ADDENDUM #1 *June 1, 2023*

TO: **ALL POTENTIAL SUBMITTERS**

FROM: **RON VENTURELLA, BUNCOMBE COUNTY PROCUREMENT MANAGER**

SUBJECT: **ADDENDUM #1 FOR REOI LANDFILL GAS BENEFICIAL USE EVALUATION FOR THE BUNCOMBE COUNTY LADNFILL**

Addendum # 1

The following changes, revisions, additions, and/or clarifications to the plans and/or specifications are hereby made a part of the original documents.

1. Sign in sheet from the mandatory pre-submittal meeting held on May 24, 20223 is attached.
2. Table 1 titled "Tons of Waste Received" has been corrected and is attached.
3. For Quality Standards for DENC to accept gas, see attached document titled "Gas Quality Standards for Renewable Gas / Rules and Regulations Appendix B" is now made part of the original documents.
4. So the County may respond to all question in a timely manner, a cut off for questions will be Friday, June 9, 2023, 5:00pm ET. The County will respond to all question in an addendum by Thursday, June 15, 2023, 5:00pm ET.

The following questions were asked by potential bidders (listed in no particular order):

1) Meeting attendee asked if they could install the line from the site to our facilities? The answer is technically, yes. However;
    a. If they constructed such a line in the DOT right of way, they would be considered an Operator and subject to the same rules, regulations and standards as DENC, Piedmont Natural Gas, or any other natural gas utility. That includes inspections, location servicing(811), maintenance and repairs to mention a few of those responsibilities.
    b. Since this is in our Franchise Territory, an agreement would have to be negotiated between DENC and the other operator before such action could be approved.

2) Meeting attendee asked the distance to the nearest connection point? It is approximately 7 miles to the nearest potential connection point. The distance given during the meeting was 6 miles to our nearest connection point which is incorrect. An estimate of the cost to extend the necessary facilities is between $2,000,000 and $3,000,000 per mile. These are only estimated numbers at this point and an Engineering Review would have to be commissioned once more information becomes available.

3) Can we see the entire gas report provided by SCS? The attachment titled "Landfill Gas Study", should contain information pertinent to this project.

4) What is the size and voltage of the current power interconnect? The line voltage is 12,900 and it is stepped down to 480 the switchgear is rated 1200 amps per phase. See the attachments the titled "Transformer" and "Switchgear"; describing the switch gear breaker and the transformer.

5) Can you provide the amount of carbon credits generated/received for each of the past 3 calendar years?
    a. 2020 32,282
    b. 2021 30,636
    c. 2022 31,203

Attached:
Sign In Sheet from Pre-Submittal Mandatory Meeting on 5/24/23 (1 page)
Corrected Table 1. Tons of Waste Received (1 page)
Rules and Regulations Appendix B (5 pages)
Landfill Gas Study (27 pages)
Transformer (1 page)
Switchgear (1 page)

END OF ADDENDUM #1
REOI LANDFILL GAS BENEFICIAL USE EVALUATION FOR THE BUNCOMBE COUNTY LADNFILL

BUNCOMBE COUNTY
SOLID WASTE MANAGEMENT FACILITY
LANDFILL GAS BENEFICIAL USE EVALUATION
REQUEST FOR EXPRESSIONS OF INTEREST

PRE-SUBMITTAL MEETING
SIGN-IN SHEET

WEDNESDAY, MAY 24, 2023
9:00 TO 10:00 AM

	NAME	COMPANY	PHONE NO.	E-MAIL ADDRESS
☐	Dane Pedersen	Buncombe	(828) 250-5477	Dane.Pedersen@buncombecounty.org
☐	Kristy Smith	Buncombe	(828) 250-5473	Kristy.Smith@buncombecounty.org
☐	Bob Budeer	VRNG	203 300 4678	bbudeer@visionrng.com
☐	FRANK TERRY	AMERESCO	919-389-2076	FTERRY@AMERESCO.COM
☐	Kiran Sonawane	Ameresco	585-350-9934	KSONAWANE@Ameresco.com
☐	MARK McCONNELL	NORTHERN BIOGAS	713-819-5886	MMCCONNELL@NORTHERNBIOGAS.COM
☐	Steve Allman	Landfillgroup	828-779-0239	Steve.Allman@landfillgroup.com
☐	Wendy Karably	TRC	704-560-8775	wkarably@trccompanies.com
☐	Kenton Yang	SCS	919-397-5863	Kyang@scsengineers.com
☐	Davis Swaim	DENC	828-273-6123	davis.swaim@dominionenergy.com
☐	Vince Howell	DENC		
☐	Paul Manley	Bio Methane Partners	832-316-6272	pmanley@biomethanepartners.com
☐				
☐				

Table 1. Tons of Waste Received (**UPDATED 05/26/2023**)

Fiscal Year	Tonnage	Cumulative Tonnage	Active Disposal Area
1997-98	86,622	86,622	Cells 1-3
1998-99	109,734	196,356	Cells 1-3
1999-00	120,143	316,499	Cells 1-3
2000-01	122,333	438,832	Cells 1-3
2001-02	146,690	585,522	Cells 4-5
2002-03	160,863	746,385	Cells 4-5
2003-04	170,170	916,555	Cells 4-5
2004-05	173,774	1,090,329	Cells 4-5
2005-06	122,034	1,212,363	Cells 4-5
2006-07	117,215	1,329,578	Cells 4-5
2007-08	143,994	1,473,572	Cell 6
2008-09	129,551	1,603,123	Cell 6
2009-10	113,497	1,716,620	Cell 6
2010-11	116,876	1,833,496	Cell 6
2011-12	109,317	1,942,813	Cell 6
2012-13	107,469	2,050,282	Cell 6
2013-14	113,026	2,163,308	Cell 6
2014-15	108,388	2,271,696	Cell 6
2015-16	112,883	2,384,579	Cell 6
2016-17	107,523	2,492,102	Cell 6
2017-18	115,068	2,607,170	Over Cells 1-6
2018-19	154,454	2,761,624	Over Cells 1-6
2019-20	184,320	2,945,944	Over Cells 1-6
2020-21	184,977	3,130,921	Over Cells 1-6
2021-22	135,665	3,266,586	Over Cells 1-6
07/01/22-12/31/22	63,378	3,329,964	Over Cells 1-6

GAS QUALITY STANDARDS FOR RENEWABLE GAS

These Gas Quality Standards set forth the terms and conditions under which PSNC will accept "Renewable Gas" onto its system and pursuant to which it will continue to accept and redeliver such gas to customers receiving service from PSNC. The terms of these Gas Quality Standards may be modified from time-to-time, with the approval of the North Carolina Utilities Commission, based upon PSNC's actual operating experience with Renewable Gas and/or any threats to PSNC's ability to provide safe, reliable, and economic natural gas service to the public.

For purposes of these Gas Quality Standards, "Renewable Gas" shall mean gas capable of combustion in customer appliances or facilities which is similar in heat content and chemical characteristics to natural gas produced from traditional underground well sources and which is intended to act as a substitute or replacement for natural gas. Renewable Gas shall include but not be limited to biogas, biomethane, and landfill gas, as well as any other type of natural gas equivalent produced or manufactured from sources other than traditional underground well sources. For purposes of the application of PSNC's rate schedules and its Rules and Regulations, Renewable Gas shall be treated in a manner equivalent to "Gas" (as that term is defined in PSNC's Rules and Regulations) except to the extent that these Gas Quality Standards specify more restrictive obligations applicable to Renewable Gas, in which case the provisions of these Gas Quality Standards shall control.

Receipt of Renewable Gas

PSNC's obligation to receive and accept Renewable Gas shall be limited as set forth below and to situations where PSNC is able to physically receive the Renewable Gas into its system without materially impacting its ability to provide service to its customers, meet its legal, contractual, and regulatory obligations, or safely and reliably operate its system. Construction of facilities needed to receive and accept Renewable Gas shall be governed by PSNC's standard feasibility analyses and PSNC shall have no obligation to construct economically infeasible facilities to enable receipt of Renewable Gas. PSNC may require prospective suppliers of Renewable Gas to enter into interconnection and facilities reimbursement agreements, as discussed below, as a condition to receipt and acceptance of Renewable Gas.

Testing Requirements

Initial Testing. Prior to the initial receipt of Renewable Gas by PSNC, any supplier thereof shall provide the results of an independent laboratory test demonstrating that supplier's Renewable Gas is in conformance with the Gas Quality Standards set forth herein. Supplier shall also provide PSNC with the results of an additional laboratory test on a second sample of its Renewable Gas taken at least seven (but no more than fourteen) days after the initial test sample, confirming the continuing conformance of supplier's Renewable Gas with the standards set forth herein. After the initial receipt of Renewable Gas by PSNC, any supplier thereof shall provide the results of three consecutive independent laboratory tests, performed no less than thirty days (or more than 45 days) apart, demonstrating that supplier's Renewable Gas is in conformance with the Gas Quality Standards set forth herein. Such testing shall be performed by an independent third-party laboratory satisfactory to PSNC at supplier's sole cost and expense.

Subsequent Testing. If receipt of supplier's Renewable Gas is interrupted or suspended by PSNC pursuant to the terms hereof, then prior to resumption of acceptance of deliveries of Renewable Gas from such supplier, and at the reasonable discretion of PSNC, that supplier may be required to provide the results of an independent laboratory test, demonstrating that supplier's Renewable Gas continues to be or has been restored to be in conformance with the Gas Quality Standards set forth herein. If such subsequent independent laboratory testing is required by PSNC, Supplier shall also provide PSNC with the results of an additional laboratory test on its Renewable Gas conducted within seven days of the initial test, confirming the conformance of supplier's Renewable Gas with the standards set forth herein. These provisions for Subsequent Testing shall not apply to (i) simple disruptions in the flow or production of Renewable Gas that occur in the normal course of supplier's business operations and which do not otherwise involve circumstances that would authorize PSNC to curtail the receipt of such supplies hereunder, or (ii) to non-material and/or incidental deviations from the specific Renewable Gas Quality Standards set forth below related to Temperature, Methane Content, CHDP, Nitrogen, Oxygen, Carbon Monoxide, Total Inerts, Heating Value, Interchangeability, Total Sulfur, Carbon Dioxide, Water, or Hydrogen Sulfide, so long as any such deviations are not recurring in nature and do not pose a threat to PSNC's equipment or facilities, the equipment or facilities of PSNC's customers, or to PSNC's ability to provide continuous, safe, and reliable service to the public.

