# Air Emission Test Report
# for
# Seven Multiple Hearth Incinerators

## Great Lakes Water Authority
## Water Resource Recovery Facility
## 9300 West Jefferson Avenue
## Detroit, Michigan

GLWA
Great Lakes Water Authority

**Renewable Operating Permit MI-ROP-B2103-2014d**
**State Registration No. B2103**

**Prepared for**
**Great Lakes Water Authority**
**Detroit, Michigan**

Bureau Veritas Project No. 11018-000100.00
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# Executive Summary

Great Lakes Water Authority (GLWA) retained Bureau Veritas North America, Inc. to test air emissions from the exhaust of seven multiple hearth incinerators (MHIs) at the GLWA Water Resource Recovery Facility in Detroit, Michigan. The seven sources are designated as EUINC07, EUINC09, EUINC10, EUINC11, EUINC12, EUINC13, and EUINC14.

The test program objectives are listed below.

For incinerators EUINC07, EUINC09, and EUINC10:

- Measure concentrations of nitrogen oxides ($NO_X$).
- Analyze the sludge for solid content.
- Evaluate compliance with emission limits within 40 CFR Part 60, Subpart MMMM, "Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units."

For incinerators EUINC11, EUINC12, EUINC13, and EUINC14:

- Measure concentrations and mass emission rates of particulate matter (PM), sulfur dioxide ($SO_2$), $NO_X$, carbon monoxide (CO), dioxins/furans (PCDD/PCDF), hydrogen chloride (HCl), and select metals (cadmium, lead, and mercury).
- Measure visible emissions (VE) from the ash handling system.
- Analyze the sludge for solid content.
- Evaluate compliance with emission limits within Subpart MMMM.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3A, 4, 5, 6C, 7E, 10, 22, 23, 26A, 29, and 205 guidelines.

The following test runs were conducted for each MHI:

| | |
|---|---|
| EUINC07, 09, and 10 | Three 60-minute test runs for $NO_X$. |
| EUINC11, 12, 13, and 14 | Three 80-minute test runs for each analyte except VE.<br>Three 60-minute test runs for visible emissions. |

Concentrations of oxygen in the exhaust gas were measured and averaged over the test run in order to correct the results to 7% oxygen as required by Subpart MMMM.

Detailed results are presented in Tables 1 through 19 after the Tables Tab of this report. The following tables summarize the results of the testing conducted on July 10 through 18, 2018.

## $NO_X$ Results for EUINC07, EUINC09, and EUINC10

| Incinerator | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limit† |
|---|---|---|---|
| EUINC07 | ppmv, dry @ 7% $O_2$ | 204 | 220 |
| EUINC09 | ppmv, dry @ 7% $O_2$ | 158 | 220 |
| EUINC10 | ppmv, dry @ 7% $O_2$ | 184 | 220 |

† Emission limit shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume

## Results for EUINC11

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limit† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 20 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 0.1 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 145 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 2,268 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 0.57 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.025 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | 0.28 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.014 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.084 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.052 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

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## Results for EUINC12

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 15 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 1.5 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 181 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 1,320 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 6.9 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.25 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | <0.20 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.030 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.043 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.085 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

## Results for EUINC13

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 21 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 0.1 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 205 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 416 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 0.74 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.028 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | <0.18 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.015 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.051 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.050 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

## Results for EUINC14

<table>
<tr><th colspan="2">Parameter</th><th>Unit</th><th>Average Result</th><th>40 CFR Part 60, Subpart MMMM Emission Limits†</th></tr>
<tr><td colspan="2">Particulate matter (PM)</td><td>mg/dscm @ 7% $O_2$</td><td>13</td><td>80</td></tr>
<tr><td colspan="2">Sulfur dioxide ($SO_2$)</td><td>ppmv, dry @ 7% $O_2$</td><td>0.1</td><td>26</td></tr>
<tr><td colspan="2">Nitrogen oxides ($NO_X$)</td><td>ppmv, dry @ 7% $O_2$</td><td>151</td><td>220</td></tr>
<tr><td colspan="2">Carbon monoxide (CO)</td><td>ppmv, dry @ 7% $O_2$</td><td>1,258</td><td>3,800</td></tr>
<tr><td colspan="2" rowspan="2">Dioxins/furans (PCDD/PCDF)</td><td>ng/dscm @ 7% $O_2$ (total mass basis)</td><td>0.98</td><td>5.0</td></tr>
<tr><td>ng/dscm @ 7% $O_2$ (toxic equivalency basis)</td><td>0.037</td><td>0.32</td></tr>
<tr><td colspan="2">Hydrogen chloride (HCl)</td><td>ppmv, dry @ 7% $O_2$</td><td><0.17</td><td>1.2</td></tr>
<tr><td rowspan="3">Metals</td><td>Cadmium</td><td>mg/dscm @ 7% $O_2$</td><td>0.0082</td><td>0.095</td></tr>
<tr><td>Lead</td><td>mg/dscm @ 7% $O_2$</td><td>0.030</td><td>0.30</td></tr>
<tr><td>Mercury</td><td>mg/dscm @ 7% $O_2$</td><td>0.034</td><td>0.28</td></tr>
<tr><td colspan="2">Visible emissions (VE) from the ash handling system</td><td>% of observation</td><td>0</td><td>5</td></tr>
</table>

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

# 1.0 Introduction

## 1.1 Summary of Test Program

Great Lakes Water Authority (GLWA) retained Bureau Veritas North America, Inc. to test air emissions from the exhaust of seven multiple hearth incinerators (MHIs) at the GLWA Water Resource Recovery Facility in Detroit, Michigan. The seven sources are designated as EUINC07, EUINC09, EUINC10, EUINC11, EUINC12, EUINC13, and EUINC14.

For incinerators EUINC07, EUINC09, and EUINC10:

- Measure concentrations of nitrogen oxides ($NO_X$).
- Analyze the sludge for solid content.
- Evaluate compliance with emission limits within 40 CFR Part 60, Subpart MMMM, "Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units."

For incinerators EUINC11, EUINC12, EUINC13, and EUINC14:

- Measure concentrations and mass emission rates of particulate matter (PM), sulfur dioxide ($SO_2$), $NO_X$, carbon monoxide (CO), dioxins/furans (PCDD/PCDF), hydrogen chloride (HCl), and select metals (cadmium, lead, and mercury).
- Measure visible emissions (VE) from the ash handling system.
- Analyze the sludge for solid content.
- Evaluate compliance with emission limits within Subpart MMMM.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3A, 4, 5, 6C, 7E, 10, 22, 23, 26A, 29, and 205 guidelines.

The following test runs were conducted for each MHI:

| | |
|---|---|
| EUINC07, 09, and 10 | Three 60-minute test runs for $NO_X$. |
| EUINC11, 12, 13, and 14 | Three 80-minute test runs for each analyte except VE.<br>Three 60-minute test runs for visible emissions. |

The air emission testing was conducted July 10 through 18, 2018, as described in the Intent-to-Test plan, which was submitted to MDEQ on June 8, 2018. The testing is summarized in Table 1-1.

**Table 1-1**
**Sources Tested, Parameters, and Test Dates**

| Source | Parameter | Test Date |
|---|---|---|
| Multiple hearth incinerators EUINC07, EUINC09, and EUINC10 | Oxygen ($O_2$) | July 10 and 11, 2018 |
| | Nitrogen oxides ($NO_x$) | |
| | Sludge solid content | |
| Multiple hearth incinerators EUINC11, EUINC12, EUINC13, and EUINC14 | Oxygen ($O_2$) | July 11 through 18, 2018 |
| | Particulate matter (PM) | |
| | Sulfur dioxide ($SO_2$) | |
| | Nitrogen oxides ($NO_x$) | |
| | Carbon monoxide (CO) | |
| | Dioxins and furans (PCDD/PCDF) | |
| | Hydrogen chloride (HCl) | |
| | Cadmium (Cd) | |
| | Lead (Pb) | |
| | Mercury (Hg) | |
| | Sludge solid content | |

## 1.2 Key Personnel

Key personnel involved in this test program are listed in Table 1-2. Mr. David Kawasaki, Air Quality Consultant with Bureau Veritas, directed the compliance testing program. Mr. Lamarr Beden with GLWA provided process coordination and arranged for facility operating parameters to be recorded.

The testing was witnessed by Messrs. Mark Dziadosz and Scott Miller, both with MDEQ.

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## Table 1-2
## Key Personnel

| GLWA | BVNA |
|---|---|
| Melvin Dacres<br>Chemist<br>**Great Lakes Water Authority**<br>9300 West Jefferson Avenue<br>Detroit, Michigan 48209<br>Telephone: 313.297.0363<br>Melvin.Dacres@glwater.org | David Kawasaki, QSTI<br>Air Quality Consultant II<br>**Bureau Veritas North America, Inc.**<br>22345 Roethel Drive<br>Novi, Michigan 48375<br>Telephone: 248.344.3081<br>Facsimile: 248.344.2656<br>david.kawasaki@us.bureauveritas.com |
| **MDEQ** | |
| Mark Dziadosz<br>Environmental Quality Analyst<br>**Michigan Department of Environmental Quality**<br>27700 Donald Court<br>Warren, Michigan 48092<br>Telephone: 586.753.3745<br>Facsimile: 586.753.3740<br>dziadoszm@michigan.gov | Scott Miller<br>Environmental Quality Analyst<br>**Michigan Department of Environmental Quality**<br>301 East Louis Glick Highway<br>Jackson, Michigan 49201<br>Telephone: 517.780.7481<br>Facsimile: 517.780.7855<br>millers@michigan.gov |

# 2.0 Source and Sampling Locations

## 2.1 Process Description

The GLWA Water Resource Recovery Facility treats storm water and sanitary wastewater from communities throughout the metropolitan Detroit area. GLWA operates eight multiple hearth sewage sludge incinerators.

Sludge is dewatered with belt filter presses and conveyed to the multiple hearth incinerators through belt conveyors. The sludge conveyors are equipped with gravimetric weigh scales for continuous monitoring of the quantity of sludge being incinerated.

The incinerators combust dewatered primary and secondary clarifier sewage sludge using natural gas burners to reduce the sludge volume and produce cool, inert, completely burned ash. Three air systems introduce air into each incinerator. Natural gas burners are used to (1) control or maintain the temperature in the middle hearths, (2) dry sludge, (3) achieve the incinerator operating temperature, and (4) burn exhaust gases before exiting the hearth.

Residual ash is stored in silos or a lagoon before transport to landfill.

GLWA personnel recorded operating parameters during the emission testing. The recorded operating parameters are included in Appendix F.

## 2.2 Control Equipment

The natural gas burners combust exhaust gases at the exit of a hearth. Emissions from the multiple hearth sewage sludge incinerators are controlled by an Air Pollution Control (APC) system, which consists of a quench, an impingement tray wet scrubber, a Venturi scrubber, and a mist eliminator.

## 2.3 Operating Parameters and Sludge Data

Operating parameters for the multiple hearth sewage sludge incinerators are controlled by programmable logic controller monitoring systems. Process and control equipment data recorded during testing are included in Appendix F.

GLWA personnel collected composite samples of sewage sludge for solid content analysis. GLWA collected composite samples at the beginning and end of each test run.

Tables 2-1 through 2-4 summarize the process data and sludge sampling data. Appendix E includes laboratory analytical results of the sewage sludge samples. Appendix F includes process data.

**Table 2-1**
**Summary of Process Data**
**EUINC07, EUINC09, EUINC10**

| Parameter | Unit | EUINC07 | EUINC09 | EUINC10 |
|---|---|---|---|---|
| Sludge feedrate | ton/hour, wet basis | 11.36 | 9.69 | 8.76 |
| Sludge solid content | - | 25.8%† | 26.0% | 25.1% |
| Sludge feedrate | ton/hour, dry basis | 2.93 | 2.52 | 2.20 |
| Heating value | Btu/lb | 1,730 | 1,760 | 1,800 |
| Scrubber pressure differential | inch of water | 25.20 | 21.71 | 20.62 |
| Scrubber water flowrate | gal/min | 1,491 | 1,508 | 1,535 |
| Scrubber water outlet pH | - | 6.70 | 7.32 | 6.53 |
| Afterburner exit temperature | - | 1,216°F | 1,037°F | 1,192°F |

ton/hour: ton per hour
Btu/lb: British thermal unit per pound
gal/min: gallon per minute
† Sample containers for EUINC07 Test Runs 1 and 2 were damaged; results shown are from Test Run 3 and not the average of three test runs.

## Table 2-2
## Summary of Process Data
## EUINC11

| Parameter | Unit | CEMs | Dioxins and Furans | Hydrogen Chloride | PM/Metals |
|---|---|---|---|---|---|
| Sludge feedrate | ton/hour, wet basis | 10.36 | 10.49 | 9.97 | 10.19 |
| Sludge solid content | - | 28.4% | 28.2% | 27.9% | 27.9% |
| Sludge feedrate | ton/hour, dry basis | 2.94 | 2.96 | 2.79 | 2.85 |
| Heating value | Btu/lb | 1,737 | 1,730 | 1,767 | 1,753 |
| Scrubber pressure differential | inch of water | 25.98 | 24.00 | 23.92 | 27.45 |
| Scrubber water flowrate | gal/min | 1,330 | 1,379 | 1,413 | 1,307 |
| Scrubber water outlet pH | - | 6.59 | 6.64 | 6.67 | 6.52 |
| Afterburner exit temperature | - | 1,168°F | 1,173°F | 1,161°F | 1,165°F |

CEMs: sulfur dioxide, nitrogen oxides, carbon monoxide
PM/Metals: particulate matter and metals (lead, cadmium, mercury)
ton/hour: ton per hour
Btu/lb: British thermal unit per pound
gal/min: gallon per minute

## Table 2-3
## Summary of Process Data
## EUINC12

| Parameter | Unit | CEMs | Dioxins and Furans | Hydrogen Chloride | PM/Metals |
|---|---|---|---|---|---|
| Sludge feedrate | ton/hour, wet basis | 10.93 | 10.97 | 11.53 | 10.93 |
| Sludge solid content | % | 33.2% | 33.1% | 35.0% | 33.2% |
| Sludge feedrate | ton/hour, dry basis | 3.63 | 3.63 | 4.04 | 3.63 |
| Heating value | Btu/lb | 1,533 | 1,553 | 1,657 | 1,533 |
| Scrubber pressure differential | inch of water | 24.47 | 24.47 | 28.75 | 24.47 |
| Scrubber water flowrate | gal/min | 1,299 | 1,299 | 1,263 | 1,299 |
| Scrubber water outlet pH | - | 6.68 | 6.68 | 6.37 | 6.68 |
| Afterburner exit temperature | | 1,228°F | 1,228°F | 1,204°F | 1,228°F |

CEMs: sulfur dioxide, nitrogen oxides, carbon monoxide
PM/Metals: particulate matter and metals (lead, cadmium, mercury)
ton/hour: ton per hour
Btu/lb: British thermal unit per pound
gal/min: gallon per minute

**Table 2-4**
**Summary of Process Data**
**EUINC13 and EUINC14**

| Parameter | Unit | EUINC13 | | EUINC14 | |
|---|---|---|---|---|---|
| | | CEMs Dioxin/Furans HCl | PM/Metals | CEMs Dioxin/Furans HCl | PM/Metals |
| Sludge feedrate | ton/hour, wet basis | 10.91 | 10.97 | 9.39 | 8.87 |
| Sludge solid content | - | 34.5% | 33.3% | 30.1% | 31.3% |
| Sludge feedrate | ton/hour, dry basis | 3.75 | 3.65 | 2.82 | 2.78 |
| Heating value | Btu/lb | 1,780 | 1,877 | 2,127 | 2,003 |
| Scrubber pressure differential | inch of water | 23.19 | 23.06 | 28.68 | 25.34 |
| Scrubber water flowrate | gal/min | 1,275 | 1,277 | 1,301 | 1,295 |
| Scrubber water outlet pH | - | 6.06 | 6.19 | 6.20 | 6.27 |
| Afterburner exit temperature | - | 1,255°F | 1,190°F | 1,178°F | 1,169°F |

CEMs: sulfur dioxide, nitrogen oxides, carbon monoxide
HCl: hydrogen chloride
PM/Metals: particulate matter and metals (lead, cadmium, mercury)
ton/hour: ton per hour
Btu/lb: British thermal unit per pound
gal/min: gallon per minute

## 2.4 Flue Gas Sampling Locations

The seven multiple hearth incinerators tested at GLWA have identical exhaust stacks that are 54 inches in diameter and have two 6-inch-diameter sampling ports. Twelve traverse points per sampling port were used during sampling. The ports are located:

- 108 inches (2.0 duct diameters) from the nearest downstream disturbance.
- 120 inches (2.2 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via scaffolding.

Figure 2-1 is a photograph of the MHI exhaust sampling location. Figure 1 in the Appendix depicts the MHI sampling and traverse point locations.


**Figure 2-1. Incinerator Sampling Location**

# 3.0 Summary and Discussion of Results

## 3.1 Objective and Test Matrix

The objective of the testing was to evaluate compliance with certain limits within 40 CFR Part 60, Subpart MMMM, "Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units."

Tables 3-1 through 3-3 summarize the sampling and analytical matrix.

**Table 3-1**
**Test Matrix**
**EUINC07, EUINC09, and EUINC10**

| Sampling Location | Test Date (2018) | Test Run | Start Time | Stop Time | Pollutant | Sampling Method | No. of Test Runs and Duration | Analytical Method | Analytical Laboratory |
|---|---|---|---|---|---|---|---|---|---|
| EUINC07 | July 10 | 1 | 13:45 | 14:45 | $O_2$, $CO_2$, $NO_x$ | 1, 3A, 7E, and 205 | Three 60-minute runs | Instrument paramagnetic and chemiluminescence analysis | Not applicable |
| | | 2 | 14:55 | 15:55 | | | | | |
| | | 3 | 17:10 | 18:10 | | | | | |
| EUINC09 | July 10 | 1 | 07:40 | 08:40 | $O_2$, $CO_2$, $NO_x$ | 1, 3A, 7E, and 205 | Three 60-minute runs | Instrument paramagnetic and chemiluminescence analysis | Not applicable |
| | | 2 | 09:02 | 10:02 | | | | | |
| | | 3 | 10:20 | 12:12 | | | | | |
| EUINC10 | July 11 | 1 | 07:00 | 08:00 | $O_2$, $CO_2$, $NO_x$ | 1, 3A, 7E, and 205 | Three 60-minute runs | Instrument paramagnetic and chemiluminescence analysis | Not applicable |
| | | 2 | 08:55 | 09:55 | | | | | |
| | | 3 | 10:05 | 11:05 | | | | | |

**Table 3-2**
**Test Matrix**
**EUINC11 and EUINC12**

| Sampling Location | Test Date (2018) | Test Run | Start Time | Stop Time | Pollutant | Sampling Method | No. of Test Runs and Duration | Analytical Method | Analytical Laboratory |
|---|---|---|---|---|---|---|---|---|---|
| EUINC11 | July 11 | 1 | 14:30 | 17:40 | $O_2$, $CO_2$, HCl | 1, 2, 3A, 4, 26A, and 205 | Three 80-minute runs | Field measurement; instrument paramagnetic, ultraviolet, chemiluminescence, and infrared analysis; gravimetric; gas chromatography; mass spectrometry; ion chromatography; cold vapor atomic absorption spectroscopy; inductively coupled plasma-mass spectrometry | Maxxam Analytics |
| | July 12 | 2 | 08:50 | 10:20 | $O_2$, $CO_2$, Dioxins, HCl | 1, 2, 3A, 4, 23, 26A, and 205 | | | |
| | | 3 | 11:20 | 13:10 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, Dioxins, HCl | 1, 2, 3A, 4, 6C, 7E, 10, 23, 26A, and 205 | | | |
| | | 4 | 13:50 | 15:35 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, Dioxins, PM, Metals | 1, 2, 3A, 4, 5, 6C, 7E, 10, 23, 29, and 205 | | | |
| | | 5 | 16:00 | 17:30 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, PM, Metals | 1, 2, 3A, 4, 5, 6C, 7E, 10, 29, and 205 | | | |
| | | 6 | 17:45 | 19:15 | $O_2$, $CO_2$, PM, Metals | 1, 2, 3A, 4, 5, 29, and 205 | | | |
| EUINC12 | July 16 | 1 | 11:05 | 12:41 | $O_2$, $CO_2$, Dioxins | 1, 2, 3A, 4, 23, and 205 | Three 80-minute runs | Field measurement; instrument paramagnetic, ultraviolet, chemiluminescence, and infrared analysis; gravimetric; gas chromatography; mass spectrometry; ion chromatography; cold vapor atomic absorption spectroscopy; inductively coupled plasma-mass spectrometry | Maxxam Analytics |
| | | 2 | 13:20 | 15:07 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, PM, Metals | 1, 2, 3A, 4, 5, 6C, 7E, 10, 29, and 205 | | | |
| | | 3 | 15:45 | 17:20 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, Dioxins, PM, Metals | 1, 2, 3A, 4, 5, 6C, 7E, 10, 23, 29, and 205 | | | |
| | | 4 | 17:40 | 19:15 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, Dioxins, PM, Metals | 1, 2, 3A, 4, 5, 6C, 7E, 10, 23, 29, and 205 | | | |
| | July 17 | 5 | 07:00 | 08:25 | $O_2$, $CO_2$, HCl | 1, 2, 3A, 4, 26A, and 205 | | | |
| | | 6 | 08:35 | 10:00 | | | | | |
| | | 7 | 10:20 | 11:45 | | | | | |

### Table 3-3
### Test Matrix
### EUINC13 and EUINC14

| Sampling Location | Test Date (2018) | Test Run | Start Time | Stop Time | Pollutant | Sampling Method | No. of Test Runs and Duration | Analytical Method | Analytical Laboratory |
|---|---|---|---|---|---|---|---|---|---|
| EUINC13 | July 17 | 1 | 13:00 | 14:35 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, Dioxins, HCl | 1, 2, 3A, 4, 6C, 7E, 10, 23, 26A, and 205 | Three 80-minute runs | Field measurement; instrument paramagnetic, ultraviolet, chemiluminescence, and infrared analysis; gravimetric; gas chromatography; mass spectrometry; ion chromatography; cold vapor atomic absorption spectroscopy; inductively coupled plasma-mass spectrometry | Maxxam Analytics |
| | | 2 | 14:50 | 16:25 | | | | | |
| | | 3 | 16:40 | 18:15 | | | | | |
| | July 18 | 4 | 07:00 | 08:25 | $O_2$, $CO_2$, PM, Metals | 1, 2, 3A, 4, 5, 29, and 205 | | | |
| | | 5 | 08:37 | 10:04 | | | | | |
| | | 6 | 10:20 | 11:44 | | | | | |
| EUINC14 | July 13 | 1 | 08:15 | 09:50 | $O_2$, $CO_2$, $SO_2$, $NO_x$, CO, Dioxins, HCl | 1, 2, 3A, 4, 6C, 7E, 10, 23, 26A, and 205 | Three 80-minute runs | Field measurement; instrument paramagnetic, ultraviolet, chemiluminescence, and infrared analysis; gravimetric; gas chromatography; mass spectrometry; ion chromatography; cold vapor atomic absorption spectroscopy; inductively coupled plasma-mass spectrometry | Maxxam Analytics |
| | | 2 | 10:15 | 11:45 | | | | | |
| | | 3 | 12:05 | 13:40 | | | | | |
| | | 4 | 14:00 | 15:30 | $O_2$, $CO_2$, PM, Metals | 1, 2, 3A, 4, 5, 29, and 205 | | | |
| | | 5 | 15:40 | 17:10 | | | | | |
| | July 16 | 6 | 08:15 | 09:40 | | | | | |

## 3.2 Field Test Changes and Issues

Communication between GLWA, Bureau Veritas, and MDEQ allowed the testing to be completed without field test changes. The following sections describe issues that occurred during sampling.

### 3.2.1 EUINC07 Sewage Sludge Samples

The sewage sludge composite sample containers for Test Runs 1 and 2 on EUINC07 were damaged during transit. Gas generation in the containers ruptured the sample containers. The sewage sludge composite sample result for Test Run 3 on EUINC07 was used as the average for all three test runs (see Table 2-1).

### 3.2.2 EUINC09, $NO_X$ Test Run 3

On July 10, 2018, gaseous sampling was paused prior to the last 10 minutes of Test Run 3 on EUINC09. During the test run, the filter box overheated and melted the Teflon sample line, plugging the line. The line was replaced and leak-checked prior to completing the test run.

### 3.2.3 EUINC11, HCl Test Run 1

On July 11, 2018, Test Run 1 for HCl on EUINC11 was paused from 15:25 to 17:04 because the sludge feed conveyors malfunctioned and stopped feed to the incinerators. The test run was completed once the conveyers were fixed.

### 3.2.4 EUINC12, Gaseous Test Run 1

On July 16, 2018, the CO measurement momentarily spiked, exceeding the calibrated range of the analyzer during Test Run 1 for gaseous sampling on EUINC12. The spike was due to a malfunction in the incinerator $O_2$ feed line. The test run was voided and an additional test run was conducted for $SO_2$, $NO_X$, and CO.

### 3.2.5 EUINC12, PM and Metals Test Run 1

On July 16, 2018, the PM and metals impinger train back flushed during the post-test leak check for Test Run 1 on EUINC12. Reagents were mixed and the reagents moistened the filter. The test run was voided and an additional test run was conducted for PM and metals.

### 3.2.6 EUINC12, Dioxins Test Run 2

On July 16, 2018, the dioxin-furan impinger train was damaged during the port change for Test Run 2 on EUINC12. The test run was voided and an additional test run was conducted for dioxins and furans.

## 3.3 Summary of Results

The results of the testing, compared to the applicable emission limits, are summarized in Tables 3-4 through 3-8.

Detailed results are presented in Tables 1 through 19 after the Table Tab of this report.

Graphs of the measured $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ concentrations are presented after the Graphs Tab of this report.

Sample calculations are presented in Appendix B.

**Table 3-4**
**Summary of $NO_x$ Results for**
**EUINC07, EUINC09, and EUINC10**

| Incinerator | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|
| EUINC07 | ppmv, dry @ 7% $O_2$ | 204 | 220 |
| EUINC09 | ppmv, dry @ 7% $O_2$ | 158 | 220 |
| EUINC10 | ppmv, dry @ 7% $O_2$ | 184 | 220 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume

## Table 3-5
## Summary of Results for EUINC11

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 20 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 0.1 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 145 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 2,268 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 0.57 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.025 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | 0.28 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.014 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.084 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.052 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

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**Table 3-6**
**Summary of Results for**
**EUINC12**

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 15 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 1.5 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 181 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 1,320 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 6.9 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.25 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | <0.20 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.030 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.043 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.085 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

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## Table 3-7
## Summary of Results for
## EUINC13

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 21 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 0.1 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 205 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 416 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 0.74 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.028 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | <0.18 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.015 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.051 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.050 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

## Table 3-8
## Summary of Results for
## EUINC14

| Parameter | | Unit | Average Result | 40 CFR Part 60, Subpart MMMM Emission Limits† |
|---|---|---|---|---|
| Particulate matter (PM) | | mg/dscm @ 7% $O_2$ | 13 | 80 |
| Sulfur dioxide ($SO_2$) | | ppmv, dry @ 7% $O_2$ | 0.1 | 26 |
| Nitrogen oxides ($NO_X$) | | ppmv, dry @ 7% $O_2$ | 151 | 220 |
| Carbon monoxide (CO) | | ppmv, dry @ 7% $O_2$ | 1,258 | 3,800 |
| Dioxins/furans (PCDD/PCDF) | | ng/dscm @ 7% $O_2$ (total mass basis) | 0.98 | 5.0 |
| | | ng/dscm @ 7% $O_2$ (toxic equivalency basis) | 0.037 | 0.32 |
| Hydrogen chloride (HCl) | | ppmv, dry @ 7% $O_2$ | <0.17 | 1.2 |
| Metals | Cadmium | mg/dscm @ 7% $O_2$ | 0.0082 | 0.095 |
| | Lead | mg/dscm @ 7% $O_2$ | 0.030 | 0.30 |
| | Mercury | mg/dscm @ 7% $O_2$ | 0.034 | 0.28 |
| Visible emissions (VE) from the ash handling system | | % of observation | 0 | 5 |

† Emission limits shown in 40 CFR Appendix Table 3 to Subpart MMMM of Part 60.
mg/dscm: milligram per dry standard cubic meter
@ 7% $O_2$: corrected to 7% oxygen
ppmv: part per million by volume
ng/dscm: nanogram per dry standard cubic meter

# 4.0 Sampling and Analytical Procedures

## 4.1 Test Methods

Bureau Veritas measured emissions in accordance with the procedures specified in the United States Environmental Protection Agency (USEPA) Standards of Performance for New Stationary Sources. Bureau Veritas used methods presented in Table 4-1.

**Table 4-1**
**Sampling Methods**

| Parameter | Location | | Reference | |
|---|---|---|---|---|
| | EUINC 07, 09, 10 | EUINC 11, 12, 13, 14 | Method | Title |
| Sampling ports and traverse points | • | • | 1 | Sample and Velocity Traverses for Stationary Sources |
| Velocity and flowrate | | • | 2 | Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube) |
| Molecular weight | • | • | 3A | Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure) |
| Moisture content | | • | 4 | Determination of Moisture Content in Stack Gases |
| Particulate matter (PM) | | • | 5 | Determination of Particulate Matter Emissions From Stationary Sources |
| Sulfur dioxide ($SO_2$) | | • | 6C | Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure) |
| Oxides of nitrogen (NOx) | • | • | 7E | Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure) |
| Carbon monoxide (CO) | | • | 10 | Determination of Carbon Monoxide Emissions From Stationary Sources (Instrumental Analyzer Procedure) |
| Visible emissions (VE) | | • | 22 | Visual Determination of Fugitive Emissions From Material Sources and Smoke Emissions From Flares |
| Dioxins/furans (PCDD/PCDF) | | • | 23 | Determination of Polychlorinated Dibenzo-*p*-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources |
| Hydrogen chloride (HCl) | | • | 26A | Determination of Hydrogen Halide and Halogen Emissions From Stationary Sources Isokinetic Method |
| Metals | | • | 29 | Determination of Metals Emissions From Stationary Sources |
| Solid content in sludge | • | • | SM2540B | Solids, Total (Gravimetric, Dried at 103-105 Degrees C.) 20th Ed. |
| Gas dilution | • | • | 205 | Verification of Gas Dilution Systems for Field Instrument Calibrations |

## 4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," from the Code of Federal Regulations, Title 40, Part 60 (40 CFR 60), Appendix A, was used to evaluate the sampling location and the number of traverse points for the measurement of velocity profiles. Figure 1 (see Figures Tab) depicts the sampling location and traverse points.

USEPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to measure flue gas velocity and calculate volumetric flowrate. An S-type Pitot tube and thermocouple assembly connected to a digital manometer and thermometer was used. Because the dimensions of Bureau Veritas' Pitot tubes meet the requirements outlined in Method 2, Section 10.0, a baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned.

The digital manometer and thermometer are calibrated using calibration standards, which are traceable to National Institute of Standards (NIST). The Pitot tube inspection and calibration sheets are included in Appendix A.

**Cyclonic Flow Check.** Bureau Veritas evaluated whether cyclonic flow was present at the incinerator sampling locations.

Cyclonic flow is defined as a flow condition with an average null angle greater than 20°. The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head readings—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack wall when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20°, the flue gas flow is considered to be cyclonic at that sampling location and an alternative location should be used.

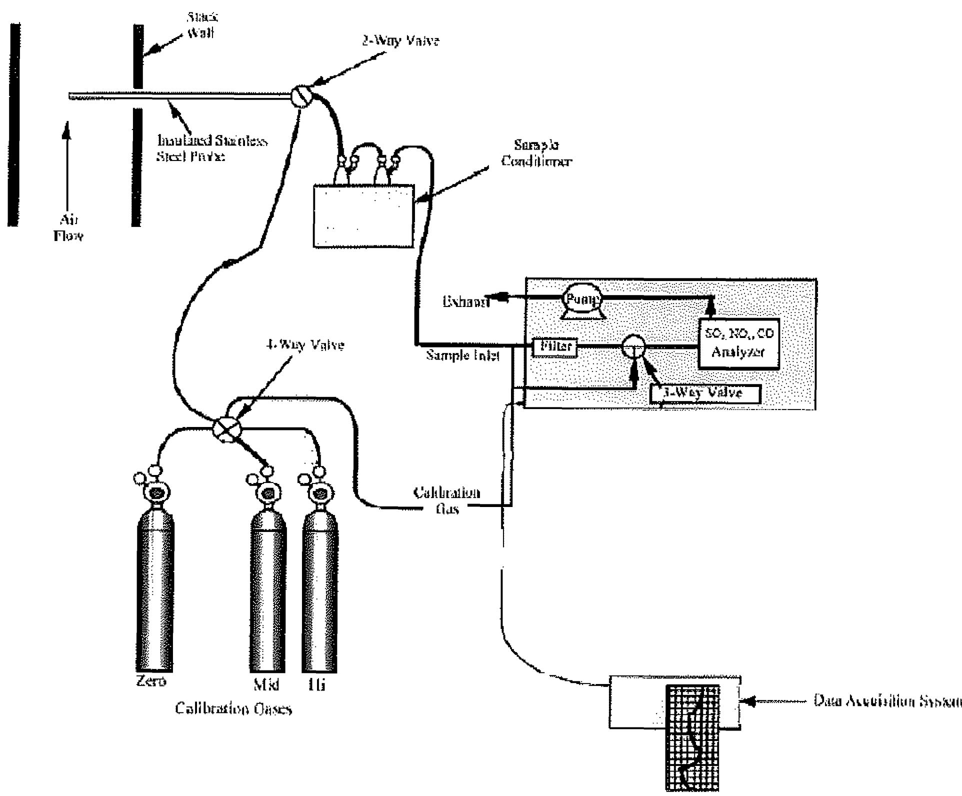
The average of the measured traverse point flue gas velocity null angle was less than 20° at each incinerator exhaust sampling location. The measurements indicate the absence of cyclonic flow at each incinerator.

Field data sheets are included in Appendix C. Computer-generated field data sheets are included in Appendix D.

## 4.1.2 Oxygen, Carbon Dioxide, Sulfur Dioxide, Nitrogen Oxides, and Carbon Monoxide (USEPA Methods 3A, 6C, 7E, and 10)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)," was used to measure the oxygen concentration of the flue gas to correct the results to 7% oxygen. USEPA Method 3A was also used to measure the oxygen and carbon dioxide concentrations of the flue gas to calculate molecular weight of the gas. Sulfur dioxide concentrations were measured using USEPA Method 6C, "Determination of Sulfur Dioxide Emissions From Stationary Sources

(Instrumental Analyzer Procedure). Nitrogen oxides concentrations were measured using USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources." Carbon monoxide concentrations were measured using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources." Figure 4-1 depicts the USEPA Methods 3A, 6C, 7E, and 10 sampling train.




