March 5, 2024
File No. 02218208.04-1

Ms. Susan "Tracey" Blalock
Air Compliance Specialist
Virginia Department of Environmental Quality
Southwest Regional Office
355-A Deadmore Street
Abingdon, VA 24210

Subject: Request for Landfill Gas Wellfield Higher Operating Value Approval
Bristol Integrated Solid Waste Management Facility – Bristol, Virginia

Dear Ms. Blalock:

On behalf of The City of Bristol, Virginia (The City), SCS Engineers (SCS) is requesting that the Virginia Department of Environmental Quality (VDEQ) approve a higher operating value (HOV) for temperature at six select landfill gas (LFG) extraction wellheads located at the Bristol Integrated Solid Waste Management Facility (Title V Permit No. SWRO11184) in Bristol, Virginia.

BACKGROUND

In accordance with 40 CFR 63.1958(c) and 40 CFR 60.34f(c), the owner or operator may establish a higher operating value for temperature at any particular well if the supporting data show that the elevated parameter does not cause fires or significantly inhibit anaerobic decomposition by killing methanogens.

The LFG collection system is operated in accordance with the applicable regulatory provisions, the Facility's Design Plan, and the requirements of the Landfill's air permit. The relevant LFG temperature limit measured at the individual wellheads without an HOV as stipulated in Limitations 2.e of the Title V Operating Permit (dated 3/13/2021) is 55°C (131°F). However, beginning on September 27, 2021, the Landfill became subject to the revised provisions of 40 CFR 63, Subpart AAAA and the Federal Emissions Guidelines (EG) Rules as prescribed in Virginia Rule 4-43.1. Since these rules are deemed more restrictive than the previous NSPS WWW Rules, in accordance with the Facility's Title V Permit, the Facility will follow the temperature standards of NESHAP AAAA and the EG Rule, rather than the standards listed in the Title V Permit.

The NESHAP AAAA and the EG Rule establishes a default operating temperature for interior LFG wellheads of 63°C (145°F), but also allows for the establishment of higher operating values at individual wells as appropriate, in accordance with 40 CFR 63.1958(c) and 40 CFR 60.34f(c).

SUMMARY OF REQUESTED HOV WELLS

Six wells (EW-54, EW-77, EW-80, EW-83, EW-88, and EW-97) have been experiencing wellhead temperatures approaching or greater than the regulatory limit on a consistent basis over the past several months.

EW-54 was drilled and connected to vacuum in December 2021. Wells EW-80 and EW-88 were drilled and connected to vacuum in April 2023. Well EW-97 was drilled and connected to vacuum in August 2023 and wells EW-77 and EW-83 were drilled and connected to vacuum in September 2023.

Wells EW-54 and EW-88 are equipped with liquid dewatering pumps that removed an estimated 1,486 and 1,391 gallons per day during the month of February 2024, respectively. EW-83 is also equipped with a liquid dewatering pump, however, it was not operational during the month of February 2024. EW-77, EW-80, and EW-97 are not equipped with a liquid dewatering pump.

EW-54 and EW-97 are located in the southern portion of the SWP #588 Landfill, EW-88 is located on the eastern side of the middle portion of the landfill, and EW-70, EW-80, and EW-83 are located on the western side of the middle portion of the landfill. Based on the historical temperatures recorded at other wellheads at the SWP #588 Landfill, the temperatures measured at all six of these wells are expected. This reflects subsurface temperature conditions consistently noted by the facility in these portions of the waste mass. An exhibit depicting the location of the six wells is presented on the layout drawing in Attachment A.

MONITORING DATA

The City, SCS Engineers, and SCS Field Services evaluated the monitoring data recorded at these six extraction components and confirmed that the subsurface conditions within the waste mass exhibited temperatures and gas quality consistent with other known high temperature wells. While these elevated temperatures may be caused by a variety of conditions, the monitoring data suggests that the elevated temperature “does not cause fires or significantly inhibit anaerobic decomposition by killing methanogens,” as discussed herein. The historical monitoring data recorded for these wells are presented in Attachment B.

The wellhead monitoring results over the past few months indicate that temperature measurements recorded at these wells have consistently approached or exceeded the regulatory threshold of 145°F (or in the case of EW-88, the previously approved HOV of 160°F). In addition to elevated temperatures, these wells are experiencing lower methane, higher carbon dioxide, and higher carbon monoxide (CO) than what is observed in typical LFG. The Facility believes that this atypical LFG composition is due to an elevated temperature landfill (ETLF) subsurface reaction (SSR) occurring in two distinct areas at the Landfill. Ongoing efforts to address the SSR include the recent installation of new vertical extraction wells, installation of dedicated dewatering pumps, improvements to the gas collection piping network, and mobilization of a supplemental blower/flare unit. As documented at other facilities with similar ongoing SSRs, efforts to increase removal of gas and liquids often result in an increase in the quality of the LFG composition over time.

As stated above, the LFG composition at these six wells does not reflect typical anaerobic decomposition via methanogenesis, however methanogenesis continues to occur at these wells, as demonstrated by the presence of some level of methane, albeit to a lesser degree than typically observed under normal conditions.

On an occasional basis, wells EW-54, EW-77, and EW-83 appear to experience conditions associated with subsurface anaerobic pyrolysis, which temporarily inhibits typical methanogenic activity. This results in greatly reduced methane concentrations (less than 15 percent) and higher balance gas concentrations attributed to an increased presence of hydrogen. However, these periods do not permanently inhibit methanogenic activity, as following these periods, methane concentrations at these wells will increase.

