BTEC Inc.

VOC, CO and NOx Emissions Test Report

Prepared for:

North American Natural Resources, Inc.

Lennon, Michigan

Venice Park Landfill Facility
9536 East Lennon Road
Lennon, MI 48449

Project No. 15-4757.00
October 22, 2015

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

BTEC Inc.

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by North American Natural Resources (NANR) to conduct air emissions testing for compliance evaluation purposes. The sampling program included the evaluation of oxides of nitrogen (NOx), carbon monoxide (CO), volatile organic compounds (VOC) emission rates from two reciprocating engines (7 and 10) located at the North American Natural Resources (NANR) Venice Park Generating Station in Lennon, Michigan. Field sampling for this emission test program was conducted on September 30, 2015. The purpose of this report is to document the results of the emissions compliance test program.

Testing consisted of triplicate 60-minute NOx, CO and VOC emission test runs on engines 7 and 10. The emissions test program is required by Michigan Permit No. PTI 123- 11A and Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations. The results of the emission test program are summarized by Table I.

Table I
North American Natural Resources – Venice Park Facility
Landfill Gas-Fired Reciprocating Engines 7 and 10
Test Program Results Summary

Source	Pollutant	Test Result	Emission Limitation
Reciprocating Engine 7	NOx	0.29 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.46 lbs/hr	2.97 lbs/hr
	CO	2.67 g/bhp-hr	3.30 g/bhp-hr
	CO	13.25 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
Reciprocating Engine 10	NOx	0.40 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.96 lbs/hr	2.97 lbs/hr
	CO	2.18 g/bhp-hr	3.30 g/bhp-hr
	CO	10.80 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr

Note: All VOC emissions were determined to be Methane (CH_4).

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by North American Natural Resources (NANR) to conduct air emissions testing for compliance evaluation purposes. The sampling program included the evaluation of oxides of nitrogen (NOx), carbon monoxide (CO), volatile organic compounds (VOC) emission rates from two reciprocating engines (7 and 10) located at the North American Natural Resources (NANR) Venice Park Generating Station in Lennon, Michigan. Field sampling for this emission test program was conducted on September 30, 2015. The purpose of this report is to document the results of the emissions compliance test program.

The Air Quality Division (AQD) of Michigan's Department of Natural Resources and Environment has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test program and results in the format outlined by the AQD document.

1.a Identification, Location, and Dates of Test

Field sampling for this emission test program was conducted on September 30, 2015 at the North American Natural Resources Venice Park Generating Station in Lennon, Michigan. The purpose of this report is to document the results of the emissions determined during compliance test program.

Testing consisted of triplicate 60-minute NOx, CO and VOC emission test runs on Engines 7 and 10. The emissions test program is required by Michigan Permit No. PTI 123-11A and Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations.

1.b Purpose of Testing

The purpose of the emissions test program was to demonstrate compliance with the emission limitations included in Permit No. 123-11A for which testing was required. Emission limitations are included in Table 1.

1.c Source Description

The Venice Park facility includes four landfill gas-fired, spark-ignition, lean-burn reciprocating engines. Each reciprocating engine produces approximately 1,600 kilowatts (kW) at 2,250 bhp. Normal operation of the engine includes operation at constant speed near 100% load conditions.

1.d Test Program Contact

The contact for the source and test plan is:

line glass fiber filter to remove any particulate, a heated Teflon® sample line, and through a Universal Analyzers 3080PV electronic sample conditioner to remove the moisture from the sample before it entered the analyzer. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. An S-type pitot tube with a thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

A cyclonic flow check was performed at the sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angles is greater than 20 degrees, cyclonic flow exists. The null angle was determined to be less than 20 degrees at each sampling point.

The Molecular Weight of the gas stream was evaluated according to procedures outlined in Title 40, Part 60, Appendix A, Method 3A. The O2 /CO2 content of the gas stream was measured using an O2 /CO2 gas analyzer.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the moisture sampling passed through (i) two impingers, each with 100 ml glycol diluted water, (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content is then determined gravimetrically.

The VOC content of the exhaust was measured using a J.U.M. Model 109A analyzer. A sample of the gas stream was drawn through an insulated stainless-steel probe with an in-line glass fiber filter to remove any particulate and a heated Teflon® sample line to prevent the condensation of any moisture from the sample before it enters the analyzer. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

For analyzer calibrations, calibration gases were mixed to desired concentrations using an Environics Series 4040 Computerized Gas Dilution System. The Series 4040 consisting of a single chassis with four mass flow controllers. 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. Schematic drawings of the flow traverse points, continuous emission systems, and the moisture sampling train are provided as Figures 1 through 4.