## Figure 4-1. USEPA Methods 3A, 6C, 7E, and 10 Sampling Train

The sampling trains for USEPA Methods 3A, 6C, 7E, and 10 are similar and the flue gas was extracted from the stack through:

- A stainless-steel probe.
- Heated (248 ±25°F) Teflon sample line to prevent condensation.
- A chilled Teflon impinger train with peristaltic pump to remove moisture from the sampled gas stream prior to entering the analyzers via separate sampling lines.
- Oxygen, carbon dioxide, sulfur dioxide, nitrogen oxides, and carbon monoxide gas analyzers.

The flue gas was extracted and continuously introduced into the paramagnetic ($O_2$ and $CO_2$), ultraviolet ($SO_2$), chemiluminescence ($NO_x$), and infrared (CO) gas analyzers to measure pollutant concentrations. Data were recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded concentrations were reported in 1-minute averages over the duration of each test run.

Prior to testing, a 3-point stratification test was conducted at 17, 50, and 83% of the stack diameter for at least twice the response time to determine the minimum number of traverse points to be sampled.

**Calibration Error Check.** A 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 verify the analyzer response is within ±2% of the certified calibration gas introduced.

**System Bias Test.** Prior to each test run, a system bias test was performed where known concentrations of calibration gases are introduced at the probe tip to measure if an analyzer's response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run, an additional system-bias check was performed to evaluate the analyzer drift from pre- and post-test system-bias checks. The system-bias check evaluates the analyzer drift against the ±3% quality assurance/quality control (QA/QC) requirement.

The analyzer drift data was used to correct the measured flue gas concentrations. Recorded concentrations were averaged over the duration of each 60-or 80-minute test run.

**NO/NO2 Conversion Check.** An $NO/NO_2$ conversion check was performed prior to testing by introducing an approximate 50 ppm $NO_2$ calibration gas into the $NO_x$ analyzer. If the analyzer's $NO_x$ concentration response is greater than 90% of the introduced $NO_2$ calibration gas concentration, the analyzer's $NO/NO_2$ conversion will meet the converter efficiency requirement of Section 13.5 of USEPA Method 7E. The response was greater than 90%

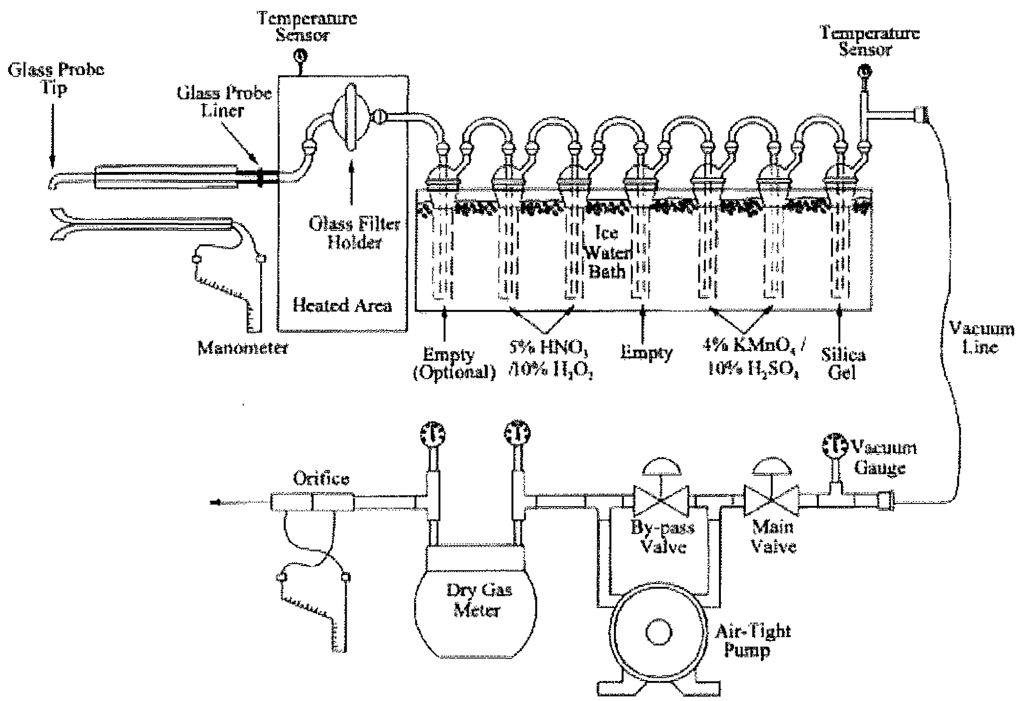
Calibration data along with the USEPA Protocol 1 certification sheets for the calibration gases used are included in Appendix A.

### 4.1.3 Moisture Content (USEPA Method 4)

Prior to testing, the moisture content was estimated using measurements from previous testing, psychrometric charts and/or water saturation vapor pressure tables. These data were used in conjunction with preliminary velocity head pressure and temperature data to calculate flue gas velocity, ideal nozzle size, and to establish the isokinetic sampling rate for the USEPA Methods 5, 23, 26A, and 29 sampling. For each sampling run, moisture content of the flue gases was measured using the reference method outlined in Section 2 of USEPA Method 4, "Determination of Moisture Content in Stack Gases" in conjunction with the performance of USEPA Methods 5, 23, 26A, and 29.

## 4.1.4 Particulate Matter and Metals (USEPA Method 5 and 29)

USEPA Method 5, "Determination of Particulate Matter Emissions from Stationary Sources," and Method 29, "Determination of Metals Emissions from Stationary Sources," were used to measure particulate matter and metals (cadmium, lead, and mercury) emissions. Figure 4-2 depicts the USEPA Methods 5 and 29 sampling train.




## Figure 4-2. USEPA Methods 5 and 29 Sampling Train

Bureau Veritas' modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated (248±25°F) borosilicate glass-lined probe.
- A desiccated and pre-weighed 110- or 83-millimeter-diameter quartz fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A set of six pre-cleaned GS impingers in an ice bath with the configuration shown in Table 4-2.
- A sampling line.

- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

**Table 4-2**
**USEPA Methods 5 and 29 Impinger Configuration**

| Impinger Order (Upstream to Downstream) | Impinger Type | Impinger Contents | Amount |
|---|---|---|---|
| 1 | Modified | 5% $HNO_3$,10% $H_2O_2$ | 100 ml |
| 2 | Greenburg-Smith | 5% $HNO_3$,10% $H_2O_2$ | 100 ml |
| 3 | Modified | Empty | 0 ml |
| 4 | Modified | Acidified $KMnO_4$ | 100 ml |
| 5 | Modified | Acidified $KMnO_4$ | 100 ml |
| 6 | Modified | Silica gel desiccant | ~200-300 g |

Before testing, a preliminary velocity traverse was performed and an ideal nozzle size was calculated. The calculated nozzle size allowed isokinetic sampling at an average rate of approximately 0.75 cfm. Bureau Veritas selected a pre-cleaned borosilicate glass nozzle with an inner diameter that approximates the calculated ideal value. The nozzle inside diameter was measured with calipers across three cross-sectional chords. The nozzle was rinsed and connected to the borosilicate glass-lined sample probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a pressure of 3 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 10 inches of mercury to the sampling train. The dry-gas meter was monitored to measure whether the sample train leak rate was less than 0.02 cfm. If the pre-test leak failed, the sampling train was adjusted until the leak rate was <0.02 cfm. Next, the sampling probe was inserted into the stack through the sampling port to begin sampling.

Ice and water were placed around the impingers and the probe and filter temperatures were allowed to stabilize at 248±25°F before each test run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate to within ±10 % for the duration of the test.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the impingers and filter were transported to the recovery area. The filter was recovered using Teflon-lined tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed with Teflon tape. The nozzle, probe, and the front half of the filter holder assembly were brushed and, at a minimum, triple-rinsed with acetone to recover particulate matter. The acetone rinses were collected in pre-cleaned sample containers.

Next, the probe nozzle, fittings, probe liner, and front-half of the filter holder were washed and brushed (using a nylon bristle brush) three times with 100 ml of 0.1-N nitric acid ($HNO_3$). This rinsate was collected in a glass sample container. Following the $HNO_3$ rinse, the probe nozzle, fittings, probe liner, and front-half of the filter holder were rinsed with high performance liquid chromatography (HPLC) water followed by acetone. The HPLC water and acetone rinses were discarded.

The weight of Impingers 1 and 2 were measured and the contents transferred to a glass sample container. Impingers 1 and 2, the filter support, the back half of the filter housing, and connecting glassware were thoroughly rinsed with 100 ml of 0.1-N $HNO_3$, and the rinsates were added to the sample container in which the contents of the first two impingers were stored.

The weight of Impinger 3 was measured and the contents transferred to a glass sample container. This impinger was rinsed with 100 ml of 0.1-N $HNO_3$, and the rinsate was added to the glass sample container.

The weight of Impingers 4 and 5 were measured and the contents transferred to a glass sample container. The impingers and connecting glassware were triple-rinsed with 100 ml of acidified $KMnO_4$ solution and the rinsate was added to the Impinger 4 and 5 sample containers. Subsequently, these impingers were rinsed with 100 ml of HPLC water, and the rinsate was added to the sample container. Because deposits may still be visible on the impinger surfaces after the water rinse, 25 ml of 8-N hydrochloric acid were used to wash these impingers and connecting glassware. This 8-N hydrochloric acid rinsate was collected in a separate sample container containing 200 ml of water.

The silica gel impinger was weighed as part of the measurement of the flue gas moisture content. All sample containers containing the acetone, 0.1-$HNO_3$, HPLC water, 5% $HNO_3$/10% $H_2O_2$, acidified $KMnO_4$, 8-N hydrochloric acid, and filter blanks were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis.

### 4.1.5 Visible Emissions (USEPA Method 22)

Bureau Veritas determined visible emissions in accordance with USEPA Method 22, "Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares." Visible emissions (VE) from the ash handling system were observed during three 60-minute test runs for each required incinerator.

Fugitive emissions from the stacks were observed from a position with a clear view of the potential emissions source. The observation location was at least 15 feet, but not more than 0.25

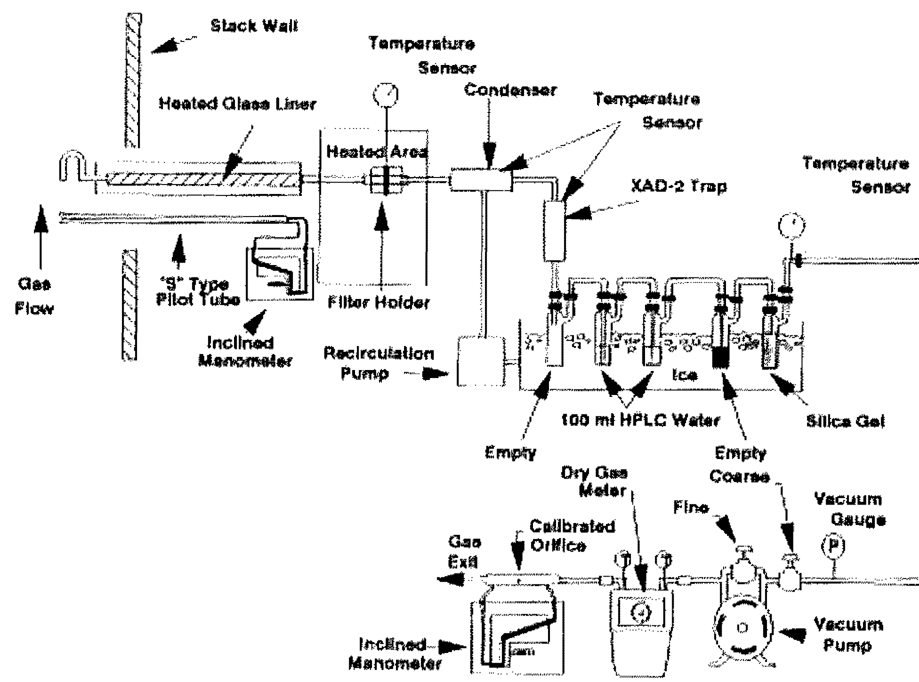
miles, from the emission source, at a point where the sunlight was not shining directly into the observer's eyes.

During the observation period, the observer continuously watched the emission source for 20 minute increments, followed by 5 minute breaks. Upon observing an emission, the amount of time the emission was observed was recorded. This procedure continued for the entire observation period. The observer recorded the accumulated time that emissions were observed on a field data sheet, which are included in Appendix C.

The observer recorded the emission location, facility type, observer's name and affiliation, and the date on a field data sheet. The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background were also recorded. The observer sketched the emission source being observed and indicated the potential and actual emission points, as well as, noted the observer's location relative to the source and the sun.

### 4.1.6 Dioxins and Furans (USEPA Method 23)

USEPA Method 23, "Determination of Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors" was used to measure dioxin and furan concentrations. Triplicate 80-minute test runs were performed at each required incinerator sampling location. Figure 4-3 depicts the USEPA Method 23 sampling train.



## Figure 4-3. USEPA Method 23 Sampling Train

Bureau Veritas' modular isokinetic stack sampling system consists of:

- A stainless steel button-hook nozzle.
- A heated (248±25°F) stainless steel-lined probe.
- A pre-cleaned glass fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A glass recirculating ice water condenser system.
- An XAD-2 sorbent trap.
- A set of five impingers: one Greenburg-Smith (GS) impingers, three modified GS impingers, and one water "knock-out" impinger with the configuration shown in Table 4-3.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

**Table 4-3**
**USEPA Method 23 Impinger Configuration**

| Impinger Order (Upstream to Downstream) | Impinger Type | Impinger Contents | Amount |
|---|---|---|---|
| 1 | "Knock-out" | Empty | 0 ml |
| 2 | Greenburg-Smith | HPLC water | 100 ml |
| 3 | Modified | HPLC water | 100 ml |
| 4 | Modified | Empty | 0 ml |
| 5 | Modified | Silica gel desiccant | ~200-300 g |

HPLC: high-performance liquid chromatography

Before testing, a preliminary velocity traverse was performed and an "ideal" nozzle size was calculated; a nozzle size was selected to enable isokinetic sampling at an average rate of approximately 0.75 cubic feet per minute (cfm). Bureau Veritas selected a pre-cleaned stainless steel nozzle that had an inner diameter that approximated the calculated ideal value. The nozzle was (1) measured with calipers across three cross-sectional chords to evaluate the inside diameter, (2) rinsed and brushed with acetone, methylene chloride, and toluene, and (3) connected to the stainless steel-lined sampling probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a pressure of 3 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 10 inches of mercury to the sampling train. The dry-gas meter was monitored to measure whether the sample train leak rate was less than 0.02 cfm. If the pre-test leak failed, the sampling train was adjusted until the leak rate was <0.02 cfm. Next, the sampling probe was inserted into the stack through the sampling port to begin sampling.

Ice and water were placed around the impingers and the probe and filter temperatures were allowed to stabilize at 248±25°F before each test run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate to within ±10 % for the duration of the test.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the condenser, XAD-2 sorbent trap, impingers, and filter were transported to the recovery area. The XAD-2 sorbent trap was removed from the sampling train, capped at both ends with aluminum foil, labeled, and stored in an iced cooler for transport to the laboratory.

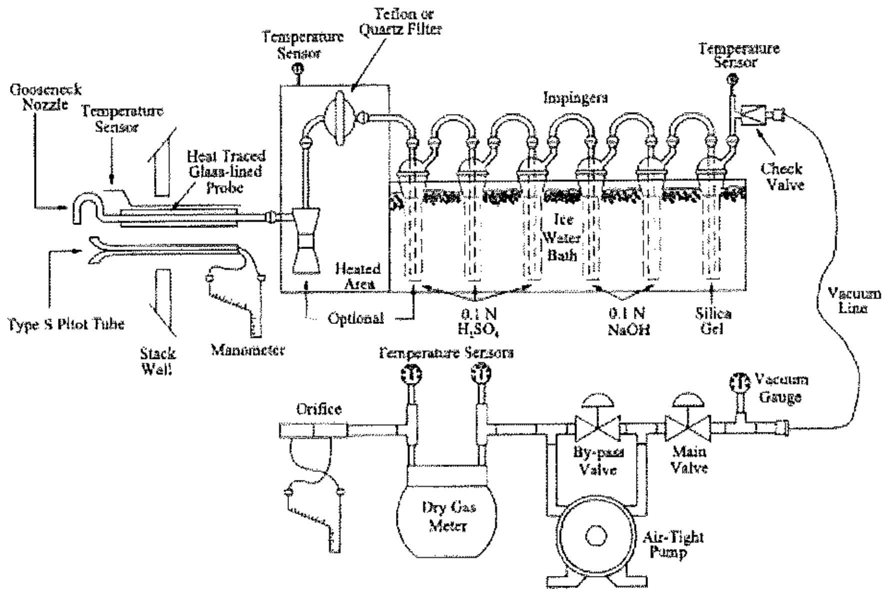
The filter was recovered using Teflon-lined tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed. The nozzle, probe, filter housing, and condenser were brushed and triple-rinsed with acetone and then methylene chloride; these solvents were collected in a pre-cleaned sample container. The nozzle, probe, filter housing, and condenser were triple-rinsed with toluene, which was collected in a separate sample container.

At the end of a test run, the liquid collected in each impinger, including the silica gel, was weighed. These weights were used to calculate the moisture content of the flue gas.

Bureau Veritas labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition, blank samples of the HPLC water, acetone, methylene chloride, toluene, adsorbent module, and filter were collected. Samples were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis.

### 4.1.7 Hydrogen Chloride (USEPA Method 26A)

USEPA Method 26A, "Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources," was used to measure hydrogen chloride emissions. Triplicate 80-minute test runs were performed at each required incinerator sampling location. Figure 4-4 depicts the USEPA Method 26A sampling train. The 0.1 N NaOH impingers were not used.




## Figure 4-4. USEPA Method 26A Sampling Train

Bureau Veritas' modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated borosilicate glass-lined probe, heated above 248°F.
- A desiccated and untared glass fiber filter in a filter box heated above 248°F.
- A set of four pre-cleaned GS impingers with the configuration shown in Table 4-4.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

**Table 4-4**
**USEPA Method 26A Impinger Configuration**

| Impinger Order (Upstream to Downstream) | Impinger Type | Impinger Contents | Amount |
|---|---|---|---|
| 1 | Greenburg-Smith | 0.1 N $H_2SO_4$ | 100 ml |
| 2 | Greenburg-Smith | 0.1 N $H_2SO_4$ | 100 ml |
| 3 | Modified | Empty | 0 ml |
| 4 | Modified | Silica gel desiccant | ~200-300 g |

Before testing, a preliminary velocity traverse was performed and an "ideal" nozzle size was calculated that would enable isokinetic sampling at an average rate of 0.75 cfm. Bureau Veritas selected a pre-cleaned borosilicate glass nozzle that has an inner diameter that approximated the calculated ideal value. The nozzle was (1) measured with calipers across three cross-sectional chords to evaluate the inside diameter, (2) rinsed and brushed with Type 3 deionized, and (3) connected to the borosilicate glass-lined sampling probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a pressure of 3 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 10 inches of mercury to the sampling train. The dry-gas meter was monitored to measure whether the sample train leak rate was less than 0.02 cfm. If the pre-test leak failed, the sampling train was adjusted until the leak rate was <0.02 cfm. Next, the sampling probe was inserted into the stack through the sampling port to begin sampling.

Ice and water were placed around the impingers, and the probe, and filter temperatures were allowed to stabilize to a temperature above 248°F before each test run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate to within ±10 % for the duration of the test.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the impingers and filter housing were transported to the recovery area. The filter was removed from the filter housing and discarded. The nozzle and probe liner, and the front half of the filter housing were rinsed with deionized water to remove particulate matter. The deionized water rinses were discarded.

At the end of a test run, the liquid collected in each impinger, including the silica gel impinger, was measured using an electronic scale; these weights were used to calculate the moisture content of the flue gas.

The contents of Impingers 1 and 2, back-half of the filter housing, and connecting glassware were placed in a glass sample container. The glassware was rinsed three times with deionized water and the rinsate was placed in the sample container.

All sample containers, including blanks, were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada, for analysis.

### 4.1.8 Solid Content of Sludge (Standard Method SM2540B)

One composite sample of sewage sludge was taken for each required incinerator and measured for percent solids in accordance with Standard Method SM2540B. Samples were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis.

### 4.1.9 Gas Dilution (USEPA Method 205)

A gas dilution system was used to introduce known values of calibration gases into the analyzers. The gas dilution system consists of calibrated orifices or mass flow controls 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 USEPA Method 205, "Verification of Gas Dilution Systems for Field Instrument Calibrations."

Before testing, the gas divider dilutions were measured to evaluate that they were within ±2% of predicted values. Three sets of two dilutions of the high-level calibration gas were performed. In addition, a certified mid-level calibration gas was introduced into an analyzer; this calibration gas concentration was within ± 10% of a gas divider dilution concentration.

## 4.2 Process Data

Process data were recorded by GLWA personnel. Refer to Section 2.3 for discussions of process and control device data and Appendix F for the operating parameters recorded during testing.

## 4.3 Sampling Identification and Custody

Mr. David Kawasaki was responsible for the handling and procurement of the data collected in the field. Mr. Kawasaki ensured the data sheets were accounted for and completed.

Recovery and analytical procedures were applicable to the sampling methods used in this test program. Sampling and recovery procedures were described in Section 4.1.

Applicable Chain of Custody procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."

For each sample collected (i.e., impinger) sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with test number, location, and test date.
- Containers were stored in a cooler.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."
- Samples were delivered to the laboratory.

Chains of custody and laboratory analytical results are included in Appendix E.

# 5.0 QA/QC Activities

Equipment used in this test program passed QA/QC procedures. Refer to Appendix A for equipment calibrations and inspection sheets. Field data sheets are presented in Appendix C. Computer-generated data sheets are presented within Appendix D.

## 5.1 Pretest QA/QC Activities

Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods."

## 5.2 QA/QC Audits

The results of select sampling and equipment QA/QC audits and the acceptable tolerance are presented in the following sections. Analyzer calibration and gas certification sheets are presented in Appendix A.

### 5.2.1 Results of Audit Samples

Audit samples, supplied by Environmental Resource Associates (ERA), were analyzed as part of this test program. The purpose of ERA's Stationary Source Audit Sample Program is to evaluate accuracy and data reliability. The audit samples were analyzed by Maxxam Analytics. The audit sample results were within the acceptance limits. The results of the audit samples are presented in Table 5-1. ERA's Audit Evaluation Report is included in Appendix E.

**Table 5-1**
**Stationary Source Audit Program QA/QC Audit Sample Results**

| Sample Catalog Number | Analyte | Unit | Maxxam Analytics Reported Value | ERA Assigned Value | Acceptable Limit | Performance Evaluation |
|---|---|---|---|---|---|---|
| 1425 | Metals on filter paper (cadmium) | µg/filter | 69.6 | 68.5 | 54.8-82.2 | Acceptable |
| 1425 | Metals on filter paper (lead) | µg/filter | 129 | 123 | 98.4-148 | Acceptable |
| 1426 | Metals in impinger solution (cadmium) | µg/mL | 1.38 | 1.33 | 1.06-1.60 | Acceptable |
| 1426 | Metals in impinger solution (lead) | µg/mL | 1.35 | 1.24 | 0.930-1.55 | Acceptable |
| 1427 | Mercury on filter paper | µg/filter | 39.8 | 40.2 | 30.2-50.2 | Acceptable |
| 1428 | Mercury in impinger solution | ng/mL | 11.4 | 11.5 | 8.62-14.4 | Acceptable |
| 1440 | Hydrogen chloride in impinger solution | mg/L | 12.5 | 12.8 | 11.5-14.1 | Acceptable |

### 5.2.2 Sampling Train QA/QC Audits

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Tables 5-2 through 5-4 summarize the QA/QC audits conducted for the USEPA Methods 23, 26A, and 5 and 29 sampling trains.

## Table 5-2
## USEPA Method 23 Sampling Train QA/QC Audits

| Parameter | Run 1 | Run 2 | Run 3 | Run 4 | Method Requirement | Comment |
|---|---|---|---|---|---|---|
| **EUINC11** | | | | | | |
| Sampling train leak check Post–test | 0 $ft^3$ for 1 min at 5 in Hg | 0 $ft^3$ for 1 min at 7 in Hg | 0 $ft^3$ for 1 min at 6 in Hg | -- | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 1 | 5 to 7 | 5 to 6 | -- | | |
| Isokinetic variation (%) | 98 | 97 | 96 | -- | 90-110% | Valid |
| **EUINC12** | | | | | | |
| Sampling train leak check Post–test | 0 $ft^3$ for 1 min at 10 in Hg | -- | 0.005 $ft^3$ for 1 min at 10 in Hg | 0 $ft^3$ for 1 min at 10 in Hg | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 5 to 8 | -- | 4 to 7 | 4 to 8 | | |
| Isokinetic variation (%) | 100 | -- | 98 | 97 | 90-110% | Valid |
| **EUINC13** | | | | | | |
| Sampling train leak check Post–test | 0 $ft^3$ for 1 min at 10 in Hg | 0.005 $ft^3$ for 1 min at 10 in Hg | 0.008 $ft^3$ for 1 min at 10 in Hg | -- | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 7 to 8 | 6 to 8 | 7 to 9 | -- | | |
| Isokinetic variation (%) | 98 | 99 | 96 | -- | 90-110% | Valid |
| **EUINC14** | | | | | | |
| Sampling train leak check Post–test | 0.005 $ft^3$ for 1 min at 10 in Hg | 0 $ft^3$ for 1 min at 10 in Hg | 0.005 $ft^3$ for 1 min at 10 in Hg | -- | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 6 to 7 | 5 to 7 | 6 to 7 | -- | | |
| Isokinetic variation (%) | 99 | 100 | 101 | -- | 90-110% | Valid |

## Table 5-3
## USEPA Method 26A Sampling Train QA/QC Audits

| Parameter | Run 1 | Run 2 | Run 3 | Method Requirement | Comment |
|---|---|---|---|---|---|
| **EUINC11** | | | | | |
| Sampling train leak check Post–test | 0 ft$^3$ for 1 min at 5 in Hg | 0 ft$^3$ for 1 min at 5 in Hg | 0 ft$^3$ for 1 min at 6 in Hg | <0.020 ft$^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 3 to 5 | 5 | 5 | | |
| Isokinetic variation (%) | 94 | 94 | 95 | 90-110% | Valid |
| **EUINC12** | | | | | |
| Sampling train leak check Post–test | 0 ft$^3$ for 1 min at 5 in Hg | 0 ft$^3$ for 1 min at 10 in Hg | 0 ft$^3$ for 1 min at 8 in Hg | <0.020 ft$^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 3 to 5 | 5 | 5 | | |
| Isokinetic variation (%) | 96 | 95 | 98 | 90-110% | Valid |
| **EUINC13** | | | | | |
| Sampling train leak check Post–test | 0 ft$^3$ for 1 min at 8 in Hg | 0.005 ft$^3$ for 1 min at 7 in Hg | 0.005 ft$^3$ for 1 min at 8 in Hg | <0.020 ft$^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 4 to 5 | 5 | 3 to 5 | | |
| Isokinetic variation (%) | 95 | 94 | 93 | 90-110% | Valid |
| **EUINC14** | | | | | |
| Sampling train leak check Post–test | 0 ft$^3$ for 1 min at 12 in Hg | 0 ft$^3$ for 1 min at 5 in Hg | 0 ft$^3$ for 1 min at 5 in Hg | <0.020 ft$^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 5 | 5 | 4 to 5 | | |
| Isokinetic variation (%) | 95 | 96 | 94 | 90-110% | Valid |

# Table 5-4
## USEPA Methods 5 and 29 Sampling Train QA/QC Audits

| Parameter | Run 1 | Run 2 | Run 3 | Run 4 | Method Requirement | Comment |
|---|---|---|---|---|---|---|
| **EUINC11** | | | | | | |
| Sampling train leak check Post–test | 0 $ft^3$ for 1 min at 5 in Hg | 0.010 $ft^3$ for 1 min at 6 in Hg | 0 $ft^3$ for 1 min at 5 in Hg | -- | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 4 | 4 | 4 | -- | | |
| Isokinetic variation (%) | 94 | 95 | 95 | -- | 90-110% | Valid |
| **EUINC12** | | | | | | |
| Sampling train leak check Post–test | -- | 0.005 $ft^3$ for 1 min at 5 in Hg | 0 $ft^3$ for 1 min at 5 in Hg | 0 $ft^3$ for 1 min at 7 in Hg | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | -- | 3 to 5 | 5 | 5 | | |
| Isokinetic variation (%) | -- | 95 | 96 | 94 | 90-110% | Valid |
| **EUINC13** | | | | | | |
| Sampling train leak check Post–test | 0 $ft^3$ for 1 min at 10 in Hg | 0.005 $ft^3$ for 1 min at 10 in Hg | 0.015 $ft^3$ for 1 min at 10 in Hg | -- | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 4 to 5 | 4 to 5 | 4 to 5 | -- | | |
| Isokinetic variation (%) | 99 | 98 | 97 | -- | 90-110% | Valid |
| **EUINC14** | | | | | | |
| Sampling train leak check Post–test | 0 $ft^3$ for 1 min at 5 in Hg | 0 $ft^3$ for 1 min at 10 in Hg | 0 $ft^3$ for 1 min at 5 in Hg | -- | <0.020 $ft^3$ for 1 minute at ≥ sample vacuum recorded during test | Valid |
| Sampling vacuum (in Hg) | 4 to 5 | 5 | 4 to 5 | -- | | |
| Isokinetic variation (%) | 94 | 99 | 98 | -- | 90-110% | Valid |

## 5.2.3 Instrument Analyzer QA/QC Audits

The instrument sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Table 5-5 summarizes the gas cylinders used during this test program. Refer to Appendix A for additional calibration data.

**Table 5-5**
**Calibration Gas Cylinder Information**

| Parameter | Gas Vendor | Cylinder Serial Number | Cylinder Value | Expiration Date |
|---|---|---|---|---|
| Oxygen ($O_2$) | Airgas | ALM-047449 | 19.99% | 5/22/26 |
| Carbon dioxide ($CO_2$) | Airgas | ALM-047449 | 19.89% | 5/22/26 |
| Carbon monoxide (CO) | Airgas | XC032359B | 4,408 ppm | 10/30/22 |
| Nitrogen ($N_2$) | Airgas | 1535054Y | 99.9995% | 2/4/24 |
| Nitrogen dioxide ($NO_2$) | Airgas | CC507540 | 50.94 ppm | 1/4/21 |
| Nitrogen oxides ($NO_X$) | Airgas | AAL-5925 | 845.6 ppm | 3/13/25 |
| Sulfur dioxide ($SO_2$) | Airgas | CC131966 | 88.21 ppm | 10/23/22 |

## 5.2.4 Dry-Gas Meter QA/QC Audits

Table 5-6 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Refer to Appendix A for DGM calibrations.

**Table 5-6**
**Dry-gas Meter Calibration QA/QC Audit**

| Dry-Gas Meter | DGM Calibration Factor (Y) (dimensionless) | Acceptable Tolerance | Comment |
|---|---|---|---|
| X | 0.971<br>June 22, 2018 | 0.97-1.03 | Valid |
| W12637 | 1.0098<br>May 17, 2018 | 0.97-1.03 | Valid |

### 5.2.5 Thermocouple QA/QC Audits

Temperature measured using thermocouples and digital pyrometers were compared to a reference temperature (i.e., ice water bath, boiling water) before and after testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are presented in Appendix A.

## 5.3 QA/QC Checks for Data Reduction and Validation

Bureau Veritas validated the computer spreadsheets onsite. The computer spreadsheets were used to evaluate the accuracy of field calculations. The field data sheets were reviewed to evaluate whether data had been recorded appropriately. The computer data sheets were checked against the field data sheets for accuracy. Sample calculations were performed to check computer spreadsheet computations.

## 5.4 QA/QC Problems

Equipment audits and QA/QC procedures demonstrate sample collection accuracy for the test runs.

