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Division of Air Quality
Fayetteville Regional Office

August 11, 2020

Mr. Jeffrey D. Cole
North Carolina Department of Environmental Quality
Division of Air Quality
225 Green Street, Suite 714
Fayetteville, NC 28301

RE: International Tie Disposal, LLC – Application Number 7700101.20A

Dear Mr. Cole:

International Tie Disposal, LLC (International Tie Disposal) is proposing to develop a biochar production site to be located in Hamlet, Richmond County, North Carolina (the Hamlet site). The Hamlet site is a greenfield facility; therefore, International Tie Disposal is submitting this revised synthetic minor construction permit application to authorize the proposed operation.

The enclosed application includes all required elements, including those identified as incomplete in the letter from the Division of Air Quality on June 29, 2020. Since International Tie Disposal is now requesting a synthetic minor permit application, this submittal includes a check for $350 for the difference between the synthetic minor application fee ($400) and the small source application fee, which was already submitted ($50). Note that International Tie Disposal is working to obtain a street address for inclusion in the application and requests that the Division of Air Quality process the application concurrently with these efforts.

International Tie Disposal appreciates the Division of Air Quality's review of this synthetic minor construction permit application for the Hamlet site. If there are any questions or more information is needed, please contact me at (704) 553-7747.

Sincerely,

TRINITY CONSULTANTS

Nicole Saniti

Nicole Saniti, P.E.
Managing Consultant

AIR QUALITY CONSTRUCTION PERMIT APPLICATION

International Tie Disposal, LLC > Hamlet, NC Site

International Tie Disposal, LLC
Marks Creek Church Rd.
Parcel No. 840200970265
Hamlet, NC 28345
(704) 321-0802

Prepared By:

Nicole Saniti, PE – Manager of Consulting Services

TRINITY CONSULTANTS
325 Arlington Ave.
Suite 500
Charlotte, NC 28203
(704) 553-7747

Project 203402.0124

August 2020

Trinity Consultants

Environmental solutions delivered uncommonly well

1. EXECUTIVE SUMMARY

International Tie Disposal, LLC (International Tie Disposal) is proposing to develop a biochar production site to be located in Hamlet, Richmond County, North Carolina (the Hamlet site). The Hamlet site is a greenfield facility; therefore, International Tie Disposal is submitting this state construction and operating permit application to authorize the proposed operations.

The proposed Hamlet facility will be classified as a synthetic minor source with respect to Title V of the Clean Air Act (CAA), as International Tie Disposal is requesting a federally enforceable limits to restrict criteria pollutant emissions of nitrogen oxides (NO_X), volatile organic compounds (VOC), carbon monoxide (CO) less than the 100 ton per year (tpy) major source threshold and hazardous air pollutants (HAP) less than the 10 tpy major source threshold for individual HAP and 25 tpy for combined HAP. All other criteria pollutant emissions will be less than the 100 tpy major source threshold without the use of air pollution control equipment. The proposed project will not trigger Prevention of Significant Deterioration (PSD) permitting requirements, as the emissions from the proposed project are less than the 250 tpy PSD major source threshold.

International Tie Disposal is submitting this permit application in accordance with 15A NCAC 02Q .0300 to install a biochar production process, consisting of untreated wood and railroad tie handling and sizing equipment, biochar kilns, and product handling, sizing, and packaging equipment. All information required to issue a construction permit under 02Q .0300 for the proposed project is contained in this permit application. International Tie Disposal is requesting a synthetic minor permit in accordance with 15A NCAC 02Q .0315 and has included the required air quality permit application fee of $400.

The International Tie Disposal site will include the following sources of regulated air pollutants:

- Kilns that share common stacks. There will be 426 kilns on site, with an estimated 160 kilns operating per day. Each kiln will utilize:
  - A natural gas-fired process heater used to initiate the kiln reaction within each individual kiln.
  - Shared stacks that include afterburner devices to provide process and emission controls.
- Fugitive haul road emissions from truck traffic that delivers raw materials to the site and transports finished biochar from the site (not included in Title V or PSD applicability determinations).
- Fugitive haul road emissions from mobile sources that are used for on-site raw material transfers and kiln transfers from loading and unloading locations within the site (not included in Title V or PSD applicability determinations).
- A shredder that is used to size the wood or railroad tie feedstock that is processed in the kiln.
- Material handling equipment including conveyors, screening equipment, storage silos, and packaging units for finished product.

This application is organized in the following manner:

- Section 2 provides a detailed description of the project;
- Section 3 provides the emission calculation methodology;
- Section 4 provides the regulatory applicability analysis;
- Section 5 contains the required DEQ permit application forms;
- Appendix A contains the area map, site layout diagram, and process flow diagram for the proposed facility;
- Appendix B contains detailed emission calculations and stack test reports; and
- Appendix C contains a check for the permit application fee.

2. PROJECT DESCRIPTION

The proposed facility will receive logs (untreated lumber) and creosote-treated railroad ties by rail or truck. Received materials will be offloaded and stacked. All raw material is reduced to a 3 – 4 inch by 12-18 inch size using a shredder and loaded into kilns in the raw material staging area. Raw material staging and handling will be performed using a tracked excavator with a handling arm.

Empty kilns will be transported to the processing area for charging with shredded ties and returned to the kiln area using a wheel-loader.

For emission calculation purposes, the site is assumed to have 426 kilns, approximately 160 of which will operate each day, while the remaining kilns are being prepared for the next day's operations, cooling or used for rotational purposes.

The capacity of each kiln will be approximately 2000 pounds of woody raw material. A kiln loaded with raw material will be equipped with an emission control stack (afterburner) for the processing period that may last 7 to 8 hours. Processing involves controlled heating (pyrolysis) to volatilize unwanted chemical components to produce the carbonaceous biochar.

Pyrolysis within the kiln is initiated by the combustion of natural gas. Once the pyrolysis is initiated, it is self-sustaining and does not require additional natural gas combustion. The kiln exhaust stacks are refractory-lined and are equipped with an afterburner to combust any organic compounds. The afterburner will be natural gas fired with a capacity of no greater than 0.125 MMBtu/hr.

At the end of the pyrolysis operation, the exhaust stack will be removed and placed on an adjacent kiln, already loaded with raw material, in preparation for firing the next day. Thus, adjacent kilns will share an emission control stack. The processed kiln is covered by seal-cover lid during the cool-down period as the kiln cools for approximately 10 to 18 hours. Stacks and lids will be handled by a mid-sized loader.

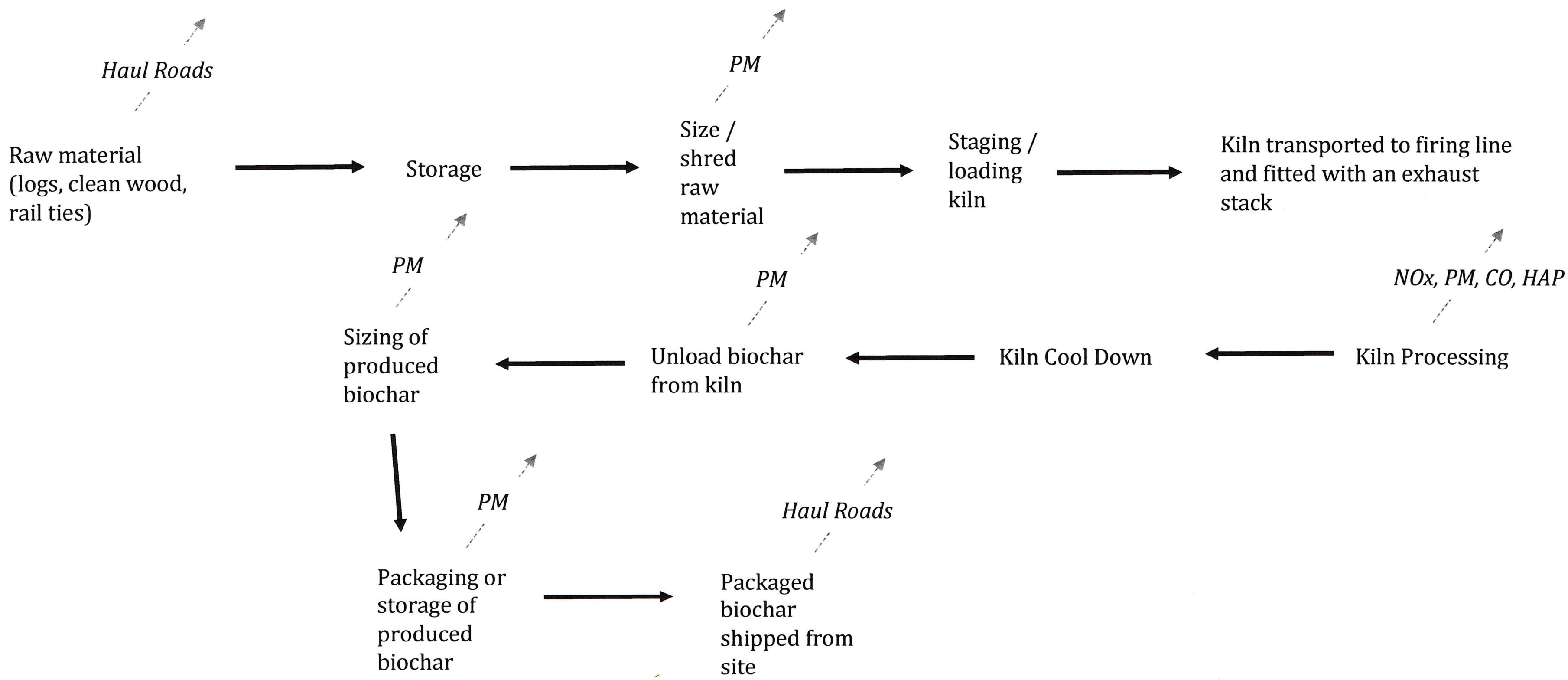
Emissions from the kiln pyrolysis process include combustion related emissions (nitrogen oxides (NO_X), carbon monoxide (CO)), VOC, including methanol, and particulate matter (PM). Emissions from the process initiation combustion and the afterburner combustion are included in the kiln emission factor since there is only one emission point for each kiln during the processing period. There are no emissions from the kilns during the cool-down period.

After the pyrolysis process and cool down, the kilns containing biochar will be transported to the sizing and packaging building by the mid-sized wheel loader for mechanical off-loading into a hopper. The loader will then transport the empty kiln to the log area where it will be loaded and then transported back to the kiln area for the next day's processing. The biochar product will be screened, crushed to a desired size, and charged to a bagging system or conveyed into one of three storage silos. Up to 500 pounds of biochar will be produced by a single kiln process. The product processing operation is conducted within the sizing and packaging building. Sizing and packaging emissions are particulates. Emissions from the wheel-loader are shown in the haul road calculations.

Packaged product will be loaded onto pallets for shipment by truck or rail off-site. Product trucks will travel to and from the sizing & packaging building via the product transport route. Emissions from truck transport are shown in the haul road emission calculations.

Other sources of emissions of regulated pollutants may include small fuel tanks, propane storage tanks, and maintenance activities such as welding. These sources, individually and collectively, are negligible sources of emission and are exempt from permitting requirements.

SIMPLIFIED PROCESS FLOW DIAGRAM SHOWING POTENTIAL EMISSION SOURCES



3. EMISSION CALCULATIONS

This section discusses the methodologies used to calculate emissions from the proposed project.

3.1. KILN EMISSIONS

The emission calculation methodology used for potential emission calculations from the kiln involves multiplying emission factors in lb/ton of material heated by the maximum amount of material heated in tons, or multiplying lb/MMBtu emission factors by the maximum heat input of the material heated in MMBtu.

Emission factors for CO, NO_X, VOC, methanol, and PM are taken from one of two stack test reports for a similar pyrolysis operation in Weld County, Colorado (Biochar Now). One performance test in 2015 was conducted using creosote treated railroad ties, and the other test in 2019 was conducted using untreated wood. Emissions are calculated using the worst-case emission factor from the two performance tests on a pollutant-by-pollutant basis, including a 25% safety factor. Note that the kilns and afterburners used at the Biochar Now facility are identical in size to the proposed kilns for this operation. Tested pollutant emissions from the process initiation combustion and afterburner are included in the kiln emission factor since there is only one emission point for each kiln during the pyrolysis period. There are no emissions from the kilns during the cool down period.

Emissions of all other pollutants from the kilns were calculated based on emission factors from AP-42, 5th Edition, Section 1.6 *Wood Residue Combustion in Boilers*, Tables 1.6-3 and 1.6-4 (Sep 2003), or using test data from the Craven County Wood Energy facility in North Carolina.[1] For these pollutants, potential emissions were calculated using the maximum of the test data and AP-42 emission factor or the test data if an AP-42 factor was not available. Although the pyrolysis process occurs in an oxygen starved environment and does not involve combustion of the material in the kiln, the use combustion emission factors provides a conservative estimate of emissions for which no test data is available.

The afterburner control efficiency of 95% is applied to all uncontrolled VOC and volatile HAP and TAP emissions.

Sulfur dioxide (SO_2), HAP and TAP emissions from the process initiation combustion and afterburners are calculated using DEQ's *Natural Gas Combustion Emissions Calculator*, Revision N (Jan 2017).

Equations used to calculate emissions from each process are provided in Appendix B.

3.2. FEEDSTOCK AND PRODUCT HANDLING

Emissions from feedstock handling (shredding and kiln loading) are calculated based on the maximum throughput of feedstock, and emission factors obtained from the table in the memorandum *"Particulate Matter Potential to Emit Emission Factors from Activities at Sawmills, Excluding Boilers, Located in Pacific Northwest Indian Country"*, May 8, 2014, from Dan Meyer, US EPA Region 10. Emissions from product handling and packaging are calculated based on published factors in AP-42 Section 11.19.2 – Crushed Stone Processing and Pulverized Mineral Processing. Emission factors in lb/ton are multiplied by the

[1] Application submitted by Coastal Carolina Clean Power, LLC to North Carolina Division of Air Quality, *PSD Air Quality Construction and Operating Permit Application*. Oct 2013.

maximum material throughput in tons. Control efficiency is applied for enclosures, which reduce PM emissions to the atmosphere.

Storage silo emissions for are based on AP-42 Section 13.2.4 – Aggregate Handling and Storage Piles, Equation 1:

$$E\left(\frac{lb}{ton}\right) = k\,(0.0032)\left[\frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right]$$

Where E is the calculated emission factor, k is the particle size multiplier, U is the mean wind speed in miles per hour, and M is the moisture content of the material. The particulate emissions (PM, PM_{10}, and $PM_{2.5}$) are calculated using the potential throughput of the material in tons per year and the calculated emission factor E (lb/ton) from the equation above.

Equations used to calculate emissions from each process are provided in Appendix B.

3.3. UNPAVED HAUL ROADS

The proposed project will include unpaved haul roads for deliveries of feedstock to the site, transporting kilns and stacks, and product transfers. Potential emissions were calculated using the methods presented in AP-42, 5th Edition, Section 13.2.2 *Unpaved Roads* (Nov 2006). Detailed emission calculations are provided in Appendix B.

4. STATE AND FEDERAL REGULATORY REQUIREMENTS

The proposed Hamlet site is subject to federal and state air regulations. This section summarizes the air permitting requirements and the key air quality regulations that apply to the proposed facility. Specifically, applicability of PSD, New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP) and North Carolina DEQ Air Quality Regulations are addressed.

4.1. FEDERAL REGULATIONS

Federal air quality regulations are codified under 40 CFR. The applicability of the following Parts were reviewed:

- Parts 51– NSR
- Part 60 – NSPS
- Part 61 – pollutant specific NESHAP
- Part 63 – source category NESHAP
- Part 70 – Title V Operating Permit Program

4.1.1. Parts 51- New Source Review (NSR)

The NSR permitting program generally requires a stationary source to obtain a permit and undertake other obligations prior to construction of any project at an industrial facility if the proposed project results in a net emissions increase in excess of certain threshold levels. The NSR program is comprised of two elements: nonattainment NSR (NNSR) and PSD. The NNSR program potentially applies to new construction or modifications that result in emission increases of a particular pollutant for which the area in which the facility is located is classified as "nonattainment" for that pollutant. The PSD program applies to project increases of those pollutants for which the area the facility is located in is classified as "attainment" or "unclassifiable."

4.1.1.1. Attainment Status

Richmond County is currently designated by the US EPA as "attainment" or "unclassifiable" for all criteria pollutants. Therefore, PSD regulations apply to any new major stationary source or major modifications to an existing major stationary source.

4.1.1.2. Part 51.166 - PSD

The PSD program regulates emissions from "major" stationary sources of regulated pollutants (i.e., criteria pollutants). As defined in 40 CFR 51.166, a stationary source is considered PSD major if

- the facility belongs to one of the 28 named source categories in 40 CFR 51.166(b)(1)(iii) and has the potential to emit 100 tpy of any pollutant subject to the regulations; or
- the facility has the potential to emit 250 tpy or more of any pollutant subject to the regulations, regardless of its source category.

The Hamlet facility is not in one of the 28 named source categories, and potential emissions from the proposed facility, excluding fugitive emissionsare less than the 250 tpy major source threshold. Therefore, the Hamlet facility is a minor source with respect to the PSD permitting regulations.

4.1.2. New Source Performance Standards (NSPS)

NSPS apply to new, modified, or reconstructed equipment after a given applicability date. NSPS applicability was reviewed for the Hamlet site; the sections below review applicability to specific NSPS that could potentially apply to the facility.

Potentially applicable NSPS subparts of 40 CFR Part 60 are discussed in the subsections below.

4.1.2.1. Subpart A - General Provisions

Any source subject to a source-specific NSPS is also subject to the general provisions of NSPS Subpart A. Unless specifically excluded by the source-specific NSPS, Subpart A generally requires initial construction notification, initial startup notification, performance tests, performance test date initial notification, general monitoring requirements, general recordkeeping requirements, and semiannual monitoring and/or excess emission reports. The Hamlet facility will comply with all applicable requirements.

4.1.2.2. Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units (40 CFR 60, Subpart Dc)

This subpart applies to units that use any fuel to generate steam or heat any heat transfer medium with heat input of greater than 10 MMBtu/hr; process heaters are not covered by this subpart. The propane heaters used in the kiln process are process heaters and have heat input of 0.125 MMBtu/hr. Therefore, this subpart does not apply.

4.1.2.3. 40 CFR 60 Subparts CCCC and DDDD - Commercial and Industrial Solid Waste Incineration (CISWI) Rules

NSPS Subpart CCCC and the emission guidelines in Subpart DDDD apply to commercial and industrial solid waste incineration (CISWI) units. Subpart CCCC applies to units for which construction commenced after June 4, 2010 or modification or reconstruction commenced after August 7, 2013. Subpart DDDD applies to units not covered by Subpart CCCC. The most recent versions of Subparts CCCC and DDDD were published on June 23, 2016 in response to comments and concerns raised from the previous final rules published on February 7, 2013. The rules define a CISWI unit as any distinct operating unit of any commercial or industrial facility that combusts, or has combusted in the preceding 6 months, any solid waste as that term is defined in 40 CFR 241. The definition of solid waste in 40 CFR 241 was published on March 21, 2011 and amended on February 7, 2013.

The provisions of Subpart CCCC apply to incineration units which commenced construction after June 4, 2010 or modified/reconstructed after August 7, 2013 that combust solid waste as defined in 40 CFR 60.2265 and are not exempted under 40 CFR 60.2020. The provisions of Subpart DDDD apply to combustion units not covered by Subpart CCCC that combust solid waste as defined in 40 CFR 60.2875.

With this application, International Tie Disposal is proposing to generate biochar from creosote-treated railroad ties through pyrolysis in kilns at the Hamlet facility. Pyrolysis is the chemical decomposition of condensed substances by heating that occurs spontaneously at high enough temperatures or a chemical change or degradation of material brought about by the action of heat. By comparison, combustion or burning is the sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the production of heat and conversion of chemical species. International Tie Disposal does not consider the kilns used for pyrolysis of the creosote treated rail ties as incinerators since pyrolysis does not involve combustion of the creosote treated rail ties. Furthermore, the kilns are utilizing a wood feedstock for the production of charcoal, which is included in the definition of a chemical recovery unit provided in 40 CFR 60.2265. Chemical recovery units are not incinerators. For these reasons, the proposed kilns are not subject to NSPS Subpart CCCC.

The afterburners are not subject to NSPS Subpart CCCC since they are control devices and therefore do not meet the definition of a CISWI unit in 60.2265.

4.1.3. National Emission Standards for Hazardous Air Pollutants (NESHAP)

The proposed facility will be an area source of HAP, as it will have a PTE of <25 tpy total HAP and <10 tpy of any individual HAP, including fugitive emissions.

The following MACT subparts in 40 CFR Part 63 are potentially applicable to the emission sources at the plant:

Table 6-1. Potentially Applicable MACT Subparts

Subpart	Description	Applicability	Affected Sources (ID)
Subpart A	General Provisions	Yes	Sources listed below
Subpart JJJJJJ	National Emission Standards for Hazardous Air Pollutants for Boilers Area Sources	No	Kiln propane heaters

Each applicable MACT Subpart of 40 CFR Part 63 is discussed in the subsections below.

4.1.3.1. Subpart A - General Provisions

Any source subject to a source-specific NESHAP is also subject to the general provisions of NESHAP Subpart A. Unless specifically excluded by the source-specific NESHAP, Subpart A generally requires initial construction notification, initial startup notification, performance tests, performance test date initial notification, general monitoring requirements, general recordkeeping requirements, and semiannual monitoring and/or excess emission reports.

4.1.3.2. NESHAP for Industrial Boilers (40 CFR Part 63, Subpart JJJJJJ)

The kiln propane heaters are considered process heaters as defined in this subpart and are not affected sources.

4.1.4. NNSR Applicability

The proposed facility is located in Richmond County, North Carolina. Richmond County is currently attainment or unclassifiable for all criteria pollutants. Therefore, the proposed facility is not subject to requirements under the Nonattainment New Source Review (NNSR) program.

4.1.5. Federal Title V Program Applicability

As shown in this application, the proposed facility will be a synthetic minor source of criteria pollutants (NO_X, SO_2, VOC, CO PM, PM_{10}, $PM_{2.5}$) and HAPs with respect to Title V permitting (i.e., emissions < 100 tpy for criteria pollutants and < 25 tpy for HAPs). Therefore, the proposed facility is not subject to Title V Operating Permit requirements. International Tie Disposal is requesting a federally enforceable limit of 100 tpy for NO_X, VOC, and CO, 10 tpy for individual HAP, and 25 tpy for combined HAP to remain a synthetic minor source.

4.2. STATE REGULATIONS

The following is a discussion of the applicability or non-applicability of regulations contained in North Carolina's State Implementation Plan (SIP) under 15A NCAC.

4.2.1. 15A NCAC 02D.0503, Particulates from Fuel Burning Indirect Heat Exchangers

15A NCAC 02D .0503 specifies that particulate matter emissions from fuel burning indirect heat exchangers should not exceed the values provided in 02D .0503(c). For burners with a heat input capacity less than 10 MMBtu/hr, the emission limit is 0.6 lb/MMBtu. The proposed natural gas-fired kiln burners and the proposed afterburners are direct-fired. Therefore, the requirements of 15A NCAC 02D .0503 do not apply.

4.2.2. 15A NCAC 02D.0504, Particulates from Wood Burning Indirect Heat Exchangers

15A NCAC 02D .0504 specifies that particulate matter emissions from wood burning indirect heat exchangers should not exceed the values provided in 02D .0504(c). The proposed kilns utilize a pyrolysis process to generate biochar from wood. This is not considered wood burning. Therefore, this section is not applicable to the proposed kilns.

4.2.3. 15A NCAC 02D.0515, Particulates from Miscellaneous Process Industries

15A NCAC 02D .0515 provides the following:

> *(a) The allowable emission rates for particulate matter from any stack, vent, or outlet of any industrial process for which no other emission control standards are applicable shall not exceed the level calculated with the equation* $E = 4.10(P)^{0.67}$ *calculated to three significant figures for process weight rates less than or equal to 30 tons per hour. For process weight rates greater than 30 tons per hour, the allowable emission rates for particulate matter shall not exceed the level calculated with the equation* $E = 55.0(P)^{0.11} - 40$ *calculated to three significant figures. For the purpose of these equations "E" equals the allowable emission rate for particulate matter in pounds per hour and "P" equals the process weight rate in tons per hour.*

The maximum throughput of material for the kilns, shredder, and product handling, and packaging equipment will be less than 30 tons per hour. Therefore, equation $E=4.10(P)^{0.67}$ applies to these emission sources. Based on kiln stack tests results and published emission factors for other facility processes, PM emissions from the facility particulate matter emission sources will comply with the limit above.

4.2.4. 15A NCAC 02D.0516, Sulfur Dioxide Emissions from Combustion Sources

15A NCAC 02D.0516 provides the following:

(a) Emission of sulfur dioxide from any source of combustion that is discharged from any vent, stack, or chimney shall not exceed 2.3 pounds of sulfur dioxide per million BTU input. Sulfur dioxide formed by the combustion of sulfur in fuels, wastes, ores, and other substances shall be included when determining compliance with this standard. Sulfur dioxide formed or reduced as a result of treating flue gases with sulfur trioxide or other materials shall also be accounted for when determining compliance with this standard.

Emissions of SO_2 from the combustion of fossil fuels in the kilns and the afterburner will not exceed the standard listed above. These sources will inherently comply with this limit through the combustion of clean fuels (natural gas).

4.2.5. 15A NCAC 02D.0521, Control of Visible Emissions

North Carolina Regulation 02D .0521 limits visible emissions from emission sources constructed after July 1, 1971, to 20 percent, when averaged over a six-minute period. The proposed operations (kilns, shredder, product handling, and packaging equipment) will comply with this requirement.

4.2.6. 15A NCAC 02D.0540, Particulates from Fugitive Dust Emission Sources

North Carolina Regulation 02D .0540 states the following:

The owner or operator of a facility required to have a permit pursuant to 15A NCAC 02Q or a source subject to a requirement pursuant to 15A NCAC 02D shall not cause or allow fugitive dust emissions to cause or contribute to substantive complaints or visible emissions in excess of that allowed pursuant to Paragraph (e) of this Rule

International Tie Disposal will utilize unpaved haul road to move feedstock, product, and equipment throughout the facility. To minimize fugitive dust emissions from these roads, the facility will implement dust control measures, including speed limits, surface chemical treatment, wet suppression, and gravel.

4.2.7. 15A NCAC 02D .1100, Control of Toxic Air Pollutants (State Only)

Under 15A NCAC 02Q .0706 (b)(1)(A) and (B), the facility is only required to submit a permit application to demonstrate compliance with 15A NCAC 02D .1100 if the modification results in:

(1) a net increase in emissions or ambient concentration as previously determined pursuant to 15A NCAC 02D .1106 and 15A NCAC 02Q .0709 of any toxic air pollutant that the facility was emitting before the modification; or
(2) emissions of any toxic air pollutant that the facility was not emitting before the modification if such emissions exceed the levels set forth in 15A NCAC 02Q .0711.

The proposed project results in emissions of toxic air pollutants (TAP). As shown in Appendix A, facility-wide emissions of all toxic air pollutants are less than the toxic pollutant exemption rates (TPERs) provided in 15A NCAC 02Q .0711. Therefore, no toxic air pollutant permitting or dispersion modeling demonstration is required.

4.2.8. 15A NCAC 02D .1806, Control of Odors (State Only)

> *(e) Control Requirements. The owner or operator of a facility subject to this Rule shall not operate the facility without implementing management practices or installing and operating odor control equipment sufficient to prevent odorous emissions from the facility from causing or contributing to objectionable odors beyond the facility's boundary.*

International Tie Disposal will take measures to comply with this regulation if the Hamlet site is causing or contributing to an objectionable odor beyond the facility's boundary.

5. NORTH CAROLINA DEQ APPLICATION FORMS

This section contains the following NCDEQ Forms:

- Form A1 – Facility (General Information);
- Form A2 & A3 – Emission Source Listing;
- Form B – Emission Source (General);
- Form B1 – Emission Source (Combustion Source);
- Form C3 – Control Device (Thermal or Catalytic);
- Form D1 – Facility-wide Emissions Summary; and
- Form D5 – Technical Analysis to Support Permit Application.

A preliminary zoning consistency determination is also included. International Tie Disposal will continue to work with the zoning department to ensure the determination is completed and sent to the state.

FORM A

GENERAL FACILITY INFORMATION

REVISED 09/22/16 — NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate — **A**

NOTE- APPLICATION WILL NOT BE PROCESSED WITHOUT THE FOLLOWING:		
☑ Local Zoning Consistency Determination (new or modification only)	☑ Appropriate Number of Copies of Application	**Application Fee** (please check one option below)
☑ Responsible Official/Authorized Contact Signature	☑ P.E. Seal (if required)	☐ Not Required ☐ ePayment ☑ Check Enclosed

GENERAL INFORMATION

Legal Corporate/Owner Name:	International Tie Disposal, LLC		
Site Name:	Project Tie		
Site Address (911 Address) Line 1:	Marks Creek Church Rd Parcel# 840200970265		
Site Address Line 2:			
City:	Hamlet	State:	NC
Zip Code:	28345	County:	Richmond

CONTACT INFORMATION

Responsible Official/Authorized Contact:		***Invoice Contact:***	
Name/Title:	A. Basil Polivka / CEO	Name/Title:	Helen Lupton
Mailing Address Line 1:	13700 Providence Road	Mailing Address Line 1:	13700 Providence Road
Mailing Address Line 2:	Suite 200	Mailing Address Line 2:	Suite 200
City: Weddington State: NC	Zip Code: 28104	City: Weddington State: NC	Zip Code: 28104
Primary Phone No.: 704-321-0802	Fax No.: 704-321-0805	Primary Phone No.: 704-321-0802	Fax No.: 704-321-0805
Secondary Phone No.:		Secondary Phone No.:	
Email Address:	basilp@polivkaintl.com	Email Address:	helenl@polivkaintl.com
Facility/Inspection Contact:		***Permit/Technical Contact:***	
Name/Title:	Jill DeLisio	Name/Title:	A. Basil Polivka / CEO
Mailing Address Line 1:	13700 Providence Road	Mailing Address Line 1:	13700 Providence Road
Mailing Address Line 2:	Suite 200	Mailing Address Line 2:	Suite 200
City: Weddington State: NC	Zip Code: 28104	City: Weddington State: NC	Zip Code: 28104
Primary Phone No.: 704-321-0802	Fax No.: 704-321-0805	Primary Phone No.: 704-321-0802	Fax No.: 704-321-0805
Secondary Phone No.:		Secondary Phone No.:	
Email Address:	jilld@polivkaintl.com	Email Address:	basilp@polivkaintl.com

APPLICATION IS BEING MADE FOR

☑ New Non-permitted Facility/Greenfield ☐ Modification of Facility (permitted) ☐ Renewal Title V ☐ Renewal Non-Title V

☐ Name Change ☐ Ownership Change ☐ Administrative Amendment ☐ Renewal with Modification

FACILITY CLASSIFICATION AFTER APPLICATION (Check Only One)

General ☐ Small ☐ Prohibitory Small ☑ Synthetic Minor ☐ Title V

FACILITY (Plant Site) INFORMATION

Describe nature of (plant site) operation(s):

Processing and pyrolysis of used railroad ties and wood to produce saleable biochar.

