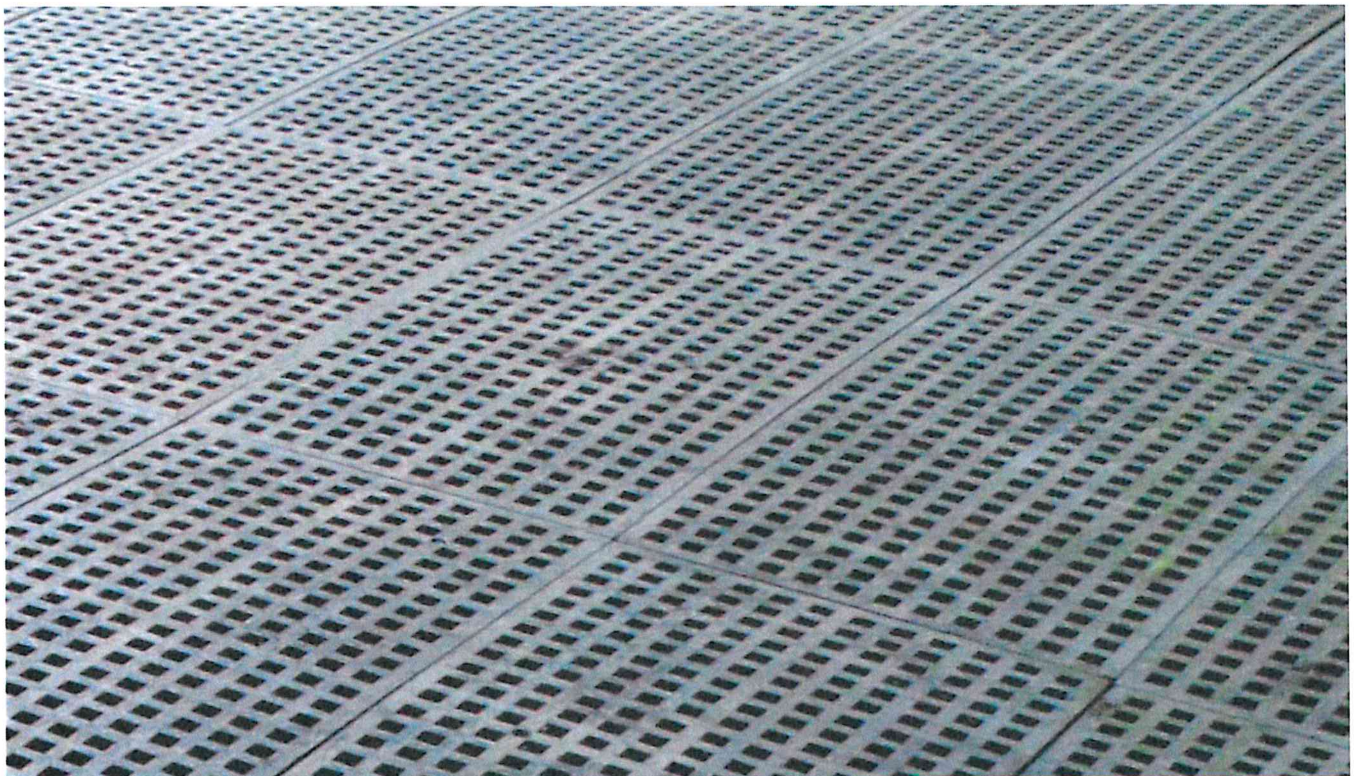
To reiterate, can you provide me with a quote that includes the following:
- Engineered Media for both biofilters
- Media support structure (preferably BacTee, or equal)
- Humidification Chamber for both biofilters
- Irrigation for both biofilters
- Water control panel for both biofilters

Feel free to give me a call with any questions. This project is pretty important to this plant and they plan to make the improvements pretty quickly. I appreciate all of the support you've been giving me lately.