Table 1
North American Natural Resources – Venice Park Facility
Landfill Gas-Fired Reciprocating Engines 7 and 10
Compliance Test Program Emission Limitations Summary

Source	Pollutant	Emission Limitation
Reciprocating Engine 7	NOx	2.0 g/bhp-hr
	NOx	2.97 lbs/hr
	CO	3.30 g/bhp-hr
	CO	16.30 lbs/hr
	VOC	0.63 g/bhp-hr
Reciprocating Engine 10	NOx	2.0 g/bhp-hr
	NOx	2.97 lbs/hr
	CO	3.30 g/bhp-hr
	CO	16.30 lbs/hr
	VOC	0.63 g/bhp-hr

Table 2
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Richard Spranger Environmental Manager	North American Natural Resources	(269) 362-5546
Mr. Matt Young Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Steve Smith Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Shane Rabideau Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Tom Gasloli Environmental Quality Analyst	MDEQ P.O. BOX 30260 Lansing, MI 48909	(517) 284-6778

Table 3
North American Natural Resources – Venice Park Facility
Landfill Gas-Fired Reciprocating Engines 7 and 10
Test Program Results Summary

Source	Pollutant	Test Result	Emission Limitation
Reciprocating Engine 7	NOx	0.29 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.46 lbs/hr	2.97 lbs/hr
	CO	2.66 g/bhp-hr	3.30 g/bhp-hr
	CO	13.25 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
Reciprocating Engine 10	NOx	0.40 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.96 lbs/hr	2.97 lbs/hr
	CO	2.18 g/bhp-hr	3.30 g/bhp-hr
	CO	10.80 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr

Note: All VOC emissions were determined to be Methane (CH_4).

Table 4
Engine 7 NOx, VOC, and CO Emission Rates
North American Natural Resources
Lennon, MI
BTEC Project No. 15-4757
Sampling Date: 9/30/2015

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	9/30/2015	9/30/2015	9/30/2015	
Test Run Time	8:12-9:12	9:50-10:50	11:26-12:26	
Outlet Flowrate (dscfm)	4,960	4,911	4,893	**4,921**
Outlet Flowrate (scfm)	5,345	5,292	5,723	**5,453**
bhp	2,272	2,254	2,251	
Outlet Oxides of Nitrogen Concentration (ppmv)	42.2	43.0	42.5	**42.6**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	42.3	41.9	40.8	**41.7**
NOx Emission Rate (lb/hr)	**1.49**	**1.51**	**1.49**	**1.50**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**1.50**	**1.47**	**1.42**	**1.46**
Outlet Carbon Monoxide Concentration (ppmv)	637.3	625.5	620.4	**627.7**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	626.8	616.8	615.0	**619.5**
CO Emission Rate (lb/hr)	**13.74**	**13.35**	**13.19**	**13.43**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**13.51**	**13.17**	**13.08**	**13.25**
Outlet VOC Concentration (ppmv as propane)	689.3	670.8	677.1	**679.1**
Outlet Methane Concentration (ppmv as methane)	1709.9	1643.2	1798.6	**1717.2**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	688.2	679.1	686.6	**684.6**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1664.3	1594.5	1745.1	**1668.0**
Outlet VOC Concentration (-Methane) *	0.0	0.0	0.0	**0.0**
Outlet Methane Concentration (-Methane, corrected as per USEPA 7E) *	0.0	0.0	0.0	**0.0**
VOC Emission Rate as Propane (lb/hr)	**0.0**	**0.0**	**0.0**	**0.0**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**0.0**	**0.0**	**0.0**	**0.0**
NOX (g/bhp-hr)	0.30	0.30	0.29	**0.29**
CO (g/bhp-hr)	2.70	2.65	2.64	**2.66**
VOC (g/bhp-hr)	0.00	0.00	0.00	**0.00**
response factor	2.32	2.32	2.32	

VOC Correction			
Co	0.39	1.29	1.29
Cma	497.8	497.8	497.8
Cm	498.67	492.09	491.24

Methane Correction			
Co	0.68	3.20	4.15
Cma	1495	1495	1495
Cm	1535.98	1540.86	1541.38

