December 4, 2024

LCA Report and Pathway Description of Renewable Natural Gas sourced from Grady Farms Delivered for Transportation Fuel use in California

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Anew RNG, LLC[1] ("Anew"), a wholly owned subsidiary of Anew Climate, LLC, is pleased to submit this LCFS application utilizing livestock-derived biomethane from Align RNG Arizona – Grady Swine facility (the "Facility"), owned and operated by Align RNG, LLC (the "Operator"). The enclosed package includes the following:

1. AFP Attestation
2. Contractual Pathway Agreements
3. Permits
4. Process flow and Metering diagram
5. LCA and Facility Operation Calculations and Overview
6. Physical Pipeline Injection Statements
7. GREET 3.0 Livestock Calculation Tool
8. Manure Management Questionnaire
9. Historical Livestock Calculation Tools (VS Carryover Calculation)
10. Livestock Population Counts
11. Utility Usage Invoices
12. Pathway Mapping
13. GREET Model Site Specific Modifications
14. Engineering Review
15. Anew Contract Flow Diagram and Contracts

Thank you,

Anew RNG, LLC
3200 SW Fwy, Ste 1310
Houston, TX 77027 rng@anewclimate.com

Description of the Project

The Grady Farms project receives biogas from 19 different swine farms (facility ID F00630, hereinafter referred to "Grady") in the surrounding area which are co-located approximately between 3 and 11 miles from Grady's biogas upgrading facility. As of Q2 of 2024, 6 of the 19 farms are actively producing biogas and sending it for upgrade. These farms are Kilpatrick Farm 1, Goodson Farm, M&M-Waters Farm, Dell Farm, DM Farm Section 3 and DM Section 2. Combined, these farms are permitted for [redacted] ([redacted], [redacted], [redacted], [redacted], [redacted] and [redacted] respectively) grow-to-finish spaces. All the farms have 1 covered lagoon/digester per facility, with DM Section 2 as an exception of 2 covered lagoons. The Facility is currently participating in the Renewable Fuel Standard (RFS) Program (EPA Facility ID: 73661) and was approved in October 2023. It has never participated in the Offset Protocol Project or in the Cap-and-Trade Program. Table 1 shows the construction dates of the farms and lagoons. The biogas upgrading facility commenced construction in February 2022 and completed construction in October 2022 with startup on November 2, 2022. The facility began the injection of RNG into the commercial pipeline on November 11, 2022.

Prior to the Grady Road project, the Magnolia site was a waste-to-power renewable project that stood alone and has been online under various owners since 2013. It consisted of 10 above ground digesters connected to engines which combusted biogas to generate electricity. Those above ground digesters have been retired in favor of in-ground covered lagoon style digesters, which are connected (or being connected) to the Grady system. The small generator has been offline since November 2023. Align RNG Magnolia LLC, a subsidiary of Align RNG Grady Road LLC, also generates and sells NC Swine RECs and Carbon Credits based off its renewable electricity production, but there is no participation in any low-CI or carbon intensity-related programs. The produced electricity was not and currently is not consumed on-site and is subtracted from biogas sent to upgrading facility.

Farm Name	**Kilpatrick Farm**	**Goodson Farm**	**M&M-Waters**	**Dell Farm**	**DM Section 3**	**DM Section 2**
Year of Construction of Farm	1985	Farm 20873 (HS 01-12): 1987 Farm 20873 (HS 13-24): 1987	Waters 1-2: 1989 M&M Farms: 1989 Waters 3-5: 1989	Melville 1:1984 Melville 2:1984 Dell Farm: 1984 DM 1-4: 1994	DM 3-1: 1995 DM 3-2: 1995 DM 3-3: 1994	DM 2-1: 1994 DM 2-2: 1994 DM 2-3: 1994 DM 2-4: 1994
Year of Construction of Lagoon	Lagoon 1: 1996 Lagoon 2: 1995	Lagoon 3: 1987 Lagoon 4: 1994 Lagoon 2: 1987	Lagoon 3: 1989 Lagoon 2: 1995 Lagoon 4: 1989	Lagoon 3: 1984 Lagoon 2: 1984 Lagoon 1: 1995 Lagoon 4: 1994	Lagoon 4: 1995 Lagoon 3: 1995 Lagoon 1: 1994, Lagoon 2: 1994	Lagoon 1: 1994 Lagoon 2: 1994 Lagoon 3: 1994 Lagoon 4: 1994
Year and month of digester/covered lagoon completion	Lagoon 1 (Covered): Aug 2021	Lagoon 1 (Digester): Sept 2021	Lagoon 1 (Digester): Aug 2021	Lagoon 1 (Covered): Apr 2022	Lagoon 1 (Covered): May 2022	Lagoon 3 (Covered): October 2023 Lagoon 2 (Covered): February 2024

Table 1: Construction dates

Figure 1 below shows the layout of the farms in respect to the upgrading facility (GUS) and injection point (Compressor Site). The currently online facilities are highlighted with their approximate driving distance from the upgrader displayed under them.