# 6.0 Limitations

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# Table 1
## EUINC07 Exhaust $O_2$ and $NO_x$ Emission Results
## Great Lakes Water Authority
## Detroit, Michigan
## Bureau Veritas Project No. 11018-000100.00
## Sampling Date: July 10, 2018

| Parameter | Run 1 | Run 2 | Run 3 | | Average |
|---|---|---|---|---|---|
| Sample Start Time | 13:45 | 14:55 | 17:10 | | |
| Test Duration (min) | 60 | 60 | 60 | | 60 |
| | | | | | |
| $O_2$ Concentration ($C_{Avg}$, %) | 10.7 | 9.4 | 10.8 | | 10.3 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **11** | **9.4** | **11** | | **10** |
| | | | | | |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | 128.9 | 200.9 | 148.2 | | 159.3 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | **126** | **201** | **144** | | **157** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | **172** | **242** | **199** | | **204** |

ppmvd = part per million by volume, dry basis

**Table 2**
**EUINC09 Exhaust $O_2$ and $NO_x$ Emission Results**
**Great Lakes Water Authority**
**Detroit, Michigan**
**Bureau Veritas Project No. 11018-000100.00**
**Sampling Date: July 10, 2018**

| Parameter | Run 1 | Run 2 | Run 3 | | Average |
|---|---|---|---|---|---|
| Sample Start Time | 7:40 | 9:02 | 10:20 | | |
| Test Duration (min) | 60 | 60 | 60 | | 60 |
| | | | | | |
| $O_2$ Concentration ($C_{Avg}$, %) | 5.9 | 12.7 | 10.2 | | 9.6 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **6.0** | **13** | **10** | | **9.7** |
| | | | | | |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | 198.4 | 80.5 | 127.7 | | 135.5 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | **193** | **77** | **123** | | **131** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | **180** | **132** | **161** | | **158** |

ppmvd = part per million by volume, dry basis

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**Table 3**
**EUINC10 Exhaust $O_2$ and $NO_x$ Emission Results**
**Great Lakes Water Authority**
**Detroit, Michigan**
**Bureau Veritas Project No. 11018-000100.00**
**Sampling Date: July 11, 2018**

| Parameter | Run 1 | Run 2 | Run 3 | | Average |
|---|---|---|---|---|---|
| Sample Start Time | 7:00 | 8:55 | 10:05 | | |
| Test Duration (min) | 60 | 60 | 60 | | 60 |
| $O_2$ Concentration ($C_{Avg}$, %) | 6.8 | 3.5 | 5.0 | | 5.1 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **6.6** | **3.3** | **4.7** | | **4.9** |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | 180.8 | 242.1 | 224.5 | | 215.8 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | **178** | **239** | **224** | | **214** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | **172** | **189** | **192** | | **184** |

ppmvd = part per million by volume, dry basis

**Table 4**
**EUINC11 Exhaust $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Emission Results**
**Great Lakes Water Authority**
**Detroit, Michigan**
**Bureau Veritas Project No. 11018-000100.00**
**Sampling Dates: July 11 and 12, 2018**

| Parameter | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | | Average |
|---|---|---|---|---|---|---|---|---|
| Sample Date | July 11 | July 12 | July 12 | July 12 | July 12 | July 12 | | |
| Sample Start Time | 14:30 | 8:50 | 11:20 | 13:50 | 16:00 | 17:45 | | |
| Test Duration (min) | 60 | 60 | 60 | 60 | 60 | 60 | | 60 |
| $O_2$ Concentration ($C_{Avg}$, %) | 10.7 | 10.2 | 9.6 | 10.3 | 9.2 | 10.0 | | 10.0 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **10** | **10** | **9.4** | **10** | **8.9** | **9.7** | | **9.7** |
| $CO_2$ Concentration ($C_{Avg}$, %) | 8.3 | 8.9 | 9.4 | 8.8 | 9.4 | 8.9 | | 8.9 |
| **Corrected $CO_2$ Concentration ($C_{Gas}$, %)** | **8.2** | **8.6** | **9.2** | **8.6** | **9.3** | **8.7** | | **8.8** |
| CO Concentration ($C_{Avg}$, ppmvd) | | | 1,394.95 | 1,109.96 | 1,896.14 | | | 1,467.02 |
| **Corrected CO Concentration ($C_{Gas}$, ppmvd)** | | | **2,753** | **1,062** | **1,842** | | | **1,886** |
| **CO Concentration (ppmvd, @ 7% $O_2$)** | | | **3,315** | **1,354** | **2,134** | | | **2,268** |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | | | 121.0 | 120.9 | 117.7 | | | 119.9 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | | | **122** | **120** | **117** | | | **120** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | | | **147** | **153** | **136** | | | **145** |
| $SO_2$ Concentration ($C_{Avg}$, ppmvd) | | | 0.1 | 0.0 | 0.0 | | | 0.0 |
| **Corrected $SO_2$ Concentration ($C_{Gas}$, ppmvd)** | | | **0.2** | **0.1** | **0.0** | | | **0.1** |
| **$SO_2$ Concentration (ppmvd, @ 7% $O_2$)** | | | **0.2** | **0.1** | **0.0** | | | **0.1** |

ppmvd = part per million by volume, dry basis

# Table 5 - EUINC11 Exhaust Dioxin and Furan Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC11** | | | |
| **Test Date** | | **Jul 12, 2018** | **Jul 12, 2018** | **Jul 12, 2018** | |
| **Meter/Nozzle Information** | | **M23 - Run 1** | **M23 - Run 2** | **M23 - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 99 | 103 | 104 | 102 |
| Meter Pressure, $P_m$ | in Hg | 29.59 | 29.60 | 29.60 | 29.60 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 50.24 | 50.30 | 50.50 | 50.35 |
| Sample Volume, $V_m$ | std $ft^3$ | 47.42 | 47.15 | 47.20 | 47.25 |
| Sample Volume, $V_m$ | std $m^3$ | 1.34 | 1.34 | 1.34 | 1.34 |
| Condensate Volume, $V_w$ | std $ft^3$ | 0.67 | 1.40 | 1.14 | 1.07 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0769 | 0.0766 | 0.0766 | 0.0767 |
| Total weight of sampled gas | lb | 3.697 | 3.718 | 3.716 | 3.710 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 98 | 97 | 96 | 97 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 81 | 80 | 82 | 81 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.78 | 29.85 | 29.78 | 29.80 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.61 | 29.51 | 29.50 | 29.54 |
| Stack Gas Specific Gravity, $G_s$ | | 1.02 | 1.02 | 1.02 | 1.02 |
| Percent Moisture, $B_{ws}$ | % | 1.40 | 2.88 | 2.36 | 2.22 |
| Water Vapor Volume (fraction) | | 0.014 | 0.029 | 0.024 | 0.022 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.53 | 16.71 | 16.87 | 16.71 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,778 | 15,950 | 16,103 | 15,944 |
| Flowrate | $ft^3$/min, standard wet | 14,243 | 14,423 | 14,505 | 14,390 |
| Flowrate | $ft^3$/min, standard dry | 14,043 | 14,007 | 14,163 | 14,071 |
| Flowrate | $m^3$/min, standard dry | 398 | 397 | 401 | 398 |
| **Collected Mass** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | pg | <2.2 | 2.6 | 4.4 | 3.1 |
| 1,2,3,7,8-Penta CDD | pg | <2.8 | <2.4 | <3.2 | <2.8 |
| 1,2,3,4,7,8-Hexa CDD | pg | <2.3 | <2.3 | <2.3 | <2.3 |
| 1,2,3,6,7,8-Hexa CDD | pg | <2.0 | <2.0 | <1.9 | <2.0 |
| 1,2,3,7,8,9-Hexa CDD | pg | <2.1 | <2.1 | <2.0 | <2.1 |
| 1,2,3,4,6,7,8-Hepta CDD | pg | 4.7 | 2.2 | <2.3 | 3.1 |
| 1,2,3,4,6,7,8,9-Octa CDD | pg | 21.2 | 10.6 | 7.2 | 13.0 |
| Total Tetra CDD | pg | <2.2 | 22.0 | 19.0 | 14.4 |
| Total Penta CDD | pg | <2.8 | <3.1 | <3.2 | <3.0 |
| Total Hexa CDD | pg | <9.1 | <7.8 | <10 | <9.0 |
| Total Hepta CDD | pg | 13.5 | 2.6 | <2.3 | 6.1 |
| Total Dioxins | pg | 48.8 | 46.1 | 41.7 | 45.5 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | pg | 5.0 | 131 | 96.2 | 77.4 |
| 1,2,3,7,8-Penta CDF | pg | <2.3 | 19.7 | 13.1 | 11.7 |
| 2,3,4,7,8-Penta CDF | pg | 4.0 | 58.0 | 39.9 | 34.0 |
| 1,2,3,4,7,8-Hexa CDF | pg | 6.8 | 13.2 | 11.6 | 10.5 |
| 1,2,3,6,7,8-Hexa CDF | pg | <1.8 | 5.2 | 3.5 | 3.5 |
| 2,3,4,6,7,8-Hexa CDF | pg | 3.6 | 7.4 | 5.8 | 5.6 |
| 1,2,3,7,8,9-Hexa CDF | pg | <2.8 | <2.6 | <2.9 | <2.8 |
| 1,2,3,4,6,7,8-Hepta CDF | pg | 9.3 | 3.5 | 3.1 | 5.3 |
| 1,2,3,4,7,8,9-Hepta CDF | pg | <2.5 | <2.8 | <3.0 | <2.8 |
| 1,2,3,4,6,7,8,9-Octa CDF | pg | 2.9 | <2.3 | <2.2 | 2.5 |
| Total Tetra CDF | pg | 5.0 | 617 | 481 | 368 |
| Total Penta CDF | pg | 4.0 | 263 | 209 | 159 |
| Total Hexa CDF | pg | 20.3 | 43.2 | 35.0 | 32.8 |
| Total Hepta CDF | pg | 9.3 | 3.5 | <2.4 | 5.1 |
| Total Furans | pg | 41.5 | 929 | 730 | 567 |
| | | | | | |
| Total Dioxin + Furan | pg | 90 | 975 | 771 | 612 |
| Total Dioxin + Furan (TEQ) | pg | 9.08 | 39.7 | 32.7 | 27.2 |

## Table 5 (continued) - EUINC11 Exhaust Dioxin and Furan Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC11** | | | |
| **Test Date** | | **Jul 12, 2018** | **Jul 12, 2018** | **Jul 12, 2018** | |
| **Run** | | **M23 - Run 1** | **M23 - Run 2** | **M23 - Run 3** | **Average** |
| **Concentration** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | ng/dscm @ 7% Oxygen | <2.1E-03 | 2.4E-03 | 4.2E-03 | 2.9E-03 |
| 1,2,3,7,8-Penta CDD | ng/dscm @ 7% Oxygen | <2.7E-03 | <2.2E-03 | <3.1E-03 | <2.6E-03 |
| 1,2,3,4,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <2.2E-03 | <2.1E-03 | <2.2E-03 | <2.2E-03 |
| 1,2,3,6,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <1.9E-03 | <1.8E-03 | <1.8E-03 | <1.8E-03 |
| 1,2,3,7,8,9-Hexa CDD | ng/dscm @ 7% Oxygen | <2.0E-03 | <1.9E-03 | <1.9E-03 | <1.9E-03 |
| 1,2,3,4,6,7,8-Hepta CDD | ng/dscm @ 7% Oxygen | 4.5E-03 | 2.0E-03 | <2.2E-03 | 2.9E-03 |
| 1,2,3,4,6,7,8,9-Octa CDD | ng/dscm @ 7% Oxygen | 2.0E-02 | 9.6E-03 | 6.9E-03 | 1.2E-02 |
| Total Tetra CDD | ng/dscm @ 7% Oxygen | <2.1E-03 | 2.0E-02 | 1.8E-02 | 1.3E-02 |
| Total Penta CDD | ng/dscm @ 7% Oxygen | <2.7E-03 | <2.8E-03 | <3.1E-03 | <2.8E-03 |
| Total Hexa CDD | ng/dscm @ 7% Oxygen | <8.6E-03 | <7.1E-03 | <9.5E-03 | <8.4E-03 |
| Total Hepta CDD | ng/dscm @ 7% Oxygen | 1.3E-02 | 2.4E-03 | 2.2E-03 | 5.8E-03 |
| Total Dioxins | ng/dscm @ 7% Oxygen | 4.6E-02 | 4.2E-02 | 4.0E-02 | 4.3E-02 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | ng/dscm @ 7% Oxygen | 4.7E-03 | 1.2E-01 | 9.2E-02 | 7.2E-02 |
| 1,2,3,7,8-Penta CDF | ng/dscm @ 7% Oxygen | <2.2E-03 | 1.8E-02 | 1.2E-02 | 1.1E-02 |
| 2,3,4,7,8-Penta CDF | ng/dscm @ 7% Oxygen | 3.8E-03 | 5.3E-02 | 3.8E-02 | 3.1E-02 |
| 1,2,3,4,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 6.5E-03 | 1.2E-02 | 1.1E-02 | 9.8E-03 |
| 1,2,3,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | <1.7E-03 | 4.7E-03 | 3.3E-03 | 3.3E-03 |
| 2,3,4,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 3.4E-03 | 6.7E-03 | 5.5E-03 | 5.2E-03 |
| 1,2,3,7,8,9-Hexa CDF | ng/dscm @ 7% Oxygen | <2.7E-03 | <2.4E-03 | <2.8E-03 | <2.6E-03 |
| 1,2,3,4,6,7,8-Hepta CDF | ng/dscm @ 7% Oxygen | 8.8E-03 | 3.2E-03 | 3.0E-03 | 5.0E-03 |
| 1,2,3,4,7,8,9-Hepta CDF | ng/dscm @ 7% Oxygen | <2.4E-03 | <2.5E-03 | <2.9E-03 | <2.6E-03 |
| 1,2,3,4,6,7,8,9-Octa CDF | ng/dscm @ 7% Oxygen | 2.8E-03 | <2.1E-03 | <2.1E-03 | 2.3E-03 |
| Total Tetra CDF | ng/dscm @ 7% Oxygen | 4.7E-03 | 5.6E-01 | 4.6E-01 | 3.4E-01 |
| Total Penta CDF | ng/dscm @ 7% Oxygen | 3.8E-03 | 2.4E-01 | 2.0E-01 | 1.5E-01 |
| Total Hexa CDF | ng/dscm @ 7% Oxygen | 1.9E-02 | 3.9E-02 | 3.3E-02 | 3.1E-02 |
| Total Hepta CDF | ng/dscm @ 7% Oxygen | 8.8E-03 | 3.2E-03 | <2.3E-03 | 4.8E-03 |
| Total Furans | ng/dscm @ 7% Oxygen | 3.9E-02 | 8.4E-01 | 7.0E-01 | 5.3E-01 |
| Total Dioxin + Furan | ng/dscm @ 7% Oxygen | 0.086 | 0.88 | 0.74 | 0.57 |
| Total Dioxin + Furan (TEQ) | ng/dscm @ 7% Oxygen | 0.0086 | 0.036 | 0.031 | 0.025 |

# Table 6 - EUINC11 Exhaust Hydrogen Chloride Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC11** | | | |
| **Test Date** | | **Jul 11, 2018** | **Jul 12, 2018** | **Jul 12, 2018** | |
| **Meter/Nozzle Information** | | **M26A - Run 1** | **M26A - Run 2** | **M26A - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 91 | 86 | 89 | 89 |
| Meter Pressure, $P_m$ | in Hg | 29.50 | 29.61 | 29.60 | 29.57 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 49.43 | 49.37 | 48.41 | 49.07 |
| Sample Volume, $V_m$ | std $ft^3$ | 45.36 | 45.88 | 44.73 | 45.32 |
| Sample Volume, $V_m$ | std $m^3$ | 1.28 | 1.30 | 1.27 | 1.28 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.60 | 1.09 | 1.07 | 1.25 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0761 | 0.0766 | 0.0768 | 0.0765 |
| Total weight of sampled gas | lb | 3.573 | 3.597 | 3.531 | 3.567 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 94 | 94 | 95 | 94 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 74 | 80 | 88 | 81 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.72 | 29.78 | 29.85 | 29.78 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.32 | 29.50 | 29.57 | 29.46 |
| Stack Gas Specific Gravity, $G_s$ | | 1.01 | 1.02 | 1.02 | 1.02 |
| Percent Moisture, $B_{ws}$ | % | 3.40 | 2.32 | 2.33 | 2.68 |
| Water Vapor Volume (fraction) | | 0.034 | 0.023 | 0.023 | 0.027 |
| Pressure, $P_s$ | in Hg | 27.56 | 27.66 | 27.66 | 27.63 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.54 | 16.81 | 16.44 | 16.60 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,782 | 16,039 | 15,687 | 15,836 |
| Flowrate | $ft^3$/min, standard wet | 14,377 | 14,493 | 13,976 | 14,282 |
| Flowrate | $ft^3$/min, standard dry | 13,888 | 14,157 | 13,651 | 13,898 |
| Flowrate | $m^3$/min, standard dry | 393 | 401 | 387 | 394 |
| **Collected Mass** | | | | | |
| Hydrogen chloride | mg | 0.540 | <0.200 | 0.330 | 0.357 |
| **Concentration** | | | | | |
| Hydrogen chloride | mg/dscf | 0.012 | <0.0044 | <0.0074 | 0.0079 |
| Hydrogen chloride | mg/dscm @ 7% Oxygen | 0.54 | 0.20 | 0.31 | 0.35 |
| Hydrogen chloride | ppmvd @ 7% Oxygen | 0.44 | 0.16 | 0.25 | 0.28 |

# Table 7 - EUINC11 Exhaust Particulate Matter and Metals Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC11** | | | |
| **Test Date** | | **Jul 12, 2018** | **Jul 12, 2018** | **Jul 12, 2018** | |
| **Meter/Nozzle Information** | | **M5/29 - Run 1** | **M5/29 - Run 2** | **M5/29 - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 92 | 93 | 95 | 93 |
| Meter Pressure, $P_m$ | in Hg | 29.60 | 29.60 | 29.60 | 29.60 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 48.66 | 48.36 | 48.92 | 48.65 |
| Sample Volume, $V_m$ | std $ft^3$ | 44.70 | 44.37 | 44.74 | 44.60 |
| Sample Volume, $V_m$ | std $m^3$ | 1.27 | 1.26 | 1.27 | 1.26 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.07 | 1.67 | 1.96 | 1.57 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0766 | 0.0764 | 0.0763 | 0.0764 |
| Total weight of sampled gas | lb | 3.505 | 3.516 | 3.511 | 3.510 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 94 | 95 | 95 | 95 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 90 | 89 | 80 | 86 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.78 | 29.84 | 29.90 | 29.84 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.50 | 29.41 | 29.40 | 29.44 |
| Stack Gas Specific Gravity, $G_s$ | | 1.02 | 1.02 | 1.02 | 1.02 |
| Percent Moisture, $B_{ws}$ | % | 2.33 | 3.64 | 4.20 | 3.39 |
| Water Vapor Volume (fraction) | | 0.023 | 0.036 | 0.042 | 0.034 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.53 | 16.58 | 16.44 | 16.52 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,774 | 15,825 | 15,692 | 15,764 |
| Flowrate | $ft^3$/min, standard wet | 14,008 | 14,071 | 14,197 | 14,092 |
| Flowrate | $ft^3$/min, standard dry | 13,681 | 13,560 | 13,600 | 13,614 |
| Flowrate | $m^3$/min, standard dry | 387 | 384 | 385 | 386 |
| **Collected Mass** | | | | | |
| Particulate Matter (PM) | mg | 24.2 | 18.2 | 22 | 21.5 |
| Mercury (Hg) | mg | 0.0530 | 0.0608 | 0.0509 | 0.0549 |
| Lead (Pb) | mg | 0.0811 | 0.0697 | 0.117 | 0.0893 |
| Cadmium (Cd) | mg | 0.0140 | 0.0133 | 0.0186 | 0.0153 |
| **Concentration** | | | | | |
| Particulate Matter (PM) | mg/dscf | 0.54 | 0.41 | 0.49 | 0.48 |
| Particulate Matter (PM) | mg/dscm @ 7% Oxygen | 24 | 17 | 20 | 20 |
| Particulate Matter (PM) | ppmvd @ 7% Oxygen | 20 | 14 | 16 | 16 |
| Mercury (Hg) | mg/dscf | 0.0012 | 0.0014 | 0.0011 | 0.0012 |
| Mercury (Hg) | mg/dscm @ 7% Oxygen | 0.053 | 0.056 | 0.046 | 0.052 |
| Mercury (Hg) | ppmvd @ 7% Oxygen | 0.043 | 0.045 | 0.037 | 0.042 |
| Lead (Pb) | mg/dscf | 0.0018 | 0.0016 | 0.0026 | 0.0020 |
| Lead (Pb) | mg/dscm @ 7% Oxygen | 0.082 | 0.064 | 0.11 | 0.084 |
| Lead (Pb) | ppmvd @ 7% Oxygen | 0.066 | 0.052 | 0.085 | 0.067 |
| Cadmium (Cd) | mg/dscf | 0.00031 | 0.00030 | 0.00042 | 0.00034 |
| Cadmium (Cd) | mg/dscm @ 7% Oxygen | 0.014 | 0.012 | 0.017 | 0.014 |
| Cadmium (Cd) | ppmvd @ 7% Oxygen | 0.011 | 0.010 | 0.013 | 0.012 |

**Table 8**
**EUINC12 Exhaust $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Emission Results**
**Great Lakes Water Authority**
**Detroit, Michigan**
**Bureau Veritas Project No. 11018-000100.00**
**Sampling Dates: July 16 and 17, 2018**

| Parameter | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run6 | Run7 | | Average |
|---|---|---|---|---|---|---|---|---|---|
| Sample Date | July 16 | July 16 | July 16 | July 16 | July 17 | July 17 | July 17 | | |
| Sample Start Time | 11:05 | 13:20 | 15:45 | 17:40 | 7:00 | 8:35 | 10:20 | | |
| Test Duration (min) | 60 | 60 | 60 | 60 | 60 | 60 | 60 | | 60 |
| $O_2$ Concentration ($C_{Avg}$, %) | 7.7 | 8.3 | 8.9 | 9.7 | 7.9 | 8.6 | 11.0 | | 8.9 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **7.7** | **8.3** | **9.0** | **9.7** | **7.9** | **8.5** | **11** | | **8.9** |
| $CO_2$ Concentration ($C_{Avg}$, %) | 8.9 | 8.3 | 8.0 | 7.2 | 8.8 | 8.2 | 6.2 | | 7.9 |
| **Corrected $CO_2$ Concentration ($C_{Gas}$, %)** | **8.8** | **8.2** | **7.9** | **7.2** | **8.7** | **8.2** | **6.3** | | **7.9** |
| CO Concentration ($C_{Avg}$, ppmvd) | | 1,211.2 | 1,065.4 | 1,214.3 | | | | | 1,163.7 |
| **Corrected CO Concentration ($C_{Gas}$, ppmvd)** | | **1,165** | **1,026** | **1,186** | | | | | **1,126** |
| **CO Concentration (ppmvd, @ 7% $O_2$)** | | **1,290** | **1,198** | **1,473** | | | | | **1,320** |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | | 150.2 | 152.6 | 156.7 | | | | | 153.2 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | | **151** | **153** | **158** | | | | | **154** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | | **167** | **179** | **197** | | | | | **181** |
| $SO_2$ Concentration ($C_{Avg}$, ppmvd) | | 0.8 | 3.7 | 0.8 | | | | | 1.8 |
| **Corrected $SO_2$ Concentration ($C_{Gas}$, ppmvd)** | | **0.2** | **3.3** | **0.5** | | | | | **1.3** |
| **$SO_2$ Concentration (ppmvd, @ 7% $O_2$)** | | **0.2** | **3.9** | **0.6** | | | | | **1.5** |

ppmvd = part per million by volume, dry basis

## Table 9 - EUINC12 Exhaust Dioxin and Furan Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC12** | | | |
| **Test Date** | | **Jul 16, 2018** | **Jul 16, 2018** | **Jul 16, 2018** | |
| **Meter/Nozzle Information** | | **M23 - Run 1** | **M23 - Run 3** | **M23 - Run 4** | **Average** |
| Meter Temperature, $T_m$ | °F | 102 | 113 | 115 | 110 |
| Meter Pressure, $P_m$ | in Hg | 29.60 | 29.59 | 29.59 | 29.59 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 51.45 | 50.85 | 50.80 | 51.03 |
| Sample Volume, $V_m$ | std $ft^3$ | 48.32 | 46.81 | 46.57 | 47.24 |
| Sample Volume, $V_m$ | std $m^3$ | 1.37 | 1.33 | 1.32 | 1.34 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.32 | 1.44 | 1.27 | 1.34 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0763 | 0.0760 | 0.0759 | 0.0761 |
| Total weight of sampled gas | lb | 3.789 | 3.667 | 3.634 | 3.697 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 100 | 98 | 97 | 99 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 85 | 86 | 82 | 84 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.72 | 29.62 | 29.54 | 29.63 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.41 | 29.28 | 29.23 | 29.30 |
| Stack Gas Specific Gravity, $G_s$ | | 1.02 | 1.01 | 1.01 | 1.01 |
| Percent Moisture, $B_{ws}$ | % | 2.65 | 2.99 | 2.66 | 2.77 |
| Water Vapor Volume (fraction) | | 0.027 | 0.030 | 0.027 | 0.028 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.75 | 16.62 | 16.57 | 16.65 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,981 | 15,860 | 15,815 | 15,885 |
| Flowrate | $ft^3$/min, standard wet | 14,308 | 14,187 | 14,248 | 14,248 |
| Flowrate | $ft^3$/min, standard dry | 13,929 | 13,763 | 13,869 | 13,854 |
| Flowrate | $m^3$/min, standard dry | 394 | 390 | 393 | 392 |
| **Collected Mass** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | pg | 2.4 | 5.2 | <2.2 | 3.3 |
| 1,2,3,7,8-Penta CDD | pg | <2.0 | <2.3 | <2.1 | <2.1 |
| 1,2,3,4,7,8-Hexa CDD | pg | <2.4 | <2.4 | <2.3 | <2.4 |
| 1,2,3,6,7,8-Hexa CDD | pg | <2.1 | <2.1 | <1.9 | <2.0 |
| 1,2,3,7,8,9-Hexa CDD | pg | <2.1 | <2.1 | <2.0 | <2.1 |
| 1,2,3,4,6,7,8-Hepta CDD | pg | 3.5 | 3.3 | 2.2 | 3.0 |
| 1,2,3,4,6,7,8,9-Octa CDD | pg | 21.5 | 11.6 | 10.3 | 14.5 |
| Total Tetra CDD | pg | 15.8 | 35.6 | 14.2 | 21.9 |
| Total Penta CDD | pg | <2.0 | 2.3 | <2.1 | 2.1 |
| Total Hexa CDD | pg | <10.0 | <9.5 | <9.1 | <9.5 |
| Total Hepta CDD | pg | 3.5 | 6.2 | 2.2 | 4.0 |
| Total Dioxins | pg | 52.8 | 65.2 | 37.9 | 52.0 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | pg | 758 | 1,220 | 584 | 854 |
| 1,2,3,7,8-Penta CDF | pg | 120 | 214.0 | 62.0 | 132 |
| 2,3,4,7,8-Penta CDF | pg | 404 | 819.0 | 337 | 520 |
| 1,2,3,4,7,8-Hexa CDF | pg | 105 | 246.0 | 138 | 163 |
| 1,2,3,6,7,8-Hexa CDF | pg | 42.1 | 101.0 | 52.7 | 65.3 |
| 2,3,4,6,7,8-Hexa CDF | pg | 65.0 | 161.0 | 102 | 109 |
| 1,2,3,7,8,9-Hexa CDF | pg | <2.7 | 3.3 | 3.1 | 3.0 |
| 1,2,3,4,6,7,8-Hepta CDF | pg | 28.8 | 64.9 | 48.0 | 47.2 |
| 1,2,3,4,7,8,9-Hepta CDF | pg | 4.2 | 5.7 | 6.4 | 5.4 |
| 1,2,3,4,6,7,8,9-Octa CDF | pg | 5.3 | 7.3 | 3.8 | 5.5 |
| Total Tetra CDF | pg | 3790 | 5,840 | 3,520 | 4,383 |
| Total Penta CDF | pg | 2300 | 4,500 | 1,760 | 2,853 |
| Total Hexa CDF | pg | 412 | 936.0 | 528 | 625 |
| Total Hepta CDF | pg | 32.9 | 97.8 | 71.5 | 67.4 |
| Total Furans | pg | 6540 | 11,381 | 5,883 | 7,935 |
| | | | | | |
| Total Dioxin + Furan | pg | 6593 | 11,446 | 5,921 | 7,987 |
| Total Dioxin + Furan (TEQ) | pg | 227 | 434 | 196 | 286 |

## Table 9 (continued) - EUINC12 Exhaust Dioxin and Furan Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC12** | | | |
| **Test Date** | | **Jul 16, 2018** | **Jul 16, 2018** | **Jul 16, 2018** | |
| **Run** | | **M23 - Run 1** | **M23 - Run 3** | **M23 - Run 4** | **Average** |
| **Concentration** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | ng/dscm @ 7% Oxygen | 1.8E-03 | 4.6E-03 | <2.1E-03 | 2.8E-03 |
| 1,2,3,7,8-Penta CDD | ng/dscm @ 7% Oxygen | <1.5E-03 | <2.0E-03 | <2.0E-03 | <1.8E-03 |
| 1,2,3,4,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <1.8E-03 | <2.1E-03 | <2.2E-03 | <2.0E-03 |
| 1,2,3,6,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <1.6E-03 | <1.9E-03 | <1.8E-03 | <1.8E-03 |
| 1,2,3,7,8,9-Hexa CDD | ng/dscm @ 7% Oxygen | <1.6E-03 | <1.9E-03 | <1.9E-03 | <1.8E-03 |
| 1,2,3,4,6,7,8-Hepta CDD | ng/dscm @ 7% Oxygen | 2.7E-03 | 2.9E-03 | 2.1E-03 | 2.6E-03 |
| 1,2,3,4,6,7,8,9-Octa CDD | ng/dscm @ 7% Oxygen | 1.7E-02 | 1.0E-02 | 9.7E-03 | 1.2E-02 |
| Total Tetra CDD | ng/dscm @ 7% Oxygen | 1.2E-02 | 3.1E-02 | 1.3E-02 | 1.9E-02 |
| Total Penta CDD | ng/dscm @ 7% Oxygen | <1.5E-03 | 2.0E-03 | <2.0E-03 | 1.8E-03 |
| Total Hexa CDD | ng/dscm @ 7% Oxygen | <7.7E-03 | <8.4E-03 | <8.6E-03 | <8.2E-03 |
| Total Hepta CDD | ng/dscm @ 7% Oxygen | 2.7E-03 | 5.5E-03 | 2.1E-03 | 3.4E-03 |
| Total Dioxins | ng/dscm @ 7% Oxygen | 4.1E-02 | 5.7E-02 | 3.6E-02 | 4.5E-02 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | ng/dscm @ 7% Oxygen | 5.8E-01 | 1.1E+00 | 5.5E-01 | 7.4E-01 |
| 1,2,3,7,8-Penta CDF | ng/dscm @ 7% Oxygen | 9.2E-02 | 1.9E-01 | 5.8E-02 | 1.1E-01 |
| 2,3,4,7,8-Penta CDF | ng/dscm @ 7% Oxygen | 3.1E-01 | 7.2E-01 | 3.2E-01 | 4.5E-01 |
| 1,2,3,4,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 8.1E-02 | 2.2E-01 | 1.3E-01 | 1.4E-01 |
| 1,2,3,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 3.2E-02 | 8.9E-02 | 5.0E-02 | 5.7E-02 |
| 2,3,4,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 5.0E-02 | 1.4E-01 | 9.6E-02 | 9.6E-02 |
| 1,2,3,7,8,9-Hexa CDF | ng/dscm @ 7% Oxygen | <2.1E-03 | 2.9E-03 | 2.9E-03 | 2.6E-03 |
| 1,2,3,4,6,7,8-Hepta CDF | ng/dscm @ 7% Oxygen | 2.2E-02 | 5.7E-02 | 4.5E-02 | 4.2E-02 |
| 1,2,3,4,7,8,9-Hepta CDF | ng/dscm @ 7% Oxygen | 3.2E-03 | 5.0E-03 | 6.0E-03 | 4.8E-03 |
| 1,2,3,4,6,7,8,9-Octa CDF | ng/dscm @ 7% Oxygen | 4.1E-03 | 6.4E-03 | 3.6E-03 | 4.7E-03 |
| Total Tetra CDF | ng/dscm @ 7% Oxygen | 2.9E+00 | 5.1E+00 | 3.3E+00 | 3.8E+00 |
| Total Penta CDF | ng/dscm @ 7% Oxygen | 1.8E+00 | 4.0E+00 | 1.7E+00 | 2.5E+00 |
| Total Hexa CDF | ng/dscm @ 7% Oxygen | 3.2E-01 | 8.2E-01 | 5.0E-01 | 5.5E-01 |
| Total Hepta CDF | ng/dscm @ 7% Oxygen | 2.5E-02 | 8.6E-02 | 6.7E-02 | 6.0E-02 |
| Total Furans | ng/dscm @ 7% Oxygen | 5.0E+00 | 1.0E+01 | 5.5E+00 | 6.9E+00 |
| Total Dioxin + Furan | ng/dscm @ 7% Oxygen | 5.1 | 10 | 5.6 | 6.9 |
| Total Dioxin + Furan (TEQ) | ng/dscm @ 7% Oxygen | 0.17 | 0.38 | 0.18 | 0.25 |

# Table 10 - EUINC12 Exhaust Hydrogen Chloride Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC12** | | | |
| **Test Date** | | **Jul 17, 2018** | **Jul 17, 2018** | **Jul 17, 2018** | |
| **Meter/Nozzle Information** | | **M26A - Run 1** | **M26A - Run 2** | **M26A - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 84 | 89 | 92 | 88 |
| Meter Pressure, $P_m$ | in Hg | 29.40 | 29.40 | 29.40 | 29.40 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 48.58 | 49.76 | 50.94 | 49.76 |
| Sample Volume, $V_m$ | std $ft^3$ | 44.98 | 45.67 | 46.48 | 45.71 |
| Sample Volume, $V_m$ | std $m^3$ | 1.27 | 1.29 | 1.32 | 1.29 |
| Condensate Volume, $V_w$ | std $ft^3$ | 2.45 | 0.81 | 1.71 | 1.66 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0755 | 0.0764 | 0.0754 | 0.0758 |
| Total weight of sampled gas | lb | 3.583 | 3.553 | 3.603 | 3.580 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 96 | 95 | 98 | 96 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 84 | 84 | 81 | 83 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.71 | 29.65 | 29.45 | 29.60 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.10 | 29.45 | 29.04 | 29.20 |
| Stack Gas Specific Gravity, $G_s$ | | 1.00 | 1.02 | 1.00 | 1.01 |
| Percent Moisture, $B_{ws}$ | % | 5.16 | 1.74 | 3.55 | 3.49 |
| Water Vapor Volume (fraction) | | 0.052 | 0.017 | 0.036 | 0.035 |
| Pressure, $P_s$ | in Hg | 27.46 | 27.46 | 27.46 | 27.46 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.79 | 16.60 | 16.72 | 16.70 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 16,021 | 15,843 | 15,957 | 15,940 |
| Flowrate | $ft^3$/min, standard wet | 14,276 | 14,120 | 14,292 | 14,229 |
| Flowrate | $ft^3$/min, standard dry | 13,540 | 13,873 | 13,784 | 13,732 |
| Flowrate | $m^3$/min, standard dry | 383 | 393 | 390 | 389 |
| **Collected Mass** | | | | | |
| Hydrogen chloride | mg | <0.200 | <0.400 | <0.200 | <0.267 |
| **Concentration** | | | | | |
| Hydrogen chloride | mg/dscf | <0.0044 | <0.0088 | <0.0043 | <0.0058 |
| Hydrogen chloride | mg/dscm @ 7% Oxygen | <0.17 | <0.35 | <0.21 | <0.24 |
| Hydrogen chloride | ppmvd @ 7% Oxygen | <0.14 | <0.28 | <0.17 | <0.20 |

