Appendix Changes

Appendix A

Example of a Preliminary Project Assessment Form

Used in the preliminary meeting between the developer/producer and the pipeline operator.

No changes made

Applicant Information					
Company Name	Awesome RNG			Today's Date	10/10/18
RNG Facility	Leftovers, Inc.				
RNG Facility Address	1234 6th Street, Brooklyn	State	NY	ZIP	11111

PROCESS INFORMATION	
Cleanup System Interconnect Pressure	Process outlet is 100#, will adjust to meet pipeline needs
Cleanup System Interconnect Temperature	Process outlet is 80F, will adjust to meet pipeline needs
Expected Heating Value Range (BTU) of Cleaned Biomethane[17]	970-990 BTU/ft3
Amount and Flow of Gas (in dth/hr, scf/hr or BTU/hr)	1MMCF/hr
Daily/Seasonal Variations in Deliverability of Gas Composition	Expected to run 24/7/365 with no variation in product flow or specifications

ADDITIONAL INFORMATION

Please provide more detailed information about expected composition of RNG

- __% methane
- __% nitrogen
- __% CO_2
- __% O_2
- Etc.

Please provide any other key process variables and any additional information if available below

- Chosen gas cleanup technology
- Data providing technology is compatible with gas feedstock
- Etc.

Pressure Swing Adsorption system. Can provide data from project X that has similar feedstock and uses a PSA system on their gas to inject into the local distribution system. Cleanup vendor TBD.

Expect to begin commissioning in August 2021 and full commercial operations in January 2022.

17 Specify HHV as real, dry @ 14.73 psia 60°F

Appendix B

Producer and Pipeline Operator Assessment Process Checklists

Important items to consider during discussions between the two parties.

Removed New York State specific language.

- ☐ Who are the parties who are entering into the contract?
- ☐ Assignment of a project manager (technical contact) from the producer
- ☐ Assignment of a project manager (technical contact) from the pipeline operator
- ☐ Physical location of the receipt/delivery point
- ☐ Agreement of producer to allow access to site where applicable
- ☐ Description of the process: Anaerobic digester gas type (dairy, WWTP, food waste, landfill) or gasification feedstock
- ☐ Definition of any technical terms
- ☐ Regulatory requirements, as necessary
- ☐ Discussion of New York State Code NYCRR Chapter 03 Gas Standards Part 229 standards for pipeline injection and pipeline operator specifications
- ☐ Specified party responsibilities and accountability aspects of O&M of the interconnect facilities
- ☐ Agreement to forward any new information regarding the project and amend the IFA / GSA when appropriate
- ☐ Periodic meeting schedule
- ☐ Description of requirements that the pipeline operator needs to provide to the producer
  - i. Company standards for the developer to follow (electrical, instrumentation, safety etc.)
  - ii. Company specifications for metering
  - iii. Technical assistance as needed for analytical instrumentation
  - iv. Odorant design and specifications (utility may operate odor equipment, but developer is responsible for installation and costs)
  - v. Any other engineering and technical assistance
- ☐ Description of requirements for the producer (equipment and facilities required for the project that is provided by producer and specified by the pipeline operator)
  - i. Gas service and associated metering equipment
  - ii. System tie-in equipment
  - iii. System to remotely transmit gas quality and flow data to utility
  - iv. On-line gas analysis equipment and associated necessities
  - v. Commitment as to reading, cleaning, repairing, inspecting, testing, calibrating, adjusting the equipment
  - vi. Remote shut-in capability
  - vii. Odor equipment and associated necessities
- ☐ Estimation of the cost to be paid by the producer to the pipeline operator
- ☐ Agreement to follow “Good Utility Practice”
- ☐ Insurance requirements
- ☐ Expiration date and termination terms

Appendix C

Gas Quality and Interchangeability Management Program Considerations

Suggestions for a gas quality management plan. Items were extracted from AGA's Natural Gas Quality Management Manual

