FINAL REPORT

CITY OF WARREN

WARREN, MICHIGAN

WASTEWATER TREATMENT PLANT: NOX AND CO EMISSIONS

RWDI # 2205782

August 29, 2022

SUBMITTED TO

Jeremy Howe
Michigan Department of Environment, Great Lakes, and Energy (EGLE)
AQD - Technical Programs Unit (TPU)
Constitution Hall 2nd Floor | South
525 West Allegan Street
Lansing, Michigan 48933

Joyce Zhu
Michigan Department of Environment, Great Lakes, and Energy (EGLE)
District Supervisor, Air Quality Division
2700 Donald Court
Warren, Michigan 48092

City of Warren
Wastewater Treatment Plant
32360 Warkop Ave
Warren, Michigan 48093

SUBMITTED BY

Brad Bergeron, A. Sc. T., d.E.T.
Senior Project Manager | Principal
Brad.Bergeron@rwdi.com

Mason Sakshaug, QSTI
Senior Scientist
Mason.Sakshaug@rwdi.com

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) was retained by Tetra Tech, Inc. (Tetra Tech) to complete the emission sampling program at the City of Warren Wastewater Treatment Facility (Warren WWTP) located at 32360 Warkop Avenue, Warren, Michigan. The facility operates a wastewater treatment facility that includes the use of an incinerator (EU-INCINERATOR). The incinerator combusts natural gas and sewage sludge as fuels for the incinerator. Sewage sludge is a product of secondary and tertiary wastewater treatment process and is also referred to as biosolids. Warren WWTP is currently operating under Renewable Operating Permit (ROP) MI-ROP-B1792-2021 and the requirements of 40 CFR Part 60 Subpart MMMM, and R336.1972.

The testing consisted of triplicate 81-minute tests for oxides of nitrogen (NOx) and carbon monoxide (CO) from EU-INCINERATOR. As outlined in the ROP, the emissions are reported for NOx and CO as parts per million by volume (dry), (ppmvd) corrected to 7% O_2. NOx and CO were determined using U.S. EPA Methods 7E and 10, respectively. Oxygen was measured during the testing following U.S. EPA Method 3A. The testing was performed and completed successfully on July 6, 2022.

The following table represents a summary of the stack testing results.

Executive Summary Table: EU-INCINERATOR Summary of Results – CO, NOx, and O_2

Parameter	In-Stack Concentration			
	Run 1	Run 2	Run 3	Average
Oxygen (%)	12.0	11.9	10.1	11.3
CO (ppmvd)	2,061.5	2,288.5	2,445.2	2,265.1
CO (ppmvd, at 7% O_2)	3,208.7	3,520.4	3,140.6	3,289.9
CO Limit (ppmvd, at 7% O_2)	**3,800**			
NO_x (ppmvd)	66.0	62.7	77.5	68.7
NO_x (ppmvd, at 7% O_2)	102.7	96.5	99.5	99.6
NOx Limit (ppmvd, at 7% O_2)	**220**			

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Tetra Tech, Inc. to complete the emission sampling program at the City of Warren Wastewater Treatment Plant (Warren WWTP) located at 32360 Warkop Ave, Warren, Michigan. This report outlines the performance testing results for the sludge incinerator (EU-INCINERATOR). The test program was conducted to determine concentrations and emission rates of Nitrogen Oxides (NOx) and Carbon Monoxide (CO) as required under Michigan Department of Environment, Great Lakes, and Energy Renewable Operating Permit MI-ROP-B1792-2021.

1.1 Location and Dates of Testing

The test program was completed on July 6th, 2022 at the Warren WWTP facility.

1.2 Purpose of Testing

The test program was conducted to determine concentrations and emission rates of Nitrogen Oxides (NOx) and Carbon Monoxide (CO) for EU-INCINERATOR.