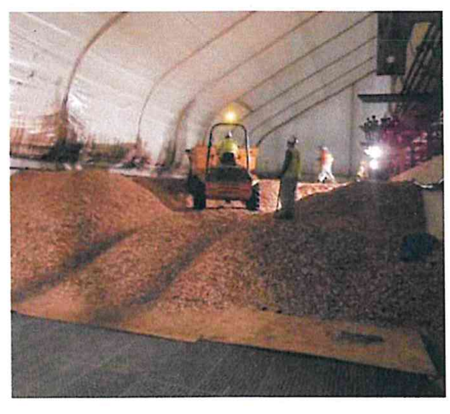
Thanks,

Lee Blakeman, P.E.
Project Manager
Webster Environmental Associates, Inc.
13121 Eastpoint Park Blvd.
Office: 502-253-3443
Cell: 502-724-9772

Appendix E – Biofilter Air Distribution Flooring Panels



hanit® Biofilter Raised Flooring System



HAHN
KUNSTSTOFFE

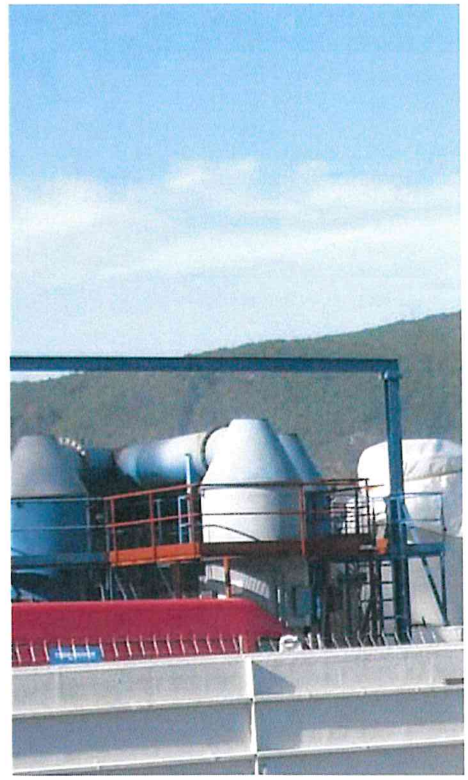
Industrial Application Guide

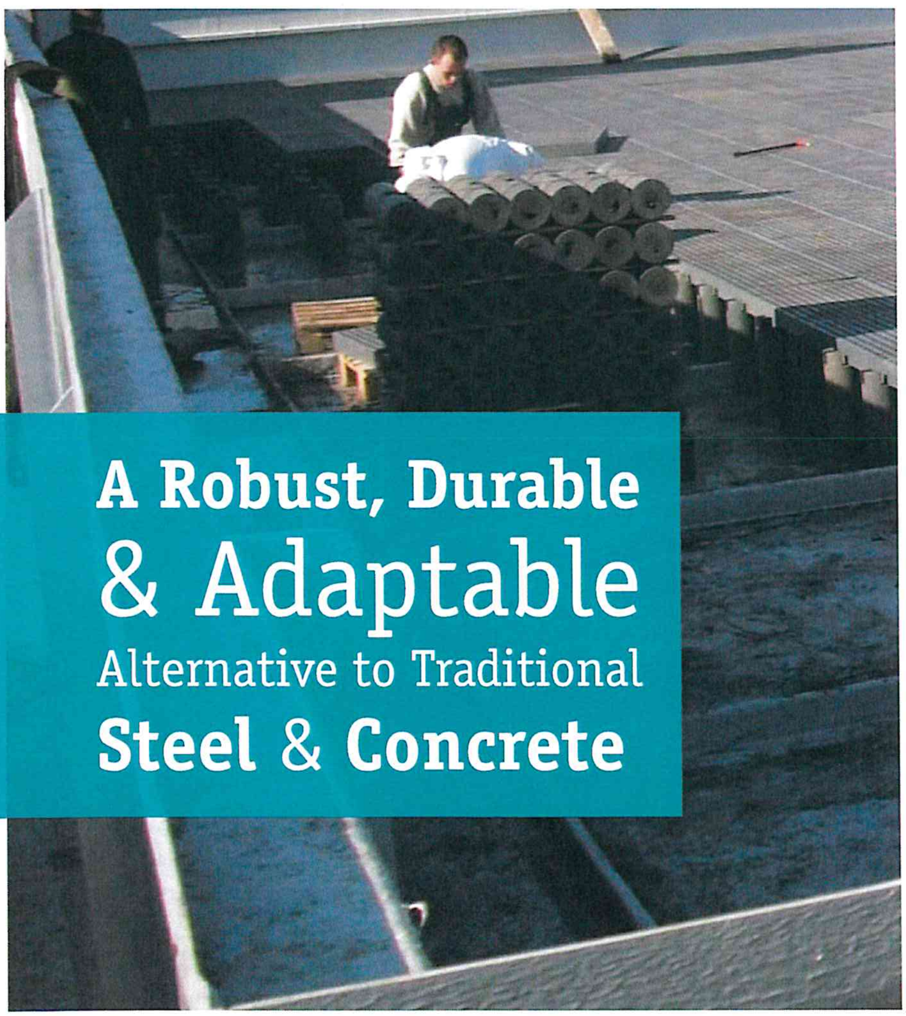
High Performance Biofilter Plant Floors - hanit® Biofilter Raised Flooring System

Utilising a great deal of technical expertise, in depth knowledge of the global biofiltration market and an understanding of client specific needs, HAHN Kunststoffe has developed a flooring product that is second to none.