Minor editorial changes, added a Gas Quality Monitoring table

- ✓ Optimize gas quality monitoring requirements
- ✓ Complete an interchangeability assessment
- ✓ Defines reasonable expectations for the potential breakthrough of trace constituents by examining feedstock and potential impact
- ✓ Discusses goals of a Verification Program
  - Identify monitoring requirements
  - Establish sampling, analytical and monitoring procedures, test methods and method detection thresholds to ensure conformance.
  - Identify response actions and/or corrective actions for anomalies/noncompliance
  - Establish data retention schedules to support compliance

Appendix D

Upgraded RNG Trace Constituents Measurement Matrix

Generic listing of parameters, testing frequencies, test methods, and expected detection limits

No change to this section

Section 1: Real-time continuous sampling

Parameter	Frequency
Heating Value	Continuous real-time or near-real time GC monitoring and periodic field samples for independent confirmation.
Temperature	Continuously measured on-line
Pressure	Continuously measured on-line
Water Content	Continuously measured on-line
Sulfur, including Hydrogen Sulfide, Ethyl & Methyl Mercaptan, Dimethyl sulfide	Continuous real-time or near-real time GC monitoring and periodic field samples for independent confirmation
Hydrogen	Continuous real-time or near-real time monitoring and periodic field samples for independent confirmation
Carbon dioxide	Continuous real-time or near-real time monitoring and periodic field samples for independent confirmation
Nitrogen	Continuous real-time or near-real time monitoring and periodic field samples for independent confirmation
Oxygen	Continuous real-time or near-real time monitoring and periodic field samples for independent confirmation

Appendix D

Upgraded RNG Trace Constituents Measurement Matrix

Generic listing of parameters, testing frequencies, test methods, and expected detection limits

Removed PCBs and Pesticides

Section 2: Spot samples

Parameter	Frequency
Biologicals (If reasonably expected)	Incorporation of a 0.2 micron filter would mitigate need for testing if bacteria/spores are reasonably expected
Mercury (if reasonably expected)	Minimum of three samples over a three-month period, with increased frequency, depending upon concentration at first sample point
Siloxanes	Minimum of three samples over a three-month period, with increased frequency, depending upon concentration at first sample point
Semi-volatile and Volatile Compounds (if reasonably expected)	Minimum of three samples over a three-month period, with increased frequency, depending upon concentration at first sample point
Halocarbons (if reasonably expected, Examples are Freons, chloroethane and vinyl chloride)	Minimum of three samples over a three-month period, with increased frequency, depending upon concentration at first sample point
Aldehydes and Ketones (if reasonably expected)	Minimum of three samples over a three-month period, with increased frequency, depending upon concentration at first sample point
PCBs/Pesticides (if reasonably expected)	Minimum of three samples over a three-month period, with increased frequency, depending upon concentration at first sample point]

Appendix D

Upgraded RNG Trace Constituents Measurement Matrix

Generic listing of parameters, testing frequencies, test methods, and expected detection limits

Updated analytical and sampling techniques

Parameter	Method	Common Laboratory Detection Limit
Heating Value	ASTM D3588 (on-line, or off-line canister collection*)	N.A.
Water Content	ASTM D5454 (on-line only)	N.A.
Sulfur, including Hydrogen Sulfide	ASTM D6228, D5504 (off-line canister collection) ASTM D4084 (H_2S on-line) and D4468 (total S on-line) ASTM D7493 (on-line sulfur speciation)	0.05 ppmv
Hydrogen	ASTM D1945, D1946 (usually only off-line gas chromatographs can measure hydrogen, canister collection)	0.1 vol% (0.001 vol% with special techniques)
Carbon dioxide	ASTM D1945, D1946 (on-line, or off-line canister collection)	0.03 vol%
Nitrogen	ASTM D1945, D1946 (on-line, or off-line canister collection)	0.03 vol%
Oxygen	ASTM D1945, D1946 (on-line, or off-line canister collection)	0.03 vol%
Biologicals	Use of a ≤0.2 micron filter to assess the presence of total bacteria/spores	0.2 microns
Mercury	ASTM D5954, D6350 (gold sorbent, on-line and off-line)	0.01 µg/m^3
Siloxanes	ASTM D8230, gas chromatography (off-line canister collection) with atomic emission detection (GC-AED) or mass spectral detection (GC-MS)	0.1 mg Si/m^3 (0.01 mg Si/m^3 with pre-concentration)
Semi-volatile and Volatile Compounds	EPA TO-14, TO-15 (off-line) Canister collection (volatiles) XAD sorbent media (semi-volatiles)	0.1 ppmv or lower, depending on technique and/or volume of gas sampled
Halocarbons	EPA TO-14, TO-15 (off-line canister collection)	0.1 ppmv or lower, depending on technique and/or volume of gas sampled