1.3 Description of Source

The following source was included in the program:

Table 1.3.1: Summary of Source Group

Emission Unit	Capacity	Pollution Control Equipment
EU-INCINERATOR	6.4 Wet Tons/hr	Scrubber

The incinerator (EU-Incinerator) combusts natural gas and sewage sludge, a product of secondary and tertiary wastewater treatment processes, also known as biosolid. The incinerator exhausts gases are passed through a wet scrubber prior to discharge to atmosphere.

1.4 Personnel Involved in Testing

Table 1.4.1: Testing Personnel

Bryan Clor Division Head Bclor@cityofwarren.com	**City of Warren**	586.264.2530 x 8103
Ted Bishop Project Manager Ted.bishop@tetratech.com	**Tetra Tech, Inc.**	248.991.9702
Brad Bergeron Senior Project Manager Brad.Bergeron@rwdi.com	**RWDI USA LLC** 2239 Star Court Rochester Hills, Michigan 48309	248.841.8442
Mason Sakshaug Senior Scientist Mason.Sakshaug@rwdi.com		
Mike Nummer Intermediate Scientist Michael.Nummer@rwdi.com		
Robert Joseph AQD Inspector Josephr4@michigan.gov	**Michigan Department of Environment, Great Lakes and Energy**	586.506.9564
Andrew Riley TPU Rileya8@michigan.gov	**Michigan Department of Environment, Great Lakes and Energy**	586.565.7379

2 SUMMARY OF RESULTS

2.1 Operating Data

Operational data collected during the testing included the following:

- Sewage sludge feed rate
- Sewage sludge feed moisture content
- Operating temperature of each hearth
- Pressure drop across the wet scrubber
- Scrubber liquid flow rate
- pH of the scrubber liquid

This information can be found in **Appendix A**.

2.2 Applicable Permit Number

The facility operates under State of Michigan Renewable Operating Permit MI-ROP-B1792-2021.

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

The incinerator (EU-Incinerator) combusts natural gas and sewage sludge, a product of secondary and tertiary wastewater treatment processes, also known as biosolid. The incinerator exhausts gases are passed through a wet scrubber prior to discharge to atmosphere.

3.2 Process Flow Sheet or Diagram

A process diagram can be obtained upon request.

3.3 Type and Quantity of Raw and Finished Materials

The process combusts dewatered biosolids which are fed to the incinerator at a maximum rate of 6.4 wet tons per hour, which is equivalent to an 85% feed rate of 5.5 wet tons per hour.

3.4 Normal Rated Capacity of Process

The maximum rated capacity of the facility is 6.4 wet tons of biosolids per hour. Average production rate is typically between 4.5 to 5.5 wet tons per hour.

3.5 Process Instrumentation Monitored During the Test

The process is regulated through monitoring of combustion temperature, exhaust gas pressure drop, and water flow through the scrubber and pH in the scrubber.

4 SAMPLING AND ANALYTICAL PROCEDURES

The emission test program utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 3A – Determination of Molecular Weight of Dry Stack Gases (instrumental)
- Method 7E – Determination of Oxides of Nitrogen from Stationary Sources
- Method 10 – Determination of Carbon Monoxide from Stationary Sources
- Method 205 – Verification of Gas Dilution Systems For Field Instrument Calibrations

4.1 Sampling for Carbon Monoxide (CO), Oxides of Nitrogen (NOx), and Oxygen (O_2)

Oxygen (O_2), carbon monoxide (CO) and oxides of nitrogen (NOx) concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system. 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 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 probe tip was equipped with a sintered stainless-steel filter for particulate removal. 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 was designed to maintain the gas temperature above 250°F to prevent condensation of stack gas moisture within the line.

Before entering the analyzers, the gas sample passed directly into a refrigerated condenser, which cools the gas to approximately 35°F to remove the stack gas moisture. After passing through the condenser, the dry gas enters a Teflon-head diaphragm pump and a flow control panel, which delivers the gas in series to the O_2, CO, and NO_x analyzers. Each of these analyzers measured the respective gas concentrations on a dry volumetric basis.