OBSERVATIONS RELATED TO POTENTIAL SUBSURFACE OXIDATION

It is our understanding that the intent of the temperature limit cited within the NESHAP/EG provisions is to reduce the potential for subsurface oxidation, which can lead to subsurface fires, and to prevent the inhibition of methane formation by biological organisms. While elevated temperatures recorded at landfill gas wellheads or elsewhere within the waste mass are often scrutinized as an initial indicator of potential subsurface oxidation, the presence of subsurface fires at landfills is almost always accompanied by other indicators as well; specifically, smoke, odors (affiliated with burning waste), rapid and discrete settlement or subsidence of the landfill surface, and elevated carbon monoxide (CO) concentrations.

The observations by on-site personnel suggest that the potential of a subsurface oxidation event in the vicinity of these six wellheads is low. SCS Engineers and Facility staff have stated that they have not witnessed any of the readily observable indicators discussed above (e.g., smoke, odors, rapid subsidence) in the vicinity of these six wells.

OBSERVATIONS RELATED TO CARBON MONOXIDE MONITORING

In accordance with 40 CFR 63.1961(a)(5), the Facility has been performing enhanced monitoring, as applicable, at these six wells. As a result, the CO lab sample frequency and average concentration for each well since November 2023 are presented below.

Table 1. Carbon Monoxide Monitoring

Well ID	Number of CO Lab Samples	Average CO Concentration (ppm)
EW-54	1	910
EW-77	9	687
EW-80[1]	13	92
EW-83	11	579
EW-88	12	218
EW-97	4	473

1: For purposes of averaging the concentration at EW-80, readings that are Non-Detect are averaged at 90 ppm, which is the laboratory detection limit.

As shown above, with the exception of EW-80, which is exhibiting low CO concentrations, the wells featured in this request letter are experiencing CO concentrations characterized as slightly elevated. Slightly elevated CO concentrations are typical of elevated temperature landfills and the slightly elevated CO concentrations observed at these select landfill gas wellheads are likely a result of the accumulated heat and various reactions that characterize ETLFs. This includes microbial CO generation ($H_2 + CO_2 \rightarrow CO + H_2O$), which can be affiliated with incomplete anerobic methanogenesis, rather than an indicator of subsurface oxidation. Notably, in the absence of indicators of a subsurface fire and with relatively consistent CO measurements over the past several months, these CO measurements are what we would expect in landfill conditions similar to those occurring at the Facility. The individual CO concentrations measured in the LFG wellhead samples by laboratory analysis are presented in Attachment C-1.

OBSERVATIONS RELATED TO METHANE FORMATION

Methanogenic bacteria that function to synthesize organic wastes, producing methane and other byproducts that comprise landfill gas (commonly referred to as methanogens) are actually comprised of numerous and diversified microbial organisms. Past research suggests that microbes belonging to methanogenic Archaea, such as Methanosarcina barkeri are able to facilitate substantial methane production at low pH (refer to Staley, Barlaz, and de los Reyes, 2008). The stages of landfill gas production are well documented throughout the literature (refer to Farquhar and Rovers, 1973). As stated in various papers (e.g., Staley, de los Reyes, and Barlaz, 2011), the stage immediately following consumption of the entrained oxygen yields formation of volatile fatty acids (such as acetic acid) and hydrogen (H_2), which is then used as an energy source and electron donor by methanobacterium. While select organisms classified as methanogens are mesophiles and achieve optimal function in temperatures less than 120°F, certain organisms are thermophiles and are believed to function in anaerobic environments with sustained temperatures above 150°F.

Based on recent and historical methane concentrations recorded at these six wells, methanogenic bacteria are clearly continuing to accomplish anaerobic decomposition of organic waste materials in conjunction with a periodic increase in the presence of other decomposition byproducts, such as hydrogen. While it is likely that the temperatures associated with these wellheads are discouraging methane production to some extent, the variety of other factors associated with the SSR in these locations are potentially additional contributors to impeding methane generation. The hydrogen concentrations measured during sampling events at EW-54, EW-83, and EW-97 were greater than 10 percent on average, indicating that methanogenesis is periodically remaining in the acid-forming stage at these wells.

A summary of Hydrogen sampling frequency and average concentrations are presented below in Table 2. Complete Hydrogen sampling results for these six wells since November 2023 are presented in Attachment C-2.

Table 2. Hydrogen Monitoring

Well ID	Number of H_2 Lab Samples	Average H_2 Concentration (% Vol)
EW-54	1	27.2
EW-77	9	0.4
EW-80	13	1.1
EW-83	11	16.6
EW-88	12	6.4
EW-97	4	10.5

SUSPECTED CAUSE OF CONDITIONS AT EW-54, EW-77, EW-80, EW-83, EW-88, AND EW-97

While the exact causes and contributing factors can vary from site to site, there are several biological and chemical processes that can occur naturally in a landfill environment and can contribute to warm temperature conditions similar to those the Facility is experiencing. The most significant heat-producer in an MSW landfill is biological decomposition which creates hydrogen, then methane and carbon dioxide. Heat is removed from the waste mass by gas extraction. Other sources of heat generation include metal corrosion, which occurs when metals are present in the waste stream and react with moisture under anaerobic conditions, and as a result of the hydration and carbonation of various compounds such as calcium oxide (CaO) or oxidized metals. These processes do not directly result in the production of hydrogen but do contribute to heat generation.

It is our belief that the conditions present in the vicinity of these six wells, specifically low oxygen, reduced methane concentrations, elevated carbon dioxide, elevated hydrogen, and elevated temperatures, suggest that many zones of the waste mass are experiencing a SSR and are

displaying tendencies to remain in the acid-forming stage of landfill gas production. However, the presence of some methane indicates that methanogenesis associated with anerobic decomposition is still occurring at these wellheads.