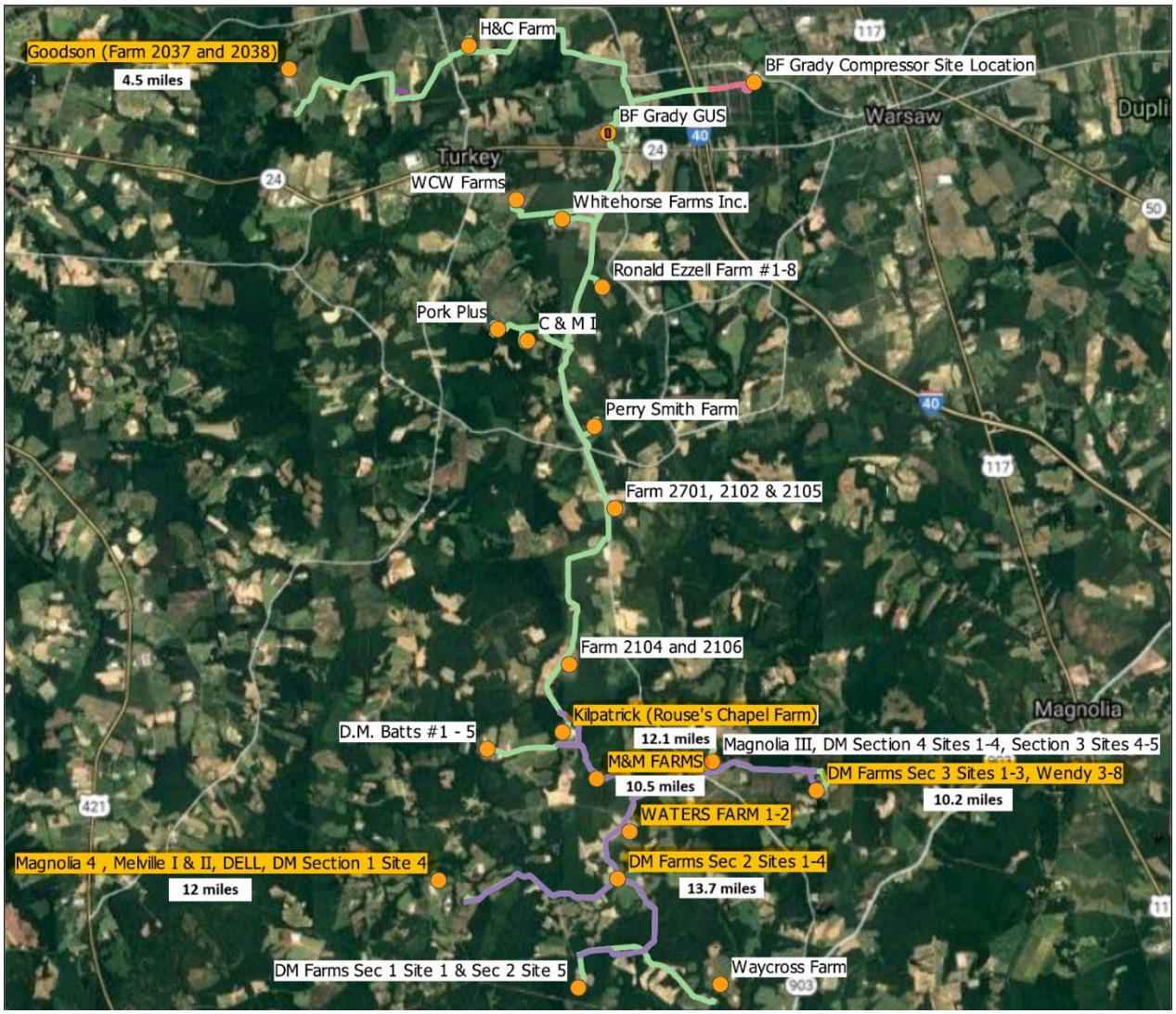

Figure 1: Grady Farms Site Layout

Process Flow

Grady collects biogas from 6, recently covered swine waste lagoon digesters. Lagoon digester biogas blowers transfer biogas via underground HDPE piping to the Grady central biogas upgrading system. The biogas upgrading system separates the raw biogas into pipeline grade renewable natural gas (RNG) and tail-gas (mainly CO_2), utilizing an Amine upgrading system. The RNG is injected into a nearby Piedmont Natural Gas Gathering line. No trucks are being used in the biogas or RNG transporting, both are flowing through a pipeline. A biological scrubber removes a significant portion of tail-gas H_2S followed by trace H_2S capture media, before being combusted in a thermal oxidizer. [redacted] supplies the electricity for the [redacted], [redacted] supplies electricity to the farms, and [redacted] supplies natural gas to the facility. The process is shown in Figure 2.