Quarterly Testing. In addition to the other testing requirements set forth herein, and on no less than a quarterly basis, supplier shall provide to PSNC the results from independent laboratory testing, satisfactory to PSNC and at supplier's sole cost and expense, demonstrating that supplier's Renewable Gas continues to conform to the Gas Quality

Standards set forth herein. PSNC may waive the quarterly testing requirement if, in the reasonable exercise of PSNC's discretion, it concludes that the percentage of Renewable Gas to be received at a specific interconnect point is immaterial in relation to the amount of geologic natural gas flowing through PSNC's system at that point such that the receipt of Renewable Gas at that point will not have a detrimental impact on PSNC's system, its operations, or services provided to customers.

Supplemental Testing. PSNC reserves the right to request supplier, at supplier's sole expense, to perform additional testing for constituent or contaminant compounds in addition to those expressly listed herein, should (i) the presence of such compounds be determined by PSNC to be reasonably possible in supplier's Renewable Gas stream, and (ii) should such constituents or compounds pose an actual or prospective threat to PSNC's system or the provision of safe and reliable natural gas service to PSNC's customers.

Renewable Gas Source. In the event a supplier flowing Renewable Gas onto PSNC's system determines to alter its source of production of Renewable Gas or to take action that might otherwise be expected to change the characteristics or constituent components of its gas stream, supplier shall promptly notify PSNC, in advance, of such prospective change and PSNC shall have no obligation to receive Renewable Gas from such supplier until it has been provided with the results of two consecutive independent laboratory tests, performed no less than seven days apart, demonstrating that supplier's modified Renewable Gas is in conformance with the Gas Quality Standards set forth herein. Such testing shall be performed by an independent third-party laboratory satisfactory to PSNC at supplier's sole cost and expense.

With regard to any of the testing provided for above, PSNC shall be provided reasonable advance notice of such testing and shall have the right to observe the samples being taken. Test results shall be promptly shared between PSNC and supplier upon receipt of such results from the testing laboratory. With regard to any of the testing provided for above, and upon request of a supplier and in the reasonable exercise of PSNC's discretion, PSNC will waive the requirement for laboratory testing for one or more constituent components, on a not unduly discriminatory basis, where certified field testing equipment satisfactory to PSNC is available to test for those components.

The Renewable Gas testing requirements set forth above shall include tests for and reportable levels of each of the constituent elements set forth below. To the extent that two consecutive laboratory tests demonstrate non-detectable levels of one or more of the constituent compounds set out below from a supplier's Renewable Gas stream at a specific interconnect point, PSNC will consider, in the reasonable exercise of its discretion, written requests for waiver of the requirement to continue testing for such constituent compounds at that specific interconnect point. PSNC may grant or deny such petition in the reasonable exercise of its discretion subject only to the requirement that any decision to deny a petition for a waiver or to revoke a waiver once granted shall state the basis for the decision in sufficient detail to facilitate further discussions and/or review of the decision by the Commission. Any such waiver shall be revocable in the reasonable exercise of PSNC's discretion subject to the requirements of the foregoing sentence.

Renewable Gas Quality Standards

All Renewable Gas delivered to PSNC shall fully comply with the quality standards and specifications set forth below.

Renewable Gas delivered to PSNC shall be free of components which might interfere with its merchantability or cause damage to the operation of PSNC's system or equipment or those of its customers. All such Renewable Gas delivered to PSNC shall specifically conform to the following minimum Gas Quality Standards:

Delivery Temperature: Minimum of 40°F and maximum of 120°F.

Methane: Minimum methane content of 94%.

Heating Value: Between 980 and 1100 Btu/SCF at dry gas conditions (14.73 psia at 60°F).

Interchangeability: All Renewable Gas delivered by any single supplier thereof shall fall within a WOBBE range of 1290 to 1370.

Hydrogen Sulfide (H_2S): Less than or equal to 0.25 grain/100 SCF.

Mercaptan: Shall not exceed 0.5 grain/100 SCF.

Total Sulfur: Less than or equal to 10 grain/100 SCF, including sulfur from hydrogen sulfide and mercaptan.

Water: Less than or equal to 7 pounds/MMSCF at dry gas conditions (14.73 psia at 60°F).

CHDP: Not greater than 20°F.

Carbon Dioxide (CO_2): Not more than 2% by volumetric basis.

Nitrogen: Not more than 2% by volumetric basis.

Oxygen: Not more than 0.2% by volumetric basis.

Carbon Monoxide (CO): Not more than 0.1% by volume.

Total Inerts: Not more than 3.2% by volumetric basis. For purposes of this provision, Total Inerts are defined as Oxygen, Nitrogen, and Carbon Dioxide.

Hydrogen: No more than 600 ppm.

Solid Particle Size: Gas filtration is required and shall be sufficient to remove 99.99% of solid particles 3 microns or larger.

Dust, Gums & Solid Matter: The gas shall be free of dust, gums, gum-forming constituents, or other liquid or solid matter which might become separated from the gas in the course of transportation through pipelines.

Biologicals: Gas, including any associated liquids, shall not contain any micro-biological organisms exceeding 4×10^4/scf (qPCR per APB, SRB, IOB group), active bacteria or bacterial agents > 0.2 microns.

Organic Silicon (Siloxanes): Total Organic Silicon (siloxanes) shall not be greater than 0.40 mg of Si/Nm^3.

Odorization Masking/Fading Agents (VOC): Gas shall be free of agents, compounds, or the like which will interfere with the process of the human olfactory process in the recognition of odorized natural gas through bonding with the odorant or causing interference with the human olfactory senses.

VOC: Renewable Gas shall be free from any halogenated compounds that when, through the process of combustion, form dioxins.

The following Constituents of Concern shall be limited as indicated:

Constituent	Limit mg/m^3 (ppmv)
Arsenic	0.48 (0.15)
p-Dichlorobenzene	140 (24)
Ethylbenzene	650 (150)
n-Nitroso-di-n-propylamine	0.81 (0.15)
Vinyl Chloride	21 (8.3)
Antimony	30 (6.1)
Copper	3.0 (1.2)
Lead	3.8 (0.44)
Methacrolein	53 (18)
Alkyl thiols (mercaptans)	N/A (610)
Toluene	45,000 (12,000)

If additional equipment is required to ensure consistent compliance of supplier's Renewable Gas to the Gas Quality Standards set forth above, PSNC may require supplier to purchase, and promptly install, any additional equipment necessary to meet the referenced gas quality specifications at supplier's expense. The unreasonable refusal to do so shall be a violation of supplier's obligations hereunder.

Termination of Obligation to Receive Gas

Except as otherwise provided below, if Renewable Gas proffered for delivery to PSNC fails to meet the specifications of the Gas Quality Standards set forth herein, or is otherwise out of conformance with the provisions of these Gas Quality Standards, PSNC may interrupt or suspend its receipt and acceptance of such Renewable Gas until such Renewable Gas is in conformity with these Gas Quality Standards and such conformity is verified by an independent certified third-party laboratory satisfactory to PSNC as provided above; except in circumstances where field testing for such compliance is permitted under the provisions of Subsequent Testing set forth above. Notwithstanding PSNC's right to terminate its receipt of Renewable Gas for non-compliance with the Gas Quality Standards set forth herein, PSNC will not terminate such receipt for minor non-compliance with such standards applicable to the enumerated constituent component measurements of a producer's Renewable Gas stream listed under Subsequent Testing above (except Temperature), where:

(a) Such constituent components can be measured in real time by field equipment operated or monitored by PSNC;

(b) Variances for one or more of the constituent component measurements listed under Subsequent Testing (except Temperature) do not exceed standards by more than ten percent (10%);

(c) Variances for one or more of the constituent component measurements listed under Subsequent Testing (except Temperature) do not exceed four hours in duration; and

(d) No operational problems or continuity of service issues are created for PSNC by the variance, as determined in the reasonable exercise of PSNC's discretion.

PSNC shall provide electronic notice to any producer of variations from standards found in such producer's Renewable Gas stream. The four-hour limit on the duration of any variances for the constituent component measurements identified above (except Temperature) shall commence upon the issuance of such notice.

PSNC shall also have the right to interrupt or suspend the receipt of Renewable Gas at any time from any supplier in the event that: (i) constituent compounds or components of supplier's Renewable Gas are determined to pose an actual or potential health risk to the public or to PSNC's employees that is different in degree or nature from the risks normally attendant upon the use and transportation of natural gas; (ii) testing or other evidence reasonably indicates that supplier's Renewable Gas contains constituent compounds or components reasonably likely to cause or actually causing harm to PSNC's facilities or equipment (including corrosion damage); (iii) testing or other evidence reasonably indicates that supplier's Renewable Gas contains constituent compounds or components reasonably likely to cause or actually causing harm to the facilities or equipment of PSNC's other customers (including corrosion damage); or (iv) the chemical characteristics or physical properties of supplier's Renewable Gas are impeding PSNC's ability to provide safe and reliable service to PSNC's other customers.

In the event of such interruption or suspension of service, PSNC shall have no obligation to resume receipt of Renewable Gas from supplier until the correction or remediation of the problem prompting such interruption or suspension of service has occurred as determined by PSNC in the exercise of its reasonable discretion.

Interconnection Agreement

Prior to and as a condition of delivering Renewable Gas to PSNC and PSNC's acceptance thereof, any proposed supplier must enter into an interconnection and facilities reimbursement agreement with PSNC addressing, to PSNC's reasonable satisfaction, the terms and conditions applicable to construction and payment for any needed incremental facilities required to accept or receive supplier's Renewable Gas. PSNC shall have no obligation to accept or receive Renewable Gas until such agreement is executed and its obligations to accept and receive Renewable Gas following such execution shall be governed by the interconnection and reimbursement agreement and these Gas Quality Standards. In the event of a conflict between the provisions set forth in these Gas Quality Standards and the terms and conditions of an interconnection and reimbursement agreement, the provisions of these Gas Quality Standards shall control.

Measurement Requirements

PSNC will measure, or receive data from the supplier to measure, on a daily or continuous basis, the quantity, heat content, WOBBE value, and specific gravity of all Renewable Gas delivered to PSNC at each point of delivery into PSNC's system utilized by Renewable Gas suppliers.

Indemnity/Liability

As a condition to the receipt and acceptance of Renewable Gas by PSNC, all suppliers of Renewable Gas shall indemnify and hold PSNC harmless from any and all claims, suits, actions, debts, accounts, damages, costs, losses, and expenses, including reasonable attorney fees, (i) arising from or related to the delivery to PSNC by supplier of any Renewable Gas that fails to meet the Gas Quality Standards set forth herein or otherwise is not in compliance with these Gas Quality Standards, or (ii) arising from or related to damage to PSNC's equipment or facilities or the equipment or facilities of PSNC's customers from receipt of supplier's Renewable Gas.