## Table 11 - EUINC12 Exhaust Particulate Matter and Metals Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC12** | | | |
| **Test Date** | | **Jul 16, 2018** | **Jul 16, 2018** | **Jul 16, 2018** | |
| **Meter/Nozzle Information** | | **M5/29 - Run 2** | **M5/29 - Run 3** | **M5/29 - Run 4** | **Average** |
| Meter Temperature, $T_m$ | °F | 93 | 94 | 95 | 94 |
| Meter Pressure, $P_m$ | in Hg | 29.60 | 29.60 | 29.60 | 29.60 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 50.17 | 48.69 | 48.80 | 49.22 |
| Sample Volume, $V_m$ | std $ft^3$ | 46.00 | 44.58 | 44.57 | 45.05 |
| Sample Volume, $V_m$ | std $m^3$ | 1.30 | 1.26 | 1.26 | 1.28 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.26 | 2.85 | 1.50 | 1.87 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0761 | 0.0751 | 0.0757 | 0.0756 |
| Total weight of sampled gas | lb | 3.599 | 3.561 | 3.470 | 3.543 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 95 | 96 | 94 | 95 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 81 | 88 | 81 | 83 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.64 | 29.62 | 29.54 | 29.60 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.33 | 28.93 | 29.16 | 29.14 |
| Stack Gas Specific Gravity, $G_s$ | | 1.01 | 1.00 | 1.01 | 1.01 |
| Percent Moisture, $B_{ws}$ | % | 2.66 | 6.01 | 3.25 | 3.97 |
| Water Vapor Volume (fraction) | | 0.027 | 0.060 | 0.033 | 0.040 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.75 | 16.87 | 16.40 | 16.67 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,981 | 16,094 | 15,647 | 15,907 |
| Flowrate | $ft^3$/min, standard wet | 14,420 | 14,349 | 14,125 | 14,298 |
| Flowrate | $ft^3$/min, standard dry | 14,036 | 13,488 | 13,665 | 13,730 |
| Flowrate | $m^3$/min, standard dry | 397 | 382 | 387 | 389 |
| **Collected Mass** | | | | | |
| Particulate Matter (PM) | mg | 20.5 | 17.1 | 13.1 | 16.9 |
| Mercury (Hg) | mg | 0.105 | 0.0982 | 0.0750 | 0.0929 |
| Lead (Pb) | mg | 0.0373 | 0.0690 | 0.0356 | 0.0473 |
| Cadmium (Cd) | mg | 0.00665 | 0.0130 | 0.0731 | 0.0309 |
| **Concentration** | | | | | |
| Particulate Matter (PM) | mg/dscf | 0.45 | 0.38 | 0.29 | 0.37 |
| Particulate Matter (PM) | mg/dscm @ 7% Oxygen | 17 | 16 | 13 | 15 |
| Particulate Matter (PM) | ppmvd @ 7% Oxygen | 14 | 13 | 10 | 12 |
| Mercury (Hg) | mg/dscf | 0.0023 | 0.0022 | 0.0017 | 0.0021 |
| Mercury (Hg) | mg/dscm @ 7% Oxygen | 0.089 | 0.091 | 0.074 | 0.085 |
| Mercury (Hg) | ppmvd @ 7% Oxygen | 0.072 | 0.074 | 0.060 | 0.069 |
| Lead (Pb) | mg/dscf | 0.00081 | 0.0015 | 0.00080 | 0.0011 |
| Lead (Pb) | mg/dscm @ 7% Oxygen | 0.032 | 0.064 | 0.035 | 0.043 |
| Lead (Pb) | ppmvd @ 7% Oxygen | 0.026 | 0.052 | 0.028 | 0.035 |
| Cadmium (Cd) | mg/dscf | 0.00014 | 0.00029 | 0.0016 | 0.00069 |
| Cadmium (Cd) | mg/dscm @ 7% Oxygen | 0.0056 | 0.012 | 0.072 | 0.030 |
| Cadmium (Cd) | ppmvd @ 7% Oxygen | 0.0046 | 0.010 | 0.059 | 0.024 |

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# Table 12
## EUINC13 Exhaust $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Emission Results
## Great Lakes Water Authority
## Detroit, Michigan
## Bureau Veritas Project No. 11018-000100.00
## Sampling Dates: July 17 and 18, 2018

| Parameter | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | | Average |
|---|---|---|---|---|---|---|---|---|
| Sample Date | July 17 | July 17 | July 17 | July 18 | July 18 | July 18 | | |
| Sample Start Time | 13:00 | 14:50 | 16:40 | 7:00 | 8:37 | 10:20 | | |
| Test Duration (min) | 60 | 60 | 60 | 60 | 60 | 60 | | 60 |
| | | | | | | | | |
| $O_2$ Concentration ($C_{Avg}$, %) | 11.0 | 11.5 | 10.8 | 10.3 | 11.0 | 11.1 | | 10.9 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **11** | **11** | **11** | **10** | **11** | **11** | | **11** |
| | | | | | | | | |
| $CO_2$ Concentration ($C_{Avg}$, %) | 5.7 | 5.6 | 6.2 | 6.3 | 5.6 | 5.5 | | 5.8 |
| **Corrected $CO_2$ Concentration ($C_{Gas}$, %)** | **5.5** | **5.5** | **6.0** | **6.3** | **5.7** | **5.6** | | **5.8** |
| | | | | | | | | |
| CO Concentration ($C_{Avg}$, ppmvd) | 411.5 | 268.8 | 358.4 | | | | | 346.2 |
| **Corrected CO Concentration ($C_{Gas}$, ppmvd)** | **364** | **218** | **308** | | | | | **297** |
| **CO Concentration (ppmvd, @ 7% $O_2$)** | **510** | **318** | **421** | | | | | **416** |
| | | | | | | | | |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | 142.3 | 141.5 | 144.9 | | | | | 142.9 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | **146** | **144** | **147** | | | | | **146** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | **205** | **210** | **200** | | | | | **205** |
| | | | | | | | | |
| $SO_2$ Concentration ($C_{Avg}$, ppmvd) | 0.2 | 0.4 | 0.3 | | | | | 0.3 |
| **Corrected $SO_2$ Concentration ($C_{Gas}$, ppmvd)** | **0.1** | **0.1** | **0.1** | | | | | **0.1** |
| **$SO_2$ Concentration (ppmvd, @ 7% $O_2$)** | **0.1** | **0.2** | **0.1** | | | | | **0.1** |

ppmvd = part per million by volume, dry basis

BUREAU VERITAS

# Table 13 - EUINC13 Exhaust Dioxin and Furan Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC13** | | | |
| **Test Date** | | **Jul 17, 2018** | **Jul 17, 2018** | **Jul 17, 2018** | |
| **Meter/Nozzle Information** | | **Run 1 - M23** | **Run 2 - M23** | **Run 3 - M23** | **Average** |
| Meter Temperature, $T_m$ | °F | 103 | 117 | 119 | 113 |
| Meter Pressure, $P_m$ | in Hg | 29.39 | 29.39 | 29.39 | 29.39 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 50.02 | 51.91 | 51.09 | 51.00 |
| Sample Volume, $V_m$ | std $ft^3$ | 46.54 | 47.12 | 46.21 | 46.62 |
| Sample Volume, $V_m$ | std $m^3$ | 1.32 | 1.33 | 1.31 | 1.32 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.46 | 2.11 | 0.79 | 1.45 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0753 | 0.0749 | 0.0759 | 0.0754 |
| Total weight of sampled gas | lb | 3.614 | 3.688 | 3.605 | 3.636 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 98 | 99 | 96 | 98 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 84 | 82 | 87 | 84 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.35 | 29.35 | 29.42 | 29.37 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.01 | 28.86 | 29.23 | 29.03 |
| Stack Gas Specific Gravity, $G_s$ | | 1.00 | 1.00 | 1.01 | 1.00 |
| Percent Moisture, $B_{ws}$ | % | 3.05 | 4.28 | 1.69 | 3.00 |
| Water Vapor Volume (fraction) | | 0.030 | 0.043 | 0.017 | 0.030 |
| Pressure, $P_s$ | in Hg | 27.46 | 27.46 | 27.46 | 27.46 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.73 | 16.79 | 16.71 | 16.74 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,963 | 16,023 | 15,949 | 15,978 |
| Flowrate | $ft^3$/min, standard wet | 14,227 | 14,317 | 14,132 | 14,225 |
| Flowrate | $ft^3$/min, standard dry | 13,794 | 13,704 | 13,894 | 13,797 |
| Flowrate | $m^3$/min, standard dry | 391 | 388 | 393 | 391 |
| **Collected Mass** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | pg | <2.1 | <2.1 | <2.2 | <2.1 |
| 1,2,3,7,8-Penta CDD | pg | <2.0 | <2.2 | <2.6 | <2.3 |
| 1,2,3,4,7,8-Hexa CDD | pg | <2.4 | <2.3 | <2.5 | <2.4 |
| 1,2,3,6,7,8-Hexa CDD | pg | <2.0 | <2.0 | <2.2 | <2.1 |
| 1,2,3,7,8,9-Hexa CDD | pg | <2.1 | <2.0 | <2.2 | <2.1 |
| 1,2,3,4,6,7,8-Hepta CDD | pg | <2.3 | <2.3 | <2.1 | <2.2 |
| 1,2,3,4,6,7,8,9-Octa CDD | pg | 6.3 | 13.0 | 8.9 | 9.4 |
| Total Tetra CDD | pg | 2.8 | 2.6 | <2.3 | 2.6 |
| Total Penta CDD | pg | <2.5 | <2.2 | <2.6 | <2.4 |
| Total Hexa CDD | pg | <7.7 | <10 | <9.2 | <9.0 |
| Total Hepta CDD | pg | 2.3 | <2.3 | 3.3 | 2.6 |
| Total Dioxins | pg | 21.6 | 30.1 | 26.3 | 26.0 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | pg | 112 | 87.7 | 58.9 | 86.2 |
| 1,2,3,7,8-Penta CDF | pg | <13 | <9.1 | 5.7 | 9.3 |
| 2,3,4,7,8-Penta CDF | pg | 44.4 | 29.0 | 22.8 | 32.1 |
| 1,2,3,4,7,8-Hexa CDF | pg | 17.4 | 11.2 | 6.9 | 11.8 |
| 1,2,3,6,7,8-Hexa CDF | pg | 7.1 | 5.0 | 2.1 | 4.7 |
| 2,3,4,6,7,8-Hexa CDF | pg | 13.1 | 9.6 | 5.0 | 9.2 |
| 1,2,3,7,8,9-Hexa CDF | pg | <2.9 | <2.9 | <2.6 | <2.8 |
| 1,2,3,4,6,7,8-Hepta CDF | pg | 6.5 | 5.2 | <2.4 | 4.7 |
| 1,2,3,4,7,8,9-Hepta CDF | pg | <2.7 | 4.3 | <3.5 | 3.5 |
| 1,2,3,4,6,7,8,9-Octa CDF | pg | <2.1 | <2.3 | <2.2 | <2.2 |
| Total Tetra CDF | pg | 728 | 371 | 311 | 470 |
| Total Penta CDF | pg | 208 | 131 | 105 | 148 |
| Total Hexa CDF | pg | 61.4 | 42.1 | 23.9 | 42.5 |
| Total Hepta CDF | pg | 6.5 | 5.2 | <2.8 | 4.8 |
| Total Furans | pg | 1,006 | 552 | 445 | 668 |
| | | | | | |
| Total Dioxin + Furan | pg | 1,028 | 582 | 471 | 694 |
| Total Dioxin + Furan (TEQ) | pg | 33.8 | 25.7 | 20.1 | 26.5 |

## Table 13 (continued) - EUINC13 Exhaust Dioxin and Furan Emission Results

| Facility | | Great Lakes Water Authority | | | |
|---|---|---|---|---|---|
| Source Designation | | EUINC13 | | | |
| Test Date | | Jul 17, 2018 | Jul 17, 2018 | Jul 17, 2018 | |
| Run | | Run 1 - M23 | Run 2 - M23 | Run 3 - M23 | Average |
| Concentration | | | | | |
| | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | ng/dscm @ 7% Oxygen | <2.2E-03 | <2.3E-03 | <2.3E-03 | <2.3E-03 |
| 1,2,3,7,8-Penta CDD | ng/dscm @ 7% Oxygen | <2.1E-03 | <2.4E-03 | <2.7E-03 | <2.4E-03 |
| 1,2,3,4,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <2.6E-03 | <2.5E-03 | <2.6E-03 | <2.6E-03 |
| 1,2,3,6,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <2.1E-03 | <2.2E-03 | <2.3E-03 | <2.2E-03 |
| 1,2,3,7,8,9-Hexa CDD | ng/dscm @ 7% Oxygen | <2.2E-03 | <2.2E-03 | <2.3E-03 | <2.2E-03 |
| 1,2,3,4,6,7,8-Hepta CDD | ng/dscm @ 7% Oxygen | <2.5E-03 | <2.5E-03 | <2.2E-03 | <2.4E-03 |
| 1,2,3,4,6,7,8,9-Octa CDD | ng/dscm @ 7% Oxygen | 6.7E-03 | 1.4E-02 | 9.3E-03 | 1.0E-02 |
| Total Tetra CDD | ng/dscm @ 7% Oxygen | 3.0E-03 | 2.8E-03 | 2.4E-03 | 2.7E-03 |
| Total Penta CDD | ng/dscm @ 7% Oxygen | <2.7E-03 | <2.4E-03 | <2.7E-03 | <2.6E-03 |
| Total Hexa CDD | ng/dscm @ 7% Oxygen | <8.2E-03 | <1.1E-02 | <9.6E-03 | <9.5E-03 |
| Total Hepta CDD | ng/dscm @ 7% Oxygen | 2.5E-03 | <2.5E-03 | 3.4E-03 | 2.8E-03 |
| Total Dioxins | ng/dscm @ 7% Oxygen | 2.3E-02 | 3.3E-02 | 2.7E-02 | 2.8E-02 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | ng/dscm @ 7% Oxygen | 1.2E-01 | 9.5E-02 | 6.1E-02 | 9.2E-02 |
| 1,2,3,7,8-Penta CDF | ng/dscm @ 7% Oxygen | <1.4E-02 | <9.9E-03 | 5.9E-03 | 9.9E-03 |
| 2,3,4,7,8-Penta CDF | ng/dscm @ 7% Oxygen | 4.7E-02 | 3.1E-02 | 2.4E-02 | 3.4E-02 |
| 1,2,3,4,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 1.9E-02 | 1.2E-02 | 7.2E-03 | 1.3E-02 |
| 1,2,3,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 7.6E-03 | 5.4E-03 | 2.2E-03 | 5.1E-03 |
| 2,3,4,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 1.4E-02 | 1.0E-02 | 5.2E-03 | 9.9E-03 |
| 1,2,3,7,8,9-Hexa CDF | ng/dscm @ 7% Oxygen | <3.1E-03 | <3.1E-03 | <2.7E-03 | <3.0E-03 |
| 1,2,3,4,6,7,8-Hepta CDF | ng/dscm @ 7% Oxygen | 6.9E-03 | 5.6E-03 | <2.5E-03 | 5.0E-03 |
| 1,2,3,4,7,8,9-Hepta CDF | ng/dscm @ 7% Oxygen | <2.9E-03 | 4.7E-03 | <3.6E-03 | 3.7E-03 |
| 1,2,3,4,6,7,8,9-Octa CDF | ng/dscm @ 7% Oxygen | <2.2E-03 | <2.5E-03 | <2.3E-03 | <2.3E-03 |
| Total Tetra CDF | ng/dscm @ 7% Oxygen | 7.8E-01 | 4.0E-01 | 3.2E-01 | 5.0E-01 |
| Total Penta CDF | ng/dscm @ 7% Oxygen | 2.2E-01 | 1.4E-01 | 1.1E-01 | 1.6E-01 |
| Total Hexa CDF | ng/dscm @ 7% Oxygen | 6.5E-02 | 4.6E-02 | 2.5E-02 | 4.5E-02 |
| Total Hepta CDF | ng/dscm @ 7% Oxygen | 6.9E-03 | 5.6E-03 | <2.9E-03 | 5.2E-03 |
| Total Furans | ng/dscm @ 7% Oxygen | 1.1E+00 | 6.0E-01 | 4.6E-01 | 7.1E-01 |
| | | | | | |
| Total Dioxin + Furan | ng/dscm @ 7% Oxygen | 1.1 | 0.63 | 0.49 | 0.74 |
| Total Dioxin + Furan (TEQ) | ng/dscm @ 7% Oxygen | 0.036 | 0.028 | 0.021 | 0.028 |

# Table 14 - EUINC13 Exhaust Hydrogen Chloride Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC13** | | | |
| **Test Date** | | **Jul 17, 2018** | **Jul 17, 2018** | **Jul 17, 2018** | |
| **Meter/Nozzle Information** | | **M26A - Run 1** | **M26A - Run 2** | **M26A - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 92 | 100 | 102 | 98 |
| Meter Pressure, $P_m$ | in Hg | 29.41 | 29.40 | 29.41 | 29.40 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 50.50 | 50.32 | 50.34 | 50.39 |
| Sample Volume, $V_m$ | std $ft^3$ | 46.07 | 45.28 | 45.12 | 45.49 |
| Sample Volume, $V_m$ | std $m^3$ | 1.30 | 1.28 | 1.28 | 1.29 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.57 | 1.39 | 1.70 | 1.55 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0752 | 0.0753 | 0.0753 | 0.0753 |
| Total weight of sampled gas | lb | 3.584 | 3.515 | 3.494 | 3.531 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 95 | 94 | 93 | 94 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 84 | 85 | 85 | 85 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.35 | 29.35 | 29.42 | 29.37 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 28.98 | 29.01 | 29.00 | 29.00 |
| Stack Gas Specific Gravity, $G_s$ | | 1.00 | 1.00 | 1.00 | 1.00 |
| Percent Moisture, $B_{ws}$ | % | 3.31 | 2.97 | 3.63 | 3.30 |
| Water Vapor Volume (fraction) | | 0.033 | 0.030 | 0.036 | 0.033 |
| Pressure, $P_s$ | in Hg | 27.46 | 27.46 | 27.46 | 27.46 |
| Average Stack Velocity, $V_s$ | ft/sec | 17.07 | 16.86 | 17.08 | 17.00 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 16,293 | 16,085 | 16,295 | 16,224 |
| Flowrate | $ft^3$/min, standard wet | 14,512 | 14,315 | 14,493 | 14,440 |
| Flowrate | $ft^3$/min, standard dry | 14,033 | 13,890 | 13,966 | 13,963 |
| Flowrate | $m^3$/min, standard dry | 397 | 393 | 395 | 395 |
| **Collected Mass** | | | | | |
| Hydrogen chloride | mg | <0.200 | <0.200 | <0.200 | <0.200 |
| **Concentration** | | | | | |
| Hydrogen chloride | mg/dscf | <0.0043 | <0.0044 | <0.0044 | <0.0044 |
| Hydrogen chloride | mg/dscm @ 7% Oxygen | <0.22 | <0.23 | <0.21 | <0.22 |
| Hydrogen chloride | ppmvd @ 7% Oxygen | <0.18 | <0.18 | <0.17 | <0.18 |

## Table 15 - EUINC13 Exhaust Particulate Matter and Metals Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC13** | | | |
| **Test Date** | | **Jul 18, 2018** | **Jul 18, 2018** | **Jul 18, 2018** | |
| **Meter/Nozzle Information** | | **Run 1 - M29** | **Run 2 - M29** | **Run 3 - M29** | **Average** |
| Meter Temperature, $T_m$ | °F | 89 | 94 | 95 | 93 |
| Meter Pressure, $P_m$ | in Hg | 29.50 | 29.50 | 29.50 | 29.50 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 51.07 | 51.40 | 50.96 | 51.14 |
| Sample Volume, $V_m$ | std $ft^3$ | 47.04 | 46.91 | 46.37 | 46.77 |
| Sample Volume, $V_m$ | std $m^3$ | 1.33 | 1.33 | 1.31 | 1.32 |
| Condensate Volume, $V_w$ | std $ft^3$ | 2.02 | 2.02 | 1.81 | 1.95 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0751 | 0.0750 | 0.0750 | 0.0750 |
| Total weight of sampled gas | lb | 3.686 | 3.668 | 3.578 | 3.644 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 99 | 98 | 97 | 98 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 80 | 78 | 78 | 79 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.42 | 29.34 | 29.33 | 29.36 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 28.95 | 28.88 | 28.90 | 28.91 |
| Stack Gas Specific Gravity, $G_s$ | | 1.00 | 1.00 | 1.00 | 1.00 |
| Percent Moisture, $B_{ws}$ | % | 4.11 | 4.12 | 3.76 | 4.00 |
| Water Vapor Volume (fraction) | | 0.041 | 0.041 | 0.038 | 0.040 |
| Pressure, $P_s$ | in Hg | 27.56 | 27.56 | 27.56 | 27.56 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.65 | 16.69 | 16.60 | 16.65 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,891 | 15,931 | 15,839 | 15,887 |
| Flowrate | $ft^3$/min, standard wet | 14,319 | 14,392 | 14,314 | 14,342 |
| Flowrate | $ft^3$/min, standard dry | 13,730 | 13,799 | 13,776 | 13,768 |
| Flowrate | $m^3$/min, standard dry | 389 | 391 | 390 | 390 |
| **Collected Mass** | | | | | |
| Particulate Matter (PM) | mg | 19.2 | 22.8 | 16.5 | 19.5 |
| Mercury (Hg) | mg | 0.0546 | 0.0470 | 0.0427 | 0.0481 |
| Lead (Pb) | mg | 0.0676 | 0.0410 | 0.0386 | 0.0491 |
| Cadmium (Cd) | mg | 0.0176 | 0.0127 | 0.0125 | 0.0143 |
| **Concentration** | | | | | |
| Particulate Matter (PM) | mg/dscf | 0.41 | 0.49 | 0.36 | 0.42 |
| Particulate Matter (PM) | mg/dscm @ 7% Oxygen | 19 | 25 | 18 | 21 |
| Particulate Matter (PM) | ppmvd @ 7% Oxygen | 15 | 20 | 15 | 17 |
| Mercury (Hg) | mg/dscf | 0.0012 | 0.0010 | 0.00092 | 0.0010 |
| Mercury (Hg) | mg/dscm @ 7% Oxygen | 0.054 | 0.051 | 0.047 | 0.050 |
| Mercury (Hg) | ppmvd @ 7% Oxygen | 0.044 | 0.042 | 0.038 | 0.041 |
| Lead (Pb) | mg/dscf | 0.0014 | 0.00087 | 0.00083 | 0.0010 |
| Lead (Pb) | mg/dscm @ 7% Oxygen | 0.067 | 0.044 | 0.042 | 0.051 |
| Lead (Pb) | ppmvd @ 7% Oxygen | 0.054 | 0.036 | 0.035 | 0.042 |
| Cadmium (Cd) | mg/dscf | 0.00037 | 0.00027 | 0.00027 | 0.00030 |
| Cadmium (Cd) | mg/dscm @ 7% Oxygen | 0.017 | 0.014 | 0.014 | 0.015 |
| Cadmium (Cd) | ppmvd @ 7% Oxygen | 0.014 | 0.011 | 0.011 | 0.012 |

BUREAU VERITAS

# Table 16
## EUINC14 Exhaust $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Emission Results
## Great Lakes Water Authority
## Detroit, Michigan
## Bureau Veritas Project No. 11018-000100.00
## Sampling Dates: July 13 and 16, 2018

| Parameter | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | | Average |
|---|---|---|---|---|---|---|---|---|
| Sample Date | July 13 | July 13 | July 13 | July 13 | July 13 | July 16 | | |
| Sample Start Time | 8:15 | 10:15 | 12:05 | 14:00 | 15:40 | 8:15 | | |
| Test Duration (min) | 60 | 60 | 60 | 60 | 60 | 60 | | 60 |
| $O_2$ Concentration ($C_{Avg}$, %) | 10.2 | 10.1 | 10.6 | 11.3 | 11.1 | 10.3 | | 10.6 |
| **Corrected $O_2$ Concentration ($C_{Gas}$, %)** | **10** | **10** | **11** | **11** | **11** | **10** | | **11** |
| $CO_2$ Concentration ($C_{Avg}$, %) | 6.6 | 7.0 | 6.5 | 6.0 | 6.1 | 6.3 | | 6.4 |
| **Corrected $CO_2$ Concentration ($C_{Gas}$, %)** | **6.7** | **7.1** | **6.8** | **6.0** | **6.1** | **6.2** | | **6.5** |
| CO Concentration ($C_{Avg}$, ppmvd) | 1,232.7 | 868.6 | 885.4 | | | | | 995.6 |
| **Corrected CO Concentration ($C_{Gas}$, ppmvd)** | **1,189** | **826** | **845** | | | | | **954** |
| **CO Concentration (ppmvd, @ 7% $O_2$)** | **1,556** | **1,069** | **1,149** | | | | | **1,258** |
| $NO_x$ Concentration ($C_{Avg}$, ppmvd) | 134.3 | 101.1 | 107.1 | | | | | 114.2 |
| **Corrected $NO_x$ Concentration ($C_{Gas}$, ppmvd)** | **135** | **101** | **106** | | | | | **114** |
| **$NO_x$ Concentration (ppmvd, @ 7% $O_2$)** | **177** | **131** | **144** | | | | | **151** |
| $SO_2$ Concentration ($C_{Avg}$, ppmvd) | 0.2 | 0.3 | 0.3 | | | | | 0.2 |
| **Corrected $SO_2$ Concentration ($C_{Gas}$, ppmvd)** | **0.0** | **0.1** | **0.1** | | | | | **0.1** |
| **$SO_2$ Concentration (ppmvd, @ 7% $O_2$)** | **0.0** | **0.1** | **0.2** | | | | | **0.1** |

ppmvd = part per million by volume, dry basis

**Table 17 - EUINC14 Exhaust Dioxin and Furan Emission Results**

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC14** | | | |
| **Test Date** | | **Jul 13, 2018** | **Jul 13, 2018** | **Jul 13, 2018** | |
| **Meter/Nozzle Information** | | **M23 - Run 1** | **M23 - Run 2** | **M23 - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 97 | 105 | 107 | 103 |
| Meter Pressure, $P_m$ | in Hg | 29.60 | 29.59 | 29.60 | 29.60 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 50.85 | 50.93 | 50.41 | 50.73 |
| Sample Volume, $V_m$ | std $ft^3$ | 48.12 | 47.56 | 46.92 | 47.53 |
| Sample Volume, $V_m$ | std $m^3$ | 1.36 | 1.35 | 1.33 | 1.35 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.20 | 2.05 | 3.55 | 2.26 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0758 | 0.0755 | 0.0745 | 0.0753 |
| Total weight of sampled gas | lb | 3.739 | 3.743 | 3.595 | 3.692 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 99 | 100 | 101 | 100 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 84 | 83 | 85 | 84 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.48 | 29.54 | 29.52 | 29.51 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.20 | 29.07 | 28.71 | 28.99 |
| Stack Gas Specific Gravity, $G_s$ | | 1.01 | 1.00 | 0.99 | 1.00 |
| Percent Moisture, $B_{ws}$ | % | 2.44 | 4.13 | 7.03 | 4.53 |
| Water Vapor Volume (fraction) | | 0.024 | 0.041 | 0.070 | 0.045 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.83 | 16.68 | 16.90 | 16.80 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 16,058 | 15,914 | 16,131 | 16,035 |
| Flowrate | $ft^3$/min, standard wet | 14,402 | 14,312 | 14,438 | 14,384 |
| Flowrate | $ft^3$/min, standard dry | 14,050 | 13,722 | 13,423 | 13,732 |
| Flowrate | $m^3$/min, standard dry | 398 | 389 | 380 | 389 |
| **Collected Mass** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | pg | <2.1 | <2.2 | <2.0 | <2.1 |
| 1,2,3,7,8-Penta CDD | pg | <2.2 | <2.2 | <2.3 | <2.2 |
| 1,2,3,4,7,8-Hexa CDD | pg | <2.2 | <2.2 | <2.3 | <2.2 |
| 1,2,3,6,7,8-Hexa CDD | pg | <1.9 | <1.9 | <2.3 | <2.0 |
| 1,2,3,7,8,9-Hexa CDD | pg | <2.0 | <2.0 | <2.2 | <2.1 |
| 1,2,3,4,6,7,8-Hepta CDD | pg | <2.3 | 2.2 | 3.0 | 2.5 |
| 1,2,3,4,6,7,8,9-Octa CDD | pg | 14.2 | 8.6 | 14.3 | 12.4 |
| Total Tetra CDD | pg | <7.3 | 6.1 | 7.2 | 6.9 |
| Total Penta CDD | pg | <2.8 | <2.2 | <2.3 | <2.4 |
| Total Hexa CDD | pg | <9.5 | <12 | <2.3 | <7.9 |
| Total Hepta CDD | pg | <2.3 | 2.2 | 3.0 | 2.5 |
| Total Dioxins | pg | 36.1 | 31.1 | 29.1 | 32.1 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | pg | 142 | 96.1 | 102 | 113 |
| 1,2,3,7,8-Penta CDF | pg | 18.5 | 15.3 | 20.2 | 18.0 |
| 2,3,4,7,8-Penta CDF | pg | 69.8 | 42.8 | 56.8 | 56.5 |
| 1,2,3,4,7,8-Hexa CDF | pg | 19.5 | 10.4 | 11.5 | 13.8 |
| 1,2,3,6,7,8-Hexa CDF | pg | 8.0 | 5.4 | 5.6 | 6.3 |
| 2,3,4,6,7,8-Hexa CDF | pg | 13.6 | 7.6 | 9.2 | 10.1 |
| 1,2,3,7,8,9-Hexa CDF | pg | <2.6 | <2.8 | <2.4 | <2.6 |
| 1,2,3,4,6,7,8-Hepta CDF | pg | 4.7 | 2.5 | 5.3 | 4.2 |
| 1,2,3,4,7,8,9-Hepta CDF | pg | <3.6 | <3.4 | <2.7 | <3.2 |
| 1,2,3,4,6,7,8,9-Octa CDF | pg | <2.4 | <2.2 | 2.4 | 2.3 |
| Total Tetra CDF | pg | 692 | 479 | 707 | 626 |
| Total Penta CDF | pg | 341 | 211 | 278 | 277 |
| Total Hexa CDF | pg | 69.7 | 41.3 | 48.7 | 53.2 |
| Total Hepta CDF | pg | 4.7 | <2.8 | 5.3 | 4.3 |
| Total Furans | pg | 1,110 | 736 | 1,041 | 963 |
| Total Dioxin + Furan | pg | 1,146 | 767 | 1,071 | 995 |
| Total Dioxin + Furan (TEQ) | pg | 45.0 | 30.6 | 35.8 | 37.1 |

# Table 17 (continued) - EUINC14 Exhaust Dioxin and Furan Emission Results

| Facility | | Great Lakes Water Authority | | | |
|---|---|---|---|---|---|
| Source Designation | | EUINC14 | | | |
| Test Date | | Jul 13, 2018 | Jul 13, 2018 | Jul 13, 2018 | |
| **Run** | | **M23 - Run 1** | **M23 - Run 2** | **M23 - Run 3** | **Average** |
| **Concentration** | | | | | |
| **Dioxins** | | | | | |
| 2,3,7,8-Tetra CDD | ng/dscm @ 7% Oxygen | <2.0E-03 | <2.1E-03 | <2.1E-03 | <2.1E-03 |
| 1,2,3,7,8-Penta CDD | ng/dscm @ 7% Oxygen | <2.1E-03 | <2.1E-03 | <2.4E-03 | <2.2E-03 |
| 1,2,3,4,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <2.1E-03 | <2.1E-03 | <2.4E-03 | <2.2E-03 |
| 1,2,3,6,7,8-Hexa CDD | ng/dscm @ 7% Oxygen | <1.8E-03 | <1.8E-03 | <2.4E-03 | <2.0E-03 |
| 1,2,3,7,8,9-Hexa CDD | ng/dscm @ 7% Oxygen | <1.9E-03 | <1.9E-03 | <2.3E-03 | <2.0E-03 |
| 1,2,3,4,6,7,8-Hepta CDD | ng/dscm @ 7% Oxygen | <2.2E-03 | 2.1E-03 | 3.1E-03 | 2.5E-03 |
| 1,2,3,4,6,7,8,9-Octa CDD | ng/dscm @ 7% Oxygen | 1.4E-02 | 8.3E-03 | 1.5E-02 | 1.2E-02 |
| Total Tetra CDD | ng/dscm @ 7% Oxygen | <7.0E-03 | 5.9E-03 | 7.4E-03 | 6.8E-03 |
| Total Penta CDD | ng/dscm @ 7% Oxygen | <2.7E-03 | <2.1E-03 | <2.4E-03 | <2.4E-03 |
| Total Hexa CDD | ng/dscm @ 7% Oxygen | <9.1E-03 | <1.2E-02 | <2.4E-03 | <7.7E-03 |
| Total Hepta CDD | ng/dscm @ 7% Oxygen | <2.2E-03 | 2.1E-03 | 3.1E-03 | 2.5E-03 |
| Total Dioxins | ng/dscm @ 7% Oxygen | 3.5E-02 | 3.0E-02 | 3.0E-02 | 3.2E-02 |
| **Furans** | | | | | |
| 2,3,7,8-Tetra CDF | ng/dscm @ 7% Oxygen | 1.4E-01 | 9.3E-02 | 1.0E-01 | 1.1E-01 |
| 1,2,3,7,8-Penta CDF | ng/dscm @ 7% Oxygen | 1.8E-02 | 1.5E-02 | 2.1E-02 | 1.8E-02 |
| 2,3,4,7,8-Penta CDF | ng/dscm @ 7% Oxygen | 6.7E-02 | 4.1E-02 | 5.8E-02 | 5.6E-02 |
| 1,2,3,4,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 1.9E-02 | 1.0E-02 | 1.2E-02 | 1.4E-02 |
| 1,2,3,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 7.7E-03 | 5.2E-03 | 5.7E-03 | 6.2E-03 |
| 2,3,4,6,7,8-Hexa CDF | ng/dscm @ 7% Oxygen | 1.3E-02 | 7.3E-03 | 9.4E-03 | 1.0E-02 |
| 1,2,3,7,8,9-Hexa CDF | ng/dscm @ 7% Oxygen | <2.5E-03 | <2.7E-03 | <2.5E-03 | <2.6E-03 |
| 1,2,3,4,6,7,8-Hepta CDF | ng/dscm @ 7% Oxygen | 4.5E-03 | 2.4E-03 | 5.4E-03 | 4.1E-03 |
| 1,2,3,4,7,8,9-Hepta CDF | ng/dscm @ 7% Oxygen | <3.5E-03 | <3.3E-03 | <2.8E-03 | <3.2E-03 |
| 1,2,3,4,6,7,8,9-Octa CDF | ng/dscm @ 7% Oxygen | <2.3E-03 | <2.1E-03 | 2.5E-03 | 2.3E-03 |
| Total Tetra CDF | ng/dscm @ 7% Oxygen | 6.7E-01 | 4.6E-01 | 7.3E-01 | 6.2E-01 |
| Total Penta CDF | ng/dscm @ 7% Oxygen | 3.3E-01 | 2.0E-01 | 2.9E-01 | 2.7E-01 |
| Total Hexa CDF | ng/dscm @ 7% Oxygen | 6.7E-02 | 4.0E-02 | 5.0E-02 | 5.2E-02 |
| Total Hepta CDF | ng/dscm @ 7% Oxygen | 4.5E-03 | <2.7E-03 | 5.4E-03 | 4.2E-03 |
| Total Furans | ng/dscm @ 7% Oxygen | 1.1E+00 | 7.1E-01 | 1.1E+00 | 9.5E-01 |
| Total Dioxin + Furan | ng/dscm @ 7% Oxygen | 1.1 | 0.74 | 1.1 | 0.98 |
| Total Dioxin + Furan (TEQ) | ng/dscm @ 7% Oxygen | 0.043 | 0.030 | 0.037 | 0.037 |