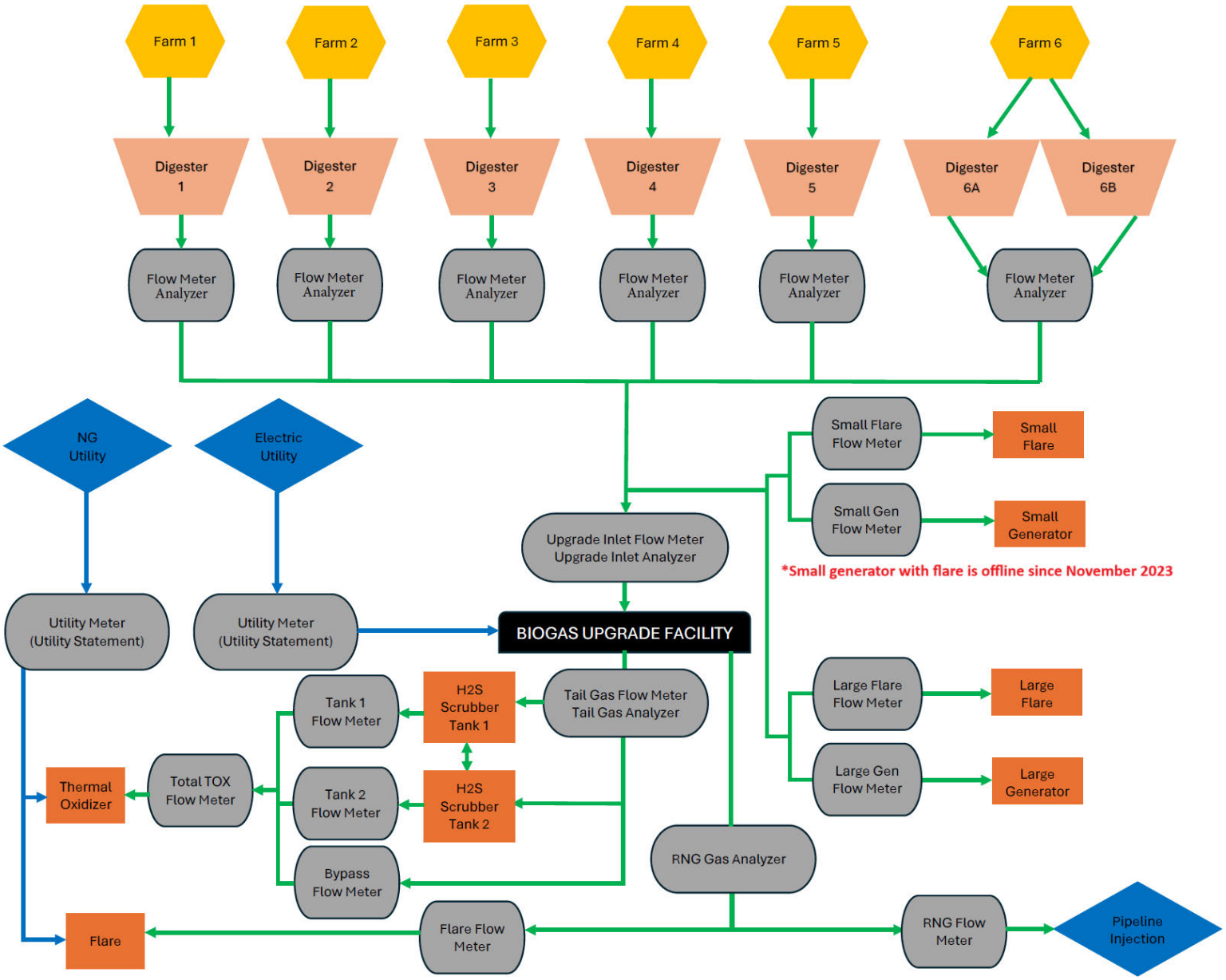

Figure 2: Process Flow Diagram

Baseline Manure Management

At all of these farm's practices, the manure and urine flow follow a specific process. Swine feces and urine fall through slatted floors, and periodically recycled water is used to flush through the sub-floor gutter, and direct manure flow to anaerobic lagoons.

Project Manure Management

Under the project condition, manure is collected the same way as baseline, however, the manure then flows through a gravity pipe, typically an [redacted]" PVC, to reach the digester. The effluent from the digester is pumped to secondary storage lagoons. Some of this wastewater is used to flush through the barns, while the remaining wastewater is stored in open lagoons. This stored wastewater is later applied to the land following an approved waste utilization plan and permit. The process is not requiring trucks for manure handling. The process is same for both the baseline and the project (Figure 3). Detailed description of the manure management can be found in Item 8.