		Facility ID No. N/A	
Primary SIC/NAICS Code:	335991	Current/Previous Air Permit No. N/A	Expiration Date:
Facility Coordinates: Latitude:	34.918829	Longitude:	-79.634894
Does this application contain confidential data?	☐ **YES** ☑ **NO**	*****If yes, please contact the DAQ Regional Office prior to submitting this application.*** (See Instructions)**	

PERSON OR FIRM THAT PREPARED APPLICATION

Person Name: Nicole Saniti, PE		Firm Name: Trinity Consultants, Inc.	
Mailing Address Line 1 :325 Arlington Ave. Suite 500		Mailing Address Line 2:	
City: Charlotte	State: NC	Zip Code: 28203	County: Mecklenburg
Phone No.: 704.553.7747 x104	Fax No.:	Email Address: NSaniti@trinityconsultants.com	

SIGNATURE OF RESPONSIBLE OFFICIAL/AUTHORIZED CONTACT

Name (typed): A. Basil Polivka	Title: CEO
X Signature(Blue Ink): [signature]	Date: 8.11.20

Attach Additional Sheets As Necessary

GENERAL FACILITY INFORMATION

REVISED 09/22/16

NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate

A

SECTION AA1 - APPLICATION FOR NON-TITLE V PERMIT RENEWAL

_____________ (Company Name) hereby formally requests renewal of Air Permit No. _____________

There have been no modifications to the originally permitted facility or the operations therein that would require an air permit since the last permit was issued.

Is your facility subject to 40 CFR Part 68 "Prevnetion of Accidental Releases" - Section 112(r) of the Clean Air Act? ☐ YES ☐ NO

If yes, have you already submitted a Risk Manage Plan (RMP) to EPA? ☐ YES ☐ NO Date Submitted: _____________

Did you attach a current emissions inventory? ☐ YES ☐ NO

If no, did you submit the inventory via AERO or by mail? ☐ Via AERO ☐ Mailed Date Mailed: _____________

SECTION AA2- APPLICATION FOR TITLE V PERMIT RENEWAL

In accordance with the provisions of Title 15A 2Q .0513, the responsible official of _____________ (Company Name) hereby formally requests renewal of Air Permit No. _____________ (Air Permit No.) and further certifies that:

(1) The current air quality permit identifies and describes all emissions units at the above subject facility, except where such units are exempted under the North Carolina Title V regulations at 15A NCAC 2Q .0500;

(2) The current air quality permit cits all applicable requirements and provides the method or methods for determing compliance with the applicable requirements;

(3) The facility is currently in compliance, and shall continue to comply, with all applicable requiremetns. (Note: As provided under 15A NCAC 2Q .0512 compliance with the conditions of the permit shall be deemed compliance with the applicable requirements specifically identified in the permit);

(4) For applicable requirements that become effective during the term of the renewed permit that the facility shall comply on a timely basis;

(5) The facility shall fulfill applicable enhanced monitoring requirements and submit a compliance certification as required by 40 CFR Part 64.

The responsible official (signature on page 1) certifies under the penalty of law that all information and statements provided above, based on information and belief formed after reasonable inquiry, are true, accurate, and complete.

SECTION AA3- APPLICATION FOR NAME CHANGE

New Facility Name: _____________

Former Facility Name: _____________

An official facility name change is requested as described above for the air permit mentioned on page 1 of this form. Complete the other sections if there have been modifications to the originally premitted facility that would requie an air quality permit since the last permit was issued and if ther has been an ownership change associated with this name change.

SECTION AA4- APPLICATION FOR AN OWNERSHIP CHANGE

By this application we hereby request transfer of Air Quality Permit No. _____________ from the former owner to the new owner as described below. The transfer of permit responsibility, coverage and liability shall be effective _____________ (immediately or insert date.) The legal ownership of the facility described on page 1 of this form has been or will be transferred on _____________ (date). There have been no modifications to the originally permitted facility that would require an air quality permit since the last permit was issued.

Signature of New (Buyer) Responsible Official/Authorized Contact (as typed on page 1):

X Signature (Blue Ink): _____________

Date:

New Facility Name:

Former Facility Name:

Signature of Former (Seller) Responsible Official/Authorized Contact:

Name (typed or print):

Title:

X Signature (Blue Ink): _____________

Date:

Former Legal Corporate/Owner Name:

In lieu of the seller's signature on this form, a letter may be submitted with the seller's signature indicating the ownership change

SECTION AA5- APPLICATION FOR ADMINISTRATIVE AMENDMENT

Describe the requested administrative amendment here (attach additional documents as necessary):

Attach Additional Sheets As Necessary

FORMs A2, A3

EMISSION SOURCE LISTING FOR THIS APPLICATION - A2

112r APPLICABILITY INFORMATION - A3

REVISED 09/22/16 — NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate — **A2**

EMISSION SOURCE LISTING: New, Modified, Previously Unpermitted, Replaced, Deleted

EMISSION SOURCE ID NO.	EMISSION SOURCE DESCRIPTION	CONTROL DEVICE ID NO.	CONTROL DEVICE DESCRIPTION
Equipment To Be ADDED By This Application (New, Previously Unpermitted, or Replacement)			
ES-1	426 Kilns	CD-1	Afterburners for operating kilns
Existing Permitted Equipment To Be MODIFIED By This Application			
Equipment To Be DELETED By This Application			

112(r) APPLICABILITY INFORMATION — A 3

Is your facility subject to 40 CFR Part 68 "Prevention of Accidental Releases" - Section 112(r) of the Federal Clean Air Act? ☐ Yes ☑ No

If No, please specify in detail how your facility avoided applicability: ____________________

If your facility is Subject to 112(r), please complete the following:

A. Have you already submitted a Risk Management Plan (RMP) to EPA Pursuant to 40 CFR Part 68.10 or Part 68.150?

☐ Yes ☐ No Specify required RMP submittal date: ____________ If submitted, RMP submittal date: ____________

B. Are you using administrative controls to subject your facility to a lesser 112(r) program standard?

☐ Yes ☐ No If yes, please specify: ____________________

C. List the processes subject to 112(r) at your facility:

PROCESS DESCRIPTION	PROCESS LEVEL (1, 2, or 3)	HAZARDOUS CHEMICAL	MAXIMUM INTENDED INVENTORY (LBS)

Attach Additional Sheets As Necessary

FORM B

SPECIFIC EMISSION SOURCE INFORMATION (REQUIRED FOR ALL SOURCES)

REVISED 09/22/16 **NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate** **B**

EMISSION SOURCE DESCRIPTION: 426 Kilns	EMISSION SOURCE ID NO: ES-1
	CONTROL DEVICE ID NO(S): CD-1
OPERATING SCENARIO 1 OF 1	EMISSION POINT (STACK) ID NO(S): EP-1

DESCRIBE IN DETAILTHE EMISSION SOURCE PROCESS (ATTACH FLOW DIAGRAM):
Up to 426 wood-fiiring kilns for pyrolysis of wood and railroad ties to generate biochar

TYPE OF EMISSION SOURCE (CHECK AND COMPLETE APPROPRIATE FORM B1-B9 ON THE FOLLOWING PAGES):

- [x] Coal,wood,oil, gas, other burner (Form B1)
- [ ] Woodworking (Form B4)
- [ ] Manuf. of chemicals/coatings/inks (Form B7)
- [ ] Int.combustion engine/generator (Form B2)
- [ ] Coating/finishing/printing (Form B5)
- [ ] Incineration (Form B8)
- [ ] Liquid storage tanks (Form B3)
- [ ] Storage silos/bins (Form B6)
- [x] Other (Form B9)

START CONSTRUCTION DATE: August 2020 DATE MANUFACTURED: August 2020

MANUFACTURER / MODEL NO.: Biochar Now EXPECTED OP. SCHEDULE: 9 HR/DAY 7 DAY/WK 52 WK/YR

IS THIS SOURCE SUBJECT TO? ☐ NSPS (SUBPARTS?):________ ☐ NESHAP (SUBPARTS?):________

PERCENTAGE ANNUAL THROUGHPUT (%): DEC-FEB 25% MAR-MAY 25% JUN-AUG 25% SEP-NOV 25%

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION FOR THIS SOURCE

AIR POLLUTANT EMITTED	SOURCE OF EMISSION FACTOR	EXPECTED ACTUAL (AFTER CONTROLS / LIMITS)		POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS)		POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS)	
		lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
PARTICULATE MATTER (PM)		4.20	6.84	11.18	48.98	11.18	6.84
PARTICULATE MATTER<10 MICRONS (PM_{10})		2.87	4.60	7.63	48.98	7.63	4.60
PARTICULATE MATTER<2.5 MICRONS ($PM_{2.5}$)		2.07	3.42	5.50	24.10	5.50	3.42
SULFUR DIOXIDE (SO2)		0.01	0.03	0.03	0.15	0.03	0.03
NITROGEN OXIDES (NOx)		60.00	97.84	159.75	699.71	159.75	97.84
CARBON MONOXIDE (CO)		12.00	19.57	31.95	139.94	31.95	19.57
VOLATILE ORGANIC COMPOUNDS (VOC)		1.38	13.12	73.48	321.86	3.67	13.12
LEAD		9.85E-06	2.73E-05	2.61E-05	1.44E-04	2.61E-05	2.73E-05
OTHER							

HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION FOR THIS SOURCE

HAZARDOUS AIR POLLUTANT	CAS NO.	SOURCE OF EMISSION FACTOR	EXPECTED ACTUAL (AFTER CONTROLS / LIMITS)		POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS)		POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS)	
			lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
			See Appendix B					

TOXIC AIR POLLUTANT EMISSIONS INFORMATION FOR THIS SOURCE

TOXIC AIR POLLUTANT	CAS NO.	SOURCE OF EMISSION FACTOR	EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS		
			lb/hr	lb/day	lb/yr
			See Appendix B		

Attachments: (1) emissions calculations and supporting documentation; (2) indicate all requested state and federal enforceable permit limits (e.g. hours of operation, emission rates) and describe how these are monitored and with what frequency; and (3) describe any monitoring devices, gauges, or test ports for this source.

COMPLETE THIS FORM AND COMPLETE AND ATTACH APPROPRIATE B1 THROUGH B9 FORM FOR EACH SOURCE

Attach Additional Sheets As Necessary

FORM B1

EMISSION SOURCE (WOOD, COAL, OIL, GAS, OTHER FUEL-FIRED BURNER)

REVISED 09/22/16 **NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate** **B1**

EMISSION SOURCE DESCRIPTION: 426 Kilns	EMISSION SOURCE ID NO: ES-1
	CONTROL DEVICE ID NO(S): CD-1
OPERATING SCENARIO: 1 OF 1	EMISSION POINT (STACK) ID NO(S): EP-1

DESCRIBE USE: ☐ PROCESS HEAT ☐ SPACE HEAT ☐ ELECTRICAL GENERATION
☐ CONTINUOUS USE ☐ STAND BY/EMERGENCY ☑ OTHER (DESCRIBE): Pyrolosis to produce Biochar product

HEATING MECHANISM: ☐ INDIRECT ☑ DIRECT

MAX. FIRING RATE (MMBTU/HOUR):

WOOD-FIRED BURNER

WOOD TYPE: ☐ BARK ☐ WOOD/BARK ☐ WET WOOD ☐ DRY WOOD ☐ OTHER (DESCRIBE): ____________

PERCENT MOISTURE OF FUEL:_________________

☐ UNCONTROLLED ☐ CONTROLLED WITH FLYASH REINJECTION ☐ CONTROLLED W/O REINJECTION

FUEL FEED METHOD: HEAT TRANSFER MEDIA: ☐ STEAM ☐ AIR ☐ OTHER (DESCRIBE) _________________

COAL-FIRED BURNER

TYPE OF BOILER IF OTHER DESCRIBE:

PULVERIZED	OVERFEED STOKER	UNDERFEED STOKER	SPREADER STOKER	FLUIDIZED BED
☐ WET BED	☐ UNCONTROLLED	☐ UNCONTROLLED	☐ UNCONTROLLED	☐ CIRCULATING
☐ DRY BED	☐ CONTROLLED	☐ CONTROLLED	☐ FLYASH REINJECTION	☐ RECIRCULATING
			☐ NO FLYASH REINJECTION	

OIL/GAS-FIRED BURNER

TYPE OF BOILER: ☐ UTILITY ☑ INDUSTRIAL ☐ COMMERCIAL ☐ INSTITUTIONAL

TYPE OF FIRING: ☑ NORMAL ☐ TANGENTIAL ☐ LOW NOX BURNERS ☐ NO LOW NOX BURNER

OTHER FUEL-FIRED BURNER

TYPE(S) OF FUEL: ________________________________ PERCENT MOISTURE: _____________

TYPE OF BOILER: ☐ UTILITY ☐ INDUSTRIAL ☐ COMMERCIAL ☐ INSTITUTIONAL

TYPE OF FIRING: ________________ TYPE(S) OF CONTROL(S) (IF ANY): ____________________________

FUEL USAGE (INCLUDE STARTUP/BACKUP FUELS)

FUEL TYPE	UNITS	MAXIMUM DESIGN CAPACITY (UNIT/HR)	REQUESTED CAPACITY LIMITATION (UNIT/HR)
Natural Gas	Btu/hr	7,800 Btu/hr/kiln	

FUEL CHARACTERISTICS (COMPLETE ALL THAT ARE APPLICABLE)

FUEL TYPE	SPECIFIC BTU CONTENT	SULFUR CONTENT (% BY WEIGHT)	ASH CONTENT (% BY WEIGHT)
Natural gas	1020 Btu/scf		

COMMENTS:

Attach Additional Sheets As Necessary

FORM C3

CONTROL DEVICE (THERMAL OR CATALYTIC)

REVISED 09/22/16 | **NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate** | **C3**

AS REQUIRED BY 15A NCAC 2Q .0112, THIS FORM MUST BE SEALED BY A PROFESSIONAL ENGINEER (P.E.) LICENSED IN NORTH CAROLINA.

CONTROL DEVICE ID NO: CD-1	CONTROLS EMISSIONS FROM WHICH EMISSION SOURCE ID NO(S): ES-1
EMISSION POINT (STACK) ID NO(S): EP-1	POSITION IN SERIES OF CONTROLS NO. 1 OF 1 UNITS
MANUFACTURER:	MODEL NO:
OPERATING SCENARIO: 1 OF 1	

TYPE ☑ AFTERBURNER ☐ REGENERATIVE THERMAL OXIDATION ☐ RECUPERATIVE THERMAL OXIDATION ☐ CATALYTIC OXIDATION

EXPECTED LIFE OF CATALYST (YRS):	METHOD OF DETECTING WHEN CATALYST NEEDS REPLACMENT:

CATALYST MASKING AGENT IN AIR STREAM ☐ HALOGEN ☐ SILICONE ☐ PHOSPHOROUS COMPOUND ☐ HEAVY METAL ☐ SULFUR COMPOUND ☐ OTHER (SPECIFY) ____________________ ☐ NONE

TYPE OF CATALYST:	CATALYST VOL (FT^3):	VELOCITY THROUGH CATALYST (FPS):

SCFM THROUGH CATALYST:

DESCRIBE CONTROL SYSTEM, INCLUDING RELATION TO OTHER CONTROL DEVICES AND SOURCES, AND ATTACH DIAGRAM OF SYSTEM:

Combustion of exhaust gases from kilns to control residual VOC emissions from pyrolysis.

POLLUTANT(S) COLLECTED:	VOC			
BEFORE CONTROL EMISSION RATE (LB/HR):	27.60			
CAPTURE EFFICIENCY:	100 %	%	%	%
CONTROL DEVICE EFFICIENCY:	95 %	%	%	%
CORRESPONDING OVERALL EFFICIENCY:	95 %	%	%	%
EFFICIENCY DETERMINATION CODE:	2			
TOTAL AFTER CONTROL EMISSION RATE (LB/HR) :	1.38			

PRESSURE DROP (IN. H_2O): MIN MAX	OUTLET TEMPERATURE (°F): 1000 F MIN 1700 F MAX
INLET TEMPERATURE (°F): 1000 F MIN 1700F MAX	RESIDENCE TIME (SECONDS):
INLET AIR FLOW RATE (ACFM): 2,100 (SCFM): 500	COMBUSTION TEMPERATURE (°F):
COMBUSTION CHAMBER VOLUME (FT^3):	INLET MOISTURE CONTENT (%):
% EXCESS AIR:	CONCENTRATION (ppmv) _______ INLET _______ OUTLET
AUXILIARY FUEL USED: Natural gas	TOTAL MAXIMUM FIRING RATE (MILLION BTU/HR): 0.125

DESCRIBE MAINTENANCE PROCEDURES:

DESCRIBE ANY AUXILIARY MATERIALS INTRODUCED INTO THE CONTROL SYSTEM:

COMMENTS:

Attach Additional Sheets As Necessary

FORM D1

FACILITY-WIDE EMISSIONS SUMMARY

REVISED 09/22/16 **NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate** **D1**

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION - FACILITY-WIDE

	EXPECTED ACTUAL EMISSIONS (AFTER CONTROLS / LIMITATIONS)	**POTENTIAL EMISSIONS** (BEFORE CONTROLS / LIMITATIONS)	**POTENTIAL EMISSIONS** (AFTER CONTROLS / LIMITATIONS)
AIR POLLUTANT EMITTED	tons/yr	tons/yr	tons/yr
PARTICULATE MATTER (PM)	7.30	53.95	7.30
PARTICULATE MATTER < 10 MICRONS (PM_{10})	4.80	35.40	4.80
PARTICULATE MATTER < 2.5 MICRONS ($PM_{2.5}$)	3.52	25.63	3.52
SULFUR DIOXIDE (SO_2)	0.03	0.15	0.03
NITROGEN OXIDES (NOx)	97.84	699.71	<100
CARBON MONOXIDE (CO)	19.57	139.94	19.57
VOLATILE ORGANIC COMPOUNDS (VOC)	13.12	321.86	13.12
LEAD	2.73E-05	1.44E-04	2.73E-05
GREENHOUSE GASES (GHG) (SHORT TONS)			
OTHER			

*** NOTE: VALUES PROVIDED EXCLUDE FUGITIVE EMISSIONS**

HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION - FACILITY-WIDE

		EXPECTED ACTUAL EMISSIONS (AFTER CONTROLS / LIMITATIONS)	**POTENTIAL EMISSIONS** (BEFORE CONTROLS / LIMITATIONS)	**POTENTIAL EMISSIONS** (AFTER CONTROLS / LIMITATIONS)
HAZARDOUS AIR POLLUTANT EMITTED	CAS NO.	tons/yr	tons/yr	tons/yr
	See Appendix B			

TOXIC AIR POLLUTANT EMISSIONS INFORMATION - FACILITY-WIDE

INDICATE REQUESTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS. EMISSIONS ABOVE THE TOXIC PERMIT EMISSION RATE (TPER) IN 15A NCAC 2Q .0711 MAY REQUIRE AIR DISPERSION MODELING. USE NETTING FORM D2 IF NECESSARY.

					Modeling Required ?		
TOXIC AIR POLLUTANT EMITTED	CAS NO.	lb/hr	lb/day	lb/year	Yes	No	
	See Appendix B					X	

COMMENTS:

Attach Additional Sheets As Necessary

FORM D4

EXEMPT AND INSIGNIFICANT ACTIVITIES SUMMARY

REVISED 09/22/16 **NCDEQ/Division of Air Quality - Application for Air Permit to Construct/Operate** **D4**

ACTIVITIES EXEMPTED PER 2Q .0102 OR INSIGNIFICANT ACTIVITIES PER 2Q .0503 FOR TITLE V SOURCES		
DESCRIPTION OF EMISSION SOURCE	**SIZE OR PRODUCTION RATE**	**BASIS FOR EXEMPTION OR INSIGNIFICANT ACTIVITY**
1. EX-1- Shredder and Kiln Loading	426 tpd	15A NCAC 2Q .0102(h)(5)
2. EX-2 - Product Handling and Packaging	106.5 tpd	15A NCAC 2Q .0102(h)(5)
3. EX-3 - Haul Roads	N/A	15A NCAC 2Q .0102(h)(5)
4. EX-4 - Diesel Storage Tank	TBD	15A NCAC 2Q .0102(g)(4)
5. EX-5 - Maintenance Welding	N/A	15A NCAC 2Q .0102(g)(1)(A)
6.		
7.		
8.		
9.		
10.		

Attach Additional Sheets As Necessary

FORM D5

TECHNICAL ANALYSIS TO SUPPORT PERMIT APPLICATION

PROVIDE DETAILED TECHNICAL CALCULATIONS TO SUPPORT ALL EMISSION, CONTROL, AND REGULATORY DEMONSTRATIONS MADE IN THIS APPLICATION. INCLUDE A COMPREHENSIVE PROCESS FLOW DIAGRAM AS NECESSARY TO SUPPORT AND CLARIFY CALCULATIONS AND ASSUMPTIONS. ADDRESS THE FOLLOWING SPECIFIC ISSUES ON SEPARATE PAGES:

A **SPECIFIC EMISSIONS SOURCE (EMISSION INFORMATION) (FORM B and B1 through B9) -** SHOW CALCULATIONS USED, INCLUDING EMISSION FACTORS, MATERIAL BALANCES, AND/OR OTHER METHODS FROM WHICH THE POLLUTANT EMISSION RATES IN THIS APPLICATION WERE DERIVED. INCLUDE CALCULATION OF POTENTIAL BEFORE AND, WHERE APPLICABLE, AFTER CONTROLS. CLEARLY STATE ANY ASSUMPTIONS MADE AND PROVIDE ANY REFERENCES AS NEEDED TO SUPPORT MATERIAL BALANCE CALCULATIONS.

B **SPECIFIC EMISSION SOURCE (REGULATORY INFORMATION)(FORM E2 - TITLE V ONLY) -** PROVIDE AN ANALYSIS OF ANY REGULATIONS APPLICABLE TO INDIVIDUAL SOURCES AND THE FACILITY AS A WHOLE. INCLUDE A DISCUSSION OUTING METHODS (e.g. FOR TESTING AND/OR MONITORING REQUIREMENTS) FOR COMPLYING WITH APPLICABLE REGULATIONS, PARTICULARLY THOSE REGULATIONS LIMITING EMISSIONS BASED ON PROCESS RATES OR OTHER OPERATIONAL PARAMETERS. PROVIDE JUSTIFICATION FOR AVOIDANCE OF ANY FEDERAL REGULATIONS (PREVENTION OF SIGNIFICANT DETERIORATION (PSD), NEW SOURCE PERFORMANCE STANDARDS (NSPS), NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAPS), TITLE V), INCLUDING EXEMPTIONS FROM THE FEDERAL REGULATIONS WHICH WOULD OTHERWISE BE APPLICABLE TO THIS FACILITY. SUBMIT ANY REQUIRED INFORMATION TO DOCUMENT COMPLIANCE WITH ANY REGULATIONS. INCLUDE EMISSION RATES CALCULATED IN ITEM "A" ABOVE, DATES OF MANUFACTURE, CONTROL EQUIPMENT, ETC. TO SUPPORT THESE CALCULATIONS.

C **CONTROL DEVICE ANALYSIS (FORM C and C1 through C9) -** PROVIDE A TECHNICAL EVALUATION WITH SUPPORTING REFERENCES FOR ANY CONTROL EFFICIENCIES LISTED ON SECTION C FORMS, OR USED TO REDUCE EMISSION RATES IN CALCULATIONS UNDER ITEM "A" ABOVE. INCLUDE PERTINENT OPERATING PARAMETERS (e.g. OPERATING CONDITIONS, MANUFACTURING RECOMMENDATIONS, AND PARAMETERS AS APPLIED FOR IN THIS APPLICATION) CRITICAL TO ENSURING PROPER PERFORMANCE OF THE CONTROL DEVICES). INCLUDE AND LIMITATIONS OR MALFUNCTION POTENTIAL FOR THE PARTICULAR CONTROL DEVICES AS EMPLOYED AT THIS FACILITY. DETAIL PROCEDURES FOR ASSURING PROPER OPERATION OF THE CONTROL DEVICE INCLUDING MONITORING SYSTEMS AND MAINTENANCE TO BE PERFORMED.

D **PROCESS AND OPERATIONAL COMPLIANCE ANALYSIS - (FORM E3 - TITLE V ONLY)** - SHOWING HOW COMPLIANCE WILL BE ACHIEVED WHEN USING PROCESS, OPERATIONAL, OR OTHER DATA TO DEMONSTRATE COMPLIANCE. REFER TO COMPLIANCE REQUIREMENTS IN THE REGULATORY ANALYSIS IN ITEM "B" WHERE APPROPRIATE. LIST ANY CONDITIONS OR PARAMETERS THAT CAN BE MONITORED AND REPORTED TO DEMONSTRATE COMPLIANCE WITH THE APPLICABLE REGULATIONS.

E **PROFESSIONAL ENGINEERING SEAL -** PURSUANT TO 15A NCAC 2Q .0112 "APPLICATION REQUIRING A PROFESSIONAL ENGINEERING SEAL," A PROFESSIONAL ENGINEER REGISTERED IN NORTH CAROLINA SHALL BE REQUIRED TO SEAL TECHNICAL PORTIONS OF THIS APPLICATION FOR NEW SOURCES AND MODIFICATIONS OF EXISTING SOURCES. (SEE INSTRUCTIONS FOR FURTHER APPLICABILITY).

I, Nicole Santi *attest that this application for* International Tie Disposal, LLC *has been reviewed by me and is accurate, complete and consistent with the information supplied in the engineering plans, calculations, and all other supporting documentation to the best of my knowledge. I further attest that to the best of my knowledge the proposed design has been prepared in accordance with the applicable regulations. Although certain portions of this submittal package may have been developed by other professionals, inclusion of these materials under my seal signifies that I have reviewed this material and have judged it to be consistent with the proposed design. Note: In accordance with NC General Statutes 143-215.6A and 143-215.6B, any person who knowingly makes any false statement, representation, or certification in any application shall be guilty of a Class 2 misdemeanor which may include a fine not to exceed $10,000 as well as civil penalties up to $25,000 per violation.*

(PLEASE USE BLUE INK TO COMPLETE THE FOLLOWING)

NAME: Nicole Santi

DATE: 8/11/20

COMPANY: Trinity Consultants, Inc.

ADDRESS: 325 Arlington Ave. Suite 500 Charlotte, NC 28203

TELEPHONE: 704-553-7747

SIGNATURE: Nicole Santi

PAGES CERTIFIED: All

(IDENTIFY ABOVE EACH PERMIT FORM AND ATTACHMENT THAT IS BEING CERTIFIED BY THIS SEAL)

PLACE NORTH CAROLINA SEAL HERE

NORTH CAROLINA PROFESSIONAL SEAL 038716 ENGINEER NICOLE L. SANTI

Attach Additional Sheets As Necessary

Zoning Consistency Determination

Facility Name	Project Tie
Facility Street Address	174 Marks Creek Church Road / Parcel 8402009702 65
Facility City	Hamlet
Description of Process	Pyrolysis
SIC/NAICS Code	*Not Applicable*
Facility Contact	Basil A Polivka II
Phone Number	(704) 321-0802
Mailing Address	13700 Providence Road, Suite 200
Mailing City, State Zip	Weddington, NC 28104

Based on the information given above:

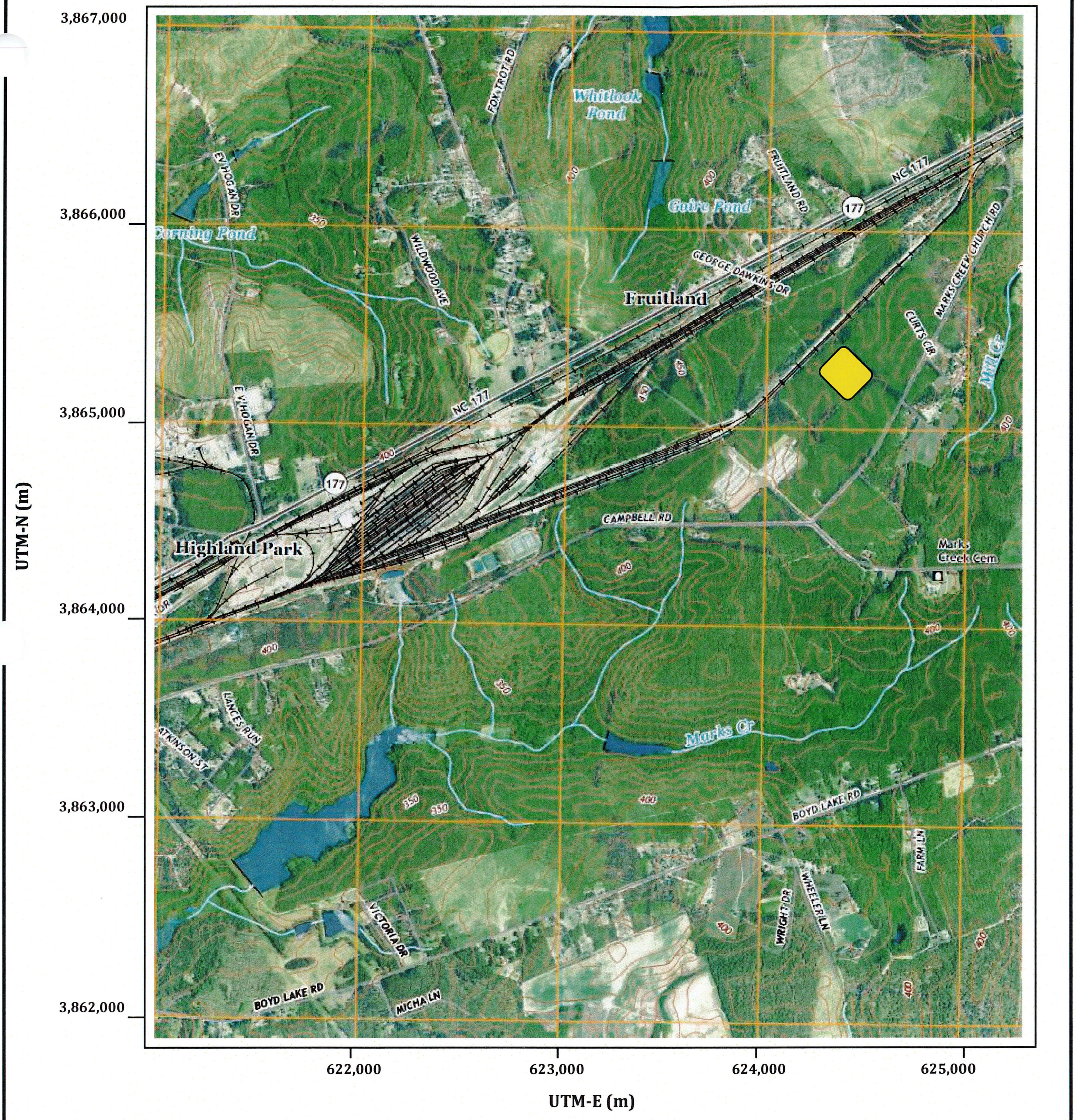
- [x] I have received a copy of the air permit application (draft or final) AND...

- [ ] There are no applicable zoning ordinances for this facility at this time
- [x] The proposed operation IS consistent with applicable zoning ordinances within H-I zoning of parcel
- [ ] The proposed operation IS NOT consistent with applicable zoning ordinances (please include a copy of the rules in the package sent to the air quality office)
- [ ] The determination is pending further information and can not be made at this time
- [ ] Other:

Agency	Richmond County Government
Name of Designated Official	Tracy R. Parris
Title of Designated Official	Planning Director
Signature	Tracy Parris
Date	1/6/2021

Please forward to the facility mailing address listed above and the air quality office at the appropriate address as checked on the back of this form.