*All non-methane VOC concentrations were negative and have been replaced with zero

scfm = standard cubic feet per minute

dscfm = dry standard cubic feet per minute

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (CO = 28.01, NOx = 46.01, C_3H_x = 44.10)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft^3 per m^3

453600 = mg per lb

g/bhp-hr = grams per brake horse power hour

Equations

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***scfm*** * 60 *for* VOC

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60

Table 5
Engine 10 NOx, VOC, and CO Emission Rates
North American Natural Resources
Lennon, MI
BTEC Project No. 15-4757
Sampling Date: 9/30/2015

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	9/30/2015	9/30/2015	9/30/2015	
Test Run Time	13:15-14:15	14:40-15:40	16:03-17:03	
Outlet Flowrate (dscfm)	4,246	4,261	4,292	**4,266**
Outlet Flowrate (scfm)	4,852	4,826	4,827	**4,835**
bhp	2,244	2,246	2,247	
Outlet Oxides of Nitrogen Concentration (ppmv)	67.6	67.8	67.1	**67.5**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	65.0	64.4	63.6	**64.3**
NOx Emission Rate (lb/hr)	**2.05**	**2.06**	**2.05**	**2.05**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**1.97**	**1.96**	**1.95**	**1.96**
Outlet Carbon Monoxide Concentration (ppmv)	588.0	586.5	588.4	**587.6**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	584.0	581.7	581.8	**582.5**
CO Emission Rate (lb/hr)	**10.85**	**10.86**	**10.98**	**10.90**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**10.78**	**10.77**	**10.85**	**10.80**
Outlet VOC Concentration (ppmv as propane)	447.1	442.6	450.9	**446.9**
Outlet Methane Concentration (ppmv as methane)	1127.9	1109.8	1138.7	**1125.5**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	453.8	448.9	454.6	**452.4**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1105.0	1084.4	1105.5	**1098.3**
Outlet VOC Concentration (-Methane) *	0.0	0.0	0.0	**0.0**
Outlet Methane Concentration (-Methane, corrected as per USEPA 7E) *	0.0	0.0	0.0	**0.0**
VOC Emission Rate as Propane (lb/hr)	**0.0**	**0.0**	**0.0**	**0.0**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**0.0**	**0.0**	**0.0**	**0.0**
NOX (g/bhp-hr)	0.40	0.40	0.39	**0.40**
CO (g/bhp-hr)	2.18	2.18	2.19	**2.18**
VOC (g/bhp-hr)	0.00	0.00	0.00	**0.00**
response factor	2.32	2.32	2.32	

VOC Correction			
Co	1.04	1.01	0.76
Cma	497.8	497.8	497.8
Cm	490.35	490.66	493.67

Methane Correction			
Co	4.76	5.14	4.04
Cma	1495	1495	1495
Cm	1524.37	1528.12	1538.49

*All non-methane VOC concentrations were negative and have been replaced with zero

scfm = standard cubic feet per minute

dscfm = dry standard cubic feet per minute

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (CO = 28.01, NOx = 46.01, C_3H_8 = 44.10)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft^3 per m^3

453600 = mg per lb

g/bhp-hr = grams per brake horse power hour

Equations

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *scfm* * 60 *for* VOC

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *dcfm* * 60

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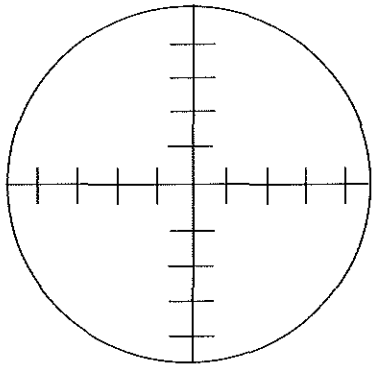
diameter = 13.5 inches