## Table 18 - EUINC14 Exhaust Hydrogen Chloride Emission Results

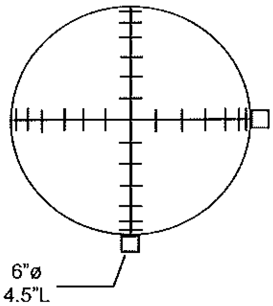
| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC14** | | | |
| **Test Date** | | **Jul 13, 2018** | **Jul 13, 2018** | **Jul 13, 2018** | |
| **Meter/Nozzle Information** | | **M26A - Run 1** | **M26A - Run 2** | **M26A - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 84 | 89 | 91 | 88 |
| Meter Pressure, $P_m$ | in Hg | 29.60 | 29.60 | 29.60 | 29.60 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 49.23 | 48.77 | 47.54 | 48.51 |
| Sample Volume, $V_m$ | std $ft^3$ | 45.93 | 45.06 | 43.74 | 44.91 |
| Sample Volume, $V_m$ | std $m^3$ | 1.30 | 1.28 | 1.24 | 1.27 |
| Condensate Volume, $V_w$ | std $ft^3$ | 1.84 | 1.69 | 2.80 | 2.11 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0754 | 0.0756 | 0.0748 | 0.0753 |
| Total weight of sampled gas | lb | 3.602 | 3.535 | 3.366 | 3.501 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 95 | 96 | 94 | 95 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 87 | 87 | 87 | 87 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.48 | 29.54 | 29.52 | 29.51 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.04 | 29.13 | 28.82 | 29.00 |
| Stack Gas Specific Gravity, $G_s$ | | 1.00 | 1.01 | 1.00 | 1.00 |
| Percent Moisture, $B_{ws}$ | % | 3.86 | 3.61 | 6.02 | 4.50 |
| Water Vapor Volume (fraction) | | 0.039 | 0.036 | 0.060 | 0.045 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 17.01 | 16.55 | 16.89 | 16.82 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 16,229 | 15,795 | 16,119 | 16,047 |
| Flowrate | $ft^3$/min, standard wet | 14,483 | 14,088 | 14,396 | 14,322 |
| Flowrate | $ft^3$/min, standard dry | 13,924 | 13,579 | 13,529 | 13,678 |
| Flowrate | $m^3$/min, standard dry | 394 | 385 | 383 | 387 |
| **Collected Mass** | | | | | |
| Hydrogen chloride | mg | <0.200 | <0.200 | <0.200 | <0.200 |
| **Concentration** | | | | | |
| Hydrogen chloride | mg/dscf | <0.0044 | <0.0044 | <0.0046 | <0.0045 |
| Hydrogen chloride | mg/dscm @ 7% Oxygen | <0.20 | <0.20 | <0.22 | <0.21 |
| Hydrogen chloride | ppmvd @ 7% Oxygen | <0.16 | <0.17 | <0.18 | <0.17 |

BUREAU VERITAS

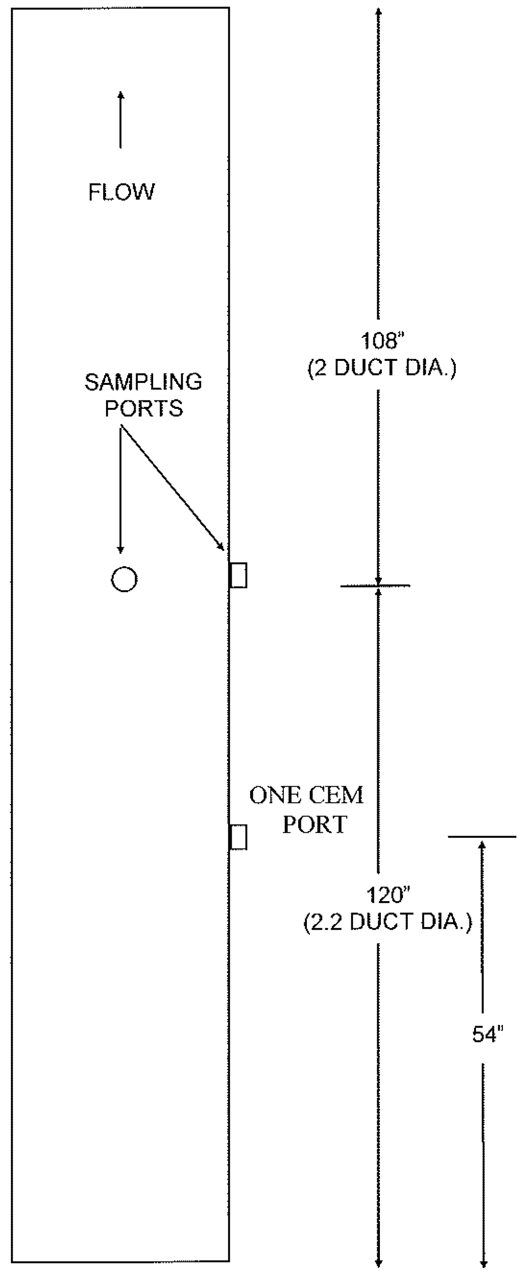
# Table 19 - EUINC14 Exhaust Particulate Matter and Metals Emission Results

| | | | | | |
|---|---|---|---|---|---|
| **Facility** | | **Great Lakes Water Authority** | | | |
| **Source Designation** | | **EUINC14** | | | |
| **Test Date** | | **Jul 13, 2018** | **Jul 13, 2018** | **Jul 16, 2018** | |
| **Meter/Nozzle Information** | | **M5/29 - Run 1** | **M5/29 - Run 2** | **M5/29 - Run 3** | **Average** |
| Meter Temperature, $T_m$ | °F | 94 | 95 | 86 | 92 |
| Meter Pressure, $P_m$ | in Hg | 29.60 | 29.60 | 29.60 | 29.60 |
| Measured Sample Volume, $V_m$ | $ft^3$ | 50.20 | 51.26 | 50.42 | 50.63 |
| Sample Volume, $V_m$ | std $ft^3$ | 45.98 | 46.85 | 46.80 | 46.54 |
| Sample Volume, $V_m$ | std $m^3$ | 1.30 | 1.33 | 1.33 | 1.32 |
| Condensate Volume, $V_w$ | std $ft^3$ | 0.42 | 1.62 | 1.95 | 1.33 |
| Gas Density, $\rho_s$ | std $lb/ft^3$ | 0.0761 | 0.0754 | 0.0751 | 0.0755 |
| Total weight of sampled gas | lb | 3.530 | 3.653 | 3.616 | 3.600 |
| Nozzle Size, $A_n$ | $ft^2$ | 0.0006874 | 0.0006874 | 0.0006874 | 0.0006874 |
| Isokinetic Variation, I | % | 94 | 99 | 98 | 97 |
| **Stack Data** | | | | | |
| Average Stack Temperature, $T_s$ | °F | 87 | 90 | 81 | 86 |
| Molecular Weight Stack Gas-dry, $M_d$ | lb/lb-mole | 29.41 | 29.42 | 29.40 | 29.41 |
| Molecular Weight Stack Gas-wet, $M_s$ | lb/lb-mole | 29.31 | 29.04 | 28.95 | 29.10 |
| Stack Gas Specific Gravity, $G_s$ | | 1.01 | 1.00 | 1.00 | 1.00 |
| Percent Moisture, $B_{ws}$ | % | 0.90 | 3.34 | 4.00 | 2.75 |
| Water Vapor Volume (fraction) | | 0.009 | 0.033 | 0.040 | 0.027 |
| Pressure, $P_s$ | in Hg | 27.66 | 27.66 | 27.66 | 27.66 |
| Average Stack Velocity, $V_s$ | ft/sec | 16.72 | 16.80 | 16.65 | 16.72 |
| Area of Stack | $ft^2$ | 15.90 | 15.90 | 15.90 | 15.90 |
| **Exhaust Gas Flowrate** | | | | | |
| Flowrate | $ft^3$/min, actual | 15,952 | 16,031 | 15,885 | 15,956 |
| Flowrate | $ft^3$/min, standard wet | 14,224 | 14,222 | 14,321 | 14,256 |
| Flowrate | $ft^3$/min, standard dry | 14,096 | 13,747 | 13,748 | 13,864 |
| Flowrate | $m^3$/min, standard dry | 399 | 389 | 389 | 393 |
| **Collected Mass** | | | | | |
| Particulate Matter (PM) | mg | 14.3 | 11.4 | 11.3 | 12.3 |
| Mercury (Hg) | mg | 0.0279 | 0.0235 | 0.0477 | 0.0330 |
| Lead (Pb) | mg | 0.0373 | 0.0307 | 0.0165 | 0.0282 |
| Cadmium (Cd) | mg | 0.0102 | 0.00816 | 0.00458 | 0.0076 |
| **Concentration** | | | | | |
| Particulate Matter (PM) | mg/dscf | 0.31 | 0.24 | 0.24 | 0.27 |
| Particulate Matter (PM) | mg/dscm @ 7% Oxygen | 16 | 12 | 11 | 13 |
| Particulate Matter (PM) | ppmvd @ 7% Oxygen | 13 | 10 | 9.1 | 11 |
| Mercury (Hg) | mg/dscf | 0.00061 | 0.00050 | 0.0010 | 0.00071 |
| Mercury (Hg) | mg/dscm @ 7% Oxygen | 0.031 | 0.025 | 0.047 | 0.034 |
| Mercury (Hg) | ppmvd @ 7% Oxygen | 0.025 | 0.020 | 0.039 | 0.028 |
| Lead (Pb) | mg/dscf | 0.00081 | 0.00066 | 0.00035 | 0.00061 |
| Lead (Pb) | mg/dscm @ 7% Oxygen | 0.041 | 0.033 | 0.016 | 0.030 |
| Lead (Pb) | ppmvd @ 7% Oxygen | 0.034 | 0.027 | 0.013 | 0.025 |
| Cadmium (Cd) | mg/dscf | 0.00022 | 0.00017 | 0.00010 | 0.00016 |
| Cadmium (Cd) | mg/dscm @ 7% Oxygen | 0.011 | 0.0087 | 0.0045 | 0.0082 |
| Cadmium (Cd) | ppmvd @ 7% Oxygen | 0.0093 | 0.0071 | 0.0037 | 0.0067 |

54" INTERNAL DIAMETER




| TRAVERSE POINT | DISTANCE FROM STACK WALL (INCHES) |
|---|---|
| 1 | 1.1 |
| 2 | 3.6 |
| 3 | 6.4 |
| 4 | 9.6 |
| 5 | 13.5 |
| 6 | 19.2 |
| 7 | 34.8 |
| 8 | 40.5 |
| 9 | 44.4 |
| 10 | 47.6 |
| 11 | 50.4 |
| 12 | 52.9 |




| | DISTANCE FROM PORTS TO NEAREST UPSTREAM BEND/ DISTURBANCE | DISTANCE FROM PORTS TO NEAREST DOWNSTREAM BEND/DISTURBANCE |
|---|---|---|
| EUINC Exhaust Stack | 120" 2.2 DIAMETERS | 108" 2 DIAMETERS |

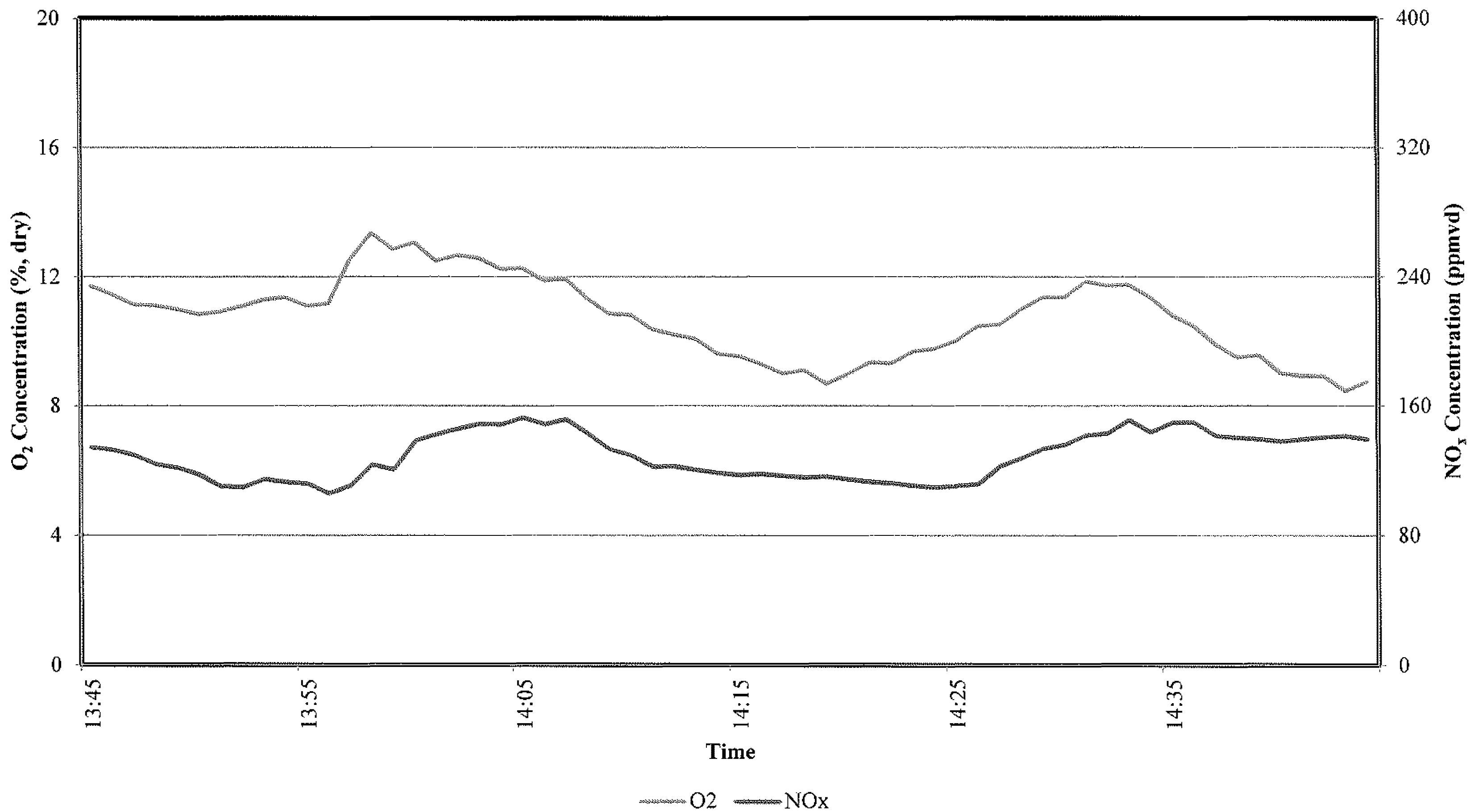
| | |
|---|---|
| SCALE | NOT TO SCALE |
| DATE | July 24, 2018 |
| PRJ NO. | 11018-000100.000 |

EUINC 07, 09-14 Exhaust
Sampling Ports and Traverse Point Locations
Great Lakes Water Authority
Detroit, Michigan

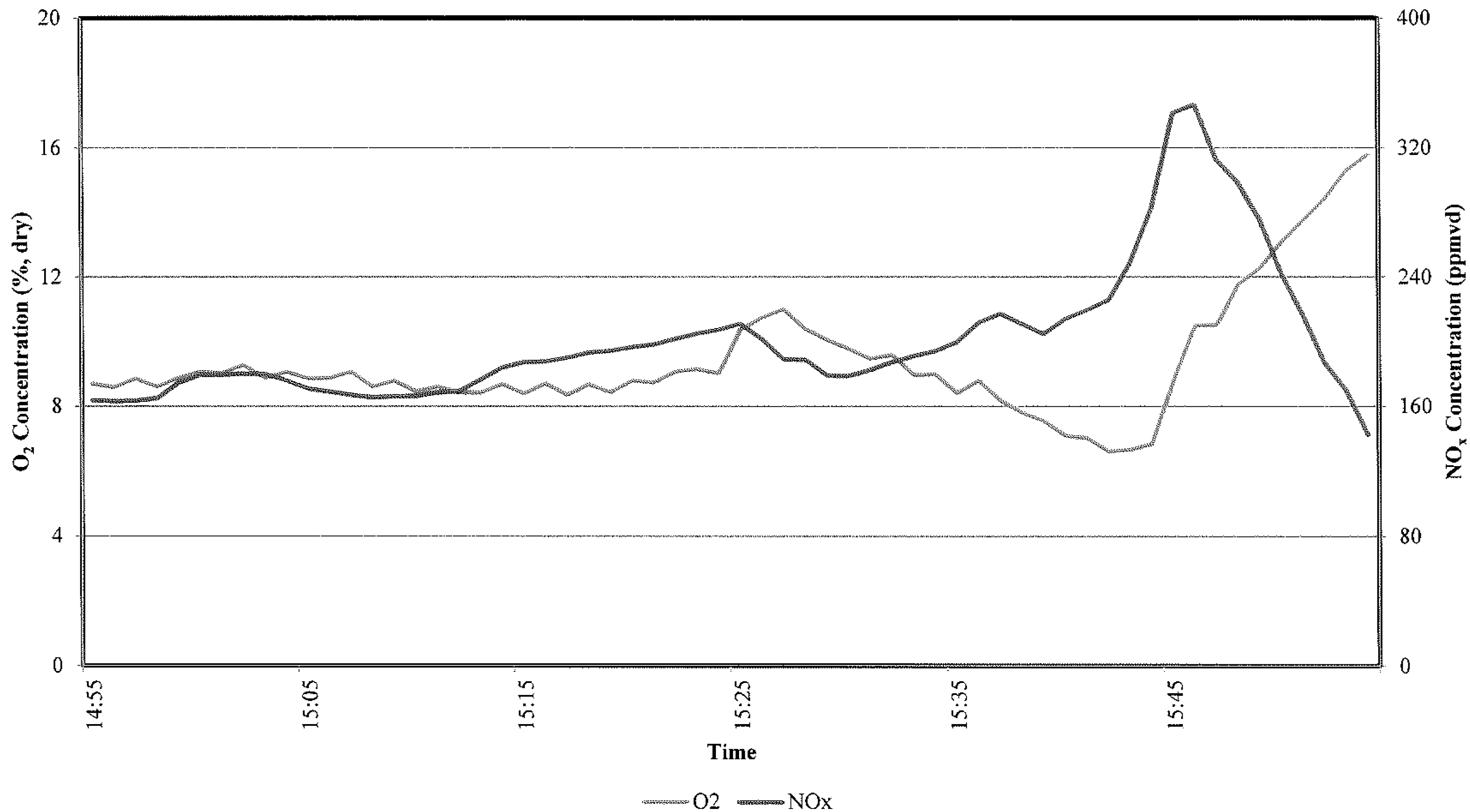
BUREAU VERITAS

FIGURE 1

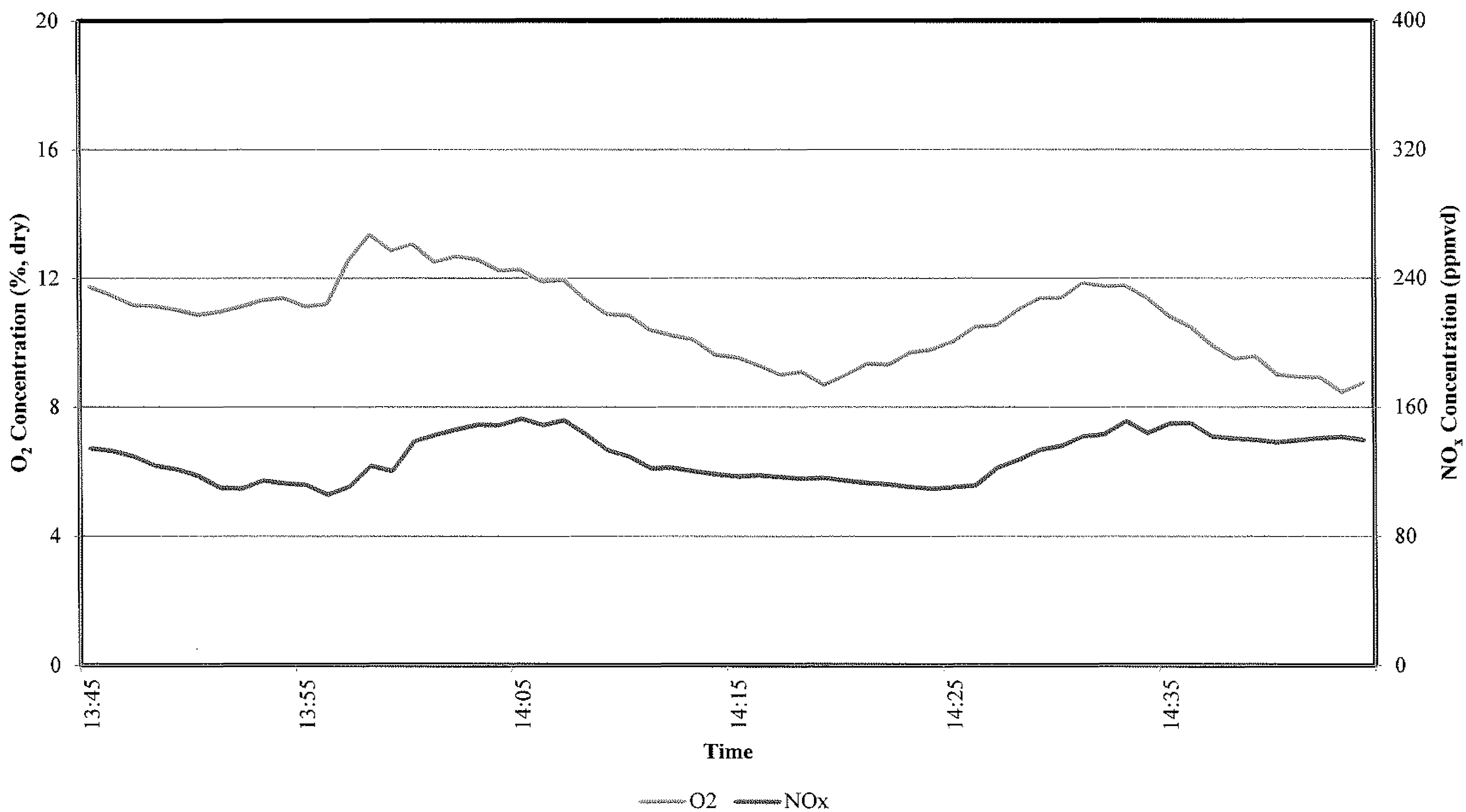
# EUINC07 $O_2$ and $NO_x$ Concentrations - Run 1
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 10, 2018



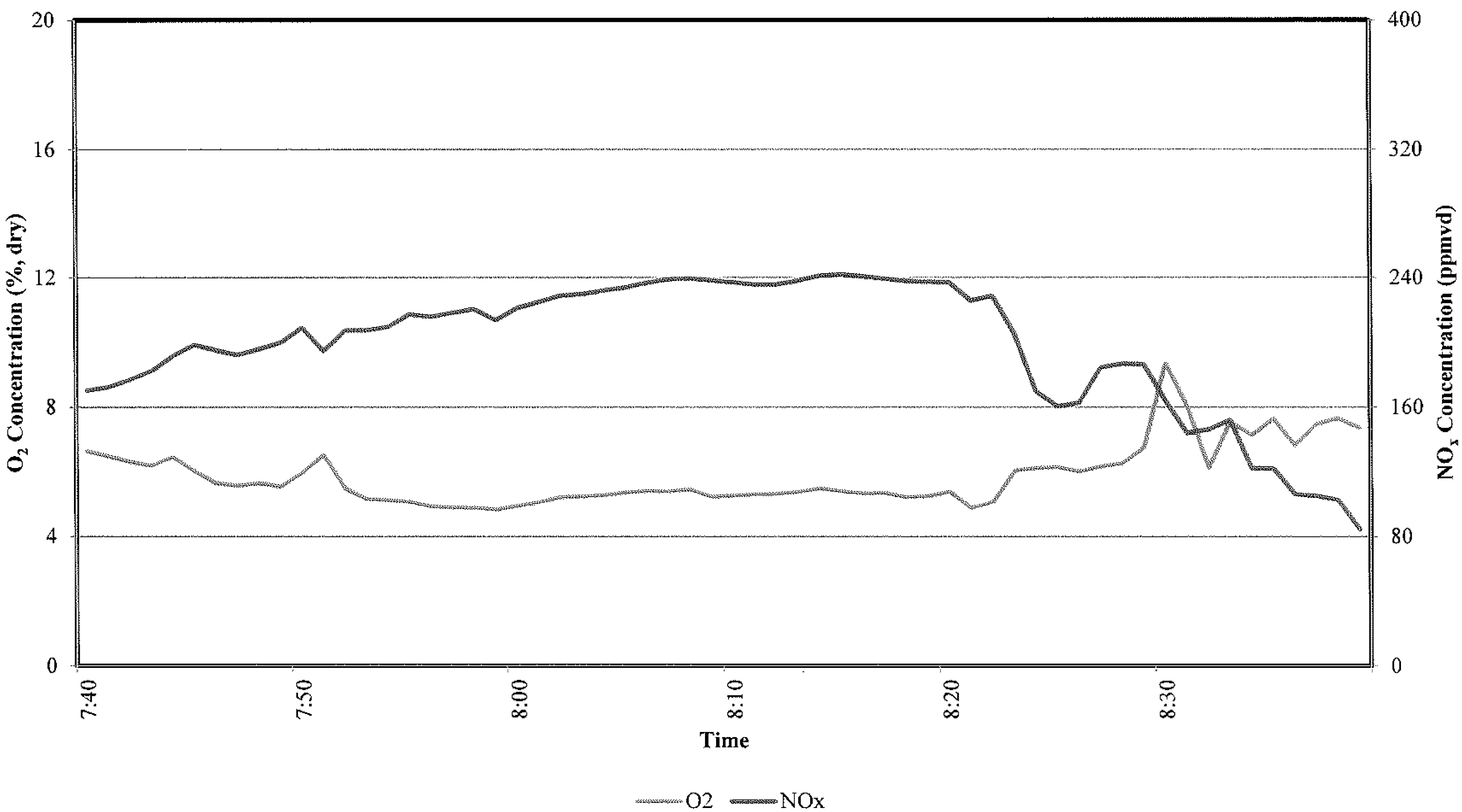
# EUINC07 $O_2$ and $NO_x$ Concentrations - Run 2
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 10, 2018



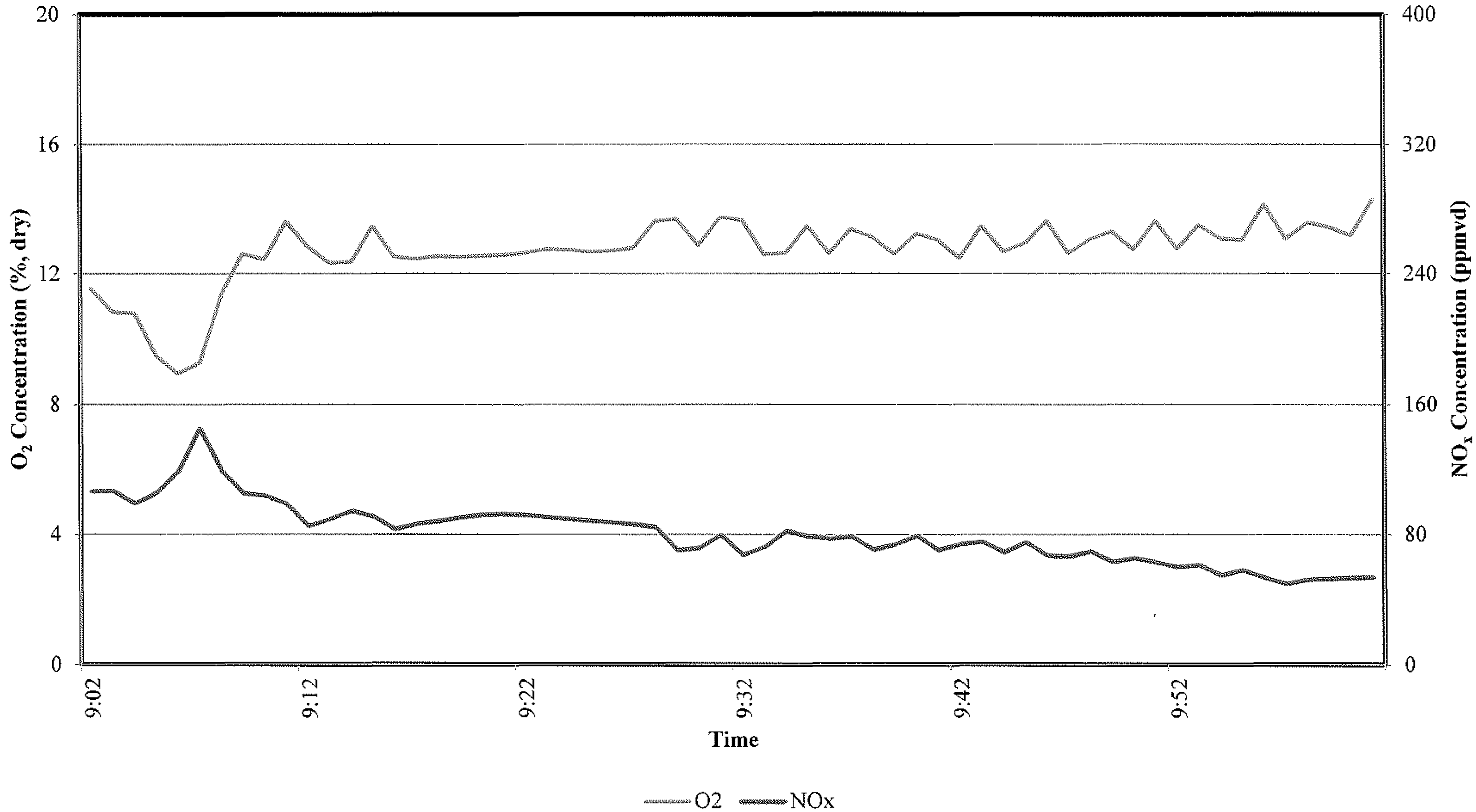
# EUINC07 $O_2$ and $NO_x$ Concentrations - Run 3
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 10, 2018



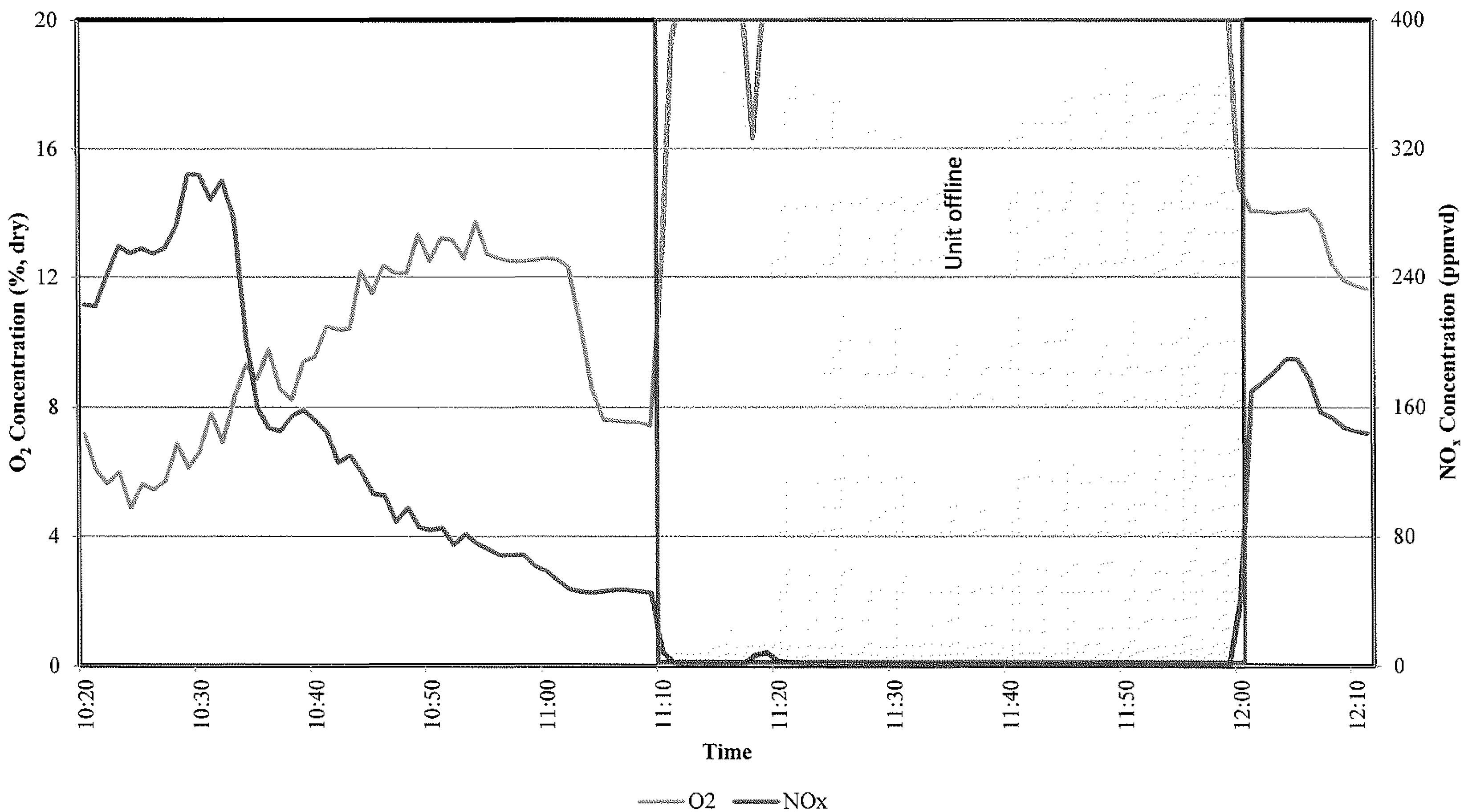
# EUINC09 $O_2$ and $NO_x$ Concentrations - Run 1
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 10, 2018