APPENDIX A: AREA MAP, SITE LAYOUT, AND PROCESS FLOW



Facility Location:
624,458.84 m E (34°55'21.8"N)
3,865,320.61 m N (79°38'14.70"W)

Facility Address:
Marks Creek Church Rd.
Parcel No. 840200970265
Hamlet, NC 28345

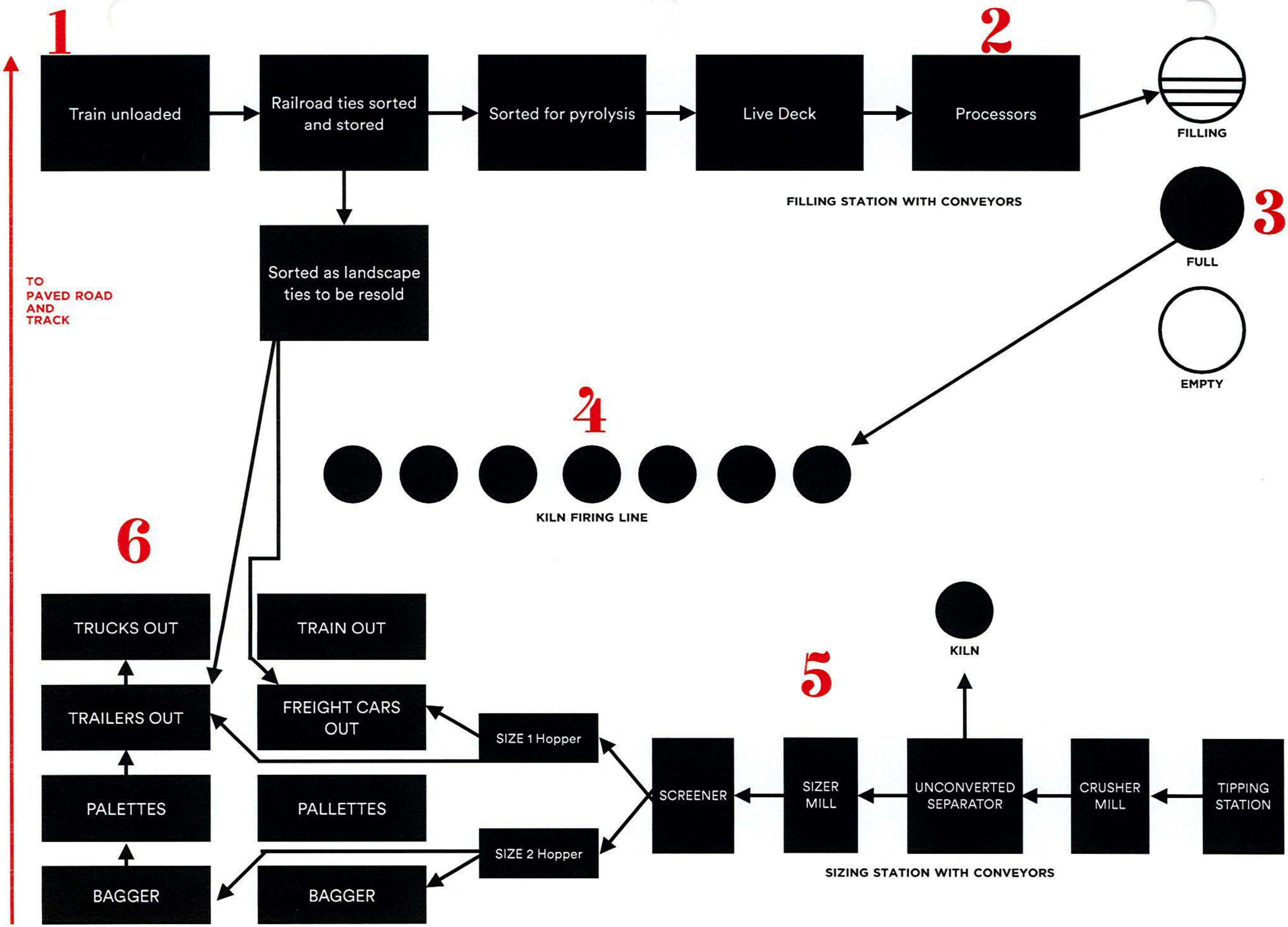
Scale 1: 24 000

0 1,000 2,000 3,000 4,000
FEET

N

Trinity Consultants


CSX TIE UNLOADING TRACK 2500 TF
BIOCHAR LOADING TRACK 750 TF
TIE UNLOADING AND SORTING
TIE GRINDER
BIOCHAR STORAGE
POT LOADING AREA
MAINTENANCE AREA
BIOCHAR PROCESSING AREA
TIE STORAGE AREA
TIE PROCESSING AREA
POT COOLING AREA
TIE BURNING AREA
Curts Cir
ek Church Rd



1
Train unloaded
Railroad ties sorted and stored
Sorted for pyrolysis
Live Deck
2
Processors
FILLING
FILLING STATION WITH CONVEYORS
3
FULL
EMPTY
Sorted as landscape ties to be resold
TO PAVED ROAD AND TRACK
4
KILN FIRING LINE
6
TRUCKS OUT
TRAIN OUT
TRAILERS OUT
FREIGHT CARS OUT
PALETTES
PALLETTES
BAGGER
BAGGER
SIZE 1 Hopper
SIZE 2 Hopper
KILN
5
SCREENER
SIZER MILL
UNCONVERTED SEPARATOR
CRUSHER MILL
TIPPING STATION
SIZING STATION WITH CONVEYORS

APPENDIX B: POTENTIAL EMISSION CALCULATIONS

Appendix B.1 - Facility Inputs for Limited Operations

Category	Operating Schedule		Raw Materials and Product					Kiln Input/Output		Capture or Control	
	Daily hrs	days/yr	Estimated #/day	Typical lb/load	Estimated ton/day	Estimated annual tons	Burner Fuel, MMBtu/yr	Wood charge (ton/kiln)	Biochar product (lb/kiln)	Description	Capture or Control Efficiency
Kilns Processing[1]	9	365	160					1.00		Afterburner	95%
Afterburners	9	365	160				65,659				
Wood delivery	9	365	8	40,000	160	58,400					
Wood chomping	9	365			160					Enclosed in a conex	90%
Product shipped	9	365	6	15,000	40	14,600			500	Enclosed in building	90%

[1] Number of kilns: **426** 160 kilns are assumed to operate daily. The number of kilns operated daily and the current emission factors will be used to calculate the emissions.

		Hourly Emissions (lb/hr)												
Source ID	**Description**	**TSP (Unc.)**	**PM_{10} (Unc.)**	**$PM_{2.5}$ (Unc.)**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NO_X**	**SO_2**	**VOC (Unc.)**	**VOC (Cont.)**	**CO**	**Lead**	**HAP**
ES-1	Kiln Operation	4.20	2.87	2.07	4.20	2.87	2.07	60.00	2.22E-05	27.60	1.38	12.00	4.27E-08	3.93E-03
ES-1	Afterburner and Kiln Combustion								0.01				9.80E-06	0.04
EX-1	Tie Chomper & Kiln Load	0.09	0.04	0.02	0.09	0.04	0.02	-	-	-	-	-	-	-
EX-2	Biochar Sizing & Packaging	2.79	1.08	0.89	0.19	0.080	0.045	-	-	-	-	-	-	-
EX-3	Haul Roads	10.08	2.87	0.29	1.89	0.54	0.05	-	-	-	-	-	-	-
	Totals:	**17.16**	**6.87**	**3.26**	**6.37**	**3.53**	**2.18**	**60.00**	**0.01**	**27.60**	**1.38**	**12.00**	**9.85E-06**	**0.04**

		Annual Emissions (tpy)												
Source ID	**Description**	**TSP (Unc.)**	**PM_{10} (Unc.)**	**$PM_{2.5}$ (Unc.)**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NO_X**	**SO_2**	**VOC (Unc.)**	**VOC (Cont.)**	**CO**	**Lead**	**HAP**
ES-1	Kiln Operation	6.84	4.60	3.42	6.84	4.60	3.42	97.84	0.01	262.31	13.12	19.57	1.12E-05	1.03
ES-1	Afterburner and Kiln Combustion								0.02				1.61E-05	0.06
EX-1	Tie Chomper & Kiln Load	0.15	0.07	0.03	0.15	0.07	0.03	-	-	-	-	-	-	-
EX-2	Biochar Sizing & Packaging	1.72	0.67	0.55	0.32	0.13	0.07	-	-	-	-	-	-	-
EX-3	Haul Roads	17.41	4.96	0.50	3.26	0.93	0.09	-	-	-	-	-	-	-
	Total Excluding Fugitives:	**8.70**	**5.34**	**3.99**	**7.30**	**4.80**	**3.52**	**97.84**	**0.03**	**262.31**	**13.12**	**19.57**	**2.73E-05**	**1.09**
	Total All Sources:	**26.11**	**10.30**	**4.49**	**10.56**	**5.73**	**3.61**	**97.84**	**0.03**	**262.31**	**13.12**	**19.57**	**2.73E-05**	**1.09**

Toxic/Hazardous Air Pollutant Summary

Toxic Air Pollutant	**HAP?**	**TAP?**	**Total Emissions**			**2Q .0711 TPER Limits**			**TPER?**
			(lb/hr)	**(lb/day)**	**(lb/yr)**	**(lb/hr)**	**(lb/day)**	**(lb/yr)**	
Metals									
Antimony	H	--	7.03E-09	1.01E-05	3.69E-03				N/A
Arsenic	H	T	1.96E-08	2.82E-05	1.03E-02			0.053	No
Beryllium	H	T	9.78E-10	1.41E-06	5.14E-04			0.28	No
Cadmium	H	T	3.65E-09	5.25E-06	1.92E-03			0.37	No
Chromium	H	--	3.45E-08	4.97E-05	1.81E-02				N/A
Chromium VI	H	T	3.11E-09	4.48E-06	1.64E-03			0.0056	No
Cobalt	H	--	1.65E-06	2.31E-05	8.44E-03				N/A
Manganese	H	T	1.42E-06	2.05E-03	7.48E-01		0.63		No
Mercury	H	T	3.11E-09	4.48E-06	1.64E-03		0.013		No
Nickel	H	T	2.94E-08	4.22E-05	1.54E-02		0.013		No
Selenium	H	--	4.73E-07	7.82E-06	2.85E-03				N/A
Miscellaneous									
Chlorine	H	T	7.03E-07	1.01E-03	3.69E-01		0.79		No
Hydrogen chloride	H	T	1.69E-05	2.43E-02	8.88E+00	0.18			No
Organics									
1,1,1-Trichloroethane	H	--	1.38E-09	1.98E-06	7.24E-04				N/A
1,2-Dichloropropane	H	--	1.47E-09	2.11E-06	7.71E-04				N/A
1,4-Dichlorobenzene	H	T	3.87E-11	5.57E-08	2.03E-05	16.8			No
2,3,7,8-Tetrachlorodibenzo-p-dioxins	H	T	1.74E-15	2.50E-12	9.13E-10			0.0002	No
2,4,6-Trichlorophenol	H	--	9.78E-13	1.41E-09	5.14E-07				N/A
2,4-Dinitrophenol	H	--	8.01E-12	1.15E-08	4.20E-06				N/A
4-Nitrophenol	H	--	4.89E-12	7.04E-09	2.57E-06				N/A
Acetaldehyde	H	T	3.35E-07	5.58E-05	2.04E-02	6.8			No
Acetophenone	H	--	1.42E-13	2.05E-10	7.48E-08				N/A
Acrolein	H	T	5.31E-07	2.59E-04	9.46E-02	0.02			No
Ammonia	--	T	6.27E-02	5.64E-01	2.06E+02	0.68			No
Benzene	H	T	4.14E-05	6.39E-04	2.33E-01			8.1	No
Benzo(a)pyrene	H	T	2.36E-08	3.78E-07	1.38E-04			2.2	No
Bis(2-ethylhexyl)phthalate	H	T	1.89E-10	2.72E-07	9.94E-05		0.63		No
Carbon Tetrachloride	H	T	2.00E-09	2.88E-06	1.05E-03			460	No
Chlorobenzene	H	T	1.47E-09	2.11E-06	7.71E-04		46		No
Chloroform	H	T	1.25E-09	1.79E-06	6.54E-04			290	No
Cresol isomers (m,p,o)	H	T	1.22E-10	1.76E-07	6.42E-05	0.56			No
Ethylbenzene	H	--	1.38E-09	1.98E-06	7.24E-04				N/A
Ethylene dichloride	H	T	1.29E-09	1.86E-06	6.77E-04			260	No
Formaldehyde	H	T	1.47E-03	1.35E-02	4.93E+00	0.04			No
Hexane	H	T	3.53E-02	3.17E-01	1.16E+02		23		No
Methanol	H	--	3.91E-03	5.63E+00	2.05E+03				N/A
Methyl bromide	H	--	6.67E-10	9.60E-07	3.50E-04				N/A
Methyl chloride	H	--	1.02E-09	1.47E-06	5.37E-04				N/A
Methylene chloride	H	T	1.29E-08	1.86E-05	6.77E-03	0.39		1600	No
Naphthalene	H	--	1.20E-05	1.14E-04	4.15E-02				N/A
Pentachlorophenol	H	T	1.01E-10	1.45E-07	5.31E-05	0.0064	0.063		No
Phenol	H	T	2.27E-09	3.26E-06	1.19E-03	0.24			No
Polychlorinated biphenyls (PCB)	H	T	3.52E-13	5.07E-10	1.85E-07			5.6	No
Polycyclic organic matter (POM)	H	--	5.64E-09	8.11E-06	2.96E-03				N/A
Propionaldehyde	H	--	2.71E-09	3.90E-06	1.42E-03				N/A
Styrene	H	T	8.45E-08	1.22E-04	4.44E-02	2.7			No
Tetrachlorodibenzo-p-dioxins	--	T	2.09E-14	3.01E-11	1.10E-08			0.0002	No
Tetrachloroethylene	H	T	1.69E-09	2.43E-06	8.88E-04			13000	No
Toluene	H	T	6.67E-05	6.59E-04	2.40E-01		98		No
Trichloroethene	H	T	1.33E-09	1.92E-06	7.01E-04			4000	No
Vinyl chloride	H	T	8.01E-10	1.15E-06	4.20E-04			26	No
Xylenes	H	T	1.11E-09	1.60E-06	5.84E-04		57		No

Appendix B.1 - Biochar Production from Processing of Wood for Limited Operation

Inputs

Activity	Value	Units
Average Kilns Processed	160	kilns/day
Average Kilns Processed	58,400	kilns/year
Annual Operating Days	365	days/yr
Load size	1.00	ton/kiln
Railroad Tie Heating Value	8,000	Btu/ton
Estimated Heat Intput	8.89E-04	MMBtu/hr
Estimated Heat Intput	467	MMBtu/yr

Single Kiln Emission Factors - Controlled [1]

Pollutant	Worst-Case Emission Factor	Units
PM	0.23	lb/ton
	0.03	lb/hr
PM_{10}	0.16	lb/ton
	0.02	lb/hr
$PM_{2.5}$	0.12	lb/ton
	0.01	lb/hr
NO_X	3.35	lb/ton
	0.38	lb/hr
VOC	0.45	lb/ton
	0.01	lb/hr
CO	0.67	lb/ton
	0.08	lb/hr

[1] Emission factors are based on the worst-case of performance tests for untreated wood and creosote-treated railroad ties for similar size kilns, and include the safety factors indicated below:

PM emission factor multiplier:	1.25
NOx emission factor mutiplier:	1.25
VOC uncontrolled emission factor mutiplier:	1.25
CO emission factor mutliplier:	1.25
MeOH uncontrolled emission factor multiplier:	1.25

Emissions

Number of Kilns	Hourly Emissions (lb/hr) [1]							
						VOC [2]		
	NO_X	CO	PM	PM_{10}	$PM_{2.5}$	Unc.	Cont.	SO_2 [4]
Per Kiln	0.38	0.08	0.026	0.018	0.013	1.73E-01	8.63E-03	1.39E-07
Average Kilns Processed	60.00	12.00	4.20	2.87	2.07	27.60	1.38	2.22E-05

Number of Kilns	Annual Emissions (tpy) [3]							
						VOC [2]		
	NO_X	CO	PM	PM_{10}	$PM_{2.5}$	Unc.	Cont.	SO_2 [4]
Average Kilns Processed	97.84	19.57	6.84	4.60	3.42	262.31	13.12	5.84E-03

[1] Per kiln emissions based on the worst-case value from the two stack test reports.
Average Kilns Processed (lb/hr) = Per Kiln Emissions (lb/hr) * Average Kilns Processed

[2] Controlled emissions based on destruction ratio efficiency (DRE) of 95%

[3] Annual Emissions (tpy) = Emission Factor (lb/ton) * Kilns Processed (kilns/yr) * Load size (ton/kiln) ÷ 2000 lb/ton

[4] SO_2 emissions calculated based on AP-42 emission factors. Detailed calculations presented in the Other Pollutant Kiln Emissions table.

Appendix B.1 - Kiln Emission Factor Analysis

Value	2019 Untreated Wood Test [1]				2015 Creosote Treated Rail Tie Test [2]
	Kiln 8	Kiln 21	Kiln 7	Average	Pole 2 NE
Quantity Processed (tons)	0.990	1.000	1.030	1.007	1.007
Run Hours	9.317	9.333	8.333	8.994	8.994
NO_X (lb/hr)	0.223	0.260	0.230	0.238	0.300
NO_X (lb/ton)	2.099	2.427	1.861	2.129	2.680
CO (lb/hr)	0.002	0.012	0.009	0.007	0.060
CO (lb/ton)	0.018	0.109	0.070	0.066	0.536
PM filt. (lb/hr)	0.014	0.018	0.015	0.015	0.005
PM filt. (lb/ton)	0.132	0.166	0.118	0.139	0.045
PM cond. (lb/hr)	0.006	0.005	0.006	0.006	N/A
PM cond. (lb/ton)	0.056	0.046	0.045	0.049	N/A
PM (lb/hr) [3]	0.020	0.023	0.020	0.021	0.011
PM (lb/ton) [3]	0.187	0.212	0.163	0.187	0.094
PM_{10} (lb/hr)	0.014	0.015	0.014	0.014	N/A
PM_{10} (lb/ton)	0.122	0.142	0.114	0.126	N/A
$PM_{2.5}$ (lb/hr)	0.010	0.011	0.010	0.010	N/A
$PM_{2.5}$ (lb/ton)	0.099	0.099	0.083	0.094	N/A
VOC (lb/hr)	0.002	0.002	0.001	0.002	0.007
VOC (lb/ton)	0.414	0.454	0.210	0.359	0.062
MeOH (lb/hr)	1.62E-04	1.46E-04	1.64E-04	1.57E-04	2.00E-04
MeOH (lb/ton)	0.030	0.027	0.027	0.028	0.002

[1] All data taken from Source Test Report 2019 Compliance Test for the Biochar Now! Berthoud Facility. Emission factors in lb/ton are calculated as the lb/hr test result multiplied by the run hours and divided by the quantity processed in tons.

[2] All data taken from Source Emissions Testing Report 2015 for the Biochar Now! Berthoud Facility, unless otherwise specified. Emission factors in lb/ton are calculated as the lb/hr test result multiplied by the run hours and divided by the quantity processed in tons. Kin is the same size as those tested in the 2019 compliance test. Kiln weight and run time during the test estimated as the average of the three tests conducted in 2019.

[3] 2015 value is the sum of PM filt from 2015 test and PM cond from 2019 test.

Pollutant	Uncontrolled Emission Factor	Emission Factor Source [1]	Uncontrolled Emissions			Controlled Emissions [2]		
			(lb/hr)	(lb/day)	(lb/yr)	(lb/hr)	(lb/day)	(lb/yr)
SO_2	2.5E-02 lb/MMBtu	f	2.22E-05	3.20E-02	1.17E+01	2.22E-05	3.20E-02	1.17E+01
Metals								
Antimony	7.9E-06 lb/MMBtu	b	7.03E-09	1.01E-05	3.69E-03	7.03E-09	1.01E-05	3.69E-03
Arsenic	2.2E-05 lb/MMBtu	b	1.96E-08	2.82E-05	1.03E-02	1.96E-08	2.82E-05	1.03E-02
Beryllium	1.1E-06 lb/MMBtu	b	9.78E-10	1.41E-06	5.14E-04	9.78E-10	1.41E-06	5.14E-04
Cadmium	4.1E-06 lb/MMBtu	b	3.65E-09	5.25E-06	1.92E-03	3.65E-09	5.25E-06	1.92E-03
Chromium	3.9E-05 lb/MMBtu	c	3.45E-08	4.97E-05	1.81E-02	3.45E-08	4.97E-05	1.81E-02
Chromium VI	3.5E-06 lb/MMBtu	b	3.11E-09	4.48E-06	1.64E-03	3.11E-09	4.48E-06	1.64E-03
Cobalt	6.5E-06 lb/MMBtu	b	5.78E-09	8.32E-06	3.04E-03	5.78E-09	8.32E-06	3.04E-03
Lead	4.8E-05 lb/MMBtu	b	4.27E-08	6.14E-05	2.24E-02	4.27E-08	6.14E-05	2.24E-02
Manganese	1.6E-03 lb/MMBtu	b	1.42E-06	2.05E-03	7.48E-01	1.42E-06	2.05E-03	7.48E-01
Mercury	3.5E-06 lb/MMBtu	b	3.11E-09	4.48E-06	1.64E-03	3.11E-09	4.48E-06	1.64E-03
Nickel	3.3E-05 lb/MMBtu	b	2.94E-08	4.22E-05	1.54E-02	2.94E-08	4.22E-05	1.54E-02
Phosphorus	2.7E-05 lb/MMBtu	b	2.40E-08	3.46E-05	1.26E-02	2.40E-08	3.46E-05	1.26E-02
Selenium	2.8E-06 lb/MMBtu	b	2.49E-09	3.58E-06	1.31E-03	2.49E-09	3.58E-06	1.31E-03
Miscellaneous								
Chlorine	7.9E-04 lb/MMBtu	a	7.03E-07	1.01E-03	3.69E-01	7.03E-07	1.01E-03	3.69E-01
Hydrogen chloride	1.9E-02 lb/MMBtu	a	1.69E-05	2.43E-02	8.88E+00	1.69E-05	2.43E-02	8.88E+00
Organics								
1,1,1-Trichloroethane	3.1E-05 lb/MMBtu	a	2.76E-08	3.97E-05	1.45E-02	1.38E-09	1.98E-06	7.24E-04
1,2-Dichloropropane	3.3E-05 lb/MMBtu	a	2.94E-08	4.22E-05	1.54E-02	1.47E-09	2.11E-06	7.71E-04
1,4-Dichlorobenzene	8.7E-07 lb/MMBtu	c	7.73E-10	1.11E-06	4.06E-04	3.87E-11	5.57E-08	2.03E-05
2,3,7,8-Tetrachlorodibenzo-p-dioxins	3.9E-11 lb/MMBtu	c	3.48E-14	5.00E-11	1.83E-08	1.74E-15	2.50E-12	9.13E-10
2,3,7,8-Tetrachlorodibenzo-p-furans	9.0E-11 lb/MMBtu	a	8.01E-14	1.15E-10	4.20E-08	4.00E-15	5.76E-12	2.10E-09
2,4,6-Trichlorophenol	2.2E-08 lb/MMBtu	a	1.96E-11	2.82E-08	1.03E-05	9.78E-13	1.41E-09	5.14E-07
2,4-Dinitrophenol	1.8E-07 lb/MMBtu	a	1.60E-10	2.30E-07	8.41E-05	8.01E-12	1.15E-08	4.20E-06
2-Chloronaphthalene	2.4E-09 lb/MMBtu	a	2.13E-12	3.07E-09	1.12E-06	1.07E-13	1.54E-10	5.61E-08
2-Methylnaphthalene	1.6E-07 lb/MMBtu	a	1.42E-10	2.05E-07	7.48E-05	7.12E-12	1.02E-08	3.74E-06
4-Nitrophenol	1.1E-07 lb/MMBtu	a	9.78E-11	1.41E-07	5.14E-05	4.89E-12	7.04E-09	2.57E-06
Acenaphthene	9.1E-07 lb/MMBtu	a	8.09E-10	1.16E-06	4.25E-04	4.05E-11	5.82E-08	2.13E-05
Acenaphthylene	5.0E-06 lb/MMBtu	a	4.45E-09	6.40E-06	2.34E-03	2.22E-10	3.20E-07	1.17E-04
Acetaldehyde	8.3E-04 lb/MMBtu	a	7.38E-07	1.06E-03	3.88E-01	3.69E-08	5.31E-05	1.94E-02
Acetophenone	3.2E-09 lb/MMBtu	a	2.85E-12	4.10E-09	1.50E-06	1.42E-13	2.05E-10	7.48E-08
Acrolein	4.0E-03 lb/MMBtu	a	3.56E-06	5.12E-03	1.87E+00	1.78E-07	2.56E-04	9.34E-02
Anthracene	3.0E-06 lb/MMBtu	a	2.67E-09	3.84E-06	1.40E-03	1.33E-10	1.92E-07	7.01E-05
Benzene	4.2E-03 lb/MMBtu	a	3.74E-06	5.38E-03	1.96E+00	1.87E-07	2.69E-04	9.81E-02
Benzo(a)anthracene	6.5E-08 lb/MMBtu	a	5.78E-11	8.32E-08	3.04E-05	2.89E-12	4.16E-09	1.52E-06
Benzo(a)pyrene	2.6E-06 lb/MMBtu	a	2.31E-09	3.33E-06	1.21E-03	1.16E-10	1.66E-07	6.07E-05
Benzo(b)fluoranthene	1.0E-07 lb/MMBtu	a	8.89E-11	1.28E-07	4.67E-05	4.45E-12	6.40E-09	2.34E-06
Benzo(e)pyrene	2.6E-09 lb/MMBtu	a	2.31E-12	3.33E-09	1.21E-06	1.16E-13	1.66E-10	6.07E-08
Benzo(g,h,i)perylene	9.3E-08 lb/MMBtu	a	8.27E-11	1.19E-07	4.34E-05	4.14E-12	5.95E-09	2.17E-06
Benzo(j,k)fluoranthene	1.6E-07 lb/MMBtu	a	1.42E-10	2.05E-07	7.48E-05	7.12E-12	1.02E-08	3.74E-06
Benzo(k)fluoranthene	3.6E-08 lb/MMBtu	a	3.20E-11	4.61E-08	1.68E-05	1.60E-12	2.30E-09	8.41E-07
Bis(2-ethylhexyl)phthalate	4.3E-06 lb/MMBtu	c	3.78E-09	5.45E-06	1.99E-03	1.89E-10	2.72E-07	9.94E-05
Carbazole	1.8E-06 lb/MMBtu	a	1.60E-09	2.30E-06	8.41E-04	8.01E-11	1.15E-07	4.20E-05
Carbon Tetrachloride	4.5E-05 lb/MMBtu	a	4.00E-08	5.76E-05	2.10E-02	2.00E-09	2.88E-06	1.05E-03
Chlorobenzene	3.3E-05 lb/MMBtu	a	2.94E-08	4.22E-05	1.54E-02	1.47E-09	2.11E-06	7.71E-04
Chloroform	2.8E-05 lb/MMBtu	a	2.49E-08	3.58E-05	1.31E-02	1.25E-09	1.79E-06	6.54E-04
Chrysene	3.8E-08 lb/MMBtu	a	3.38E-11	4.86E-08	1.78E-05	1.69E-12	2.43E-09	8.88E-07
Cresol isomers (m,p,o)	2.7E-06 lb/MMBtu	c	2.44E-09	3.52E-06	1.28E-03	1.22E-10	1.76E-07	6.42E-05
Decachlorobiphenyl	2.7E-10 lb/MMBtu	a	2.40E-13	3.46E-10	1.26E-07	1.20E-14	1.73E-11	6.31E-09
Dibenzo(a,h)anthracene	9.1E-09 lb/MMBtu	a	8.09E-12	1.16E-08	4.25E-06	4.05E-13	5.82E-10	2.13E-07
Dichlorobiphenyl	7.4E-10 lb/MMBtu	a	6.58E-13	9.47E-10	3.46E-07	3.29E-14	4.74E-11	1.73E-08
Dioxins/furans	1.7E-06 lb/MMBtu	e	1.49E-09	2.14E-06	7.81E-04	7.44E-11	1.07E-07	3.91E-05
Ethylbenzene	3.1E-05 lb/MMBtu	a	2.76E-08	3.97E-05	1.45E-02	1.38E-09	1.98E-06	7.24E-04
Ethylene dichloride	2.9E-05 lb/MMBtu	a	2.58E-08	3.71E-05	1.35E-02	1.29E-09	1.86E-06	6.77E-04
Fluoranthene	1.6E-06 lb/MMBtu	a	1.42E-09	2.05E-06	7.48E-04	7.12E-11	1.02E-07	3.74E-05
Fluorene	3.4E-06 lb/MMBtu	a	3.02E-09	4.35E-06	1.59E-03	1.51E-10	2.18E-07	7.94E-05
Formaldehyde	4.4E-03 lb/MMBtu	a	3.91E-06	5.63E-03	2.06E+00	1.96E-07	2.82E-04	1.03E-01
Heptachlorobiphenyl	6.6E-11 lb/MMBtu	a	5.87E-14	8.45E-11	3.08E-08	2.94E-15	4.22E-12	1.54E-09
Heptachlorodibenzo-p-dioxins	2.0E-09 lb/MMBtu	a	1.78E-12	2.56E-09	9.34E-07	8.89E-14	1.28E-10	4.67E-08
Heptachlorodibenzo-p-furans	2.4E-10 lb/MMBtu	a	2.13E-13	3.07E-10	1.12E-07	1.07E-14	1.54E-11	5.61E-09
Hexachlorobiphenyl	5.5E-10 lb/MMBtu	a	4.89E-13	7.04E-10	2.57E-07	2.45E-14	3.52E-11	1.28E-08
Hexachlorodibenzo-p-dioxins	1.6E-06 lb/MMBtu	a	1.42E-09	2.05E-06	7.48E-04	7.12E-11	1.02E-07	3.74E-05
Hexachlorodibenzo-p-furans	2.8E-10 lb/MMBtu	a	2.49E-13	3.58E-10	1.31E-07	1.25E-14	1.79E-11	6.54E-09
Indeno(1,2,3-cd)pyrene	8.7E-08 lb/MMBtu	a	7.74E-11	1.11E-07	4.06E-05	3.87E-12	5.57E-09	2.03E-06
Methanol	87.92 lb/MMBtu	d	0.08	1.13E+02	41074.67	3.91E-03	5.63E+00	2.05E+03
Methyl bromide	1.5E-05 lb/MMBtu	a	1.33E-08	1.92E-05	7.01E-03	6.67E-10	9.60E-07	3.50E-04
Methyl chloride	2.3E-05 lb/MMBtu	a	2.05E-08	2.94E-05	1.07E-02	1.02E-09	1.47E-06	5.37E-04
Methylene chloride	2.9E-04 lb/MMBtu	a	2.58E-07	3.71E-04	1.35E-01	1.29E-08	1.86E-05	6.77E-03
Naphthalene	9.7E-05 lb/MMBtu	a	8.63E-08	1.24E-04	4.53E-02	4.31E-09	6.21E-06	2.27E-03
Octachlorodibenzo-p-dioxins	6.6E-08 lb/MMBtu	a	5.87E-11	8.45E-08	3.08E-05	2.94E-12	4.22E-09	1.54E-06
Octachlorodibenzo-p-furans	8.8E-11 lb/MMBtu	a	7.83E-14	1.13E-10	4.11E-08	3.91E-15	5.63E-12	2.06E-09
Pentachlorobiphenyl	1.2E-09 lb/MMBtu	a	1.07E-12	1.54E-09	5.61E-07	5.34E-14	7.68E-11	2.80E-08
Pentachlorodibenzo-p-dioxins	1.5E-09 lb/MMBtu	a	1.33E-12	1.92E-09	7.01E-07	6.67E-14	9.60E-11	3.50E-08
Pentachlorodibenzo-p-furans	4.2E-10 lb/MMBtu	a	3.74E-13	5.38E-10	1.96E-07	1.87E-14	2.69E-11	9.81E-09
Pentachlorophenol	2.3E-06 lb/MMBtu	c	2.02E-09	2.91E-06	1.06E-03	1.01E-10	1.45E-07	5.31E-05

