# FINAL REPORT



# BLUE WATER RENEWABLE, LLC

SMITHS CREEK, MICHIGAN

**COMPLIANCE TESTING REPORT:**
**FG-ICEENGINES NOX, CO, NMOC, HCL, AND SO2 EMISSIONS**

RWDI #2301562

April 20, 2023


**SUBMITTED TO**

**Maureen Bennett**
Environmental Engineer
Maureen.Bennett@dteenergy.com
M: 734.834.0005

**Blue Water Renewables, LLC**
6779 Smiths Creek Rd
Smiths Creek, Michigan 48074

**Irrana Konanahalli**
**EGLE, Air Quality Division**
27700 Donald Court
Warren, Michigan 48092-2793

**TPU Supervisor**
**EGLE, Air Quality Division**
Constitution Hall, 2nd Floor South
525 West Allegan Street
Lansing, MI 48933

**SUBMITTED BY**

**Steve Smith, QSTI**
Project Manager
Steve.Smith@rwdi.com | ext. 3706

**Mason Sakshaug, QSTI**
Senior Scientist
Mason.Sakshaug@rwdi.com | ext. 3703

**RWDI USA LLC**
**Consulting Engineers & Scientists**
2239 Star Court
Rochester Hills, Michigan 48309

T: 248.841.8442
F: 519.823.1316

# EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) has been retained by Blue Water Renewables, LLC (Blue Water) to complete the emission sampling program at the Smiths Creek Landfill facility located at 6779 Smiths Creek Road, Smiths Creek, Michigan 48074. Blue Water operates two (2) landfill-fired engines (FG-ICEENGINES/FG-ICEENGINES-BWR2) (referred to as Engine 1 and Engine 2). Testing consisted of emissions for nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane organic compounds (NMOC), sulfur dioxide ($SO_2$), and hydrogen chloride (HCl). The testing was required by Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

Compliance testing was completed for Engine 1 on February 28, 2023, and for Engine 2 on March 1, 2023.

**Executive Table i:** Results Summary – Engine 1

| Source | Analyte | Units | Average | Limit |
|---|---|---|---|---|
| **Engine 1** | $NO_x$ | $ppmv_d$ @ 15% $O_2$ | 34.78 | 150.0 |
| | | lb/hr | 2.53 | 3.0 |
| | | g/hp-hr | 0.5 | 2.0 |
| | CO | $ppmv_d$ @ 15% $O_2$ | 279.67 | 610 |
| | | lb/hr | 12.40 | 16.3 |
| | | g/hp-hr | 2.6 | 5.0 |
| | HCl | $ppmv_d$ @ 15% $O_2$ | 0.48 | 80 |
| | | lb/hr | 0.03 | 0.51 |
| | $SO_2$ | lb/hr | 2.43 | 6.21 |
| | NMOC | g/hp-hr | 0.05 | 1.0 |

**Executive Table ii:** Results Summary – Engine 2

| Source | Analyte | Units | Average | Limit |
|---|---|---|---|---|
| **Engine 2** | $NO_x$ | $ppmv_d$ @ 15% $O_2$ | 38.51 | 150.0 |
| | | lb/hr | 2.82 | 3.0 |
| | | g/hp-hr | 0.6 | 2.0 |
| | CO | $ppmv_d$ @ 15% $O_2$ | 279.86 | 610 |
| | | lb/hr | 12.47 | 16.3 |
| | | g/hp-hr | 2.6 | 5.0 |
| | HCl | $ppmv_d$ @ 15% $O_2$ | 0.76 | 80 |
| | | lb/hr | 0.04 | 0.51 |
| | $SO_2$ | lb/hr | 2.39 | 6.21 |
| | NMOC | g/hp-hr | 0.00 | 1.0 |

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| | | g/hp-hr | 2.6 | 5.0 |
| | HCl | ppmv$_d$ @ 15% $O_2$ | 0.48 | 80 |
| | | lb/hr | 0.03 | 0.51 |
| | $SO_2$ | lb/hr | 2.43 | 6.21 |
| | NMOC | g/hp-hr | 0.05 | 1.0 |

**Executive Table ii:** Results Summary – Engine 2

| Source | Analyte | Units | Average | Limit |
|---|---|---|---|---|
| Engine 2 | $NO_x$ | ppmv$_d$ @ 15% $O_2$ | 38.51 | 150.0 |
| | | lb/hr | 2.82 | 3.0 |
| | | g/hp-hr | 0.6 | 2.0 |
| | CO | ppmv$_d$ @ 15% $O_2$ | 279.86 | 610 |
| | | lb/hr | 12.47 | 16.3 |
| | | g/hp-hr | 2.6 | 5.0 |
| | HCl | ppmv$_d$ @ 15% $O_2$ | 0.76 | 80 |
| | | lb/hr | 0.04 | 0.51 |
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| | NMOC | g/hp-hr | 0.00 | 1.0 |