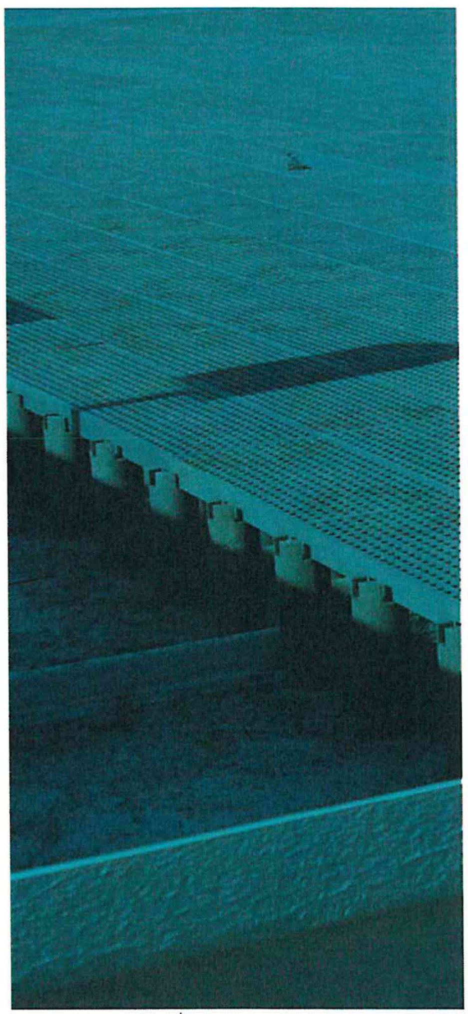
The **hanit®** Biofilter Raised Flooring System provides the perfect solution to the problems experienced in laying wooden or steel flooring systems in biofilter plants. In a very harsh, chemical environment this adaptable and durable system is the logical choice.

HAHN Kunststoffe recycled plastic products provide the perfect solution as they can perform at 35°C and 100% humidity in a chemical environment, they have excellent airflow and have the ability to bear the weight of loading/unloading vehicles.