Appendix E

Example of Interconnect Feasibility Analysis Agreement (IFA)

Agreement for pipeline operator to conduct more detailed engineering assessments

Minor editorial changes

Execution of this agreement indicates that:

- The pipeline operator determined that the desired interconnect has enough capacity
- The project developer indicated the preliminary estimate for pipeline connection cost is within their feasibility range

Appendix E is just an example and framework.

It is expected that the pipeline operator and the project developer will negotiate their specific agreement

Appendix F

Example of a Gas Sales Agreement (GSA) or Interconnect Agreement

Defines the commercial aspects of accepting gas from the proposed facility

Minor editorial changes

Can be negotiated in parallel with the IFA

Appendix F is just an example and framework.

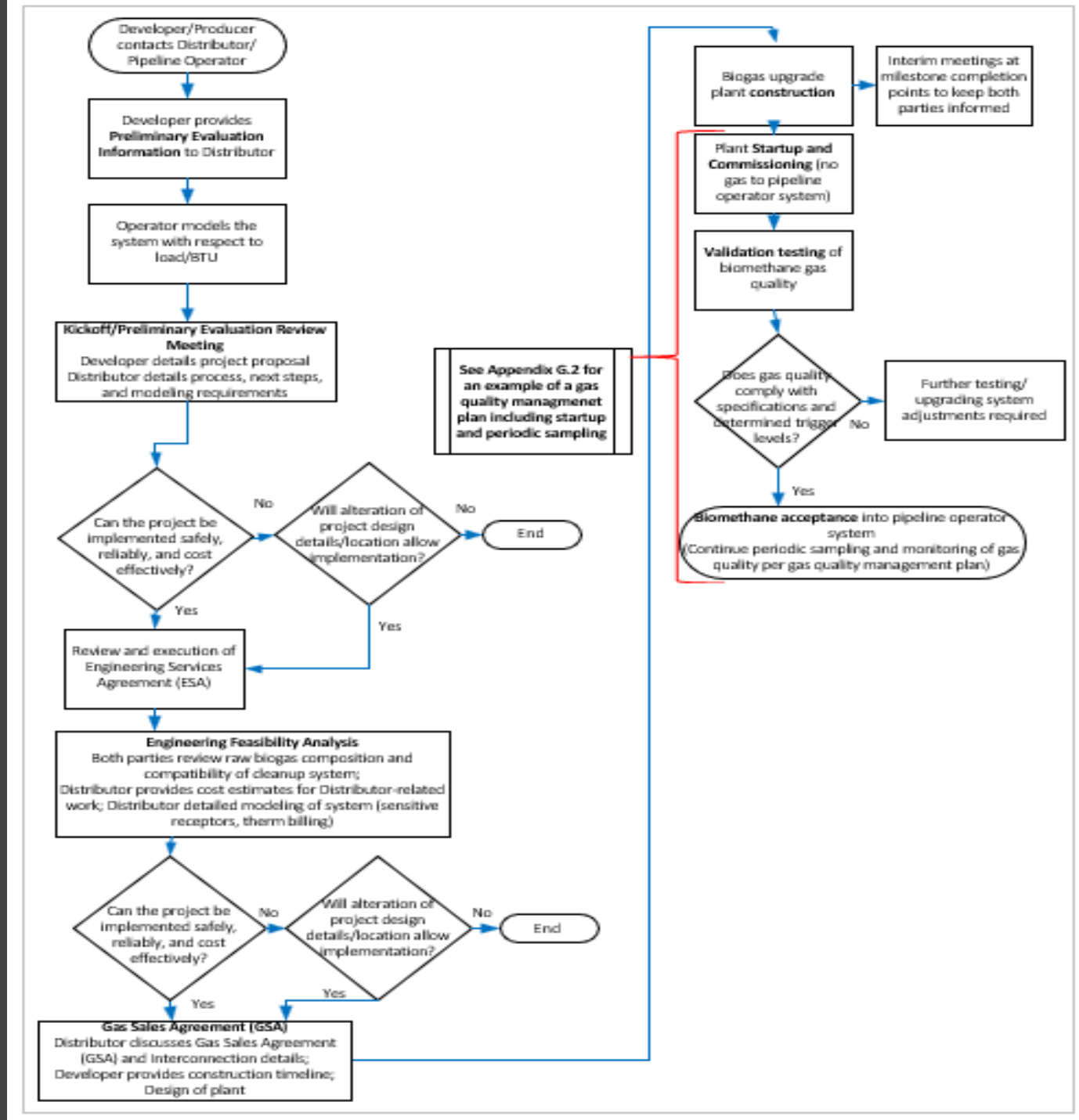
It is expected that the pipeline operator and the project developer will negotiate their specific agreement