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# 1 INTRODUCTION

RWDI USA LLC (RWDI) has been retained by Blue Water Renewables, LLC (Blue Water) to complete the emission sampling program at the Smiths Creek Landfill facility located at 6779 Smiths Creek Road, Smiths Creek, Michigan 48074. Blue Water operates two (2) landfill-fired engines (FG-ICEENGINES/FG-ICEENGINES-BWR2) (referred to as Engine 1 and Engine 2). Testing consisted of emissions for nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane organic compounds (NMOC), sulfur dioxide ($SO_2$), and hydrogen chloride (HCl). The testing was required by Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

## 1.1 Location and Date of Testing

The testing program was completed on February 28, 2023 and March 1, 2023 at the Smiths Creek Landfill/Blue Water facility located at 6779 Smiths Creek Road, Smiths Creek, Michigan.

## 1.2 Purpose of the Testing

The purpose of testing was to show compliance with Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

## 1.3 Description of the Source

Blue Water Renewables operates two Caterpillar G3520C Engines with associated generator sets. The engines are fueled by landfill gas generated by the landfill and produce electricity which is sent to the electric grid.

## 1.4 Personnel Involved in Testing

**Table 1.4.1:** List of Testing Personnel

| | | |
|---|---|---|
| **Maureen Bennett**<br>Environmental Engineer<br>Maureen.Bennett@dteenergy.com | **Blue Water Renewable, LLC**<br>6779 Smiths Creek Road<br>Smiths Creek, MI 48074 | (734) 834-0005 |
| **Lindsay Wells**<br>Air Quality Division<br>WellsL8@michigan.gov | **State of Michigan**<br>Department of Environment, Great Lakes, and Energy<br>Technical Programs Unit | (517) 282-2345 |
| **Mason Sakshaug**<br>Technical Supervisor<br>Mason.Sakshaug@rwdi.com | **RWDI USA LLC**<br>2239 Star Court<br>Rochester Hills, MI 48309 | (248) 234-3885 |
| **Ben Durham**<br>Senior Field Technician<br>Ben.Durham@rwdi.com | | (734) 474-1731 |

# 2 SUMMARY OF RESULTS

## 2.1 Operating Data

Operational data collected during the testing included the following (found in **Appendix A**):

- Engine Power Output (kW);
- Engine Speed;
- Engine Operating Horsepower (bHp);
- Fuel flow;
- Engine Serial Number; and
- Engine Total Operating Hours.

## 2.2 Applicable Permit Number

Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018

# 3 SOURCE DESCRIPTION

## 3.1 Description of Process and Emission Control Equipment

Refer to Section 1.3 for a description of the process.

Engine 1 and Engine 2 have catalytic converters for emissions control.

## 3.2 Process Flow Sheet or Diagram

A process schematic can be provided upon request.

## 3.3 Type and Quantity of Raw and Finished Materials

The Engines use landfill gas to produce power.

## 3.4 Normal Rated Capacity of Process

Both engines are identical spark ignition, lean burn, reciprocating internal combustion engines (Caterpillar G3520C, 2,333 bhp at 100% load) for combusting treated landfill gas to produce electricity (1.6-megawatt gross electrical output).

## 3.5 Process Instrumentation Monitored During the Testing

Engine parameters included the following:

- Engine Power Output (kW);
- Engine Speed;
- Engine Operating Horsepower (bHp);
- Fuel flow;
- Engine Serial Number; and
- Engine Total Operating Hours.

# 4 POLLUTANTS TO BE MEASURED

Testing consisted of emissions for nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane organic compounds (NMOC), sulfur dioxide ($SO_2$), and hydrogen chloride (HCl).

# 5 SAMPLING AND ANALYSIS PROCEDURES

The following section provides brief descriptions of the proposed sampling methods and discusses any proposed modifications to the reference test methods.

## 5.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocities and flow rates were determined following the USEPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)" from the outlet only. Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer. Volumetric flow rates were determined following the equal area method as outlined in US EPA Method 2. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in US EPA Method 3A "Determination of Molecular Weight of Dry Stack Gas" for $O_2$. USEPA Method 320 was used for $CO_2$ content.

Stack moisture content was determined in accordance with USEPA Method 320.

## 5.2 NMOC by USEPA Method 25A

Non-methane organic compounds (NMOC) were determined following USEPA Method 25A "Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer" on each engine.

The compliance test consisted of three 60-minute tests on each source. Regular performance checks on the CEMS were carried out by zero and span calibration checks using US EPA Protocol calibration gases. These checks verified the ongoing precision of the monitor with time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases was reviewed frequently as an ongoing indication of analyzer performance.