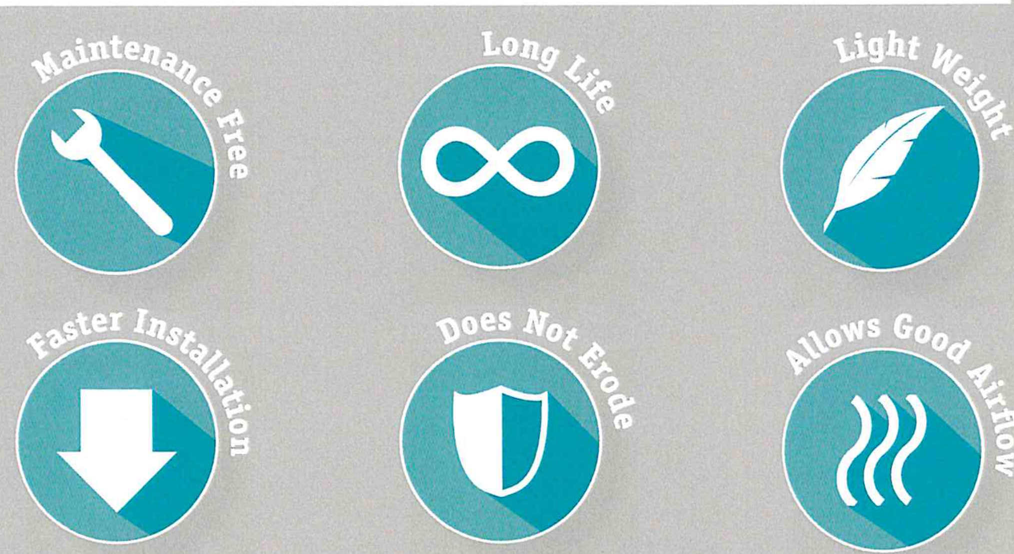




A Robust, Durable
& Adaptable
Alternative to Traditional
Steel & Concrete



Biofilter Raised Flooring System



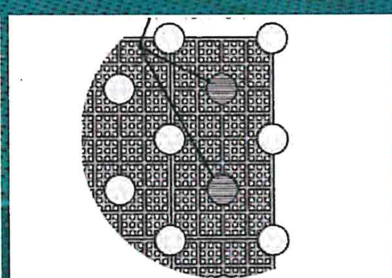
Installation

Installation Advantages

- Simple, fast, and cost-efficient installation due to large but lightweight components
- Reduced manpower requirements
- The **hanit**® flooring supports can be fitted to any part of the floor, therefore enabling the installation of countless filter shapes and dimensions
- Easy mechanical treatment (drilling, sawing, screwing)
- The **hanit**® system can be driven on immediately after installation, eliminating idle time.

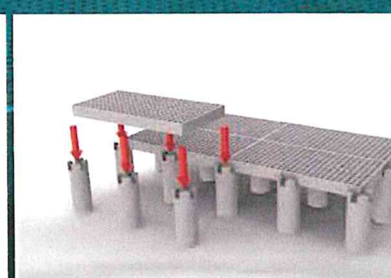
Step 1

The supports are arranged on a level, load-bearing surface with the tenons pointing upwards.



Step 2

The covered area is accessible by vehicles between 2T and 3T total weight. Two additional supports need to be placed in the centre of each grid to enable a 3T vehicle to access the covered area. (2T Vehicles require 6 supports).



Step 3

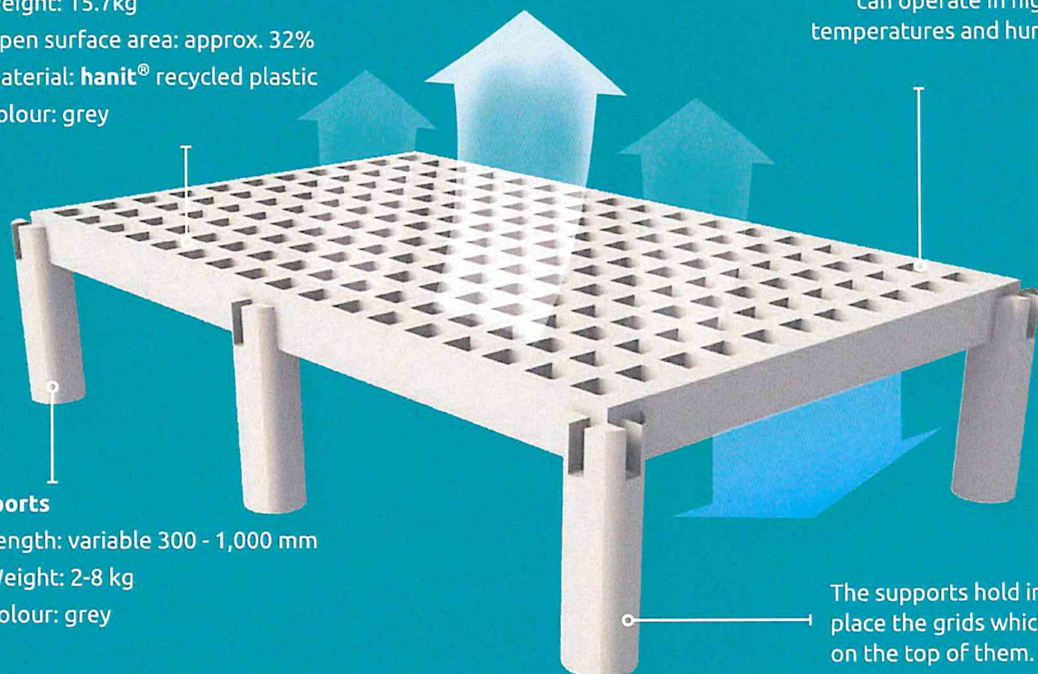
The grids are fitted into the tenon crown of the supports.

Biofilter Raised Flooring System

Flooring System

- Dimensions: 1,000 x 500 x 80 mm
- Weight: 15.7kg
- Open surface area: approx. 32%
- Material: **hanit**® recycled plastic
- Colour: grey

The grates provide drainage, air flow and can operate in high temperatures and humidity.



Supports

- Length: variable 300 - 1,000 mm
- Weight: 2-8 kg
- Colour: grey

The supports hold in place the grids which fit on the top of them.