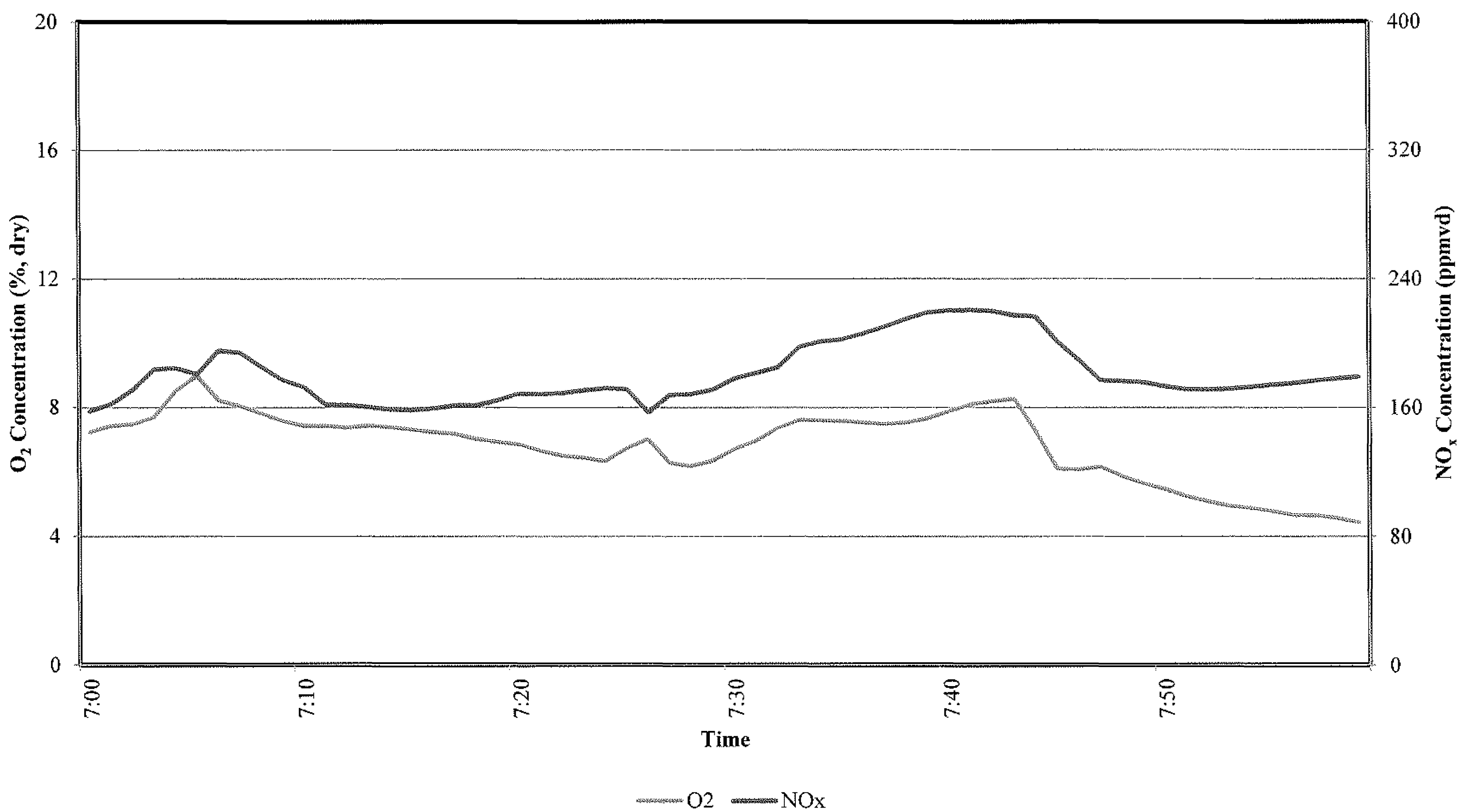
# EUINC09 $O_2$ and $NO_x$ Concentrations - Run 2
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 10, 2018



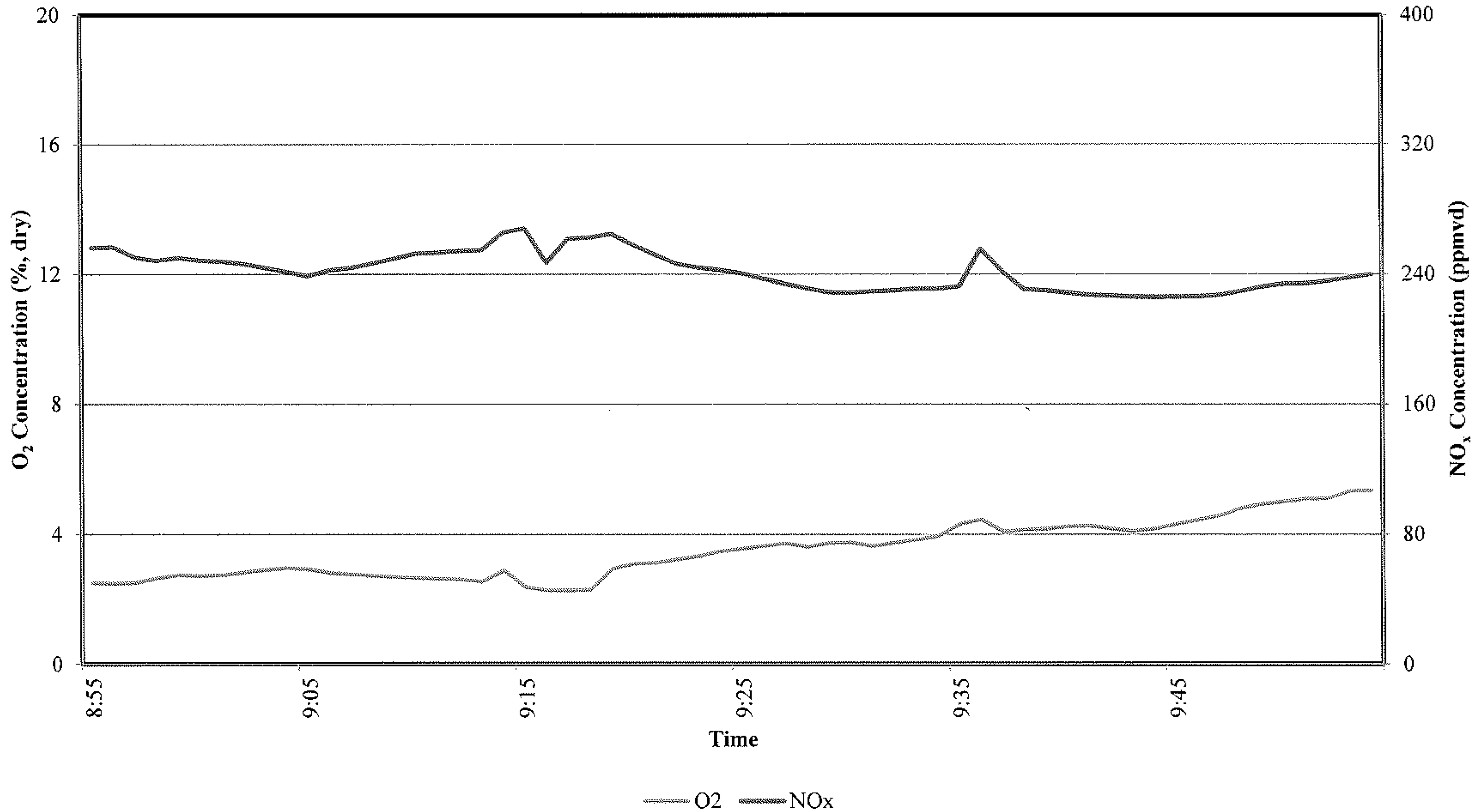
# EUINC09 $O_2$ and $NO_x$ Concentrations - Run 3
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 10, 2018



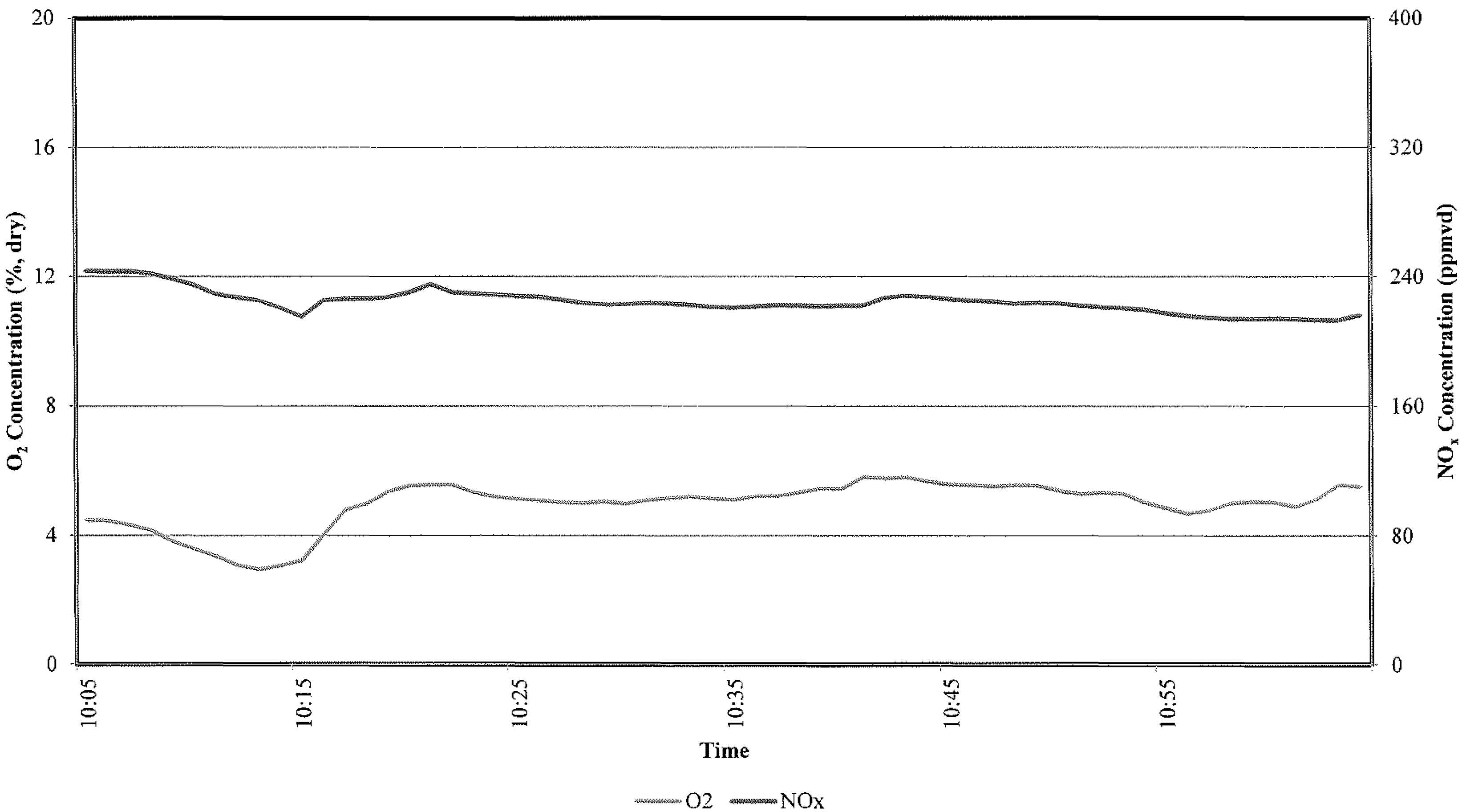
# EUINC10 $O_2$ and $NO_x$ Concentrations - Run 1
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 11, 2018



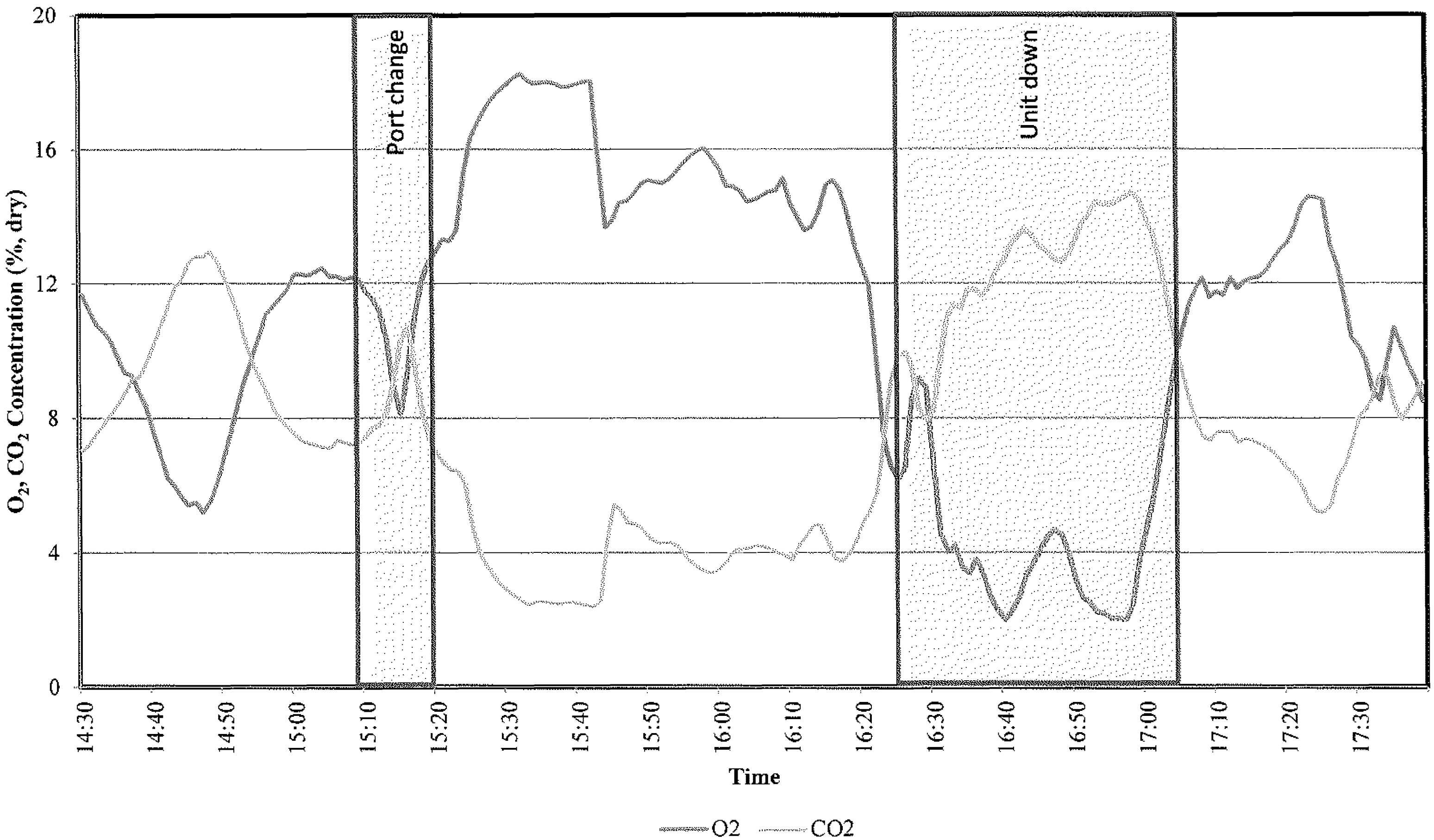
# EUINC10 $O_2$ and $NO_x$ Concentrations - Run 2
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 11, 2018



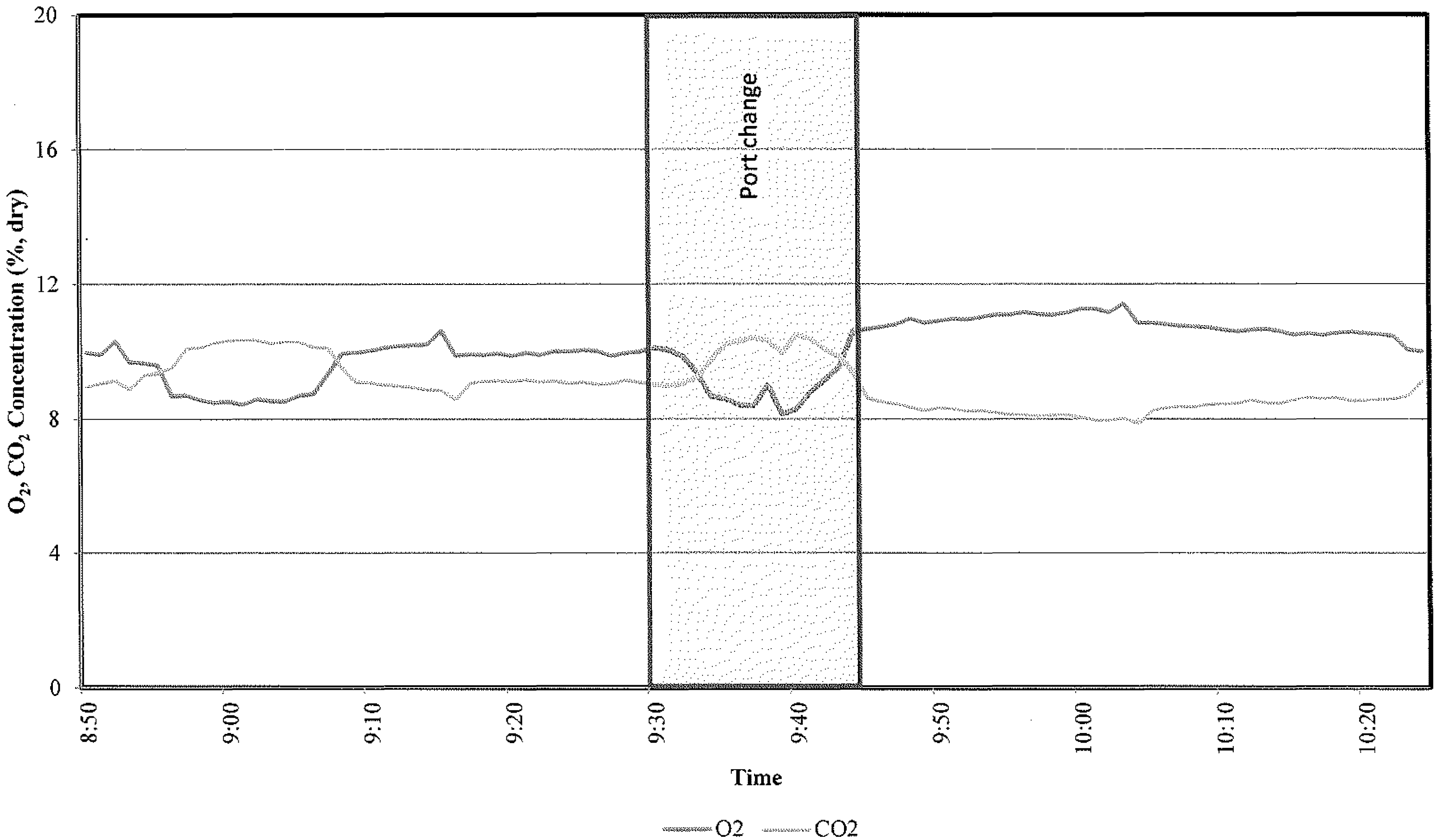
# EUINC10 $O_2$ and $NO_x$ Concentrations - Run 3
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 11, 2018



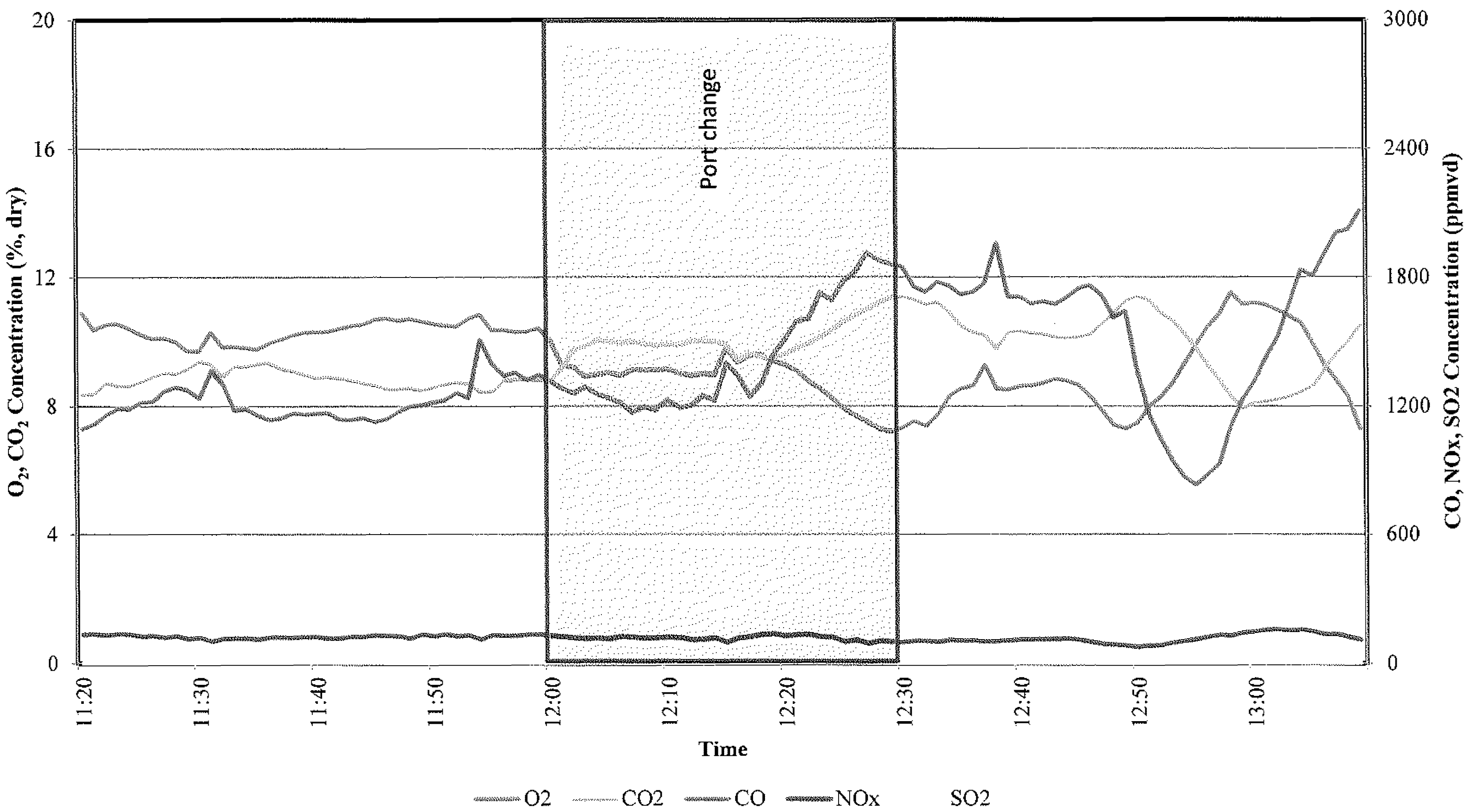
# EUINC11 $O_2$ and $CO_2$ Concentrations - Run 1
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 11, 2018



# EUINC11 $O_2$ and $CO_2$ Concentrations - Run 2
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 12, 2018



# EUINC11 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 3
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 12, 2018



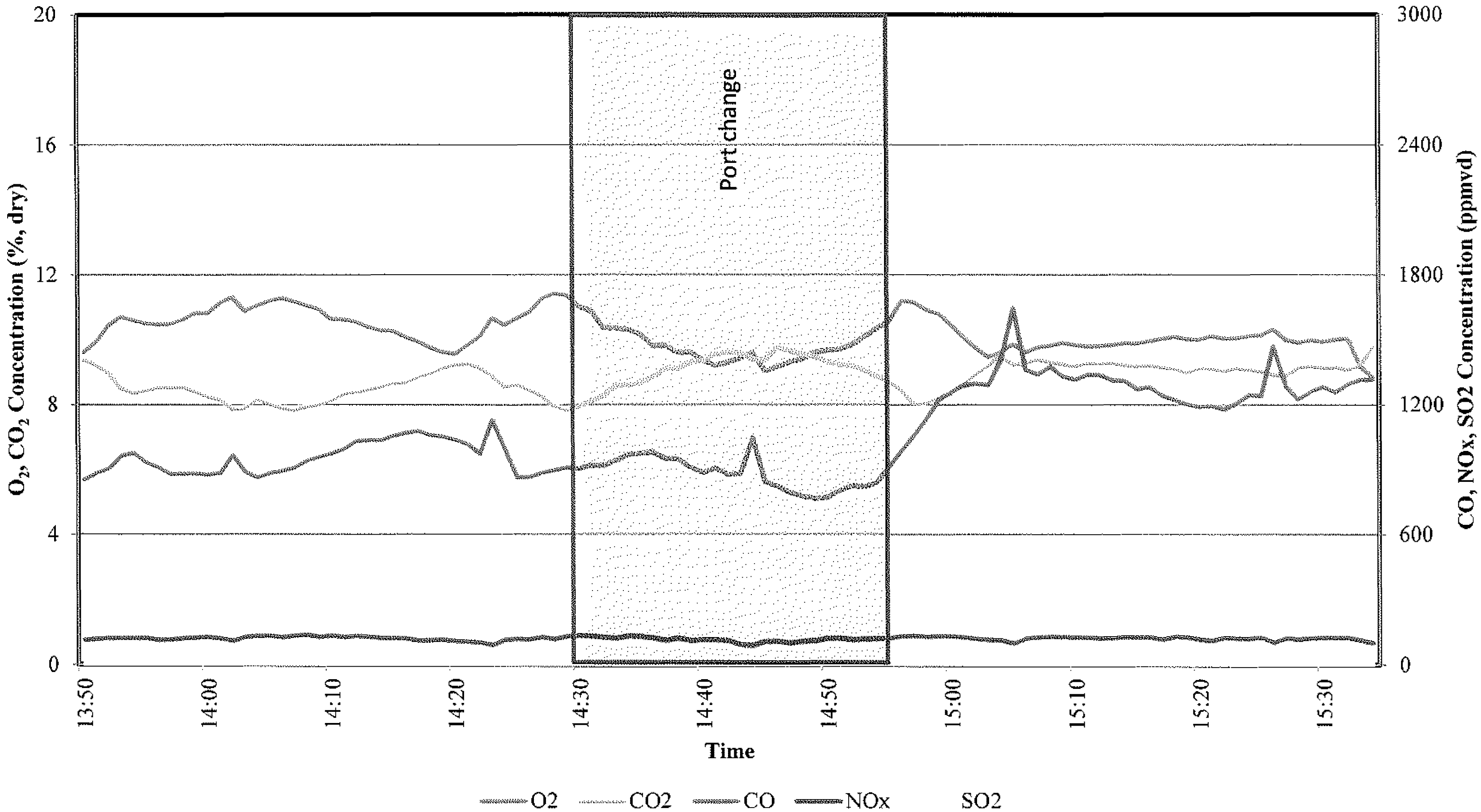
# EUINC11 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 4

## Great Lakes Water Authority

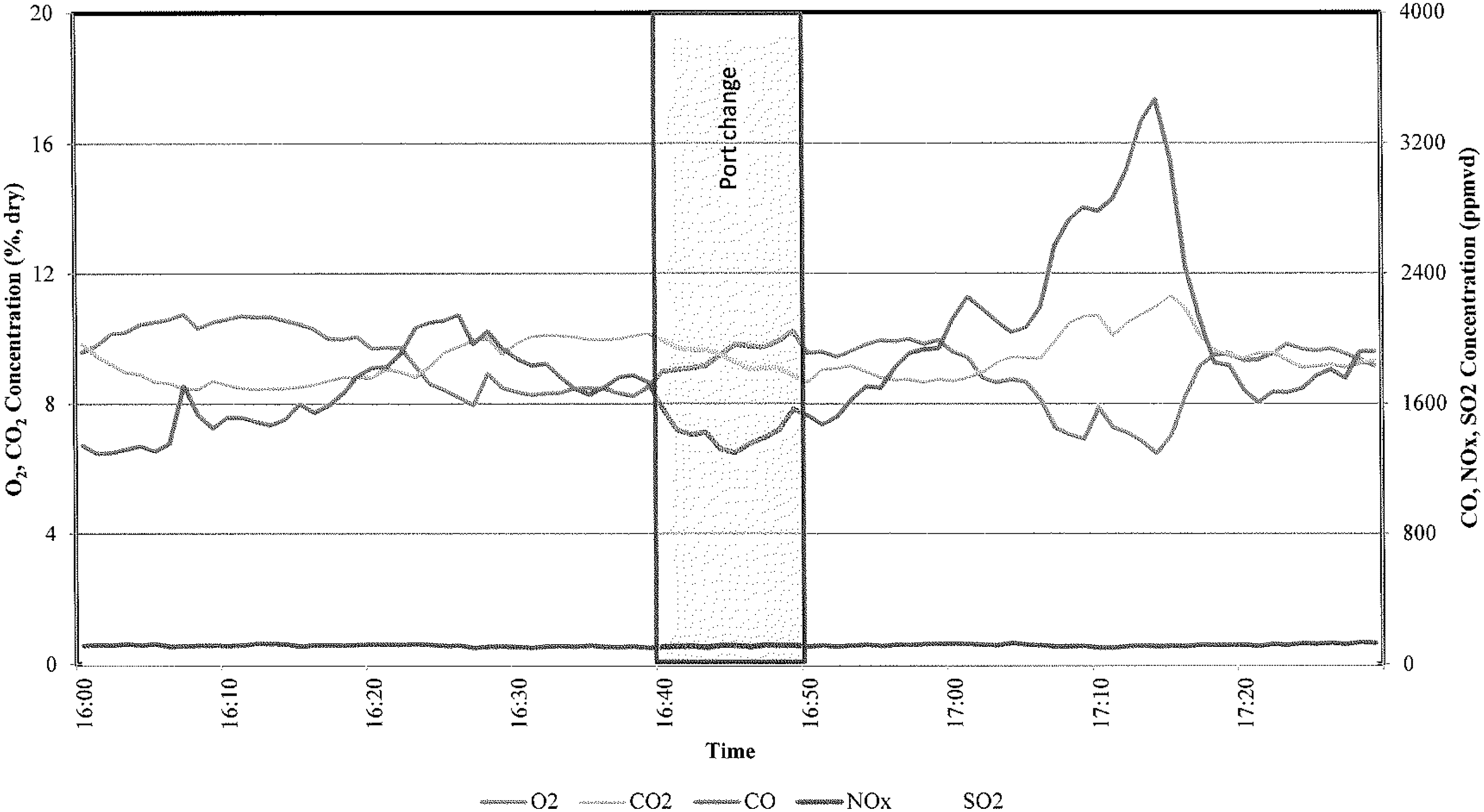
## Detroit, Michigan

## Project No. 11018-000100.00

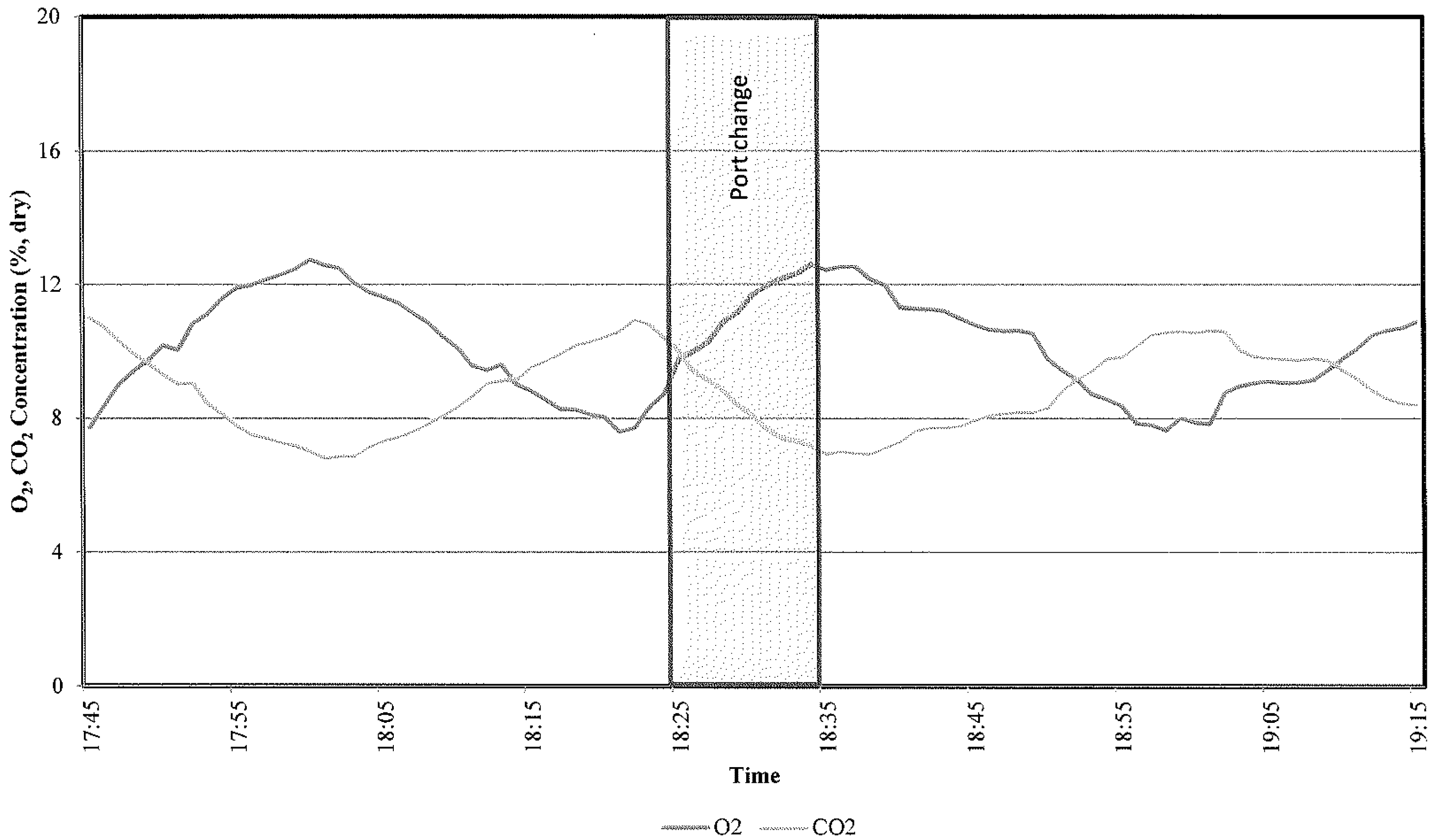
## Sampling Date: July 12, 2018



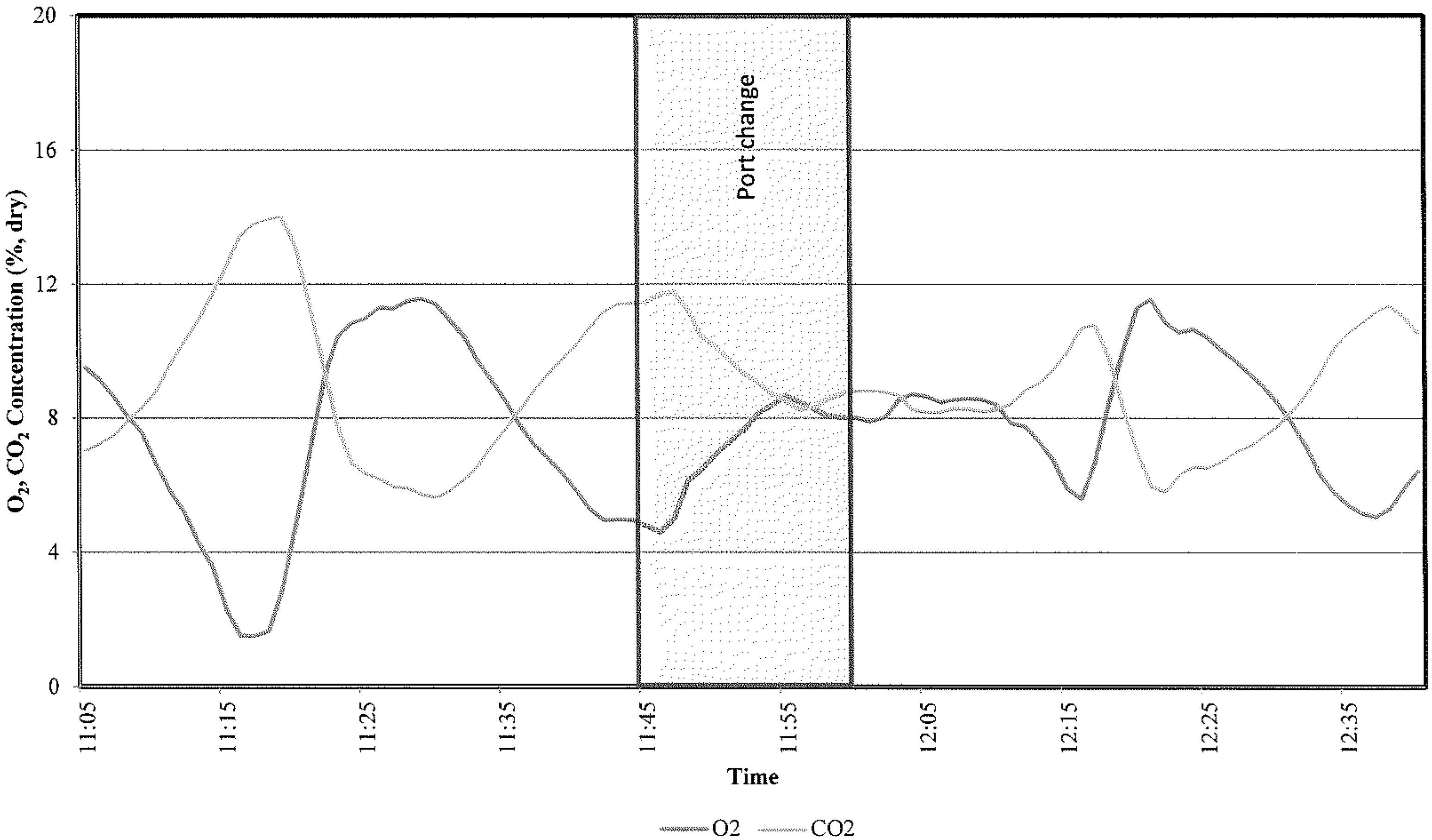
# EUINC11 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 5
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 12, 2018