Prior to testing, a 4-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, low, mid, and high-level calibration gases through the heated sampling line and into the analyzer. The calibration error check was performed to confirm that the analyzer response is within ±5% of the certified calibration gas introduced. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response were within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre- and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. Upscale is either the mid- or high-range gas, whichever most closely approximates the flue gas level. During these checks, the calibration gases were introduced into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the CEM system. The heated sample line is designed to maintain the gas temperature at or above 250°F to prevent condensation of stack gas moisture within the line.

## 5.3 $NO_x$, $SO_2$, CO, and HCl by USEPA Method 320

Emissions testing was performed at the outlet of each engine. Pollutant concentrations was determined utilizing RWDI's continuous emissions monitoring system (CEM) which consists of the FTIR and oxygen analyzer (measuring on wet basis).

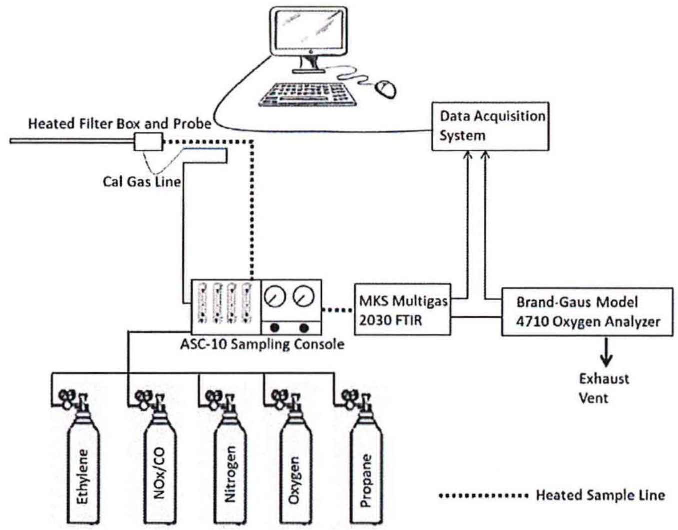
Stack gas concentrations for $NO_x$, CO, $H_2O$, HCl, $SO_2$, $CO_2$ and $O_2$ was measured using EPA Reference Methods 320 and 3A.

Oxygen measurements were taken continuously following USEPA Method 3A on the outlet (using a wet oxygen analyzer or equivalent). Stratification checks using $O_2$ as the surrogate for all pollutants, was completed on the exhaust of each engine at three points (16.7%, 50% and 83.3% of inner diameter) on a line passing through the centroidal area, as per the alternative approach in EPA Method 7E Section 8.1.2.

Regular performance checks on the CEMS were carried out by zero and span calibration checks on the oxygen analyzer and necessary QA procedures on the FTIR using USEPA Protocol calibration gases. These checks will verify the ongoing precision of the FTIR with time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the FTIR. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases was reviewed frequently as an ongoing indication of analyzer performance.

Monitoring was conducted by drawing a sample stream of flue gases through a stainless-steel probe attached to a heated filter and a heated sample line that is attached to the MAX Analytical ASC-10ST sampling console. Lengths of unheated sample line was kept to a minimum and insulated. The ASC-10ST sampling console delivers a continuous sample to the MKS MultiGas 2030 FTIR and oxygen analyzer for analysis. The heated filter and line were maintained at approximately 191°C (375°F) and the MKS MultiGas 2030 FTIR and ASC-10ST gas components were kept at 191°C (375°F). The end of the probe was connected to a heated Teflon sample line, which will deliver the sample gases from the stack to the FTIR system. The heated sample line was designed to maintain the gas temperature at approximately 375°F to prevent condensation of stack gas moisture within the line and condition air to the same temperature as the FTIR. A schematic of the sampling system setup is depicted in **Figure 5.2a.**

**Figure 5.2a:** MKS 2030 Multigas FTIR/ASC-10ST/Model 4710 Oxygen Analyzer Sampling System Schematic




The ASC-10ST was used to deliver calibration gases (Calibration Transfer Standard (CTS), QA Spike and Nitrogen) to the FTIR in direct (to analyzer) and system (to probe) modes.

A laptop computer was utilized for operating the MKS MultiGas 2030 FTIR and MAX Analytical ASC-10ST sampling console and logging the multi-gas FTIR data. Data was logged as one-minute averages for the actual test period (FTIR PRN files and Spectra). All concentration data was determined using the MKS 2030 MultiGas FTIR software. A typical MKS 2030 FTIR and ASC-10 ST configuration is depicted in **Figure 5.2b**

For oxygen measurement only, prior to testing, a 3-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, mid and high-level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response is within ±2% of the certified calibration gas introduced. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run. The analyzer will measure the respective gas concentrations on a wet volumetric basis which was converted to a dry volumetric number.

The probe tip was equipped with a heated filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which will deliver the sample gases from the stack to the FTIR/4710 Oxygen analyzer system. The heated sample line was designed to maintain the gas temperature at approximately 375°F to prevent condensation of stack gas moisture within the line.

