Sterling Environmental Engineering, P.C.

August 4, 2023

Ms. Erin Burns
NYSDEC Region 5
Regional Permit Administrator, Division of Environmental Permits
1115 NYS Route 86, PO Box 296
Ray Brook, New York 12977

Via Email: erin.burns@dec.ny.gov

Subject: Saratoga Biochar Solutions, LLC
Notice of Incomplete Application & Request for Additional Information
NYSDEC Permit Application ID 5-4144-00187/00001
STERLING File #2020-20

Dear Ms. Burns,

On behalf of Saratoga Biochar Solutions, LLC (SBS), Sterling Environmental Engineering, P.C. (STERLING) submits this letter in response to the June 14, 2023 Notice of Incomplete Application (NOIA) and the July 11, 2023 and July 27, 2023 Requests for Additional Information (RFAI) issued by the New York State Department of Environmental Conservation (NYSDEC).

For ease of reference, the following responses correspond directly to the enumerated comments provided by NYSDEC. An updated Air Permit Application submittal is enclosed including the requested additional information provided in this response.

Notice of Incomplete Application – June 14, 2023:

1. Casella Organics (Casella) has provided representative data of per- and polyfluoroalkyl substances (PFAS) collected from municipalities within Casella's operating footprint over the past 4+ years. These facilities are representative of those that that will generate biosolids ultimately destined for management at the SBS Facility. Average and maximum concentrations for six PFAS compounds are summarized in the table below.

Representative PFAS Concentrations in Source Biosolids

Year	Average Concentrations (ng/g, ppb)					
	PFBS	**PFOA**	**PFOS**	**PFNA**	**HFPO-DA**	**PFHxS**
2019	0.83	7.8	19.39	--	--	--
2020	2.2	7.76	20.6	1.4	--	<0.35
2021	3.04	6.94	20.04	--	--	--
2022	2.81	4.62	16.41	1.12	--	1.2
2023	2.24	3.42	12.61	1.31	ND	<1.8
Overall Average	**2.22**	**6.11**	**17.81**	**1.28**	**ND**	**1.2**

Year	Maximum Concentrations (ng/g, ppb)					
	PFBS	**PFOA**	**PFOS**	**PFNA**	**HFPO-DA**	**PFHxS**
2019	1.9	63	77	--	--	--
2020	2.71	30.6	63	1.4	--	<0.35
2021	4.8	40	48	--	--	--
2022	7.3	38.9	66	2.2	--	1.2
2023	2.24	14.3	48.3	2.54	ND	<1.8
Overall Max	**7.3**	**63**	**77**	**2.54**	**ND**	**1.2**

NOTE: PFBS = Perfluorobutanesulfonic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid
PFNA = Perfluorononanoic acid
HFPO-DA = Hexafluoropropylene oxide-dimer acid
PFHxS = Perfluorohexane sulfonate

2. Currently only PFOA has an established air guideline concentration and is therefore used as a surrogate for other PFAS compounds by summing all detected PFAS compounds and assessing the total potential emission as PFOA. Based on the data provided in Response 1, the sum of the maximum concentrations for each PFAS compound results in a total PFAS concentration of 151 parts per billion (ppb). The following calculations provide an estimate of an untreated PFOA emission rate for a single process line:

$$PFOA\ Release\ from\ Biosolids = 151\ \frac{ng}{g} = 151 \frac{\mu g}{kg}\ on\ dry\ weight\ basis$$

$$Biosolids\ Processing\ Rate = 20{,}000\ \frac{lb}{hr}\ (wet\ weight) = 4{,}600\ \frac{lb}{hr}\ (dry\ weight) = 2{,}086\ \frac{kg}{hr}$$

$$Process\ Line\ Air\ Flow = 34{,}146\ acfm = 58{,}006\ \frac{m^3}{hr}$$

$$PFOA\ Emission\ Factor = \ 151\ \frac{\mu g}{kg} \times 2{,}086\ \frac{kg}{hr} \div 58{,}006 \frac{m^3}{hr} = 5.4 \frac{\mu g}{m^3} = 5.4 \times 10^{-3} \frac{mg}{m^3}$$

3. NYSDEC has indicated that the Facility will be subject to a PFOA emission limit of 0.001 lb/hr per process line. The estimated untreated PFOA emission factor is 5.4 x 10^{-3} mg/m^3 (i.e., 6.95 x 10^{-4} lb/hr) per process line, which is less than the 0.001 lb/hr emission limit. The AERMOD assessment included in the Air Permit Application conservatively used the higher emission limit of 0.001 lb/hr per process line to assess potential impacts. The AERMOD assessment remains valid for assessing potential emissions of PFAS compounds since the modeled emissions achieve the annual guideline concentration (AGC) using the 0.001 lb/hr emission limit.