Pollutant	Uncontrolled Emission Factor	Emission Factor Source [1]	Uncontrolled Emissions (lb/hr)	Uncontrolled Emissions (lb/day)	Uncontrolled Emissions (lb/yr)	Controlled Emissions[2] (lb/hr)	Controlled Emissions[2] (lb/day)	Controlled Emissions[2] (lb/yr)
Perylene	5.2E-10 lb/MMBtu	a	4.63E-13	6.66E-10	2.43E-07	2.31E-14	3.33E-11	1.21E-08
Phenanthrene	7.0E-06 lb/MMBtu	a	6.23E-09	8.96E-06	3.27E-03	3.11E-10	4.48E-07	1.64E-04
Phenol	5.1E-05 lb/MMBtu	a	4.54E-08	6.53E-05	2.38E-02	2.27E-09	3.26E-06	1.19E-03
Polychlorinated biphenyls (PCB)	7.9E-09 lb/MMBtu	e	7.05E-12	1.01E-08	3.70E-06	3.52E-13	5.07E-10	1.85E-07
Polycyclic organic matter (POM)	1.3E-04 lb/MMBtu	e	1.13E-07	1.62E-04	5.92E-02	5.64E-09	8.11E-06	2.96E-03
Propionaldehyde	6.1E-05 lb/MMBtu	a	5.43E-08	7.81E-05	2.85E-02	2.71E-09	3.90E-06	1.42E-03
Pyrene	3.7E-06 lb/MMBtu	a	3.29E-09	4.74E-06	1.73E-03	1.65E-10	2.37E-07	8.64E-05
Styrene	1.9E-03 lb/MMBtu	a	1.69E-06	2.43E-03	8.88E-01	8.45E-08	1.22E-04	4.44E-02
Tetrachlorobiphenyl	2.5E-09 lb/MMBtu	a	2.22E-12	3.20E-09	1.17E-06	1.11E-13	1.60E-10	5.84E-08
Tetrachlorodibenzo-p-dioxins	4.7E-10 lb/MMBtu	a	4.18E-13	6.02E-10	2.20E-07	2.09E-14	3.01E-11	1.10E-08
Tetrachlorodibenzo-p-furans	7.5E-10 lb/MMBtu	a	6.67E-13	9.60E-10	3.50E-07	3.34E-14	4.80E-11	1.75E-08
Tetrachloroethylene	3.8E-05 lb/MMBtu	a	3.38E-08	4.86E-05	1.78E-02	1.69E-09	2.43E-06	8.88E-04
Toluene	9.2E-04 lb/MMBtu	a	8.18E-07	1.18E-03	4.30E-01	4.09E-08	5.89E-05	2.15E-02
Trichlorobiphenyl	2.6E-09 lb/MMBtu	a	2.31E-12	3.33E-09	1.21E-06	1.16E-13	1.66E-10	6.07E-08
Trichloroethene	3.0E-05 lb/MMBtu	a	2.67E-08	3.84E-05	1.40E-02	1.33E-09	1.92E-06	7.01E-04
Vinyl chloride	1.8E-05 lb/MMBtu	a	1.60E-08	2.30E-05	8.41E-03	8.01E-10	1.15E-06	4.20E-04
Xylenes	2.5E-05 lb/MMBtu	a	2.22E-08	3.20E-05	1.17E-02	1.11E-09	1.60E-06	5.84E-04
Total HAP			0.08	112.58	41,093	3.93E-03	5.66	2,064

[1] Emission Factor Data Sources as indicated below. Note that Craven County Wood Energy test results for creosote-treated wood combustion were used if the test results exceeded the emission factor in AP-42, or if there was no emission factor in AP-42. Test results obtained from application submitted by Coastal Carolina Clean Power, LLC to North Carolina Division of Air Quality, PSD Air Quality Construction and Operating Permit Application. Oct 2013.

a AP-42, 5th Edition, Section 1.6, Table 1.6-3 (09/03)
b AP-42, 5th Edition, Section 1.6, Table 1.6-4 (09/03)
c Craven County Wood Energy Test Data
d Based on stack testing completed at similar Biochar Now facility in Berthound, Colorado conducted on October 2019. Includes a 25% safety factor.
e Sum of emissions of individual compounds in pollutant category (dioxins/furans, PCBs, POM)
f AP-42, 5th Edition, Section 1.6, Table 1.6-2 (09/03)

[2] Controlled emissions based on destruction ratio efficiency (DRE) of 95% for organic compounds

Appendix B.1 -Kiln Initiation and Afterburner Emissions for Limited Operations

Inputs

Parameter	Value	Units
Burner Heat Input	0.125	MMBtu/hr
Number of Burners Operating	160	burners
Daily Hours	9	hrs/day
Operating Schedule	365	days/yr
Natural Gas HHV	1020	Btu/scf
Estimated Hourly Fuel Usage	20.00	MMBtu/hr
Estimated Annual Fuel Usage	65,658.6	MMBtu/yr

Emissions

	Emission Factor [1]	Total Emissions			
Pollutants	**(lb/MMscf)**	**(lb/hr)**	**(lb/day)**	**(lb/yr)**	**(tpy)**
Criteria Pollutants					
SO_2	0.6	1.18E-02	1.06E-01	3.86E+01	1.93E-02
Hazardous/Toxic Air Pollutants					
Acetaldehyde	1.52E-05	2.98E-07	2.68E-06	9.78E-04	4.89E-07
Acrolein	1.80E-05	3.53E-07	3.17E-06	1.16E-03	5.79E-07
Ammonia	3.20E+00	6.27E-02	5.64E-01	2.06E+02	1.03E-01
Benzene	2.10E-03	4.12E-05	3.70E-04	1.35E-01	6.76E-05
Benzo(a)pyrene	1.20E-06	2.35E-08	2.12E-07	7.72E-05	3.86E-08
Cobalt	8.40E-05	1.65E-06	1.48E-05	5.41E-03	2.70E-06
Formaldehyde	7.50E-02	1.47E-03	1.32E-02	4.83E+00	2.41E-03
Hexane	1.80E+00	3.53E-02	3.17E-01	1.16E+02	5.79E-02
Lead	5.00E-04	9.80E-06	8.82E-05	3.22E-02	1.61E-05
Naphthalene	6.10E-04	1.20E-05	1.08E-04	3.93E-02	1.96E-05
Selenium	2.40E-05	4.71E-07	4.23E-06	1.54E-03	7.72E-07
Toluene	3.40E-03	6.67E-05	6.00E-04	2.19E-01	1.09E-04
Total HAP		**0.04**	**0.33**	**121.13**	**0.06**

1 Emission factors from DEQ natural gas combustion calculation spreadsheet, Rev. N (January 5, 2017). Afterburner and kiln criteria pollutant emissions were included in the kiln source test results.

Appendix B.1 - Tie Chomper and Kiln Loading Emissions for Limited Operations

Inputs

Description	Value	Units
Kilns Processed	160	kilns/day
Daily Operating Hours	9	hrs/day
Annual Operating Days	365	days/yr
Wood Throughput	1.00	tons/kiln
	17.79	tons/hr

Emissions

Activity	Emission Factor (lb/ton) [1,2]			Enclosure Capture Efficiency [3]	Hourly Emissions (lb/hr) [4]			Annual Emissions (tpy) [5]		
	PM	PM_{10}	$PM_{2.5}$		PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Tie Chomper	0.03500	0.01750	0.00875	90%	0.06	0.03	0.02	0.10	0.05	0.03
Kiln Loading	0.0015	0.0007	0.0001	0%	0.03	0.01	1.78E-03	0.04	0.02	2.92E-03
				Total:	**0.09**	**0.04**	**0.02**	**0.15**	**0.07**	**0.03**

[1] Emission factor for log bucking (i.e., sizing logs down). The chomper reduces railroad ties to 3 inch "chunks" of wood and is more akin to log bucking than to log sawing. The emission factor is obtained from the table in the memorandum "Particulate Matter Potential to Emit Emission Factors from Activities at Sawmills, Excluding Boilers, Located in Pacific Northwest Indian Country", May 8, 2014, Dan Meyer, US EPA Region 10.

[2] Emission factor for a "drop" of "bone-dry" material into a kiln. Emission factor from the aforementioned source.

[3] Chomper will be enclosed within a conex (shipping container). Represented capture efficiency accounts for emissions occurring in an enclosed building.

[4] Hourly emissions (lb/hr) = Emission factor (lb/ton) * Log Processing Throughput (tons/hr) * (1 - Capture Efficiency)

[5] Annual emissions (tpy) = Hourly Emissions (lb/hr) * Daily Operating Hours (hrs/day) * Annual Operating Days (days/yr) / 2,000 (lb/ton)

Appendix B.2 -EX-2 Product Handling and Packaging Emissions for Unrestricted Operations

Inputs

Parameter	Value	Units
Product Throughput[1]	500	lb biochar/kiln
Percent Unconverted Wood	10%	percent
Daily Operating Hours	9	hrs/day
Daily Kilns Processed	426	kilns/day
Annual Operating Days	365	days/yr

Controlled Operation Emissions

Activity	Emission Factor (lb/ton biochar)[2]			Material Throughput[4]		Capture Efficiency[3]	Dust Collector Control Efficiency	Uncontrolled Hourly Emissions (lb/hr)[5]			Uncontrolled Annual Emissions (tpy)[5]			Controlled Hourly Emissions (lb/hr)[5]			Controlled Annual Emissions (tpy)[5]		
	PM	PM_{10}	$PM_{2.5}$	(tons/hr)	(tons/yr)			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Process 1: Kiln Dump to Hopper onto Conveyor[6]	0.0079	0.0037	0.0006	11.84	38,873	90%	99%	0.09	0.04	0.01	0.15	0.07	0.01	0.01	4.84E-03	7.32E-04	1.68E-02	7.94E-03	1.20E-03
Process 2a: Sizing Chomper	0.039	0.015	0.015	11.84	38,873	90%	99%	0.46	0.18	0.18	0.76	0.29	0.29	0.05	0.02	0.02	8.26E-02	3.18E-02	3.18E-02
Process 4: Sizing Hammermil	0.039	0.015	0.015	11.84	38,873	90%	99%	0.46	0.18	0.18	0.76	0.29	0.29	0.05	0.02	0.02	8.26E-02	3.18E-02	3.18E-02
Process 5a: Screener 1	0.025	0.0087	0.0087	11.84	38,873	90%	99%	0.30	0.10	0.10	0.49	0.17	0.17	0.03	0.01	0.01	5.30E-02	1.84E-02	1.84E-02
Process 5b: Small Char Long Conveyor	0.0079	0.0037	0.0006	11.84	38,873	90%	99%	0.09	0.04	0.01	0.15	0.07	0.01	0.01	4.84E-03	7.32E-04	1.68E-02	7.94E-03	1.20E-03
Process 5c: Three Destoners	0.025	0.0087	0.0087	11.84	38,873	90%	99%	0.30	0.10	0.10	0.49	0.17	0.17	0.03	0.01	0.01	5.30E-02	1.84E-02	1.84E-02
Process 6: Rollermill	0.039	0.015	0.015	11.84	38,873	90%	99%	0.46	0.18	0.18	0.76	0.29	0.29	0.05	0.02	0.02	8.26E-02	3.18E-02	3.18E-02
Process 7b: Screener 2	0.025	0.0087	0.0087	11.84	38,873	90%	99%	0.30	0.10	0.10	0.49	0.17	0.17	0.03	0.01	0.01	5.30E-02	1.84E-02	1.84E-02
Process 7c: Bagging Drop[6]	0.0079	0.0037	0.0006	11.84	38,873	90%	99%	0.09	0.04	0.01	0.15	0.07	0.01	0.01	4.84E-03	7.32E-04	1.68E-02	7.94E-03	1.20E-03

Uncontrolled Operation Emissions

Activity	Emission Factor (lb/ton biochar)[2]			Material Throughput[4]		Building Enclosure Efficiency[7]	Dust Collector Control Efficiency	Uncontrolled Hourly Emissions (lb/hr)[5]			Uncontrolled Annual Emissions (tpy)[5]			Controlled Hourly Emissions (lb/hr)[5]			Controlled Annual Emissions (tpy)[5]		
	PM	PM_{10}	$PM_{2.5}$	(tons/hr)	(tons/yr)			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Process 2b: Unconverted Wood Drop to Outdoor Bin[6]	0.0079	0.0037	0.0006	1.18	3,887	0%		0.01	4.44E-03	6.72E-04	0.02	7.28E-03	1.10E-03	0.01	4.44E-03	6.72E-04	0.02	0.01	1.10E-03
Process 3: Detwigging	0.025	0.0087	0.0087	11.84	38,873	90%		0.03	0.01	0.01	0.05	0.02	0.02	0.03	0.01	0.01	0.05	0.02	0.02
Process 7a: Drop to Bucket Elevator[6]	0.0079	0.0037	0.0006	11.84	38,873	90%		0.01	4.44E-03	6.72E-04	0.02	7.28E-03	1.10E-03	0.01	4.44E-03	6.72E-04	0.02	0.01	1.10E-03
Process 7d: Storage Silos[6]	0.0079	0.0037	0.0006	11.84	38,873	0%		0.19	0.09	0.01	0.31	0.15	2.21E-02	0.19	0.09	0.01	0.31	0.15	0.02
Total								2.79	1.08	0.89	4.58	1.78	1.46	0.51	0.21	0.12	0.84	0.35	0.20

1 Includes a margin of safety multiplier for product shipped daily as shown in the Facility Inputs tab.

2 Emission factors are from AP-42 Section 11.19.2, Table 11.19.2-2, unless otherwise noted.

3 Capture efficiency accounts for activities occurring under a hood, or within an enclosure where doors could potentially be open.

4 Material Throughput (ton/hr) = Product Throughput (lb biochar/kiln) / 2,000 (lb/ton) * Daily Kilns Cooked (kilns/day) / Daily Operating Hours (hrs/day)
Material Throughput (ton/yr) = Product Throughput (lb biochar/kiln) / 2,000 (lb/ton) * Daily Kilns Cooked (kilns/day) * Operating Days (days/yr)

5 Uncontrolled hourly emissions (lb/hr) = Emission Factor (lb/ton) * Throughput (tons/hr) * (1-Building Enclosure Efficiency%), where building enclosure efficiency is applicable
Controlled hourly emissions for controlled sources (lb/hr) = Emission Factor (lb/ton) * Throughput (tons/hr) * ((1-Capture Efficiency %) + (Capture Efficiency % * (1-Dust Collector Control Efficiency %)))
Uncontrolled annual emissions (tpy) = Emission Factor (lb/ton) * Throughput (tpy) * (1-Building Enclosure Efficiency %)/2000 lb/ton, where building enclosure efficiency is applicable.
Controlled annual emissions for controlled sources (tpy) = Emission factor (lb/ton) * Throughput (tpy) * ((1-Capture Efficiency %) + (Capture Efficiency % * (1-Dust Collector Control Efficiency %))) / 2000 lb/ton

6 Material is transferred to using conveyors. Material drop point emissions are based on AP-42 Section 13.2.4 - Aggregate Handling and Storage Piles, Equation 1. Silo emissions assume two drop points.

$$E\left(\frac{lb}{ton}\right) = k\,(0.0032)\left[\frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right]$$

Where k = Particle size multiplier 0.74 PM < 30 microns
0.35 PM < 10 microns
0.053 PM < 2.5 microns

U = Mean wind speed 6 mph
http://myforecast.co/bin/climate.m?city=24989&zip_code=28345&metric=false&selectedMonthNum=2

M = Moisture content 1 % for charcoal fresh from kiln
http://www.fao.org/3/x5328e/x5328e0b.htm#:~:text=Charcoal%20fresh%20from%20an%20opened.even%20in%20well%2Dburned%20charcoal.

7 Building enclosure efficiency of 90% accounts for activities conducted within an enclosed building based on the TCEQ emission calculation workbook for rock crushing plants (https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/emiss-calc-rock1.xlsx)

Unpaved Road Dust Emission Factors

Category	silt (s)[1] (%)	Unloaded Weight[2] (lb)	Loaded Weight[3] (lb)	Average Weight[4] (W) (tons)	Uncontrolled[5] (%)	Control[5] (%)	Uncontrolled Emission Factor (lb/VMT)[6]			Controlled Emission Factor (lb/VMT)[6]		
							PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Log/rail tie delivery	8.4	40,000	80,000	30.0	72%	95%	3.01	0.86	0.09	0.56	0.16	0.02
Rail tie pile and chomper	8.4	36,226	38,226	18.6	72%	95%	2.43	0.69	0.07	0.46	0.13	0.01
Kiln lids and stacks	8.4	10,849	11,849	5.7	72%	95%	1.42	0.41	0.04	0.27	0.08	0.01
Kilns transport	8.4	26,083	31,083	14.3	72%	95%	2.16	0.62	0.06	0.40	0.12	0.01
Product shipping	8.4	32,000	15,000	11.8	72%	95%	1.98	0.56	0.06	0.37	0.11	0.01

[1] Silt content of road surface material (s) obtained from EPA AP-42, Section 13.2.2, Table 13.2.2-1 for Lumber sawmills/log yards.

[2] Unloaded weights: kiln wheel loader obtained from spec sheet for a Case-621 loader; log piles, Case CX160 excavator; and lids, Case 121E.

Log delivery unloaded weight of trucks based on typical log truck. http://www.forestry.uga.edu/research/forestry/forestbusiness/log-truck-weight-policy.php

Product delivery vehicles are semi-trailer trucks (tractor and cargo trailer). Typical empty weights from http://www.ask.com/vehicles/much-empty-semi-trailer-weigh-735e3574c4658c6d

[3] Loaded weight estimated as the sum of the unloaded weight and the capacity or working load of each loader or truck, respectively.

[4] Weight (tons) calculated as the average of the unloaded and loaded weights for each type of vehicle.

[5] Control efficiency for unpaved roads obtained from CDPHE Guidance, Control Efficiencies, Appendix B as a total of Gravel (50%), Water as needed (25%), and Surface Chemical Treatment (75%), as well as a control efficiency for a speed limit of 25 mph (44%) from the WRAP Fugitive Dust Handbook.
Uncontrolled reduction efficiency reflects gravel roads and speed limit only.

[6] Emission factor in lb/VMT calculated per EPA AP-42, Section 13.2.2, Equation 1a as follows:

$$E = k\,(s/12)^a\,(W/3)^b$$

k: Particle Size Multiplier (lb/VMT)
W: Mean vehicle weight (tons)
s: Silt content of road surface material (%)

	PM	PM_{10}	$PM_{2.5}$
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

Emission Calculation for Unpaved Roads

	Round Trip Distance (miles)	Number of Trucks[1]		Vehicle Miles Traveled[2] (VMT)		Uncontrolled Hourly Emissions[3] (lb/hr)			Uncontrolled Annual Emissions[4] (tpy)			Controlled Hourly Emissions[3] (lb/hr)			Controlled Annual Emissions[4] (tpy)		
		Per Hour	Per Year	Hourly	Annual VMT	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Log/rail tie delivery [5]	0.60	0.92	8,030	0.55	4,818	1.66	0.47	0.05	7.26	2.07	0.21	0.31	0.09	0.01	1.36	0.39	0.04
Log/rail tie pile and shredder [6]	0.20	0.07	365	0.01	73	0.03	0.01	9.24E-04	0.09	0.03	2.53E-03	0.01	1.73E-03	1.73E-04	0.02	4.74E-03	4.74E-04
Kiln lids and stacks [7]	0.05	28	155,490	1.42	7,775	2.02	0.58	0.06	5.54	1.58	0.16	0.38	0.11	0.01	1.04	0.30	0.03
Kiln transport [5]	0.20	18	155,490	3.55	31,098	7.66	2.18	0.22	33.55	9.56	0.96	1.44	0.41	0.04	6.29	1.79	0.18
Product shipping [5]	0.60	0.63	5,475	0.38	3,285	0.74	0.21	0.02	3.25	0.93	0.09	0.14	0.04	3.96E-03	0.61	0.17	0.02
Totals:						**11.37**	**3.24**	**0.32**	**46.43**	**13.24**	**1.32**	**2.13**	**0.61**	**0.06**	**8.71**	**2.48**	**0.25**

1 Number of trucks calculated as Loads per Day/Hours per Day:

Description	Load size (lb)	Loads per day	Hours per day
Log delivery	40,000	22	24
Log pile & shredder	N/A	1	15
Kiln stacks and lids	1,000	426	15
Kilns to sizing/packaging & shredder	5000	426	24
Product shipping	15,000	15	24

2 Vehicle miles traveled calculated as the Number of Trucks x Round trip distance per truck.

3 Hourly emissions (lb/hr) = Emission factor for unpaved or paved (lb/VMT) x Hourly VMT.

4 Annual emissions (tpy) = Emission factor for unpaved or paved (lb/VMT) x Annual VMT.

5 Routes distance based on distances for existing facility with similar layout to the proposed facility.

6 The log/rail tie pile and shredder vehicle will travel an estimated 1000 feet per working day. Most motion will be axial swivels and relatively little lateral movement will take place.

7 The kiln lid/stack units will operate in the vicinity of a kiln bank.

Appendix B.1 -EX-2 Product Handling and Packaging Emissions for Limited Operations

Inputs

Parameter	Value	Units
Product Throughput[1]	500	lb biochar/kiln
Percent Unconverted Wood	10%	percent
Daily Operating Hours	9	hrs/day
Daily Kilns Processed	160	kilns/day
Annual Operating Days	365	days/yr

Controlled Operation Emissions

Activity	Emission Factor (lb/ton biochar)[2]			Material Throughput[4]		Capture Efficiency[3]	Dust Collector Control Efficiency	Uncontrolled Hourly Emissions (lb/hr)[5]			Uncontrolled Annual Emissions (tpy)[5]			Controlled Hourly Emissions (lb/hr)[5]			Controlled Annual Emissions (tpy)[5]		
	PM	PM_{10}	$PM_{2.5}$	(tons/hr)	(tons/yr)			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Process 1: Kiln Dump to Hopper onto Conveyor[6]	0.0079	0.0037	0.0006	4.45	14,600	90%	99%	0.04	0.02	2.52E-03	0.06	0.03	4.14E-03	3.84E-03	1.82E-03	2.75E-04	6.30E-03	2.98E-03	4.51E-04
Process 2a: Sizing Chomper	0.039	0.015	0.015	4.45	14,600	90%	99%	0.17	0.07	0.07	0.28	0.11	0.11	0.02	0.01	0.01	3.10E-02	1.19E-02	1.19E-02
Process 4: Sizing Hammermil	0.039	0.015	0.015	4.45	14,600	90%	99%	0.17	0.07	0.07	0.28	0.11	0.11	0.02	0.01	0.01	3.10E-02	1.19E-02	1.19E-02
Process 5a: Screener 1	0.025	0.0087	0.0087	4.45	14,600	90%	99%	0.11	0.04	0.04	0.18	0.06	0.06	0.01	4.22E-03	4.22E-03	1.99E-02	6.92E-03	6.92E-03
Process 5b: Small Char Long Conveyor	0.0079	0.0037	0.0006	4.45	14,600	90%	99%	0.04	0.02	2.52E-03	0.06	0.03	4.14E-03	3.84E-03	1.82E-03	2.75E-04	6.30E-03	2.98E-03	4.51E-04
Process 5c: Three Destoners	0.025	0.0087	0.0087	4.45	14,600	90%	99%	0.11	0.04	0.04	0.18	0.06	0.06	0.01	4.22E-03	4.22E-03	1.99E-02	6.92E-03	6.92E-03
Process 6: Rollermill	0.039	0.015	0.015	4.45	14,600	90%	99%	0.17	0.07	0.07	0.28	0.11	0.11	0.02	0.01	0.01	3.10E-02	1.19E-02	1.19E-02
Process 7b: Screener 2	0.025	0.0087	0.0087	4.45	14,600	90%	99%	0.11	0.04	0.04	0.18	0.06	0.06	0.01	4.22E-03	4.22E-03	1.99E-02	6.92E-03	6.92E-03
Process 7c: Bagging Drop[6]	0.0079	0.0037	0.0006	4.45	14,600	90%	99%	0.04	0.02	2.52E-03	0.06	0.03	4.14E-03	3.84E-03	1.82E-03	2.75E-04	6.30E-03	2.98E-03	4.51E-04

Uncontrolled Operation Emissions

Activity	Emission Factor (lb/ton biochar)[2]			Material Throughput[4]		Building Enclosure Efficiency[7]	Dust Collector Control Efficiency	Uncontrolled Hourly Emissions (lb/hr)[5]			Uncontrolled Annual Emissions (tpy)[5]			Controlled Hourly Emissions (lb/hr)[5]			Controlled Annual Emissions (tpy)[5]		
	PM	PM_{10}	$PM_{2.5}$	(tons/hr)	(tons/yr)			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Process 2b: Unconverted Wood Drop to Outdoor Bin[6]	0.0079	0.0037	0.0006	0.44	1,460	0%		3.52E-03	1.67E-03	2.52E-04	0.01	2.73E-03	4.14E-04	3.52E-03	1.67E-03	2.52E-04	0.01	2.73E-03	4.14E-04
Process 3: Detwigging	0.025	0.0087	0.0087	4.45	14,600	90%		0.01	3.87E-03	3.87E-03	0.02	0.01	0.01	0.01	3.87E-03	3.87E-03	0.02	0.01	0.01
Process 7a: Drop to Bucket Elevator[6]	0.0079	0.0037	0.0006	4.45	14,600	90%		3.52E-03	1.67E-03	2.52E-04	0.01	2.73E-03	4.14E-04	3.52E-03	1.67E-03	2.52E-04	0.01	2.73E-03	4.14E-04
Process 7d: Storage Silos[6]	0.0079	0.0037	0.0006	4.45	14,600	0%		0.07	0.03	0.01	0.12	0.05	8.28E-03	0.07	0.03	0.01	0.12	0.05	0.01
Total								1.05	0.41	0.33	1.72	0.67	0.55	0.19	0.08	0.04	0.32	0.13	0.07

1 Includes a margin of safety multiplier for product shipped daily as shown in the Facility Inputs tab.

2 Emission factors are from AP-42 Section 11.19.2, Table 11.19.2-2, unless otherwise noted.

3 Capture efficiency accounts for activities occurring under a hood, or within an enclosure where doors could potentially be open.

4 Material Throughput (ton/hr) = Product Throughput (lb biochar/kiln) / 2,000 (lb/ton) * Daily Kilns Cooked (kilns/day) / Daily Operating Hours (hrs/day)
Material Throughput (ton/yr) = Product Throughput (lb biochar/kiln) / 2,000 (lb/ton) * Daily Kilns Cooked (kilns/day) * Operating Days (days/yr)

5 Uncontrolled hourly emissions (lb/hr) = Emission Factor (lb/ton) * Throughput (tons/hr) * (1-Building Enclosure Efficiency%), where building enclosure efficiency is applicable
Controlled hourly emissions for controlled sources (lb/hr) = Emission Factor (lb/ton) * Throughput (tons/hr) * ((1-Capture Efficiency %) + (Capture Efficiency % * (1-Dust Collector Control Efficiency %)))
Uncontrolled annual emissions (tpy) = Emission Factor (lb/ton) * Throughput (tpy) * (1-Building Enclosure Efficiency %)/2000 lb/ton, where building enclosure efficiency is applicable.
Controlled annual emissions for controlled sources (tpy) = Emission factor (lb/ton) * Throughput (tpy) * ((1-Capture Efficiency %) + (Capture Efficiency % * (1-Dust Collector Control Efficiency %))) / 2000 lb/ton

6 Material is transferred to using conveyors. Material drop point emissions are based on AP-42 Section 13.2.4 - Aggregate Handling and Storage Piles, Equation 1. Silo emissions assume two drop points.

$$E\left(\frac{lb}{ton}\right) = k\,(0.0032)\left[\frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right]$$

Where k = Particle size multiplier 0.74 PM < 30 microns
0.35 PM < 10 microns
0.053 PM < 2.5 microns

U = Mean wind speed 6 mph
http://myforecast.co/bin/climate.m?city=24989&zip_code=28345&metric=false&selectedMonthNum=2

M = Moisture content 1 % for charcoal fresh from kiln
http://www.fao.org/3/x5328e/x5328e0b.htm#:~:text=Charcoal%20fresh%20from%20an%20opened,even%20in%20well%2Dburned%20charcoal.

7 Building enclosure efficiency of 90% accounts for activities conducted within an enclosed building based on the TCEQ emission calculation workbook for rock crushing plants (https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/emiss-calc-rock1.xlsx)

Unpaved Road Dust Emission Factors

Category	silt (s)[1] (%)	Unloaded Weight[2] (lb)	Loaded Weight[3] (lb)	Average Weight[4] (W) (tons)	Uncontrolled[5] (%)	Control[5] (%)	Uncontrolled Emission Factor (lb/VMT)[6]			Controlled Emission Factor (lb/VMT)[6]		
							PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Log/rail tie delivery	8.4	40,000	80,000	30.0	72%	95%	3.01	0.86	0.09	0.56	0.16	0.02
Rail tie pile and chomper	8.4	36,226	38,226	18.6	72%	95%	2.43	0.69	0.07	0.46	0.13	0.01
Kiln lids and stacks	8.4	10,849	11,849	5.7	72%	95%	1.42	0.41	0.04	0.27	0.08	0.01
Kilns transport	8.4	26,083	31,083	14.3	72%	95%	2.16	0.62	0.06	0.40	0.12	0.01
Product shipping	8.4	32,000	15,000	11.8	72%	95%	1.98	0.56	0.06	0.37	0.11	0.01

[1] Silt content of road surface material (s) obtained from EPA AP-42, Section 13.2.2, Table 13.2.2-1 for Lumber sawmills/log yards.

[2] Unloaded weights: kiln wheel loader obtained from spec sheet for a Case-621 loader; log piles, Case CX160 excavator; and lids, Case 121E.

Log delivery unloaded weight of trucks based on typical log truck. http://www.forestry.uga.edu/research/forestry/forestbusiness/log-truck-weight-policy.php

Product delivery vehicles are semi-trailer trucks (tractor and cargo trailer). Typical empty weights from http://www.ask.com/vehicles/much-empty-semi-trailer-weigh-735e3574c4658c6d

[3] Loaded weight estimated as the sum of the unloaded weight and the capacity or working load of each loader or truck, respectively.

[4] Weight (tons) calculated as the average of the unloaded and loaded weights for each type of vehicle.

[5] Control efficiency for unpaved roads obtained from CDPHE Guidance, Control Efficiencies, Appendix B as a total of Gravel (50%), Water as needed (25%), and Surface Chemical Treatment (75%), as well as a control efficiency for a speed limit of 25 mph (44%) from the WRAP Fugitive Dust Handbook. Uncontrolled reduction efficiency reflects gravel roads and speed limit only.