4.2 USEPA Method 205 and Gas Dilution System

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 in the Source Testing Report. A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures. The gas dilution system consisting 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*". The gas divider dilution was 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.

4.3 Quality Assurance/Quality Control Activities

Applicable quality assurance measures were implemented during the sampling program to ensure the integrity of the results. These measurements included detailed documentation of field data, and equipment calibrations for all measured parameters.

Quality control procedures specific to the CEM system equipment included linearity checks to determine the instrument performance and reproducibility checks prior to its use in the field. Regular performance checks on the analyzers were also carried out during the testing program by performing hourly zero checks and span calibration checks using primary gas standards. Sample system bias checks were also done. These checks were used to verify the ongoing accuracy of the monitor and sampling system over time. Pollutant-free air was introduced to perform the zero checks, followed by a known calibration (span) gas into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gas were recorded regularly during the tests.

4.4 Description of Recovery and Analytical Procedures

There were no samples to recover during this test program. All testing used real time data from the analyzers.

4.5 Sampling Port Description

Continuous emissions monitoring (CEM) for NOx and O_2 occurred at EU-INCINERATOR. The outlet exhaust stack was located just off the building and accessed via test platform. To evaluate the emissions, triplicate 81-minute tests were conducted on the source.

Table 4.5.1: Sample Location Details

Source	Parameter	Diameter	Duct Diameters from Flow Disturbance	Number of Ports	Points per Traverse	Total Points per Test
EU-Incinerator	CO, NOx, and O_2	47.5"	3.79 downstream and 1.52 upstream	2	6 – CO, NOx, and O_2	12 – CO, NOx, and O_2

5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

The emissions data for this study are presented in the **Tables** section of this report. Detailed information regarding each test run can be found in **Appendix B**.

Table 5.1: EU-INCINERATOR Summary of Results – CO, NOx, and O_2

Parameter	In-Stack Concentration			
	Run 1	Run 2	Run 3	Average
Oxygen (%)	12.0	11.9	10.1	11.3
CO (ppmvd)	2,061.5	2,288.5	2,445.2	2,265.1
CO (ppmvd, at 7% O_2)	3,208.7	3,520.4	3,140.6	3,289.9
CO Limit (ppmvd, at 7% O_2)	**3,800**			
NO_x (ppmvd)	66.0	62.7	77.5	68.7
NO_x (ppmvd, at 7% O_2)	102.7	96.5	99.5	99.6
NOx Limit (ppmvd, at 7% O_2)	**220**			

Field notes are presented in **Appendix C**. All calibration information for the equipment used for the program is included in **Appendix D**.

5.2 Discussion of Results

Results were below the limit as outlined in **Section 5.1**.

5.3 Variations in Testing Procedures

Test 2 was re-started due to an issue aligning the clocks on Warren WWTP operational data CEMDAS system with stack test data acquisition system. This issued was communicated to Mr. Riley at the time of occurrence. Some operational data was lost during the process of resetting the Warren WWTP CEMDAS clock, so the first attempt at Run 2 was aborted, and then Run 2 was started for a 2nd time to ensure that a complete set of operational data would be available for the compliance determination. Data from the aborted period is provided in **Appendix B**.

5.4 Process Upset Conditions During Testing

There were no upsets to the process conditions during the testing.

5.5 Maintenance Performed in Last Three Months

The incinerator was retrofitted with VenturiPak™ technology in May of 2016. The system undergoes annual/regular maintenance and inspection per requirements of NSPS Subpart MMMM.

5.6 Re-Test

This was not a retest.

5.7 Audit Samples

This test did not require any audit samples.

5.8 Calibration Sheets

Calibration sheets can be found in **Appendix D**.

5.9 Sample Calculations

Sample calculations can be found in **Appendix E**.

5.10 Field Data Sheets

Field data sheets can be found in **Appendix C**.

5.11 Laboratory Data

There was no laboratory data from this testing program.