4. SBS retained the services of EcoEngineers to perform a life cycle analysis (LCA) on the manufactured Carbon Fertilizer™ to obtain a carbon intensity (CI) to quantify the greenhouse gas (GHG) footprint of the Facility for comparison to baseline disposal methods for biosolids. EcoEngineers has prepared an addendum to their February 21, 2023 report that provides supporting calculations and emission factors. The emission factors were obtained from California Air Resources Board CA-GREET3.0 LCA model and are comparable to the USEPA Emission Factors for Greenhouse Gas Inventories. The addendum is included in Attachment 7 of the enclosed updated Air Permit Application.

Request for Additional Information – July 11, 2023:

1. The enclosed Air Permit Narrative has been revised for clarity. The thermal oxidizer is designed to operate with a reducing zone followed by a conditioning zone and an oxidizing zone to achieve the design 99.99% destruction and removal efficiency (DRE) for volatile organic compounds (VOC) and PFAS compounds. The reducing zone operates at a minimum temperature of 2,300 °F with a residence time of 0.5 seconds. The temperature is reduced in a conditioning zone, but remains above a minimum temperature of 1,650 °F. The oxidizing zone operates at a minimum temperature of 1,800 °F with a residence time of 1.0 second.

   NYSDEC's RFAI comments were provided to the Facility's Thermal Oxidizer designer, Process Combustion Corporation (PCC), who confirmed that the 99.99% design DRE for PFAS compounds is expected to be met even if there are detectable PFAS compounds in the exhaust gas. As indicated in the responses above to the June 14, 2023 NOIA, potential emissions of untreated PFAS compounds achieves the AGC for PFOA. Therefore, the SBS facility is projected to have minimal potential for PFAS emissions due to:

   - Relatively low PFAS concentrations in source biosolids.
   - 99.99% design DRE in the multi-stage thermal oxidizer.
   - Phased construction of the Facility to verify emissions.

   PCC provided an article (Sheilds, et al.) from the peer reviewed research journal Environmental Science and Technology regarding the thermal destruction of PFAS compounds. A copy of the article is included in Attachment 8 of the updated Air Permit Application. The article presents results from pilot-scale thermal treatment of legacy aqueous film forming foam (AFFF) with a total PFAS concentration of 10,008,550 ppb. The pilot-scale test calculated the %DRE for 10 PFAS compounds at temperatures ranging from 810°C to 1,180°C (1,490°F to 2,156°F). 99.99% DRE was achieved for all PFAS compounds at a temperature of 1,090°C (1,994°F), which is below the operating temperature of reducing zone for the thermal oxidizer in the SBS Facility. The study also tested for volatile products of incomplete combustion (PICs), which found very few PICs at temperatures above 1,090°C (1,994°F).

   One of the monitored PICs was tetrafluoromethane (CF4), which was not detected above detection limits at all test temperatures. HF was also monitored with concentrations ranging from 227 ppm at 810°C (1,490°F) to 340 ppm at 1,180°C (2,156°F). The Facility's air treatment system designer, Condorchem, confirmed that the hydrated lime scrubber will also provide removal of HF in addition to SO_2 control. Further, review of the USEPA Compilation of Air Emissions Factors (AP-42) Chapter 8.7 for Hydrofluoric Acid indicates that caustic scrubbers can provide a control efficiency of 99%.

   The ES&T pilot-scale results are based on a feedstock total PFAS concentration of 10,008,550 ppb with a single-stage combustion unit. The SBS Facility will use a multi-stage thermal oxidizer with temperatures exceeding the pilot-study and with significantly lower PFAS concentrations in the feedstock (i.e., 151 ppb in biosolids versus 10,008,550 ppb in AFFF). Therefore, the SBS facility is expected to achieve the following:

   - 99.99% DRE for PFAS compounds.
   - No formation of CF4 as a PIC.

- Formation of HF during the complete mineralization of PFAS compounds that will be removed from the exhaust gas by the hydrated lime scrubber.

2. The control efficiencies of the air pollution control devices are as follows:
    - Cyclone Separators: 90% Removal Efficiency for Particulate Dust
    - Sulfuric Acid Scrubber: 95.5% Removal Efficiency for Ammonia
    - Hydrated Lime Scrubber: 95% Removal Efficiency for SO_2
    - Bio-Scrubber: 80% Removal Efficiency for Odor Units

3. The Air Permit Narrative has been updated to include additional detail regarding the Degree of Air Cleaning Requirements contained in 6 NYCRR 212-2.3(a) Table 3 and 6 NYCRR Part 212-2.3(b) Table 4.

4. The Air Permit Narrative text has been updated to clarify that the full-scale pyrolysis chamber will have a minimum residence time of 20 minutes at a minimum temperature of 900 °F (482 °C). The Facility will conduct PFAS testing on produced biochar during startup to confirm the operating temperature and residence time in the pyrolysis kiln results in removal of PFAS compounds from the solid phase. The Facility's objective is to operate at a temperature and residence time that maximizes biochar production and minimizes residual PFAS in the biochar.