**Figure 5.2b:** Typical MKS 2030 Multigas FTIR and ASC-10ST Configuration


## 5.4 Gas Dilution USEPA Method 205

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included. A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures. The gas dilution system consists of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with US EPA Method 205 "*Verification of Gas Dilution Systems for Field Instrument Calibrations*". Before testing, the gas divider dilutions were measured to evaluate that the responses are within ±2% of predicted values. In addition, a certified mid-level calibration gas within ±10% of one of the tested dilution gases was introduced into an analyzer to ensure the response of the gas calibration is within ±2% of gas divider dilution concentration.

# 6 NUMBER AND LENGTH OF SAMPLING RUNS

Testing consisted of triplicate 1-hour tests on each Engine.

# 7 STACK INFORMATION

Engine 1 and Engine 2 had identical stack measurements.

**Table 7.1:** Summary of the Stack Characteristics

| Source | Diameter | Approximate Duct Diameters from Flow Disturbance | Number of Ports | Points per Traverse | Total Points per Test |
|---|---|---|---|---|---|
| **Engine 1 & Engine 2** | 15.5" | 3.56 downstream and 2.71 upstream | 2 | 6 | 12 Flow |

# 8 FLUE GAS CONDITIONS

**Table 8.1:** Flue Gas Conditions

| Parameter | Flue Gas Conditions | | |
|---|---|---|---|
| | Stack Temperature | Flow Rate | Percent Moisture |
| **Engine 1** | 916°F | 4,600 dscfm | 11.8% |
| **Engine 2** | 896°F | 4,800 dscfm | 11.6% |

# 9 TEST RESULTS AND DISCUSSION

## 9.1 Detailed Results

Detailed results for all analytes are provided in **Appendix B**.

**Table 9.1.1:** Results Summary – Engine 1

| Source | Analyte | Units | Average | Limit |
|---|---|---|---|---|
| **Engine 1** | $NO_x$ | $ppmv_d$ @ 15% $O_2$ | 34.78 | 150.0 |
| | | lb/hr | 2.53 | 3.0 |
| | | g/hp-hr | 0.5 | 2.0 |
| | CO | $ppmv_d$ @ 15% $O_2$ | 279.67 | 610 |
| | | lb/hr | 12.40 | 16.3 |
| | | g/hp-hr | 2.6 | 5.0 |
| | HCl | $ppmv_d$ @ 15% $O_2$ | 0.48 | 80 |
| | | lb/hr | 0.03 | 0.51 |
| | $SO_2$ | lb/hr | 2.43 | 6.21 |
| | NMOC | g/hp-hr | 0.05 | 1.0 |

**Table 9.1.2:** Results Summary – Engine 2

| Source | Analyte | Units | Average | Limit |
|---|---|---|---|---|
| **Engine 2** | $NO_x$ | ppmv$_d$ @ 15% $O_2$ | 38.51 | 150.0 |
| | | lb/hr | 2.82 | 3.0 |
| | | g/hp-hr | 0.6 | 2.0 |
| | CO | ppmv$_d$ @ 15% $O_2$ | 279.86 | 610 |
| | | lb/hr | 12.47 | 16.3 |
| | | g/hp-hr | 2.6 | 5.0 |
| | HCl | ppmv$_d$ @ 15% $O_2$ | 0.76 | 80 |
| | | lb/hr | 0.04 | 0.51 |
| | $SO_2$ | lb/hr | 2.39 | 6.21 |
| | NMOC | g/hp-hr | 0.0 | 1.0 |

## 9.2 Discussion of Results

The detailed results of individual tests can be found in **Appendix B**.

## 9.3 Variations in Testing Procedures

In the instance of a negative NMOC number (due to the methane subtraction), a zero value was used.

## 9.4 Process Upset Conditions During Testing

There were no upsets in the process during testing.

## 9.5 Maintenance Performed in Last Three Months

All maintenance in the last three months has been routine.

## 9.6 Re-Test

This was not a retest.

## 9.7 Audit Samples

This test did not require any audit samples.

## 9.8 Process Data

Process data can be found in **Appendix A**.

## 9.9 Calibration Data

Calibration can be found in **Appendix E**.

## 9.10 Example Calculations

Example calculations can be found in **Appendix G**.

## 9.11 Laboratory Data

There was no laboratory data affiliated with this testing.

## 9.12 Source Testing Plan and EGLE Correspondence

Copy of the correspondence received from the Source Testing Plan from EGLE and the Source Testing Plan submitted can be found in **Appendix F**.