PSNC SHALL HAVE NO RESPONSIBILITY OR LIABILITY TO SUPPLIER, SUPPLIER'S CUSTOMER, OR ANY THIRD-PARTY ASSOCIATED WITH ITS EXERCISE OF THE RIGHT TO INTERRUPT OR SUSPEND RECEIPT OF RENEWABLE GAS AS PROVIDED FOR ABOVE AND IN NO EVENT SHALL BE LIABLE FOR ANY PUNITIVE, CONSEQUENTIAL, OR EXEMPLARY DAMAGES ARISING FROM ITS RECEIPT OR ACCEPTANCE (OR FAILURE TO RECEIVE OR ACCEPT) RENEWABLE GAS UNDER THE TERMS HEREOF OR OTHERWISE.

1.0 INTRODUCTION

1.1 PURPOSE

Beginning in 2011, the Buncombe County Solid Waste Department (County) has operated a landfill gas-to-energy (LFGTE) facility at the Subtitle D landfill (Landfill) in Alexander, North Carolina. The LFGTE program includes a landfill gas (LFG) collection and control system (GCCS) wellfield and a 1.4-megawatt (MW) Jenbacher engine. The renewable electrical power generated by the engine is sold to Duke Energy under a power purchase agreement (PPA). In late 2021, the Duke Energy PPA will expire, and the County is interested in pro-actively planning for the next phase of LFG beneficial use.

In an effort to understand LFG recovery potential and possible LFG beneficial end use options, SCS Engineers, PC (SCS) assessed the GCCS and, on a high-level, discussed potential end use options for the County. The LFG assessment is presented as follows:

- **Section 1** – Purpose of study and GCCS description
- **Section 2** – Assessment of integrity, condition, and operating performance of the existing GCCS and LFG quality
- **Section 3** – Recommendations to improve the GCCS performance
- **Section 4** – Evaluation of LFG recovery potential
- **Section 5** – LFG end-use options and recommendations

1.2 SITE DESCRIPTION

The Buncombe County Solid Waste Management Facility is located in the mountains of western North Carolina, approximately 9 miles north of the City of Asheville. The 654-acre solid waste management facility (see **Figure 1-1**) opened in 1997 and comprises of a Subtitle D landfill, construction and demolition (C&D) landfill, LFGTE facility with flare, wood waste mulching facility, convenience center for residential drop-off, a household hazardous waste (HHW) facility, a white goods and tires holding facility, and leachate storage pond.

Cells 1 through 10 of the Subtitle D landfill are being constructed progressively over the approximated 30-year life of the facility. The County has constructed Cells 1 through 6, covering approximately 56 acres.

The Buncombe County Solid Waste Management Facility is a host site for a research project conducted under the United States Environmental Protection Agency's (EPA) Project XL Program. Under the Project XL, the County is operating a bioreactor, a combined leachate recirculation and LFG recovery system, at the Subtitle D landfill. The purpose of the project is to determine if liquids addition has adverse effects on alternative liner systems. The County is also monitoring the effects of liquids addition on waste density and settlement to determine if an increase in landfill life and LFG generation for beneficial use can be realized.

Figure 1-1: Buncombe County Solid Waste Management Facility

1.3 GCCS DESCRIPTION

The GCCS serves to collect the LFG generated by waste degradation in the Landfill, and it was installed on a non-regulatory basis (not currently subject to federal landfill air regulation). The system (see **Figure 1-2** and **Table 1-1**) consists of:

- Twenty-three (23) vertical LFG extraction wells (VW-6 and VW-17 were abandoned in 2020)
- Two (2) LFG migration collectors at the landfill base of the north slope (near the flare)
- One (1) leachate sump slope riser collector in Cell 5
- One (1) protective cover horizontal collectors in Cell 6

The bioreactor system consists of surficial gravity trenches (SGTs) and horizontal injection trenches (HITs) that generally have dual leachate recirculation/injection and LFG collection capabilities (see **Figure 1-3**). The bioreactor system components include:

- Thirteen (13) SGTs, which have ceased to collect LFG
- Six (6) HITs in Cells 1 through 5, which have ceased to collect LFG
- Eight (8) HITs in Cell 6, which LFG is collected from four of those eight

New HITs in Cell 6 will be dedicated to leachate recirculation. Leachate recirculation has been suspended since 2017 due to the side slope filling operations; however, at the date of this study, leachate recirculation in specific infrastructure that is no longer near the side slope filling operations is commencing.

The LFGTE facility and flare consists of a 500-standard cubic feet per minute (scfm) blower, a 3,000-scfm open flare, a Jenbacher Model JGS420 LFG-fired engine preceded by a treatment system (dewatering, filtering, and compression).

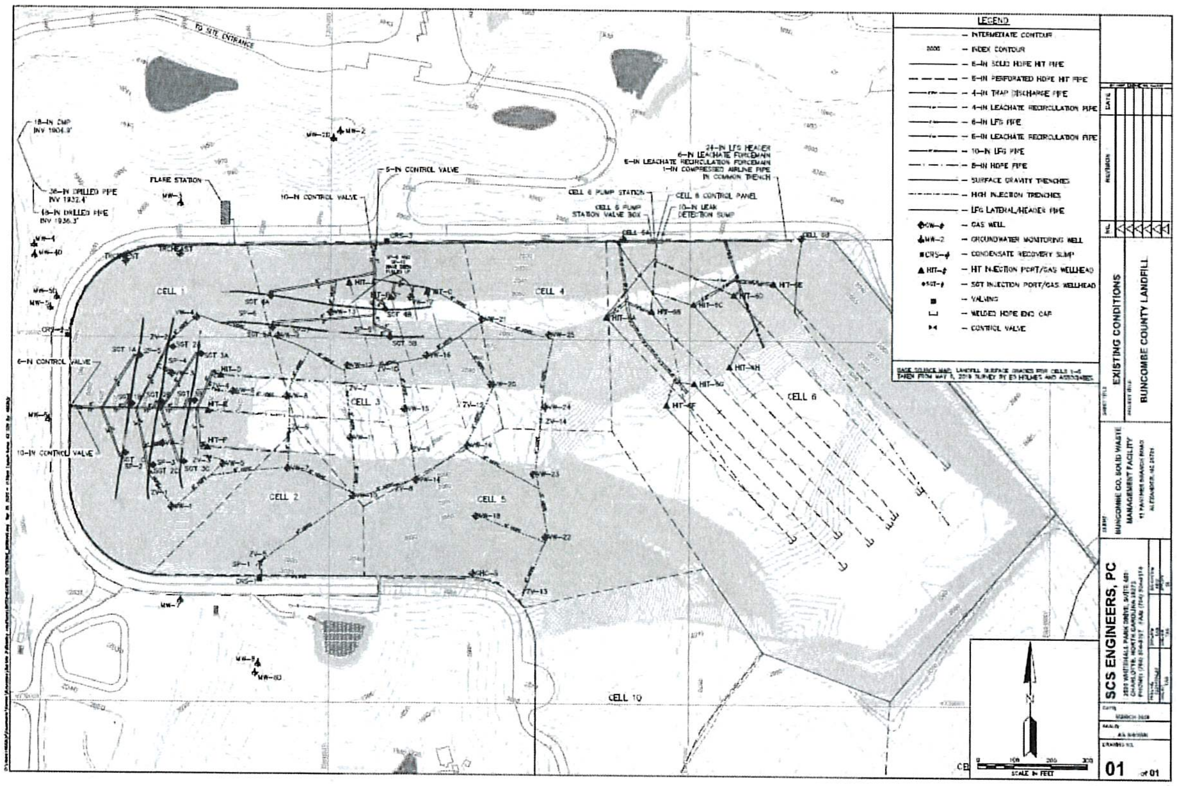

Figure 1-2: GCCS System

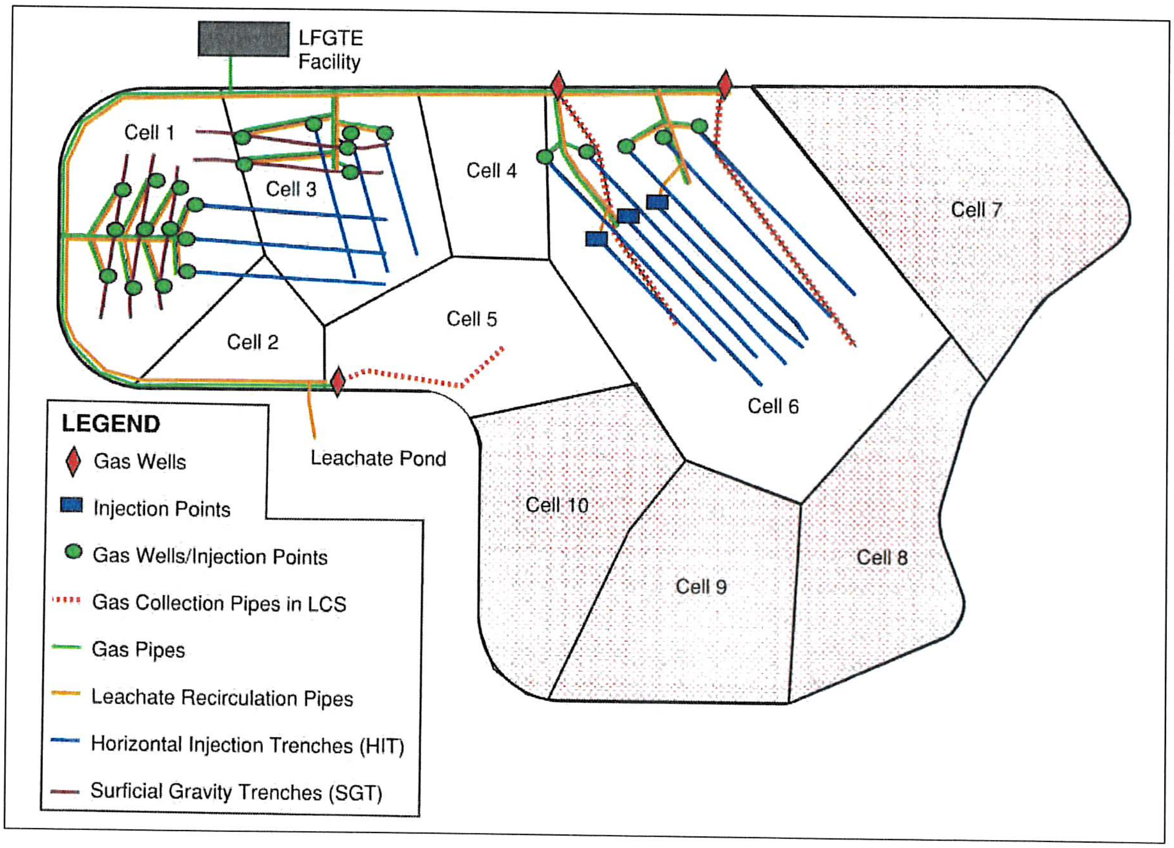

Figure 1-3: Bioreactor System

1.4 GCCS PERFORMANCE

Table 1-1 presents 5-year average LFG flowrate and methane from the 35 active wellhead collection features (January 2015 to July 2020). Because wellheads were typically not monitored or recorded on a frequent basis over the 5-year period, some degree of data inconsistency may somewhat limit general observations.