6 CONCLUSIONS

Testing was successfully completed on July 6th, 2022. Testing was conducted in accordance with referenced methodologies following the protocols provided in the Source Testing Plan

TABLES

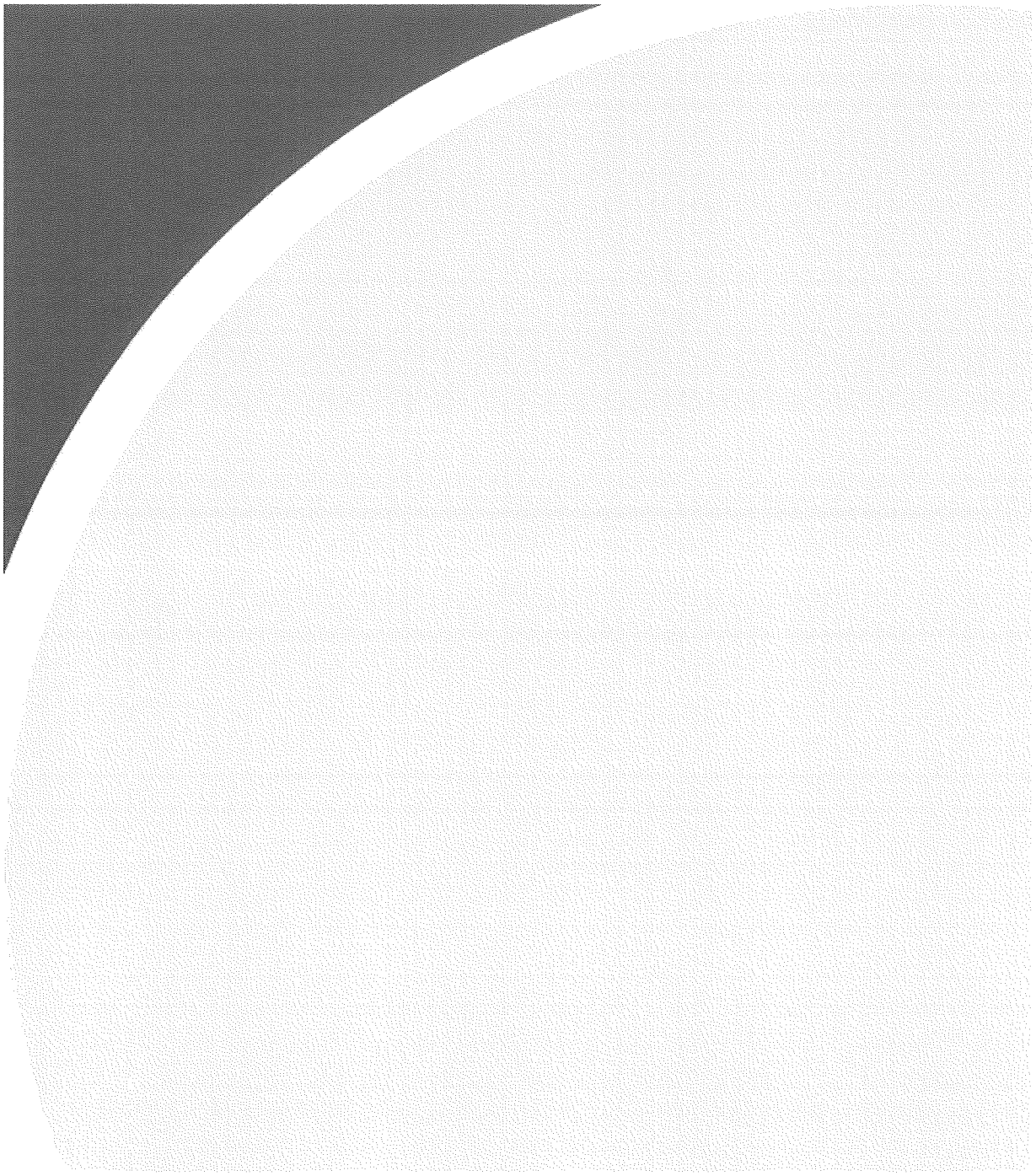


Table 1: Summary of Sampling Parameters and Methodology

Source	No. of Tests per Stack	Sampling Parameter	Sampling Method
Incinerator	3	Stack Parameters	U.S. EPA [1] Method 1
	3	Oxygen	U.S. EPA [1] Method 3A
	3	Nitrogen Oxides	U.S. EPA [1] Method 7E
	3	Carbon Monoxide	U.S. EPA [1] Method 10