While the evidence suggests there likely is some degree of anaerobic exothermic pyrolysis occurring in the immediate vicinity of wells EW-54 and EW-83, these conditions are localized, because numerous surrounding wells, while experiencing temperatures above 145°F, typically produce LFG with more normal methane concentrations associated with methanogenesis.

We believe it is prudent to extract the LFG that is being produced from these portions of the Landfill, regardless of the characteristics, rather than allow it to fugitively emit to the atmosphere. Additionally, LFG extraction at these locations will remove heat and relieve pressure from these areas, which are the fundamental response actions to ETLF conditions.

SUMMARY OF BASIS OF HOV REQUEST

Based on our review of the monitoring data, historical conditions, analyses at surrounding wells, and our experience operating the LFG collection and control system at this site, we offer the following observations as demonstration and supporting data for requesting this temperature HOV:

- The potential for subsurface fire, combustion, or aerobic conditions is unlikely given the low oxygen levels and other LFG composition characteristics. No evidence of subsurface fires, such as burning odors, significantly elevated CO concentrations in the absence of hydrogen, visible smoke, or discrete areas of dramatic differential settlement have been observed by either the landfill owner or the LFG system operator in the vicinity of these six wells. In addition, technicians working at the site have not noticed any evidence of melted well riser piping or smoke that would indicate the presence of a subsurface fire at these wellheads.

- The historical temperature data recorded at these six wells is fairly uniform and consistent, which implies the wells are well balanced. Although the temperature values often exceed 63°C (145°F) or the approved HOV, the observed temperatures are considered to be within the range that facilitates thermophilic microbial metabolism and/or other types of chemical or bio-chemical processes that are occurring within the waste mass.

- The LFG system operator has been required to complete weekly CO readings in accordance with the enhanced monitoring requirements outlined in 40 CFR 60.63.1961(a)(5) for months. If Higher Operating Values are not approved, the Facility will continue to be burdened with time consuming and expensive CO monitoring at several wells that were specifically installed to collect gas and relieve pressure in areas of the landfill characterized by elevated temperatures. In the case of these six wells, CO concentrations (along with H_2 concentrations) have been thoroughly documented and data indicates that subsurface oxidation events are unlikely, which is the purpose of the enhanced monitoring protocol.

- At certain wellheads, the LFG system operator often throttles back on the wellhead valve and thereby restricts the LFG recovery quantities from these six extraction components in an attempt to maintain compliance with the EG/NESHAP temperature threshold. This is contrary

to the Facility’s objective of maximizing LFG collection rates and enhancing the LFG system’s effectiveness. Granting a temperature HOV at these six wellheads will enable the operator to potentially increase the LFG flowrates at these wells and extract the LFG being produced (acknowledged to be characterized by elevated temperatures) which may spread to other locations if not extracted.

- The situation at the Facility is evolving and construction of multiple capital projects associated with management and containment of ETLF conditions, as well as mitigation and abatement of odors, is ongoing. Active efforts to control the SSR include the installation of several new wells specifically to relieve pressure and remove heat in elevated temperature areas, as well as significant efforts to dewater the gas wells. Granting a temperature HOV at these six wellheads will assist the Facility in its goal of removing heat via gas and liquid extraction.

- Three of the six wells (EW-54, EW-83, and EW-88) are equipped with dewatering pumps. As the wells are dewatered, gas, often characterized by elevated temperature conditions, can be collected from deeper portions of the landfill. Therefore, effective pumping operations often result in a higher temperature measurement. However, the increase in temperature is often a necessary side-effect of pumping operations that remove heat from these portions of the waste mass and allow gas extraction from deeper areas.

Wellheads from previous temperature HOV approvals (dated 7/26/23, 9/28/23, and 1/9/24) are in the near vicinity of some of these wellheads, as shown on the attached drawing. The conditions of the wells in these previously approved HOV requests are similar to the conditions of these six wells. The Facility is therefore carefully and actively addressing the elevated temperature in these wells. The Facility will continue to monitor the wellhead conditions at these six wellheads to consistently evaluate subsurface conditions at these and surrounding wells. In addition, the Facility will continue to monitor CO concentrations using field instrumentation at these wells on a periodic basis.

Without the continued operation of these six wells, the LFG system coverage in their portions of the waste mass would not be as comprehensive as other regions of the Landfill, and ultimately heat would not be able to be collected in these portions of the landfill.

REQUESTED HIGHER OPERATING VALUES

In accordance with 40 CFR Subpart AAAA §63.1958(c), 40 CFR 60.34f(c), and the landfill’s Title V Operating Permit, the landfill requests to establish temperature HOVs for the following LFG collection components:

- EW-54: 190°F
- EW-77: 165°F
- EW-80: 165°F
- EW-83: 190°F
- EW-88: 190°F
- EW-97: 175°F

Data, specifically wellhead pressure, temperature, and methane content, will continue to be collected during normal monthly well monitoring to observe if the higher well temperatures inhibit anaerobic decomposition. In addition, visual observations will be performed to look for any indicators of subsurface fire. Daily temperature data will be collected at EW-54, using the automated temperature monitoring sensors.

Assuming this HOV is approved by VDEQ, temperature measurements recorded at these wellheads that are less than or equal to the approved HOV will not trigger the 5- and 15-day exceedance re-monitoring and corrective action requirements, nor the enhanced monitoring requirements. The LFG system operator will continue to perform monitoring and balancing activities generally similar to other wells.

Thank you in advance for your consideration of these requests. Please acknowledge your decision regarding this HOV for the Landfill's files and for reporting and recordkeeping purposes. If you have questions or require additional information, please feel free to contact either of the undersigned.