Table 1-1: GCCS Summary (January 2015 to July 2020)

	IDs	Average LFG Flow (scfm)[1]	Average Methane (%)[2]	Comments
VERTICAL WELLS	VW-1	3	55	
	VW-2	14	55	
	VW-3	5	56	
	VW-4	3	54	
	VW-5	4	56	
	VW-6	4	40	Abandoned in August 2020
	VW-7	8	55	
	VW-8	17	54	
	VW-9	24	58	
	VW-10	6	56	
	VW-11	11	54	
	VW-12	9	55	
	VW-13	3	58	
	VW-14	11	55	
	VW-15	11	56	
	VW-16	5	56	
	VW-17	3	56	Abandoned
	VW-18	13	55	
	VW-19	11	55	
	VW-20	25	57	
	VW-21	13	49	
	VW-22	38	56	
	VW-23	19	57	
	VW-24	10	57	
	VW-25	9	56	
HORIZONTAL INJECTION TRENCHES	HIT-6A	10	56	
	HIT-6B	1	56	
	HIT-6C	8	57	
	HIT-6D	2	53	No longer active
	HIT-6E	12	55	
OTHER FEATURES	Cell 6A	4	20	No longer active
	Cell 6B	17	56	
	GHC-5	19	55	
	T-East	28	56	
	T-West	3	40	
	[1]Blue highlighted are wellhead locations that are under the average flowrate per feature			
	[2]Orange highlighted are wellhead locations that are outside optimum from 40 to 55 percent			

As discussed above and shown in Table 1-1, the County had 35 active wellhead collection features. The following conclusions are made:

- Total average flowrates are:
  - Vertical wells = 280 scfm (73%)
  - Horizontal injection trenches = 33 scfm (8%)
  - Other features = 71 scfm (19%)
  - **Total = 383 scfm**
- Vertical wells are the major collection features for the GCCS.
- Cell 6 is assumed to be the area with the largest quantity of new waste; however, as shown above, the four HITs and Cells 6A and 6B are the main collection features and contribute only 14 percent of the total flowrate. The Cell 6 LFG potential likely suggests that greater LFG recovery is possible.
- The average flowrate per feature of the total average flowrate is:
  - Vertical wells = 11 scfm
  - Horizontal injection trenches = 7 scfm
  - Other features = 14 scfm
- Those monitoring locations that are under the average flowrate are highlighted in blue in Table 1-1. Thirteen (13) of the 25 vertical wells (or 52%) are below the average flowrate.
- Optimum methane concentration is from 40 to 55 percent and the monitoring locations outside of that range are highlighted in orange in Table 1-1. Twenty (20) wellheads have methane outside that range with the majority (18 or 51%) with high methane. This suggests the presence of uncaptured LFG and can be somewhat contributed to operating the LFGTE facility on load control in lieu of vacuum control.

2.0 GCCS ASSESSMENT

SCS staff assessed the GCCS and bioreactor LFG components on August 24th and 25th in 2020. SCS staff discussed GCCS operations with County personnel. Adjustments were not made to any components during the site visit. During the site visit, SCS staff completed the following:

- Assessed the condition of GCCS components aboveground and by using a down-hole camera
- Measured depth to liquid in wells
- Documented operational performance of wells
- Documented LFG monitoring data
- Documented on general GCCS observations

2.1 GCCS OBSERVATIONS

2.1.1 LFG Monitoring Data

Twenty-nine (29) locations of the GCCS were assessed for static pressure, gas temperature, flow rates (where applicable), and gas composition (CH_4, CO_2, O_2 and balance gases) as shown in **Appendix A. Table 2-1** presents a summary of the LFG monitoring data.

Table 2-1: LFG Monitoring Data (August 25, 2020)

	IDs	Methane (%)	Oxygen (%)	LFG Flow (scfm)
VERTICAL WELLS	VW-1	58.8	0.5	1.3
	VW-2	59	0.5	6.9
	VW-3	59.6	0.1	4.1
	VW-4	Was not monitored due to location		
	VW-5	59.1	0.2	4.5
	VW-6	Abandoned		
	VW-7	61.4	0.3	12.7
	VW-8	54.6	0.1	20.8
	VW-9	59.7	0.3	8.2
	VW-10	59.1	0.2	4.7
	VW-11	54.7	0.3	20.4
	VW-12	57.1	0.5	6.6
	VW-13	60.1	0.2	5.5
	VW-14	57.8	0.2	9.8
	VW-15	58.9	0	7.6
	VW-16	56.2	0.5	10.9
	VW-17	Abandoned		
	VW-18	58.7	0.8	20.3
	VW-19	58.9	0.2	13.1
	VW-20	System shut down, no readings taken		
	VW-21	14.7	15	0
	VW-22	55.7	0.2	36.8
	VW-23	59.4	0.2	21.4
	VW-24	Was not monitored due to location		
	VW-25	60.2	0.3	3.8
HORIZONTAL INJECTION TRENCHES	HIT-6A	59	0.4	N/A
	HIT-6B	58.3	0.2	N/A
	HIT-6C	58.8	0.5	N/A
	HIT-6D	30.1	9.8	N/A
	HIT-6E	59.8	0.3	N/A
OTHER FEATURES	Cell 6A	No longer collecting		
	Cell 6B	56.6	1.1	N/A
	GHC-5	58.6	0.2	23.4
	T-East	57.9	0.5	37.6
	T-West	53.2	0.2	5.1

The conclusions stated in Section 1.4 analyzing data from the last 5 years are similar to the August 25, 2020 monitoring data; however, total LFG flowrate decreased approximately 100 scfm (286 scfm) for this one event. This could be based on system downtown prior to the site assessment.

SCS recommends that VW-21 and HIT-6D wellheads be closed due to high oxygen concentrations. Based on this, the County's GCCS should be comprised of:

- Twenty-two (22) vertical LFG extraction wells

- Four (4) HITs in Cell 6
- One (1) protective cover horizontal collectors in Cell 6 [Cell 6B]
- One (1) leachate sump slope riser collector in Cell 5 [GHC-5]
- Two (2) LFG migration collectors at the landfill base of the north slope (near the flare) [T-East and T-West]

2.1.2 Well Integrity and Condition

Well integrity, including the structural components (i.e., is the casing damaged, etc.), and well condition (i.e., liquid levels, etc.), were assessed. **Table 2-2** presents a summary of the well integrity and condition assessment. The well condition inspection forms are provided in **Appendix B**.

Table 2-2: Well Conditions (August 24, 2020)

	IDs	Casing Height[1] (ft)	Depth to Slots[2] (ft)	Depth to Liquid[3] (ft)	Depth to Bottom[4] (ft)	Comments/Recommendations
VERTICAL WELLS	VW-1	3	14	18	24	--
	VW-2	3	15	22	30	--
	VW-3	3	15	21	36	--
	VW-4	6	24	20	37	No inspection form due to location in working area
	VW-5	4	15	37	49	--
	VW-6	Abandoned				
	VW-7	4	13	28	36	--
	VW-8	5	24	45	49	Fill settlement area
	VW-9	4	23	37	38	Replace fernco
	VW-10	3	15	26	28	--
	VW-11	6	27	40	43	Fill settlement area
	VW-12	6	30	37	40	Replace flex hose
	VW-13	2	15	12	32	Replace flex hose
	VW-14	4	14	--	39	No liquid, ball valve partially open, open full
	VW-15	3	25	--	26	Blockage at 26 feet, replace fernco and fill settlement area
	VW-16	5	31	34	41	Flex hose is stretching, replace
	VW-17	Abandoned				
	VW-18	4	15	24	32	--
	VW-19	5	23	--	38	No liquid, flex hose is stretching, replace
	VW-20	9	26	--	29	No liquid
	VW-21	4	N/A	28	43	High O_2 and did not see slots. Pump well down and see if it improves
	VW-22	3	13	15	30	--
	VW-23	4	14	--	40	Casing broken at 40 feet
	VW-24	3	12	--	18	No liquid, working face
	VW-25	6	N/A	--	8	Casing broken at 8 feet and no vacuum. Need new well and lateral.
HORIZONTAL INJECTION TRENCHES	HIT-6A	--	--	--	--	--
	HIT-6B	--	--	--	--	--
	HIT-6C	--	--	--	--	--
	HIT-6D	--	--	--	--	--
	HIT-6E	--	--	--	--	--
OTHER FEATURES	Cell 6A	No longer collecting				
	Cell 6B	--	--	--	--	Larger wellhead will increase flow.
	GHC-5	--	--	--	--	--
	T-East	--	--	--	--	No label
	T-West	--	--	--	--	No label

[1]Casing Height = top of casing to ground elevation
[2]Depth to Slots = top of casing to slotted section of pipe by camera inspection
[3]Depth to Liquid = top of casing to top of liquid by camera inspection
[4]Depth to Bottom = top of casing to bottom of well by camera inspection

2.1.2.1 Well Slotted Assessment

Since vertical wells are a major component of the GCCS, the correlated available slotted pipe length is important to assess and compare to the as-built condition. **Figure 2-1** presents the vertical gas extraction well design detail. Because record drawings were not provided, this assessment assumes 6 feet of solid pipe from ground elevation to slotted pipe and 3 feet from top of casing to ground elevation.