[6] Emission factor in lb/VMT calculated per EPA AP-42, Section 13.2.2, Equation 1a as follows:

$$E = k\,(s/12)^a\,(W/3)^b$$

k: Particle Size Multiplier (lb/VMT)
W: Mean vehicle weight (tons)
s: Silt content of road surface material (%)

	PM	PM_{10}	$PM_{2.5}$
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

Emission Calculation for Unpaved Roads

	Round Trip Distance (miles)	Number of Trucks[1]		Vehicle Miles Traveled[2] (VMT)		Uncontrolled Hourly Emissions[3] (lb/hr)			Uncontrolled Annual Emissions[4] (tpy)			Controlled Hourly Emissions[3] (lb/hr)			Controlled Annual Emissions[4] (tpy)		
		Per Hour	Per Year	Hourly	Annual VMT	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Log/rail tie delivery [5]	0.60	0.89	2,920	0.53	1,752	1.61	0.46	0.05	2.64	0.75	0.08	0.30	0.09	0.01	0.49	0.14	0.01
Log/rail tie pile and chomper [6]	0.20	0.07	365	0.01	73	0.03	0.01	9.24E-04	0.09	0.03	2.53E-03	0.01	1.73E-03	1.73E-04	0.02	4.74E-03	4.74E-04
Kiln lids and stacks [7]	0.05	11	58,400	0.53	2,920	0.76	0.22	0.02	2.08	0.59	0.06	0.14	0.04	4.06E-03	0.39	0.11	0.01
Kiln transport [5]	0.20	18	58,400	3.56	11,680	7.68	2.19	0.22	12.60	3.59	0.36	1.44	0.41	0.04	2.36	0.67	0.07
Product shipping [5]	0.60	0.67	2,190	0.40	1,314	0.79	0.23	0.02	1.30	0.37	0.04	0.15	0.04	4.23E-03	0.24	0.07	0.01
Totals:						**10.08**	**2.87**	**0.29**	**17.41**	**4.96**	**0.50**	**1.89**	**0.54**	**0.05**	**3.26**	**0.93**	**0.09**

1 Number of trucks calculated as Loads per Day/Hours per Day:

Description	Load size (lb)	Loads per day	Hours per day
Log delivery	40,000	8	9
Log pile & shredder	N/A	1	15
Kiln stacks and lids	1,000	160	15
Kilns to sizing/packaging & shredder	5000	160	9
Product shipping	15,000	6	9

2 Vehicle miles traveled calculated as the Number of Trucks x Round trip distance per truck.

3 Hourly emissions (lb/hr) = Emission factor for unpaved or paved (lb/VMT) x Hourly VMT.

4 Annual emissions (tpy) = Emission factor for unpaved or paved (lb/VMT) x Annual VMT.

5 Routes distance based on distances for existing facility with similar layout to the proposed facility.

6 The log/rail tie pile and shredder vehicle will travel an estimated 1000 feet per working day. Most motion will be axial swivels and relatively little lateral movement will take place.

7 The kiln lid/stack units will operate in the vicinity of a kiln bank.

Appendix B.2 - Facility Inputs for Unrestricted Operations

Category	Operating Schedule		Raw Materials and Product					Kiln Input/Output		Capture or Control	
	Daily hrs	days/yr	Estimated #/day	Typical lb/load	Potential ton/day	Potential annual tons	Burner Fuel, MMBtu/yr	Wood charge (ton/kiln)	Biochar product (lb/kiln)	Description	Capture or Control Efficiency
Kilns Processing[1]	24	365	426					1.00		Afterburner	95%
Afterburners	24	365	426				466,470				
Wood delivery	24	365	22	40,000	426	155,490					
Wood chomping	24	365			426					Enclosed in a conex	90%
Product shipped	24	365	15	15,000	107	38,873			500	Enclosed in building	90%

[1] Number of kilns: **426** The number of kilns operated daily and the current emission factors will be used to calculate the emissions.

Appendix B.2 - Facility Summary for Unrestricted Operations

		Hourly Emissions (lb/hr)												
Source ID	**Description**	**TSP (Unc.)**	**PM_{10} (Unc.)**	**$PM_{2.5}$ (Unc.)**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NO_X**	**SO_2**	**VOC (Unc.)**	**VOC (Cont.)**	**CO**	**Lead**	**HAP**
ES-1	Kiln Operation	11.18	7.63	5.50	11.18	7.63	5.50	159.75	8.33E-06	73.48	3.67	31.95	1.60E-08	1.47E-03
ES-1	Afterburner and Kiln Combustion								0.03				2.61E-05	0.10
EX-1	Tie Chomper & Kiln Load	0.09	0.04	0.02	0.09	0.04	0.02	-	-	-	-	-	-	-
EX-2	Biochar Sizing & Packaging	2.79	1.08	0.89	0.51	0.214	0.119	-	-	-	-	-	-	-
EX-3	Haul Roads	11.37	3.24	0.32	2.13	0.61	0.06	-	-	-	-	-	-	-
	Totals:	**25.43**	**12.00**	**6.73**	**13.92**	**8.50**	**5.70**	**159.75**	**0.03**	**73.48**	**3.67**	**31.95**	**2.61E-05**	**0.10**

		Annual Emissions (tpy)												
Source ID	**Description**	**TSP (Unc.)**	**PM_{10} (Unc.)**	**$PM_{2.5}$ (Unc.)**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NO_X**	**SO_2**	**VOC (Unc.)**	**VOC (Cont.)**	**CO**	**Lead**	**HAP**
ES-1	Kiln Operation	48.98	33.43	24.10	48.98	33.43	24.10	699.71	0.02	321.86	16.09	139.94	2.99E-05	2.75
ES-1	Afterburner and Kiln Combustion								0.14				1.14E-04	0.43
EX-1	Tie Chomper & Kiln Load	0.39	0.19	0.08	0.39	0.19	0.08	-	-	-	-	-	-	-
EX-2	Biochar Sizing & Packaging	4.58	1.78	1.46	0.84	0.35	0.20	-	-	-	-	-	-	-
EX-3	Haul Roads	46.43	13.24	1.32	8.71	2.48	0.25	-	-	-	-	-	-	-
	Total Excluding Fugitives:	**53.95**	**35.40**	**25.63**	**50.21**	**33.97**	**24.37**	**699.71**	**0.15**	**321.86**	**16.09**	**139.94**	**1.44E-04**	**3.18**
	Total All Sources:	**100.38**	**48.63**	**26.96**	**58.92**	**36.45**	**24.62**	**699.71**	**0.15**	**321.86**	**16.09**	**139.94**	**1.44E-04**	**3.18**

Toxic/Hazardous Air Pollutant Summary

Toxic Air Pollutant	**HAP?**	**TAP?**	**Total Emissions**			**2Q .0711 TPER Limits**			**TPER?**
			(lb/hr)	**(lb/day)**	**(lb/yr)**	**(lb/hr)**	**(lb/day)**	**(lb/yr)**	
Metals									
Antimony	H	--	2.63E-09	2.69E-05	9.83E-03				N/A
Arsenic	H	T	7.33E-09	7.50E-05	2.74E-02			0.053	No
Beryllium	H	T	3.67E-10	3.75E-06	1.37E-03			0.28	No
Cadmium	H	T	1.37E-09	1.40E-05	5.10E-03			0.37	No
Chromium	H	--	1.29E-08	1.32E-04	4.83E-02				N/A
Chromium VI	H	T	1.17E-09	1.19E-05	4.35E-03			0.0056	No
Cobalt	H	--	4.39E-06	1.27E-04	4.65E-02				N/A
Manganese	H	T	5.33E-07	5.45E-03	1.99E+00		0.63		No
Mercury	H	T	1.17E-09	1.19E-05	4.35E-03		0.013		No
Nickel	H	T	1.10E-08	1.12E-04	4.10E-02		0.013		No
Selenium	H	--	1.25E-06	3.96E-05	1.45E-02				N/A
Miscellaneous									
Chlorine	H	T	2.63E-07	2.69E-03	9.83E-01		0.79		No
Hydrogen chloride	H	T	6.33E-06	6.48E-02	2.36E+01	0.18			No
Organics									
1,1,1-Trichloroethane	H	--	5.17E-10	5.28E-06	1.93E-03				N/A
1,2-Dichloropropane	H	--	5.50E-10	5.62E-06	2.05E-03				N/A
1,4-Dichlorobenzene	H	T	1.45E-11	1.48E-07	5.41E-05	16.8			No
2,3,7,8-Tetrachlorodibenzo-p-dioxins	H	T	6.51E-16	6.66E-12	2.43E-09			0.0002	No
2,4,6-Trichlorophenol	H	--	3.67E-13	3.75E-09	1.37E-06				N/A
2,4-Dinitrophenol	H	--	3.00E-12	3.07E-08	1.12E-05				N/A
4-Nitrophenol	H	--	1.83E-12	1.87E-08	6.84E-06				N/A
Acetaldehyde	H	T	8.07E-07	1.60E-04	5.86E-02	6.8			No
Acetophenone	H	--	5.33E-14	5.45E-10	1.99E-07				N/A
Acrolein	H	T	1.01E-06	7.04E-04	2.57E-01	0.02			No
Ammonia	--	T	1.67E-01	4.01E+00	1.46E+03	0.68			No
Benzene	H	T	1.10E-04	3.35E-03	1.22E+00			8.1	No
Benzo(a)pyrene	H	T	6.27E-08	1.95E-06	7.10E-04			2.2	No
Bis(2-ethylhexyl)phthalate	H	T	7.09E-11	7.25E-07	2.65E-04		0.63		No
Carbon Tetrachloride	H	T	7.50E-10	7.67E-06	2.80E-03			460	No
Chlorobenzene	H	T	5.50E-10	5.62E-06	2.05E-03		46		No
Chloroform	H	T	4.67E-10	4.77E-06	1.74E-03			290	No
Cresol isomers (m,p,o)	H	T	4.58E-11	4.68E-07	1.71E-04	0.56			No
Ethylbenzene	H	--	5.17E-10	5.28E-06	1.93E-03				N/A
Ethylene dichloride	H	T	4.83E-10	4.94E-06	1.80E-03			260	No
Formaldehyde	H	T	3.92E-03	9.47E-02	3.46E+01	0.04			No
Hexane	H	T	9.40E-02	2.26E+00	8.23E+02		23		No
Methanol	H	--	1.47E-03	1.50E+01	5.47E+03				N/A
Methyl bromide	H	--	2.50E-10	2.56E-06	9.33E-04				N/A
Methyl chloride	H	--	3.83E-10	3.92E-06	1.43E-03				N/A
Methylene chloride	H	T	4.83E-09	4.94E-05	1.80E-02	0.39		1600	No
Naphthalene	H	--	3.18E-05	7.81E-04	2.85E-01				N/A
Pentachlorophenol	H	T	3.79E-11	3.87E-07	1.41E-04	0.0064	0.063		No
Phenol	H	T	8.50E-10	8.69E-06	3.17E-03	0.24			No
Polychlorinated biphenyls (PCB)	H	T	1.32E-13	1.35E-09	4.93E-07			5.6	No
Polycyclic organic matter (POM)	H	--	2.11E-09	2.16E-05	7.88E-03				N/A
Propionaldehyde	H	--	1.02E-09	1.04E-05	3.79E-03				N/A
Styrene	H	T	3.17E-08	3.24E-04	1.18E-01	2.7			No
Tetrachlorodibenzo-p-dioxins	--	T	7.83E-15	8.01E-11	2.92E-08			0.0002	No
Tetrachloroethylene	H	T	6.33E-10	6.48E-06	2.36E-03			13000	No
Toluene	H	T	1.78E-04	4.42E-03	1.61E+00		98		No
Trichloroethene	H	T	5.00E-10	5.11E-06	1.87E-03			4000	No
Vinyl chloride	H	T	3.00E-10	3.07E-06	1.12E-03			26	No
Xylenes	H	T	4.17E-10	4.26E-06	1.55E-03		57		No

Appendix B.2 - Biochar Production from Processing of Wood for Unrestricted Operations

Inputs

Activity	Value	Units
Average Kilns Processed	426	kilns/day
Average Kilns Processed	155,490	kilns/year
Annual Operating Days	365	days/yr
Load size	1.00	ton/kiln
Railroad Tie Heating Value	8,000	Btu/ton
Estimated Heat Intput	3.33E-04	MMBtu/hr
Estimated Heat Intput	1,244	MMBtu/yr

Single Kiln Emission Factors - Controlled [1]

Pollutant	Worst-Case Emission Factor	Units
PM	0.23	lb/ton
	0.03	lb/hr
PM_{10}	0.16	lb/ton
	0.02	lb/hr
$PM_{2.5}$	0.12	lb/ton
	0.01	lb/hr
NO_X	3.35	lb/ton
	0.38	lb/hr
VOC	0.45	lb/ton
	0.01	lb/hr
CO	0.67	lb/ton
	0.08	lb/hr

[1] Emission factors are based on the worst-case of performance tests for untreated wood and creosote-treated railroad ties for similar size kilns, and include the safety factors indicated below:

PM emission factor multiplier:	1.25
NOx emission factor mutiplier:	1.25
VOC uncontrolled emission factor mutiplier:	1.25
CO emission factor mutliplier:	1.25
MeOH uncontrolled emission factor multiplier:	1.25

Emissions

Number of Kilns	Unrestricted Hourly Emissions (lb/hr) [1]							
	NO_X	CO	PM	PM_{10}	$PM_{2.5}$	VOC [2] Unc.	VOC [2] Cont.	SO_2 [4]
Per Kiln	0.38	0.08	0.026	0.018	0.013	1.73E-01	8.63E-03	1.96E-08
Average Kilns Processed	159.75	31.95	11.18	7.63	5.50	73.48	3.67	8.33E-06

Number of Kilns	Unrestricted Annual Emissions (tpy) [3]							
	NO_X	CO	PM	PM_{10}	$PM_{2.5}$	VOC [2] Unc.	VOC [2] Cont.	SO_2 [4]
All Kilns	699.71	139.94	48.98	33.43	24.10	321.86	16.09	1.55E-02

[1] Per kiln emissions based on the worst-case value from the two stack test reports.
Average Kilns Processed (lb/hr) = Per Kiln Emissions (lb/hr) * Average Kilns Processed

[2] Controlled emissions based on destruction ratio efficiency (DRE) of 95%

[3] Annual Emissions (tpy) = Emission Rate (lb/hr) * 8,760 (hr/yr) ÷ 2000 lb/ton

Appendix B.2 - Kiln Emission Factor Analysis

Value	2019 Untreated Wood Test [1]				2015 Creosote Treated Rail Tie Test [2]
	Kiln 8	Kiln 21	Kiln 7	Average	Pole 2 NE
Quantity Processed (tons)	0.990	1.000	1.030	1.007	1.007
Run Hours	9.317	9.333	8.333	8.994	8.994
NO_X (lb/hr)	0.223	0.260	0.230	0.238	0.300
NO_X (lb/ton)	2.099	2.427	1.861	2.129	2.680
CO (lb/hr)	0.002	0.012	0.009	0.007	0.060
CO (lb/ton)	0.018	0.109	0.070	0.066	0.536
PM filt. (lb/hr)	0.014	0.018	0.015	0.015	0.005
PM filt. (lb/ton)	0.132	0.166	0.118	0.139	0.045
PM cond. (lb/hr)	0.006	0.005	0.006	0.006	N/A
PM cond. (lb/ton)	0.056	0.046	0.045	0.049	N/A
PM (lb/hr) [3]	0.020	0.023	0.020	0.021	0.011
PM (lb/ton) [3]	0.187	0.212	0.163	0.187	0.094
PM_{10} (lb/hr)	0.014	0.015	0.014	0.014	N/A
PM_{10} (lb/ton)	0.122	0.142	0.114	0.126	N/A
$PM_{2.5}$ (lb/hr)	0.010	0.011	0.010	0.010	N/A
$PM_{2.5}$ (lb/ton)	0.099	0.099	0.083	0.094	N/A
VOC (lb/hr)	0.002	0.002	0.001	0.002	0.007
VOC (lb/ton)	0.414	0.454	0.210	0.359	0.062
MeOH (lb/hr)	1.62E-04	1.46E-04	1.64E-04	1.57E-04	2.00E-04
MeOH (lb/ton)	0.030	0.027	0.027	0.028	0.002

1 All data taken from Source Test Report 2019 Compliance Test for the Biochar Now! Berthoud Facility. Emission factors in lb/ton are calculated as the lb/hr test result multiplied by the run hours and divided by the quantity processed in tons.

2 All data taken from Source Emissions Testing Report 2015 for the Biochar Now! Berthoud Facility, unless otherwise specified. Emission factors in lb/ton are calculated as the lb/hr test result multiplied by the run hours and divided by the quantity processed in tons. Kin is the same size as those tested in the 2019 compliance test. Kiln weight and run time during the test estimated as the average of the three tests conducted in 2019.

3 2015 value is the sum of PM filt from 2015 test and PM cond from 2019 test.

Appendix B.2 -Other Pollutant Kiln Emissions for Unrestricted Operations

Pollutant	Uncontrolled Emission Factor	Emission Factor Source [1]	Uncontrolled Emissions (lb/hr)	Uncontrolled Emissions (lb/day)	Uncontrolled Emissions (lb/yr)	Controlled Emissions[2] (lb/hr)	Controlled Emissions[2] (lb/day)	Controlled Emissions[2] (lb/yr)
SO_2	2.5E-02 lb/MMBtu	f	8.33E-06	8.52E-02	3.11E+01	8.33E-06	8.52E-02	3.11E+01
Metals								
Antimony	7.9E-06 lb/MMBtu	b	2.63E-09	2.69E-05	9.83E-03	2.63E-09	2.69E-05	9.83E-03
Arsenic	2.2E-05 lb/MMBtu	b	7.33E-09	7.50E-05	2.74E-02	7.33E-09	7.50E-05	2.74E-02
Beryllium	1.1E-06 lb/MMBtu	b	3.67E-10	3.75E-06	1.37E-03	3.67E-10	3.75E-06	1.37E-03
Cadmium	4.1E-06 lb/MMBtu	b	1.37E-09	1.40E-05	5.10E-03	1.37E-09	1.40E-05	5.10E-03
Chromium	3.9E-05 lb/MMBtu	c	1.29E-08	1.32E-04	4.83E-02	1.29E-08	1.32E-04	4.83E-02
Chromium VI	3.5E-06 lb/MMBtu	b	1.17E-09	1.19E-05	4.35E-03	1.17E-09	1.19E-05	4.35E-03
Cobalt	6.5E-06 lb/MMBtu	b	2.17E-09	2.22E-05	8.09E-03	2.17E-09	2.22E-05	8.09E-03
Lead	4.8E-05 lb/MMBtu	b	1.60E-08	1.64E-04	5.97E-02	1.60E-08	1.64E-04	5.97E-02
Manganese	1.6E-03 lb/MMBtu	b	5.33E-07	5.45E-03	1.99E+00	5.33E-07	5.45E-03	1.99E+00
Mercury	3.5E-06 lb/MMBtu	b	1.17E-09	1.19E-05	4.35E-03	1.17E-09	1.19E-05	4.35E-03
Nickel	3.3E-05 lb/MMBtu	b	1.10E-08	1.12E-04	4.10E-02	1.10E-08	1.12E-04	4.10E-02
Phosphorus	2.7E-05 lb/MMBtu	b	9.00E-09	9.20E-05	3.36E-02	9.00E-09	9.20E-05	3.36E-02
Selenium	2.8E-06 lb/MMBtu	b	9.33E-10	9.54E-06	3.48E-03	9.33E-10	9.54E-06	3.48E-03
Miscellaneous								
Chlorine	7.9E-04 lb/MMBtu	a	2.63E-07	2.69E-03	9.83E-01	2.63E-07	2.69E-03	9.83E-01
Hydrogen chloride	1.9E-02 lb/MMBtu	a	6.33E-06	6.48E-02	2.36E+01	6.33E-06	6.48E-02	2.36E+01
Organics								
1,1,1-Trichloroethane	3.1E-05 lb/MMBtu	a	1.03E-08	1.06E-04	3.86E-02	5.17E-10	5.28E-06	1.93E-03
1,2-Dichloropropane	3.3E-05 lb/MMBtu	a	1.10E-08	1.12E-04	4.10E-02	5.50E-10	5.62E-06	2.05E-03
1,4-Dichlorobenzene	8.7E-07 lb/MMBtu	c	2.90E-10	2.96E-06	1.08E-03	1.45E-11	1.48E-07	5.41E-05
2,3,7,8-Tetrachlorodibenzo-p-dioxins	3.9E-11 lb/MMBtu	c	1.30E-14	1.33E-10	4.86E-08	6.51E-16	6.66E-12	2.43E-09
2,3,7,8-Tetrachlorodibenzo-p-furans	9.0E-11 lb/MMBtu	a	3.00E-14	3.07E-10	1.12E-07	1.50E-15	1.53E-11	5.60E-09
2,4,6-Trichlorophenol	2.2E-08 lb/MMBtu	a	7.33E-12	7.50E-08	2.74E-05	3.67E-13	3.75E-09	1.37E-06
2,4-Dinitrophenol	1.8E-07 lb/MMBtu	a	6.00E-11	6.13E-07	2.24E-04	3.00E-12	3.07E-08	1.12E-05
2-Chloronaphthalene	2.4E-09 lb/MMBtu	a	8.00E-13	8.18E-09	2.99E-06	4.00E-14	4.09E-10	1.49E-07
2-Methylnaphthalene	1.6E-07 lb/MMBtu	a	5.33E-11	5.45E-07	1.99E-04	2.67E-12	2.73E-08	9.95E-06
4-Nitrophenol	1.1E-07 lb/MMBtu	a	3.67E-11	3.75E-07	1.37E-04	1.83E-12	1.87E-08	6.84E-06
Acenaphthene	9.1E-07 lb/MMBtu	a	3.03E-10	3.10E-06	1.13E-03	1.52E-11	1.55E-07	5.66E-05
Acenaphthylene	5.0E-06 lb/MMBtu	a	1.67E-09	1.70E-05	6.22E-03	8.33E-11	8.52E-07	3.11E-04
Acetaldehyde	8.3E-04 lb/MMBtu	a	2.77E-07	2.83E-03	1.03E+00	1.38E-08	1.41E-04	5.16E-02
Acetophenone	3.2E-09 lb/MMBtu	a	1.07E-12	1.09E-08	3.98E-06	5.33E-14	5.45E-10	1.99E-07
Acrolein	4.0E-03 lb/MMBtu	a	1.33E-06	1.36E-02	4.98E+00	6.67E-08	6.82E-04	2.49E-01
Anthracene	3.0E-06 lb/MMBtu	a	1.00E-09	1.02E-05	3.73E-03	5.00E-11	5.11E-07	1.87E-04
Benzene	4.2E-03 lb/MMBtu	a	1.40E-06	1.43E-02	5.22E+00	7.00E-08	7.16E-04	2.61E-01
Benzo(a)anthracene	6.5E-08 lb/MMBtu	a	2.17E-11	2.22E-07	8.09E-05	1.08E-12	1.11E-08	4.04E-06
Benzo(a)pyrene	2.6E-06 lb/MMBtu	a	8.67E-10	8.86E-06	3.23E-03	4.33E-11	4.43E-07	1.62E-04
Benzo(b)fluoranthene	1.0E-07 lb/MMBtu	a	3.33E-11	3.41E-07	1.24E-04	1.67E-12	1.70E-08	6.22E-06
Benzo(e)pyrene	2.6E-09 lb/MMBtu	a	8.67E-13	8.86E-09	3.23E-06	4.33E-14	4.43E-10	1.62E-07
Benzo(g,h,i)perylene	9.3E-08 lb/MMBtu	a	3.10E-11	3.17E-07	1.16E-04	1.55E-12	1.58E-08	5.78E-06
Benzo(j,k)fluoranthene	1.6E-07 lb/MMBtu	a	5.33E-11	5.45E-07	1.99E-04	2.67E-12	2.73E-08	9.95E-06
Benzo(k)fluoranthene	3.6E-08 lb/MMBtu	a	1.20E-11	1.23E-07	4.48E-05	6.00E-13	6.13E-09	2.24E-06
Bis(2-ethylhexyl)phthalate	4.3E-06 lb/MMBtu	c	1.42E-09	1.45E-05	5.29E-03	7.09E-11	7.25E-07	2.65E-04
Carbazole	1.8E-06 lb/MMBtu	a	6.00E-10	6.13E-06	2.24E-03	3.00E-11	3.07E-07	1.12E-04
Carbon Tetrachloride	4.5E-05 lb/MMBtu	a	1.50E-08	1.53E-04	5.60E-02	7.50E-10	7.67E-06	2.80E-03
Chlorobenzene	3.3E-05 lb/MMBtu	a	1.10E-08	1.12E-04	4.10E-02	5.50E-10	5.62E-06	2.05E-03
Chloroform	2.8E-05 lb/MMBtu	a	9.33E-09	9.54E-05	3.48E-02	4.67E-10	4.77E-06	1.74E-03
Chrysene	3.8E-08 lb/MMBtu	a	1.27E-11	1.30E-07	4.73E-05	6.33E-13	6.48E-09	2.36E-06
Cresol isomers (m,p,o)	2.7E-06 lb/MMBtu	c	9.16E-10	9.37E-06	3.42E-03	4.58E-11	4.68E-07	1.71E-04
Decachlorobiphenyl	2.7E-10 lb/MMBtu	a	9.00E-14	9.20E-10	3.36E-07	4.50E-15	4.60E-11	1.68E-08
Dibenzo(a,h)anthracene	9.1E-09 lb/MMBtu	a	3.03E-12	3.10E-08	1.13E-05	1.52E-13	1.55E-09	5.66E-07
Dichlorobiphenyl	7.4E-10 lb/MMBtu	a	2.47E-13	2.52E-09	9.21E-07	1.23E-14	1.26E-10	4.60E-08
Dioxins/furans	1.7E-06 lb/MMBtu	e	5.57E-10	5.70E-06	2.08E-03	2.79E-11	2.85E-07	1.04E-04
Ethylbenzene	3.1E-05 lb/MMBtu	a	1.03E-08	1.06E-04	3.86E-02	5.17E-10	5.28E-06	1.93E-03
Ethylene dichloride	2.9E-05 lb/MMBtu	a	9.67E-09	9.88E-05	3.61E-02	4.83E-10	4.94E-06	1.80E-03
Fluoranthene	1.6E-06 lb/MMBtu	a	5.33E-10	5.45E-06	1.99E-03	2.67E-11	2.73E-07	9.95E-05
Fluorene	3.4E-06 lb/MMBtu	a	1.13E-09	1.16E-05	4.23E-03	5.67E-11	5.79E-07	2.11E-04
Formaldehyde	4.4E-03 lb/MMBtu	a	1.47E-06	1.50E-02	5.47E+00	7.33E-08	7.50E-04	2.74E-01
Heptachlorobiphenyl	6.6E-11 lb/MMBtu	a	2.20E-14	2.25E-10	8.21E-08	1.10E-15	1.12E-11	4.10E-09
Heptachlorodibenzo-p-dioxins	2.0E-09 lb/MMBtu	a	6.67E-13	6.82E-09	2.49E-06	3.33E-14	3.41E-10	1.24E-07
Heptachlorodibenzo-p-furans	2.4E-10 lb/MMBtu	a	8.00E-14	8.18E-10	2.99E-07	4.00E-15	4.09E-11	1.49E-08
Hexachlorobiphenyl	5.5E-10 lb/MMBtu	a	1.83E-13	1.87E-09	6.84E-07	9.17E-15	9.37E-11	3.42E-08
Hexachlorodibenzo-p-dioxins	1.6E-06 lb/MMBtu	a	5.33E-10	5.45E-06	1.99E-03	2.67E-11	2.73E-07	9.95E-05
Hexachlorodibenzo-p-furans	2.8E-10 lb/MMBtu	a	9.33E-14	9.54E-10	3.48E-07	4.67E-15	4.77E-11	1.74E-08
Indeno(1,2,3-cd)pyrene	8.7E-08 lb/MMBtu	a	2.90E-11	2.96E-07	1.08E-04	1.45E-12	1.48E-08	5.41E-06
Methanol	87.92 lb/MMBtu	d	0.03	3.00E+02	109361.30	1.47E-03	1.50E+01	5.47E+03
Methyl bromide	1.5E-05 lb/MMBtu	a	5.00E-09	5.11E-05	1.87E-02	2.50E-10	2.56E-06	9.33E-04
Methyl chloride	2.3E-05 lb/MMBtu	a	7.67E-09	7.84E-05	2.86E-02	3.83E-10	3.92E-06	1.43E-03
Methylene chloride	2.9E-04 lb/MMBtu	a	9.67E-08	9.88E-04	3.61E-01	4.83E-09	4.94E-05	1.80E-02
Naphthalene	9.7E-05 lb/MMBtu	a	3.23E-08	3.31E-04	1.21E-01	1.62E-09	1.65E-05	6.03E-03
Octachlorodibenzo-p-dioxins	6.6E-08 lb/MMBtu	a	2.20E-11	2.25E-07	8.21E-05	1.10E-12	1.12E-08	4.10E-06
Octachlorodibenzo-p-furans	8.8E-11 lb/MMBtu	a	2.93E-14	3.00E-10	1.09E-07	1.47E-15	1.50E-11	5.47E-09
Pentachlorobiphenyl	1.2E-09 lb/MMBtu	a	4.00E-13	4.09E-09	1.49E-06	2.00E-14	2.04E-10	7.46E-08
Pentachlorodibenzo-p-dioxins	1.5E-09 lb/MMBtu	a	5.00E-13	5.11E-09	1.87E-06	2.50E-14	2.56E-10	9.33E-08
Pentachlorodibenzo-p-furans	4.2E-10 lb/MMBtu	a	1.40E-13	1.43E-09	5.22E-07	7.00E-15	7.16E-11	2.61E-08
Pentachlorophenol	2.3E-06 lb/MMBtu	c	7.57E-10	7.74E-06	2.83E-03	3.79E-11	3.87E-07	1.41E-04

Appendix B.2 -Other Pollutant Kiln Emissions for Unrestricted Operations

Pollutant	Uncontrolled Emission Factor	Emission Factor Source [1]	Uncontrolled Emissions (lb/hr)	(lb/day)	(lb/yr)	Controlled Emissions[2] (lb/hr)	(lb/day)	(lb/yr)
Perylene	5.2E-10 lb/MMBtu	a	1.73E-13	1.77E-09	6.47E-07	8.67E-15	8.86E-11	3.23E-08
Phenanthrene	7.0E-06 lb/MMBtu	a	2.33E-09	2.39E-05	8.71E-03	1.17E-10	1.19E-06	4.35E-04
Phenol	5.1E-05 lb/MMBtu	a	1.70E-08	1.74E-04	6.34E-02	8.50E-10	8.69E-06	3.17E-03
Polychlorinated biphenyls (PCB)	7.9E-09 lb/MMBtu	e	2.64E-12	2.70E-08	9.86E-06	1.32E-13	1.35E-09	4.93E-07
Polycyclic organic matter (POM)	1.3E-04 lb/MMBtu	e	4.23E-08	4.32E-04	1.58E-01	2.11E-09	2.16E-05	7.88E-03
Propionaldehyde	6.1E-05 lb/MMBtu	a	2.03E-08	2.08E-04	7.59E-02	1.02E-09	1.04E-05	3.79E-03
Pyrene	3.7E-06 lb/MMBtu	a	1.23E-09	1.26E-05	4.60E-03	6.17E-11	6.30E-07	2.30E-04
Styrene	1.9E-03 lb/MMBtu	a	6.33E-07	6.48E-03	2.36E+00	3.17E-08	3.24E-04	1.18E-01
Tetrachlorobiphenyl	2.5E-09 lb/MMBtu	a	8.33E-13	8.52E-09	3.11E-06	4.17E-14	4.26E-10	1.55E-07
Tetrachlorodibenzo-p-dioxins	4.7E-10 lb/MMBtu	a	1.57E-13	1.60E-09	5.85E-07	7.83E-15	8.01E-11	2.92E-08
Tetrachlorodibenzo-p-furans	7.5E-10 lb/MMBtu	a	2.50E-13	2.56E-09	9.33E-07	1.25E-14	1.28E-10	4.66E-08
Tetrachloroethylene	3.8E-05 lb/MMBtu	a	1.27E-08	1.30E-04	4.73E-02	6.33E-10	6.48E-06	2.36E-03
Toluene	9.2E-04 lb/MMBtu	a	3.07E-07	3.14E-03	1.14E+00	1.53E-08	1.57E-04	5.72E-02
Trichlorobiphenyl	2.6E-09 lb/MMBtu	a	8.67E-13	8.86E-09	3.23E-06	4.33E-14	4.43E-10	1.62E-07
Trichloroethene	3.0E-05 lb/MMBtu	a	1.00E-08	1.02E-04	3.73E-02	5.00E-10	5.11E-06	1.87E-03
Vinyl chloride	1.8E-05 lb/MMBtu	a	6.00E-09	6.13E-05	2.24E-02	3.00E-10	3.07E-06	1.12E-03
Xylenes	2.5E-05 lb/MMBtu	a	8.33E-09	8.52E-05	3.11E-02	4.17E-10	4.26E-06	1.55E-03
Total HAP			0.03	299.75	109,410	1.47E-03	15.06	5,496

[1] Emission Factor Data Sources as indicated below. Note that Craven County Wood Energy test results for creosote-treated wood combustion were used if the test results exceeded the emission factor in AP-42, or if there was no emission factor in AP-42. Test results obtained from application submitted by Coastal Carolina Clean Power, LLC to North Carolina Division of Air Quality, PSD Air Quality Construction and Operating Permit Application. Oct 2013.

a AP-42, 5th Edition, Section 1.6, Table 1.6-3 (09/03)
b AP-42, 5th Edition, Section 1.6, Table 1.6-4 (09/03)
c Craven County Wood Energy Test Data
d Based on stack testing completed at similar Biochar Now facility in Berthound, Colorado conducted on October 2019. Includes a 25% safety factor.
e Sum of emissions of individual compounds in pollutant category (dioxins/furans, PCBs, POM)
f AP-42, 5th Edition, Section 1.6, Table 1.6-2 (09/03)

[2] Controlled emissions based on destruction ratio efficiency (DRE) of 95% for organic compounds

Appendix B.2 -Kiln Initiation and Afterburner Emissions for Unrestricted Operations

Inputs

Parameter	Value	Units
Burner Heat Input	0.125	MMBtu/hr
Number of Burners Operating	426	burners
Daily Hours	24	hrs/day
Operating Schedule	365	days/yr
Natural Gas HHV	1020	Btu/scf
Estimated Hourly Fuel Usage	53.25	MMBtu/hr
Estimated Annual Fuel Usage	466,470.0	MMBtu/yr

Emissions

	Emission Factor [1]	Total Emissions			
Pollutants	**(lb/MMscf)**	**(lb/hr)**	**(lb/day)**	**(lb/yr)**	**(tpy)**
Criteria Pollutants					
SO_2	0.6	3.13E-02	7.52E-01	2.74E+02	1.37E-01
Hazardous/Toxic Air Pollutants					
Acetaldehyde	1.52E-05	7.94E-07	1.90E-05	6.95E-03	3.48E-06
Acrolein	1.80E-05	9.40E-07	2.26E-05	8.23E-03	4.12E-06
Ammonia	3.20E+00	1.67E-01	4.01E+00	1.46E+03	7.32E-01
Benzene	2.10E-03	1.10E-04	2.63E-03	9.60E-01	4.80E-04
Benzo(a)pyrene	1.20E-06	6.26E-08	1.50E-06	5.49E-04	2.74E-07
Cobalt	8.40E-05	4.39E-06	1.05E-04	3.84E-02	1.92E-05
Formaldehyde	7.50E-02	3.92E-03	9.40E-02	3.43E+01	1.71E-02
Hexane	1.80E+00	9.40E-02	2.26E+00	8.23E+02	4.12E-01
Lead	5.00E-04	2.61E-05	6.26E-04	2.29E-01	1.14E-04
Naphthalene	6.10E-04	3.18E-05	7.64E-04	2.79E-01	1.39E-04
Selenium	2.40E-05	1.25E-06	3.01E-05	1.10E-02	5.49E-06
Toluene	3.40E-03	1.78E-04	4.26E-03	1.55E+00	7.77E-04
Total HAP		**0.10**	**2.36**	**860.57**	**0.43**

[1] Emission factors from DEQ natural gas combustion calculation spreadsheet, Rev. N (January 5, 2017). Afterburner and kiln criteria pollutant emissions were included in the kiln source test results.