Sincerely,

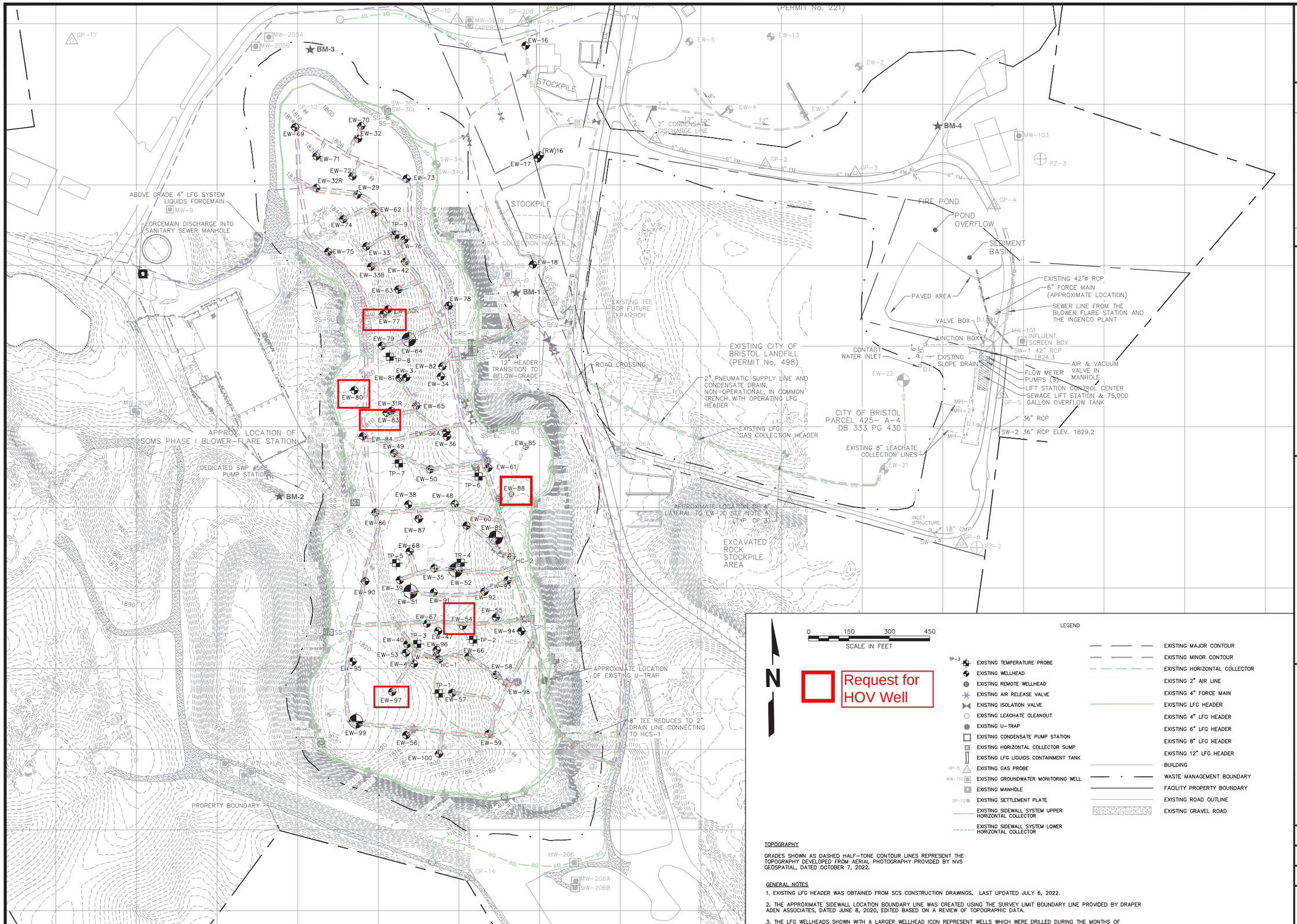
Lucas S. Nachman
Senior Project Professional
SCS Engineers

Quinn F. Bernier, PE
Project Professional
SCS Engineers

LSN/QFB

cc: Alex Everhart, U.S. Environmental Protection Agency, Region III
Erin Malone, U.S. Environmental Protection Agency, Region III
Jeff Hurst, VDEQ SWRO Regional Director
Stacey Bowers, VDEQ
Randall Eads, City of Bristol
Jonathan Hayes, City of Bristol
Laura Socia, City of Bristol
Jake Chandler, City of Bristol

Enclosures



0 150 300 450
SCALE IN FEET

N

Request for HOV Well

LEGEND

- EXISTING TEMPERATURE PROBE
- EXISTING WELLHEAD
- EXISTING REMOTE WELLHEAD
- EXISTING AIR RELEASE VALVE
- EXISTING ISOLATION VALVE
- EXISTING LEACHATE CLEANOUT
- EXISTING U-TRAP
- EXISTING CONDENSATE PUMP STATION
- EXISTING HORIZONTAL COLLECTOR SUMP
- EXISTING LFG LIQUIDS CONTAINMENT TANK
- EXISTING GAS PROBE
- EXISTING GROUNDWATER MONITORING WELL
- EXISTING MANHOLE
- EXISTING SETTLEMENT PLATE
- EXISTING SIDEWALL SYSTEM UPPER HORIZONTAL COLLECTOR
- EXISTING SIDEWALL SYSTEM LOWER HORIZONTAL COLLECTOR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING HORIZONTAL COLLECTOR
- EXISTING 2" AIR LINE
- EXISTING 4" FORCE MAIN
- EXISTING LFG HEADER
- EXISTING 4" LFG HEADER
- EXISTING 6" LFG HEADER
- EXISTING 8" LFG HEADER
- EXISTING 12" LFG HEADER
- BUILDING
- WASTE MANAGEMENT BOUNDARY
- FACILITY PROPERTY BOUNDARY
- EXISTING ROAD OUTLINE
- EXISTING GRAVEL ROAD

TOPOGRAPHY

GRADES SHOWN AS DASHED HALF-TONE CONTOUR LINES REPRESENT THE TOPOGRAPHY DEVELOPED FROM AERIAL PHOTOGRAPHY PROVIDED BY NVS GEOSPATIAL, DATED OCTOBER 7, 2022.