Appendix G

Overall Gas to Grid Process

Provides a more detailed Gas-to-Grid process flow diagram

Flow diagram was updated to reflect new text in main document



Appendix H

Feedstock/Upgraded Gas Constituent Guidance Matrix

Listing of potential constituents from raw Biogas from specific feedstocks

Removed PCBs and pesticides.

Parameter	Landfill	Agricultural and Clean Organics	WWTP	Source Separated Organics and Facility Separated Organics	Gasifier, Syngas
Water Content	■	■	■	■	■
Sulfur, including Hydrogen Sulfide	■	■	■	■	■
Hydrogen	■	■	■	■	■
Carbon dioxide	■	■	■	■	■
Nitrogen	■	■	■	■	■
Oxygen	■	■	■	■	■
Ammonia	■	■	■	■	■
Biologicals (bacteria or spores ≤0.2 micron)	■	■	■	■	
Mercury	■		■		■
Volatile metals	■				■
Siloxanes	■		■	■	
Volatile Organic Compounds	■		■		■
Semi-volatile Organic Compounds	■				■
Halocarbons	■		■		■
Aldehydes and Ketones	■				■
Polychlorinated biphenyls (PCBs)					
Pesticides					

Appendix H

Feedstock/Upgraded Gas Constituent Guidance Matrix

Also includes observed ranges in RNG derived from landfills, dairies, and wastewater treatment plants with a comparison to ranges found in pipeline natural gas and AGA 4A