Appendix B.2 - Tie Chomper and Kiln Loading Emissions for Unrestricted Operations

Inputs

Description	Value	Units
Kilns Processed	426	kilns/day
Daily Operating Hours	24	hrs/day
Annual Operating Days	365	days/yr
Wood Throughput	1.00	tons/kiln
	17.75	tons/hr

Emissions

	Emission Factor (lb/ton) [1,2]			Enclosure Capture Efficiency [3]	Hourly Emissions (lb/hr) [4]			Annual Emissions (tpy) [5]		
Activity	PM	PM_{10}	$PM_{2.5}$		PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Tie Chomper	0.03500	0.01750	0.00875	90%	0.06	0.03	0.02	0.27	0.14	0.07
Kiln Loading	0.0015	0.0007	0.0001	0%	0.03	0.01	1.78E-03	0.12	0.05	0.01
				Total:	**0.09**	**0.04**	**0.02**	**0.39**	**0.19**	**0.08**

[1] Emission factor for log bucking (i.e., sizing logs down). The chomper reduces railroad ties to 3 inch "chunks" of wood and is more akin to log bucking than to log sawing. The emission factor is obtained from the table in the memorandum "Particulate Matter Potential to Emit Emission Factors from Activities at Sawmills, Excluding Boilers, Located in Pacific Northwest Indian Country", May 8, 2014, Dan Meyer, US EPA Region 10.

[2] Emission factor for a "drop" of "bone-dry" material into a kiln. Emission factor from the aforementioned source.

[3] Chomper will be enclosed within a conex (shipping container). Represented capture efficiency accounts for emissions occurring in an enclosed building.

[4] Hourly emissions (lb/hr) = Emission factor (lb/ton) * Log Processing Throughput (tons/hr) * (1 - Capture Efficiency)

[5] Annual emissions (tpy) = Hourly Emissions (lb/hr) * Daily Operating Hours (hrs/day) * Annual Operating Days (days/yr) / 2,000 (lb/ton)

Appendix B.2 -EX-2 Product Handling and Packaging Emissions for Unrestricted Operations

Inputs

Parameter	Value	Units
Product Throughput[1]	500	lb biochar/kiln
Percent Unconverted Wood	10%	percent
Daily Operating Hours	9	hrs/day
Daily Kilns Processed	426	kilns/day
Annual Operating Days	365	days/yr

Controlled Operation Emissions

Activity	Emission Factor (lb/ton biochar)[2]			Material Throughput[4]		Capture Efficiency[3]	Dust Collector Control Efficiency	Uncontrolled Hourly Emissions (lb/hr)[5]			Uncontrolled Annual Emissions (tpy)[5]			Controlled Hourly Emissions (lb/hr)[5]			Controlled Annual Emissions (tpy)[5]		
	PM	PM_{10}	$PM_{2.5}$	(tons/hr)	(tons/yr)			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Process 1: Kiln Dump to Hopper onto Conveyor[6]	0.0079	0.0037	0.0006	11.84	38,873	90%	99%	0.09	0.04	0.01	0.15	0.07	0.01	0.01	4.84E-03	7.32E-04	1.68E-02	7.94E-03	1.20E-03
Process 2a: Sizing Chomper	0.039	0.015	0.015	11.84	38,873	90%	99%	0.46	0.18	0.18	0.76	0.29	0.29	0.05	0.02	0.02	8.26E-02	3.18E-02	3.18E-02
Process 4: Sizing Hammermil	0.039	0.015	0.015	11.84	38,873	90%	99%	0.46	0.18	0.18	0.76	0.29	0.29	0.05	0.02	0.02	8.26E-02	3.18E-02	3.18E-02
Process 5a: Screener 1	0.025	0.0087	0.0087	11.84	38,873	90%	99%	0.30	0.10	0.10	0.49	0.17	0.17	0.03	0.01	0.01	5.30E-02	1.84E-02	1.84E-02
Process 5b: Small Char Long Conveyor	0.0079	0.0037	0.0006	11.84	38,873	90%	99%	0.09	0.04	0.01	0.15	0.07	0.01	0.01	4.84E-03	7.32E-04	1.68E-02	7.94E-03	1.20E-03
Process 5c: Three Destoners	0.025	0.0087	0.0087	11.84	38,873	90%	99%	0.30	0.10	0.10	0.49	0.17	0.17	0.03	0.01	0.01	5.30E-02	1.84E-02	1.84E-02
Process 6: Rollermill	0.039	0.015	0.015	11.84	38,873	90%	99%	0.46	0.18	0.18	0.76	0.29	0.29	0.05	0.02	0.02	8.26E-02	3.18E-02	3.18E-02
Process 7b: Screener 2	0.025	0.0087	0.0087	11.84	38,873	90%	99%	0.30	0.10	0.10	0.49	0.17	0.17	0.03	0.01	0.01	5.30E-02	1.84E-02	1.84E-02
Process 7c: Bagging Drop[6]	0.0079	0.0037	0.0006	11.84	38,873	90%	99%	0.09	0.04	0.01	0.15	0.07	0.01	0.01	4.84E-03	7.32E-04	1.68E-02	7.94E-03	1.20E-03

Uncontrolled Operation Emissions

Activity	Emission Factor (lb/ton biochar)[2]			Material Throughput[4]		Building Enclosure Efficiency[7]	Dust Collector Control Efficiency	Uncontrolled Hourly Emissions (lb/hr)[5]			Uncontrolled Annual Emissions (tpy)[5]			Controlled Hourly Emissions (lb/hr)[5]			Controlled Annual Emissions (tpy)[5]		
	PM	PM_{10}	$PM_{2.5}$	(tons/hr)	(tons/yr)			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Process 2b: Unconverted Wood Drop to Outdoor Bin[6]	0.0079	0.0037	0.0006	1.18	3,887	0%		0.01	4.44E-03	6.72E-04	0.02	7.28E-03	1.10E-03	0.01	4.44E-03	6.72E-04	0.02	0.01	1.10E-03
Process 3: Detwigging	0.025	0.0087	0.0087	11.84	38,873	90%		0.03	0.01	0.01	0.05	0.02	0.02	0.03	0.01	0.01	0.05	0.02	0.02
Process 7a: Drop to Bucket Elevator[6]	0.0079	0.0037	0.0006	11.84	38,873	90%		0.01	4.44E-03	6.72E-04	0.02	7.28E-03	1.10E-03	0.01	4.44E-03	6.72E-04	0.02	0.01	1.10E-03
Process 7d: Storage Silos[6]	0.0079	0.0037	0.0006	11.84	38,873	0%		0.19	0.09	0.01	0.31	0.15	2.21E-02	0.19	0.09	0.01	0.31	0.15	0.02
						Total		2.79	1.08	0.89	4.58	1.78	1.46	0.51	0.21	0.12	0.84	0.35	0.20

1 Includes a margin of safety multiplier for product shipped daily as shown in the Facility Inputs tab.

2 Emission factors are from AP-42 Section 11.19.2, Table 11.19.2-2, unless otherwise noted.

3 Capture efficiency accounts for activities occurring under a hood, or within an enclosure where doors could potentially be open.

4 Material Throughput (ton/hr) = Product Throughput (lb biochar/kiln) / 2,000 (lb/ton) * Daily Kilns Cooked (kilns/day) / Daily Operating Hours (hrs/day)
Material Throughput (ton/yr) = Product Throughput (lb biochar/kiln) / 2,000 (lb/ton) * Daily Kilns Cooked (kilns/day) * Operating Days (days/yr)

5 Uncontrolled hourly emissions (lb/hr) = Emission Factor (lb/ton) * Throughput (tons/hr) * (1-Building Enclosure Efficiency%), where building enclosure efficiency is applicable
Controlled hourly emissions for controlled sources (lb/hr) = Emission Factor (lb/ton) * Throughput (tons/hr) * ((1-Capture Efficiency %) + (Capture Efficiency % * (1-Dust Collector Control Efficiency %)))
Uncontrolled annual emissions (tpy) = Emission Factor (lb/ton) * Throughput (tpy) * (1-Building Enclosure Efficiency %)/2000 lb/ton, where building enclosure efficiency is applicable.
Controlled annual emissions for controlled sources (tpy) = Emission factor (lb/ton) * Throughput (tpy) * ((1-Capture Efficiency %) + (Capture Efficiency % * (1-Dust Collector Control Efficiency %))) / 2000 lb/ton

6 Material is transferred to using conveyors. Material drop point emissions are based on AP-42 Section 13.2.4 - Aggregate Handling and Storage Piles, Equation 1. Silo emissions assume two drop points.

$$E\left(\frac{lb}{ton}\right) = k\,(0.0032)\left[\frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right]$$

Where k = Particle size multiplier 0.74 PM < 30 microns
0.35 PM < 10 microns
0.053 PM < 2.5 microns

U = Mean wind speed 6 mph
http://myforecast.co/bin/climate.m?city=24989&zip_code=28345&metric=false&selectedMonthNum=2

M = Moisture content 1 % for charcoal fresh from kiln
http://www.fao.org/3/x5328e/x5328e0b.htm#:~:text=Charcoal%20fresh%20from%20an%20opened,even%20in%20well%2Dburned%20charcoal.

7 Building enclosure efficiency of 90% accounts for activities conducted within an enclosed building based on the TCEQ emission calculation workbook for rock crushing plants (https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/emiss-calc-rock1.xlsx)

Appendix B.2 -EX-3 Fugitive Road Dust for Unrestricted Operations

Unpaved Road Dust Emission Factors

Category	silt (s)[1] (%)	Unloaded Weight[2] (lb)	Loaded Weight[3] (lb)	Average Weight[4] (W) (tons)	Uncontrolled[5] (%)	Control[5] (%)	Uncontrolled Emission Factor (lb/VMT)[6] PM	PM_{10}	$PM_{2.5}$	Controlled Emission Factor (lb/VMT)[6] PM	PM_{10}	$PM_{2.5}$
Log/rail tie delivery	8.4	40,000	80,000	30.0	72%	95%	3.01	0.86	0.09	0.56	0.16	0.02
Rail tie pile and chomper	8.4	36,226	38,226	18.6	72%	95%	2.43	0.69	0.07	0.46	0.13	0.01
Kiln lids and stacks	8.4	10,849	11,849	5.7	72%	95%	1.42	0.41	0.04	0.27	0.08	0.01
Kilns transport	8.4	26,083	31,083	14.3	72%	95%	2.16	0.62	0.06	0.40	0.12	0.01
Product shipping	8.4	32,000	15,000	11.8	72%	95%	1.98	0.56	0.06	0.37	0.11	0.01

[1] Silt content of road surface material (s) obtained from EPA AP-42, Section 13.2.2, Table 13.2.2-1 for Lumber sawmills/log yards.

[2] Unloaded weights: kiln wheel loader obtained from spec sheet for a Case-621 loader; log piles, Case CX160 excavator; and lids, Case 121E.

Log delivery unloaded weight of trucks based on typical log truck. http://www.forestry.uga.edu/research/forestry/forestbusiness/log-truck-weight-policy.php

Product delivery vehicles are semi-trailer trucks (tractor and cargo trailer). Typical empty weights from http://www.ask.com/vehicles/much-empty-semi-trailer-weigh-735e3574c4658c6d

[3] Loaded weight estimated as the sum of the unloaded weight and the capacity or working load of each loader or truck, respectively.

[4] Weight (tons) calculated as the average of the unloaded and loaded weights for each type of vehicle.

[5] Control efficiency for unpaved roads obtained from CDPHE Guidance, Control Efficiencies, Appendix B as a total of Gravel (50%), Water as needed (25%), and Surface Chemical Treatment (75%), as well as a control efficiency for a speed limit of 25 mph (44%) from the WRAP Fugitive Dust Handbook.
Uncontrolled reduction efficiency reflects gravel roads and speed limit only.

[6] Emission factor in lb/VMT calculated per EPA AP-42, Section 13.2.2, Equation 1a as follows:

$$E = k\,(s/12)^a\,(W/3)^b$$

k: Particle Size Multiplier (lb/VMT)
W: Mean vehicle weight (tons)
s: Silt content of road surface material (%)

	PM	PM_{10}	$PM_{2.5}$
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

Emission Calculation for Unpaved Roads

	Round Trip Distance (miles)	Number of Trucks[1] Per Hour	Per Year	Vehicle Miles Traveled[2] (VMT) Hourly	Annual VMT	Uncontrolled Hourly Emissions[3] (lb/hr) PM	PM_{10}	$PM_{2.5}$	Uncontrolled Annual Emissions[4] (tpy) PM	PM_{10}	$PM_{2.5}$	Controlled Hourly Emissions[3] (lb/hr) PM	PM_{10}	$PM_{2.5}$	Controlled Annual Emissions[4] (tpy) PM	PM_{10}	$PM_{2.5}$
Log/rail tie delivery [5]	0.60	0.92	8,030	0.55	4,818	1.66	0.47	0.05	7.26	2.07	0.21	0.31	0.09	0.01	1.36	0.39	0.04
Log/rail tie pile and shredder [6]	0.20	0.07	365	0.01	73	0.03	0.01	9.24E-04	0.09	0.03	2.53E-03	0.01	1.73E-03	1.73E-04	0.02	4.74E-03	4.74E-04
Kiln lids and stacks [7]	0.05	28	155,490	1.42	7,775	2.02	0.58	0.06	5.54	1.58	0.16	0.38	0.11	0.01	1.04	0.30	0.03
Kiln transport [5]	0.20	18	155,490	3.55	31,098	7.66	2.18	0.22	33.55	9.56	0.96	1.44	0.41	0.04	6.29	1.79	0.18
Product shipping [5]	0.60	0.63	5,475	0.38	3,285	0.74	0.21	0.02	3.25	0.93	0.09	0.14	0.04	3.96E-03	0.61	0.17	0.02
Totals:						**11.37**	**3.24**	**0.32**	**46.43**	**13.24**	**1.32**	**2.13**	**0.61**	**0.06**	**8.71**	**2.48**	**0.25**

1 Number of trucks calculated as Loads per Day/Hours per Day:

Description	Load size (lb)	Loads per day	Hours per day
Log delivery	40,000	22	24
Log pile & shredder	N/A	1	15
Kiln stacks and lids	1,000	426	15
Kilns to sizing/packaging & shredder	5000	426	24
Product shipping	15,000	15	24

2 Vehicle miles traveled calculated as the Number of Trucks x Round trip distance per truck.

3 Hourly emissions (lb/hr) = Emission factor for unpaved or paved (lb/VMT) x Hourly VMT.

4 Annual emissions (tpy) = Emission factor for unpaved or paved (lb/VMT) x Annual VMT.

5 Routes distance based on distances for existing facility with similar layout to the proposed facility.

6 The log/rail tie pile and shredder vehicle will travel an estimated 1000 feet per working day. Most motion will be axial swivels and relatively little lateral movement will take place.

7 The kiln lid/stack units will operate in the vicinity of a kiln bank.

MONTROSE
AIR QUALITY SERVICES

SOURCE TEST REPORT
2019 COMPLIANCE TEST
BIOCHAR NOW!
BERTHOUD FACILITY
THREE BIOCHAR KILNS
BERTHOUD, COLORADO

Prepared For:

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For Submittal To:

Colorado Department of Public Health and Environment
Air Pollution Control Division
4300 Cherry Creek South Drive
Denver, CO 80246

Prepared By:

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Denver, CO 80238

Document Number: **C-043AS-552991-RT-188**
Test Dates: **October 8th through 14th, 2019**

STAC

MONTROSE
AIR QUALITY SERVICES

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: ______________ Date: November 7, 2019

Name: Jeff Goldfine Title: Field Project Manager

I have reviewed, technically and editorially, details calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: ______________ Date: November 7, 2019

Name: Jeff Holtz Title: Client Project Manager

FACILITY CERTIFICATION

I have reviewed this document and agree that the information contained herein is true, accurate, and complete, to the best of my knowledge.

Signature: ______________ Date: ______________

Name: Jim Geist Title: Owner

TABLE OF CONTENTS

1.0 OBJECTIVES AND SUMMARY OF TEST PROGRAM

1.1 PROGRAM OBJECTIVES

Montrose Air Quality Services, LLC (Montrose) was contracted by Biochar Now, LLC to perform a series of air emission tests at the biochar kiln facility located in Berthoud, Colorado. The purpose of the test program was to determine the compliance of three (3) biochar kilns with emissions limits as required by the facility's State of Colorado Construction Permit # 15WE1395 Issuance: 4.

The purpose of the test program was to determine the concentrations and mass emission rates of particulate matter (PM), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), carbon monoxide (CO), nitrogen oxides (NO_X), volatile organic compounds (VOC) and methanol (MeOH) from the exhaust stack of three (3) kilns during the processing step. The emissions of non-methane organic compounds (NMOC) were reported for VOC emission rates.

Prior to the commencement of tests, three kilns were loaded with clean wood. The wood mass loaded into each kiln was recorded in order to calculate emission factors with units of "lb pollutant/ton raw wood". The three kilns were transported to available locations on the firing line and each were fitted with a stack. Connections were made from the kiln/stack to the process control system and to utilities. The kilns are then ready for the stack emission testing.

The kilns are identical in mechanical and electric design, as are the stacks. While kilns and stacks include identifying marks, these are for maintenance purposes only. The placement of a kiln on the firing line is based on availability of space. Thus kilns, stack, and firing line location are interchangeable factors that have no effect on the emissions during processing. For purposes of the differentiating the emission tests, the kiln/stack combinations were indicated as Kiln #7, Kiln #8, Kiln #21, and Kiln #40*.

Performance test runs of 120-minutes each were conducted to determine the emissions concentrations of particulate matter (filterable and condensable), CO, NO_X, and VOC. The first performance test started upon the initiation of the processing. Concurrent stack gas velocity, oxygen (O_2), carbon dioxide (CO_2) and moisture (H_2O) content were measured to determine mass emission rates.

Methanol emissions testing followed the 120-minute test run method described above. Concurrent stack gas velocity, oxygen (O_2), carbon dioxide (CO_2) and moisture (H_2O) content were measured to determine mass emission rates.

*The testing on Kiln #40 was stopped on October 8, 2019. The particulate data and the gas data are displayed in the appendix at the request of CDPHE. The methanol testing was not completed.

The PM_{10} and $PM_{2.5}$ emissions were calculated based on the emission factors presented in the permit. A PM_{10} emission factor of 58% of total filterable PM, and $PM_{2.5}$ emission factor of 32% of total filterable PM were used to calculate filterable PM_{10} and $PM_{2.5}$ emissions. Condensable particulate matter (CPM) were included in PM_{10} and $PM_{2.5}$ total emissions (filterable plus condensable).

The opacity of visible emissions (VE) were measured from each kiln on an hourly basis for the duration of the processing cycle (~ 8 to 15-hours). Each hourly Method 9 observation period was six minutes in duration.†

† Opacity observations are displayed in the appendix.

TABLE 1-1

KILN TEST RESULTS

EMISSION FACTORS USED TO DETERMINE COMPLIANCE WITH CONDITION 2, 15WE1395, ISSUANCE 4

Pollutant	Units	Kiln #8	Kiln #21	Kiln #7	Average Emission Factor	Notes to Permit Holder, #4 Table Point 001: Kilns
PM	lb / ton raw wood	0.187	0.212	0.163	0.19	0.19
PM_{10}		0.122	0.142	0.114	0.13	0.18
$PM_{2.5}$		0.0987	0.099	0.083	0.09	0.18
NO_x	lb / hr	0.223	0.260	0.230	0.24	0.14
CO	lb / hr	0.00186	0.01170	0.00866	0.01	0.12
VOC*	lb / ton raw wood	0.414	0.454	0.21	0.36	9.3
Methanol*		0.0304	0.0274	0.0266	0.03	4

**The uncontrolled value shown assumes 95% control.*

1.3 PROJECT CONTACTS

A list of project participants is included below:

Facility Information

Source Location:	Biochar Now, LLC Berthoud Plant 19500 Weld County Road 7 Berthoud, Colorado
Project Contact:	Jim Geist
Role:	COO
Telephone:	970-218-3364
Email:	jim.geist@biocharnow.com

Agency Information

Regulatory Agency:	Colorado Department of Public Health and Environment Air Pollution Control Division
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Testing Company Information

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Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D-7036 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose completed multiple functional assessments for ASTM D7036-04 which were conducted by the American Association for Laboratory Accreditation (A2LA). All testing is overseen and supervised on site by at least one Qualified Individual (QI), as defined in 40 CFR 72.2. Our project managers are either certified as a qualified source testing individual (QSTI) through the program instituted by the Source Evaluation Society (SES), or as a QI by successfully completing the SES QSTI exams or through internal examination.

2.0 SOURCE DESCRIPTION

2.1 FACILITY AND SOURCE DESCRIPTION

Kilns were loaded with approximately 2200 - 2700 pounds of clean wood. The loaded kilns were transported to the firing line where a stack is attached to each kiln prior to processing.

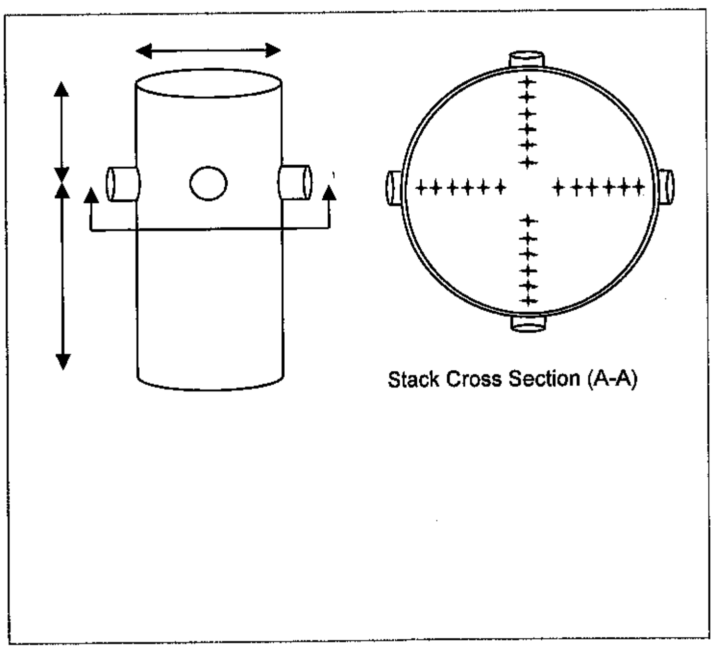
Processing removes volatile components from the clean wood through pyrolysis to create biochar. The process goals in the production of the biochar are kiln and stack temperature. In turn, these parameters are modulated by an automated process control system to ensure controlled volatilization and optimal biochar yield.

Processing progresses through a period of gasification. Processing ends when the kiln is sealed; its air supply having been capped off. The typical processing duration is 8 – 10 hours after which the stack is removed and a sealed lid is fitted to the kiln for a cool down period with a duration of 9 – 18 hours.

Pollutants that potentially impact air quality are emitted only during the processing step. There are no pollutant emissions during the sealed, cool-down step.

2.2 SAMPLING LOCATIONS AND ACCESS

The sampling locations consisted of vertical, circular stacks with four orthogonal sampling ports located at least two diameters downstream and one-half diameter upstream of the nearest flow disturbances. Particulate matter testing was conducted across a grid of 24 points determined using EPA Method 1. See the schematic below.



Particulate Test Diagram	
Diameter (D)	24"
Upstream Distance (A)	>12"
Downstream Distance (B)	>48"
Sample Point Distances from Stack Wall	
Traverse Point 1	0.5"
Traverse Point 2	1.6"
Traverse Point 3	2.8"
Traverse Point 4	4.2"
Traverse Point 5	6.0"
Traverse Point 6	8.5"

3.0 TEST METHOD DETAILS

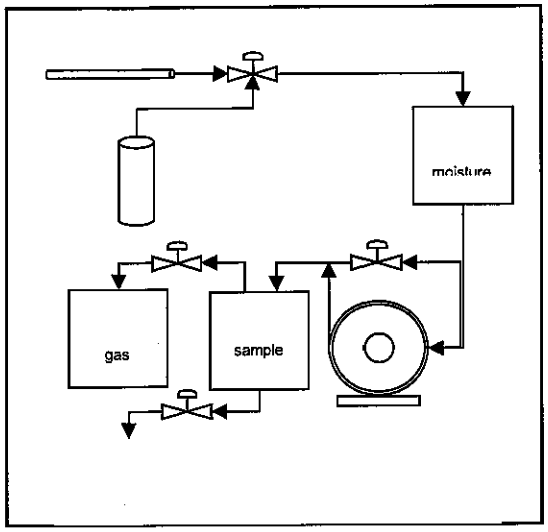
3.1 LIST OF TEST METHODS

The test procedures for this test program are summarized in Table 3-1 below. Additional information regarding specific applications or modifications to standard procedures is presented in the following sub-sections.

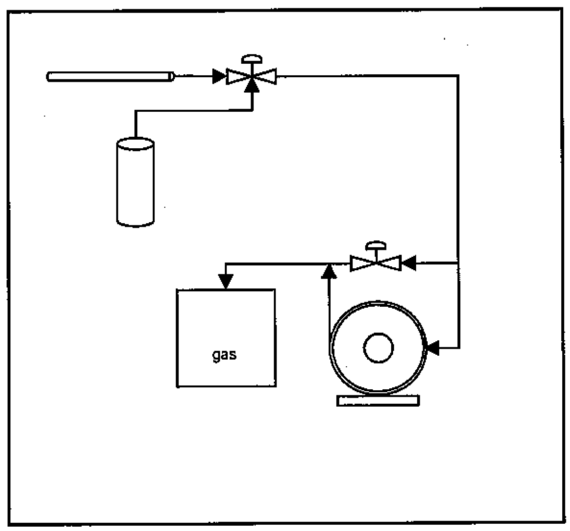
TABLE 3-1
TEST PROCEDURES

Parameter	Measurement Principle	Reference Method
Volumetric flow rate	Pitot/temperature traverse	EPA 1, 2
O_2	Paramagnetism	EPA 3A
CO_2	Non-dispersive infrared	EPA 3A
Moisture	Impinger weight gain	EPA 4
NO_x	Chemiluminescence	EPA 7E
Opacity	Visual observation	EPA 9
CO	Gas filter correlation NDIR	EPA 10
VOC	Flame Ionization Detection	EPA 25A
Filterable & Condensable Particulate Matter	Gravimetry with condensable analysis	EPA 5/202
Methanol	Gas chromatography – Flame ionization detector	EPA 308

3.1.1 TEST DETAILS

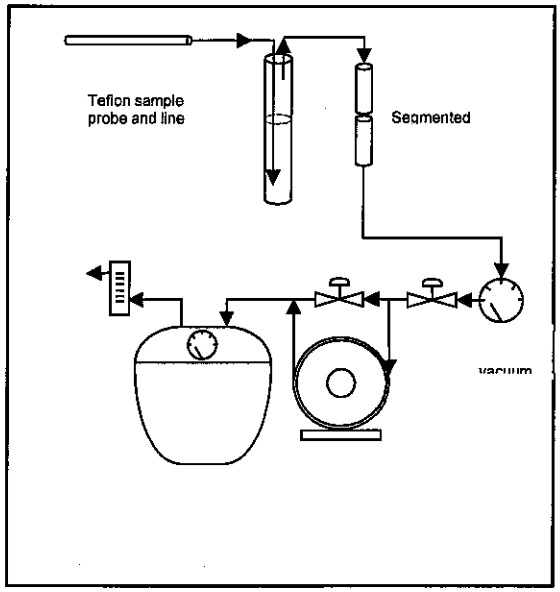


Pollutant gas testing were performed using EPA Methods 3A, 7E, 10 and 25A. The O_2/CO_2/NO_x and CO sample were withdrawn from the exhaust stack at a constant flow rate, transported through a Teflon sample line, through a moisture removal system, and directed to a Horiba PG-250z O_2 / CO_2 / NO_x / CO analyzer. (See the diagram of EPA Method 7E at right.) Concentrations of O_2 and CO_2 were reported in units of dry volume percent (%vd); concentrations of NO_x and CO were reported in units of parts per million on a dry volume basis (ppmvd). Gas concentration data were recorded as ten-second and one-minute averages to an Excel spreadsheet. Following each test run, the analyzers were challenged with EPA Protocol 1 calibration gases to determine instrument drift and to correct the raw pollutant data for system bias. NO_x and CO concentration data were combined with measured exhaust flow rate data to determine NO_x and CO mass emissions in units of pounds per hour (lb/hr).