# TABLES

## Table 1: Summary of Emissions - Engine#1

**Blue Water Renewables**

**Facility:** Blue Water Renewables
**City:** Smith's Creek, MI
**Source:** Engine#1
**Date:** 2/28/2023

| | Symbol | Units | Test 1 | Test 2 | Test 3 | Average | Corrected to 15% $O_2$ | Limits |
|---|---|---|---|---|---|---|---|---|
| Nitrogen Oxides Concentration | $NO_x$ | ppmvd | 73.57 | 76.47 | 79.06 | 76.36 | 34.78 | 150.0 |
| Carbon Monoxide Concentration | CO | ppmvd | 611.15 | 614.77 | 616.11 | 614.01 | 279.67 | 610 |
| Hydrogen Chloride Concentration | HCl | ppmvd | 1.09 | 1.12 | 0.95 | 1.05 | 0.48 | 80 |
| Sulfur Dioxide Concentration | $SO_2$ | ppmvd | 53.03 | 52.62 | 51.90 | 52.52 | - | - |
| Oxygen Concentration | $O_2$ | $\%_{wet}$ | 7.01 | 7.01 | 7.02 | 7.01 | - | - |
| Oxygen Concentration | $O_2$ | $\%_{dry}$ | 7.94 | 7.94 | 7.95 | 7.95 | - | - |
| Total Hydrocarbons (as propane) Concentration | THC | ppmv | 531.83 | 587.43 | 607.01 | 575.42 | - | - |
| Total Hydrocarbons (as propane) Concentration | THC | ppmvd | 602.77 | 666.16 | 687.92 | 652.28 | - | - |
| Methane (as methane) Concentration | $CH_4$ | ppmv | 1262.85 | 1405.11 | 1416.94 | 1,361.63 | - | - |
| Methane (as methane) Concentration | $CH_4$ | ppmvd | 1431.29 | 1593.43 | 1605.80 | 1,543.51 | - | - |
| Methane (as propane) Concentration | $CH_4$ | ppmvd | 633.31 | 683.88 | 666.31 | 661.17 | - | - |
| Non-Methane Organic Compounds Concentration | NMOC | ppmvd | *0.00* | *0.00* | 21.61 | 7.20 | - | - |
| | | | | | | | | |
| Nitrogen Oxides Emission Rate | $NO_x$ | pph | 2.44 | 2.53 | 2.62 | 2.53 | - | 3.0 |
| Carbon Monoxide Emission Rate | CO | pph | 12.35 | 12.41 | 12.46 | 12.40 | - | 16.3 |
| Hydrogen Chloride Emission Rate | HCl | pph | 0.03 | 0.03 | 0.03 | 0.03 | - | 0.51 |
| Sulfur Dioxide Emission Rate | $SO_2$ | pph | 2.45 | 2.43 | 2.40 | 2.43 | - | 6.21 |
| Non-Methane Organic Compounds Emission Rate | NMOC | pph | *0.00* | *0.00* | 0.69 | 0.23 | - | - |
| | | | | | | | | |
| Nitrogen Oxides Concentration | $NO_x$ | g/HP-hr | 0.52 | 0.54 | 0.56 | 0.5 | - | 2.0 |
| Carbon Monoxide Concentration | CO | g/HP-hr | 2.61 | 2.62 | 2.64 | 2.6 | - | 5.0 |
| Non-Methane Organic Compounds Concentration | NMOC | g/HP-hr | *0.00* | *0.00* | 0.15 | 0.05 | - | 1.0 |
| *Reaction factor for methane subtraction:* | | | 2.26 | 2.33 | 2.41 | | | |

*For Test 1 and 2, NMOC numbers were negative after methane subtraction and are being reported as 0.*

# Table 2: Engine#1 Flow Measurements

**Blue Water Renewables**

**Facility:** Blue Water Renewables
**City:** Smith's Creek, MI
**Source:** Engine #1

| Parameter | Units | Test 1 | Test 2 | Test 3 | Average |
|---|---|---|---|---|---|
| Stack Gas Temperature | °F | 916.1 | 916.0 | 918.2 | 916.8 |
| Stack Gas Moisture | % | 11.77 | 11.82 | 11.76 | 11.78 |
| Velocity | ft/sec | 178.7 | 178.5 | 179.0 | 178.7 |
| Actual Flowrate | acfm | 14,048 | 14,035 | 14,075 | 14,053 |
| Dry Reference Flowrate | dscfm | 4,649 | 4,642 | 4,651 | 4,648 |
| Dry Reference Flowrate | $m^3/s$ | 2.19 | 2.19 | 2.20 | 2.19 |