Updated table and added median information, removed PCBs and pesticides

Parameter	AGA 4A 2021 Common Reported Tariff/Specification Range[1]	Range Found in Upgraded Landfill-Derived RNG			Range Found in Pipeline Natural Gas Samples		
		Min	Max	Med	Min	Max	Med
Gross HV, BTU/ft^3 (60°F, 14.73 psia)	950-974 (min.) 1,100-1,124 (max.)	929	1,008	969	988	1,193	1,024
Total Sulfur, grains per 100 SCF (0.003)	max. 0.5 to 20	BDL	0.46	0.015	BDL	1.13	0.09
Hydrogen Sulfide, grains per 100 SCF (0.003)	max. 0.25 to 1.0	BDL	0.44	BDL	BDL	0.36	0.008
Hydrogen, vol% (0.1)	max. 0.01 to 0.1	BDL	1.65	BDL	BDL	0.12	BDL
Carbon dioxide, vol% (0.03)	max. 1 to 3	BDL	2.46	1.08	BDL	2.62	0.74
Nitrogen, vol% (0.03)	max. 1 to 4	0.34	7.22	2.65	BDL	3.45	0.97
Oxygen, vol% (0.03)	max. 0.001 to 1 majority: 0.1 to 0.2	BDL	1.31	0.18	BDL	0.56	BDL
~~Diluents + Inerts~~ CO_2 + N2, vol%	max. 3 to 6	0.53	8.21	3.89	0.29	4.28	1.80
Ammonia, ppmv (10)	none	BDL	BDL	BDL	BDL	BDL	BDL
Total Bacteria, # per 100 SCF	none	6.65E+02	3.29E+08	7.52E+05	3.47E+04	6.39E+07	2.08E+06
Mercury, µg/m^3 (0.02)	none	BDL	0.28	BDL	BDL	0.19	BDL
Other Volatile Metals, µg/m^3 (30)	none	BDL	250 Cr, Cu[2], Mn, Pb, Sb, Zn[2]	BDL	BDL	213 As, Cu[2], Pb, Zn[2]	BDL
Siloxanes (D4), mg Si/m^3 (0.5-0.01)	none	BDL[3]	7.70	BDL[3]	BDL[3]	BDL[3]	BDL[3]
Non-Halogenated Volatile Compounds, ppmv (0.1)	none	BDL[4]	2.4 BTEX	BDL[4]	BDL[4]	471 (1,3-butadiene, acrylonitrile, pyridine, BTEX)	3.8
Non-Halogen. Semi-Volatile Compounds, ppmv (0.1)	none	BDL	BDL	BDL	BDL	BDL	BDL
Halocarbons - Freons, ppmv (0.1)	none	BDL	7.28	0.28	BDL	BDL	BDL
Halocarbons, ppmv (0.1)	none	BDL	1.04 chloroethane, vinyl chloride	BDL	BDL	BDL	BDL
Aldehyde/Ketones, ppbv (10)	none	BDL	522 acetone[2]	25.7	BDL	24,000 acetaldehyde, acetone[2], others	BDL

Appendix H

Feedstock/Upgraded Gas Constituent Guidance Matrix

Also includes observed ranges in RNG derived from landfills, dairies, and wastewater treatment plants with a comparison to ranges found in pipeline natural gas and AGA 4A

Updated table and added median information, removed PCBs and pesticides

Parameter	AGA 4A 2021 Common Reported Tariff/Specification Range[1]	Range Found in Upgraded Agriculture-Derived RNG			Range Found in Pipeline Natural Gas Samples		
		Min	Max	Med	Min	Max	Med
Gross HV, BTU/ft^3 (60°F, 14.73 psia)	950-974 (min.) 1,100-1,124 (max.)	949	1,013	1,006	988	1,193	1,024
Total Sulfur, grains per 100 SCF (0.003)	max. 0.5 to 20	BDL	0.827	BDL	BDL	1.13	0.09
Hydrogen Sulfide, grains per 100 SCF (0.003)	max. 0.25 to 1.0	BDL	0.028	BDL	BDL	0.36	0.008
Hydrogen, vol% (0.1)	max. 0.01 to 0.1	BDL	BDL	BDL	BDL	0.12	BDL
Carbon dioxide, vol% (0.03)	max. 1 to 3	BDL	1.97	0.17	BDL	2.62	0.74
Nitrogen, vol% (0.03)	max. 1 to 4	0.06	5.80	0.63	BDL	3.45	0.97
Oxygen, vol% (0.03)	max. 0.001 to 1 majority: 0.1 to 0.2	BDL	1.16	BDL	BDL	0.56	BDL
~~Diluents + Inerts~~ CO_2 + N2, vol%	max. 3 to 6	BDL	2.80	0.85	0.29	4.28	1.80
Ammonia, ppmv (10)	none	BDL	BDL	BDL	BDL	BDL	BDL
Total Bacteria, # per 100 SCF	none	1.30E+03	1.02E+07	1.28E+05	3.47E+04	6.39E+07	2.08E+06
Mercury, µg/m^3 (0.02)	none	BDL	BDL	BDL	BDL	0.19	BDL
Other Volatile Metals, µg/m^3 (30)	none	BDL	BDL	BDL	BDL	213 (As, Cu[2], Pb, Zn[2])	BDL
Siloxanes (D4), mg Si/m^3 (0.5-0.01)	none	BDL	BDL	BDL	BDL[3]	BDL[3]	BDL[3]
Non-Halogenated Volatile Compounds, ppmv (0.1)	none	BDL	BDL	BDL	BDL[4]	471 (1,3-butadiene, acrylonitrile, pyridine, BTEX)	3.8
Non-Halogen. Semi-Volatile Compounds, ppmv (0.1)	none	BDL	BDL	BDL	BDL	BDL	BDL
Halocarbons - Freons, ppmv (0.1)	none	BDL	BDL	BDL	BDL	BDL	BDL
Halocarbons, ppmv (0.1)	none	BDL	BDL	BDL	BDL	BDL	BDL
Aldehyde/Ketones, ppbv (10)	none	BDL	162 acetone[2]	BDL	BDL	24,000 acetaldehyde, acetone[2], others	BDL