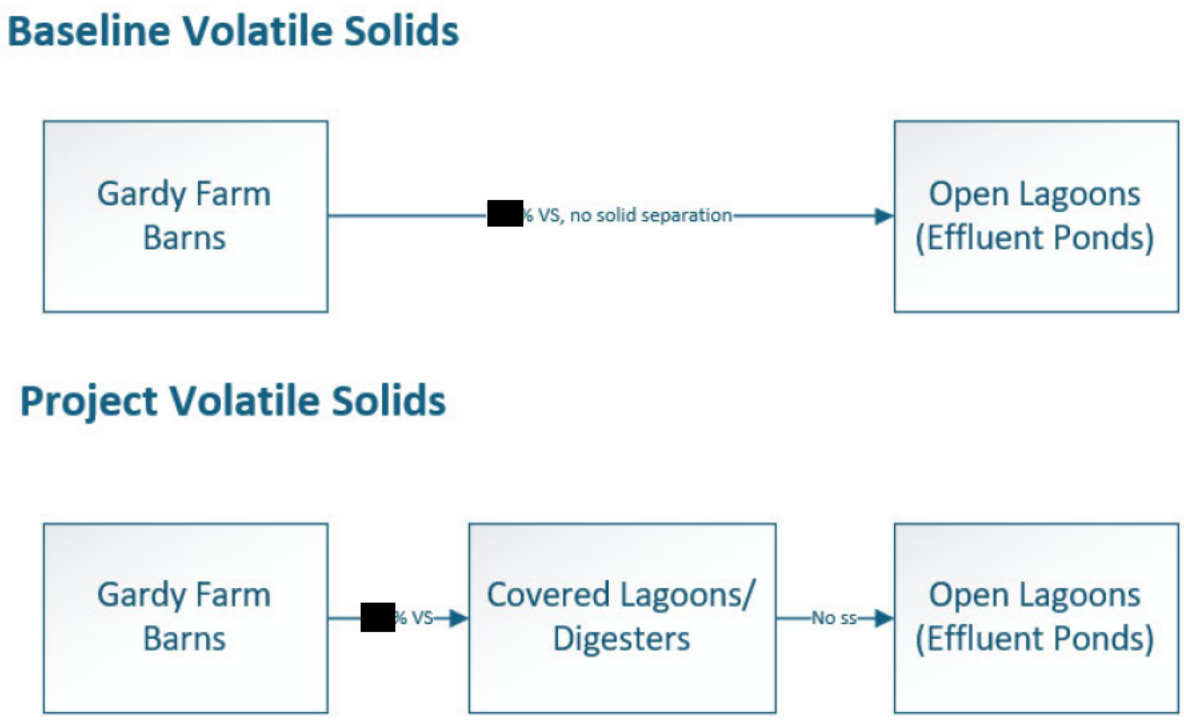

Figure 3: Goodson Farm Overview

Site maps

The manure flow is indicated by blue arrows. Higher resolution maps are found in Item 4.