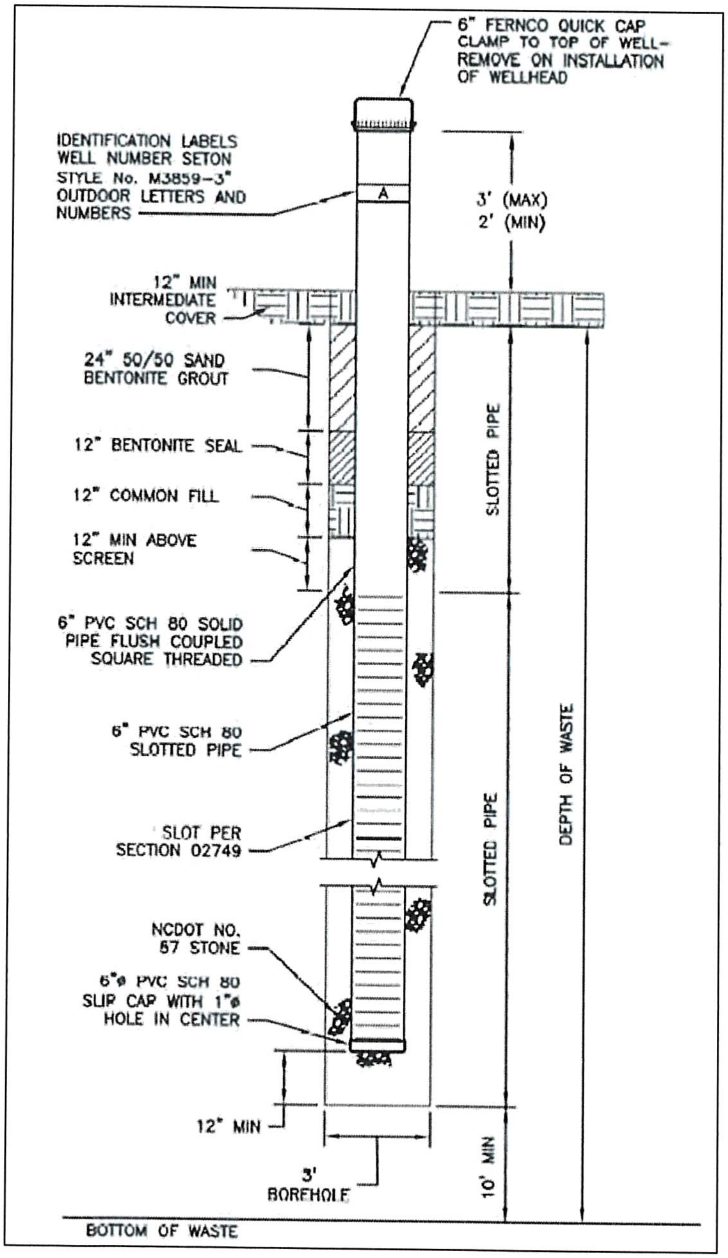

Figure 2-1: Vertical Well Design Detail

Using the well as-built documentation from Sargent Corporation, dated September 9, 2010 (see **Appendix C**), an as-built slotted pipe length was estimated. **Table 2-3** presents the as-built well information and estimate the total slotted pipe length at 1,100 feet.

Table 2-3: As-Built Slotted Pipe Length

Well ID	Well Depth (A)[1] (vf)	Slotted Length[2] (ft)
VW-1	33	27
VW-2	42	36
VW-3	42	36
VW-4	37	31
VW-5	55	49
VW-6	56	50
VW-7	44	38
VW-8	45	39
VW-9	34	28
VW-10	31	25
VW-11	65	59
VW-12	65	59
VW-13	34	28
VW-14	44	38
VW-15	92	86
VW-16	74	68
VW-17	34	28
VW-18	38	32
VW-19	64	58
VW-20	71	65
VW-21	31	25
VW-22	34	28
VW-23	71	65
VW-24	66	60
VW-25	47	41
TOTAL	**1,250**	**1,100**

[1]Well Depth = surface elevation - well bottom elevation
[2]Slotted Length = well depth - 6 feet (surface elevation to top of slotted section)

To assist in understanding the section tables and associated lengths, **Figure 2-2** presents the corresponding well nomenclature and its position on the well for the as-built and current conditions.

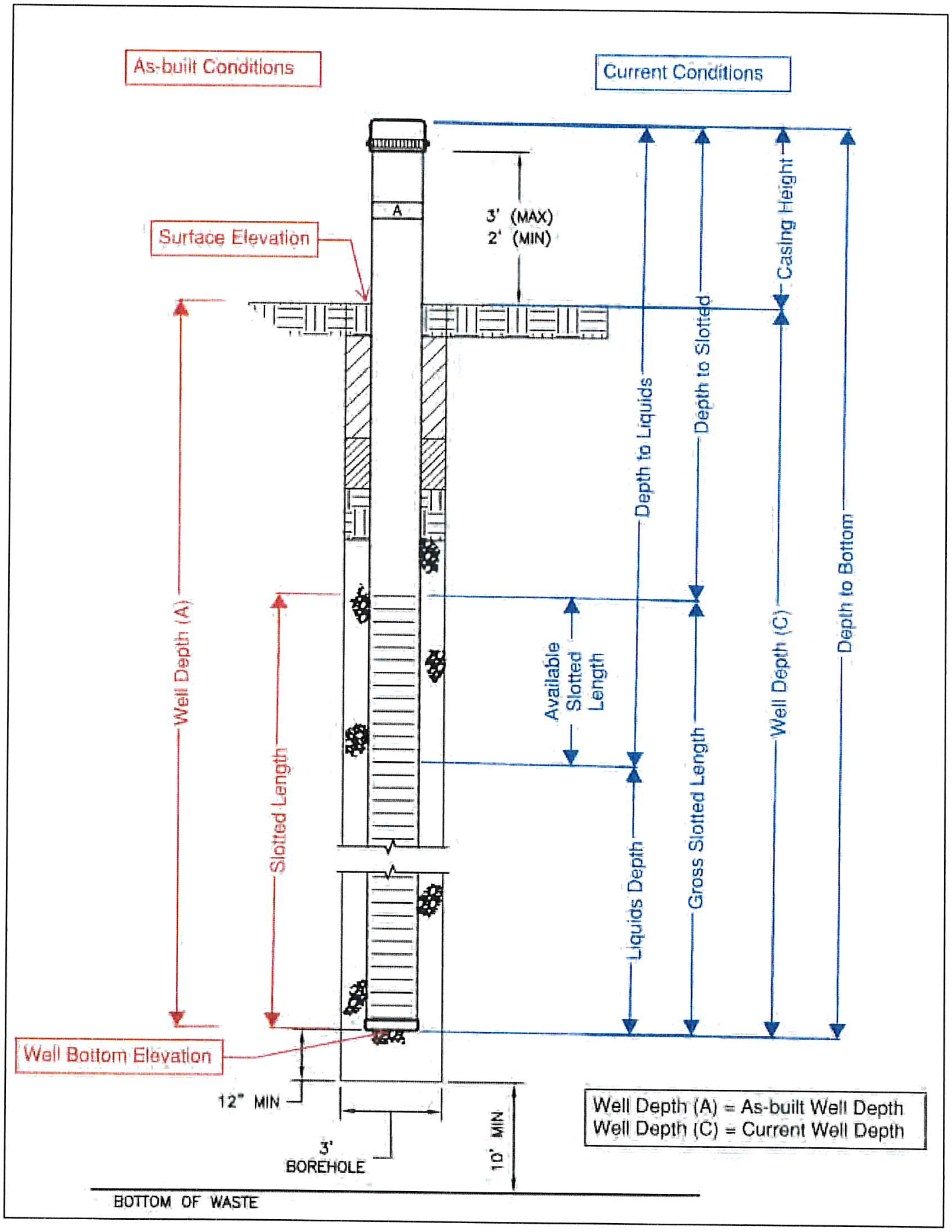

Figure 2-2: Vertical Well Design Detail

Based on the SCS assessment presented in Table 2-1 and the as-built information from Table 2-3, a comparison of current slotted pipe length was determined and is shown in **Table 2-4.** The available slotted pipe length considers the impacts from liquids and sediment (i.e., if well depth has decreased over time).

Table 2-4: Current Slotted Pipe Length (August 24, 2020)

Well ID	Depth to Bottom[1] (vf)	Depth to Slotted[2] (vf)	Gross Slotted Length[3] (ft)	Depth to Liquids[4] (vf)	Liquids Depth[5] (vf)	Available Slotted Length[6] (ft)
VW-1	24	14	10	18	6	4
VW-2	30	15	15	22	8	7
VW-3	36	15	21	21	15	6
VW-4	37	24	13	20	17	0
VW-5	49	15	34	37	12	22
VW-6	Abandoned					
VW-7	36	13	23	28	8	15
VW-8	49	24	25	45	4	21
VW-9	38	23	15	37	1	14
VW-10	28	15	13	26	2	11
VW-11	43	27	16	40	3	13
VW-12	40	30	10	37	3	7
VW-13	32	15	17	12	20	0
VW-14	39	14	25	**No liquids**	--	25
VW-15	Blockage at 26 ft					
VW-16	41	31	10	34	7	3
VW-17	Abandoned					
VW-18	32	15	17	24	8	9
VW-19	38	23	15	**No liquids**	--	15
VW-20	29	26	3	**No liquids**	--	3
VW-21	Did not see slots					
VW-22	30	13	17	15	15	2
VW-23	40	14	26	**Casing broke at 40'**	0	26
VW-24	18	12	6	**No liquids**	0	6
VW-25	Casing broke at 8' and did not see slots					
TOTAL			**331**			**209**

[1]Depth to Bottom (Table 2-1) = top of casing to well bottom by camera inspection
[2]Depth to Slotted (Table 2-1) = top of casing to slotted section of well by camera inspection
[3]Gross Slotted Length = Depth to Bottom - Depth to Slotted
[4]Depth to Liquids = top of casing to top of liquid by camera inspection
[5]Liquids Depth = Depth to Liquids - Depth to Bottom
[6]Available Slotted Length = Gross Slotted Length - Liquid Depth

Although the as-built slotted pipe length total was estimated at 1,100 feet (see Table 2-2), it is apparent that in over 10 years the available slotted pipe length has decreased. The following can be concluded as presented in Table 2-4:

- Current available slotted pipe length is approximately 209 feet or approximately 20 percent of the as-built slotted pipe length.
- If the County dewatered, approximately 331 feet of slotted pipe (or 122 feet more than what is currently available) may be available for LFG collection. That is approximately 30 percent of the as-built slotted pipe length.

2.1.3 Operating Performance

In addition to the existing well condition assessment, SCS presents the following operating performance observations and recommendations:

- System vacuum was minus 11 (-11) inches of water column ("WC) and methane content at the blower was measured at 57.5 percent. A higher system vacuum, possibly at -25"WC, could increase LFG flow and reduce LFG quality to recommended methane content target of 50 percent.
- Operating the system in load control with the flare off does not allow tuning the wellfield for maximizing LFG flow. We recommend operating under vacuum control with excess LFG (beyond the engine genset use) routed to the flare. This will allow stable vacuum to the wellfield for tuning.
- The County uses a Landtec GEM5000 for LFG monitoring. Some of the GEM5000 IDs are set as probes. The IDs should be set to the wellhead flow device and system pressure that is present at each monitoring location. This will allow better evaluation of the well condition.
- HIT-6A underground ball valve was closed. After slightly opening the valve, positive pressure overcame what vacuum was available. We recommend leaving valve open and increasing system vacuum so that HIT-6A can be tuned with wellfield (see first bullet).
- Cell 6B vacuum was measured at -11"WC and 56.6 percent methane. Differential pressure was greater than 10"WC; therefore, the wellhead is restricting flow. Recommend installing a larger wellhead to allow more LFG to be collected.
- Majority of the wellheads are 1.5-inch Shaw with 0.75-inch Venturi flow devices. If system vacuum is increased, we assume that several wellheads would be undersized and will restrict flow.
- Numerous high methane concentrations suggest the presence of uncaptured LFG.