GENERAL NOTES

1. EXISTING LFG HEADER WAS OBTAINED FROM SCS CONSTRUCTION DRAWINGS, LAST UPDATED JULY 6, 2022.

2. THE APPROXIMATE SIDEWALL LOCATION BOUNDARY LINE WAS CREATED USING THE SURVEY LIMIT BOUNDARY LINE PROVIDED BY DRAPER ADEN ASSOCIATES, DATED JUNE 8, 2020, EDITED BASED ON A REVIEW OF TOPOGRAPHIC DATA.

3. THE LFG WELLHEADS SHOWN WITH A LARGER WELLHEAD ICON REPRESENT WELLS WHICH WERE DRILLED DURING THE MONTHS OF SEPTEMBER AND OCTOBER OF 2021, AND LATER CONNECTED IN NOVEMBER AND DECEMBER OF 2021. THESE WELLS HAVE NOT YET BEEN

NO.	REVISION	DATE

SHEET TITLE
EXISTING CONDITIONS

PROJECT TITLE

CLIENT
CITY OF BRISTOL INTEGRATED SOLID WASTE MANAGEMENT FACILITY
2655 VALLEY DRIVE
BRISTOL, VA 24201

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS, INC.
CHESTERFIELD, MIDLOTHIAN, VIRGINIA 23113
PH: (804) 378-7440 FAX: (804) 378-7433

PROJ. NO.
DSN. BY: HGW
DWN. BY: HGW
CHK. BY: DBK
Q/A RVW BY:
APP. BY:

CADD FILE:

DATE: 2/17/23

SCALE: AS SHOWN

DRAWING NO.

Attachment B: Wellfield Monitoring Data
Bristol Integrated Solid Waste Management Facility