Points	Distance "
1	0.4
2	1.4
3	2.6
4	4.4
5	9.1
6	10.9
7	12.1
8	13.1



Not to Scale

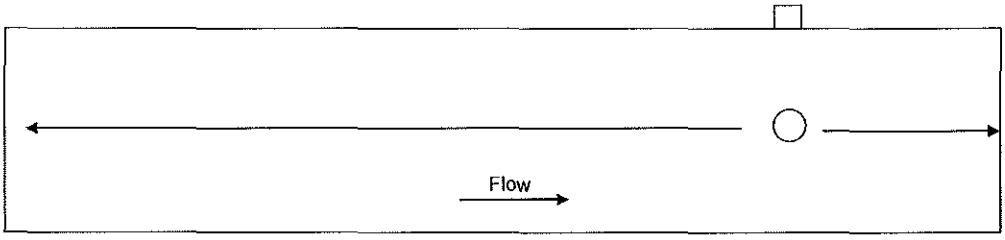


Figure 1

Site:	Sampling Date:	
Engines #7 and #10 Exhaust North American Natural Resources Lennon, Michigan	September 30, 2015	BT Environmental Consulting, Inc. 4949 Fernlee Avenue Royal Oak, Michigan 48073

BTEC Inc.

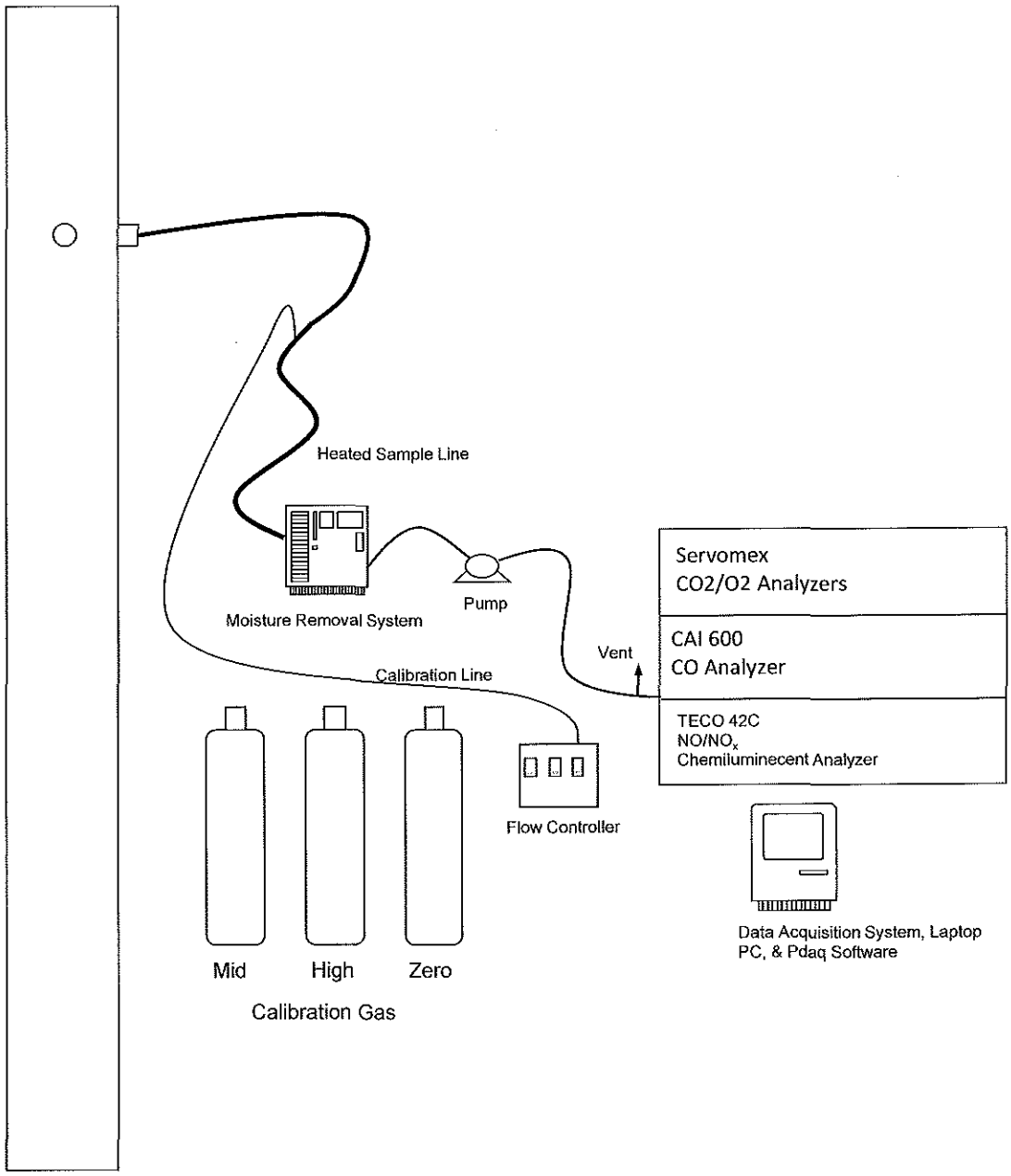


Figure 2

Site: **USEPA Method 3A/7E/10** **North American Natural Resources** **Lennon, Michigan**	**Sampling Date:** **September 30, 2015**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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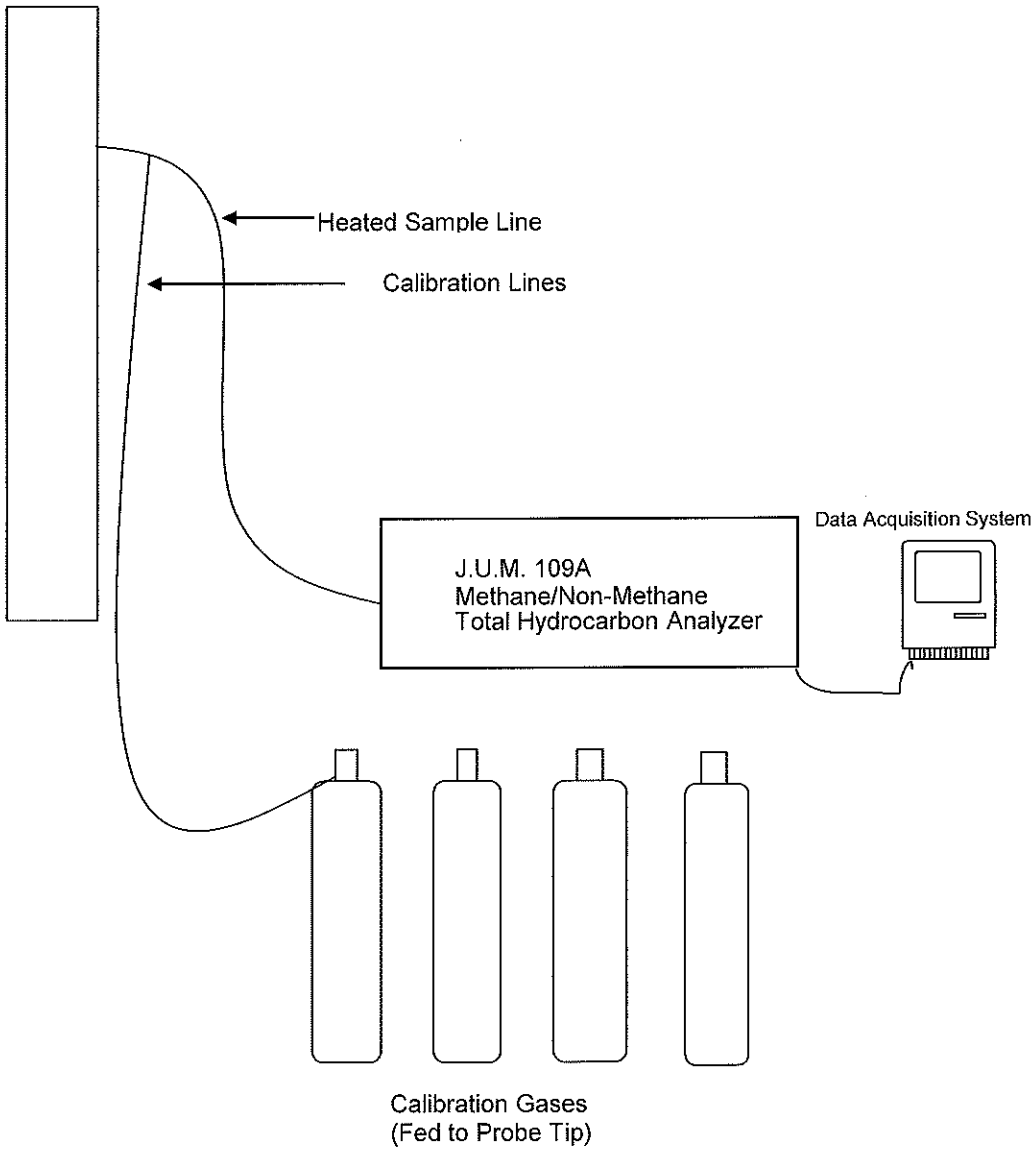