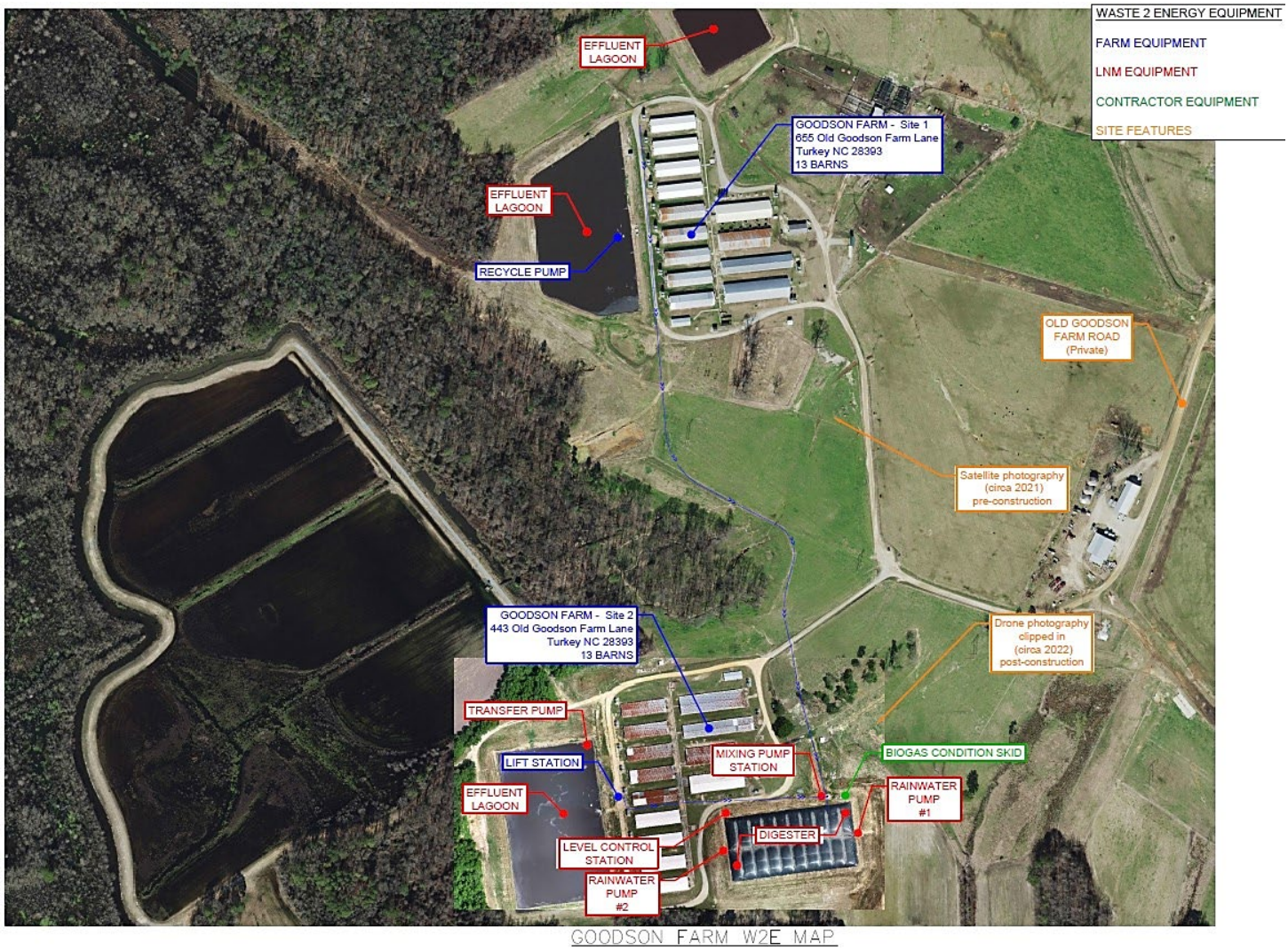

Figure 4: Goodson Farm Overview

Figure 5: Kilpatrick Farm Overview

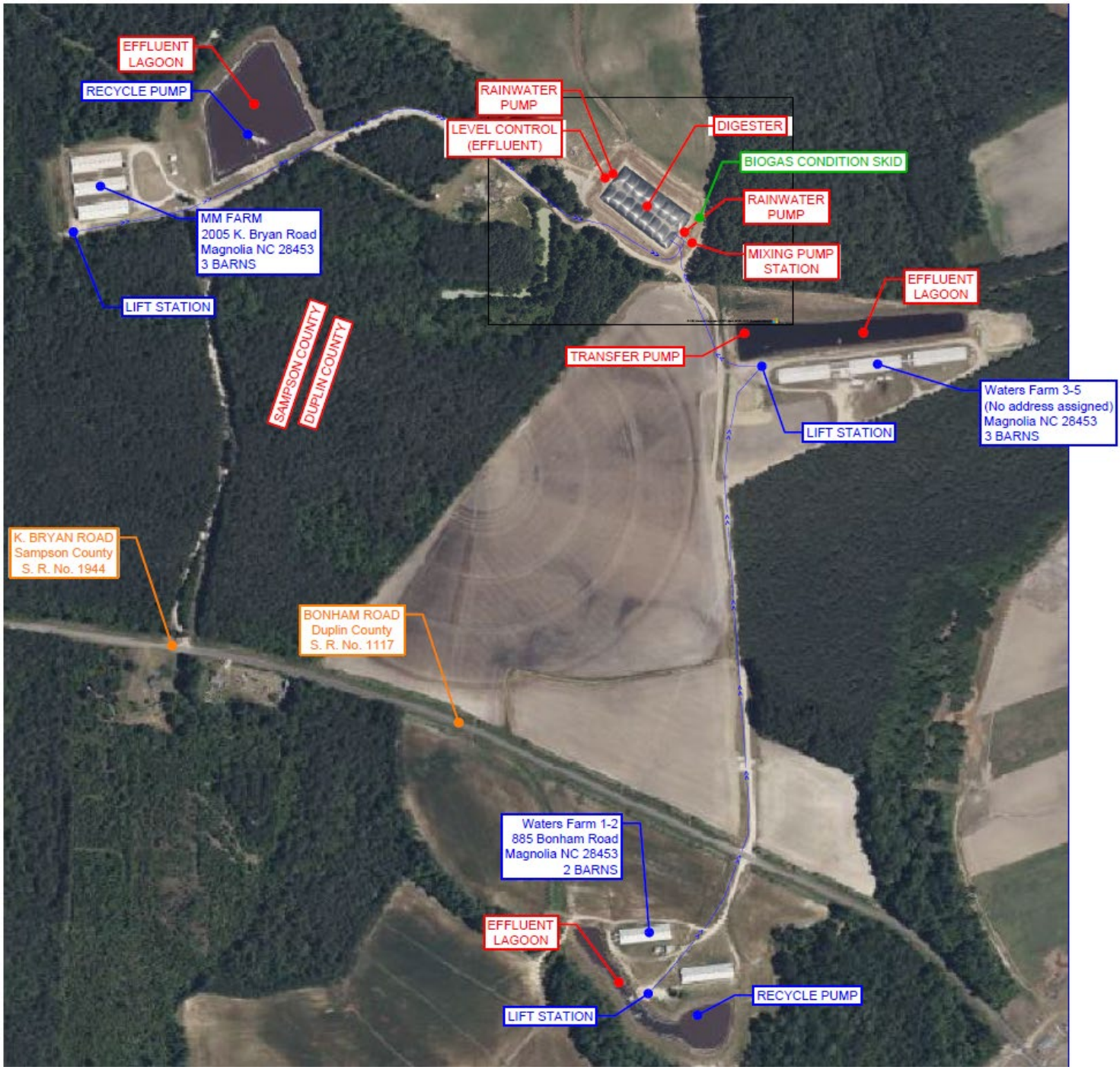

Figure 6: M&M Waters Map

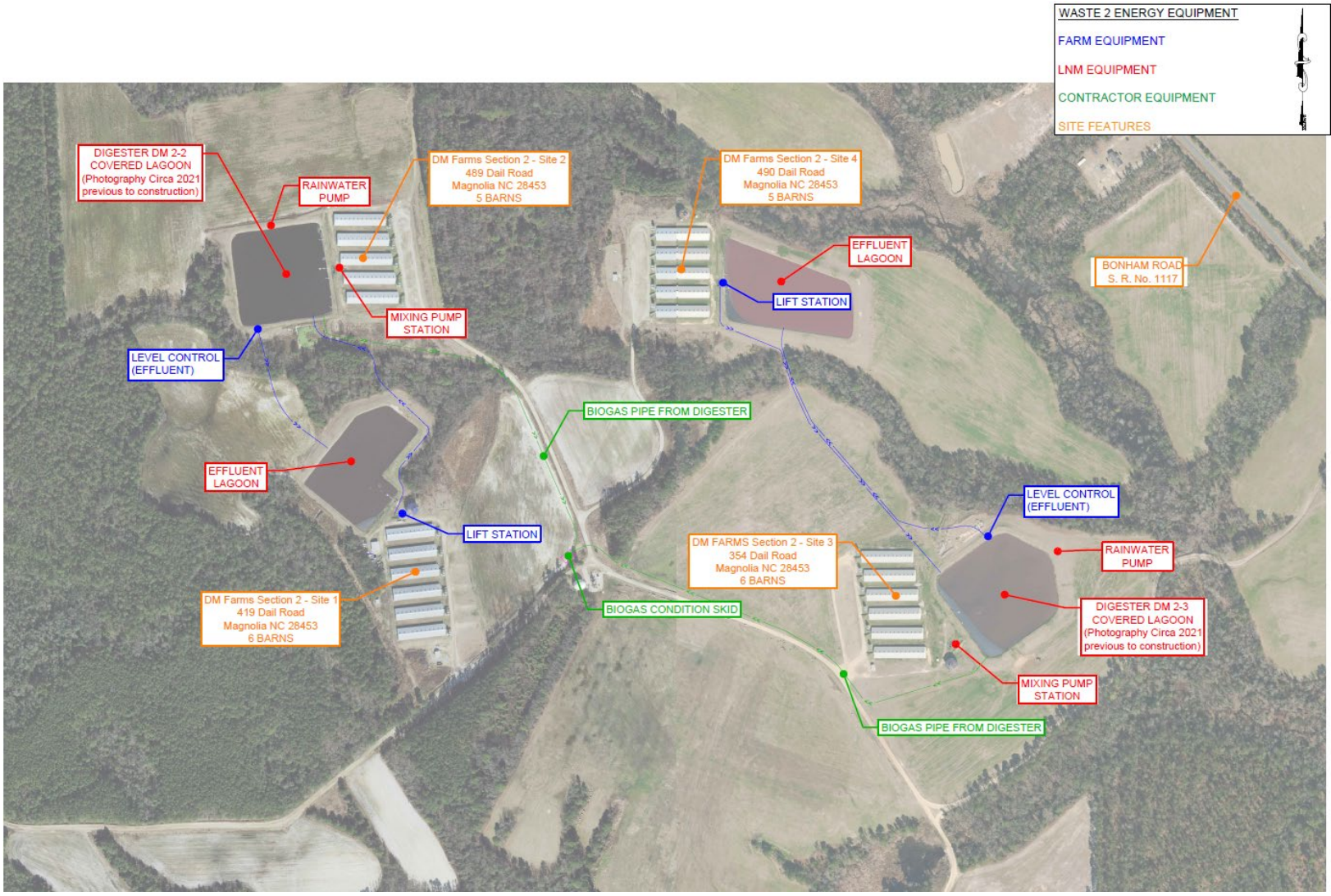

Figure 7: DM Section 2 Farms Overview

Figure 8: DM Section 3 Overview

Upgrading facility and RNG Injection Point

The biogas upgrading facility is located at 2940 NC-24, Turkey, NC 28393, approximately 3 miles from the injection point located at 867 Penny Branch Rd, Warsaw, NC 28398, USA. **Figure 9** is showing an aerial photo of the upgrading facility made with a drone, while **Figure 10** shows an aerial image of the injection point with added description.