Appendix H

Feedstock/Upgraded Gas Constituent Guidance Matrix

Also includes observed ranges in RNG derived from landfills, dairies, and wastewater treatment plants with a comparison to ranges found in pipeline natural gas and AGA 4A

Updated table and added median information, removed PCBs and pesticides

Parameter	AGA 4A 2021 Common Reported Tariff/Specification Range[1]	Range Found in Upgraded WWTP-Derived RNG			Range Found in Pipeline Natural Gas Samples		
		Min	Max	Med	Min	Max	Med
Gross HV, BTU/ft^3 (60°F, 14.73 psia)	950-974 (min.) 1100-1124 (max.)	927	1,011	1,006	988	1193	1024
Total Sulfur, grains per 100 SCF (0.003)	max. 0.5 to 20	BDL	0.207	BDL	BDL	1.13	0.09
Hydrogen Sulfide, grains per 100 SCF (0.003)	max. 0.25 to 1.0	BDL	0.207	BDL	BDL	0.36	0.008
Hydrogen, vol% (0.1)	max. 0.01 to 0.1	BDL	BDL	BDL	BDL	0.12	BDL
Carbon dioxide, vol% (0.03)	max. 1 to 3	BDL	7.12	BDL	BDL	2.62	0.74
Nitrogen, vol% (0.03)	max. 1 to 4	BDL	3.12	0.74	BDL	3.45	0.97
Oxygen, vol% (0.03)	max. 0.001 to 1 majority: 0.1 to 0.2	BDL	0.67	0.03	BDL	0.56	BDL
~~Diluents + Inerts~~ CO_2 + N2, vol%	max. 3 to 6	BDL	8.29	0.83	0.29	4.28	1.80
Ammonia, ppmv (10)	none	BDL	BDL	BDL	BDL	BDL	BDL
Total Bacteria, # per 100 SCF	none	5.40E+03	2.80E+07	1.25E+05	3.47E+04	6.39E+07	2.08E+06
Mercury, µg/m^3 (0.02)	none	BDL	0.08	BDL	BDL	0.19	BDL
Other Volatile Metals, µg/m^3 (30)	none	BDL	229 Zn[2]	BDL	BDL	213 As, Cu[2], Pb, Zn[2]	BDL
Siloxanes (D4), mg Si/m^3 (0.5-0.01)	none	BDL[3]	BDL[3]	BDL[3]	BDL[3]	BDL[3]	BDL[3]
Non-Halogenated Volatile Compounds, ppmv (0.1)	none	BDL	0.5 t-butylbenzene (one sample)	BDL	BDL[4]	471 (1,3-butadiene, acrylonitrile, pyridine, BTEX)	3.8
Non-Halogen. Semi-Volatile Compounds, ppmv (0.1)	none		6.1 bis(2-Ethylhexyl)phthalate (one sample)		BDL	BDL	BDL
Halocarbons - Freons, ppmv (0.1)	none	BDL	BDL	BDL	BDL	BDL	BDL
Halocarbons, ppmv (0.1)	none	BDL	BDL	BDL	BDL	BDL	BDL
Aldehyde/Ketones, ppbv (10)	none	BDL	BDL	BDL	BDL	24,000 acetaldehyde, acetone[2], others	BDL