GEM ID	Date Time	CH4 % by vol	CO2 % by vol	O2 % by vol	Bal Gas % by vol	Adj Flow	Initial Temp (°F)	Adjusted Temp (°F)	Init Static Pressure In. H2O	Adj Static Pressure In. H2O	System Pressure
EW-54	11/6/2023 10:10	7.2	13.9	15.7	63.3	1.3	65.9	66.1	-2.84	-2.85	-2.84
EW-54	11/20/2023 10:13	9.3	17.2	14.9	58.7	2.8	60.8	60.4	-4.4	-4.4	-4.45
EW-54	12/4/2023 10:13	7.1	12.4	15.9	64.6	3.3	52.8	53.1	-4.93	-4.93	-4.95
EW-54	12/18/2023 10:54	12.3	40.3	8.4	39	4.6	42.9	43	-4.95	-4.93	-5.13
EW-54	1/3/2024 10:01	11.1	21	14.3	53.7	2	38.4	38.6	-3.97	-3.96	-4.22
EW-54	1/19/2024 9:16	1.4	71.1	0.4	27.1	5.5	184.3	184.5	-2.06	-1.88	-4.18
EW-54	1/19/2024 12:58	1.7	75.6	0	22.8	28.6	185.9	186	-2.99	-2.91	-4.38
EW-54	1/24/2024 9:52	4.3	68	0	27.7	4.1	129.8	130.5	-3.82	-3.86	-4.01
EW-54	1/30/2024 15:10	6	66.5	0.1	27.4	1.7	98.5	100.3	-4.11	-3.87	-4.04
EW-54	2/12/2024 10:23	3.6	71.7	0	24.7	2.8	147.1	149.2	-3.28	-3.23	-4.38
EW-54	2/15/2024 9:12	7.7	70.2	0	22.2	2.3	100.7	101	-4.34	-3.74	-4.35
EW-54	2/26/2024 10:16	4.2	70.2	0	25.7	3.6	147.5	148.4	-2.69	-2.58	-4.53
EW-54	2/29/2024 10:12	3.6	70.7	0	25.7	6	185.4	185.2	-1.03	-1.28	-4.31
EW-77	11/7/2023 10:37	5.8	13.4	8.4	72.5	92.7	108.4	108.4	-2.89	-2.13	-10.27
EW-77	11/8/2023 17:05	7.1	14	7.6	71.4	39.4	117.1	117.1	-1.18	-0.37	-4.43
EW-77	11/20/2023 15:00	13.7	18.3	6.5	61.5	38.3	93.1	93.1	-0.34	-0.33	-5.55
EW-77	12/4/2023 15:08	14.6	19.2	6.6	59.5	40.4	143.7	143.7	-0.42	-0.42	-6.14
EW-77	12/19/2023 10:26	12.7	21	5.1	61.3	42.2	156.7	156.7	-0.46	-0.46	-7.09
EW-77	12/21/2023 10:32	16.9	24.2	3.1	55.8	44.9	156.1	156.1	-0.83	-0.53	-8.3
EW-77	12/27/2023 10:51	14.4	18.2	7.2	60.2	42.1	156.2	156.2	-0.5	-0.47	-7.53
EW-77	1/3/2024 14:51	16.1	20.4	6.8	56.8	41.6	155.1	155.1	-0.45	-0.45	-7.6
EW-77	1/4/2024 10:24	13	18.4	7.5	61.2		153.3	153.3	-0.5	-0.46	-7.91
EW-77	1/10/2024 9:29	10.6	16.8	8	64.7		152.3	152.3	-0.53	-0.52	-8.2
EW-77	1/15/2024 10:28	11.4	18	7.5	63.1		154.2	154.2	-0.47	-0.4	-8.12
EW-77	1/19/2024 8:41	12.1	18.3	6.6	63		152	152	-0.48	-0.39	-8.7
EW-77	1/24/2024 10:17	14.2	19.2	6.2	60.5		155	155	-0.38	-0.36	-7.99
EW-77	1/30/2024 13:38	17.1	21.7	5.4	55.8		154.5	154.5	-0.36	-0.32	-8.51
EW-77	2/1/2024 9:00	16.5	21.3	5.5	56.7		154.4	154.4	-0.33	-0.32	-9.1
EW-77	2/7/2024 8:41	16.7	21.3	5.5	56.6		151.4	151.4	-0.35	-0.34	-9.19
EW-77	2/14/2024 9:16	21.8	26.1	4.4	47.7		149.3	149.3	-0.07	-0.04	-5.99
EW-77	2/15/2024 9:51	20.6	24	4.9	50.5		152.8	152.8	-0.35	-0.3	-8.57
EW-77	2/21/2024 9:10	19	24.3	4.9	51.7		153.3	153.3	-0.97	-1.06	-9.17
EW-80	11/6/2023 8:54	27.5	49.2	0	23.4	25.5	143.9	143.9	-0.39	-0.33	-2.16
EW-80	11/20/2023 8:46	18.6	37.8	1.6	42	36.1	148.1	147.9	-0.73	-0.61	-5.24
EW-80	11/22/2023 7:53	20.1	41.3	1.1	37.5	42.7	148.1	148.1	-0.78	-0.77	-6.32
EW-80	11/30/2023 11:22	19.7	40.7	1.5	38.1	38.8	150	150	-0.65	-0.65	-5.37
EW-80	12/4/2023 8:51	19	40	1.7	39.3	42.8	149.7	149.7	-0.81	-0.8	-6.72
EW-80	12/6/2023 13:24	18.2	38.2	2.4	41.2	41.2	149.9	149.9	-0.79	-0.76	-6.4
EW-80	12/14/2023 9:18	14.4	31.6	3.7	50.4	42.5	151.6	151.6	-0.79	-0.78	-6.66
EW-80	12/18/2023 9:29	16.3	34.7	3.7	45.3	38.9	151.5	151.5	-0.88	-0.71	-7.15
EW-80	12/21/2023 9:36	36	51.1	0	12.9	43.6	147.9	148	-0.8	-0.81	-8.76
EW-80	12/27/2023 9:04	38.8	54.8	0	6.4	41.4	147.2	147.3	-0.7	-0.71	-7.66
EW-80	1/3/2024 8:43	20.2	37.5	3	39.3	31.3	150.1	149.7	-0.84	-0.52	-8.08
EW-80	1/4/2024 8:36	21.7	41.3	2	35.1	30.2	149.3	149.3	-0.49	-0.49	-8.01
EW-80	1/10/2024 8:02	22.3	42.7	1.5	33.6	28.6	149.5	149.5	-0.55	-0.46	-8.36
EW-80	1/18/2024 13:32	14.5	30.2	5.8	49.5	28	151.4	151.4	-0.41	-0.4	-7.87
EW-80	1/19/2024 9:00	20.7	39.6	3	36.6	30	151.2	151.2	-0.53	-0.46	-8.78
EW-80	1/24/2024 10:07	18.3	34.5	3.7	43.4	28.4	152.8	152.7	-0.46	-0.47	-8.2
EW-80	2/1/2024 9:53	21.1	37.4	3.2	38.2	26.7	151.5	151.5	-0.4	-0.4	-9.13
EW-80	2/7/2024 9:04	17	32.2	4.1	46.7	26.4	151.8	151.8	-0.43	-0.42	-9.52
EW-80	2/12/2024 8:50	21.2	35.4	3.2	40.2	23.2	152.2	152.1	-0.38	-0.35	-8.93
EW-80	2/15/2024 8:47	19.3	32.1	4	44.6	20.9	151.5	151.4	-0.36	-0.3	-9.05

GEM ID	Date Time	CH4 % by vol	CO2 % by vol	O2 % by vol	Bal Gas % by vol	Adj Flow	Initial Temp (°F)	Adjusted Temp (°F)	Init Static Pressure In. H2O	Adj Static Pressure In. H2O	System Pressure
EW-80	2/21/2024 9:03	18.3	33	4	44.8	20.3	152.2	152.1	-0.27	-0.27	-9.37
EW-83	11/7/2023 10:13	9.1	67.3	1	22.6	41.9	123.6	67.8	-0.44	-0.4	-2.38
EW-83	11/7/2023 10:20	9.1	68.5	1	21.4	37.3	123.6	123.6	-0.43	-0.39	-2.34
EW-83	11/20/2023 13:08	11.6	48.6	0.2	39.6	64.6	118.8	118.8	-1.43	-1.03	-3.7
EW-83	12/4/2023 13:44	9.7	69.5	0.2	20.5	62.5	180.9	180.9	-1.32	-1.11	-5.23
EW-83	12/6/2023 13:16	9.9	57	0.3	32.8	62.7	170.3	170.3	-1.14	-1.08	-5.57
EW-83	12/14/2023 9:10	9.8	53.9	0.3	36.1	68.6	163.2	163.2	-1.29	-1.24	-6
EW-83	12/19/2023 10:05	9.9	59.3	0.2	30.6	25.5	185.3	185.3	-0.29	-0.16	-1.99
EW-83	12/21/2023 9:45	12.4	54.6	0	33	55	172.8	172.8	-0.82	-0.81	-5.68
EW-83	12/27/2023 10:27	14.1	56.9	0.1	28.9	48.2	184.5	184.5	-0.67	-0.65	-5.01
EW-83	1/3/2024 13:02	14	54.7	0.3	31	41.4	180.5	180.5	-0.59	-0.46	-4.73
EW-83	1/4/2024 10:06	14.8	52.5	0	32.7		183	183	-0.78	-0.75	-5.43
EW-83	1/10/2024 9:12	15.9	55.3	0	28.8		181.3	181.3	-0.77	-0.76	-5.68
EW-83	1/19/2024 9:22	15.1	66.2	0	18.6		174	174	-0.74	-0.61	-5.9
EW-83	1/24/2024 9:59	14.6	55.2	0	30.1		184.6	184.6	-0.77	-0.76	-6.39
EW-83	1/30/2024 13:52	12.1	54.8	0.1	33.1		182.8	182.8	-0.76	-0.73	-5.72
EW-83	2/1/2024 9:12	9.8	53	0.2	37.1		181.6	181.6	-0.94	-0.93	-6.23
EW-83	2/7/2024 8:49	9.4	50.8	0.1	39.8		181.7	181.7	-1.23	-1.02	-6.44
EW-83	2/14/2024 13:03	11.8	49.4	0	38.8		180.9	180.9	-1.04	-0.91	-6.05
EW-83	2/15/2024 9:22	10.8	51.9	0.1	37.2		181.8	181.8	-1.02	-0.95	-5.99
EW-83	2/21/2024 8:47	13.1	50.8	0.9	35.2		180.9	180.9	-1.04	-1.03	-6.62
EW-88	11/2/2023 10:35	33.6	64	0	2.4	9.4	156.9	156.8	-1.72	-1.67	-1.92
EW-88	11/6/2023 13:16	36.2	61.7	0	2.2	10.9	155.7	155.4	-2.48	-2.44	-2.75
EW-88	11/9/2023 8:57	38.4	56	0	5.6	13	151.2	151.3	-3.92	-3.69	-4.02
EW-88	11/17/2023 10:33	35.1	54.8	0.2	9.8	16.5	161.8	161.7	-3.97	-3.98	-4.59
EW-88	11/20/2023 11:06	31.1	61.2	0.1	7.5	21.9	177.3	177.3	-3.48	-3.49	-4.73
EW-88	11/22/2023 8:32	30	58.7	0.2	11.1	16.7	163.8	163.7	-3.65	-4.25	-5
EW-88	11/30/2023 9:55	30.4	56	0	13.7	14.5	162.2	162.4	-2.9	-2.77	-3.47
EW-88	12/4/2023 13:08	31.9	51.1	0.3	16.8	16.6	155.4	155.5	-4.84	-4.83	-5.41
EW-88	12/6/2023 9:34	29.1	50.8	0.4	19.7	16.9	155.2	155.3	-4.23	-4.31	-4.96
EW-88	12/14/2023 8:52	29.6	49.1	0.3	21.1	17.3	156.1	156	-5.38	-5.4	-6.06
EW-88	12/18/2023 13:10	19	29.2	9.5	42.3	13.4	154.2	154.3	-5.21	-4.8	-5.24
EW-88	12/21/2023 10:09	29.2	51.6	0	19.2	14.3	154.4	154.5	-4.45	-4.33	-5.05
EW-88	12/27/2023 9:37	29.7	54.7	0	15.7	15.3	166.1	166.1	-3.63	-3.6	-4.2
EW-88	1/3/2024 12:38	31.9	46.2	0.4	21.5	16	156.8	156.5	-3.63	-3.68	-4.26
EW-88	1/4/2024 9:21	27.1	55.1	0	17.9	16.9	169.1	169.1	-3.53	-3.61	-4.36
EW-88	1/10/2024 8:24	30.4	51.2	0.1	18.3	14.1	150.9	150.7	-4.08	-4.19	-4.54
EW-88	1/15/2024 10:49	29.1	50.3	0	20.7	14.9	152.4	152.5	-4.57	-4.5	-5.3
EW-88	1/19/2024 9:40	32.9	55.7	0	11.4	13.7	156.8	156.9	-3.34	-3.47	-4.19
EW-88	2/12/2024 12:49	0.1	0.6	21.1	78.2	23.6	184.1	184	-3.11	-3.1	-4.56
EW-88	2/15/2024 9:00	26	52.3	0	21.6	22.5	181.8	181.7	-3.58	-3.65	-4.28
EW-88	2/21/2024 8:40	27.1	54.9	0	18	22.8	182.2	182.5	-3.52	-3.51	-5.28
EW-88	2/26/2024 13:23	25.2	53.4	0	21.4	17.1	180	180	-2.97	-2.86	-4.16
EW-88	2/29/2024 10:22	24.5	57	0	18.5	23.4	181.1	181.1	-3.26	-3.34	-4.29
EW-97	11/6/2023 9:22	23.2	39.1	6.2	31.5	52.5	139.6	139.6	-0.8	-0.7	-1.89
EW-97	11/20/2023 9:15	19	30.7	8.5	41.8	69.2	131.3	52.9	-1.72	-1.06	-3.7
EW-97	11/20/2023 9:53	19.4	34.3	7.6	38.7	62.1	131.3	131.3	-0.99	-0.98	-4.02
EW-97	12/4/2023 9:18	25.3	41.3	4.6	28.8	32.7	140.3	140.3	-1.01	-0.28	-3.77
EW-97	12/18/2023 10:00	29.5	56.7	0.6	13.3	19.2	144.8	144.8	-0.31	-0.05	-4.55
EW-97	1/3/2024 9:13	22.4	64.8	0	12.8	23.9	163.1	163.1	-0.04	-0.14	-3.76
EW-97	1/4/2024 8:51	28	53.7	1.4	17		156.4	156.4	-0.38	-0.38	-4.32
EW-97	1/19/2024 10:48	26.3	61.9	0	11.8		158.6	158.6	-0.55	-0.56	-3.88
EW-97	1/19/2024 12:34	26	65	0	9		156.2	156.2	-0.62	-0.95	-4.05
EW-97	1/24/2024 9:34	35.6	52.7	0.1	11.6		159.5	159.5	-1.24	-1.61	-3.7
EW-97	1/30/2024 14:20	39	50.7	0	10.2		157.8	157.8	-1.87	-1.78	-3.97

GEM ID	Date Time	CH4 % by vol	CO2 % by vol	O2 % by vol	Bal Gas % by vol	Adj Flow	Initial Temp (°F)	Adjusted Temp (°F)	Init Static Pressure In. H2O	Adj Static Pressure In. H2O	System Pressure
EW-97	2/1/2024 9:35	36.8	47.9	1.1	14.3		147.3	147.3	-2.14	-2.13	-4.5
EW-97	2/7/2024 8:59	37.3	45.9	1.1	15.7		133.7	133.7	-3.09	-3.06	-4.52
EW-97	2/12/2024 9:18	36.7	48.8	0.5	14.1		144.7	144.7	-2.44	-2.36	-3.66
EW-97	2/26/2024 9:19	39.7	48.4	0.3	11.6		148.7	148.7	-2.37	-2.57	-3.46
EW-97	2/29/2024 10:02	42.1	50	0.1	7.7		149.1	149.1	-2.9	-2.98	-4.17

ATTACHMENT C-1
CARBON MONOXIDE READINGS - LABROTORY ANALYSIS
BRISTOL INTEGRATED SOLID WASTE MANAGEMENT FACILITY
BRISTOL, VIRGINIA

EW-54		EW-77		EW-80		EW-83		EW-88		EW-97	
Date	CO Reading (ppmv)	Date	CO Reading (ppmv)	Date	CO Reading (ppmv)	Date	CO Reading (ppmv)	Date	CO Reading (ppmv)	Date	CO Reading (ppmv)
1/19/2024	910	12/21/2023	219	11/22/2023	ND	12/6/2023	611	11/2/2023	247	1/4/2024	539
Avg	**910**	12/27/2023	224	11/30/2023	ND	12/14/2023	562	11/9/2023	153	1/19/2024	572
		1/4/2024	408	12/6/2023	117	12/21/2023	564	11/17/2023	240	1/24/2024	417
		1/10/2024	718	12/14/2023	ND	12/27/2023	564	11/22/2023	226	2/1/2024	362
		1/19/2024	1690	12/21/2023	ND	1/4/2024	512	11/30/2023	192	**Avg**	**473**
		1/24/2024	964	12/27/2023	ND	1/10/2024	442	12/6/2023	183		
		2/1/2024	944	1/4/2024	ND	1/19/2024	716	12/14/2023	181		
		2/7/2024	824	1/10/2024	ND	1/24/2024	598	12/21/2023	171		
		2/15/2024	189	1/19/2024	94.1	2/1/2024	624	12/27/2023	228		
		Avg	**687**	1/24/2024	ND	2/7/2024	623	1/4/2024	284		
				2/1/2024	ND	2/15/2024	556	1/10/2024	158		
				2/7/2024	ND	**Avg**	**579**	2/15/2024	347		
				2/15/2024	ND			**Avg**	**218**		
				Avg	**92**						

Notes: ND = Non-Detected
1: For purposes of averaging the concentration at EW-80, readings that are Non-Detect are averaged at 90 ppm, which is the laboratory detection limit.

ATTACHMENT C-2
HYDROGEN READINGS - LABROTORY ANALYSIS
BRISTOL INTEGRATED SOLID WASTE MANAGEMENT FACILITY
BRISTOL, VIRGINIA

EW-54		EW-77		EW-80		EW-83		EW-88		EW-97	
Date	H2 Reading (% by Vol.)	Date	H2 Reading (% by Vol.)	Date	H2 Reading (% by Vol.)	Date	H2 Reading (% by Vol.)	Date	H2 Reading (% by Vol.)	Date	H2 Reading (% by Vol.)
1/19/2024	27.2	12/21/2023	0.5	11/22/2023	1.2	12/6/2023	17.4	11/2/2023	7.7	1/4/2024	10.3
Avg	**27.2**	12/27/2023	0.4	11/30/2023	1.2	12/14/2023	19.0	11/9/2023	5.1	1/19/2024	12.8
		1/4/2024	0.4	12/6/2023	1.3	12/21/2023	16.9	11/17/2023	6.2	1/24/2024	10.6
		1/10/2024	0.5	12/14/2023	0.8	12/27/2023	17.3	11/22/2023	6.3	2/1/2024	8.2
		1/19/2024	0.3	12/21/2023	0.5	1/4/2024	13.6	11/30/2023	5.1	**Avg**	**10.5**
		1/24/2024	0.3	12/27/2023	0.3	1/10/2024	14.8	12/6/2023	5.5		
		2/1/2024	0.5	1/4/2024	1.8	1/19/2024	20.5	12/14/2023	5.4		
		2/7/2024	0.3	1/10/2024	1.3	1/24/2024	16.2	12/21/2023	5.7		
		2/15/2024	0.4	1/19/2024	1.7	2/1/2024	16.1	12/27/2023	7.2		
		Avg	**0.4**	1/24/2024	1.3	2/7/2024	16.0	1/4/2024	8.1		
				2/1/2024	1.1	2/15/2024	15.0	1/10/2024	5.2		
				2/7/2024	1.1	**Avg**	**16.6**	2/15/2024	9.1		
				2/15/2024	1.0			**Avg**	**6.4**		
				Avg	**1.1**						