# Table 3: Engine#1 Process Data

**Blue Water Renewables**

**Facility:** Blue Water Renewables
**City:** Smith's Creek, MI
**Source:** Engine #1
**Max Horspower:** 2233
**Max Kilowatt:** 1665

| Test | Time | Kilowatts (KW) | Brake Horse Power (BHP) | Load (%) |
|---|---|---|---|---|
| 1 | 11:00 | 1,604 | 2,151.0 | 96.3% |
| | 11:15 | 1,597 | 2,141.6 | 95.9% |
| | 11:30 | 1,596 | 2,140.2 | 95.8% |
| | 11:45 | 1,598 | 2,142.9 | 96.0% |
| | 12:00 | 1,602 | 2,148.3 | 96.2% |
| | **Average** | **1,599** | **2,144.8** | **96.1%** |
| 2 | 13:05 | 1,588 | 2129.5 | 95.4% |
| | 13:20 | 1,605 | 2152.3 | 96.4% |
| | 13:35 | 1,591 | 2133.5 | 95.5% |
| | 13:50 | 1,603 | 2149.6 | 96.3% |
| | 14:05 | 1,615 | 2165.7 | 97.0% |
| | **Average** | **1,600** | **2146.1** | **96.1%** |
| 3 | 14:35 | 1,590 | 2132.2 | 95.5% |
| | 14:50 | 1,609 | 2157.7 | 96.6% |
| | 15:05 | 1,594 | 2137.6 | 95.7% |
| | 15:20 | 1,586 | 2126.8 | 95.2% |
| | 15:35 | 1,597 | 2141.6 | 95.9% |
| | **Average** | **1,595** | **2,139.2** | **95.8%** |

*KW to BHP Conversion Factor:* 1.341

## Table 4: Summary of Emissions - Engine#2

**Blue Water Renewables**

**Facility:** Blue Water Renewables
**City:** Smith's Creek, MI
**Source:** Engine#2
**Date:** 3/1/2023

| | Symbol | Units | Test 1 | Test 2 | Test 3 | Average | Corrected to 15% $O_2$ | Limits |
|---|---|---|---|---|---|---|---|---|
| Nitrogen Oxides Concentration | $NO_x$ | ppmvd | 79.71 | 84.12 | 84.60 | 82.81 | 38.51 | 150.0 |
| Carbon Monoxide Concentration | CO | ppmvd | 596.95 | 604.06 | 604.35 | 601.79 | 279.86 | 610 |
| Hydrogen Chloride Concentration | HCl | ppmvd | 1.89 | 1.54 | 1.49 | 1.64 | 0.76 | 80 |
| Sulfur Dioxide Concentration | $SO_2$ | ppmvd | 53.03 | 49.13 | 49.13 | 50.43 | - | - |
| Oxygen Concentration | $O_2$ | $\%_{wet}$ | 7.26 | 7.26 | 7.26 | 7.26 | - | - |
| Oxygen Concentration | $O_2$ | $\%_{dry}$ | 8.21 | 8.22 | 8.21 | 8.21 | - | - |
| Total Hydrocarbons (as propane) Concentration | THC | ppmv | 494.99 | 588.57 | 573.76 | 552.44 | - | - |
| Total Hydrocarbons (as propane) Concentration | THC | ppmvd | 559.86 | 665.95 | 649.39 | 625.07 | - | - |
| Methane (as methane) Concentration | $CH_4$ | ppmv | 1207.12 | 1484.11 | 1489.71 | 1,393.65 | - | - |
| Methane (as methane) Concentration | $CH_4$ | ppmvd | 1365.33 | 1679.23 | 1686.05 | 1,576.87 | - | - |
| Methane (as propane) Concentration | $CH_4$ | ppmvd | 604.13 | 726.94 | 729.89 | 686.99 | - | - |
| Non-Methane Organic Compounds Concentration | NMOC | ppmvd | *0.00* | *0.00* | *0.00* | 0.00 | - | - |
| | | | | | | | | |
| Nitrogen Oxides Emission Rate | $NO_x$ | pph | 2.75 | 2.84 | 2.86 | 2.82 | - | 3.0 |
| Carbon Monoxide Emission Rate | CO | pph | 12.55 | 12.43 | 12.44 | 12.47 | - | 16.3 |
| Hydrogen Chloride Emission Rate | HCl | pph | 0.05 | 0.04 | 0.04 | 0.04 | - | 0.51 |
| Sulfur Dioxide Emission Rate | $SO_2$ | pph | 2.55 | 2.31 | 2.31 | 2.39 | - | 6.21 |
| Non-Methane Organic Compounds Emission Rate | NMOC | pph | 0.00 | 0.00 | 0.00 | 0.00 | - | - |
| | | | | | | | | |
| Nitrogen Oxides Concentration | $NO_x$ | g/HP-hr | 0.58 | 0.60 | 0.60 | 0.6 | - | 2.0 |
| Carbon Monoxide Concentration | CO | g/HP-hr | 2.66 | 2.63 | 2.63 | 2.6 | - | 5.0 |
| Non-Methane Organic Compounds Concentration | NMOC | g/HP-hr | 0.00 | 0.00 | 0.00 | 0.00 | - | 1.0 |
| | | *Reaction factor for methane subtraction:* | 2.26 | 2.31 | 2.31 | | | |