Figure 9: Upgrading facility drone photo

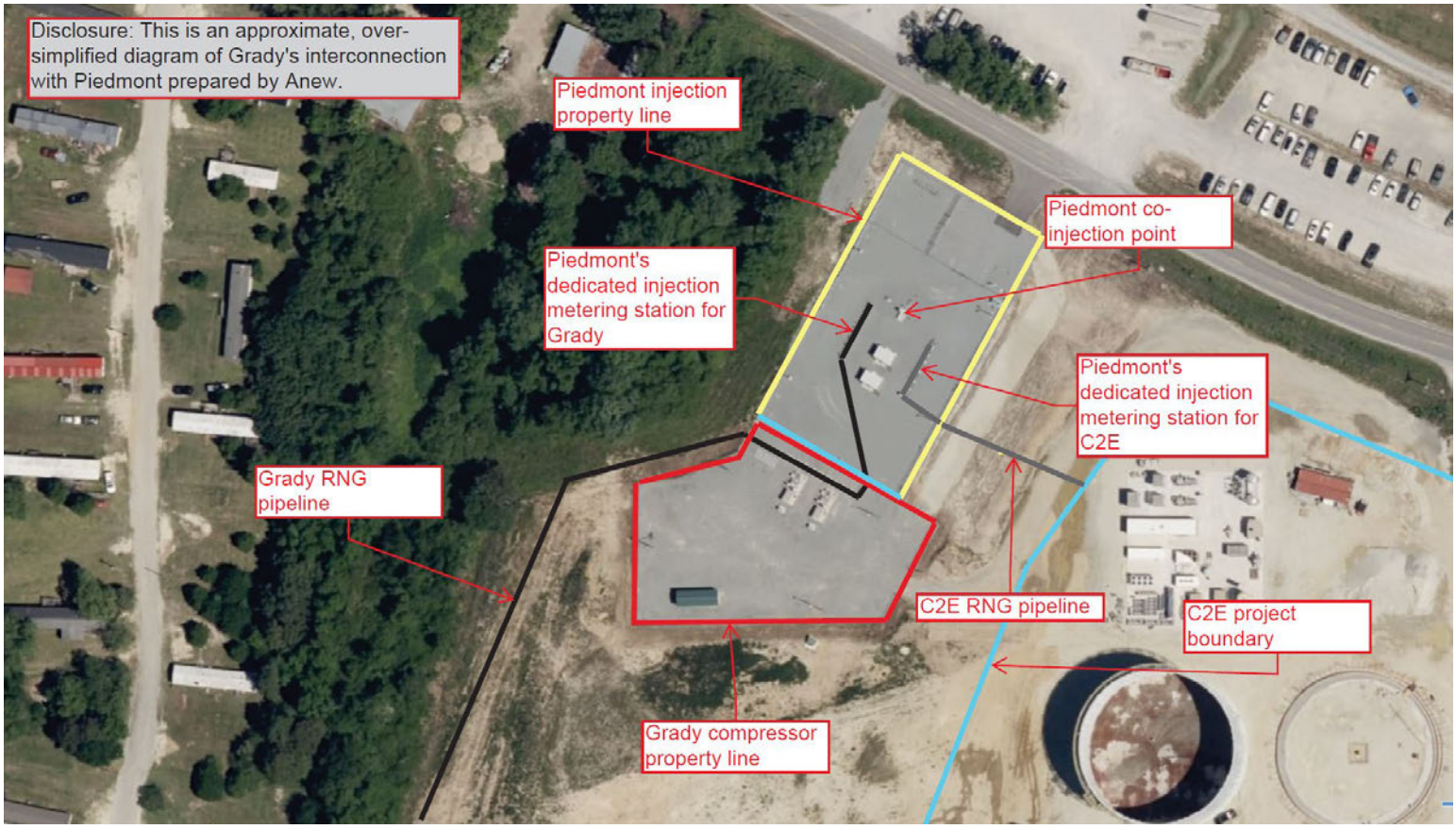

Figure 10: Injection point

System Boundary

The system boundary is detailed in Figure 7 below.

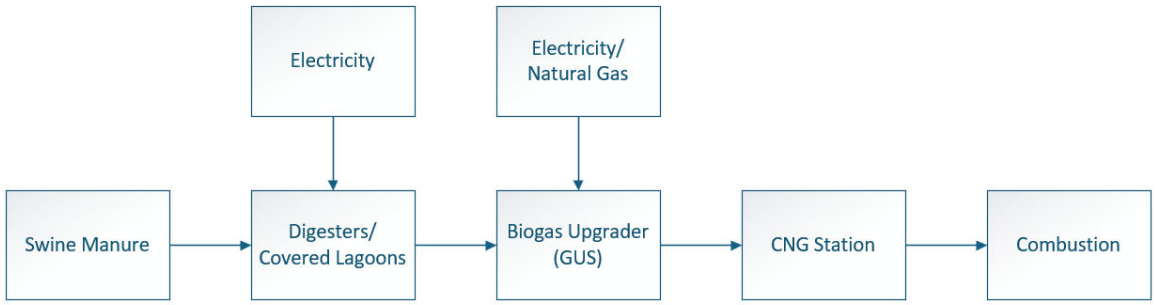

Figure 11: System boundary from Biogas to RNG Production

Ownership of Environmental Attributes

The biomethane and associated environmental attributes are conveyed to Anew at the pipeline injection point. Anew matches the associated environmental attributes to fuel dispensed at various CNG fueling stations in California. Anew holds the rights to associated environmental attributes, LCFS reporting and credit generation.

Operations and Meter Data

The GREET modeling and LOP period covers 5 months of project operational data from April 2024 through August 2024 and 24 months of historical livestock. During the operational period, no venting event occurred. The process flow diagram and meter configuration of the upgrading facility has been provided separately with the application. Continuous meter data readings used for GREET modeling are available for each of the required metering locations and have been provided in the Life Cycle Analysis spreadsheet attached in. All submitted data has been reviewed by CARB staff and verified by an approved independent third-party.

Pipeline Injection for transportation to California

Grady Farms biogas processing facility includes on-site pipeline injection infrastructure. There is a dedicated flow and gas chromatograph meter data at the injection point to clearly distinguish the amount of RNG reaches the pipeline. The third-party pipeline injection statement as also measured with utility grade instruments and the physical statements have been included with the application and details on the pipeline injection volumes used in the GREET model are shown in the corresponding LCA spreadsheet.

Methane Emissions and Carbon Intensity Calculations (GREET)

Beginning the year of 2019, a *Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Dairy and Swine Manure* was released by ARB staff. A calibrated Tier 2 GREET model is attached with the application, and the contents of relevant sections to this application are described below. Details of the inputs and modifications made to the GREET model are included in this report and attached. Any modifications done to the GREET model default values and inputs are shown in the GREET model with highlighted cells and text descriptions.
The baseline quantity of avoided methane reflected in the CI calculation is additional to any legal requirement for the capture and destruction of biogas that apply to the project.

a) Manure-to-Biogas (LOP Inputs) tab

This part of the GREET model calculator requires project operational data in conjunction with associated livestock data (**Item 10**) to calculate project baseline methane emissions. This includes livestock weight measurement recordkeeping, which is only used as reference material and is not used to change any GREET model default values or livestock data. The livestock populations provided by Grady Farms have been included as **Item 10.** with the application and calculations for the VS carry over have been included in **Item 9**.