New Appendix

Example of Gas Aggregation or Pairing Agreement

Offers further information defining the commercial aspects of accepting gas from the proposed facility

Could be used in cases where the gas quality does not meet applicable specifications and parties agree that blending or aggregating gas is acceptable.

Offers opportunity for small producers to connect to a transporter.

New Appendix

Rationale for Eliminating Certain Constituents

Provides science-based reasons for removing PCBs and pesticides from the analyte list

PCBs have not been detected in any raw or processed landfill gas samples at concentrations greater than detection limits.

Pesticides rarely found. Levels were sub-ppbv.

2 to 4 orders of magnitude lower than OSHA 8-hour time weighted average (TWA) concentration

Low vapor pressures keeps saturated concentrations low.

New Definitions Added

Updated definitions based on new text added to the document

Halocarbons – Organic compounds containing the elements fluorine (F), chlorine (Cl), bromine (Br), and iodine (I), which make up the seventh period in the periodic table of the elements. Compounds which consist of these elements are often used in disinfectant solutions, or as refrigerant gases in air conditioning and other cooling equipment. Upon degradation, the elements may be released as gases. For example, these constituents include Freons, chloroethane and vinyl chloride.

Heating Value – Gross heating value, also known as Higher Heating Value (HHV), is defined as the amount of energy transferred as heat from the complete, ideal combustion of the gas with air, at a standard temperature, in which all the water formed by the reaction condenses to liquid. Another commonly seen heating value parameter is net heating value, or Lower Heating Value (LHV). The difference between HHV and LHV is that the water produced by combustion remains in the vapor state when determining the LHV. The energy gained by the condensation of the water vapor is not realized so the heating value is lower. Heating values are also often reported as wet or dry. Wet gas refers to gas that is completely saturated with water vapor. A wet gas has a lower heating value per volume than a dry gas because some of the gas volume is occupied by the water vapor, so the absolute amount of combustible gas is less. The North American Energy Standards Board recommends utilizing the HHV expressed on a dry basis.

Hydrocarbon Dewpoint Temperature – The hydrocarbon dew point temperature (HDP) is the temperature of the corresponding state condition at which the non-methane hydrocarbon components of natural gas begin to condense into the liquid phase.

Hydrogen (H_2) – The lightest element in the periodic table and found in water and organic material. It is colorless, odorless, tasteless, non-toxic, and very combustible. It is a potential byproduct of the anaerobic digestion process and produced during gasification processes.

Hydrogen Enriched Natural Gas (HENG) – Natural gas that is blended with hydrogen.

Hydrogen Sulfide (H_2S) – A colorless gas known for its pungent "rotten egg" odor at low concentrations. It is extremely flammable and highly toxic. H_2S is produced during anaerobic digestion and gasification processes where the feedstock contains sulfur.

Inert Gas Sample Collection Cylinder – Sample collection cylinders containing an inert coating or otherwise passivated so that the cylinder exhibits very low reactivity to compounds such as sulfur odorants or H_2S.

Interchangeability – The ability to substitute one gas for another (in the context of natural gas replacement) without materially changing or influencing environmental health and safety, end use performance, or pipeline integrity.

Interconnect Feasibility Analysis (IFA) – An agreement between the producer and the distributor, or pipeline operator to conduct a detailed engineering assessment, design review, and cost analysis for making the connection to the pipeline system. Also known as an Engineering Services Agreement (ESA).