*For all three (3) tests, NMOC numbers were negative after methane subtraction and are being reported as 0.*

# Table 5: Engine#2 Flow Measurements

**Blue Water Renewables**

**Facility:** Blue Water Renewables
**City:** Smith's Creek, MI
**Source:** Engine #2

| Parameter | Units | Test 1 | Test 2 | Test 3 | Average |
|---|---|---|---|---|---|
| Stack Gas Temperature | °F | 896.1 | 896.4 | 896.4 | 896.3 |
| Stack Gas Moisture | % | 11.59 | 11.62 | 11.65 | 11.62 |
| Velocity | ft/sec | 182.1 | 178.4 | 178.4 | 179.7 |
| Actual Flowrate | acfm | 14,319 | 14,027 | 14,028 | 14,125 |
| Dry Reference Flowrate | dscfm | 4,837 | 4,735 | 4,734 | 4,769 |
| Dry Reference Flowrate | $m^3/s$ | 2.28 | 2.24 | 2.23 | 2.25 |

# Table 6: Engine#2 Process Data

**Blue Water Renewables**

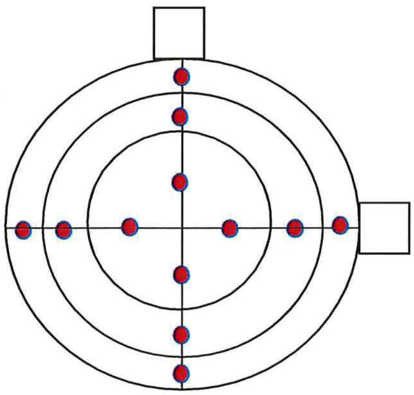
**Facility:** Blue Water Renewables
**City:** Smith's Creek, MI
**Source:** Engine #2
**Max Horspower:** 2233
**Max Kilowatt:** 1665

| Test | Time | Kilowatts (KW) | Brake Horse Power (BHP) | Load (%) |
|---|---|---|---|---|
| 1 | 9:20 | 1,589 | 2,130.8 | 95.4% |
| | 9:35 | 1,595 | 2,138.9 | 95.8% |
| | 9:50 | 1,600 | 2,145.6 | 96.1% |
| | 10:05 | 1,601 | 2,146.9 | 96.1% |
| | 10:20 | 1,603 | 2,149.6 | 96.3% |
| | **Average** | **1,598** | **2,142.4** | **95.9%** |
| 2 | 12:00 | 1,605 | 2152.3 | 96.4% |
| | 12:15 | 1,596 | 2140.2 | 95.8% |
| | 12:30 | 1,601 | 2146.9 | 96.1% |
| | 12:45 | 1,594 | 2137.6 | 95.7% |
| | 13:00 | 1,596 | 2140.2 | 95.8% |
| | **Average** | **1,598** | **2143.5** | **96.0%** |
| 3 | 13:25 | 1,594 | 2137.6 | 95.7% |
| | 13:40 | 1,605 | 2152.3 | 96.4% |
| | 13:55 | 1,598 | 2142.9 | 96.0% |
| | 14:10 | 1,608 | 2156.3 | 96.6% |
| | 14:25 | 1,595 | 2138.9 | 95.8% |
| | **Average** | **1,600** | **2,145.6** | **96.1%** |