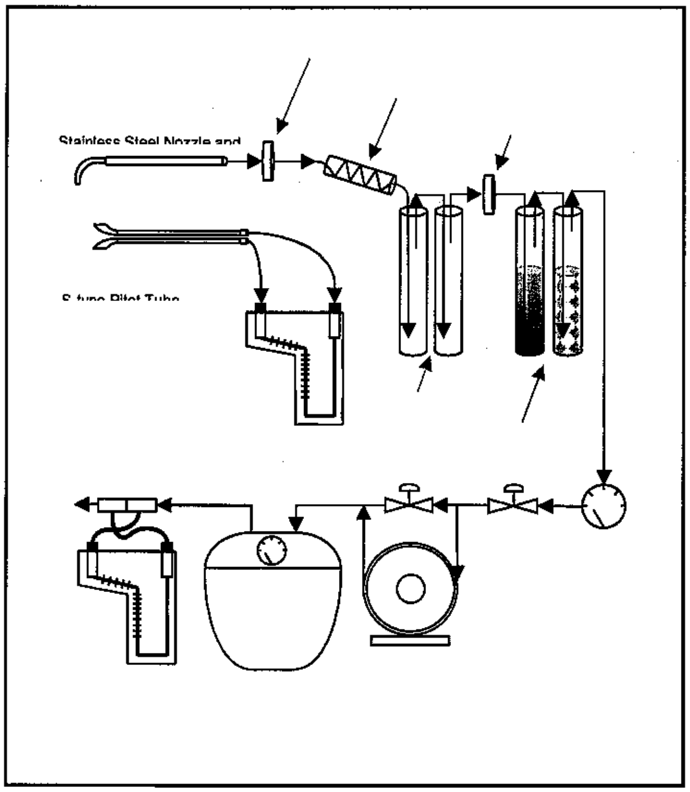


Concurrent with the above, the VOC sample were withdrawn from the exhaust stack at a constant flow rate, transported through a heated Teflon sample line and directed to a California Analytical Model 600 M-HFID Analyzer equipped with a methane cutter. (See the diagram of EPA Method 25A at right.) Prior to sampling, the instrument was calibrated with EPA Protocol 1 propane calibration gases and challenged with a methane calibration gas to confirm methane cutter operation. Concentrations of non-methane VOC were reported in units of parts per million on a wet volume basis (ppmvw) as propane. Gas concentration data were recorded as ten-second and one-minute averages to an Excel spreadsheet. Following each test run, the analyzer was challenged with EPA Protocol 1 calibration gases to determine instrument drift. VOC concentration data were combined with measured exhaust flow rate and moisture data to determine VOC mass emissions in units of pounds per hour (lb/hr).

Methanol sampling was performed in accordance with EPA Method 308. Each sample was withdrawn from the stack at a constant flow rate of 0.4 liters per minute through a Teflon sample line, through a chilled midget impinger containing 20 milliliters of HPLC-grade water, through a two-segment adsorption tube packed with silica gel, and through a calibrated dry gas meter. Following sampling, the liquid catches from the midget impinger and the adsorption tube were recovered and transported to Enthalpy Analytical Inc. in Durham, North Carolina for analysis using gas chromatography. All Quality Assurance requirements of Method 308 were followed. Following sampling, concentrations of methanol were combined with concurrently collected moisture data (see below) to determine pollutant concentrations in units of parts per million on a dry volume basis. Pollutant concentrations were combined with exhaust flow rate data to determine pollutant mass emission rates in units of pounds per hour (lb/hr).



PM and CPM testing were performed using EPA Methods 1, 2, 3, 4, 5 and 202. Each test run were 120 minutes. Sampling was performed along a grid of points determined using EPA Method 1. Exhaust gas flow measurements were taken using an S-type pitot tube, K-type thermocouple and inclined-vertical manometer in accordance with EPA Method 2. A sample of exhaust gas were withdrawn from the stack at an isokinetic flow rate through a stainless-steel nozzle, through a heated stainless-steel probe liner, through a water-cooled condenser and two empty glass impingers, through an out-of-stack CPM filter, through a chilled glass impinger containing 100 mL of water and a chilled glass impinger containing a known mass of silica gel, and through a calibrated dry gas meter. (See Figure 1 at right.) Stack gas moisture concentrations were determined gravimetrically in accordance with EPA Method 4. Following each sampling period, the impinger train was purged with nitrogen for 60 minutes in accordance with §8.5.3 of Method 202. The filter and acetone rinses of the nozzle and probe liner were recovered and shipped to the Montrose laboratory for gravimetric analysis. The CPM filter, impinger contents and hexane rinses of the glassware were recovered in accordance with



Method 202 and returned to the Montrose laboratory for gravimetric analysis. Following analysis, the total PM and CPM masses captured during each test run were combined with concurrent flow, diluent and moisture data to calculate particulate matter emissions in units of pounds per hour (lb/hr).

4.1 DISCUSSION OF RESULTS

The results for individual kiln tests are shown in Table 1-1. Because the limits shown in the table in Condition 2 of the Air Quality Permit 15WE1395, Issuance 4 are annual limits based on the total number of kilns processed, a comparison of a single kiln test with the permit limits is meaningless. Instead, a comparison of the average of the emission factors for each regulated pollutant, as determined by the tests, with the emission factors shown in the *Notes to Permit Holder, item 4, Table "Point 001: Kilns"* of the permit provides basis for determining whether an Air Pollution Emission Notice revision is required. The emission factors determined by the stack tests can also be used to calculate the actual annual emissions for comparison to the annual limits shown in the table in Condition 2 of the permit.

The average emission factors resulting from the three kiln tests are shown in Table 1-1. The average emission factors are compared to the emission factors found in *Notes to Permit Holder, item 4, Table "Point 001: Kilns"* Air Quality Permit 15WE1395, Issuance 4

Additional information is included in the appendices. Appendix A presents the general and specific equations used for the emissions calculations and computer spreadsheets. Raw field data sheets and data acquisition printouts are included in Appendix B. Laboratory reports and chain of custody sheets for the samples are located in Appendix C. Appendix D includes the process data collected by the facility. Appendix E presents the quality assurance information, including instrument calibration data.

4.2 DEVIATIONS AND EXCEPTIONS

The testing was completed on October 9, October 11, and October 14, 2019. This was a deviation from the proposed schedule provided in the test protocol. Run 3 on Kiln #8 on October 9, 2019 was only 80 minutes due to the completion of the process cycle. Testing was delayed due to weather and equipment operation. Testing on Kiln #40 began on October 8, 2019, issues withy process conditions led to stopping the testing and resuming on October 9 with new process conditions. The data recorded and recovered during the test are provided in the appendix.

No other deviations or exceptions were reported by the test crew and/or field project manager.

APPENDIX A
CALCULATIONS

Appendix A.1
Pollutant Emissions Spreadsheets

043AS-522991
Biochar Now
Kiln #8
10/9/2019

	Run #	**1**	**2**	**3**	
	Start Time	7:56	12:07	15:12	
	Stop Time	10:23	14:33	16:48	

EPA Method 2 Data		**1**	**2**	**3**	**Average**
	Inputs				
D_s	Stack Diameter (inches)	24.00	24.00	24.00	**24.00**
P_{bar}	Barometric Pressure ("Hg)	24.87	24.87	24.87	**24.87**
P_g	Stack Static Pressure ("H_2O)	-0.01	-0.01	-0.01	**-0.01**
C_p	Pitot Tube Coefficient (unitless)	0.84	0.84	0.84	**0.84**
$\sqrt{\Delta p_{avg}}$	Avg. Velocity Head of Stack Gas √("H_2O)	0.1208	0.1261	0.1295	**0.1255**
T_s	Stack Gas Temperature (°F)	1300	1324	1095	**1240**
	Calculations				
A	Stack Area (ft^2)	3.142	3.142	3.142	**3.142**
P_g	Stack Static Pressure ("Hg)	0.00	0.00	0.00	**0.00**
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.06	29.93	29.70	**29.90**
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.28	28.42	28.43	**28.38**
P_s	Absolute Stack Pressure ("Hg)	24.87	24.87	24.87	**24.87**
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1760	1784	1555.3	**1700**
V_s	Stack Gas Velocity (ft/sec)	13.72	14.39	13.79	**13.97**
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	32,987	34,940	39,213	**35,713**
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	550	582	654	**595**

EPA Method 4 Data		**1**	**2**	**3**	**Average**
	Inputs				
V_{lc}	Volume of Water Condensed (mL)	228.2	199.3	122.0	**183.2**
V_m	Volume of Stack Gas Collected (dcf)	72.422	81.099	58.558	**70.693**
Y	Meter Calibration Factor (unitless)	1.0270	1.0270	1.0270	**1.0270**
ΔH	Pressure Differential Across Orifice ("H_2O)	1.26	1.50	1.80	**1.52**
T_m	Temperature at Gas Meter (°F)	68	110	106	**95**
	Calculations				
P_m	Absolute Pressure at Gas Meter ("Hg)	24.96	24.98	25.00	**24.98**
T_m	Absolute Temperature at Gas Meter (°R)	528	570	566.4	**555**
$V_{wc(std)}$	Volume of Water Condensed (scf)	10.74	9.38	5.74	**8.62**
$V_{m(std)}$	Sample Gas Volume (dscf)	62.03	64.39	46.83	**57.75**
B_{ws}	Stack Gas Moisture Content (%/100)	0.148	0.127	0.109	**0.128**

EPA Method 3A, 7E, 10 and 25A Data	**1**	**2**	**3**	**Average**	**Limit**
O_2 (%vd)	8.5	9.7	10.2	**9.5**	
CO_2 (%vd)	10.8	9.7	8.1	**9.5**	
NO_x (ppmvd)	54.3	66.3	37.9	**52.8**	
CO (ppmvd)	1.1	0.0	1.0	**0.7**	
TVOC (ppmvw as C_3H_8)	1.0	0.2	0.2	**0.5**	
TVOC (ppmvd as C_3H_8)	1.2	0.2	0.3	**0.6**	

Mass Emission Calculations (Using EPA Methods 1-4)	**1**	**2**	**3**	**Average**	**Limit**
Exhaust Flow (dscfh)	32987	34940	39213	35713	
NO_x (lb/hr)	0.214	0.276	0.177	**0.223**	**0.14**
CO (lb/hr)	0.00270	0.0000	0.00289	**0.00186**	**0.12**
TVOC (lb/hr as C_3H_8)	0.00463	0.000827	0.00114	**0.00220**	
TVOC (lb/ton raw feed as C_3H_8)	0.0436	0.00778	0.0107	**0.0207**	**0.41**

*Kiln processed 0.99 tons of raw feed in 9.317 hours.

043AS-552991
Biochar
Kiln #8
10/9/2019

		Run #	1	2	3		
		Start Time	7:56	12:07	15:12		
		Stop Time	10:23	14:33	16:48		
θ		Sample Time (min.)	120	120	80		
EPA Method 2 Data			1	2	3	Average	
	Inputs						
D_s	Stack Diameter (inches)		24.0	24.0	24.0	24.0	
P_{bar}	Barometric Pressure ("Hg)		24.87	24.87	24.87	24.9	
P_g	Stack Static Pressure ("H_2O)		0.0	0.0	0.0	-0.01	
C_p	Pitot Tube Coefficient (unitless)		0.84	0.84	0.84	0.84	
$\sqrt{\Delta P_{avg}}$	Avg. Velocity Head of Stack Gas √("H_2O)		0.1208	0.1261	0.1295	0.1255	
T_s	Stack Gas Temperature (°F)		1300	1324	1095.3	1240	
	Calculations						
A	Stack Area (ft^2)		3.142	3.142	3.142	3.142	
P_g	Stack Static Pressure ("Hg)		0.00	0.00	0.00	0.00	
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)		30.07	29.94	29.70	29.90	
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)		28.29	28.42	28.43	28.38	
P_s	Absolute Stack Pressure ("Hg)		24.87	24.87	24.87	24.87	
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)		1760	1784	1555.3	1700	
V_s	Stack Gas Velocity (ft/sec)		13.7	14.4	13.8	14.0	
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)		32,985	34,937	39,213	35,712	
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)		550	582	654	595	
EPA Method 3A Data			1	2	3	Average	
	O_2 (%vd)		8.5	9.7	10.2	9.5	
	CO_2 (%vd)		10.8	9.7	8.1	9.5	
EPA Method 4 Data			1	2	3	Average	
	Inputs						
V_{lc}	Volume of Water Condensed (mL)		228.2	199.3	122.0	183.2	
V_m	Volume of Stack Gas Collected (dcf)		72.422	81.099	58.558	70.693	
Y	Meter Calibration Factor (unitless)		1.0270	1.0270	1.0270	1.0270	
ΔH	Pressure Differential Across Orifice ("H_2O)		1.3	1.5	1.8	1.5	
T_m	Temperature at Gas Meter (°F)		68	110	106.4	95	
	Calculations						
P_m	Absolute Pressure at Gas Meter ("Hg)		24.96	24.98	25.00	24.98	
T_m	Absolute Temperature at Gas Meter (°R)		528	570	566.4	554.8	
$V_{wc(std)}$	Volume of Water Condensed (scf)		10.74	9.38	5.74	8.62	
$V_{m(std)}$	Sample Gas Volume (dscf)		62.03	64.39	46.83	57.75	
$B_{ws\ act}$	Observed Stack Gas Moisture Content (%/100)		0.148	0.127	0.109	0.128	
$B_{ws\ sat}$	Saturated Moisture Content (%/100)		2383.917	2526.464	1345.195	2085.192	
B_{ws}	Moisture Content Used (%/100)		0.148	0.127	0.109	0.128	
EPA Method 5 Data			1	2	3	Average	
	Inputs						
D_n	Nozzle diameter (")		0.750	0.750	0.75	0.75	
C1	Mass of PM collected on filter (mg)		9.5	8.2	2.9	6.9	
C2	Mass of PM collected in rinses (mg)		4.7	2.9	3.6	3.7	
W_a	Mass of acetone blank (mg)		0.2	0.2	0.1	0.2	
EPA Method 202 Data			1	2	3	Average	Permit Limit
	Inputs						
	Mass of Inorganic Condensible PM (mg)		5.8	4.4	2.3	4.2	
	Mass of Organic Condensible PM (mg)		2.2	2.5	2.6	2.4	
	Total CPM Mass (mg)		8.0	6.9	4.9	6.6	
	Mass of train blank (mg)		2.0	2.0	2.0	2.0	
	Total CPM Mass less Blank (mg)		6.0	4.9	2.9	4.6	
	Emission Calculations						
A_n	Cross-sectional area of nozzle (ft^2)		3.07E-03	3.07E-03	3.07E-03	3.07E-03	
I	Isokinetic variation (%)		96.3	94.4	91.8	94.2	
m_n	Total Filterable PM mass less blank (mg)		14.0	10.9	6.4	10.4	
C_s	Filterable Particulate concentration (gr/dscf)		3.48E-03	2.61E-03	2.11E-03	2.73E-03	
C_s	Filterable Particulate concentration (lb/dscf)		4.98E-07	3.73E-07	3.01E-07	3.91E-07	
$E_{lb/hr}$	Filterable Particulate mass emission rate (lb/hr)		0.016	0.013	0.012	0.014	
F_c	Filterable Particulate mass emission rate (lb/mmBtu)		0.008	0.007	0.007	0.007	
C_s	Condensible Particulate concentration (gr/dscf)		1.49E-03	1.17E-03	9.56E-04	1.21E-03	
C_s	Condensible Particulate concentration (lb/dscf)		2.13E-07	1.68E-07	1.37E-07	1.73E-07	
$E_{lb/hr}$	Condensible Particulate mass emission rate (lb/hr)		0.007	0.006	0.005	0.006	
F_c	Condensible Particulate mass emission rate (lb/mmBtu)		0.004	0.003	0.003	0.003	
	Total Particulate concentration (gr/dscf)		4.98E-03	3.79E-03	3.06E-03	3.94E-03	
	Total Particulate concentration (lb/dscf)		7.11E-07	5.41E-07	4.38E-07	5.63E-07	
	Total Particulate mass emission rate (lb/hr)		0.023	0.019	0.017	0.020	
	Total Particulate mass emission rate (lb/mmBtu)		0.012	0.010	0.010	0.011	
	Total Particulate mass emission rate (lb/ton raw feed)***		0.221	0.178	0.162	0.187	0.19
$E_{lb/hr}$	PM10 mass emission rate (lb/hr)*		0.017	0.013	0.012	0.014	
	PM10 mass emission rate (lb/ton raw feed)***		0.156	0.110	0.100	0.122	0.18
$E_{lb/hr}$	PM2.5 mass emission rate (lb/hr)**		0.012	0.010	0.009	0.010	
	PM2.5 mass emission rate (lb/ton raw feed)***		0.116	0.0944	0.0860	0.0987	0.18

*PM10 = Total Filterable PM * 0.58 + CPM
**PM2.5 = Total Filterable PM * 0.32 + CPM
***Kiln processed 0.99 tons of raw feed over 9.317 hours.

043AS-552991
Biochar
Kiln #8
10/9/2019

	Run #	**1**	**2**	**3**	
	Start Time	7:56	12:07	15:12	
	Stop Time	10:23	14:33	16:47	

	EPA Method 308 Meter Data	**1**	**2**	**3**	**Average**
	Inputs				
P_{bar}	Barometric Pressure ("Hg)	24.87	24.87	24.87	**24.87**
V_m	Volume of Stack Gas Collected (L)	48.243	48.753	32.068	**43.021**
Y	Meter Calibration Factor (unitless)	1.009	1.009	1.009	**1.009**
T_m	Temperature at Gas Meter (°F)	63	95	83	**80**
	Calculations				
V_m	Volume of Stack Gas Collected (dcm)	0.048	0.049	0.032	**0.043**
P_{bar}	Absolute Pressure at Gas Meter (mmHg)	631.63	631.63	631.63	**631.63**
T_m	Absolute Temperature at Gas Meter (K)	290	308	301	**300**
$V_{m(std)}$	Sample Gas Volume (dscm)	0.041	0.039	0.026	**0.035**
$V_{m(std)}$	Sample Gas Volume (std L)	40.821	38.873	26.159	**35.284**

	EPA Method 308 Laboratory Results	**1**	**2**	**3**	**Average**
	Methanol (µg)	2.60	2.85	2.08	**2.51**
MW=32.04	Methanol (ppmvd)	0.0478	0.0550	0.0597	**0.0542**

	Mass Emission Calculations (Using EPA Methods 1-4)	**1**	**2**	**3**	**Average**	
	Exhaust Flow (dscfh)	32,987	34,940	39,213	**35,713**	
MW=32.04	Methanol (lb/hr)	0.000131	0.000160	0.000195	**0.000162**	
	Methanol (lb/ton raw feed)*	0.00123	0.00151	0.00183	**0.00152**	**0.02**

*Kiln processed 0.99 tons of raw feed in 9.317 hours.

043AS-522991
Biochar Now
Kiln #21
10/11/2019

	Run #	1	2	3
	Start Time	8:40	11:47	14:59
	Stop Time	11:02	14:03	17:18

EPA Method 2 Data		1	2	3	Average
	Inputs				
D_s	Stack Diameter (inches)	24.00	24.00	24.00	**24.00**
P_{bar}	Barometric Pressure ("Hg)	25.14	25.14	25.14	**25.14**
P_g	Stack Static Pressure ("H_2O)	-0.01	-0.01	-0.01	**-0.01**
C_p	Pitot Tube Coefficient (unitless)	0.84	0.84	0.84	**0.84**
$\sqrt{\Delta p_{avg}}$	Avg. Velocity Head of Stack Gas √("H_2O)	0.1339	0.1328	0.1333	**0.1333**
T_s	Stack Gas Temperature (°F)	1395	1400	819	**1205**
	Calculations				
A	Stack Area (ft^2)	3.142	3.142	3.142	**3.142**
P_g	Stack Static Pressure ("Hg)	0.00	0.00	0.00	**0.00**
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.28	30.08	29.78	**30.05**
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.55	28.63	29.04	**28.74**
P_s	Absolute Stack Pressure ("Hg)	25.14	25.14	25.14	**25.14**
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1855	1860	1279	**1665**
V_s	Stack Gas Velocity (ft/sec)	15.46	15.33	12.67	**14.49**
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	35,915	36,393	46,589	**39,632**
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	599	607	776	**661**

EPA Method 4 Data		1	2	3	Average
	Inputs				
V_{lc}	Volume of Water Condensed (mL)	239.3	201.6	117.5	**186.1**
V_m	Volume of Stack Gas Collected (dcf)	75.370	82.227	98.520	**85.372**
Y	Meter Calibration Factor (unitless)	1.0270	1.0270	1.0270	**1.0270**
ΔH	Pressure Differential Across Orifice ("H_2O)	1.50	1.70	2.40	**1.87**
T_m	Temperature at Gas Meter (°F)	43	81	86	**70**
	Calculations				
P_m	Absolute Pressure at Gas Meter ("Hg)	25.25	25.27	25.32	**25.28**
T_m	Absolute Temperature at Gas Meter (°R)	503	541	546	**530**
$V_{wc(std)}$	Volume of Water Condensed (scf)	11.26	9.49	5.53	**8.76**
$V_{m(std)}$	Sample Gas Volume (dscf)	68.54	69.57	82.76	**73.62**
B_{ws}	Stack Gas Moisture Content (%/100)	0.141	0.120	0.063	**0.108**

EPA Method 3A, 7E, 10 and 25A Data	1	2	3	Average	Limit
O_2 (%vd)	8.3	9.8	10.4	**9.5**	
CO_2 (%vd)	12.2	10.5	8.5	**10.4**	
NO_x (ppmvd)	62.2	75.9	33.1	**57.1**	
CO (ppmvd)	3.4	0.0	7.8	**3.7**	
TVOC (ppmvw as C_3H_8)	0.3	0.8	0.4	**0.5**	
TVOC (ppmvd as C_3H_8)	0.3	0.9	0.4	**0.5**	

Mass Emission Calculations (Using EPA Methods 1-4)	1	2	3	Average	Limit
Exhaust Flow (dscfh)	35915	36393	46589	**39632**	
NO_x (lb/hr)	0.267	0.330	0.184	**0.260**	**0.14**
CO (lb/hr)	0.00882	0.0000	0.0263	**0.01170**	**0.12**
TVOC (lb/hr as C_3H_8)	0.00130	0.00378	0.00222	**0.00243**	
TVOC (lb/ton raw feed as C_3H_8)	0.0121	0.0352	0.0207	**0.0227**	**0.41**

*Kiln processed 1.0 tons of raw feed in 9.333 hours.

043AS-552991
Biochar
Kiln #21
10/11/2019

		1	2	3	Average	Permit Limit
	Run #	1	2	3		
	Start Time	8:40	11:47	14:59		
	Stop Time	11:02	14:03	17:18		
θ	Sample Time (min.)	120	120	120		
EPA Method 2 Data		1	2	3	Average	
	Inputs					
D_s	Stack Diameter (inches)	24.0	24.0	24.0	24.0	
P_{bar}	Barometric Pressure ("Hg)	25.14	25.14	25.14	25.1	
P_g	Stack Static Pressure ("H_2O)	0.0	0.0	0.0	-0.01	
C_p	Pitot Tube Coefficient (unitless)	0.84	0.84	0.84	0.84	
$\sqrt{\Delta p_{avg}}$	Avg. Velocity Head of Stack Gas $\sqrt{(\text{"}H_2O)}$	0.1339	0.1328	0.1333	0.1333	
T_s	Stack Gas Temperature (°F)	1395	1400	819	1205	
	Calculations					
A	Stack Area (ft^2)	3.142	3.142	3.142	3.142	
P_g	Stack Static Pressure ("Hg)	0.00	0.00	0.00	0.00	
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.28	30.07	29.77	30.04	
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.55	28.62	29.03	28.73	
P_s	Absolute Stack Pressure ("Hg)	25.14	25.14	25.14	25.14	
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1855	1860	1279	1665	
V_s	Stack Gas Velocity (ft/sec)	15.5	15.3	12.7	14.5	
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	35,911	36,396	46,598	39,635	
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	599	607	777	661	
EPA Method 3A Data		1	2	3	Average	
	O_2 (%vd)	8.3	9.8	10.6	9.6	
	CO_2 (%vd)	12.2	10.5	8.4	10.4	
EPA Method 4 Data		1	2	3	Average	
	Inputs					
V_{lc}	Volume of Water Condensed (mL)	239.3	201.6	117.5	186.1	
V_m	Volume of Stack Gas Collected (dcf)	75.37	82.227	98.52	85.372	
Y	Meter Calibration Factor (unitless)	1.0270	1.0270	1.0270	1.0270	
ΔH	Pressure Differential Across Orifice ("H_2O)	1.5	1.7	2.4	1.9	
T_m	Temperature at Gas Meter (°F)	43	81	86	70	
	Calculations					
P_m	Absolute Pressure at Gas Meter ("Hg)	25.25	25.27	25.32	25.28	
T_m	Absolute Temperature at Gas Meter (°R)	503	541	546	530.0	
$V_{wc(std)}$	Volume of Water Condensed (scf)	11.26	9.49	5.53	8.76	
$V_{m(std)}$	Sample Gas Volume (dscf)	68.54	69.57	82.76	73.62	
B_{ws}	Moisture Content Used (%/100)	0.141	0.120	0.063	0.108	
EPA Method 5 Data		1	2	3	Average	
	Inputs					
D_n	Nozzle diameter (")	0.75	0.75	0.75	0.75	
C1	Mass of PM collected on filter (mg)	12.0	13.1	7.4	10.8	
C2	Mass of PM collected in rinses (mg)	6.9	3.5	3.3	4.6	
W_a	Mass of acetone blank (mg)	0.3	0.3	0.3	0.3	
EPA Method 202 Data		1	2	3	Average	Permit Limit
	Inputs					
	Mass of Inorganic Condensible PM (mg)	5.4	4.6	2.0	4.0	
	Mass of Organic Condensible PM (mg)	2.1	2.8	1.8	2.2	
	Total CPM Mass (mg)	7.5	7.4	3.8	6.2	
	Mass of train blank (mg)	2.0	2.0	2.0	2.0	
	Total CPM Mass less Blank (mg)	5.5	5.4	1.8	4.2	
	Emission Calculations					
A_n	Cross-sectional area of nozzle (ft^2)	3.07E-03	3.07E-03	3.07E-03	3.07E-03	
I	Isokinetic variation (%)	97.8	97.9	91.0	95.6	
m_n	Total Filterable PM mass less blank (mg)	18.6	16.3	10.5	15.1	
C_s	Filterable Particulate concentration (gr/dscf)	4.19E-03	3.62E-03	1.96E-03	3.25E-03	
C_s	Filterable Particulate concentration (lb/dscf)	5.98E-07	5.17E-07	2.80E-07	4.65E-07	
$E_{lb/hr}$	Filterable Particulate mass emission rate (lb/hr)	0.0215	0.0188	0.0130	0.0178	
F_c	Filterable Particulate mass emission rate (lb/mmBtu)	0.0090	0.0091	0.0061	0.0081	
C_s	Condensible Particulate concentration (gr/dscf)	1.24E-03	1.20E-03	3.36E-04	9.24E-04	
C_s	Condensible Particulate concentration (lb/dscf)	1.77E-07	1.71E-07	4.80E-08	1.32E-07	
$E_{lb/hr}$	Condensible Particulate mass emission rate (lb/hr)	0.0064	0.0062	0.0022	0.0049	
F_c	Condensible Particulate mass emission rate (lb/mmBtu)	0.0027	0.0030	0.0011	0.0022	
	Total Particulate concentration (gr/dscf)	5.43E-03	4.81E-03	2.29E-03	4.18E-03	
	Total Particulate concentration (lb/dscf)	7.75E-07	6.88E-07	3.28E-07	5.97E-07	
	Total Particulate mass emission rate (lb/hr)	0.028	0.025	0.015	0.023	
	Total Particulate mass emission rate (lb/mmBtu)	0.012	0.012	0.007	0.010	
	Total Particulate mass emission rate (lb/ton raw feed)***	0.260	0.234	0.143	0.212	0.19
$E_{lb/hr}$	PM10 mass emission rate (lb/hr)*	0.019	0.017	0.010	0.015	
	PM10 mass emission rate (lb/ton raw feed)***	0.176	0.160	0.091	0.142	0.18
$E_{lb/hr}$	PM2.5 mass emission rate (lb/hr)**	0.013	0.012	0.006	0.011	
	PM2.5 mass emission rate (lb/ton raw feed)***	0.123	0.114	0.060	0.099	0.18

*PM10 = Total Filterable PM * 0.58 + CPM
**PM2.5 = Total Filterable PM * 0.32 + CPM
*Kiln processed 1.0 tons of raw feed in 9.333 hours.

043AS-552991
Biochar
Kiln #21
10/11/2019

	Run #	**1**	**2**	**3**	
	Start Time	8:40	11:47	14:59	
	Stop Time	11:02	14:03	17:18	

EPA Method 308 Meter Data		**1**	**2**	**3**	**Average**
	Inputs				
P_{bar}	Barometric Pressure ("Hg)	25.14	25.14	25.14	**25.14**
V_m	Volume of Stack Gas Collected (L)	48.612	48.509	48.311	**48.477**
Y	Meter Calibration Factor (unitless)	1.009	1.009	1.009	**1.009**
T_m	Temperature at Gas Meter (°F)	32	69	71	**57**
	Calculations				
V_m	Volume of Stack Gas Collected (dcm)	0.049	0.049	0.048	**0.048**
P_{bar}	Absolute Pressure at Gas Meter (mmHg)	638.48	638.48	638.48	**638.48**
T_m	Absolute Temperature at Gas Meter (K)	273	294	295	**287**
$V_{m(std)}$	Sample Gas Volume (dscm)	0.044	0.041	0.041	**0.042**
$V_{m(std)}$	Sample Gas Volume (std L)	44.201	41.021	40.699	**41.974**

EPA Method 308 Laboratory Results		**1**	**2**	**3**	**Average**
	Methanol (µg)	2.60	2.42	2.42	**2.48**
MW=32.04	Methanol (ppmvd)	0.0442	0.0443	0.0446	**0.0**

Mass Emission Calculations (Using EPA Methods 1-4)		**1**	**2**	**3**	**Average**	
	Exhaust Flow (dscfh)	35,915	36,393	46,589	**39,632**	
MW=32.04	Methanol (lb/hr)	0.000132	0.000134	0.000173	**0.000146**	
	Methanol (lb/ton raw feed)*	0.00123	0.00125	0.00161	**0.00137**	**0.02**

*Kiln processed 1.0 ton of raw feed in 9.33 hours.