# EUINC11 $O_2$ and $CO_2$ Concentrations - Run 6
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 12, 2018



# EUINC12 $O_2$ and $CO_2$ Concentrations - Run 1
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 16, 2018



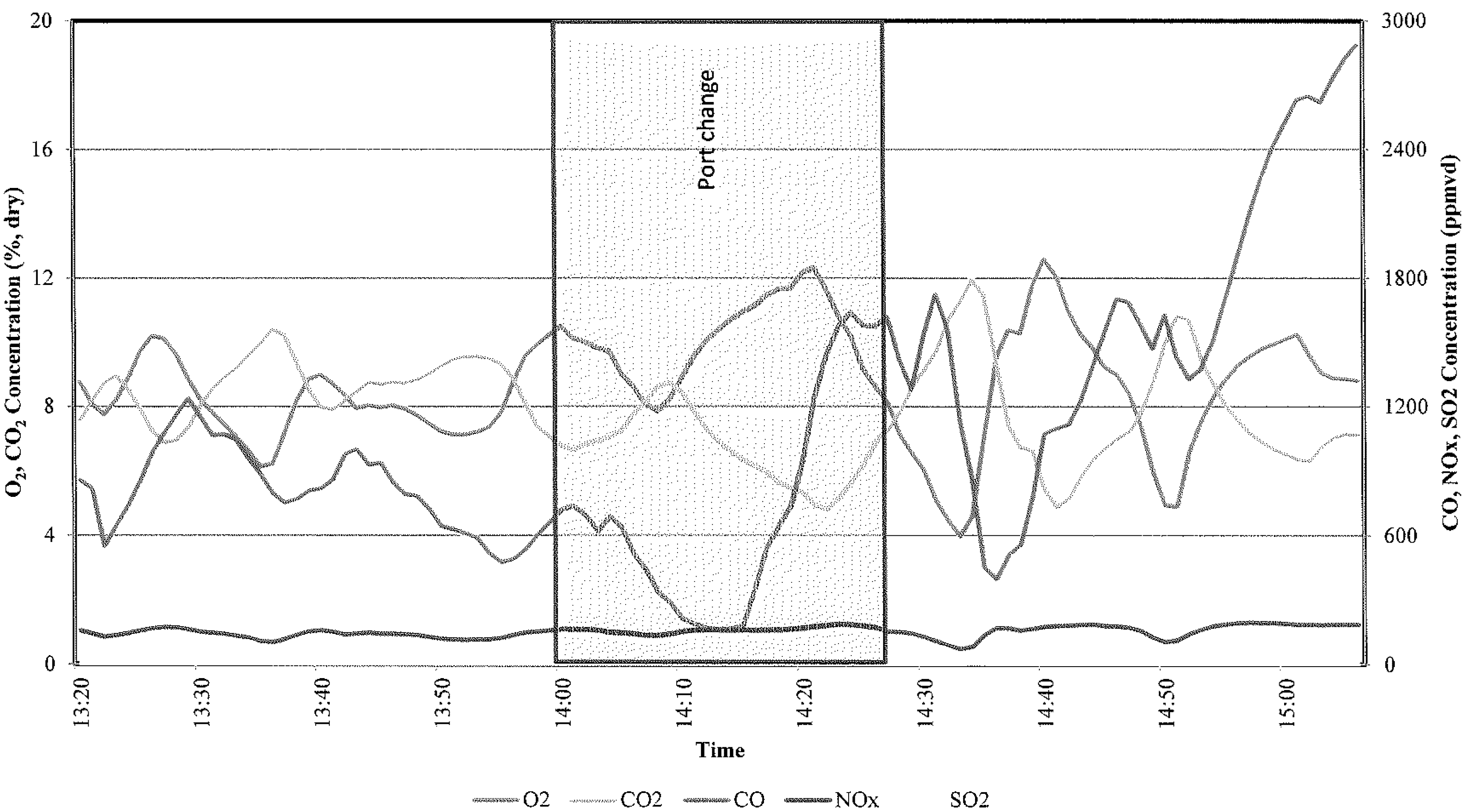
# EUINC12 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 2

## Great Lakes Water Authority

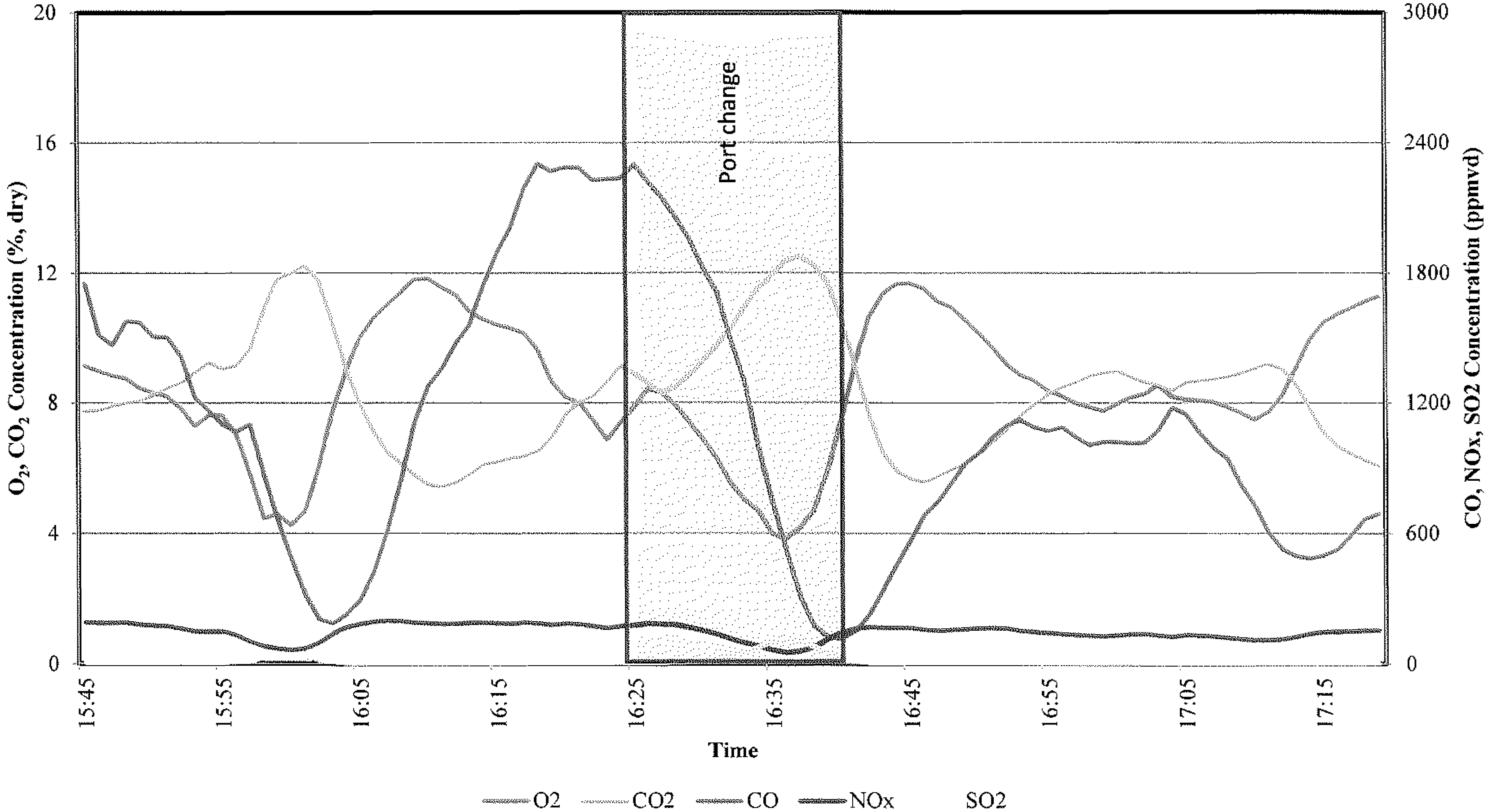
## Detroit, Michigan

## Project No. 11018-000100.00

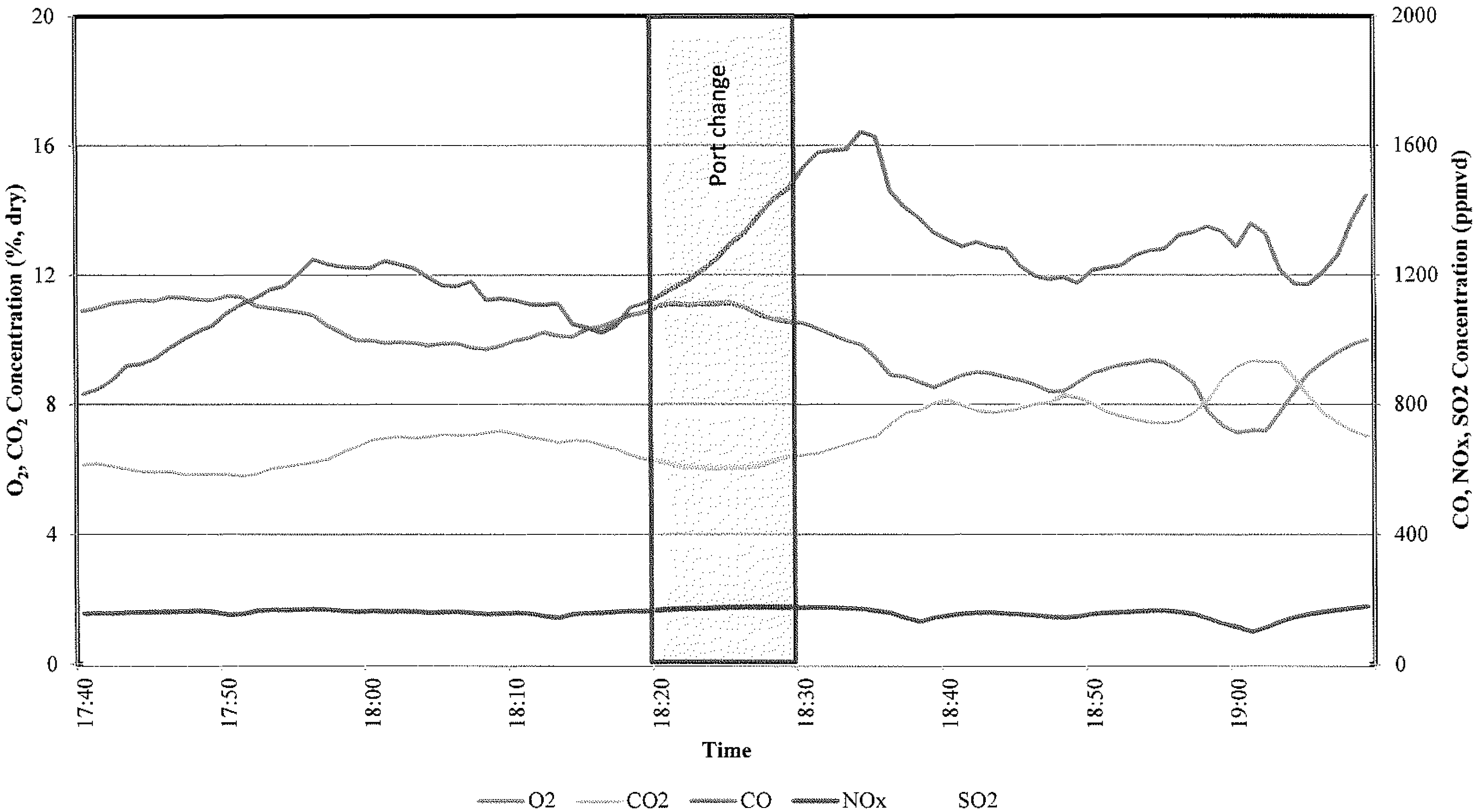
## Sampling Date: July 16, 2018



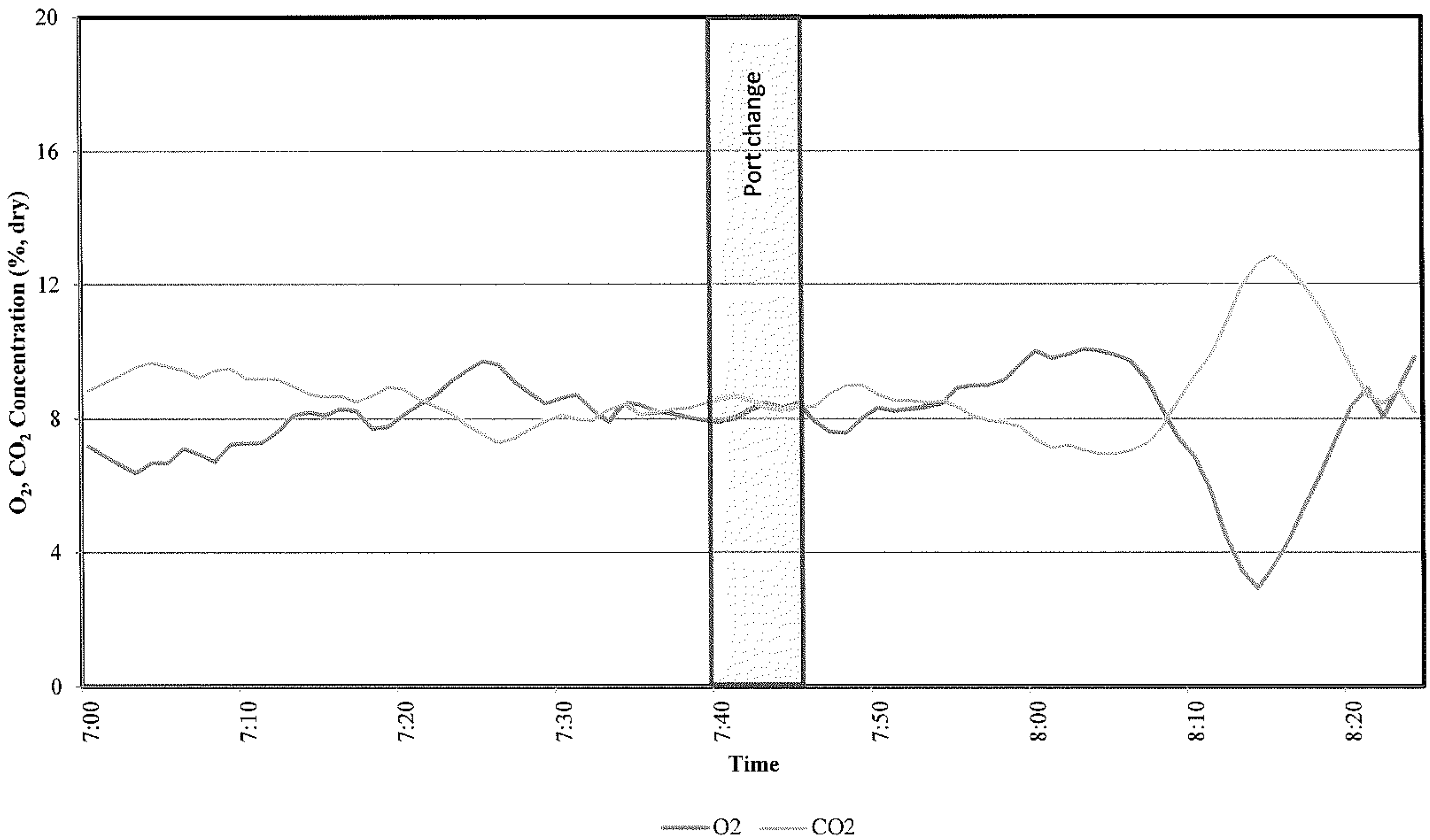
# EUINC12 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 3
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 16, 2018



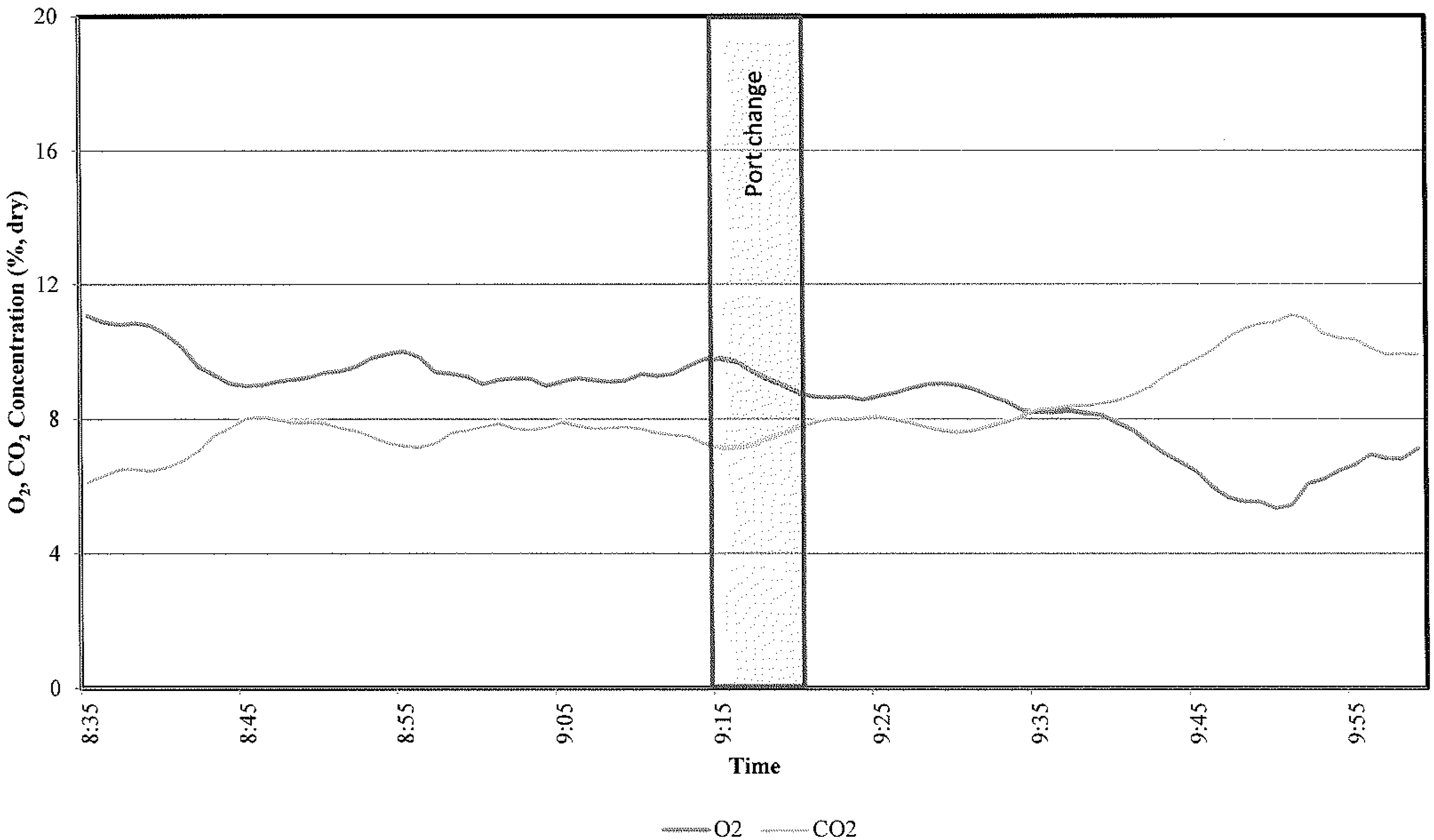
# EUINC12 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 4
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 16, 2018



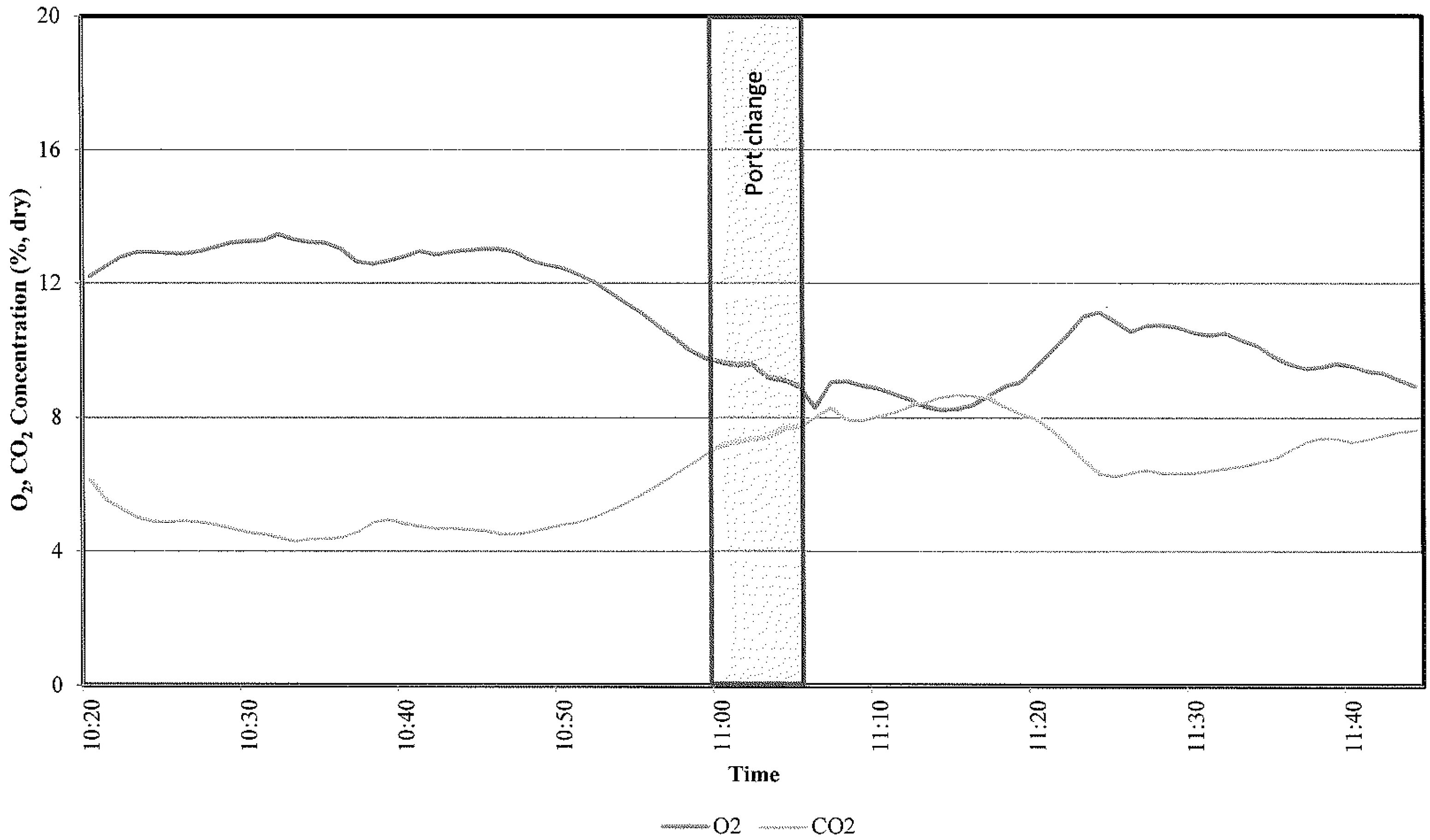
# EUINC12 $O_2$ and $CO_2$ Concentrations - Run 5
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 17, 2018



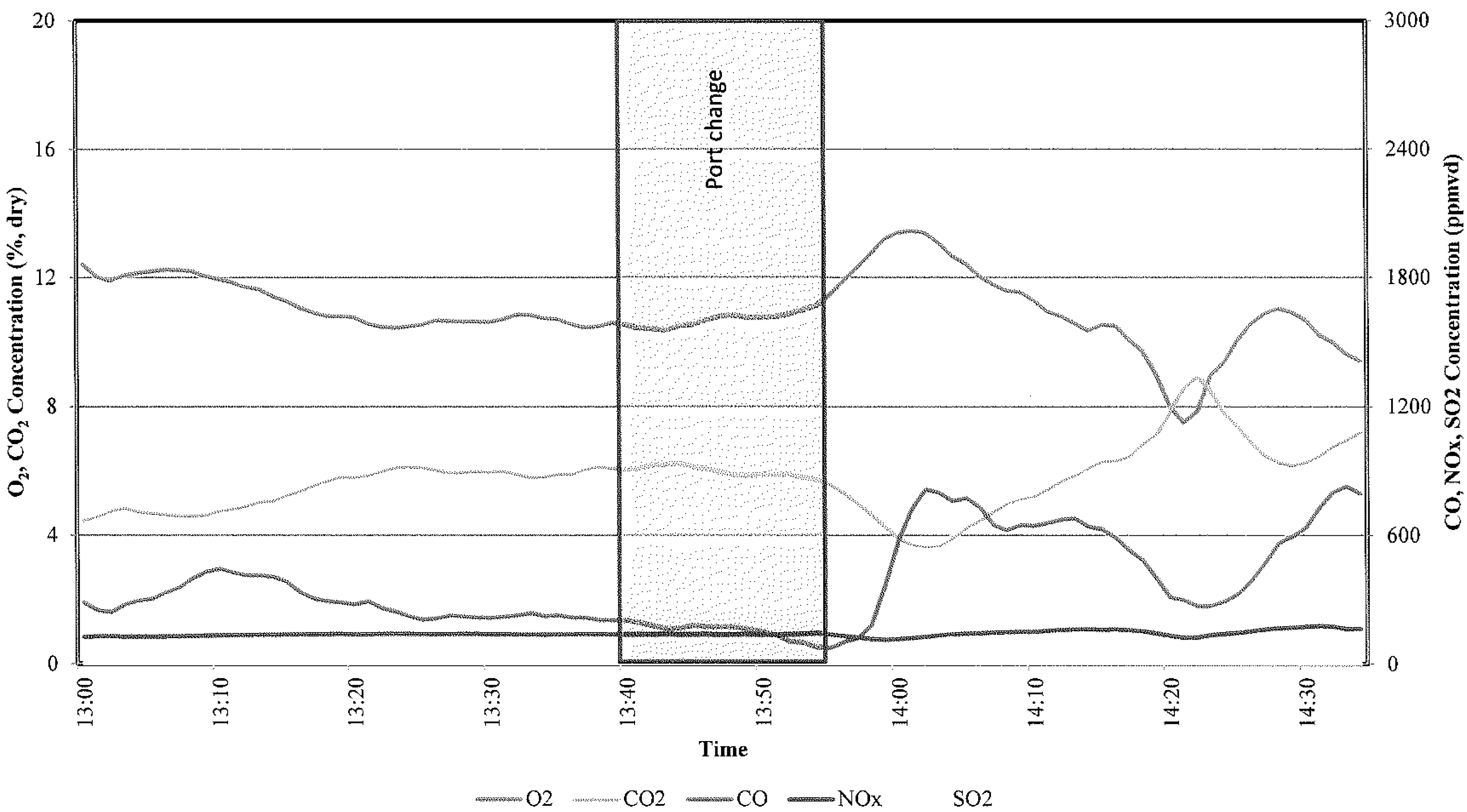
# EUINC12 $O_2$ and $CO_2$ Concentrations - Run 6
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 17, 2018



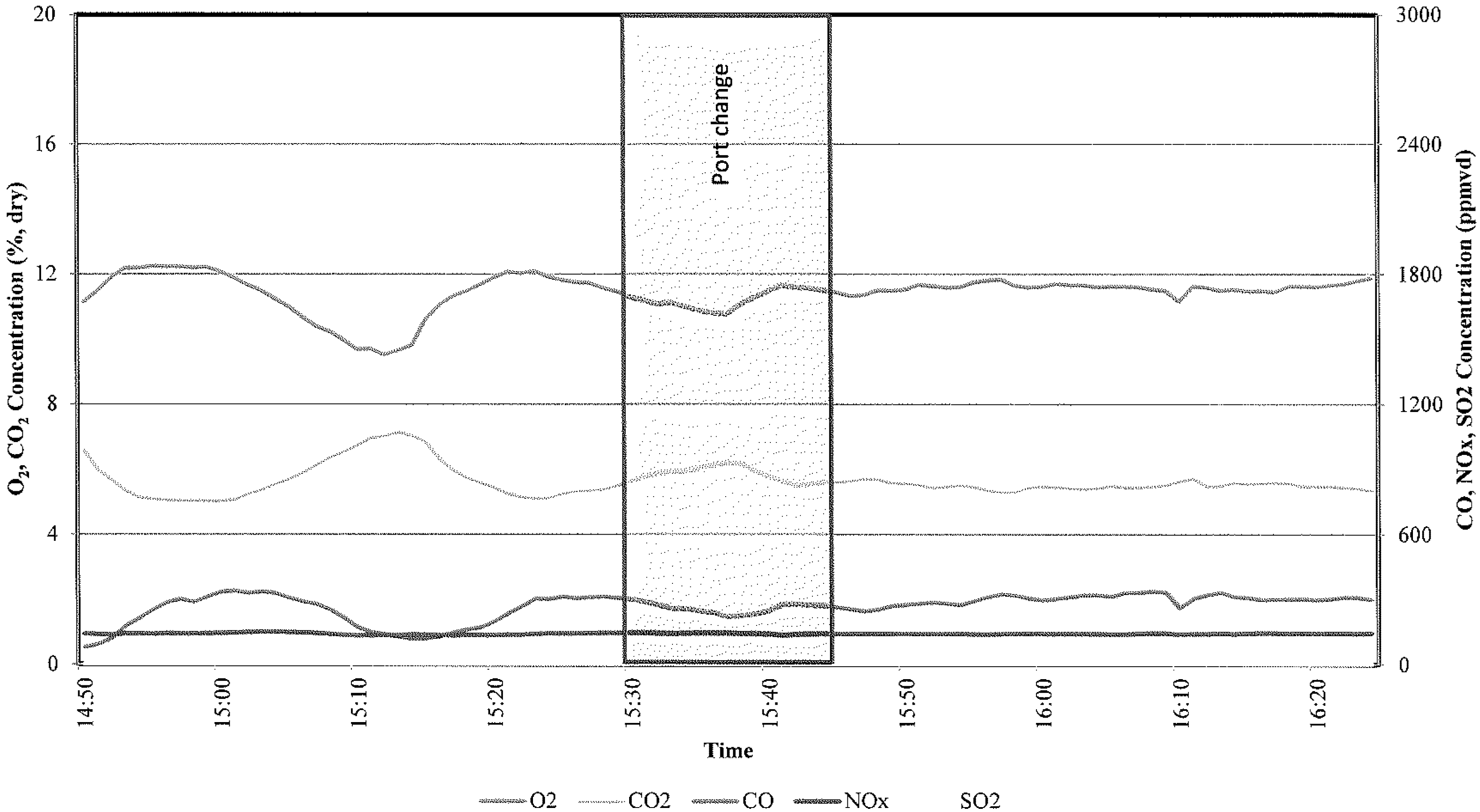
# EUINC12 $O_2$ and $CO_2$ Concentrations - Run 7
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 17, 2018