Figure 3

Site: **USEPA Method 25A** **North American Natural Resources** **Lennon, Michigan**	**Sampling Date:** **September 30, 2015**
BT Environmental Consulting, Inc. **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**	

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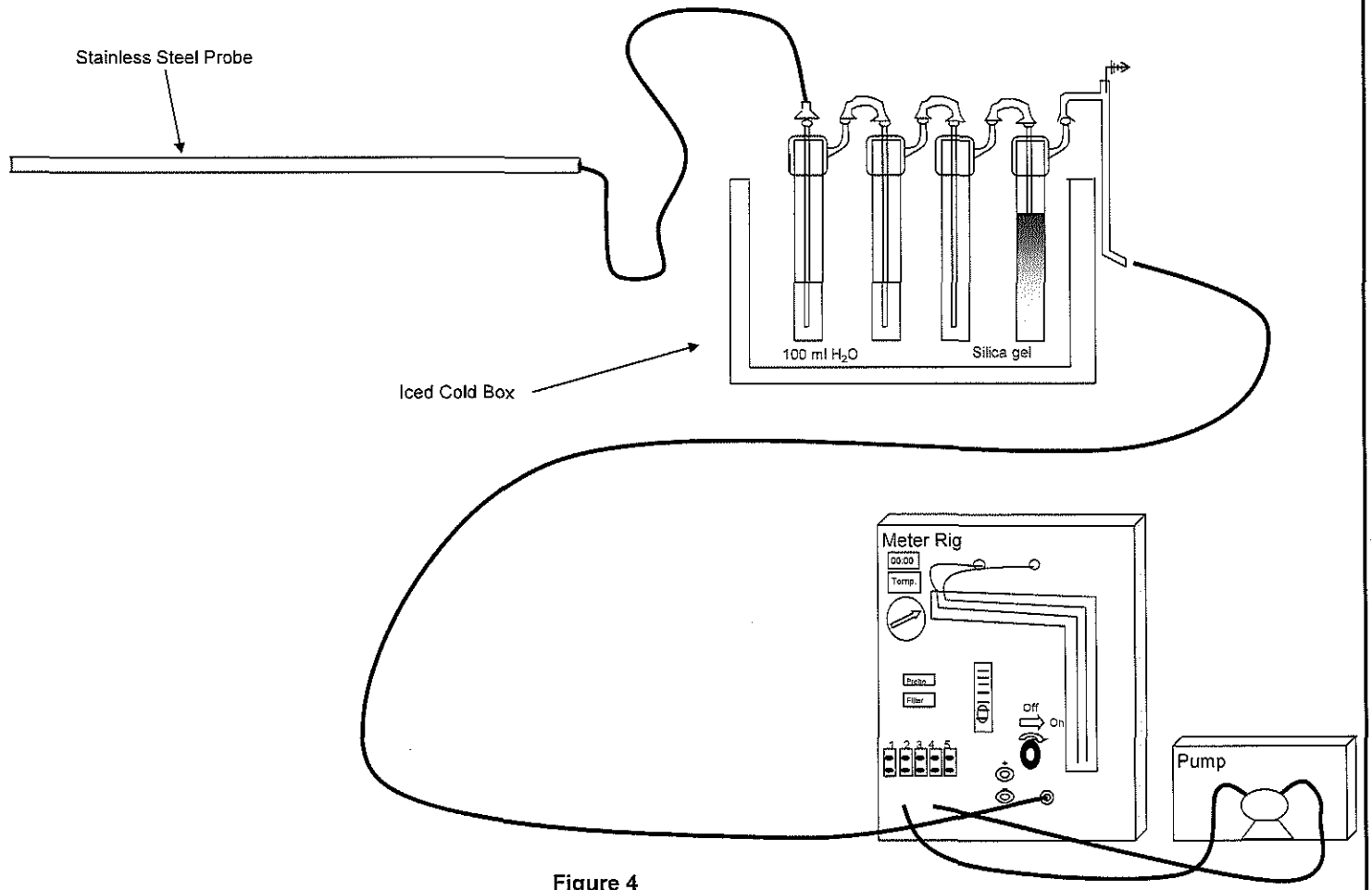

Figure 4

Site: **USEPA Method 4** **North American Natural Resources** **Lennon, Michigan**	**Sampling Date:** **September 30, 2015**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**