The approach used to establish the LOP baseline was to include all months of the modeling period (i.e. to include the winter months when the lagoons too cold for microbial activity, and no digester gas is collected and processed). Equation 5.3 of the LOP takes ambient temperature into account through the application of the Van't Hoff-Arrhenius factor to allow for accurate modeling of the biogas production throughout the year.

b) Biogas-to-RNG tab

Detailed inputs and analysis of metered and invoiced data can be found in the attached LCA spreadsheet (i.e. **Item 11 or Item 5**). Operational meter data will be collected every month of the year. This includes the months when the biogas upgrading facility is not operating, the lagoons may store biogas during this period.
Invoices for electricity process fuel usage have been included as **Item 11**. Any changes to the GREET model are captured in **Item 13**, which includes adjustments following ARB guidance. The physical pipeline distance from the Farms to the CNG facilities has been established between 1 and 12 miles. Demonstration of this measurement and locations is provided in **Item 12**.

c) Avoided Emissions tab

The GREET model instructions and default formulas were followed as closely as possible. However, there were multiple instances where Conservative Margin of Safety practices were implemented to account for potential process variability and diminish the risk of non-compliance with the certified CI.

The net baseline methane emissions modeled by the COP Livestock Calculation Tool may exceed the amount of metered total methane capture in the modeling period. To avoid overstatement of avoided methane in the pathway, the net methane emissions avoided value was set to the level of metered total methane captured. In addition, the avoided methane is now equal to produced methane and no diverted CO2 credits should be awarded.

However, in the event the net baseline methane net baseline methane emissions modeled by the COP Livestock Calculation Tool do not exceed the amount of metered total methane capture in the modeling period, the default GREET model calculations are reverted.

Details of the changes to the GREET model are shown in **Item 13**.

d) Mass Balance

Following the guidelines described in ARB's *Biomethane From Dairy and Livestock Operations* GREET model calculator, the following mass balance equation from metered parameters was used during the modeling of biogas sent to the upgrading facility and RNG pipeline injection.

[1] = [2] + [3] + [4] + [5]
Where:

[1] – biogas methane flow [redacted]
[2] – biogas methane flow [redacted]
[3] – biogas sent to [redacted]

[4] – biogas methane flow of [redacted]
[5] – renewable natural gas [redacted]
[6] – mass balance adjustment, calculated as [1]-[2]-[3]-[4]–[5]

Any adjustments resulting from the sub-formula resulting from the mass balance calculation are attributed to fugitive emissions if the value is greater than the default 2%. This is an additional Conservative Margin of Safety practice applied, as gas flow allocated to the fugitive emissions increases the RNG upgrading emissions in the pathway.

LCA Overview

The methods, steps and resources used to calibrate the GREET Model, LOP tool and LCA spreadsheet are described in the previous sections. For additional details, the applicable documentation and narrative has been provided either as an attachment or noted within the application material. fuel pathway application has been submitted with the required AFP Attestation (**Item 1**) and the contractual flow diagram (**Item 2**).

To summarize, the aggregate shown in **Item 5** highlights GREET model energy inputs and associated emissions with the final CI value.

The final CI was calculated using the CI calculator along with a conservative margin of safety added by the applicant.

Section 4. CI Calculation Details					
Manure to LNG			GHG emissions CO_2e	CI, gCO_2e/MMBtu	gCO_2e/MJ
23-SRVC Mix	Raw Biogas Production-Digester	Net-Diesel	[redacted]	[redacted]	[redacted]
		Net-Grid electricity	[redacted]	[redacted]	[redacted]
		Utility source NG	[redacted]	[redacted]	[redacted]
		Biomethane (heat)	[redacted]	[redacted]	[redacted]
		Subtotal			21.67
	Biogas upgrading	Grid electricity	[redacted]	[redacted]	[redacted]
		Utility source NG	[redacted]	[redacted]	[redacted]
		Biomethane (process fuel)	[redacted]	[redacted]	[redacted]
		Onsite electricity from biomethane	[redacted]	[redacted]	[redacted]
		Biomethane (flaring)	[redacted]	[redacted]	[redacted]
		Feed Loss (fugitive methane)	[redacted]	[redacted]	[redacted]
		Subtotal			32.30
1-US Average	Biomethane Transmission	by pipeline to LNG Plant	[redacted]	[redacted]	[redacted]
		by pipeline to CNG Plant	[redacted]	[redacted]	[redacted]
3-CAMX Mix	LNG Production	NG used as process fuel	[redacted]	[redacted]	[redacted]
		Electricity	[redacted]	[redacted]	[redacted]
		Subtotal			0.00
	LNG Transport and Distribution	By Truck	[redacted]	[redacted]	[redacted]
	LNG Storage		[redacted]	[redacted]	[redacted]
		Subtotal			0.00
Manure to CNG/LNG			GHG emissions CO_2e	CI, gCO_2e/MMBtu	gCO_2e/MJ
3-CAMX Mix	L-CNG and CNG Production	CI for Compression of CNG (standard Value)		3,688.80	3.50
	Tailpipe Emissions	CNG Vehicles		64.073	60.73
		LNG Vehicles		64.024	60.68
	Credits			Methane avoided	-518.28
				CO2 diverted	0.00
				Final CNG CI, g/MJ	-388.63
				Final LNG CI, g/MJ	0.00
				Final L-CNG CI, g/MJ	0.00

Figure 12: Table copied from the calibrated GREET Model attached to the application.