Notes:

[1] U.S. EPA - United States Environmental Protection Agency

Table 2: Sampling Times

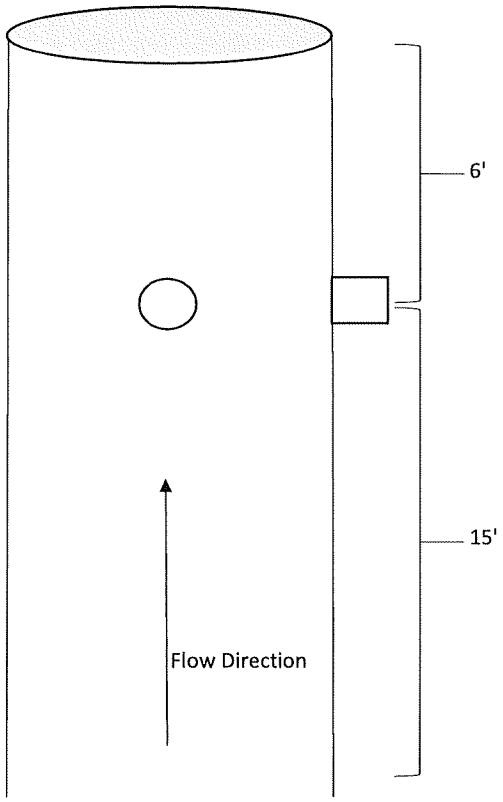
Source	Test No.	Sampling Date	Port 1 Test Time		Port 2 Test Tme	
			Start	**End**	**Start**	**End**
EU-INCINERATOR	1	July 6, 2022	9:15 AM	9:56 AM	10:00 AM	10:41 AM
EU-INCINERATOR (Voided Time Perid)	2	July 6, 2022	11:51 AM	12:24 PM	N/A	N/A
EU-INCINERATOR	2	July 6, 2022	12:25 PM	1:06 PM	1:10 PM	1:51 PM
EU-INCINERATOR	3	July 6, 2022	2:05 PM	2:46 PM	2:50 PM	3:31 PM

Table 3: Summary of Results

		Test 1			Test 2			Test 3			Average		
Source	Parameter	PPM	O2 (%,dry)	PPM @ 7% O2	PPM	O2 (%,dry)	PPM @ 7% O2	PPM	O2 (%,dry)	PPM @ 7% O2	PPM	O2 (%,dry)	PPM @ 7% O2
EU-INCINERATOR	NOx	66.0	12.0	102.7	62.7	11.9	96.5	77.5	10.1	99.5	68.7	11.3	99.6
	CO	2061.5		3208.7	2288.5		3520.4	2445.2		3140.6	2265.1		3289.9