2.2 SUMMARY OF FINDINGS

Table 2-5 presents the summary of findings and recommendations for the vertical wells.

Table 2-5: Vertical Wells Recommendations

Well ID	Liquids Depth[1] (vf)	Dewater	Slotted Length (ft)		Redrill	Recommendations
			As-Built[1]	Gross[2]		
VW-1	6	YES	27	10	YES	Dewater and/or redrill potential
VW-2	8	YES	36	15	YES	Dewater and/or redrill potential
VW-3	15	YES	36	21		Dewater potential
VW-4	17	YES	31	13	YES	Dewater and/or redrill potential
VW-5	12	YES	49	34		Dewater potential
VW-6	--	--	50	--	YES	Abandoned, redrill potential
VW-7	8	YES	38	23		Dewater potential
VW-8	4	YES	39	25		Fill settlement area, dewater potential
VW-9	1	No	28	15		Replace fernco
VW-10	2	No	25	13		--
VW-11	3	No	59	16	YES	Fill settlement area, redrill potential
VW-12	3	No	59	10	YES	Replace flex hose, redrill potential
VW-13	20	YES	28	17		Replace flex hose, dewatering potential
VW-14	0	--	38	25		No liquid
VW-15	0	--	86	0	YES	Redrill potential
VW-16	7	YES	68	10	YES	Replace flex hose, dewater and/or redrill potential
VW-17	--	--	28	--		Abandoned, redrill potential
VW-18	8	YES	32	17		Dewater potential
VW-19	0	--	58	15	YES	No liquid, replace flex hose, redrill potential
VW-20	0	--	65	3	YES	No liquid, redrill potential
VW-21	15	N/A	25	0	YES	Abandon due to high O_2, redrill potential
VW-22	15	YES	28	17		Dewater potential
VW-23	0	--	65	26	YES	Casing broken at 40 feet, redrill potential
VW-24	0	--	60	6	YES	No liquid, redrill potential
VW-25	0	--	41	0	YES	Casing broken at 8 feet, no vacuum, redrill potential
TOTAL			**1,100**	**331**		

[1]From Table 2-3
[2]From Table 2-4

Dewatering potential applied to wells with liquid depth greater than 5 feet. Redrill potential is recommended for any abandoned wells, wells that should be abandoned due to poor condition or high oxygen, and any wells that have less than 50 percent of gross slots compared to as-built slots available. The following are conclusions from Table 2-5:

- VW-21 should be removed from the GCCS (wellhead valve closed) due to high oxygen concentrations; therefore, with its removal, there would be 22 active vertical LFG wells.
- There are 11 wells (out of the original 25) that can be first dewatered to determine LFG recovery impact prior to redrilling (if the County elects to redrill).
- There are 11 wells (out of the original 25) that are candidates for redrill.
- To assess the effects of these recommendations, SCS recommends increasing vacuum and flaring excess LFG.
- There are 3 wells that SCS does not recommend dewatering or redrilling activities.

Based on Table 2-1, the County's GCCS should be comprised of the following as a baseline moving forward:

- Twenty-two (22) vertical LFG extraction wells,
- Four (4) HITs in Cell 6,
- One (1) protective cover horizontal collectors in Cell 6 [Cell 6B],
- One (1) leachate sump slope riser collector in Cell 5 [GHC-5], and
- Two (2) LFG migration collectors at the landfill base of the north slope (near the flare) [T-East and T-West].

2.3 LFG SAMPLING RESULTS

As part of this assessment, SCS sampled LFG at the blower on April 17, 2020 (see **Appendix D** for results). Although one sample may not be representative of average (or maximum) concentrations over an extended period, our interpretations of the sampling results include:

- Method 3C: The CH_4 and CO_2 appear typical. Regarding the N_2 and O_2, the N_2:O_2 ratio is typically around 4 since these compounds are usually only present in LFG due to air intrusion into the GCCS and air is 79 percent N_2 and 21 percent O_2. However, the Landfill's ratio is 6. We suspect that some portion of the wellfield may be subject to air infiltration, and the oxygen may be consumed by aerobic decomposition of the waste, which reduced the O_2 component, but not the N_2 fraction, resulting in the higher ratio.
- TO-15: The speciated concentrations appear to generally be less than or equal to typical LFG for sanitary landfills.
- Total Reduced Sulfur (TRS): The County LFG results indicate TRS values of 167 and 141 ppm. It is common to see wide variations in TRS values at MSW landfills along the east coast. Despite the wide variations observed at other landfills, these values are within typical ranges. However, we would characterize TRS values of 167 and 141 ppm as in the range in which sulfur compounds are sufficiently high to potentially produce detrimental impacts on LFGE equipment (engines or processing equipment) and fugitive emissions could contribute to off-site odor impacts in surrounding communities. However, these values are lower than those measured at sites that have to install TRS

removal and pre-treatment systems. The maximum allowable H_2S concentration in LFG fueling turbines is 450 ppm per 40 CFR 60 Subpart KKKK.

- NMOC per Method 25C: The County LFG results indicate NMOC of 93.3 and 120.7 ppm as Hexane (which is equivalent to 560 and 724 ppm as Carbon). These are significantly lower values than the default value of 595 ppm as Hexane published in AP-42 Section 2.4. In addition, these values are lower than the average of the 30 sanitary landfills in NC and VA that SCS has measured NMOCs during the past 25 years. At the current time, and unrelated to this assessment, a Tier 2 test (to determine NMOC emissions under federal rule) is scheduled for the Landfill in 2021.
- BTU and Siloxanes: The BTU content of the LFG appears to be stable and sufficient for energy project development. The BTU analysis will be of more of interest to engine and energy developers. The County LFG results for siloxanes appear to be within the typical range for other landfills that do not have elevated siloxanes (at least not at levels expected to cause significant problems for LFGE equipment).

4.0 LFG RECOVERY POTENTIAL

4.1 SCS LFG MODELING METHOD

Using the site-specific data, SCS determined the LFG recovery potential utilizing our LFG model. The LFG model applies the same first-order decay equation as the US Environmental Protection Agency's (EPA's) Landfill Gas Emissions Model (LandGEM). Unlike LandGEM, which estimates LFG generation, the LFG model developed by SCS for performing LFG project due diligence assessments estimates the LFG recovery potential, which is the maximum amount of LFG a fully comprehensive, efficiently-operated GCCS can recover. The LFG recovery potential is estimated by applying model k and L_0 factors that are calibrated to LFG flow rates measured at the landfill being modeled, or developed by SCS using a database of over 1,200 years of LFG flow and methane data from 253 landfills with operational LFG collection systems.

Given the limitations of the actual or proposed GCCS, expected recovery is calculated by multiplying the recovery potential by the estimated fraction of LFG that is effectively collected, a measure referred to in these projections as collection system coverage. Collection system coverage is analogous to collection efficiency, except that collection system coverage describes the fraction of potentially recoverable LFG which is collected, while collection efficiency describes the fraction of generated LFG which is collected. Realistic estimates of collection system coverage based on the existing system design and performance, and planned GCCS build-out schedules, can then be applied to the model projections of the LFG recovery potential to derive estimates of expected recovery.

4.1.1 Model Limitations and Disclaimer

This report has been prepared in accordance with the care and skill generally exercised by reputable LFG professionals, under similar circumstances, in this or similar localities. Because the L_0 and k values developed by SCS for modeling LFG recovery at U.S. landfills do not provide information on LFG emissions, they should not be used for any regulatory purpose and are not consistent with U.S. EPA regulation and guidance for LFG modeling for Clean Air Act programs. The LFG recovery projections are based on our engineering judgment as of the date of this report. No warranty, express or implied, is made as to the professional opinions presented herein. Changes in the landfill property use and conditions (for example: variations in rainfall, water levels, waste composition, landfill operations, final cover systems, or other factors) may affect future gas recovery at the landfill. SCS does not guarantee the quantity or the quality of the available landfill gas.

This report is prepared exclusively for the use of Buncombe County. No other party, known or unknown to SCS, is intended as a beneficiary of this report or the information it contains. Third parties use this report at their own risk. SCS assumes no responsibility for the accuracy of information obtained from, or provided by, third-party sources.

4.2 WASTE DISPOSAL HISTORY AND INFORMATION

Waste disposal data provided by the County shows the landfill began receiving municipal solid waste (MSW) in 1997, and the Landfill currently consists of Cells 1 through 6, which have about 2.8 million tons of waste in place. The capacity of the landfill is 12.8 million cubic yards (yd^3), or about 8.1 million tons, using the historical average in-place density of 1,260 pounds per cubic yard (pcy) calculated by SCS in the Fiscal Year 2020 Airspace Analysis Report (SCS, July 2020).

Annual total waste disposal rates reached about 153,000 tons in 2003 before declining to less than 130,000 tons per year from 2005 through 2016. Annual disposal increased from 103,000 tons in 2016 to about 130,000 tons in 2017 and 2018, and then increased by 34 percent to 174,844 tons in 2019. SCS assumes that the tonnage reached in 2019 is representative of waste disposal in future years, with a projected increase of 1 percent annually after 2019. Given the estimated capacity and projected disposal rates, the landfill could continue to operate until 2046.

Waste was disposed in Cells 1 through 5 from 1997 through 2006, after which disposal moved into Cell 6. Starting in 2017, disposal began occurring on the side slopes of Cells 1 through 5 when weather permitted. This practice is expected to continue through 2022. Approximately 30 percent of waste disposed at the landfill from 2017 through 2022 is estimated to be deposited on the Cells 1 through 5 side slopes, with the remainder disposed in Cell 6. Disposal is projected to begin in Cell 7 in 2023 and is assumed to be completely out of Cell 6 by 2025, filling Cells 7 through 10 until the estimated site capacity is reached, currently estimated to occur in 2046.

Data on the types of waste disposed by source category is not available, but diversion of collection vehicles delivering construction and demolition (C&D) waste to the adjacent C&D landfill has limited C&D and inert waste disposal at the MSW landfill to incidental amounts that are delivered in mixed waste loads. Available airspace in the C&D landfill is sufficient to accommodate 24 more years of disposal at 1 percent annual growth, which covers all but the last 2 years of the projected lifetime of the MSW landfill. Based on these site-specific considerations, SCS assumes that disposed waste contained 85 to 90 percent MSW historically and will consist of 85 percent MSW in future years, with the remainder allocated to C&D and inert wastes.