*KW to BHP Conversion Factor:* 1.341

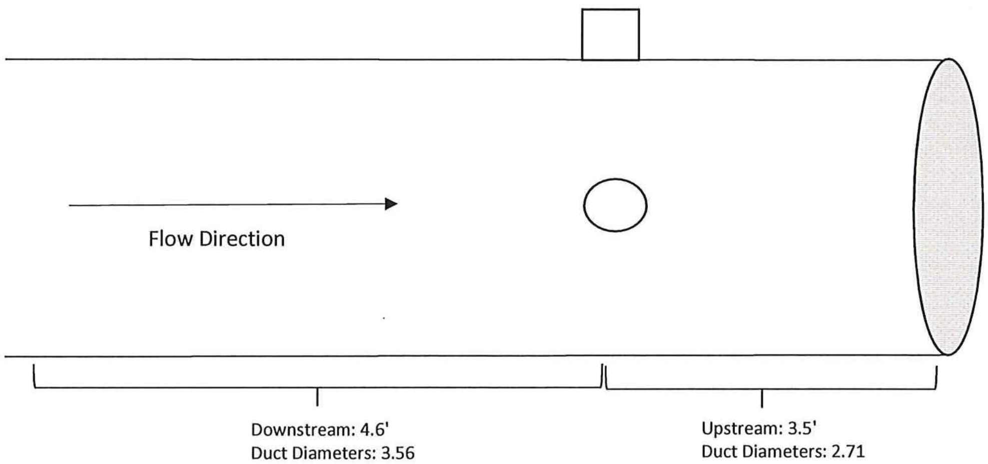
# FIGURES

**Figure No. 1**



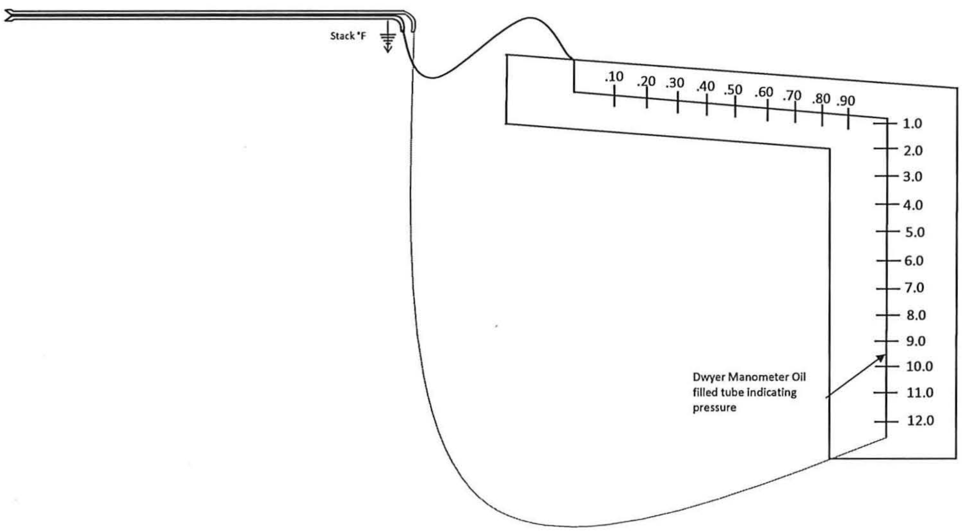
Diameter ("): 15.5

| Sampling Points (in.) | |
|---|---|
| 1 | 0.68 |
| 2 | 2.26 |
| 3 | 4.59 |
| 4 | 10.91 |
| 5 | 13.24 |
| 6 | 14.82 |




| | | |
|---|---|---|
| **Engine #1 & #2** | Date: | **RWDI USA LLC** |
| Bluewater Renewables | February 28-March 1, 2023 | 2239 Star Court |
| Smiths Creek, Michigan | | Rochester Hills, MI 48309 |

Figure No. 2: USEPA Method 2




**USEPA Method 2**

**Bluewater Renewables**

Engines #1 & #2

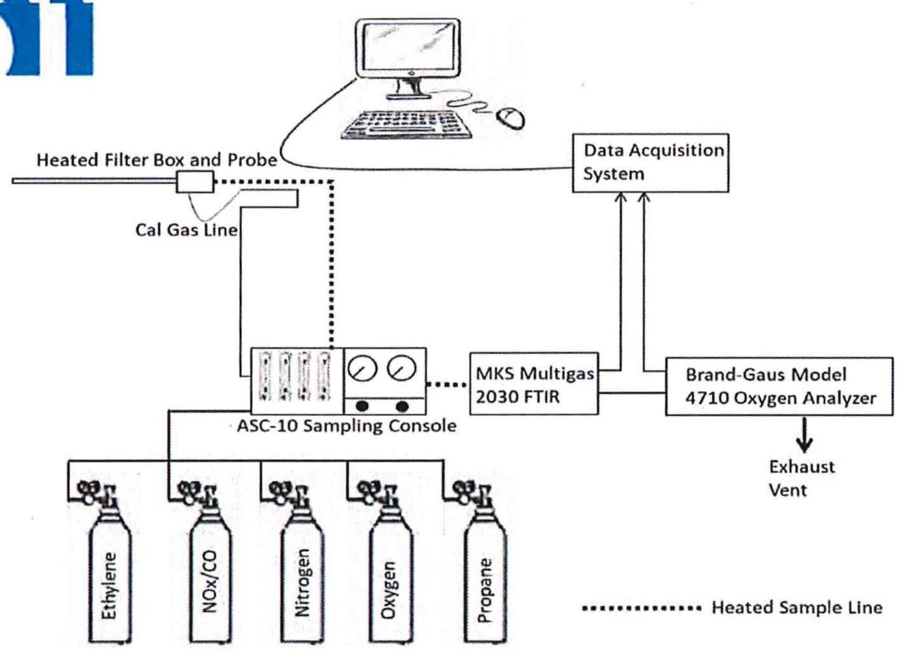
Smiths Creek, Michigan

Project #2301562

**Figure No. 2**

**Date: February 28-March 1, 2023**

Figure No. 3: USEPA Method 3A/320




## USEPA Method 3A/320

**Bluewater Renewables**
Engines #1 & #2
Smiths Creek, Michigan

Project# 2301562

**Date: February 28-March 1, 2023**