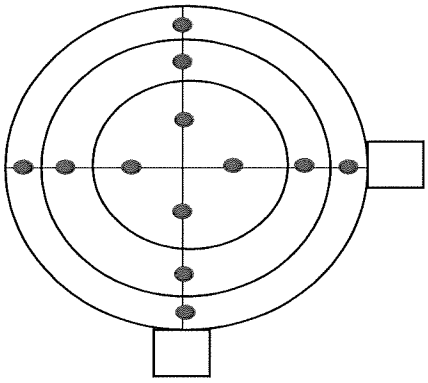
FIGURES

Figure No. 1



Diameter: 47.5

Sampling Points (in.)	
1	4.09
2	8.94
3	16.06
4	35.44
5	42.57
6	47.41



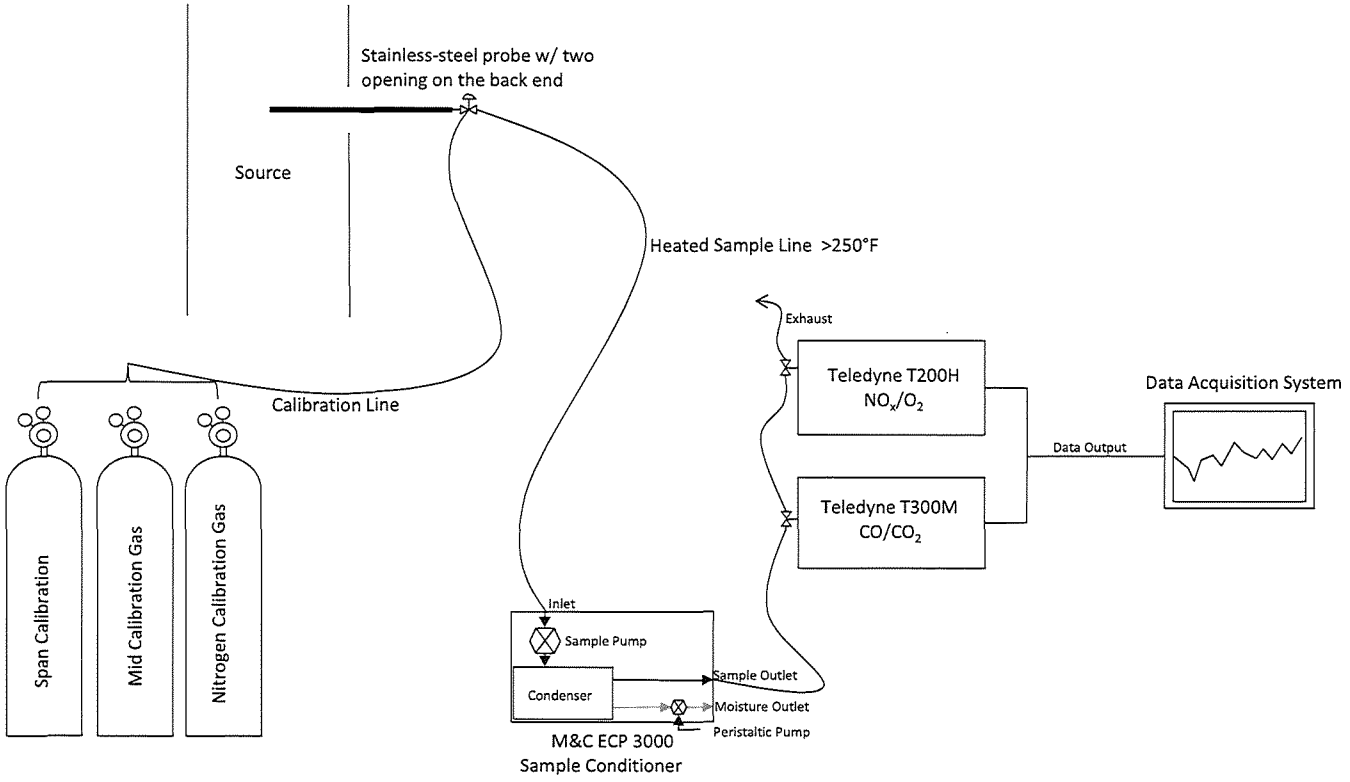
Not to scale

Incinerator
City of Warren
Warren Wastewater Treatment Plant
Warren, Michigan

Date:
July 6, 2022

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

Figure No. 2: USEPA Method 3A,7E,10 Schematic



USEPA Method 3A,7E,10

City of Warren

Warren Wastewater Treatment Plant

Warren, Michigan

Project# 2205782

Date: July 6, 2022