RANGE OF APPLICATIONS

Raised floor for use in:

- Biofilters within biogas production
- Industrial and utility facilities
- Walking surfaces to allow drainage
- Composting facilities
- Sewage treatment plants
- Biogas plants
- Waste processing plants
- Slaughterhouses
- Food industry
- Odorous facilities

TECHNICAL PROPERTIES

- Large airflow surface
- Resistant to chemicals, acids and micro-organisms
- Durable and nonporous
- Adaptable to every filter shape (inc. round filters)
- The cross-section of the ventilation holes prevents the filter medium from falling through
- Accessible by vehicles (depending on installation) of 2T to 3T gross weight

ADVANTAGES

- Allows good airflow
- Excellent performance at high temperatures and humidity
- Simple to handle and install
- Inherently stable due to support mechanism

NOTE: Please visit the downloads section of our website for more information www.hahnkunststoffe.de

Email: info@hahnkunststoffe.de

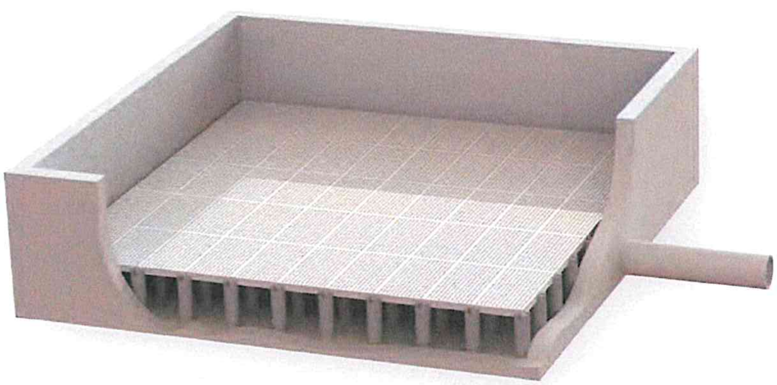
A Global Need for Specialist Biofilter Plant Components in Odour Control & Biogas

Biogas plants have started to play an increasingly important role in the drive to reduce global emissions. In the past, the market has benefitted from significant government subsidies and incentives; aiding the construction of a great number of plants in various different countries across the world.

Many of the original subsidy and incentive programs have started to come to an end, which means that the industry as a whole has become more reliant on the overall business case and economics behind building and operating new plants. The demand for innovative, cost effective, reliable and sustainable plant components has never been greater as plant builders, owners and operators look to do their job in the most efficient manner possible.

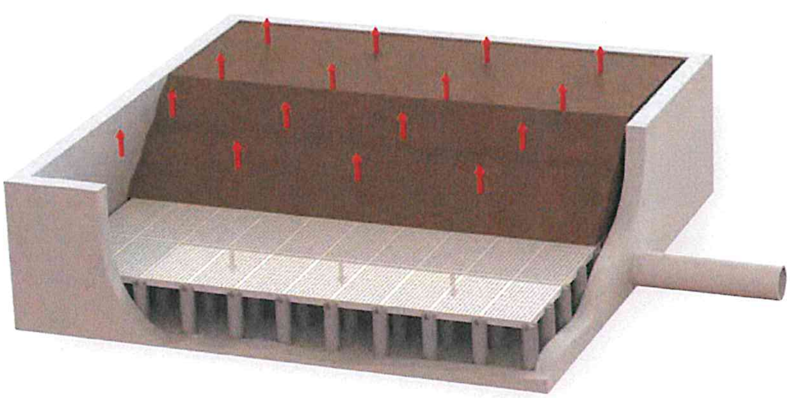
1. Adaptable to Any Size

hanit® Biofilter Raised Flooring System can be easily altered on site, allowing it to be made to measure and work around complex areas.



2. Simple & Quick Installation

Because of its design the **hanit**® Biofilter Raised Flooring System can be positively fitted into the tenon crowns of the supports. A fast and economical installation.



3. Inherently Strong with Large Airflow Surface

The **hanit**® Biofilter Raised Flooring System is ideally suited as a ventilation floor or airflow surface in biofilter facilities. It is able to take the weight of the media and the weight of a loading/ unloading vehicle up to 3 tonnes*

(*3 tonnes using the 8 leg system)

HAHN
KUNSTSTOFFE

We develop, design and manufacture for you!

Contact us:

Telephone: +49 (0) 6543 9886 - 0

Email: info@hahnkunststoffe.de

HAHN Kunststoffe GmbH
Gebäude 1027
55483 Hahn-Flughafen

www.hahnkunststoffe.de