5. The Air Permit Narrative and application forms in Attachment 1 have been updated to clarify potential HAP emissions. The table below lists contaminants that are identified as HAPs. Note that naphthalene emissions are conservatively calculated using a DRE of 99.5% while the actual DRE is expected to be 99.99%. Also, the Air Permit Application originally represented an emission rate for the family of compounds identified as "Methyl and Ethylamines". By email dated March 21, 2023, NYSDEC requested that six individual amines be separately assessed. The Air Permit Application was revised by conservatively applying 100% of the emission rate for "Methyl and Ethylamines" to each of the six individual amines, including triethylamine, which is a HAP. Therefore, the total potential HAP emissions in the table below are expected to be lower than estimated.

Hazardous Air Pollutants – Potential to Emit

CAS No.	Contaminant Name	Potential To Emit Ton/yr
0091-20-3	Naphthalene	9.5
00121-44-8	Triethylamine	3.4
07647-01-0	Hydrogen Chloride	1.5
07439-97-6	Mercury	0.038
	TOTAL	**14.4**

Request for Additional Information – July 27, 2023:

1. Following the April 14, 2022 email from NYSDEC with comments related to the CLCPA consistency assessment, a conference call was held among SBS, STERLING, and NYSDEC on May 3, 2022. The outcome of the May 3, 2022 conference call resulted in the enhanced narrative and supporting calculations included in the June 13, 2022 submittal that indicates the SBS Facility is consistent with the CLCPA. In accordance with Section 7(3) of the CLCPA and with DAR-21 "The Climate Leadership and Community Protection Act and Air Permit Applications", actions that are consistent with the CLCPA do not need to evaluate or implement mitigation measures.

   The May 15, 2023 submittal expanded on the CLCPA consistency assessment by including a greenhouse gas LCA prepared by EcoEngineers, an independent third party that specializes in GHG accounting. The LCA concluded that the SBS Facility will result in a net GHG reduction of 135% compared to landfill disposal, which is currently the predominant biosolids management practice in New York State. In essence, the SBS Facility provides GHG mitigation for the current statewide practice of biosolids landfill disposal. Specifically, the SBS Facility provides the following mitigation measures for reducing statewide GHG emissions associated with biosolids management:

   - **Bioenergy/Renewable Energy** – The biogenic energy available in the biosolids and waste wood feedstock is recovered in the thermal treatment process and used as a fuel source to reduce fossil fuel consumption from natural gas. The heat generated in the thermal treatment process is recovered for use in the drying process, which accounts for 83% of the heat energy needed for the Facility. Recovered heat from the biogenic energy content of the biosolids and wood waste minimizes the fossil fuel energy demand of the Facility.
   - **Carbon Sequestration –** The recovered Carbon Fertilizer™ represents avoided GHG emissions that are transformed into solid "fixed" carbon that becomes sequestered in soil. The Facility is specifically designed to manufacture a granular Carbon Fertilizer™ that can be used directly in existing commercially available fertilizer spreading equipment. The carbon sequestration mitigation alone exceeds the Facility's direct GHG emissions, yielding a carbon negative GHG footprint.

   Therefore, SBS Facility is consistent with the CLCPA and supports New York State's ability to meet the statewide GHG emissions limits. The Air Permit Narrative has been updated with a new section (Section 9.4 – Mitigation) to incorporate this response.

2. The Air Permit Narrative has been revised for clarity to indicate that the thermal oxidizer is expected to have a DRE of 99.99% for VOCs, including methane. The syngas from the pyrolysis kiln is expected to contain a mixture of organic compounds, including methane. The thermal oxidizer is integral to the thermal treatment process to provide heat generation for the biosolids dryer, while also providing control of air pollutants. Therefore, the expected potential emissions of methane from the SBS Facility is 0 tons per year.

3. As indicated in the responses above to the July 11, 2023 RFAI, the SBS Facility does not project to have any emissions of CF4.

We trust that this submittal addresses all outstanding application completeness items. Please contact me should you have any questions or comments.

Very truly yours,
STERLING ENVIRONMENTAL ENGINEERING, P.C.

Andrew M. Millspaugh, P.E.
Vice President
Andrew.Millspaugh@sterlingenvironmental.com

Email/FedEx
Attachments

cc: Raymond Apy, Saratoga Biochar Solutions, LLC. (email)
Bryce Meeker, Saratoga Biochar Solutions, LLC. (email)
Beth Magee, NYSDEC (email)
Aaron Love, NYSDEC (email)
Kevin Wood, P.E., NYSDEC (email)
Katelyn White, NYSDEC (email)
Paul Sierzenga, NYSDEC (email)
Kathleen Prather, P.E., NYSDEC (email)
Mark Lanzafame, P.E. NYSDEC (email)
Yasmini Patel, NYSDEC (email)
Julia Stuart, NYSDEC (email)
Jordan Gougler, NYSDEC (email)
Kerri Pickard-DePriest, NYSDEC (email)
Alanah Keddell-Tuckey, NYSDEC (email)