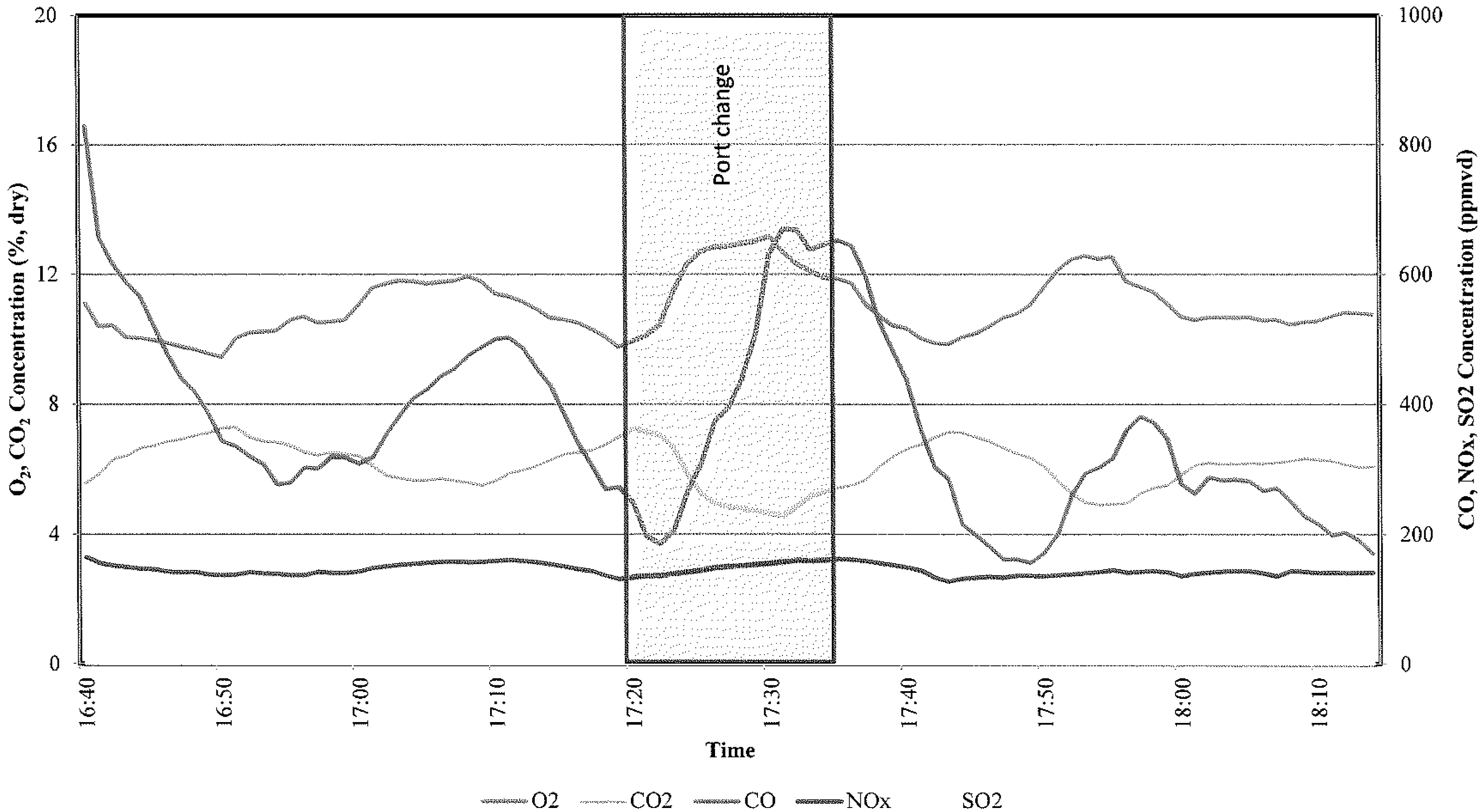
# EUINC13 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 1
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 17, 2018



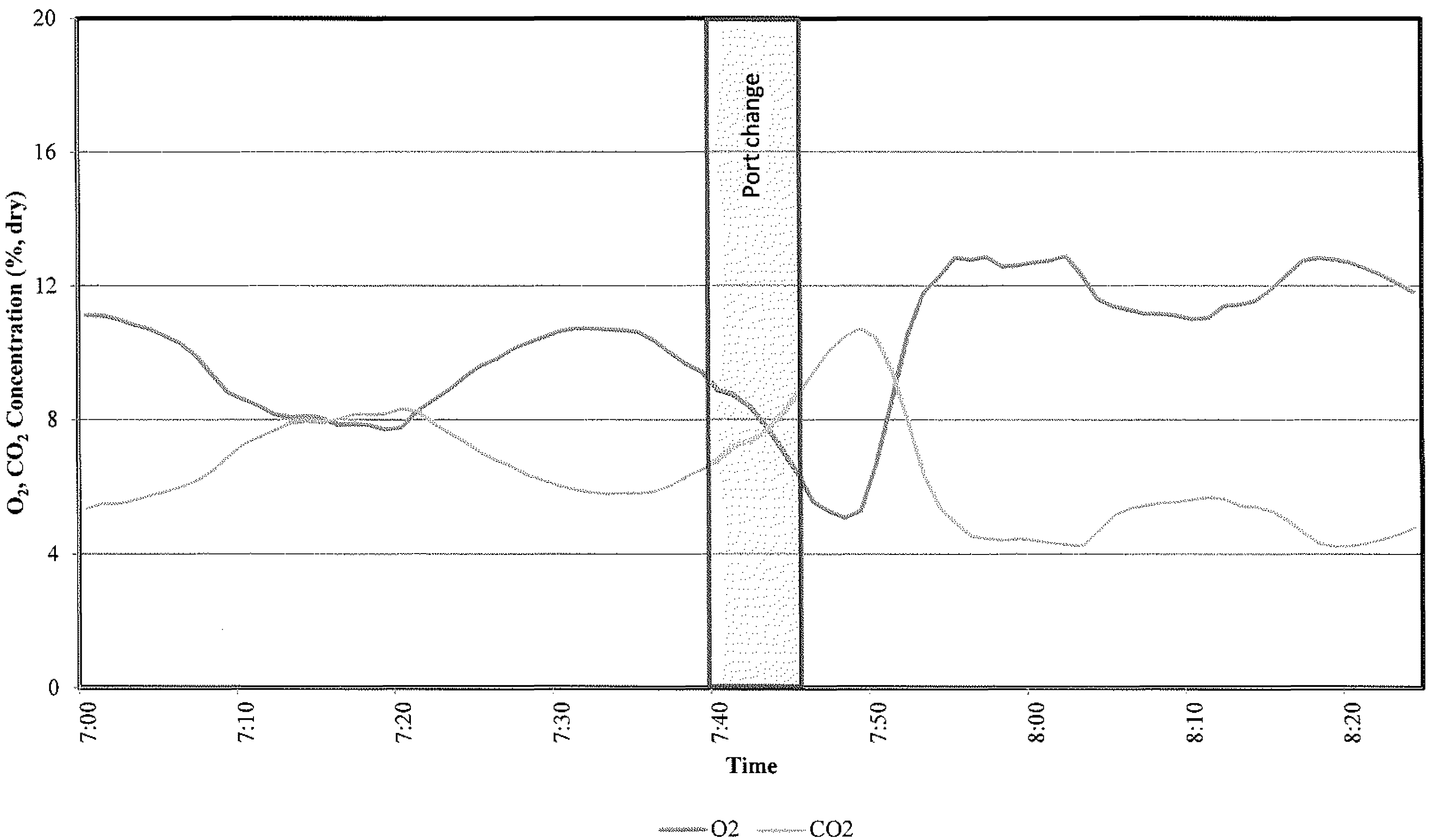
# EUINC13 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 2
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 17, 2018



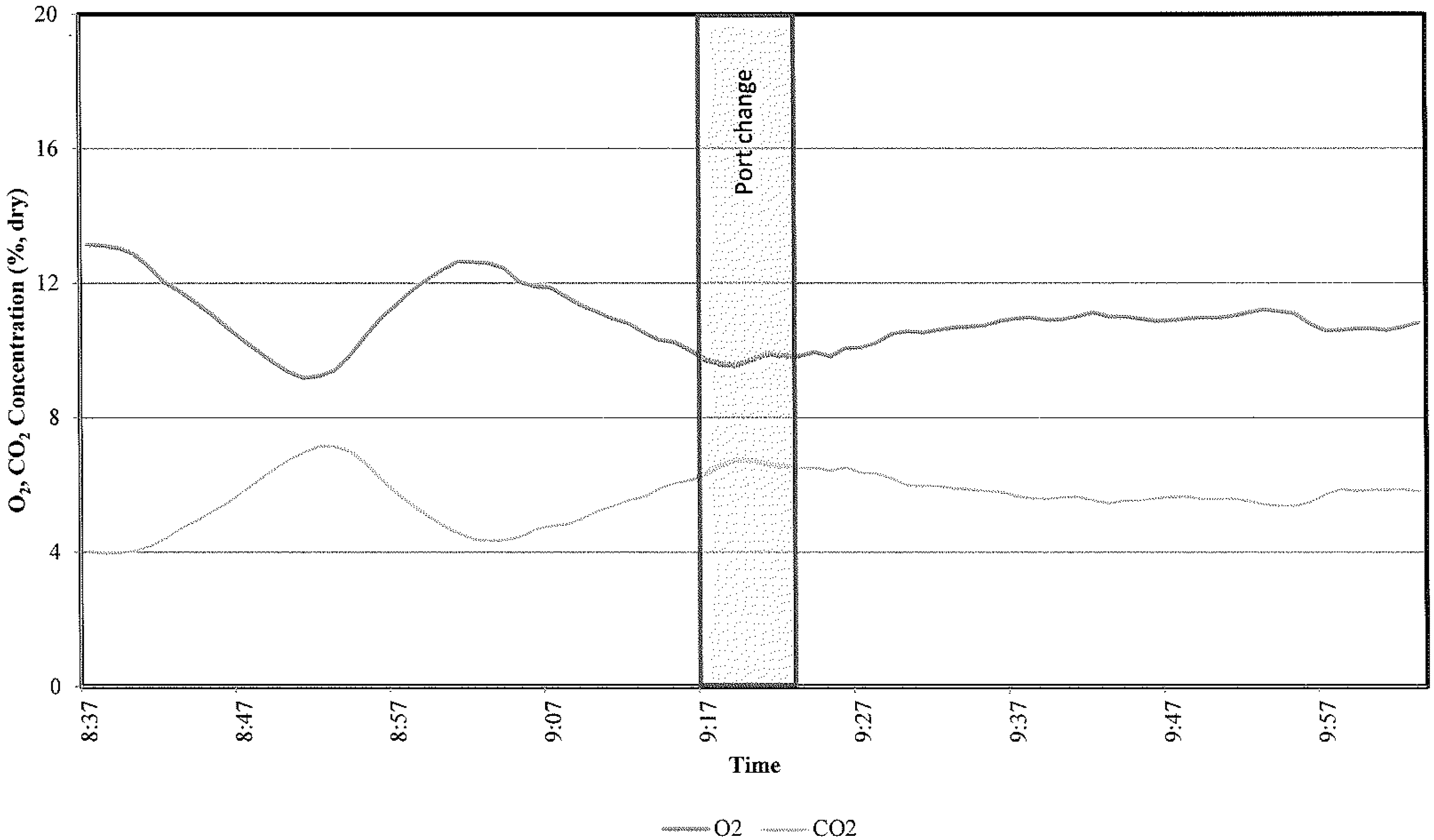
# EUINC13 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 3
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 17, 2018



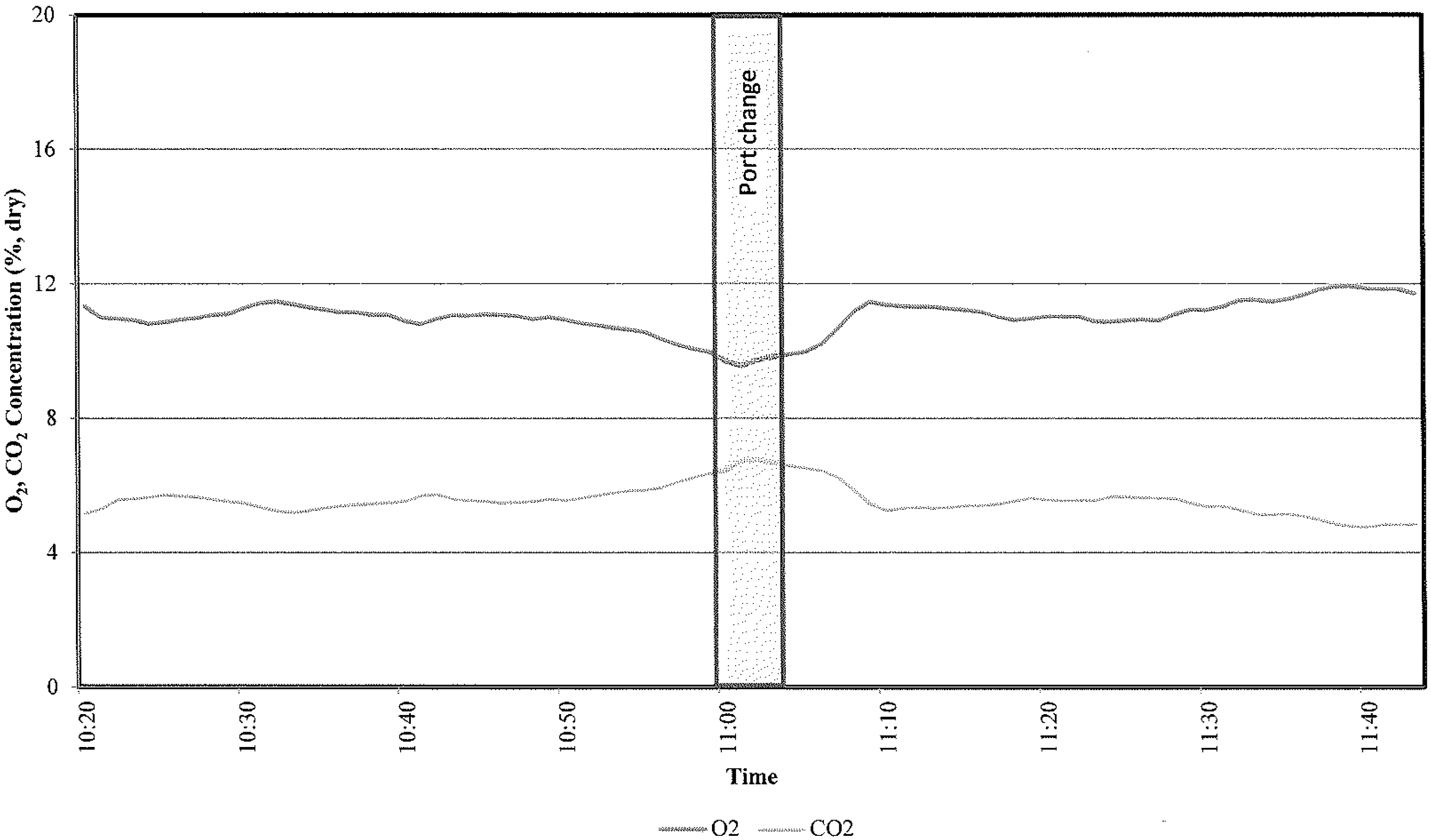
# EUINC13 $O_2$ and $CO_2$ Concentrations - Run 4
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 18, 2018

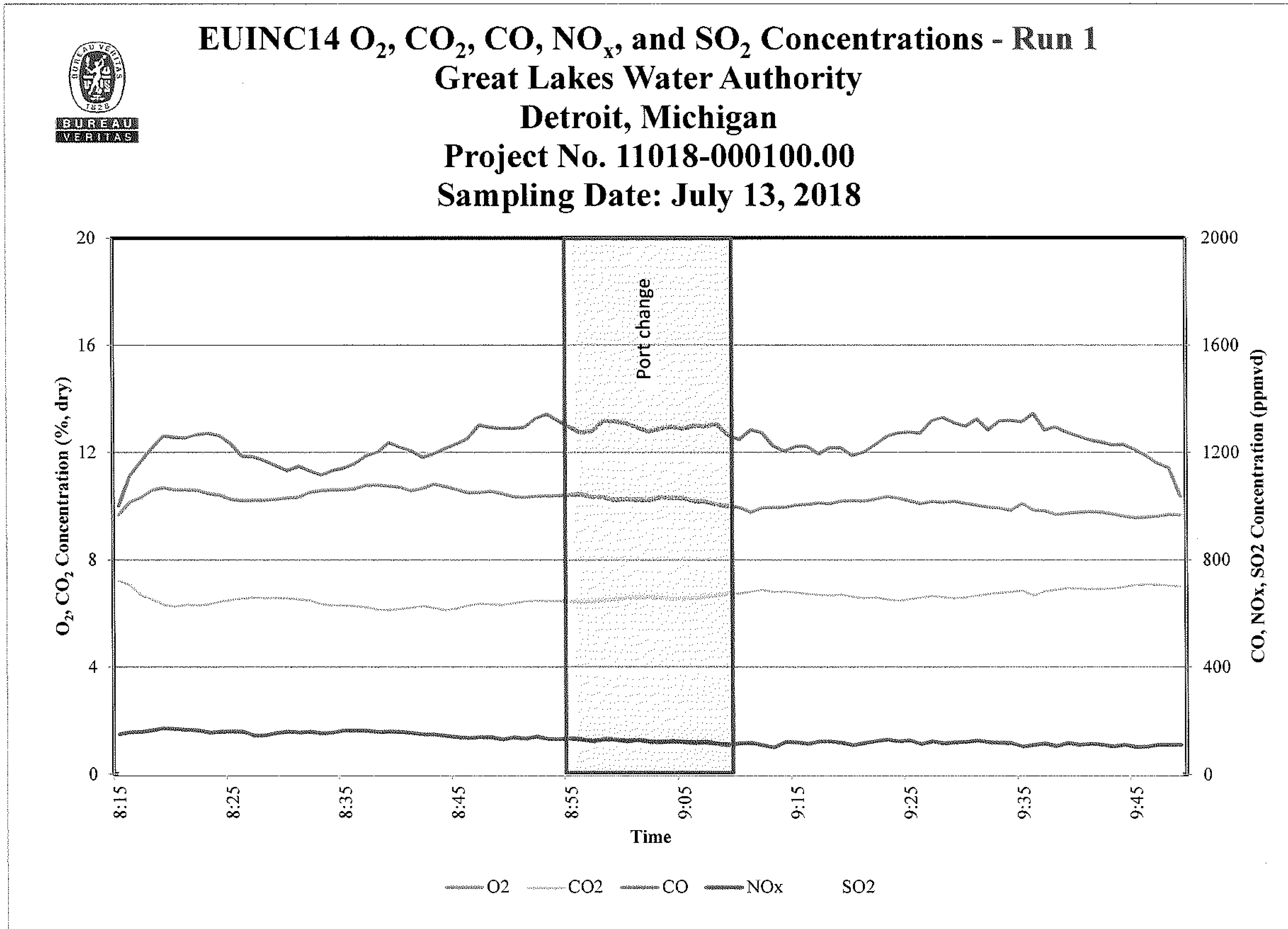


# EUINC13 $O_2$ and $CO_2$ Concentrations - Run 5
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 18, 2018



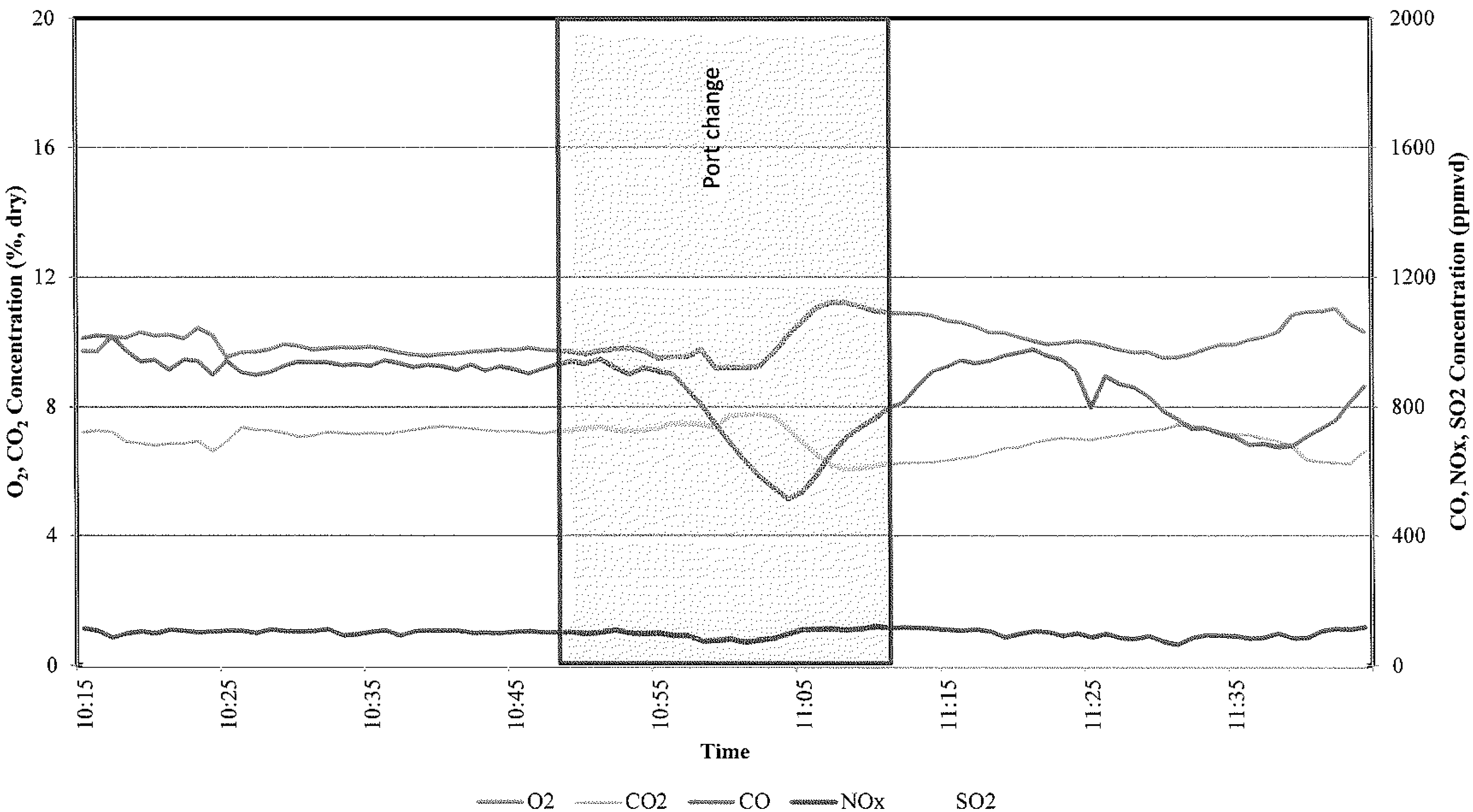
# EUINC13 $O_2$ and $CO_2$ Concentrations - Run 6
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 18, 2018



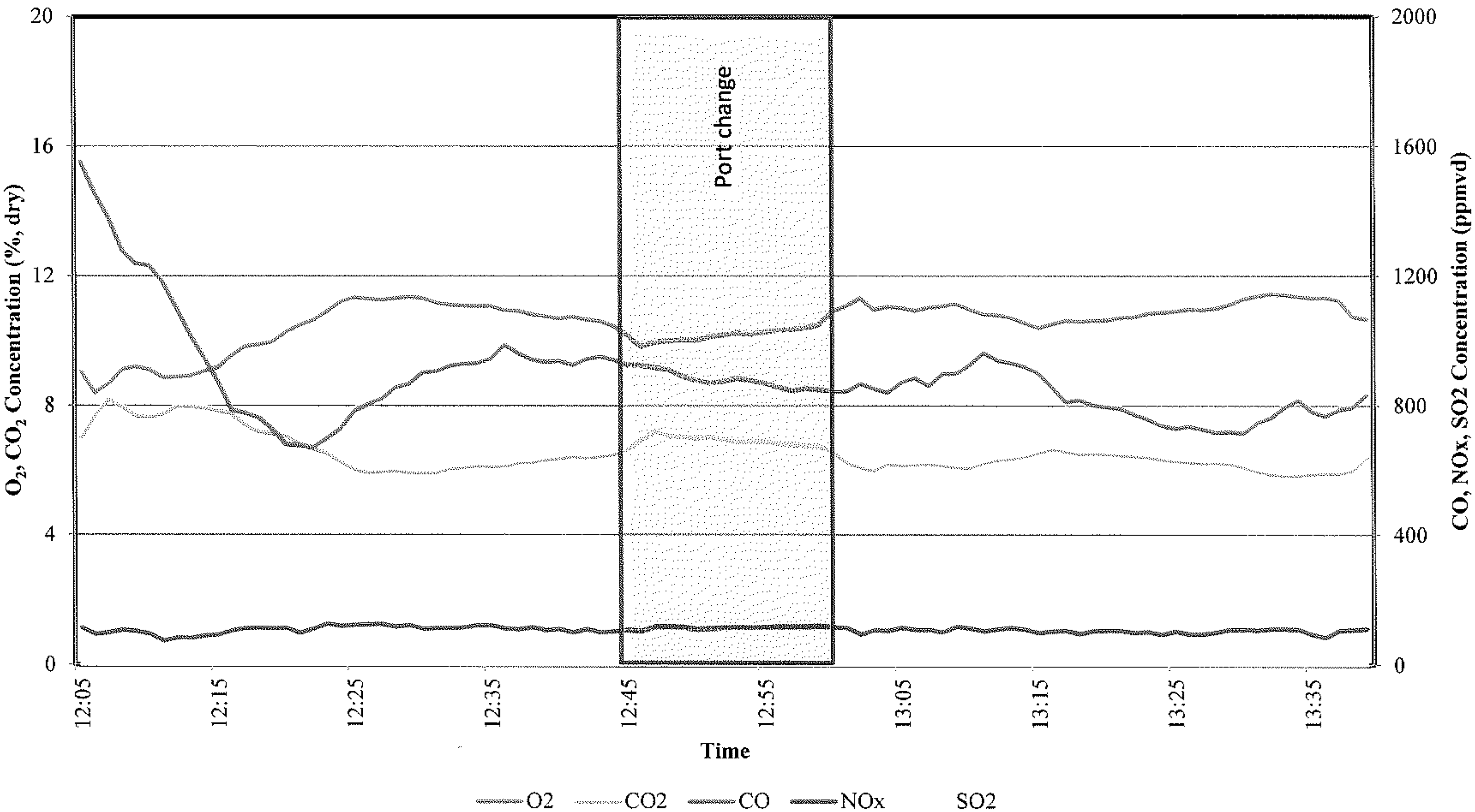


EUINC14 O2, CO2, CO, NOx, and SO2 Concentrations - Run 1
Great Lakes Water Authority
Detroit, Michigan
Project No. 11018-000100.00
Sampling Date: July 13, 2018
BUREAU VERITAS
1828
Port change
O2, CO2 Concentration (%, dry)
CO, NOx, SO2 Concentration (ppmvd)
Time
20
16
12
8
4
0
2000
1600
1200
800
400
0
8:15
8:25
8:35
8:45
8:55
9:05
9:15
9:25
9:35
9:45
O2
CO2
CO
NOx
SO2

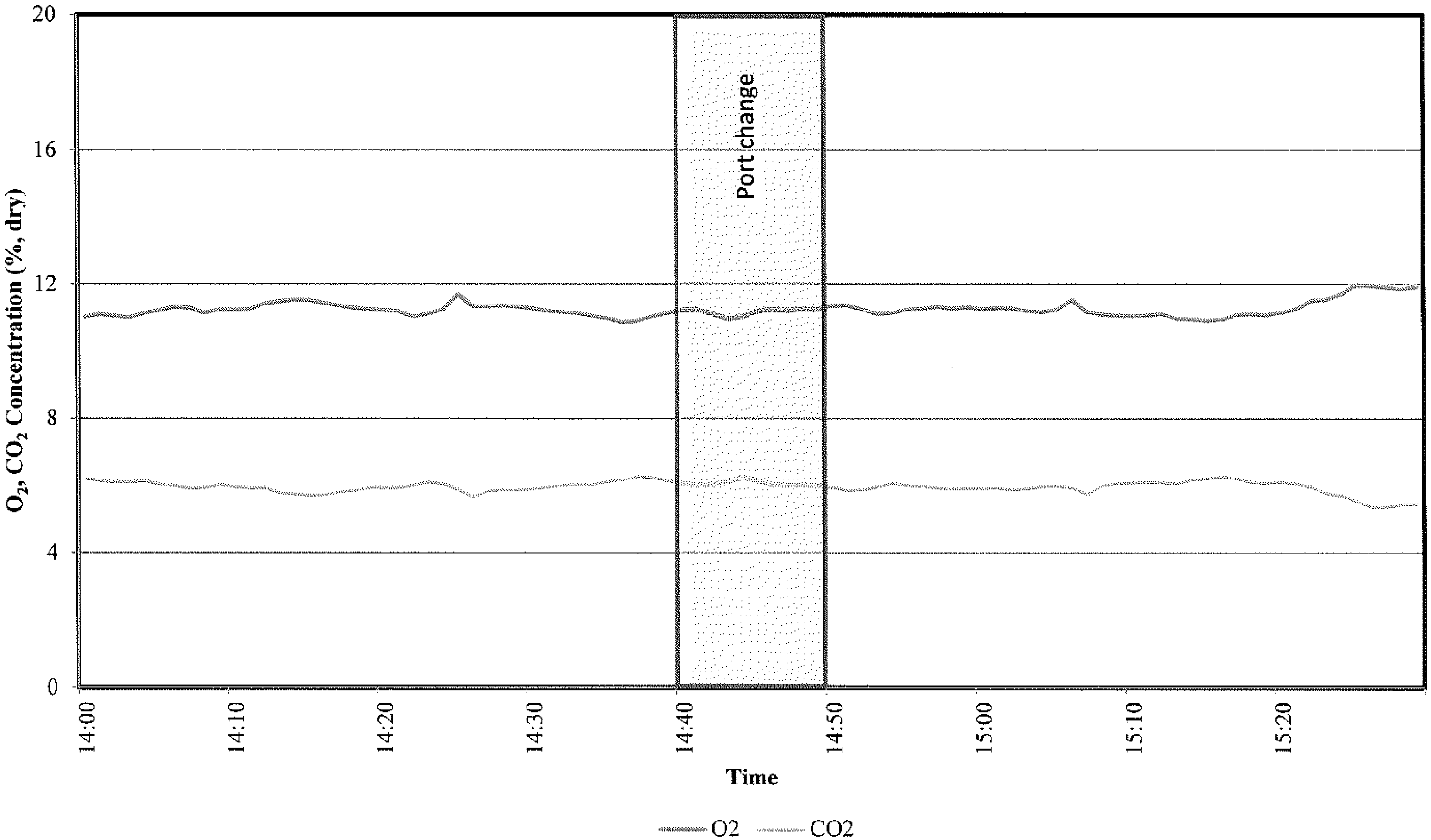
# EUINC14 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 2
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 13, 2018



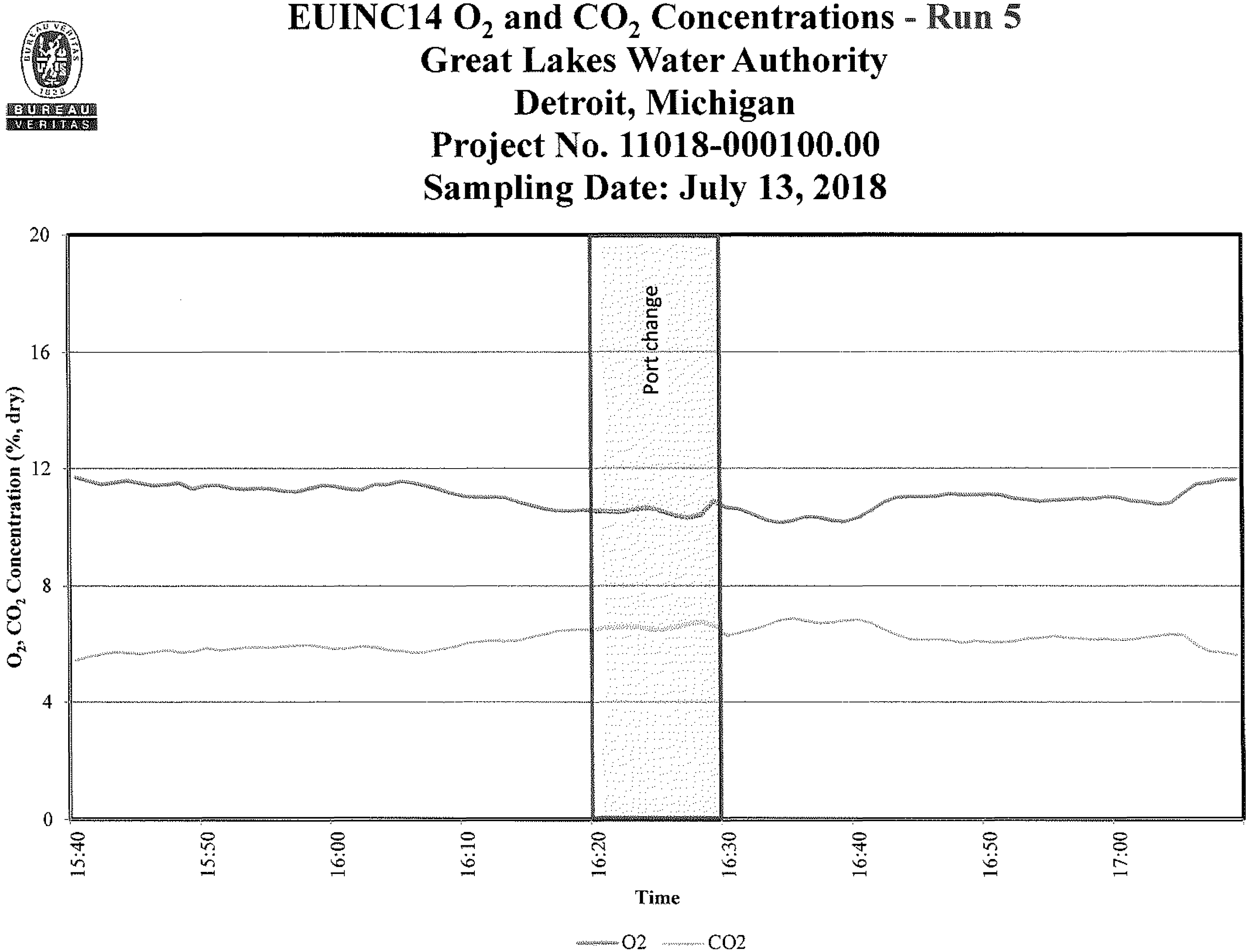
# EUINC14 $O_2$, $CO_2$, CO, $NO_x$, and $SO_2$ Concentrations - Run 3
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 13, 2018



# EUINC14 $O_2$ and $CO_2$ Concentrations - Run 4
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 13, 2018



# EUINC14 $O_2$ and $CO_2$ Concentrations - Run 5
## Great Lakes Water Authority
## Detroit, Michigan
## Project No. 11018-000100.00
## Sampling Date: July 13, 2018



# EUINC14 $O_2$ and $CO_2$ Concentrations - Run 6
# Great Lakes Water Authority
# Detroit, Michigan
# Project No. 11018-000100.00
# Sampling Date: July 16, 2018