4.3 LEACHATE RECIRCULATION

Historic leachate recirculation volumes applied are shown in **Table 4-1**. Leachate recirculation was suspended in 2017 but has since resumed primarily in Cell 6. As the program is reinitiated, the recirculated volumes are minimal.

Table 4-1: Leachate Recirculation Volumes

Year	Leachate Recirculation Volumes (gallons)		
	Cells 1-5	Cell 6	TOTAL
2006	230,000	0	230,000
2007	200,000	0	200,000
2008	261,610	0	261,610
2009	171,030	0	171,030
2010	701,400	0	701,400
2011	585,820	0	585,820
2012	761,420	0	761,420
2013	142,880	0	142,880
2014	563,870	85,520	649,390
2015	712,021	217,160	929,181
2016	737,620	136,810	874,430
2017	775,214	429,770	1,204,984

Leachate recirculation increases waste moisture and decay rates in the vicinity of the leachate recirculation injection lines. Quantifying the effects of specific volumes of leachate on organic waste decay rates in a landfill is difficult considering that the LFG industry has not been able to define the relationship of precipitation-based moisture levels (i.e., prior to adding liquids) to waste decay rates. Although the EPA's LandGEM assigns regulatory default values for model "k" values that define waste decay rates for "arid", "conventional", and "wet" sites, the values have very little empirical basis and cannot be used to assign leachate application impacts. Futhermore, LandGEM cannot account for changing moisture levels caused by different rates of leachate application because it does not allow model k to vary over time from a single user-defined value.

SCS has been exploring the relationship between precipitation rates and waste decay rates defined in the LFG model k value for MSW over the past two decades. Research by SCS has found a strong relationship between waste moisture implied by average annual precipitation and waste decay rates as reflected in SCS LFG model k values.

To factor in leachate recirculation, SCS has developed a unique "variable k" LFG recovery model to account for variations in waste moisture due to leachate recirculation and other site management practices that may impact waste moisture (e.g., increased organic waste diversion). SCS developed the variable k model to allow adjustments to k over time for waste affected by changes in moisture levels from baseline conditions after leachate recirculation. SCS estimates that moderate adjustments to the model k in Cells 1 through 5 are required to account for added moisture due to leachate application from 2006 to 2009, with more significant increases starting in 2010 after leachate application rates increased. LFG model calculations for MSW disposed in Cell 6, which started to receive moderate amounts of liquids in 2014, with a significant increase in amounts in 2017, also require MSW k value increases. LFG model k values are assumed to decrease back to the (climate-based) default value starting in 2018 after leachate recirculation stopped. Leachate recirculation is expected to begin again in existing waste starting in 2021, requiring an increase in k values for MSW disposed in Cells 1 through 6 through 2017. SCS assumes that leachate recirculation will begin in Cell 7 in 2025, following the installation of new horizontal injection trenches in that cell. Leachate recirculation is assumed to continue in future disposal cells after 2025 until after the landfill closes.

Specific model k values applied are discussed in a later report section on model input assumptions.

4.4 LFG COLLECTION SYSTEM

Sections 1 and 2 of this report presents a discussion of the GCCS.

4.4.1 Historical LFG Collection Rates

SCS uses actual LFG recovery rates to calibrate the LFG recovery model by adjusting model input parameters to correlate projected recovery with collection system coverage and measured LFG flows. Data listing LFG flow and methane concentrations, measured daily between March 2012 and June 2020, were compiled to calculate annual average LFG recovery rates for 2012 through 2020. Annual average LFG flows, methane content, and LFG recovery adjusted to 50 percent methane in 2012 through 2020 are shown in **Table 4-2**, and monthly averages for January 2019 through June 2020 are shown in **Table 4-3**.

Table 4-2: Annual LFG Recovery Rates[1]

Year	Average LFG Recovery (scfm)	% CH_4	Average LFG Recovery (scfm at 50% CH_4)
2012	382	53.1%	406
2013	414	52.8%	437
2014	413	51.0%	421
2015	405	53.4%	433
2016	395	52.8%	417
2017	376	52.8%	398
2018	306	53.5%	327
2019	350	54.9%	384
2020	371	57.2%	424
[1]LFG recovery include flow routed to both the engine and flare			

Table 4-2 shows that average annual LFG recovery has not increased since 2013 despite ongoing waste disposal, which implies that potential recovery is not being realized, and perhaps, suggests a limited effort historically to recover more LFG than the amount required to fuel the generator.

Table 4-3: Monthly LFG Recovery Rates

Month	Average LFG Recovery (scfm)	% CH_4	Average LFG Recovery (scfm at 50% CH_4)
January 2019	351	55.6%	391
February 2019	372	54.6%	406
March 2019	341	55.4%	377
April 2019	341	55.5%	379
May 2019	357	55.2%	394
June 2019	372	53.4%	397
July 2019	383	53.6%	411
August 2019	346	50.8%	351
September 2019	381	52.3%	399
October 2019	366	52.5%	384
November 2019	303	52.8%	320
December 2019	311	56.6%	352
January 2020	297	57.6%	342
February 2020	414	59.3%	492
March 2020	416	54.7%	456
April 2020	368	56.7%	417
May 2020	359	57.3%	411
June 2020	352	58.0%	408

4.4.2 Historical Collection System Coverage

The current collection system layout provides relatively complete physical coverage of Cells 1 through 5, and limited coverage of Cell 6. The 23 vertical wells in Cells 1 through 5 are spaced approximately 200 feet apart across the central-top deck area and upper side slopes, with more limited coverage of the landfill perimeter and near recently abandoned wells VW-6 and VW-17. The six (6) horizontal injection trenches installed at elevation 2030 in Cell 6 in 2015 provide limited ability to collect LFG from waste deposited in recent years that currently has reached elevation 2100. Sections 1 and 2 of this report presents more details of the GCCS and monitoring data.

Based on the site drawing, wellfield monitoring data, and LFG recovery data, SCS estimates that collection system coverage in Cells 1 through 5 was about 55 percent in 2019 and 60 percent in early 2020. Collection system coverage in Cell 6 is estimated to be about 40 to 45 percent in 2019 and 2020. SCS calculated the total (flow-weighted) site average effective collection system coverage to be 45 percent in 2019 and 47 percent in 2020. Collection system coverage in prior years was estimated using actual LFG recovery to range between 30 and 50 percent during 2012 through 2018.

4.4.3 Future Collection System Expansions and Estimated Coverage

SCS applied the following assumptions for the schedule of future collection system expansions and for collection system coverage by disposal cell, based on the County's historical and expected collection system expansion frequency:

- The current wellfield in Cells 1 through 5 will be maintained with an expansion occurring in 2023. Collection system coverage in Cells 1 through 5 is projected to decline to 50 percent by 2022 due to ongoing disposal on the side slopes of these cells through 2022, and then increase to 70 percent coverage starting in 2023. These estimates do not account for declines due to unchecked wellfield deterioration or increases if Cells 1 through 5 have a final cover installed before the landfill closes.
- The current HIT wells in Cell 6 will be maintained with an expansion occurring in 2022. Collection system coverage in Cell 6 is projected to decline to 35 percent in 2021 due to ongoing disposal at elevations outside of the influence of the existing HITs. In 2022, the installation of vertical wells is projected to increase system coverage in Cell 6 to 60 percent.
- The next collection system expansion (vertical well installation) in Cell 6 is assumed to occur in 2026. System coverage in Cell 6 is projected to decline to 50 percent in 2023, 47 percent in 2024, and remain at 47 percent in 2025 because disposal is assumed to be completed in Cell 6 by 2025. The 2026 system expansion in Cell 6 is assumed to increase coverage to 70 percent, and coverage is projected to remain at 70 percent until increasing to 75 percent after a final cover is installed in 2047.
- Cell 7 is assumed to start extracting LFG in 2027 and achieve 60 percent system coverage in that year. Collection system expansions are assumed to occur every 4 years in Cell 7 and future cells after 2027, with coverage declines in the intervening years. System coverage is assumed to be slightly higher with each successive expansion, reaching 65 percent in 2035, 67 percent in 2039, and 69 percent in 2043. Collection system coverage in Cells 7 through 10 is assumed to reach a maximum of 75 percent in 2048 after a final cover is installed.
- Total site (flow-weighted average) collection system coverage is projected to decrease to 40 percent in 2021 and increase to 57 percent in 2022. Total site collection system coverage is projected to decline slowly after 2022, increase to 66 percent in 2027, 65 percent in 2031, 66 percent in 2035, and 68 percent in 2039, with declines in coverage in the intervening years between system expansions. Overall collection system coverage is projected to reach 69 percent in 2043, and a maximum of 75 percent in 2048 after a final cover is installed over the landfill.

Although this study does not include an analysis of the timing of collection system installations or expansions that may be required in the future under applicable New Source Performance Standards (NSPS), SCS anticipates that this system expansion schedule will likely comply with or be more frequent than the schedule that may be required under NSPS.

4.5 LFG MODEL ASSUMPTIONS AND RESULTS

The LFG recovery model was developed using the following input assumptions:

- **Historical and projected waste disposal rates.** The derivation of estimated total waste disposal rates, amounts disposed by waste category, and future waste disposal rates and composition, is described above.
- **Collection system coverage.** The derivation of estimated collection system coverage, including historical and future coverage estimates, is described above.
- **Methane Decay Rate Constant (k):** SCS assigned a k value of 0.082 per year to MSW, which is the SCS default k value for MSW at sites in this region that receive an average of 45 inches of precipitation annually.[2] A model k value of 0.066 was assigned to C&D waste based on the estimated decay rate for the organic fraction (primarily wood) and the estimated ratio of C&D to MSW k values. Model k values for MSW in Cells 1 through 5 were increased in 2006 through 2017 based on volumes of leachate application to account for estimated moisture impacts on waste decay rates, followed by k value decreases back to the default value after leachate application ended in 2018. Model k values for MSW in Cells 1 through 5 reached maximum levels of 0.14/year in 2010, 2012, and 2015 through 2017 when leachate application levels exceeded 700,000 gallons per year. Modest k value increases were also applied to Cell 6 MSW starting in 2014 when leachate application began in these cells.

  Leachate recirculation is assumed to start again in existing waste in 2021, in Cell 7 in 2025, and in future cells in later years. The k value for MSW in Cells 1 through 6 is assumed to increase starting in 2021 to a maximum of 0.12 by 2022, and to remain elevated for several years before declining slowly as liquids application shifts towards newer disposal areas over time. The k values for MSW in Cells 7 through 10 are assumed to increase to average about 0.12 starting in 2025, and remain elevated in future years until the landfill closes, assuming that leachate recirculation continues to occur in these disposal cells.