043AS-522991
Biochar Now
Kiln #7
10/14/2019

	Run #	1	2	3	
	Start Time	9:38	12:37	15:37	
	Stop Time	11:58	14:56	17:45	

EPA Method 2 Data		1	2	3	Average
	Inputs				
D_s	Stack Diameter (inches)	24.00	24.00	24.00	**24.00**
P_{bar}	Barometric Pressure ("Hg)	24.87	24.87	24.87	**24.87**
P_g	Stack Static Pressure ("H_2O)	-0.01	-0.01	0.01	**0.00**
C_p	Pitot Tube Coefficient (unitless)	0.84	0.84	0.84	**0.84**
$\sqrt{\Delta p_{avg}}$	Avg. Velocity Head of Stack Gas √("H_2O)	0.1343	0.1348	0.1337	**0.1343**
T_s	Stack Gas Temperature (°F)	1270	1355	1306	**1310**
	Calculations				
A	Stack Area (ft^2)	3.142	3.142	3.142	**3.142**
P_g	Stack Static Pressure ("Hg)	0.00	0.00	0.00	**0.00**
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.24	30.18	29.66	**30.02**
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.69	28.58	28.76	**28.68**
P_s	Absolute Stack Pressure ("Hg)	24.87	24.87	24.87	**24.87**
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1730	1815	1766	**1770**
V_s	Stack Gas Velocity (ft/sec)	15.02	15.47	15.09	**15.19**
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	37,646	36,746	39,135	**37,842**
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	627	612	652	**631**

EPA Method 4 Data		1	2	3	Average
	Inputs				
V_{lc}	Volume of Water Condensed (mL)	225.1	234.6	125.3	**195.0**
V_m	Volume of Stack Gas Collected (dcf)	89.032	90.980	89.074	**89.695**
Y	Meter Calibration Factor (unitless)	1.0270	1.0270	1.0270	**1.0270**
ΔH	Pressure Differential Across Orifice ("H_2O)	1.90	1.90	1.80	**1.87**
T_m	Temperature at Gas Meter (°F)	90	105	112	**102**
	Calculations				
P_m	Absolute Pressure at Gas Meter ("Hg)	25.01	25.01	25.00	**25.01**
T_m	Absolute Temperature at Gas Meter (°R)	550	565	571.7	**562**
$V_{wc(std)}$	Volume of Water Condensed (scf)	10.59	11.04	5.90	**9.18**
$V_{m(std)}$	Sample Gas Volume (dscf)	73.34	72.96	70.57	**72.29**
B_{ws}	Stack Gas Moisture Content (%/100)	0.126	0.131	0.077	**0.112**

EPA Method 3A, 7E, 10 and 25A Data	1	2	3	Average	Limit
O_2 (%vd)	8.6	8.9	11.4	**9.6**	
CO_2 (%vd)	11.8	11.4	7.5	**10.2**	
NO_x (ppmvd)	51.1	75.2	27.8	**51.3**	
CO (ppmvd)	7.6	0.0	1.8	**3.1**	
TVOC (ppmvw as C_3H_8)	0.5	0.1	0.2	**0.3**	
TVOC (ppmvd as C_3H_8)	0.5	0.1	0.2	**0.3**	

Mass Emission Calculations (Using EPA Methods 1-4)	1	2	3	Average	Limit
Exhaust Flow (dscfh)	37646	36746	39135	**37842**	
NO_x (lb/hr)	0.230	0.330	0.130	**0.230**	**0.14**
CO (lb/hr)	0.02077	0.0000	0.00521	**0.00866**	**0.12**
TVOC (lb/hr as C_3H_8)	0.00229	0.000525	0.00107	**0.00129**	
TVOC (lb/ton raw feed as C_3H_8)	0.000283	0.000065	0.000132	**0.000160**	**0.41**

*Kiln processed 1.03 tons of raw feed in 8.333 hours.

043AS-552991
Biochar
Kiln #7
10/14/2019

	Run #	1	2	3
	Start Time	9:38	12:37	15:37
	Stop Time	11:58	14:56	17:45
e	Sample Time (min.)	120	120	120

EPA Method 2 Data		1	2	3	Average
	Inputs				
D_s	Stack Diameter (inches)	24.0	24.0	24.0	24.0
P_{bar}	Barometric Pressure ("Hg)	24.87	24.87	24.87	24.9
P_g	Stack Static Pressure ("H_2O)	0.0	0.0	0.0	-0.01
C_p	Pitot Tube Coefficient (unitless)	0.84	0.84	0.84	0.84
$\sqrt{\Delta P_{avg}}$	Avg. Velocity Head of Stack Gas $\sqrt{("H_2O)}$	0.1343	0.1348	0.1337	0.1343
T_s	Stack Gas Temperature (°F)	1270	1355	1306	1310
	Calculations				
A	Stack Area (ft²)	3.142	3.142	3.142	3.142
P_g	Stack Static Pressure ("Hg)	0.00	0.00	0.00	0.00
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.23	30.18	29.64	30.02
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.69	28.58	28.74	28.67
P_s	Absolute Stack Pressure ("Hg)	24.87	24.87	24.87	24.87
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1730	1815	1766.4	1770
V_s	Stack Gas Velocity (ft/sec)	15.0	15.5	15.1	15.2
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	37,650	36,744	39,143	37,845
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	627	612	652	631

EPA Method 3A Data		1	2	3	Average
	O_2 (%vd)	8.6	8.9	11.7	9.7
	CO_2 (%vd)	11.8	11.4	7.3	10.2

EPA Method 4 Data		1	2	3	Average
	Inputs				
V_{lc}	Volume of Water Condensed (mL)	225.1	234.6	125.3	195.0
V_m	Volume of Stack Gas Collected (dcf)	89.032	90.98	89.074	89.695
Y	Meter Calibration Factor (unitless)	1.0270	1.0270	1.0270	1.0270
ΔH	Pressure Differential Across Orifice ("H_2O)	1.9	1.9	1.8	1.9
T_m	Temperature at Gas Meter (°F)	90	105	112	102
	Calculations				
P_m	Absolute Pressure at Gas Meter ("Hg)	25.01	25.01	25.00	25.01
T_m	Absolute Temperature at Gas Meter (°R)	550	565	571.7	562.2
$V_{wc(std)}$	Volume of Water Condensed (scf)	10.59	11.04	5.90	9.18
$V_{m(std)}$	Sample Gas Volume (dscf)	73.34	72.96	70.57	72.29
B_{ws}	Moisture Content Used (%/100)	0.126	0.131	0.077	0.112

EPA Method 5 Data		1	2	3	Average
	Inputs				
D_n	Nozzle diameter (")	0.75	0.75	0.75	0.75
C1	Mass of PM collected on filter (mg)	18.4	9.1	3.7	10.4
C2	Mass of PM collected in rinses (mg)	3.2	2.1	2.4	2.6
W_a	Mass of acetone blank (mg)	0.1	0.2	0.2	0.2

EPA Method 202 Data		1	2	3	Average	Permit Limit
	Inputs					
	Mass of Inorganic Condensible PM (mg)	5.4	5.3	2.9	4.5	
	Mass of Organic Condensible PM (mg)	2.3	2.4	2.4	2.4	
	Total CPM Mass (mg)	7.7	7.7	5.3	6.9	
	Mass of train blank (mg)	2.0	2.0	2.0	2.0	
	Total CPM Mass less Blank (mg)	5.7	5.7	3.3	4.9	
	Emission Calculations					
A_n	Cross-sectional area of nozzle (ft²)	3.07E-03	3.07E-03	3.07E-03	3.07E-03	
I	Isokinetic variation (%)	99.8	101.7	92.4	98.0	
m_n	Total Filterable PM mass less blank (mg)	21.5	11.0	5.9	12.8	
C_s	Filterable Particulate concentration (gr/dscf)	4.52E-03	2.33E-03	1.29E-03	2.71E-03	
C_s	Filterable Particulate concentration (lb/dscf)	6.46E-07	3.32E-07	1.84E-07	3.88E-07	
$E_{lb/hr}$	Filterable Particulate mass emission rate (lb/hr)	0.0243	0.0122	0.0072	0.0146	
F_c	Filterable Particulate mass emission rate (lb/mmBtu)	0.0101	0.0054	0.0046	0.0067	
C_s	Condensible Particulate concentration (gr/dscf)	1.20E-03	1.21E-03	7.22E-04	1.04E-03	
C_s	Condensible Particulate concentration (lb/dscf)	1.71E-07	1.72E-07	1.03E-07	1.49E-07	
$E_{lb/hr}$	Condensible Particulate mass emission rate (lb/hr)	0.0065	0.0063	0.0040	0.0056	
F_c	Condensible Particulate mass emission rate (lb/mmBtu)	0.0027	0.0028	0.0026	0.0027	
	Total Particulate concentration (gr/dscf)	5.72E-03	3.53E-03	2.01E-03	3.76E-03	
	Total Particulate concentration (lb/dscf)	8.18E-07	5.05E-07	2.87E-07	5.37E-07	
	Total Particulate mass emission rate (lb/hr)	0.031	0.019	0.011	0.020	
	Total Particulate mass emission rate (lb/mmBtu)	0.013	0.008	0.007	0.009	
	Total Particulate mass emission rate (lb/ton raw feed)***	0.249	0.150	0.091	0.163	0.19
$E_{lb/hr}$	PM10 mass emission rate (lb/hr)*	0.021	0.013	0.008	0.014	
	PM10 mass emission rate (lb/ton raw feed)***	0.166	0.109	0.066	0.114	0.18
$E_{lb/hr}$	PM2.5 mass emission rate (lb/hr)**	0.014	0.010	0.006	0.010	
	PM2.5 mass emission rate (lb/ton raw feed)***	0.115	0.083	0.051	0.083	0.18

*PM10 = Total Filterable PM * 0.58 + CPM
**PM2.5 = Total Filterable PM * 0.32 + CPM
*Kiln processed 1.03 tons of raw feed in 8.333 hours.

043AS-522991
Biochar Now
Kiln #7
10/14/2019

	Run #	1	2	3	
	Start Time	9:38	12:37	15:37	
	Stop Time	11:58	14:56	17:45	

EPA Method 308 Meter Data		1	2	3	Average
	Inputs				
P_{bar}	Barometric Pressure ("Hg)	24.87	24.87	24.87	**24.87**
V_m	Volume of Stack Gas Collected (L)	48.376	48.221	48.011	**48.203**
Y	Meter Calibration Factor (unitless)	1.009	1.009	1.009	**1.009**
T_m	Temperature at Gas Meter (°F)	82.0	89.0	72.0	**81.0**
	Calculations				
V_m	Volume of Stack Gas Collected (dcm)	0.048	0.048	0.048	**0.048**
P_{bar}	Absolute Pressure at Gas Meter (mmHg)	631.63	631.63	631.63	**631.63**
T_m	Absolute Temperature at Gas Meter (K)	301	305	295	**300**
$V_{m(std)}$	Sample Gas Volume (dscm)	0.039	0.039	0.040	**0.039**
$V_{m(std)}$	Sample Gas Volume (std L)	39.498	38.869	39.937	**39.435**

EPA Method 308 Laboratory Results		1	2	3	Average
	Methanol (µg)	2.77	2.77	2.68	**2.74**
MW=32.04	Methanol (ppmvd)	0.0527	0.0535	0.0504	**0.0522**

Mass Emission Calculations (Using EPA Methods 1-4)		1	2	3	Average	
	Exhaust Flow (dscfh)	37,646	36,746	39,135	**37,842**	
MW=32.04	Methanol (lb/hr)	0.000165	0.000163	0.000164	**0.000164**	
	Methanol (lb/ton raw feed)*	0.00133	0.00132	0.00133	**0.00133**	**0.02**

*Kiln processed 1.03 tons of raw feed in 8.33 hours.

043AS-552991
Biochar Now
Kiln #40
10/8/2019

Run #	1
Start Time	10:00
Stop Time	12:28

EPA Method 2 Data		1
	Inputs	
D_s	Stack Diameter (inches)	24.0
P_{bar}	Barometric Pressure ("Hg)	24.85
P_g	Stack Static Pressure ("H_2O)	-0.01
C_p	Pitot Tube Coefficient (unitless)	0.84
$\sqrt{\Delta p_{avg}}$	Avg. Velocity Head of Stack Gas √("H_2O)	0.1308
T_s	Stack Gas Temperature (°F)	1296
	Calculations	
A	Stack Area (ft^2)	3.142
P_g	Stack Static Pressure ("Hg)	0.00
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.21
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.46
P_s	Absolute Stack Pressure ("Hg)	24.85
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1756
V_s	Stack Gas Velocity (ft/sec)	14.80
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	35,834
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	597

EPA Method 4 Data		1
	Inputs	
V_{lc}	Volume of Water Condensed (mL)	251.4
V_m	Volume of Stack Gas Collected (dcf)	85.284
Y	Meter Calibration Factor (unitless)	1.0270
ΔH	Pressure Differential Across Orifice ("H_2O)	1.70
T_m	Temperature at Gas Meter (°F)	83
	Calculations	
P_m	Absolute Pressure at Gas Meter ("Hg)	24.98
T_m	Absolute Temperature at Gas Meter (°R)	543
$V_{wc(std)}$	Volume of Water Condensed (scf)	11.83
$V_{m(std)}$	Sample Gas Volume (dscf)	71.06
B_{ws}	Stack Gas Moisture Content (%/100)	0.143

EPA Method 3A, 7E, 10 and 25A Data	1	Limit
O_2 (%vd)	10.3	
CO_2 (%vd)	11.2	
NO_x (ppmvd)	42.8	
CO (ppmvd)	479.8	
TVOC (ppmvw as C_3H_8)	22.9	
TVOC (ppmvd as C_3H_8)	26.7	

Mass Emission Calculations (Using EPA Methods 1-4)	1	Limit
Exhaust Flow (dscfh)	35834	
NO_x (lb/hr)	0.18	**0.14**
CO (lb/hr)	1.25	**0.12**
TVOC (lb/hr as C_3H_8)	0.11	
TVOC (lb/ton raw feed as C_3H_8)	--	**0.41**

*Only a single run was completed, the operating temperature was adjusted.

043AS-552991
Biochar
Kiln #40
10/8/2019

	Run #	1	
	Start Time	10:00	
	Stop Time	12:28	
θ	Sample Time (min.)	120	
EPA Method 2 Data		1	
	Inputs		
D_s	Stack Diameter (inches)	24.0	
P_{bar}	Barometric Pressure ("Hg)	24.85	
P_g	Stack Static Pressure ("H_2O)	-0.01	
C_p	Pitot Tube Coefficient (unitless)	0.84	
$\sqrt{\Delta p_{avg}}$	Avg. Velocity Head of Stack Gas √("H_2O)	0.1308	
T_s	Stack Gas Temperature (°F)	1296	
	Calculations		
A	Stack Area (ft^2)	3.142	
P_g	Stack Static Pressure ("Hg)	0.00	
M_d	Stack Gas Molecular Weight, dry basis (lb/lb-mole)	30.24	
M_s	Stack Gas Molecular Weight, wet basis (lb/lb-mole)	28.49	
P_s	Absolute Stack Pressure ("Hg)	24.85	
$T_{s(abs)}$	Absolute Stack Gas Temperature (°R)	1756	
V_s	Stack Gas Velocity (ft/sec)	14.8	
Q	Stack Gas Dry Volumetric Flow Rate (dscf/hr)	35,818	
Q	Stack Gas Dry Volumetric Flow Rate (dscf/min)	597	
EPA Method 3A Data		1	
	O_2 (%vd)	10.3	
	CO_2 (%vd)	11.4	
EPA Method 4 Data		1	
	Inputs		
V_{lc}	Volume of Water Condensed (mL)	251.4	
V_m	Volume of Stack Gas Collected (dcf)	85.284	
Y	Meter Calibration Factor (unitless)	1.0270	
ΔH	Pressure Differential Across Orifice ("H_2O)	1.7	
T_m	Temperature at Gas Meter (°F)	83	
	Calculations		
P_m	Absolute Pressure at Gas Meter ("Hg)	24.98	
T_m	Absolute Temperature at Gas Meter (°R)	543	
$V_{wc(std)}$	Volume of Water Condensed (scf)	11.83	
$V_{m(std)}$	Sample Gas Volume (dscf)	71.06	
$B_{ws\ act}$	Observed Stack Gas Moisture Content (%/100)	0.143	
B_{ws}	Moisture Content Used (%/100)	0.143	
EPA Method 5 Data		1	
	Inputs		
D_n	Nozzle diameter (")	0.75	
C1	Mass of PM collected on filter (mg)	11.8	
C2	Mass of PM collected in rinses (mg)	7.4	
W_a	Mass of acetone blank (mg)	0.1	
EPA Method 202 Data		1	Permit Limit
	Inputs		
	Mass of Inorganic Condensible PM (mg)	3.2	
	Mass of Organic Condensible PM (mg)	15.3	
	Total CPM Mass (mg)	18.5	
	Mass of train blank (mg)	2.0	
	Total CPM Mass less Blank (mg)	16.5	
	Emission Calculations		
A_n	Cross-sectional area of nozzle (ft^2)	3.07E-03	
I	Isokinetic variation (%)	101.6	
m_n	Total Filterable PM mass less blank (mg)	19.1	
C_s	Filterable Particulate concentration (gr/dscf)	4.15E-03	
C_s	Filterable Particulate concentration (lb/dscf)	5.93E-07	
$E_{lb/hr}$	Filterable Particulate mass emission rate (lb/hr)	0.0212	
F_c	Filterable Particulate mass emission rate (lb/mmBtu)	0.00956	
C_s	Condensible Particulate concentration (gr/dscf)	3.58E-03	
C_s	Condensible Particulate concentration (lb/dscf)	5.12E-07	
$E_{lb/hr}$	Condensible Particulate mass emission rate (lb/hr)	0.0183	
F_c	Condensible Particulate mass emission rate (lb/mmBtu)	0.00826	
	Total Particulate concentration (gr/dscf)	7.73E-03	
	Total Particulate concentration (lb/dscf)	1.10E-06	
	Total Particulate mass emission rate (lb/hr)	0.0396	
	Total Particulate mass emission rate (lb/mmBtu)	0.0178	
	Total Particulate mass emission rate (lb/ton raw feed)***	--	0.19
$E_{lb/hr}$	PM10 mass emission rate (lb/hr)*	0.0306	
	PM10 mass emission rate (lb/ton raw feed)***	--	0.18
$E_{lb/hr}$	PM2.5 mass emission rate (lb/hr)**	0.0251	
	PM2.5 mass emission rate (lb/ton raw feed)***	--	0.18

*PM10 = Total Filterable PM * 0.58 + CPM
**PM2.5 = Total Filterable PM * 0.32 + CPM
***Only a single run was completed, the operating temperature was adjusted.

AIR POLLUTION TESTING, INC.
DENVER, SALT LAKE CITY

Source Emissions Testing Report
Biochar Now

One (1) Batch Biochar Kiln
CO, NOx, VOC, Methanol, & Particulate Matter

Weld County, Colorado

Test Date: December 22, 2015

Report prepared for:
Biochar Now
1907 Gail Court
Loveland, Colorado 80537

Report prepared by:
Air Pollution Testing Inc.
5530 Marshall Street
Arvada, Colorado 80002

APT Project BCN5355

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T

Certification

Team Leader Certification:

I certify that all of the sampling and analytical procedures and data presented in this report are authentic and accurate.

Matthew Ferrier
Field Team Leader / Project Manager

Reviewer Certification:

I certify that all of the testing details and conclusions are accurate and valid.

Matthew Ferrier
Reviewer / Technical Writer

Table of Contents

1. Introduction

Air Pollution Testing, Inc. (APT) was contracted by Biochar Now (Biochar) for emission testing services at their manufacturing facility, located in Weld County at 19750 Weld County Road 7, Berthoud, Colorado 80513.

The purpose of the emissions testing program was to determine the concentrations and mass emission rates of nitrogen oxides (NO_X), carbon monoxide (CO), non-methane organic compounds (NMOC), methanol (MeOH), and particulate matter (PM) from the exhaust of one (1) biochar producing kiln during the volatilization step. Concurrent stack gas velocity, oxygen (O_2), carbon dioxide (CO_2) and moisture (H_2O) content were measured to determine mass emission rates.

The kiln was charged with railroad tie feedstock prior to processing. Operating conditions in the kiln included tightly controlled temperature, pressure, and oxygen levels to volatilize organic components. A cool down prior to unloading produced biochar follows. The volatilization step is typically complete after 8 – 15 hours.

The Biochar yield is optimized and emissions of pollutants are mitigated by the following methods:

- Sophisticated sensors and process controls during the kiln processing;
- Processing conditions which include a balanced oxygen environment with high temperature and negative pressure in the kiln during the volatilization step;
- Exit stack temperature of approximately 1650 degrees Fahrenheit in the presence of excess oxygen during the volatilization step

Key contact personnel involved in the project are shown in Table 1.1, on the following page.

Biochar Now: Kiln Testing Testing Program Contact Personnel		
Name, Title	*Company, Address*	*Contact Numbers*
Mr. Dave Parks, COO	Biochar Now 1907 Gail Court Loveland, Colorado 80537	970-305-1609
Mr. Bill Beierwaltes, CEO	Biochar Now 1907 Gail Court Loveland, Colorado 80537	970-593-9100, 970-667-3380 fax
Mr. Jeffrey Bishop Environmental Protection Specialist	CDPHE, APCD-SS-B1 4300 Cherry Creek Drive South Denver, Colorado 80246	303-692-3106
Mr. Dave Maiers, Operations Director	Air Pollution Testing, Inc. 5530 Marshall Street Arvada, Colorado 80002	303-420-5949 ext. 33, 303-420-5920 fax
Mr. George Iwaszek Managing Consultant	Trinity Consultants 1391 N Speer Blvd, Suite 350 Denver, Colorado 80204	720-638-7647 x105 303-349-4673 (m)

Table 1.1: Testing Program Contact Personnel

2. Summary of Results

The results of the testing program are summarized in Table 2.1. Any emission parameters not found in the table may be found in *Appendix 1 – Testing Parameters & Sample Calculations*. The following terms are used in the table:

- °F – temperature in degrees Fahrenheit
- "H_2O – pressure drop in inches of water
- %vd – diluent concentration, dry volume percent
- dscfm – volumetric flow, dry standard cubic feet per minute
- %vw – concentration, percent volume wet
- ppmvd – parts per million, dry volume basis
- g/dscf – grams per dry standard cubic foot
- lb/hr – pounds per hour
- tpy – tons per year
- NO_x – nitrogen oxides
- CO – carbon monoxide
- NMOC – non-methane organic compounds
- C_3H_8 – as propane
- MeOH – methanol
- PM – particulate matter

Biochar Now, Berthoud, Colorado Pole 2 NE Kiln NOx, CO, NMOC, MeOH, & Particulate Matter Emission Testing Results Summary EPA Methods 1-5, 7E, 10, 18, 25A December 22, 2015				
	Run 1	Run 2	Run 3	Average
Date	12/22/2015	12/22/2015	12/22/2015	
Start Time	7:54	10:20	13:00	
Stop Time	9:57	12:23	15:03	
Stack Temp. (°F)	1,211	1,147	1,130	**1,163**
O_2 (%vd)	8.6	10.1	9.4	**9.4**
CO_2 (%vd)	10.7	8.7	9.9	**9.7**
H_2O (%vw)	11.5	12.0	13.1	**12.2**
Stack Flow (dscfm)	489	474	461	**475**
Isokinetic Ratio (%)	95.2	99.4	100.0	**98.2**
NO_X (ppmvd)	93.5	58.6	81.8	**77.9**
NO_X (lb/hr)	0.3	0.2	0.3	**0.3**
NO_X (tpy)*	0.9	0.6	0.7	**0.7**
CO (ppmvd)	74.6	4.4	4.3	**27.8**
CO (lb/hr)	0.16	0.01	0.01	**0.06**
CO (tpy)*	0.44	0.02	0.02	**0.16**
NMOC (ppmvd as C_3H_8)	6.1	0.1	0.0	**2.1**
NMOC (lb/hr as C_3H_8)	0.0204	0.0005	0.0000	**0.0069**
NMOC (tpy as C_3H_8)*	0.056	0.001	0.000	**0.019**
MeOH (ppmvd)	0.10	0.10	0.06	**0.09**
MeOH (lb/hr)	0.0002	0.0002	0.0001	**0.0002**
MeOH (tpy)*	0.0007	0.0006	0.0004	**0.0006**
Front Half Particulate Matter – Method 5				
PM emissions (gr/dscf)	0.004	0.003	0.007	**0.005**
PM emissions (lb/hr)	0.004	0.003	0.007	**0.005**
PM emissions (tpy)	0.001	0.001	0.003	**0.002**
*Tons per year calculated using 5,475 hours of operation per year.				

Table 2.1: Kiln Test Results Summary – 12/22/2015

3. Sampling Methods

All testing was conducted in accordance with the following U.S. Environmental Protection Agency (USEPA) source emissions test methods referenced in *40 CFR Part 60, Appendix A*.

- *Method 1 – Sample and Velocity Traverses for Stationary Sources*
- *Method 2 – Determination of Gas Velocity and Volumetric Flow Rate in Ducts (S-Type Pitot)*
- *Method 3A – Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)*
- *Method 4 – Determination of Moisture Content in Stack Gases*
- *Method 5 – Determination of Particulate Matter Emissions from Stationary Sources*
- *Method 7E – Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)*
- *Method 10 – Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)*
- *Method 18 – Measurement of Gaseous Organic Compound Emissions by Gas Chromatography*
- *Method 25A – Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*

4. Test Program Summary

Three (3), 2-hour sample runs were conducted at the unit's exhaust to determine the emission concentrations of NO_x, CO, non-methane organic compounds (NMOC), methanol (MeOH), and particulate matter (PM). Concentration data were combined with concurrently collected oxygen (O_2), carbon dioxide (CO_2), moisture (H_2O) and gas velocity data to determine pollutant mass emission rates.

APT provided all necessary equipment and labor for the determination of all emission parameters detailed in Table 4.1, on the following page. All on-site gas analyzers were housed in a mobile, analytical trailer to provide a temperature-controlled environment for stable, accurate analyzer response.

Biochar Now: Kiln Testing **Sampling and Analytical Methods**			
Gas Parameter	*Sampling Method*	*Analytical Method*	*Laboratory*
gas flow	Methods 1, 2	draft gauge, thermocouple, pitot tube	APT - on-site
O_2, CO_2	Method 3A	paramagnetic and non-dispersive infrared analyzers	
H_2O	Method 4	gravimetric	
NO_X	Method 7E	chemiluminescent analyzer	
CO	Method 10	gas filter correlation, infrared analyzer	
MEOH	Method 18	gas chromatography	
NMOC	Method 25A	flame ionization analyzer with methane separation	
PM	Method 5	gravimetric	APT – Arvada, CO

Table 4.1: Sampling and Analytical Methods Summary

5. Test Method Details

5.1. Stack Gas Velocity, Volumetric Flow Rate, Moisture, & Particulate Matter

Stack gas velocity, volumetric flow rate, moisture (H_2O) content, and particulate matter were measured in accordance with EPA Methods 1, 2, 4, and 5.

Each sampling period consisted of conducting a temperature and differential pressure traverse of the stack using a K-type thermocouple and a wind tunnel-calibrated S-type pitot tube. A gas sample was extracted from the stack along a grid of points at an isokinetic flow rate. The gas sample was passed through a quartz probe nozzle, a heated quartz probe, across a heated quartz fiber filter, through a series of chilled glass impingers, and through a calibrated dry gas meter.

Prior to sampling, the first two impingers were seeded with 100 milliliters of water each. The third impinger was left empty. The fourth impinger was seeded with 250 grams of dried silica gel. Following sampling, the moisture gain in the impingers was measured gravimetrically to determine the moisture content of the stack gas. The filter and a series of acetone rinses of the nozzle, probe, and front-half connecting hardware (including the front half filter bell housing) were quantitatively recovered for gravimetric analysis to determine the PM content of the stack gas.

A total of three integrated samples for stack gas PM content analysis were collected.

The temperature and differential pressure traverse data were combined with diluent data to calculate the stack gas velocity and volumetric flow rate in units of feet per second (ft/sec), actual cubic feet per minute (acfm), and dry standard cubic feet per minute (dscfm). PM emissions were reported in concentrations of grains per dry standard cubic feet (gr/dscf), and mass rates of pounds per hour (lb/hr) and tons per year (tpy).

5.2. Diluent (O_2 and CO_2), Nitrogen Oxides and Carbon Monoxide

O_2, CO_2, NO_X and CO emission concentrations were measured in accordance with EPA Methods 3A (O_2 and CO_2), 7E (NO_X) and 10 (CO).

Each sampling period consisted of extracting a gas sample from the stack at a constant flow rate of approximately four liters per minute (lpm). The sample passed through a refrigeration-type gas conditioner to remove moisture and into the sampling port of a Thermo Environmental Instruments (TECO) Model 42CHL chemiluminescent NO_X analyzer, a TECO Model 48H gas filter correlation infrared CO analyzer, and a Servomex Series 1400 paramagnetic O_2 / non-dispersive infrared CO_2 analyzer. The gas concentrations were displayed on the analyzer front panels in units of either parts per million, dry volume basis (ppmvd – NO_X and CO) or percent, dry volume basis (%vd – O_2 and CO_2) and logged to a computerized data acquisition system (CDAS). Please see *Appendix 5 – Schematics* for a diagram of the EPA Methods 3A, 7E and 10 sampling train.

The initial three-point calibration test for each species was conducted in direct calibration mode. Periodically, the sample system was challenged with calibration gases for a system bias check, and to quantify zero and span drift for the previous sampling period. The calibration gases were prepared and certified in accordance with EPA Protocol 1.

The initial 3-point calibration error was less than ±2% of the calibration span gas (CS). The sampling system bias recorded during the performance test was less than ±5 percent of the CS. The zero and span calibration drift did not exceed ±3 percent of the CS over the period of each run.

Sampling was conducted from a single point in the approximate area center of the stack. The stack geometry provided adequate gas mixing. A stratification was not conducted due to the process cycling through multiple batch conditions.

A NO_X converter efficiency test was conducted on-site.

Following sampling, the CDAS data were averaged in one-minute increments, corrected for instrumental drift, and reported as average O_2, CO_2, NO_X and CO emission concentrations for each sampling period in units of %vd or ppmvd. The concentration data was combined with concurrently collected stack gas flow data to calculate the CO_2, NO_X and CO mass emission rates in units of lb/hr and tpy based on production. NO_X is expressed as NO_2.

5.3. Non-Methane Organic Compounds

NMOC concentrations were measured in accordance with EPA Method 25A using a hydrocarbon analyzer equipped with a methane separator.

Each sampling period consisted of extracting a hot, wet gas sample from the stack at a constant flow rate of approximately two liters per minute using a heated Teflon line. The gas was directed into a column of the Thermo Model 55C flame ionization analyzer, where the methane is separated from the sample. NMOC concentrations were displayed on the analyzer front panel in units of parts per million, wet volume basis (ppmvw – as propane) and logged to a CDAS (see *Appendix 5 – Schematics*).

Triplicate Protocol 1 propane standards were used to calibrate the 55C non-methane measurement system. Periodically, the analyzer was challenged with EPA Protocol 1 calibration gases to calibrate the instrument, to verify linearity of response, and to quantify zero and span drift for the previous sampling period. To ensure no system bias, the analyzer calibrations were conducted by introducing all gases to the analyzer at the sampling probe at stack pressure. Following sampling, the CDAS data were averaged in one-minute increments, corrected for instrumental drift, and reported as average emission concentrations for each sampling period.

The concentration measurements were combined with concurrently collected flow data to calculate NMOC emissions in units of lb/hr and tpy based on production.

5.4. Methanol

Methanol emission levels were determined in accordance with EPA Method 18 using the direct interface sampling and analysis procedures detailed in the method. Samples were analyzed on-site with an HP Model 5890 Series II Gas Chromatograph equipped with a flame ionization detector (FID) and Chemstation software.

Gas phase calibration standards were prepared by dilution of a +/-2% accuracy certified gas standard. Preparation of diluted standards was conducted using a gas-tight volumetric syringe and new Tedlar bags. Triplicate injections, per gas standard, were used to create a three-point calibration curve for each gas component. A least squares line (y=mx) was fit to each data set.

Prior to sampling, a system check was conducted with methanol. The sampling system is valid if sample loss is less than +/-20%. Additionally, a grab sample of stack gas was spiked with methanol to ensure quantification of the appropriate peak.

Direct interface sampling consisted of approximately five (5) injections per hour. Using a heated sample probe/line, stack gas was transported directly to the GC gas sampling valve. Following analysis of stack gas samples, the mid-level calibration standard was re-analyzed at the gas sampling valve in triplicate. The initial calibration response (triplicate average) and the post-test check response (triplicate average) were within 5%

of their mean value, so the initial calibration linear regression data was used to quantify emission levels.

The results of the GC analysis were used to calculate methanol emission levels in units of parts per million, wet volume basis (ppmvw). Methanol concentrations were combined with volumetric flow rates to determine mass emission rates.