- **Ultimate Methane Recovery Potential (L_0):** SCS assigned an L_0 value of 3,000 ft^3/ton to MSW and an L_0 value of 1,480 ft^3/ton for C&D waste, which are the SCS default L_0 values for landfills in this climate.

4.5.1 LFG Recovery Projections

The LFG recovery projections are provided in **Appendix F**, Exhibits 1 through 4. Exhibit 1 shows the LFG recovery projection for Cells 1 through 5. Exhibit 2 shows the projections for Cells 6 through 10. Exhibits 3 and 4 show LFG recovery projections for the entire landfill. All LFG flows are shown at 50 percent methane content. Exhibits 1 through 3 provide the following information:

- Annual historical and projected future waste disposal rates.
- Annual tons of waste in place values.

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[2] The average of historical annual precipitation rates reported at www.Worldclimate.com for Asheville Airport is 45 inches.

- Projected theoretical maximum LFG recovery potential, which is 100 percent of the maximum amount of LFG that is potentially recoverable with a comprehensive and efficiently operated collection system.
- Estimated collection system coverage.
- Projected LFG recovery from the existing and planned collection system.

Exhibit 4 provides the following information:

- Projected theoretical maximum LFG recovery potential ("100% recovery").
- Projected site-specific maximum LFG recovery potential ("75% recovery"), which is 75 percent of the theoretical maximum potential. SCS estimates that this curve represents the likely maximum recovery rate achievable at this site with a comprehensive and efficiently operated collection system.
- Projected LFG recovery from the existing and planned system.
- Average actual LFG recovery rates in 2012 through 2020.

The LFG recovery projection graph provided as Exhibit 4 also is shown as **Figure 4-1** below.

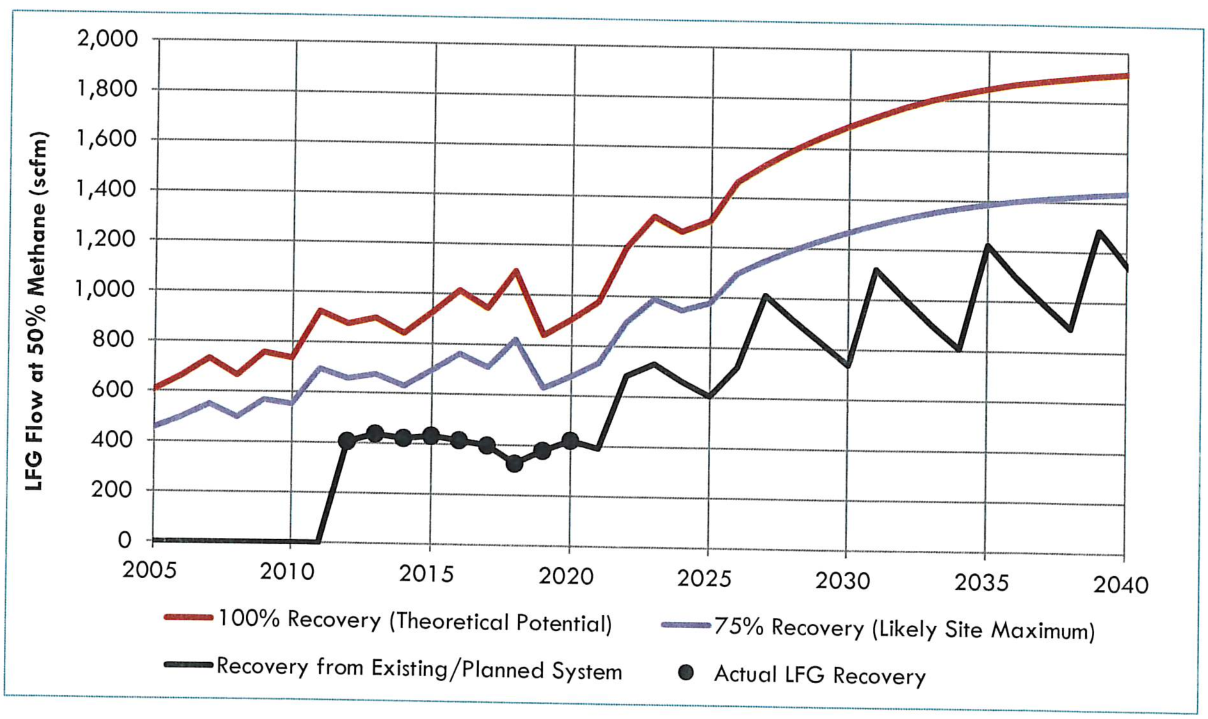

Figure 4-1: LFG Recovery Projection

SCS projects that the LFG recovery at 50 percent methane will decrease from 421 scfm in early 2020 to 391 scfm in 2021. Projected LFG recovery increases to 684 scfm in 2022 and to 732 scfm in 2023 following the system expansion in Cell 6 in 2022 and Cells 1 through 5 in 2023. Projected decreases in LFG recovery in 2024 and 2025 average about 9 percent per year. An assumed system expansion in Cell 6 in 2026 and startup of LFG collection in Cell 7 in 2027 result in increases in projected LFG recovery to 724 scfm in 2026 and 1,012 scfm in 2027, followed by annual declines of about 10 percent in 2028 through 2030. This projected 4-year cycle of system expansions will continue to result in substantial increases in LFG recovery in the expansion year, followed by decreases averaging about 10 percent in the non-expansion years. A maximum LFG recovery rate of 1,322 scfm is projected for 2047 (1 year after site closure), after which LFG recovery will decline rapidly.

Q2C Number: 28033675	Quote Number: 1	Revision Number: 2
Project Name: LANDFILL GAS-TO-ENERGY PROJ		Quote Name:

Item No.	Qty.	Catalog Number / Details

SPEC SECTION 16431 – PAD-MOUNT TRANSFORMER

003-00 1 **Designation:** 2500KVA
CLASS 7230 PADMOUNT TRANSFORMER
SQUARE D 7230 PAD-MOUNTED TRANSFORMER

LIQUID FILLED:: MINERAL OIL
STEP UP APPLICATION
2500 KVA rated
PRIMARY VOLT: 12470GY/7200
95 KV BIL
SECONDARY VOLT: 480 DELTA
30 KV BIL
STANDARD 60 HERTZ
IMPEDANCE: 5.75% +/- 7.5% TOLERANCE
CONDUCTOR: ALUMINUM WINDINGS
TEMP: 120 DEGREES INSULATION CLASS
55/65 RISE OVER 30 AVG - 40 MAX AMB
TAPS: 2-2.5% FCAN, 2-2.5% FCBN
ALTITUDE: STD. 3300 FEET MAXIMUM
62 DB SOUND LEVEL

MODIFICATIONS:

HIGH VOLTAGE LIVE FRONT
RADIAL FEED W/THREE PORCELAIN BUSHINGS
THREE DIST. MOV 18 KV ARRESTERS
UNDER OIL SWITCH: NONE
FUSES: NONE
LOW VOLTAGE BUSHINGS: EPOXY
TIN PLATED ALUMINUM MATERIAL
10 HOLE LV BUSHING SPADE
SECONDARY SPADE SUPPORTS
UL LISTING
ENERGY EFFICIENT PER DOE 2010
MIN EFFICIENCY (50% Load) = 99.49%
ALUMINUM TRANSFORMER NAMEPLATE
STAINLESS STEEL ID NAMEPLATE
DESIGNATION: T-1

ACCESSORIES:

1" DRAIN VALVE W/ 3/8" SAMPLER
DIAL TYPE THERMOMETER
LIQUID LEVEL GAUGE
PRESSURE VACUUM GAUGE
STANDARD PRESSURE RELIEF VALVE
PRESSURE RELIEF DIAPHRAGM
NITROGEN TEST PORT
3 METERING ACCURACY CT'S
COLOR: MUNSELL #7.0GY-3.29/1.5 W/TOUCH-UP
UNDERCOATING
PENTAHEAD BOLTS

Schneider Electric

Switchboard Inspection & Test

CUSTOMER	GRAYBAR ELECT CO 5818836	JOB #	30379438-001
		PAGE	
END USER	BUNCOMBE COUNTY LANDFILL	DATE	08/04/2011
TEMPERATURE	°F	HUMIDITY	%
SITE LOCATION	BUNCOMBE COUNTY LANDFILL	DBID	31-233120
SUBSTATION	Main	END USER ASSET/ID	
DESIGNATION	Main Switchgear	DEVICE	02001 - SE Switchboard Inspection & Test
TESTED BY	Mike McKinney	EQUIPMENT USED	

NAMEPLATE DATA

MANUFACTURER	Square D	PHASE AMPACITY	1200 AMPS	VOLTAGE CLASS	15 kV
TYPE or STYLE	Masterclad Arc Resistant	NEUTRAL AMPACITY	- AMPS	CONDUCTOR	◉ CU ○ AL
CATALOG NO.	28033675-002	DRAWING NO.	same		
SERIAL NUMBER	28033675-002	WITHSTAND RATING	25 kA		

INSTALLED DEVICES

VOLTAGE RELAYS	SEL-351S	PANEL METERS	SEL-351S / 551C	CURRENT TRANSFORMERS	various
OVERCURRENT RELAYS	SEL-351S / 551C	KWH METERS	-	POTENTIAL TRANSFORMERS	12000:120
AUXILIARY RELAYS	-	LOADBREAK DISCONNECTS	-	CPT's	25 kVA
OTHER PROTECTIVE RELAYS	-	NUMBER OF BAYS	4	OTHER	-

TEST DATA

TEST VOLTAGE 2,500

INSULATION RESISTANCE Values in Gig-ohms

A-B	350
B-C	330
C-A	360
A-GND	115
B-GND	125
C-GND	120
N-GND	0

VOLTAGE (kV) 38 ○ A/C ◉ D/C

DIELECTRIC WITHSTAND TEST
{Note: All specimens not under test are grounded}

	Micro-Amps	Meg-Ohms	N/A
A-B	0		
B-C	0		
C-A	0		
A-GND	25	1520	
B-GND	32	1187.5	
C-GND	15	2533.33	
N-GND	0	2533.33	

CONTROL WIRING INSULATION RESISTANCE
Values in Gig-ohms

TEST VOLTAGE	-
Highest Reading	-
Lowest Reading	-

BUSWORK CONNECTION RESISTANCE

BUS SECTION TESTED		RESISTANCE IN MICRO-OHMS					BUS SECTION TESTED		RESISTANCE IN MICRO-OHMS				
FROM	TO	A	B	C	N	G	FROM	TO	A	B	C	N	G

COMMENTS:
DEFICIENCIES: