Characterization of Emissions from a 1 MW_e Reciprocating Engine Fired with Landfill Gas

BFI Usine de Triage Lachenaie Ltée Lachenaie, Québec

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Report ERMD 2001-03
January 2002
Emissions Research and Measurement Division
Environmental Technology Advancement Directorate

Environment Canada Environnement Canada
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ACKNOWLEDGEMENTS

The Emissions Research and Measurement Division would like to express their appreciation to BFI Usine de triage Lachenaie Ltée and Messrs. Yves Normandin, Jean-Marc Viau and Richard Brown for their cooperation and assistance during the test program. Special thanks are extended to the Analysis and Ambient Air Quality Division at the Environmental Technology Centre for performing the dioxin, furan, hexachlorobenzene, octachlorostyrene, PAH and VOC analyses.

1. INTRODUCTION

The Kyoto Protocol encourages the reduction of emissions of greenhouse gases. Landfill gas, a product of the decomposition of organic waste in landfills, is roughly 50% methane, a potent greenhouse gas having 21 times the global warming potential of carbon dioxide. In Canada, six million tonnes of carbon dioxide equivalent is being reduced annually through the combustion of landfill gas. The potential exists to double this capture rate in Canada.

While the combustion of landfill gas greatly reduces the impact of greenhouse gases, landfill gas contains numerous aliphatic, aromatic and halogenated compounds. These volatile organic compounds (VOCs) which are present in the order of a few hundred ppm are major precursors for smog formation while Freons are known ozone-depleting substances. The volatile organic compounds may also contain vinyl chloride and 1,3-butadiene which are classified as CEPA-toxic substances.

The effectiveness of flares, engines and boilers in the destruction of non-methane components of landfill gas has only been studied in a preliminary fashion in Canada. As a result, a joint program was initiated among the Waste Prevention Division of the National Office of Pollution Prevention (NOPP), landfill operators/developers and the Emissions Research and Measurement Division (ERMD). The objective of this program is to evaluate the effectiveness of landfill gas combustors for the destruction of VOCs and the potential formation of significant substances such as criteria air contaminants (NO_x, SO_2 and CO), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans (PCDDs/PCDFs), hexachlorobenzene (HCB) and octachlorostyrene (OCS). Sampling also includes measurement of particulate, hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions.

The testing program encompasses three mechanisms for landfill gas combustion including engines, boilers and enclosed flares. This report documents testing at a reciprocating engine producing 1 MW_e at the BFI Usine de triage Lachenaie Ltée landfill. In addition to this document, detailed reports are available for testing of landfill gas combustion in two other types of reciprocating engines, an enclosed flare and a boiler.

ERMD conducted sampling to test for the presence of PCDDs/PCDFs, PAHs, HCB, OCS, VOCs, acid gases, particulate, NO_x, SO_2, CO and O_2. In the case of VOCs, landfill gas and exhaust data were used to determine the destruction efficiency of selected VOCs across the reciprocating engine.

2. SAMPLING SITE AND LOCATION

Four engines are used to produce power from LFG at the Lachenaie landfill. Sampling was conducted on the exhaust of the No. 2 Engine. This is a Waukasha Model 7042 GLD gas engine. At the time of testing, No. 2 Engine had approximately 25,000 operating hours. An engine overhaul is scheduled for April 2002. No adjustments were made to the engine prior to or during the sampling program, i.e. the air/fuel mixture was pre-set. Maintenance on the engine had consisted of routine servicing such as gapping of spark plugs and replacement of engine oil and air filters.

The sampling location is illustrated in Figure 1. The stack sampling platform was located over the muffler approximately 5 feet above the roof top. Sampling was conducted from two 3" ports located at 90° to each other around the stack and approximately 30" above the top deck of the scaffolding.

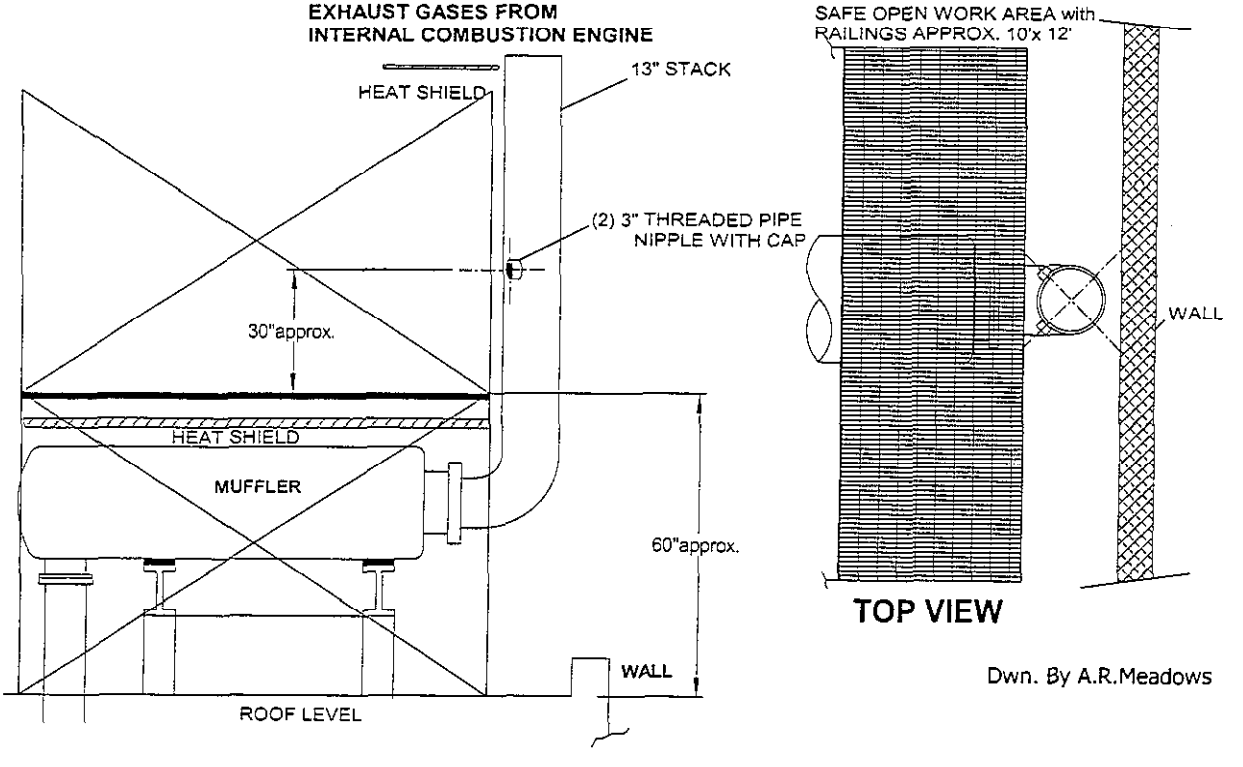


Figure 1 – Reciprocating Engine Sampling Location

3. SAMPLING METHODS

3.1 General

The Method 5 train formed the basis of the manual methods used to collect particulate and semi-volatile organics during the sampling phase. The train consisted of a heated probe, heated filter enclosure, leak-free vacuum line, vacuum gauge, flow control valves, vacuum pump and a dry gas and orifice meter. Stack gas and orifice pressures were measured with an inclined manometer. Temperatures were measured in the hot box, impinger train outlet and at the inlet and outlet of the dry gas meter. In the case of the SVOCs, the temperature was also monitored at the Amberlite XAD-2 inlet. All trains were assembled in the ERMD mobile lab.

Leak-checks were conducted at the beginning and at the end of each run or whenever a train joint was opened. Sampling was conducted isokinetically along two 12-point traverses. Sampling duration at each point was 10 minutes with readings and flow adjustments every 5 minutes. Sampling duration for the particulate and organic runs was 2 hours and 4 hours respectively. Due to the extremely low particulate loading during a 2-hour test run, the three particulate runs (6 hours) were conducted contiguously and collected on the same train to improve the gravimetric determination of the filter and acetone rinses.

3.2 Particulate/Acid Gases Train Description

The Environment Canada Report EPS 1/RM/8 *"Reference Method for Source Testing: Measurement of Releases of Particulate from Stationary Sources"* was used to determine the emissions of particulate and acid gases from the engine exhaust. Particulate in the flue gas was collected on a glass fibre filter. The first two impingers, containing deionized water, trapped the acid gases. A schematic of the sampling train is shown in Figure 2. Blanks for the glass fibre filter, acetone and deionized water were also submitted for analysis.

3.3 Semi-volatile Organic Compounds (SVOC) Train

3.3.1 SVOC Train Description

The Environment Canada Report EPS 1/RM/2 *"Reference Method for Source Testing: Measurement of Releases of Semi-volatile Organic Compounds from Stationary Sources"* was used to determine the emissions of PCDDs/PCDFs, PAHs, HCB, and OCS from the stack. This method is the most widely accepted for the measurement of organic compounds with boiling points above 100°C (see Figure 2). Gaseous organics were trapped in a single adsorbent tube containing about 40 grams of Amberlite XAD-2 resin. As the temperature of the resin must be kept below 20°C for optimal collection efficiency, the hot gases leaving the filter enclosure were cooled by passing them through a condenser cooled with ice bath water. The tube containing the XAD-2 resin was also water-cooled. Condensate formed in the cooling coil percolated through the resin bed and was collected in a condensate trap. An impinger containing ethylene glycol inserted downstream of the Amberlite acted as a back-up collection media in the event of breakthrough of organics through the resin. The resin tube was covered with aluminium foil during sampling and storage to prevent photodegradation of the trapped organics. All glassware joints were wrapped with Teflon tape as vacuum greases are not permitted for organic sampling.

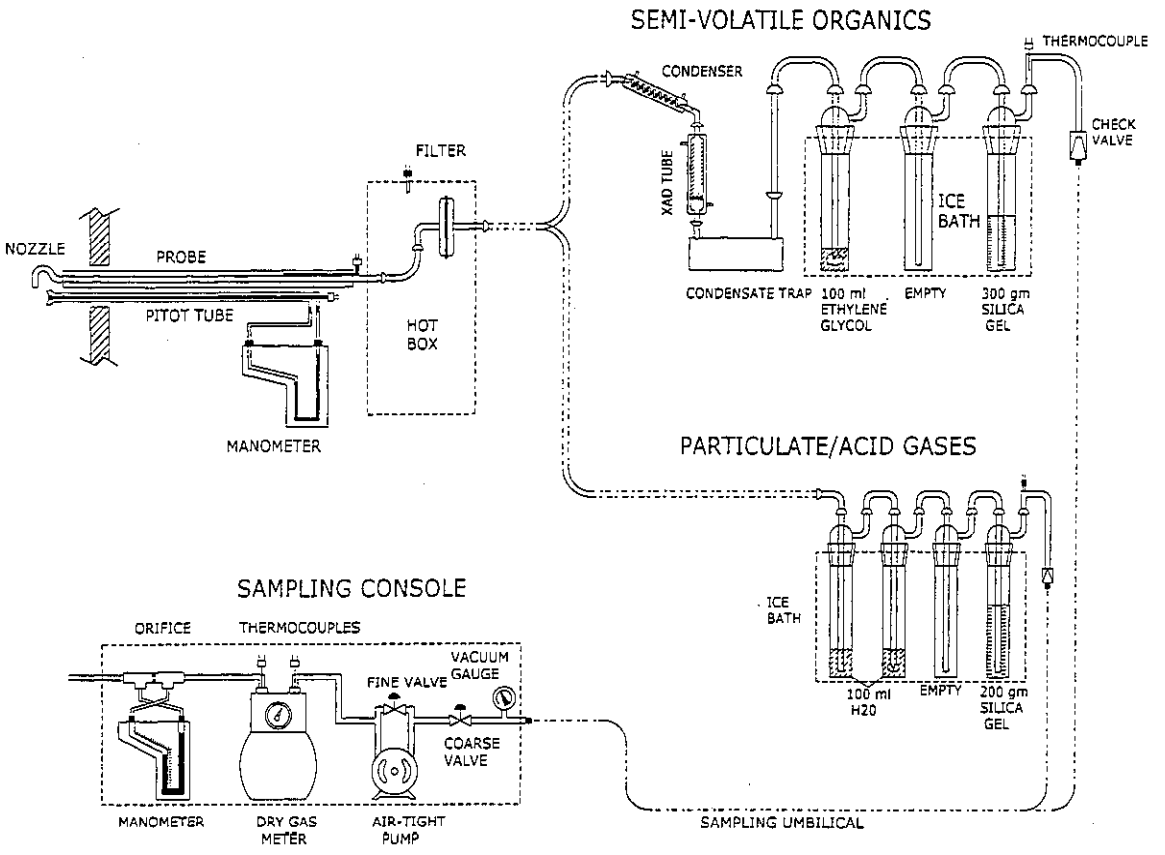


Figure 2 - Particulate/Acid Gases and Semi-volatile Organics Sampling Trains

A simple train was utilized at the inlet to sample the landfill gas for semi-volatile organic compounds. The pressure in the manifold was used to push the landfill gas through a resin tube filled with Amberlite. The volume was recorded on a dry gas meter. Water was collected in an impinger to determine the raw gas moisture level. A schematic of this train is shown in Figure 3.

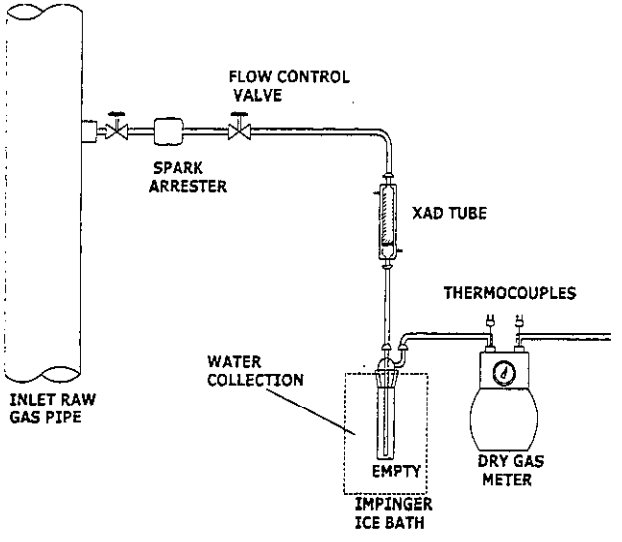


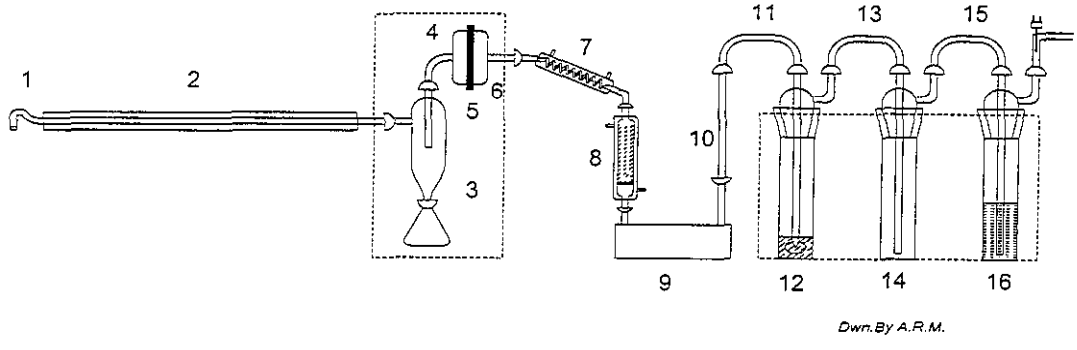
Figure 3 - Inlet SVOC Train

3.3.2 Glassware Cleaning and Proofing

Prior to the test program, all train glassware, probe brushes, glass wool and aluminium foil were cleaned following a rigorous procedure. The glassware cleaning procedures were verified by analyzing the proofing rinses of the sampling trains. Pre-cleaned and proofed commercial sample storage bottles were used for this test. Four complete sets of train glassware were prepared for this survey. The XAD-2 was pre-cleaned and analyzed for contamination prior to the survey. All reagents were distilled-in-glass grade. Details of the cleaning and proofing procedures are given in Report EPS 1/RM/2.

3.3.3 Sample Recovery

Following the completion of each run, the organic train was recovered in the ERMD laboratory. During the transportation between the sampling site and the lab, all openings were sealed with pre-cleaned glass plugs or caps or aluminium foil. The recovery procedures involved the brushing and rinsing of the train components with acetone and hexane. Only Teflon wash bottles were used during sample recovery. Amberlite tubes were capped and re-wrapped in aluminium foil. Liquid samples were stored in pre-cleaned amber bottles to prevent photodegradation of the organics. Bottle lids were lined with Teflon. All samples were kept refrigerated following recovery. The sample recovery procedures are detailed in Figure 4. All samples were forwarded to the Analysis and Air Quality Division (AAQD) of Environment Canada for organic analysis.



Sample	Component(s)	Recovery Procedure
1	1,2,3,4	Wash and brush 3 times each with acetone (A) and hexane (H). Rinse 3 times each with A and H.
2	5	Remove carefully from filter holder. Place on pre-cleaned foil. Fold in half and crimp the foil edges. Place in pre-cleaned petri dish. Seal petri dish.
3	6,7	Soak 5 minutes each with A and H. Rinse 3 times each with A and H.
4	8	Cap ends and wrap in foil.
5	9,10,11,12	Empty contents into container and rinse 3 times with HPLC water.
6	6 to 15 except 8	Rinse three times each with A and H.

Mark liquid levels on all bottles and wrap all the caps with tape.
All sample containers are pre-cleaned amber glass bottles with pre-cleaned Teflon lid liners.

Figure 4 – Recovery Procedure for Semi-volatile Organic Compounds

In addition to the regular sampling trains, a blank train was assembled for the tests. The blank train was treated in the same manner as the sampling trains except that no stack gases were sampled. However, a volume of ambient air, equal to that drawn during the leak checks, was drawn through the blank train. Essentially, the blank train serves as a check for background levels of organics originating from ambient air, handling of train glassware and rinsing agents.

3.4 Volatile Organic Compounds (VOCs)

VOCs are classified as those organics having saturated vapour pressures at 25°C greater than 10^{-1} mm Hg. The method is based on the collection of a gaseous sample in a previously cleaned, verified and evacuated, 6-liter, stainless steel canister. The canister's interior surface is covered by pure chrome-nickel oxide which is formed during the SUMMA® passivating process. This type of vessel provides sample collection and storage stability for many organic compounds. A schematic of the sampling train is shown in Figure 5.

The samples for VOCs were collected at the inlet to the engine (raw gas) and at the exhaust stack of the engine. Two canisters were collected for each SVOC run at the engine exhaust and only 2 samples were taken of the landfill gas. Sampling duration for the VOC samples was variable ranging from 68 to 75 minutes at the inlet and 56 to 110 minutes at the outlet. The sample was collected into the evacuated canister to a final pressure of 11 psig at the inlet and 25 to 27 psig for the exhaust samples. Following sample collection, the canister valve was closed and the canisters were transported to the AAQD laboratory for analysis.

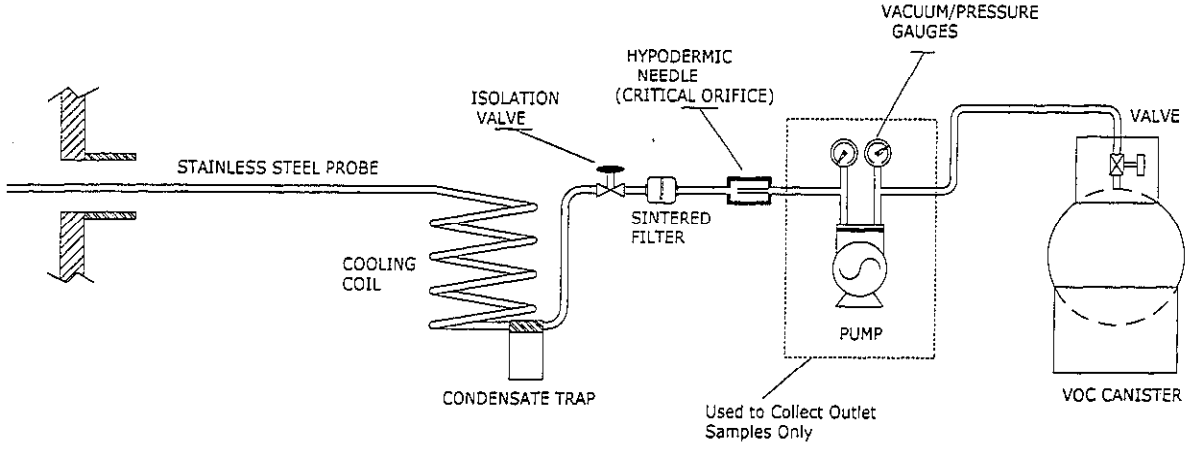


Figure 5 – Volatile Organic Compounds Sampling Train

A modified method TO-14 *(Compendium Method TO-14 Quality Assurance Division, Environmental Monitoring Systems Laboratory, U.S. EPA, May 1988)* was used as the basis for the VOC sampling train. The train consisted of an in-stack sintered filter, stainless-steel probe connected by Teflon tubing to the canister. The gases were drawn by a Teflon-coated pump through a critical orifice (hypodermic needle) into the canister (Figure 5). In the case of the raw gas samples, the pressure in the manifold as well as a manual hand pump were used to fill the canisters.

3.5 Flue Gases

An integrated gaseous sample method was employed to collect a representative sample from the stack. This was accomplished by drawing sample gas through a 30-inch Inconel probe. The probe assembly was located directly in the exhaust stream of the stack with a peristaltic pump drawing sample into a high volume Tedlar sample bag. A sampling rate of 1 liter per minute was used over a 30-minute sampling period per sample. A schematic of the system is shown in Figure 6.

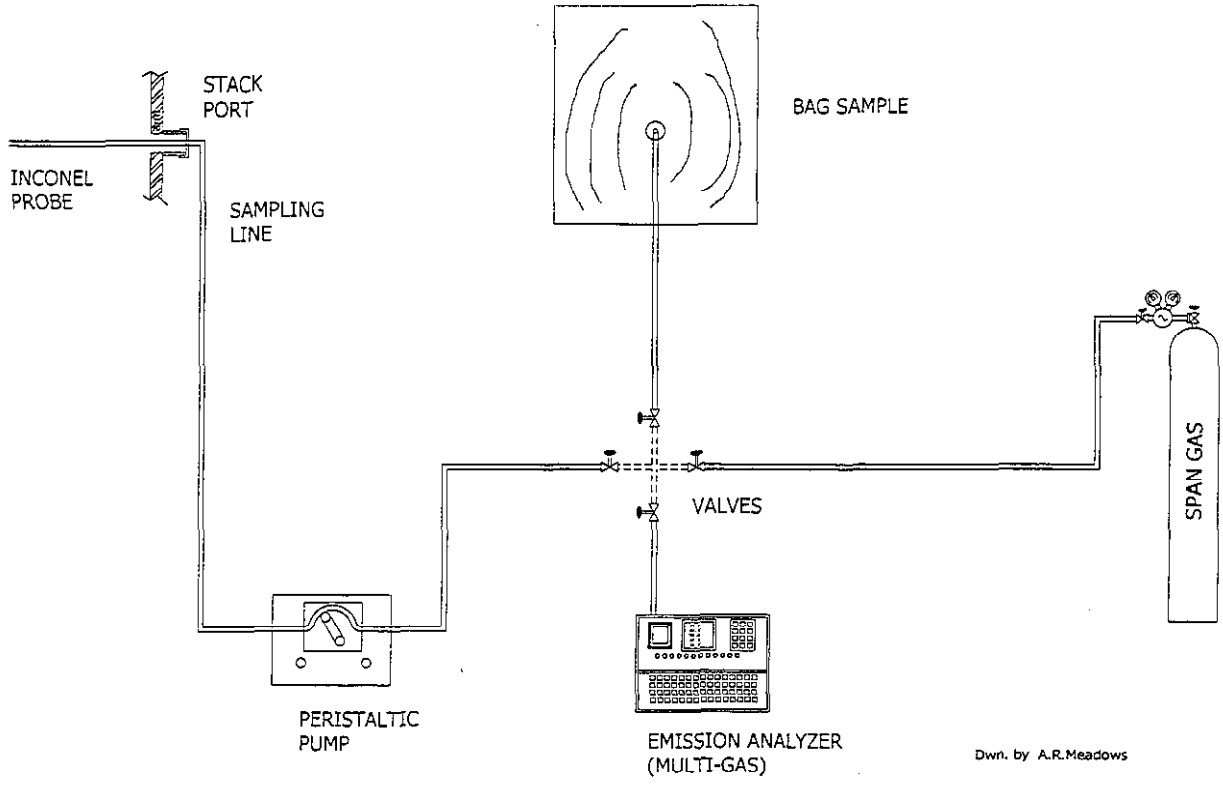


Figure 6 Flue Gas Monitoring System

Each integrated sample was then analyzed using both an ECOM Model KD and Nova Model 306 BD, both electrochemical analyzers, to determine target species concentration. Each instrument was individually calibrated twice a day using two ranges of certified Matheson gas standards. Initial calibration was carried out prior to the commencement of sampling, once all equipment had reached operating conditions, while final calibration was performed at the end of sampling.

4. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

All stack sampling equipment was calibrated prior to sampling using accepted techniques. Items that were calibrated included:

- Dry Gas Meter (γ)
- Orifice (K_0)

- Pitot Tubes (C_p)
- Barometers (P_{bar})
- Inclined Gauges (Δp)
- Nozzle Diameters (N_d)
- Temperature Readers (T)

The dry gas and orifice meters were calibrated using a spirometer. Pitot tubes were calibrated at the National Research Council wind tunnel. Barometers and inclined gauges were calibrated against a standard reference mercury barometer and an inclined manometer respectively. Thermocouple readers were calibrated using an ice bath and boiling water. Nozzle openings were measured by averaging three measurements with a vernier caliper. In addition to the above, the sampling consoles and inclined gauges were checked for leaks and the operation of all probe and box heaters was verified. The Ecom-KL combustion gas analyzer was verified before the program and daily during the sampling program with calibration gases.

5. ANALYTICAL METHODS

5.1 Particulate/Acid Gases

Particulate was determined gravimetrically following desiccation of the front-half acetone rinse and loaded filter. Acid gases were determined from the impinger solutions using ion chromatography.

5.2 Semi-volatile Organic Compounds

Stack samples were analyzed by the AAQD at the Environmental Technology Centre for dioxins, furans, polycyclic aromatic hydrocarbons, hexachlorobenzene and octachlorostyrene using HRGC /HRMS/MS. The recovered stack samples were spiked with surrogates to monitor recoveries followed by extraction with a mixture of 80:20 cyclohexane/toluene. Sample cleanup followed to separate target from non-target species. A detailed summary of the analytical procedure for the determination of PCDDs/PCDFs, PAHs, HCB and OCS is included in Appendix II.

5.3 Volatile Organic Compounds (VOCs)

The Air Toxics lab of AAQD performed the VOC analyses on the canister samples. The canister samples were quantitatively analyzed by GC/MSD (Hewlett-Packard 5890 GC and 5971 MSD) using a cryogenic pre-concentration technique. One hundred and forty-five VOC species (from C_2 to C_{10}) were quantified in the samples. The VOCs were separated on a 50-meter HP-1 liquid phase, 0.31 mm fused silica capillary column with 1.0 μm film thickness.

6. RESULTS

6.1 General Sampling Data

The general sampling data for the engine test program is presented in Table 1. This table includes the average velocity, volumetric flow rate (referenced to 25°C and 101.3 kPa), average stack temperature and average moisture. The reported average oxygen and carbon dioxide levels are taken from the flue gas monitoring samples. The traverse data for each run and summaries are presented in Appendix I.

The landfill gas flow, power output and the methane content of the landfill gas were taken from the plant instrumentation. An average value was determined over the duration of the sampling run.

6.2 Particulate/Acid Gases

Particulate and acid gas results for the No. 2 Engine are summarized in Table 2. Particulate loading was based on the filter catch and the acetone rinses of the front-half glassware of the sampling train. Particulate loading was low at this source. A concentration at the stack of 2.53 mg/m^3 was observed, with an emission rate of 13.6 g/hr for the six-hour particulate run.

Chlorides and fluorides were determined on the catch of these ions in the water impingers of the particulate train. Chlorine and fluorine are present in the raw landfill gas as halogenated hydrocarbons. The water samples were analyzed by ion chromatography. Chlorides and fluorides are expressed as HCl and HF respectively. The HCl average concentration observed was 2.80 mg/m^3 while HF was 0.49 mg/m^3. The corresponding average emission rates were 15.0 g/hr and 2.64 g/hr for HCl and HF respectively.

Particulate, HCl and HF emissions expressed in terms of the power produced and methane input to the engine are summarized in the following table. Both the power produced and the methane input to the engine were very stable throughout the test program.

Summary of Particulate, HCl and HF Emissions from No. 2 Engine

Pollutant	(g/kW-hr)	(g/m^3 CH_4)
Particulate	0.0142	0.0399
HCl	0.0157	0.0440
HF	0.0028	0.0077

Table 1 - Summary of General Sampling Data

Run Number	Combined Part/AG 1-3	Semi-volatile Organics		
		SVOC 1	SVOC 2	SVOC 3
Process Conditions				
Fuel Type / Methane (%)	LFG / 60.7	LFG / 60.8	LFG / 61.1	LFG / 61.3
Landfill Gas In (CFM)	330	328	332	332
Power Output (kW)	957	957	962	962
Run Conditions				
Date (Oct 2001)	1	2	3	4
Sampling Time (local)	13:00-19:10	10:13-14:24	09:38-13:46	09:24-13:33
Test Duration (min)	360	240	240	240
Isokineticity (%)	97.8	96.5	98.5	99.3
Sample Volume (m^3)	7.065	4.461	4.609	4.723
Stack Gas Characteristics				
Flow Rate (m^3/min)	89.4	79.0	80.1	81.5
Actual Velocity (m/s)	46.91	45.37	45.85	46.55
Temperature (°C)	380	383	384	378
Moisture (%, wet basis)	11.70	12.11	11.86	12.01
Oxygen (%)	9.90	9.50	9.70	9.60
Carbon Dioxide (%)	10.3	10.4	10.60	10.30
Molecular Weight (lb/lb-mole)	30.04	30.04	30.08	30.03

All values are expressed on a dry basis referenced to 25°C and 101.325 kPa.

Table 2 - Summary of Particulate/Acid Gases

	Combined Part/AG 1-3*
Date (October 2001)	1
Stack Gas Characteristics	
Sample Volume (m^3)	7.065
Flow Rate (m^3/min)	89.4
Train Catches (mg)	
Particulate (mg)	17.9
Chloride (mg)	19.221
Fluoride (mg)	3.296
Concentrations (mg/m^3)	
Particulate	2.534
Chloride as HCl	2.798
Fluoride as HF	0.491
Emission Rate (g/hr)	
Particulate	13.59
Chloride as HCl	15.01
Fluoride as HF	2.64

All values are expressed on a dry basis referenced to 25°C and 101.325 kPa
** Sampling consisted of 3 contiguous 2-hour runs using the same train*

6.3 Oxygen, Sulphur Dioxide, Carbon Monoxide and Nitrogen Oxides

A summary of the concentrations for oxygen, carbon monoxide, sulphur dioxide and nitrogen oxides for the exit of the engine and the raw landfill gas is given in Table 3. As mentioned previously, no adjustments were made to the engine during the sampling program. The landfill gas was analyzed by plant monitors as well as a LandTec Gem500 multi-gas instrument. The exit gases were analyzed by a Nova 302 (CO_2) and an Ecom-KL (O_2, CO, SO_2 and NO_x) portable combustion gas analyzers. The individual readings for the particulate and organic runs are detailed in Appendix I.

During the organic runs, the raw landfill gas was analyzed for O_2, CO_2, CO and NO_x from the VOC canister samples and portable analyzers. CO was found at levels ranging from 58 to 71 ppm with NO_x levels around 3 ppm. No sulphur dioxide was detected in the raw landfill gas.

Table 3 - Summary of O_2, CO, NO, NO_2 and NO_x Concentrations

Compound	O_2 (%)	CO (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm)
No. 2 Engine Exhaust (Ecom KL analyzer)					
Semi-volatile Organics/Particulate/Acid Gases					
Part/AG 1-3	9.9	745	Data invalid		
SVOC 1	9.5	795	76	63	139
SVOC 2	9.7	778	57	55	112
SVOC 3	9.6	771	66	60	126
Average	9.7	769	64	59	123
Std Dev	0.6	46	9	4	12
Landfill Gas*					
Plant Analyzers	< 0.1	NA	NA	NA	NA
Average of 2 canisters	< 0.2	65	NA	NA	3

** Sample collected from common header to engines*

The CO, SO_2 and NO_x emissions in the exhaust were expressed in terms of the methane input to the engine and the power output. No SO_2 emissions were observed in the engine exhaust. The average flow of LFG to the engine for each run ranged from 328 to 332 CFM. Methane concentration in the landfill gas ranged from 60.7 to 61.3 percent (carbon dioxide was 38.6 to 39.3 percent). The methane flow was calculated based on the average flow of LFG and the average methane concentration for each organic and particulate run. CO and NO_x emissions in the exhaust are summarized below.

Summary of CO and NO_x Emissions

Run	Output (kW)	Methane in (m^3/hr)	CO		NO_x*	
			(g/kW-hr)	(g/m^3 CH_4)	(g/kW-hr)	(g/m^3 CH_4)
Part/AG 1-3	957	341	4.78	13.42	NA	NA
SVOC 1	957	339	4.51	12.73	1.30	3.66
SVOC 2	962	344	4.45	12.42	1.05	2.94
SVOC 3	962	346	4.48	12.46	1.20	3.35

** Expressed as NO_2*

6.4 Dioxins, Furans, Hexachlorobenzene and Octachlorostyrene

PCDD/PCDF data is reported on the basis of the seventeen 2,3,7,8-substituted dioxin and furan congeners. This data is further transformed by multiplying each of the 17 congeners by their respective international toxicity equivalency factors (I-TEFs). The factors range from 1.0 for 2,3,7,8-TCDD to 0.001 for OCDD and OCDF. Analytical results of the loaded trains, blank train, proofing and control samples are presented in Appendix II.

The emission summaries of the TEQ dioxins and furans for the engine are given in Table 4. Typically, the front and back half components of the SVOC train which correspond to the particulate and gaseous fractions respectively in the sample gas are analyzed separately. In this project, both fractions were combined as low levels of PCDD/PCDF were expected in the train samples. Train catches are corrected for the blank train (which consisted of OCDD) and all concentrations are corrected to 11% O_2.

Concentration levels were variable but were low for the three runs, ranging between 0.23 and 0.33 pg TEQ/m^3. One congener (2,3,7,8-T4CDF) accounted for the majority of the TEQ. The TEQ contribution from the dioxin congeners was negligible. Emission rates ranged between 11 and 16 µg TEQ per year.

A sample of the landfill gas was collected for dioxin and furan analysis and very low levels of PCDDs/PCDFs were detected. It is believed that these levels originated in the XAD-2 resin.

An analysis for hexachlorobenzene and octachlorostyrene was also conducted for the train samples and the landfill gas. Neither hexachlorobenzene nor octachlorostyrene was detected in either the landfill gas sample or the train samples.

Table 4 – Concentrations and Emission Rates of Dioxins and Furans

Congener	CONCENTRATION (pg TEQ/m^3 @ 11% O_2)			EMISSION RATE (µg TEQ / year)		
	SVOC 1	SVOC 2	SVOC 3	SVOC 1	SVOC 2	SVOC 3
2378-T4CDD	0.00	0.00	0.00	0	0	0
12378-P5CDD	0.00	0.00	0.00	0	0	0
123478-H6CDD	0.00	0.00	0.00	0	0	0
123678-H6CDD	0.00	0.00	0.00	0	0	0
123789-H6CDD	0.00	0.00	0.00	0	0	0
1234678-H7CDD	0.00	0.00	0.00	0	0	0
OCDD	0.00	0.00	0.00	0	0	0
2378-T4CDF	0.26	0.15	0.12	12	7	6
12378-P5CDF	0.01	0.00	0.00	0	0	0
23478-P5CDF	0.00	0.07	0.09	0	3	5
123478-H6CDF	0.03	0.01	0.02	2	0	1
123678-H6CDF	0.02	0.00	0.00	1	0	0
234678-H6CDF	0.00	0.00	0.00	0	0	0
123789-H6CDF	0.00	0.00	0.00	0	0	0
1234678-H7CDF	0.00	0.00	0.00	0	0	0
1234789-H7CDF	0.00	0.00	0.00	0	0	0
OCDF	0.00	0.00	0.00	0	0	0
TOTAL	0.33	0.23	0.24	15.8	11.0	11.6

Concentrations are expressed on a dry basis referenced to 25°C and 101.325 kPa and corrected to 11% O_2.
"0" denotes not detected.
Totals may not add due to rounding.

6.5 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbon emissions are summarized in Tables 5 and 6. As mentioned previously, the front and back halves of the sampling train were combined into one extract. Train catches were corrected for the PAHs detected in the blank train. Six compounds were detected in the blank but many of these were at or slightly above the detection limit. PAH analytical results of the loaded trains, blank train, proofing and control samples are presented in Appendix II.

The concentrations of PAHs at the engine exhaust and the landfill gas are detailed in Table 5. The total for each train ranged from 1.10 to 1.34 ug/m^3. These concentrations are not corrected to 11% oxygen. The lighter half of the target PAH compounds accounted for the majority of the PAHs in all three runs. Benzo(g,h,i)perylene was the heaviest compound detected in the list of PAHs. Phenanthrene was the most abundant compound (26-35%) for each of the three SVOC runs. Other significant compounds in the train included acenapthene, fluorene and pyrene. These four compounds accounted for 60 to 65% of the total reported PAHs. The PAH concentration in the engine exhaust was very stable between the three SVOC runs.

Polycyclic aromatic hydrocarbons were also determined on the landfill gas prior to combustion. PAHs were detected in the raw landfill gas. The level of PAHs in the raw LFG was 11.59 ug/m^3 or 154 mg/day entering into No. 2 Engine. Acenapthene accounted for the majority (70%) of the detected PAHs in the landfill gas. Detected PAHs were found only in the lighter half of the target compounds.

Mass emission rates for each PAH from the engine exhaust and the landfill gas are given in Table 6. Total rates ranged from 130 to 153 mg/day. Less PAHs were measured in the exhaust of the reciprocating engine than the inlet. PAH destruction across the engine was 11%. PAH emissions in terms of power output and methane input for each SVOC run are summarized below.

Summary of PAH Emissions

Run	Output (kW)	Methane in (m^3/hr)	PAHs	
			(µg/kW-hr)	(µg/m^3 CH_4)
SVOC 1	957	339	6.65	18.8
SVOC 2	962	344	5.63	15.7
SVOC 3	962	346	5.61	15.6

Table 5 - Concentration of PAHs (ng/m^3)

Compound	Landfill Gas	No. 2 Engine Exhaust		
		SVOC 1	SVOC 2	SVOC 3
Acenapthylene	158	94	77	102
Acenapthene	8124	107	103	119
Fluorene	2776	146	132	140
2-Methyl-Fluorene	173	70	60	80
Phenanthrene	311	468	301	287
Anthracene	47	39	38	38
Fluoranthene	0	95	93	76
Pyrene	2	151	158	120
Benzo(a)Fluorene	0	12	11	11
Benzo(b)Fluorene	0	8	7	6
1-Methyl-Pyrene	0	12	13	11
Benzo(g,h,i)Fluoranthene	0	20	21	17
Benzo(a)Anthracene	0	13	14	12
Chrysene	0	36	39	40
Triphenylene	0	13		
7-Methyl-Benzo(a)Anthracene	0	0	0	0
Benzo(b)Fluoranthene	0	16	13	13
Benzo(k)Fluoranthene	0		3	
Benzo(e)Pyrene	0	16	15	13
Benzo(a)Pyrene	0	0	2	0
Perylene	0	0	0	0
3-Methyl-Cholanthrene	0	0	0	0
Indeno(1,2,3-cd)Pyrene	0	8	8	6
Dibenzo(a,h)Anthracene	0	0	0	0
Benzo(b)Chrysene	0	0	0	0
Benzo(g,h,i)Perylene	0	16	18	12
Anthanthrene	0	0	0	0
TOTAL	**11590**	***1342***	***1127***	***1104***

Values expressed on a dry basis referenced to 25°C and 101.325 kPa.
"0" denotes not detectable.
Totals may not add due to rounding.

Table 6 - Mass Emission Rates of PAHs (mg/day)

Compound	Landfill Gas	No. 2 Engine Exhaust		
		SVOC 1	SVOC 2	SVOC 3
Acenapthylene	2.1	10.7	8.9	12.0
Acenapthene	108.3	12.2	11.9	14.0
Fluorene	37.0	16.6	15.2	16.5
2-Methyl-Fluorene	2.3	8.0	6.9	9.4
Phenanthrene	4.1	53.2	34.7	33.7
Anthracene	0.6	4.4	4.4	4.4
Fluoranthene	0.0	10.9	10.8	8.9
Pyrene	0.0	17.2	18.2	14.1
Benzo(a)Fluorene	0.0	1.4	1.3	1.3
Benzo(b)Fluorene	0.0	0.9	0.8	0.7
1-Methyl-Pyrene	0.0	1.4	1.5	1.3
Benzo(g,h,i)Fluoranthene	0.0	2.3	2.4	2.0
Benzo(a)Anthracene	0.0	1.5	1.6	1.4
Chrysene	0.0	4.1	4.5	4.6
Triphenylene	0.0	1.4		
7-Methyl-Benzo(a)Anthracene	0.0	0.0	0.0	0.0
Benzo(b)Fluoranthene	0.0	1.9	1.5	1.5
Benzo(k)Fluoranthene	0.0		0.3	
Benzo(e)Pyrene	0.0	1.8	1.8	1.5
Benzo(a)Pyrene	0.0	0.0	0.3	0.0
Perylene	0.0	0.0	0.0	0.0
3-Methyl-Cholanthrene	0.0	0.0	0.0	0.0
Indeno(1,2,3-cd)Pyrene	0.0	0.9	1.0	0.7
Dibenzo(a,h)Anthracene	0.0	0.0	0.0	0.0
Benzo(b)Chrysene	0.0	0.0	0.0	0.0
Benzo(g,h,i)Perylene	0.0	1.8	2.1	1.4
Anthanthrene	0.0	0.0	0.0	0.0
TOTAL	***154.5***	***152.7***	***130.0***	***129.5***

"0" denotes not detectable,
Totals may not add due to rounding

6.6 Volatile Organic Compounds (VOCs)

The full VOC target list contains 145 compounds, however, this list was pared down as many of the species are of lesser interest. For this exercise, the reported VOCs include ODS (ozone depleting substances) such as Freons, BTEX (benzene, ethylbenzene, toluene and xylenes) and halogenated hydrocarbons. Halogenated hydrocarbons include vinyl chloride, dichloromethane, tri and tetrachloroethene, chlorobenzene and dichlorobenzene. Where applicable, compounds have been listed as CEPA-toxic. Naphthalene, a PAH compound was also included since it is not reliably determined using the modified Method 5 type train. The full list of VOC concentrations and emission rates for the inlet and outlet locations is given in Appendix II.

Samples for VOCs were collected from the processed landfill gas and the engine exhaust. Two samples were collected at the outlet for each SVOC run and two samples were collected at the inlet. In total, 8 canister samples were submitted for VOC analysis. The determination of the VOC destruction efficiency (DE) was based on an average of the inlet and outlet canisters.

As illustrated in Table 7, the total VOC variation at the inlet to the No. 2 Engine was minimal, with some variation in the VOC outlet levels. Two CEPA-toxic substances, carbon tetrachloride and 1,2-dichloroethane, were not detected in the engine exhaust however the latter compound was present in the landfill gas.

Table 7 - VOC Concentrations at the Inlet and Outlet ($\mu g/m^3$)

Location	SVOC 1		SVOC 2		SVOC 3	
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Inlet	532650	537810				
Outlet	3987	3938	3656	3745	4776	4864

The destruction efficiencies of VOCs (based on mass emissions) for the selected compounds described above are detailed in Table 8. Destruction efficiencies (DE) were calculated using the following equation:

$$DE = \frac{VOC_{inlet} - VOC_{outlet}}{VOC_{inlet}} \times 100$$

Table 8 - Destruction Efficiencies of Selected VOCs (%)

Compound	Type	Inlet VOCs (µg/min)	Outlet VOCs (µg/min)	Destruction Efficiency (%)
Ozone Depleting Substances				
Freon 22	ODS	13676	584	95.73
Freon 12	ODS	27305	1750	93.59
Freon 114	ODS	3794	251	93.39
Freon 11	ODS	4496	258	94.27
Freon 113	ODS	1686	70	95.86
	Total ODS	50958	2912	94.29
BTEX				
Benzene	CEPA-toxic	15877	7773	51.05
Toluene		1385784	41216	97.03
Ethylbenzene		323309	13737	95.75
m/p-Xylene		806095	29040	96.40
o-Xylene		214603	8412	96.08
	Total BTEX	2745668	100178	96.35
Halogenated Hydrocarbons				
Chloromethane		2435	663	72.78
Vinyl chloride	CEPA-toxic	58592	2762	95.29
1,3-Butadiene		0	1000	Formed
Bromomethane		0	991	Formed
Chloroethane		4543	197	95.66
1,1-Dichloroethene		1124	160	85.75
Dichloromethane	CEPA-toxic	30022	1148	96.18
t-1,2-Dichloroethene		2435	327	86.56
1,1-Dichloroethane		18313	501	97.26
c-1,2-Dichloroethene		78825	3117	96.05
1,1,1-Trichloroethane	CEPA-toxic	2716	90	96.70
Trichloroethene		26603	1429	94.63
Tetrachloroethene	CEPA-toxic	48756	3332	93.17
Chlorobenzene	CEPA-toxic	0	192	Formed
1,1,2,2-Tetrachloroethane		0	239	Formed
1,4-Dichlorobenzene		21076	1519	92.79
1,2-Dichlorobenzene		0	49	Formed
1,2,4-Trichlorobenzene		375	25	93.28
Naphthalene	PAH	11287	1230	89.10
	Total halogenated	307104	18971	93.82
	Total (all of the above)	3103729	122062	96.07
	TOTAL (all VOCs)	5013609	333695	93.34

"0" denotes not detectable.

Totals may not add due to rounding, significant digits ignored.

Overall, the average destruction efficiency for all of the VOCs was 93.3%. Five of the selected VOCs were not detected in the inlet gas but were formed in the engine. Excluding the five compounds just mentioned, destruction efficiencies ranged from 51% to 97% for the selected VOCs.

The selected VOCs reported in Table 8 represent 37% of the total VOCs reported at the outlet (62% at the inlet). BTEX, of which toluene was the largest component, represented 82% of the selected VOCs at the outlet (88% at the inlet). Of the non-selected VOCs, propene was the largest component in the exhaust accounting for 20% of the total VOCs. Propene was formed in the engine. At the inlet, four of the heavier compounds, nonane, decane, p-cymene and undecane were the largest non-selected VOCs accounting for 13% of the total.

The following table shows the individual destruction efficiencies for the three groups of selected VOCs and the emissions based on an average power production and methane input to the No. 2 Engine.

Summary of Destruction Efficiencies and VOC Emissions

Substance	Output (kW)	Methane in (m^3/hr)	DE (%)	VOC Emissions*	
				(mg/kW-hr)	(mg/m^3 CH_4)
Ozone Depleting Substances	960	343	94.29	0.18	0.51
Benzene, Toluene, Ethylbenzene, Xylenes			96.35	6.26	17.52
Halogenated Hydrocarbons**			93.82	1.19	3.32
Total all VOCs (145 compounds)			93.34	20.85	58.35

**Average of six canisters.*

*** excluding ozone depleting substances*

7. SUMMARY

The target compounds identified in the landfill gas and engine exhaust are summarized in the following table. No modifications were made to the engine controls during the testing program. Particulate and acid gases were not determined in the landfill gas to the engine. The emissions of the various components detected in the exhaust from the engine are expressed in terms of power produced and methane input to the reciprocating engine.

Detection and Quantification of Target Compounds

LANDFILL GAS	
Component	**Detected?**
CO	Yes
SO_2	No
$NO/NO_2/NO_x$	Yes
PCDDs/PCDFs	No
PAHs	Yes
HCB	No
OCS	No
VOCs	Yes
Particulate	Not Done
HCl	Not Done
HF	Not Done

Waukesha Model 7042GLD

No. 2 Engine

ENGINE EXHAUST			
Component	**Detected ?**	**(g/kW-hr)**	**(g/m^3 CH_4)**
CO	Yes	4.55	12.76
SO_2	No		
NO_x*	Yes	1.18	3.31
PCDDs/PCDFs	Yes		
PAHs	Yes	$5.96 \cdot 10^{-6}$	$16.7 \cdot 10^{-6}$
HCB	No		
OCS	No		
VOCs	Yes	0.0209	0.0584
Particulate	Yes	0.0142	0.0399
HCl	Yes	0.0157	0.0440
HF	Yes	0.0028	0.0077

**as NO_2*

Dioxin and furan emissions were 0.27 pg TEQ/m^3 corrected to 11% oxygen. HCB and OCS were not detected and the average PAH concentration was 1.19 $\mu g/m^3$. The average destruction efficiency for the 145 VOC compounds was 93.3% over the three SVOC runs. The destruction efficiencies ranged from 93.8% to 96.4% for the three selected groups of VOC compounds.

APPENDIX I

- **Particulate Traverse Data**
- **SVOC Traverse Data**
- **ECOM KL Readings**
- **Process Data**

BFI, LACHENAIE, QUEBEC
PARTICULATE RUN # 1
DATE: OCT. 1, 2001 TIME: 13:00 - 19:10

LIST OF CONSTANTS

Pitot tube factor	0.776	cv		
Meter calibration factor	1.017	y		
Nozzle diameter	0.188	in	4.76	mm
Barometric pressure	29.85	in Hg	758.19	mm Hg
Stack Diameter	1.042	ft		
Stack area	0.852	ft2	0.079	m2
Static press.	-0.95	in H2O	-21.59	mm H2O

STACK GAS CHARACTERISTICS

Average velocity			153.92	ft/sec	46.91	m/sec
Average temperature			716.89	Deg F	380.49	Deg C
Volumetric flowrate			3156.9	ft3/min	89.41	m3/min
Molecular weight	Md	30.04	28.64	Ms		
Flue gas composition		dry	wet			
	O2	9.90	8.74	%		
	CO2	10.30	9.10	%		
	SO2	0.00	0.00	%		
	N2	79.80	70.46	%		
	H2O		11.70	%		

SAMPLING DATA

Total volume sampled	249.460	ft3	7.065	m3
Total sampling time	360.00	min		
Isokineticity (ave.)	97.64	%		
Front-half catch (probe)	0.01160	gm		
Front-half catch (filter)	0.00630	gm		
Back-half catch (imp.)	0.00000	gm		
Water catch in impingers	688.53	gm		

EMISSION DATA

			VALUES CORRECTED TO			
			50%EA.	11%O2	12%CO2	3%O2
Particulate concentration	2.53E-03	mg/m3	3.19E-03	2.28E-03	2.95E-03	4.12E-03
Particulate emission rate	1.36E-05	kg/hr				
	3.26E-04	kg/day				
Gaseous concentration	0.00E+00	mg/m3	0.00E+00	0.00E+00	0.00E+00	
Gaseous emission rate	0.00E+00	gm/hr				
	0.00E+00	kg/day				
Excess Air (percent)	88.7	%				
AIR INFILTRATION (%)		%				
FUEL FACTOR	1.07	Fo				

* Gas Volumes are reported on dry basis at 25 Deg C and 101.3 kPa

BFI, LACHENAIE, QUEBEC
PARTICULATE RUN # 1
DATE: OCT. 1, 2001 TIME: 13:00 - 19:10

TRAVERSE POINT (NO.)	SAMPLING TIME (min)	STACK GAS TEMP. (oF)	VELOCITY PRESSURE (DP) (in H2O)	ORIFICE PRESSURE (DH) (in H2O)	STACK GAS VELOCITY (ft/sec)	INITIAL METER VOLUME (ft3)	FINAL METER VOLUME (ft3)	METER VOLUME SAMPLED (ft3)	INLET METER TEMP. (oF)	OUTLET METER TEMP. (oF)	ISOKIN-ETICITY %
West 1	5.00	720	4.100	1.840	157.70	203.125	206.740	3.615	81	81	100.79
1	5.00	720	4.150	1.860	158.66	206.740	210.280	3.540	83	81	97.92
1	5.00	719	4.200	1.900	159.54	210.280	213.860	3.580	86	81	98.13
2	5.00	719	4.220	1.920	159.92	213.860	217.460	3.600	89	82	98.09
2	5.00	718	4.350	1.980	162.30	217.460	221.110	3.650	91	82	97.75
2	5.00	719	4.300	1.960	161.43	221.110	224.740	3.630	92	83	97.64
3	5.00	720	4.150	1.900	158.66	224.740	228.330	3.590	93	84	98.14
3	5.00	720	4.100	1.880	157.70	228.330	231.890	3.560	94	85	97.73
3	5.00	721	4.100	1.880	157.77	231.890	235.400	3.510	94	85	96.40
4	5.00	720	4.050	1.860	156.74	235.400	238.850	3.450	95	86	95.11
4	5.00	721	4.100	1.880	157.77	238.850	242.480	3.630	95	87	99.42
4	5.00	722	4.100	1.880	157.83	242.480	246.010	3.530	96	87	96.63
5	5.00	725	4.300	1.970	161.84	246.010	249.600	3.590	97	88	95.93
5	5.00	734	4.300	1.960	162.46	249.600	253.210	3.610	97	88	96.83
5	5.00	734	4.300	1.960	162.46	253.210	256.750	3.540	98	89	94.78
6	5.00	736	3.600	1.640	148.77	256.750	260.090	3.340	98	89	97.74
6	5.00	736	3.550	1.620	147.73	260.090	263.385	3.295	98	89	97.10
6	5.00	735	3.600	1.640	148.71	263.385	266.700	3.315	98	90	96.88
7	5.00	735	3.550	1.620	147.67	266.700	269.990	3.290	98	90	96.82
7	5.00	735	3.500	1.590	146.63	269.990	273.220	3.230	98	90	95.72
7	5.00	735	3.550	1.620	147.67	273.220	276.475	3.255	98	90	95.79
8	5.00	734	3.500	1.600	146.57	276.475	279.725	3.250	98	90	96.28
8	5.00	733	3.500	1.600	146.50	279.725	282.980	3.255	98	91	96.30
8	5.00	734	3.550	1.620	147.61	282.980	286.230	3.250	98	91	95.52
9	5.00	730	3.500	1.600	146.32	286.230	289.480	3.250	98	91	96.03
9	5.00	731	3.500	1.600	146.38	289.480	292.710	3.230	98	91	95.48
9	5.00	731	3.500	1.600	146.38	292.710	295.960	3.250	98	91	96.07
10	5.00	731	3.550	1.620	147.42	295.960	299.420	3.460	98	91	101.56
10	5.00	735	4.850	2.210	172.60	299.420	303.260	3.840	98	91	96.73
10	5.00	735	4.850	2.210	172.60	303.260	307.100	3.840	99	91	96.65
11	5.00	734	4.900	2.240	173.42	307.100	310.970	3.870	99	92	96.78
11	5.00	734	4.850	2.210	172.53	310.970	314.810	3.840	99	92	96.52
11	5.00	733	4.850	2.220	172.46	314.810	318.660	3.850	99	92	96.73
12	5.00	735	4.750	2.170	170.82	318.660	322.510	3.850	100	92	97.73
12	5.00	735	4.700	2.150	169.91	322.510	326.250	3.740	100	92	95.43
12	5.00	734	4.700	2.150	169.84	326.250	330.015	3.765	100	92	96.03
South 1	5.00	647	3.250	1.580	135.99	330.015	333.520	3.505	93	92	104.03
1	5.00	639	3.250	1.600	135.50	333.520	336.890	3.370	94	90	99.76
1	5.00	650	3.250	1.600	136.18	336.890	340.135	3.245	95	90	96.45
2	5.00	646	3.250	1.590	135.93	340.135	343.380	3.245	96	90	96.18
2	5.00	650	3.250	1.590	136.18	343.380	346.635	3.255	97	91	96.48
2	5.00	667	3.100	1.500	134.01	346.635	349.780	3.145	98	91	96.07
3	5.00	678	2.450	1.170	119.72	349.780	352.680	2.900	99	91	99.96
3	5.00	686	2.500	1.190	121.36	352.680	355.515	2.835	100	92	96.91
3	5.00	685	2.500	1.190	121.30	355.515	358.370	2.855	100	92	97.55
4	5.00	688	2.500	1.190	121.46	358.370	361.220	2.850	100	92	97.50
4	5.00	686	2.550	1.220	122.56	361.220	364.130	2.910	100	93	98.41
4	5.00	687	2.500	1.180	121.41	364.130	367.040	2.910	100	93	99.42
5	5.00	684	2.550	1.200	122.46	367.040	369.880	2.840	100	93	95.95
5	5.00	679	2.500	1.190	120.98	369.880	372.600	2.720	101	94	92.44
5	5.00	685	2.500	1.200	121.30	372.600	375.740	3.140	101	94	107.00
6	5.00	686	2.450	1.170	120.14	375.740	378.450	2.710	101	94	93.32
6	5.00	728	1.950	0.900	109.12	378.450	380.980	2.530	101	94	99.36
6	5.00	730	1.950	0.900	109.22	380.980	384.290	3.310	101	94	130.10
7	5.00	732	4.350	1.990	163.26	384.290	387.950	3.660	101	94	96.66
7	5.00	733	4.350	2.000	163.33	387.950	391.590	3.640	102	94	96.09
7	5.00	733	4.350	2.000	163.33	391.590	395.255	3.665	102	95	96.66
8	5.00	733	4.300	1.980	162.39	395.255	398.885	3.630	103	95	96.20
8	5.00	732	5.150	2.380	177.64	398.885	402.860	3.975	104	95	96.23
8	5.00	732	5.200	2.400	178.50	402.860	406.910	4.050	104	95	97.57
9	5.00	732	5.200	2.400	178.50	406.910	410.970	4.060	105	96	97.64
9	5.00	732	5.200	2.400	178.50	410.970	415.020	4.050	105	96	97.40
9	5.00	731	5.200	2.410	178.42	415.020	419.110	4.090	105	96	98.32
10	5.00	731	5.200	2.410	178.42	419.110	423.190	4.080	106	96	97.99
10	5.00	731	5.300	2.460	180.13	423.190	427.320	4.130	106	96	98.27
10	5.00	731	5.300	2.460	180.13	427.320	431.450	4.130	106	96	98.27
11	5.00	732	5.250	2.230	179.36	431.450	435.565	4.115	105	96	98.45
11	5.00	732	5.250	2.430	179.36	435.565	439.670	4.105	105	96	98.26
11	5.00	732	5.250	2.430	179.36	439.670	443.770	4.100	105	96	98.14
12	5.00	731	5.250	2.430	179.28	443.770	447.870	4.100	105	96	98.10
12	5.00	731	5.200	2.410	178.42	447.870	451.930	4.060	105	96	97.60
12	5.00	731	5.150	2.380	177.56	451.930	456.003	4.073	105	96	98.38
AVE.		716.9		1.832	153.92				98.68	91.07	97.84

LACHENAIE LANDFILL SITE, ENGINE TESTING
SVOC RUN # 1
DATE: Oct. 2 / 2001 TIME: 10:13 - 14:24

LIST OF CONSTANTS

Pitot tube factor			0.776	cv		
Meter calibration factor			1.017	y		
Nozzle diameter			0.188	in	4.76	mm
Barometric pressure			29.83	in Hg	757.68	mm Hg
Stack area			0.785	ft2	0.073	m2
Static press.			-0.45	in H2O	-11.43	mm H2O

STACK GAS CHARACTERISTICS

Average velocity			148.86	ft/sec	45.37	m/sec
Average temperature			721.52	Deg F	383.07	Deg C
Volumetric flowrate			2790.7	ft3/min	79.03	m3/min
Molecular weight	Md	30.04	28.59	Ms		
Flue gas composition		dry	wet			
	O2	9.50	8.35	%		
	CO2	10.40	9.14	%		
	SO2	0.00	0.00	%		
	N2	80.10	70.40	%		
	H2O		12.11	%		

SAMPLING DATA

Total volume sampled			157.525	ft3	4.461	m3
Total sampling time			240.00	min		
Isokineticity (ave.)			96.51	%		
Front-half catch (probe)			0.00000	gm		
Front-half catch (filter)			0.00000	gm		
Back-half catch (imp.)			0.00000	gm		
Water catch in impingers			452.14	gm		

EMISSION DATA

				VALUES CORRECTED TO			
				50%EA	11%O2	12%CO2	3%O2
Particulate concentration			0.000	mg/m3	0.0	0.0	0.0	0.0
Particulate emission rate			0.000	kg/hr				
			0.000	kg/day				
Gaseous concentration			0.00E+00	mg/m3	0.000	0.000	0.000	
Gaseous emission rate			0.00E+00	gm/hr				
			0.000	kg/day				
Excess Air (percent)			81.6	%				
AIR INFILTRATION (%)				%				
FUEL FACTOR			1.10	Fo				

* Gas Volumes are reported on dry basis at 25 Deg C and 101.3 kPa

LACHENAIE LANDFILL SITE, ENGINE TESTING

SVOC RUN # 2

DATE: Oct. 3 / 2001 TIME: 9:38 - 13:46

PORT	TRAVERSE POINT (NO.)	SAMPLING TIME (min)	STACK GAS TEMP. (oF)	VELOCITY PRESSURE (DP) (in H2O)	ORIFICE PRESSURE (DH) (in H2O)	STACK GAS VELOCITY (ft/sec)	INITIAL METER VOLUME (ft3)	FINAL METER VOLUME (ft3)	METER VOLUME SAMPLED (ft3)	INLET METER TEMP (oF)	OUTLET METER TEMP (oF)	ISOKINETICITY %
SW	1	5.00	719	4.00	1.720	155.52	616.088	619.390	3.302	61	60	97.06
	1	5.00	720	4.05	1.750	156.56	619.390	622.755	3.365	65	61	97.87
	2	5.00	718	4.10	1.790	157.39	622.755	626.140	3.385	69	62	97.31
	2	5.00	715	4.05	1.790	156.23	626.140	629.550	3.410	75	64	97.77
	3	5.00	714	4.05	1.800	156.16	629.550	633.000	3.450	79	67	98.22
	3	5.00	713	4.10	1.840	157.05	633.000	636.480	3.480	82	69	97.98
	4	5.00	726	4.35	1.940	162.66	636.480	640.060	3.580	85	71	97.96
	4	5.00	726	4.40	1.970	163.60	640.060	643.660	3.600	88	73	97.50
	5	5.00	733	4.40	1.970	164.08	643.660	647.280	3.620	90	75	97.97
	5	5.00	734	4.40	1.970	164.15	647.280	650.890	3.610	91	77	97.47
	6	5.00	734	4.25	1.900	161.33	650.890	654.490	3.600	91	78	98.80
	6	5.00	733	4.20	1.890	160.31	654.490	658.010	3.520	94	80	96 69
	7	5.00	737	3.60	1.620	148.66	658.010	661.350	3.340	95	81	99 01
	7	5.00	735	3.65	1.650	149.57	661.350	664.690	3.340	95	82	98 17
	8	5.00	738	3.50	1.570	146.65	664.690	667.970	3.280	95	83	98.46
	8	5.00	737	3.50	1.570	146.58	667.970	671.230	3.260	95	83	97.82
	9	5.00	739	3.80	1.710	152.86	671.230	674.625	3.395	95	84	97.79
	9	5.00	737	3.80	1.710	152.74	674.625	678.030	3.405	96	85	97.82
	10	5.00	737	4.10	1.850	158.65	678.030	681.570	3.540	96	86	97.85
	10	5.00	734	4.10	1.860	158.45	681.570	685.130	3.560	97	86	98.20
	11	5.00	736	4.55	2.060	167.06	685.130	688.840	3.710	97	87	97.18
	11	5.00	735	4.50	2.040	166.07	688.840	692.550	3.710	98	87	97.59
	12	5.00	737	4.65	2.100	168.96	692.550	696.350	3.800	98	88	98.34
	12	5.00	737	4.55	2.060	167.13	696.350	700.106	3.756	98	88	98.25
SE	1	5.00	670	2.95	1.400	130.75	700.106	703.270	3.164	92	87	100.34
	1	5.00	674	2.90	1.370	129.87	703.270	706.340	3.070	93	88	98.19
	2	5.00	671	2.90	1.380	129.70	706.340	709.385	3.045	95	88	97.08
	2	5.00	677	2.90	1.380	130.04	709.385	712.435	3.050	96	89	97.32
	3	5.00	683	2.90	1.370	130.38	712.435	715.500	3.065	96	89	98.06
	3	5.00	684	2.90	1.380	130.44	715.500	718.540	3.040	99	90	96.95
	4	5.00	682	2.90	1.380	130.33	718.540	721.590	3.050	100	91	97.01
	4	5.00	731	1.10	0.500	81.97	721.590	723.670	2.080	101	91	109.37
	5	5.00	731	1.20	0.550	85.62	723.670	725.680	2.010	100	92	101.20
	5	5.00	732	1.30	0.590	89.15	725.680	727.780	2.100	99	92	101.73
	6	5.00	733	1.35	0.610	90.89	727.780	729.900	2.120	99	92	100.82
	6	5.00	733	1.35	0.610	90.89	729.900	732.025	2.125	99	92	101.06
	7	5.00	735	4.40	1.990	164.22	732.025	735.550	3.525	99	93	93.17
	7	5.00	735	4.30	1.950	162.34	735.550	739.235	3.685	99	92	98.60
	8	5.00	734	4.90	2.230	173.22	739.235	743.160	3.925	101	93	98.14
	8	5.00	734	4.90	2.240	173.22	743.160	747.135	3.975	103	93	99.22
	9	5.00	731	5.25	2.410	179.08	747.135	751.240	4.105	103	94	98.82
	9	5.00	731	5.15	2.370	177.36	751.240	755.310	4.070	105	94	98.74
	10	5.00	733	5.05	2.320	175.78	755.310	759.370	4.060	105	94	99.53
	10	5.00	733	5.05	2.320	175.78	759.370	763.410	4.040	106	94	98.96
	11	5.00	734	4.90	2.250	173.22	763.410	767 400	3.990	106	95	99.15
	11	5.00	733	4.90	2.260	173.15	767.400	771.400	4.000	106	95	99.36
	12	5.00	733	4.80	2.210	171.37	771.400	775.410	4.010	106	95	100.63
	12	5.00	733	4.90	2.260	173.15	775.410	779.338	3.928	106	96	97.49
	AVE.		723.4		1.739	150.42				94.56	84.71	98.54

LACHENAIE LANDFILL SITE, ENGINE TESTING
SVOC RUN # 2
DATE: Oct. 3 / 2001 TIME: 9:38 - 13:46

LIST OF CONSTANTS

Pitot tube factor	0.776	cv	
Meter calibration factor	1.017	y	
Nozzle diameter	0.188	in	4.76 mm
Barometric pressure	29.89	in Hg	759.21 mm Hg
Stack area	0.785	ft2	0.073 m2
Static press.	-0.70	in H2O	-17.78 mm H2O

STACK GAS CHARACTERISTICS

Average velocity			150.42	ft/sec	45.85 m/sec
Average temperature			723.42	Deg F	384.12 Deg C
Volumetric flowrate			2827.4	ft3/min	80.07 m3/min
Molecular weight	Md	30.08	28.65	Ms	
Flue gas composition		dry	wet		
	O2	9.70	8.55	%	
	CO2	10.60	9.34	%	
	SO2	0.00	0.00	%	
	N2	79.70	70.25	%	
	H2O		11.86	%	

SAMPLING DATA

Total volume sampled	162.758	ft3	4.609 m3
Total sampling time	240.00	min	
Isokineticity (ave.)	98.54	%	
Front-half catch (probe)	0.00000	gm	
Front-half catch (filter)	0.00000	gm	
Back-half catch (imp.)	0.00000	gm	
Water catch in impingers	456.23	gm	

EMISSION DATA

			VALUES CORRECTED TO			
			50%EA	11%O2	12%CO2	3%O2
Particulate concentration	0.000	mg/m3	0.0	0.0	0.0	0.0
Particulate emission rate	0.000	kg/hr				
	0.000	kg/day				
Gaseous concentration	0.00E+00	mg/m3	0.000	0.000	0.000	
Gaseous emission rate	0.00E+00	gm/hr				
	0.000	kg/day				
Excess Air (percent)	85.5	%				
AIR INFILTRATION (%)		%				
FUEL FACTOR	1.06	Fo				

* Gas Volumes are reported on dry basis at 25 Deg C and 101.3 kPa

LACHENAIE LANDFILL SITE, ENGINE TESTING
SVOC RUN # 3
DATE: Oct. 4 / 2001 TIME: 9:24 - 13:33

LIST OF CONSTANTS

Pitot tube factor			0.776	cv		
Meter calibration factor			1.017	y		
Nozzle diameter			0.188	in	4.76	mm
Barometric pressure			29.71	in Hg	754.63	mm Hg
Stack area			0.785	ft2	0.073	m2
Static press.			-0.62	in H2O	-15.75	mm H2O

STACK GAS CHARACTERISTICS

Average velocity			152.75	ft/sec	46.55	m/sec
Average temperature			711.90	Deg F	377.72	Deg C
Volumetric flowrate			2877.4	ft3/min	81.49	m3/min
Molecular weight	Md	30.03	28.59	Ms		
Flue gas composition		dry	wet			
	O2	9.60	8.45	%		
	CO2	10.30	9.06	%		
	SO2	0.00	0.00	%		
	N2	80.10	70.48	%		
	H2O		12.01	%		

SAMPLING DATA

Total volume sampled		166.773	ft3	4.723	m3
Total sampling time		240.00	min		
Isokineticity (ave.)		99.25	%		
Front-half catch (probe)		0.00000	gm		
Front-half catch (filter)		0.00000	gm		
Back-half catch (imp.)		0.00000	gm		
Water catch in impingers		474.34	gm		

EMISSION DATA

			VALUES CORRECTED TO			
			50%EA	11%O2	12%CO2	3%O2
Particulate concentration	0.000	mg/m3	0.0	0.0	0.0	0.0
Particulate emission rate	0.000	kg/hr				
	0.000	kg/day				
Gaseous concentration	0.00E+00	mg/m3	0.000	0.000	0.000	
Gaseous emission rate	0.00E+00	gm/hr				
	0.000	kg/day				
Excess Air (percent)	83.1	%				
AIR INFILTRATION (%)		%				
FUEL FACTOR	1.10	Fo				

* Gas Volumes are reported on dry basis at 25 Deg C and 101.3 kPa

LACHENAIE LANDFILL SITE, ENGINE TESTING
SVOC RUN # 3
DATE: Oct. 4 / 2001 TIME: 9:24 - 13:33

PORT	TRAVERSE POINT (NO.)	SAMPLING TIME (min)	STACK GAS TEMP. (oF)	VELOCITY PRESSURE (DP) (in H2O)	ORIFICE PRESSURE (DH) (in H2O)	STACK GAS VELOCITY (ft/sec)	INITIAL METER VOLUME (ft3)	FINAL METER VOLUME (ft3)	METER VOLUME SAMPLED (ft3)	INLET METER TEMP. (oF)	OUTLET METER TEMP. (oF)	ISOKIN-ETICITY %
SW	1	5.00	693	3.70	1.620	148.52	779.431	782.760	3.329	60	58	100.63
	1	5.00	693	3.70	1.630	148.52	782.760	786.020	3.260	64	59	98.07
	2	5.00	690	3.70	1.650	148.32	786.020	789.310	3.290	69	61	98.19
	2	5.00	691	3.70	1.660	148.39	789.310	792.625	3.315	74	63	98.33
	3	5.00	686	3.75	1.710	149.06	792.625	795.990	3.365	78	65	98.38
	3	5.00	708	3.95	1.780	154.45	795.990	799.430	3.440	82	68	98.30
	4	5.00	717	4.30	1.930	161.77	799.430	803.030	3.600	85	71	98.46
	4	5.00	720	4.25	1.920	161.03	803.030	806.655	3.625	88	73	99.39
	5	5.00	720	4.40	1.990	163.84	806.655	810.300	3.645	90	75	97.87
	5	5.00	721	4.40	2.000	163.91	810.300	813.975	3.675	92	77	98.36
	6	5.00	722	4.40	2.000	163.98	813.975	817.660	3.685	94	79	98.31
	6	5.00	728	4.50	2.040	166.26	817.660	821.380	3.720	96	81	98.03
	7	5.00	728	3.80	1.730	152.78	821.380	824.880	3.500	96	82	100.20
	7	5.00	730	3.80	1.730	152.91	824.880	828.370	3.490	97	83	99.82
	8	5.00	731	3.80	1.720	152.97	828.370	831.850	3.480	97	85	99.39
	8	5.00	730	3.80	1.730	152.91	831.850	835.330	3.480	98	86	99.17
	9	5.00	731	4.30	1.960	162.72	835.330	838.980	3.650	99	87	97.70
	9	5.00	730	4.25	1.940	161.71	838.980	842.650	3.670	99	88	98.68
	10	5.00	728	4.60	2.100	168.09	842.650	846.470	3.820	100	89	98.51
	10	5.00	728	4.60	2.110	168.09	846.470	850.290	3.820	101	90	98.33
	11	5.00	728	4.60	2.110	168.09	850.290	854.140	3.850	102	90	99.01
	11	5.00	727	4.55	2.090	167.11	854.140	858.000	3.860	103	92	99.50
	12	5.00	728	4.70	2.170	169.91	858.000	861.860	3.860	104	92	97.87
	12	5.00	729	4.70	2.160	169.98	861.860	865.768	3.908	104	93	99.04
SE	1	5.00	656	3.30	1.590	137.99	865.768	869.165	3.397	95	92	100.29
	1	5.00	658	3.30	1.600	138.12	869.165	872.510	3.345	97	92	98.67
	2	5.00	661	3.35	1.620	139.34	872.510	875.870	3.360	98	92	98.42
	2	5.00	662	3.30	1.590	138.36	875.870	879.210	3.340	99	93	98.43
	3	5.00	666	3.30	1.590	138.61	879.210	882.545	3.335	100	92	98.46
	3	5.00	661	3.30	1.600	138.30	882.545	885.880	3.335	101	93	98.07
	4	5.00	706	1.50	0.700	95.10	885.880	888.200	2.320	101	93	102.97
	4	5.00	709	1.45	0.670	93.62	888.200	890.455	2.255	100	93	102.01
	5	5.00	702	1.35	0.630	90.06	890.455	892.635	2.180	99	93	101.98
	5	5.00	709	1.30	0.600	88.64	892.635	894.770	2.135	98	93	102.17
	6	5.00	709	1.20	0.560	85.17	894.770	896.845	2.075	97	93	103.43
	6	5.00	722	1.20	0.550	85.64	896.845	898.890	2.045	97	92	102.59
	7	5.00	726	5.10	2.320	176.84	898.890	902.760	3.870	97	92	94.75
	7	5.00	729	5.10	2.320	177.07	902.760	906.800	4.040	98	92	98.95
	8	5.00	729	5.50	2.510	183.88	906.800	911.000	4.200	100	92	98.92
	8	5.00	729	5.35	2.450	181.36	911.000	915.180	4.180	101	92	99.72
	9	5.00	728	5.20	2.380	178.72	915.180	919.270	4.090	101	92	98.91
	9	5.00	725	5.20	2.390	178.49	919.270	923.380	4.110	101	92	99.27
	10	5.00	726	5.20	2.390	178.57	923.380	927.470	4.090	102	92	98.74
	10	5.00	723	5.30	2.440	180.05	927.470	931.610	4.140	102	92	98.89
	11	5.00	723	5.05	2.330	175.75	931.610	935.695	4.085	102	92	99.93
	11	5.00	724	5.05	2.330	175.83	935.695	939.770	4.075	102	92	99.73
	12	5.00	725	5.05	2.320	175.90	939.770	943.845	4.075	102	93	99.68
	12	5.00	726	5.00	2.300	175.10	943.845	947.882	4.037	102	92	99.37
	AVE.		711.9		1.818	152.75				95.08	85.48	99.25

Gaseous Emissions from Engine Two at the LaChenaie Power Generation Facility

CEM Run 1: Particulate Runs 1-3

Time	O_2	CO2	CO	NOx
min	%	%	ppm	ppm
30	10.2	9.8	720	-
60	9.5	10.6	773	-
90	9.6	10.5	776	-
120	9.5	10.6	776	-
150	9.6	10.6	770	-
180	9.5	10.6	774	-
210	13.3	7.8	520	-
240	9.5	10.6	782	-
270	9.6	10.5	784	-
300	9.6	10.6	767	-
330	9.6	10.6	760	-
360	9.6	10.5	742	-
Ave	9.9	10.3	745	-

CEM Run 2: Organic Run 1

Time	O_2	CO2	CO	NOx
min	%	%	ppm	ppm
30	9.6	10.1	773	-
60	9.5	10.4	791	-
90	9.5	10.5	793	-
120	9.4	10.7	806	-
150	9.5	10.4	812	149
180	9.4	10.5	810	146
210	9.5	10.3	789	134
240	9.6	10.3	783	128
Ave	9.5	10.4	795	139

CEM Run 3: Organic Run 2

Time	O_2	CO2	CO	NOx
min	%	%	ppm	ppm
30	9.8	10.6	784	108
60	9.7	11.0	772	115
90	9.6	10.7	790	115
120	9.6	10.7	782	114
150	9.6	11.1	783	120
180	9.7	10.3	764	107
210	9.6	10.3	767	107
240	9.6	10.3	781	111
Ave	9.7	10.6	778	112

CEM Run 4: Organic Run 3

Time	O_2	CO2	CO	NOx
min	%	%	ppm	ppm
30	9.6	10.5	772	121
60	9.6	10.4	763	125
90	9.6	10.3	764	125
120	9.6	10.3	774	125
150	9.5	10.4	773	131
180	9.6	10.3	788	131
210	9.6	10.3	769	124
240	9.6	10.1	765	128
Ave	9.6	10.3	771	126

bag sample over 30 minutes @ 1 l/min

BFI LACHENAIE LANDFILL ENGINE DATA

(Particulate Run)

DATE Y/M/D	TIME	GAS COMPOSITION			ENGINE #2			TOTAL OF ALL ENGINES			FLARES	TOTAL
		CH4 %	CO2 %	O2 %	LOAD KW	FUEL CF/M	HP	LOAD KW	FUEL CF/M	HP	SCFM	SCFM
01/10/01	1248	60.60	39.40	0.00	957	328	1365	3867	1364	6836		
	1333	61.60	38.40	0.00	959	332	1367	3855	1334	5495		
	1403	60.70	39.30	0.00	952	328	1358	3849	1326	5487		
	1433	60.30	39.70	0.00	959	330	1367	3864	1329	5508		
	1503	60.20	39.80	0.00	958	330	1366	3860	1330	5503	2993	4323
	1531	61.10	38.90	0.00	959	331	1367	3868	1336	5514	2980	4309
	1600	60.60	39.40	0.00	958	330	1365	3864	1332	5506		
	1625	60.70	39.30	0.00	958	331	1366	3859	1334	5502		
	1657	61.00	39.00	0.00	953	330	1359	3847	1331	5482		
	1730	60.80	39.20	0.00	954	328	1361	3855	1323	5496		
	1800	61.00	39.00	0.00	957	332	1364	3856	1337	5496		
	1827	60.70	39.30	0.00	958	330	1366	3857	1328	5501		
	1853	60.20	39.80	0.00	963	334	1373	3878	1344	5529		
	1910	60.70	39.30	0.00	956	331	1363	3868	1338	5515		
	Avg	60.73	39.27	0.00	957.21	330.36	1364.79	3860.50	1334.71	5597.86		

BFI LACHENAIE LANDFILL ENGINE DATA

(organic #1)

DATE Y/M/D	TIME	GAS COMPOSITION			ENGINE #2			TOTAL OF ALL ENGINES			FLARES	TOTAL
		CH4 %	CO2 %	O2 %	LOAD KW	FUEL CF/M	HP	LOAD KW	FUEL CF/M	HP	SCFM	SCFM
01/10/02	939	60.00	40.00	0.00	954	328	1361	3837	1320	5472	2093	3413
	1009	60.40	39.60	0.00	957	328	1364	3861	1322	5504	1690	3012
	1041	60.80	39.20	0.00	955	328	1362	3847	1321	5485	1664	2986
	1114	60.40	39.60	0.00	957	328	1364	3867	1324	5511	1673	2997
	1143	61.20	38.80	0.00	959	330	1367	3846	1325	5483	1593	2918
	1214	60.90	39.10	0.00	953	323	1359	3850	1304	5490	1481	2786
	1241	61.00	39.00	0.00	951	325	1356	3815	1306	5439	1537	2843
	1310	61.30	38.70	0.00	955	327	1362	3848	1318	5487	1578	2896
	1343	61.10	38.90	0.00	957	328	1364	3851	1321	5490	2920	4242
	1413	60.70	39.30	0.00	960	329	1368	3874	1326	5520	2883	4210
	1423	60.60	39.40	0.00	961	333	1370	3859	1336	5501	2898	4234
	1427	60.80	39.20	0.00	962	332	1372	3877	1337	5528	2878	4214
	Avg	60.77	39.23	0.00	957	328	1364	3853	1322	5493	2074	3396

BFI LACHENAIE LANDFILL ENGINE DATA

(Organic # 2)

DATE Y/M/D	TIME	GAS COMPOSITION			ENGINE #2			TOTAL OF ALL ENGINES			FLARES	TOTAL
		CH4 %	CO2 %	O2 %	LOAD KW	FUEL CF/M	HP	LOAD KW	FUEL CF/M	HP	SCFM	SCFM
01/10/03	901				957	330	1365	3835	1321	5468	2849	4170
	920				955	331	1362	3824	1325	5452	2968	4193
	940				960	330	1368	3857	1326	5499	2851	4176
	1000				966	329	1377	3876	1320	5527	2863	4182
	1014				965	332	1376	3884	1337	5536	2853	4190
	1030				966	329	1377	3885	1325	5537	2871	4196
	1045				963	332	1373	3860	1330	5501	2851	4181
	1100	61.90	38.10	0.00	964	328	1374	3881	1321	5532	2872	4194
	1114	61.70	38.30	0.00	959	333	1367	3834	1332	5467	2864	4197
	1133	61.80	38.20	0.00	959	333	1367	3833	1331	5464	2887	4218
	1146	61.30	38.70	0.00	960	331	1369	3866	1334	5512	2866	4199
	1200				955	328	1361	3849	1321	5486	2867	4188
	1214				955	333	1361	3820	1331	5444	2866	4196
	1230				970	336	1383	3872	1340	5519	2847	4186
	1244				968	335	1380	3868	1339	5514	2858	4198
	1300				965	337	1375	3826	1337	5453	2857	4194
	1314	60.60	39.40	0.00	965	333	1376	3864	1333	5508	2822	4155
	1330	60.50	39.50	0.00	959	331	1367	3865	1334	5509	2822	4156
	1344	60.60	39.40	0.00	954	328	1360	3853	1326	5493	2818	4145
	1400	60.30	39.70	0.00	974	336	1388	3905	1346	5566	3201	4547
	Avg	61.09	38.91	0.00	962	332	1371	3858	1330	5499	2878	4203

BFI LACHENAIE LANDFILL ENGINE DATA

(Organic # 3)

DATE Y/M/D	TIME	GAS COMPOSITION			ENGINE #2			TOTAL OF ALL ENGINES			FLARES SCFM	TOTAL SCFM
		CH4 %	CO2 %	O2 %	LOAD KW	FUEL CF/M	HP	LOAD KW	FUEL CF/M	HP		
01/10/04	834				958	332	1366	3827	1326	5454	2787	4113
	916	62.20	35.80	0.00	961	332	1370	3840	1327	5476	2827	4153
	925	62.80	37.20	0.00	957	330	1364	3827	1320	5457	2841	4162
	932	62.50	37.50	0.00	963	330	1372	3846	1317	5482	2867	4184
	946	62.40	37.60	0.00	962	331	1371	3840	1322	5472	2985	4307
	958	62.20	37.80	0.00	961	332	1370	3833	1326	5464	2852	4177
	1014	61.20	38.80	0.00	960	330	1368	3830	1318	5459	2851	4169
	1029	61.40	38.60	0.00	962	331	1371	3839	1322	5472	2854	4176
	1044	61.30	38.70	0.00	963	334	1373	3847	1333	5483	2837	4169
	1059	61.00	39.00	0.00	962	333	1371	3839	1330	5473	2871	4201
	1114	61.20	38.80	0.00	962	330	1371	3836	1315	5470	2955	4271
	1129	61.00	39.00	0.00	962	332	1372	3836	1324	5469	2924	4249
	1144	60.40	39.60	0.00	965	333	1375	3850	1329	5488	2936	4265
	1159	60.60	39.40	0.00	959	333	1367	3821	1327	5447	3015	4343
	1214	61.20	38.80	0.00	960	332	1368	3844	1329	5481	3003	4331
	1229	60.70	39.30	0.00	968	333	1380	3856	1328	5496	3055	4383
	1244	60.60	39.40	0.00	974	338	1389	3879	1344	5528	3017	4361
	1259	60.60	39.40	0.00	959	333	1367	3859	1338	5500	3021	4360
	1314	60.70	39.10	0.00	968	335	1380	3858	1333	5498	2995	4329
	1329				962	333	1371	3833	1327	5462	2975	4301
	1334	60.90	39.10	0.00	957	332	1365	3816	1323	5439	2931	4253
	Avg	61.31	38.57	0.00	962	332	1371	3841	1327	5475	2924	4250

APPENDIX II

- Ion Chromatography Report
- Summary of SVOC Analytical Procedure
- Dioxin, Furan, HCB and PAH Analytical Report
- SVOC Proofing Analysis
- VOC Analysis

MEMORANDUM - NOTE DE SERVICE

TO/A: **Date:** October 23rd, 2001

Ian D. Rigden
ERMD

From/De:

Maria Piechowski
Inorganic Section, AAQD

Subject/Objet: Particulate Emission Samples from Engines burning Landfill Gas

Please find attached chloride and Fluoride results for 2 water samples. The analyses were performed using Ion Chromatography – Method: 6.3/4.0/M (System 2).

Please do not hesitate to contact me further, if required.

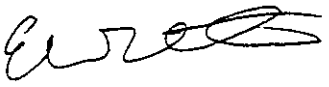
M. Piechowski

Maria Piechowski

cc: Dr. Ewa Dabek
Dominic Cianciarelli

Inorganic Section - AAQD
TEST REPORT RESULTS

CLIENT:	Source Testing Unit - ERMD	**Received:**	10-Oct-01
PROJECT:	Highland Energy	**Analyzed:**	11-Oct-01
SAMPLES:	Particulate Emission from Engines burning Landfill Gas	**Reported:**	23-Oct-01
METHOD:	6.3/4.0/M - System 2		
Numbers of samples:	2		
Analyst:	M.Piechowski		
Approved:	Dr. E.Dabek		



	Concentration, [mg/L]		Amount, [mg/sample]	
Sample Name	**Fluoride**	**Chloride**	**Fluoride**	**Chloride**
110002	4.02	23.44	3.29	19.22
110003	0.00	0.00	0.00	0.00
DL	0.002	0.025		
QL	0.007	0.085		

Note: 0.000 means < QL

Volume of the sample #110002 - 820 mL

SUMMARY OF SVOC ANALYTICAL PROCEDURE

Upon receipt in the laboratory the samples are inspected to ensure integrity and proper labelling. The samples are then entered into the laboratory information management system (LIMS) where they are assigned a laboratory code. The code is then entered onto each container which are then stored in a fridge at 4°C until sample processing proceeds.

Typically the train samples are divided into the front-half (probe rinse, filter, and front-half filter holder rinse) and back-half sections (back-half filter holder rinse, XAD, condensate trap, glycol impinger and back-half glassware rinses). The solvent fractions are dried by passage through sodium sulphate and reduced in volume by rotary evaporation. The solids (filter and XAD) are air dried prior to a 20 hour soxhlet extraction using toluene. Prior to extraction, each sample is spiked with a solution containing a known amount of Carbon-13 labelled dioxin/furans and hexachlorobenzene as well as deuterated PAH. These are used to assess losses incurred during the extraction and sample cleanup procedures. Analytical results for dioxin/furan and hexachlorobenzene are corrected for the recovery of these surrogates.

After extraction, the solvent extracts of the solids are reduced in volume and combined with the train rinses prior to cleanup. The samples are split into two equal fractions. One is used for PAH cleanup and analysis while the other is used for dioxin/furan and hexachlorobenzene cleanup and analysis.

The PAH cleanup involves passing the sample extract through an activated silica column. Co-extracted compounds which may cause interference during analysis are eluted out of the column while the PAH are retained on the column. A more polar solvent is then applied to the column to elute the PAHs. The cleaned up sample extract is concentrated to 500 uL and an internal standard is added to monitor instrumental performance and is used to correct for any variations in injection and sample volume. The sample is analyzed using low resolution mass spectroscopy. Calibration standards containing a various known amounts of the analytes are injected into the instrument before, during and after the samples are injected. These standards are used to determine the concentrations of the analytes in the sample. The accuracy of the standards are periodically assessed using standard reference materials.

The dioxin/furan and hexachlorobenzene cleanup is more rigorous since the concentration of the dioxin/furans are much lower than other compounds which may be present in the extract. These co-extractants could interfere with the final analysis. Initially the sample extract is passed through a multibed silica column containing layers of acid, base, and silver nitrate. Some of the co-extractants are retained on the column, and others may be reduced or oxidized. Sulphur containg compounds are removed by the silver nitrate. The extract is then passed through an alumina column to separate out the dioxin/furans from other compounds such as PCBs and hexachlorobenzene. The fraction containing hexachlorobenzene is reduced to 500 uL and an internal standard is added to monitor instrumental performance and is used to correct for any variations in injection and sample volume. The sample is analyzed using low resolution mass spectroscopy. The fraction containing dioxin/furans is reduced to 20 uL and an internal standard is added to monitor instrumental performance and is used to correct for any variations in injection and sample volume. The sample is analyzed using high resolution mass spectroscopy.

As a part of quality assurance and quality control, a method blank, containing none of the analytes, is usually processed along with the samples to assess cross contamination. A control sample containing a known amount of analytes may also be processed along with the samples to check extraction, cleanup and analytical efficiency. The division participates in interlaboratory studies the results of which are used to compare results from several different laboratories for various analytes from a variety of matrices. The division is accredited by CAEAL for the analysis of PAH and dioxin/furan.

Environmental Technology Center / Centre de Technologie Environnementale

Analysis & Air Quality Division
*ETC, **Environment Canada***
3439 River Road, Ottawa, Ontario K1A 0H3
Tel.: (613) 990-8564 / Fax: (613) 990-8568
poole.gary@etc.ec.gc.ca

November 19, 2001

Dominique Cianciarelli
ERMD

Re: Dioxin, PAH, HCB and OCS Results from Lachenaie Landfill

Dominique:

Attached please find the PCDD/PCDF, PAH, HCB and OCS results for 4 combined train samples and an XAD raw gas sample. Also included are the results of a method blank that was processed along with the samples. Please note that the samples were extracted and prepared in-house however Wellington Laboratories did GC/HRMS analysis for the dioxins.

If you require further information, please let me know.

Sincerely,

Gary Poole
Supervisor, Organic Laboratories

cc C. Chiu, R.Turle, M. Tardif

14/11/2001

CLIENT:	ERMD	**PROJECT:**	Lachenaie PQ Landfill Engine	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	Train	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-206
SAMPLE ID:	AAQ01-O-00719	**SAMPLING DATE:**	02-Oct-01	**ANALYSIS DAT**	25/10/2001
FIELD ID:	BFlOrg#1OC-ETS1 to 6	**SAMPLE TYPE:**	Combined Train	**FILE:**	DFN14110195.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	[0.3]	[0.03]
123678-H6CDD	[1.2]	[0.12]
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	4.2	0.04
OCDD	18.6	0.02
2378-TCDF*	13.4	1.34
12378-P5CDF	1.4	0.07
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	2.3	0.23
123678-H6CDF	1.1	0.11
234678-H6CDF	[1.1]	[0.11]
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	[4.5]	[0.04]
1234789-H7CDF	[2.3]	[0.02]
OCDF	3.6	0.00
Total TEQ		1.81

Homologue	pg	DL	NP
Total TCDD	162.0	0.9	4
Total P5CDD	39.4	0.7	2
Total H6CDD	6.0	0.7	1
Total H7CDD	7.4	0.7	2
OCDD	18.6	0.7	1
Total PCDD	233.4		
Total TCDF	36.2	0.7	6
Total P5CDF	13.4	0.4	5
Total H6CDF	7.1	0.4	4
Total H7CDF	N.D.	0.5	0
OCDF	3.6	0.6	1
Total PCDF	60.3		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	104
13C12-TCDF	1.0	91
13C12-P5CDD	1.0	97
13C12-P5CDF	1.0	108
13C12-H6CDD	1.0	103
13C12-H6CDF	1.0	109
13C12-H7CDD	1.0	109
13C12-H7CDF	1.0	103
13C12-OCDD	2.0	98

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * *represents maximum possible amount as this isomer could coelute with other isomer(s).*
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY: Poole

14/11/2001

:	ERMD	**PROJECT:**	Lachenaie PQ Landfill Engine	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	Train	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-206
SAMPLE ID:	AAQ01-O-00720	**SAMPLING DATE:**	03-Oct-01	**ANALYSIS DAT**	25/10/2001
FIELD ID:	BFIOrg#2OC-ETS1 to 6	**SAMPLE TYPE:**	Combined Train	**FILE:**	DFN14110196.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	2.5	0.03
OCDD	10.5	0.01
2378-TCDF*	8.0	0.80
12378-P5CDF	[0.8]	[0.04]
23478-P5CDF*	1.3	0.65
123478-H6CDF*	1.1	0.11
123678-H6CDF	N.D.	N.C.
234678-H6CDF	[0.9]	[0.09]
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	[2.1]	[0.02]
1234789-H7CDF	N.D.	N.C.
OCDF	1.2	0.00
Total TEQ		1.60

Homologue	pg	DL	NP
Total TCDD	158.0	0.9	3
Total P5CDD	24.5	0.7	3
Total H6CDD	N.D.	0.7	0
Total H7CDD	3.9	0.7	2
OCDD	10.5	0.7	1
Total PCDD	196.9		
Total TCDF	27.1	0.6	8
Total P5CDF	2.1	0.4	2
Total H6CDF	1.1	0.4	1
Total H7CDF	N.D.	0.5	0
OCDF	1.2	0.5	1
Total PCDF	31.5		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	96
13C12-TCDF	1.0	100
13C12-P5CDD	1.0	100
13C12-P5CDF	1.0	100
13C12-H6CDD	1.0	100
13C12-H6CDF	1.0	100
13C12-H7CDD	1.0	101
13C12-H7CDF	1.0	100
13C12-OCDD	2.0	94

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

14/11/2001

____T:	ERMD	**PROJECT:**	Lachenaie PQ Landfill Engine	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	Train	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-206
SAMPLE ID:	AAQ01-O-00721	**SAMPLING DATE:**	04-Oct-01	**ANALYSIS DAT**	25/10/2001
FIELD ID:	BFIOrg#3OC-ETS1 to 6	**SAMPLE TYPE:**	Combined Train	**FILE:**	DFN14110197.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	[0.9]	[0.09]
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	3.4	0.03
OCDD	13.0	0.01
2378-TCDF*	6.5	0.65
12378-P5CDF	0.8	0.04
23478-P5CDF*	1.6	0.80
123478-H6CDF*	1.6	0.16
123678-H6CDF	[0.7]	[0.07]
234678-H6CDF	[0.7]	[0.07]
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	[3.4]	[0.03]
1234789-H7CDF	N.D.	N.C.
OCDF	7.0	0.01
Total TEQ		1.70

Homologue	pg	DL	NP
Total TCDD	148.0	0.9	3
Total P5CDD	29.9	0.7	2
Total H6CDD	*N.D.*	*0.7*	*0*
Total H7CDD	5.5	0.8	2
OCDD	13.0	0.7	1
Total PCDD	196.4		
Total TCDF	17.6	0.6	7
Total P5CDF	5.6	0.4	5
Total H6CDF	2.4	0.4	2
Total H7CDF	N.D.	0.5	1
OCDF	7.0	0.5	1
Total PCDF	32.6		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	91
13C12-TCDF	1.0	95
13C12-P5CDD	1.0	91
13C12-P5CDF	1.0	93
13C12-H6CDD	1.0	97
13C12-H6CDF	1.0	106
13C12-H7CDD	1.0	101
13C12-H7CDF	1.0	102
13C12-OCDD	2.0	97

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

14/11/2001

:	ERMD	**PROJECT:**	Lachenaie PQ Landfill Engine	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	Train	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-206
SAMPLE ID:	AAQ01-O-00722	**SAMPLING DATE:**	03-Oct-01	**ANALYSIS DAT**	25/10/2001
FIELD ID:	BFIOrg#4OB-ETS2 to 6	**SAMPLE TYPE:**	Combined Train	**FILE:**	DFN14110198.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	[0.9]	[0.09]
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	2.0	0.02
OCDD	9.0	0.01
2378-TCDF*	N.D.	N.C.
12378-P5CDF	0.6	0.03
23478-P5CDF*	0.6	0.30
123478-H6CDF*	0.6	0.06
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	1.2	0.01
1234789-H7CDF	N.D.	N.C.
OCDF	2.1	0.00
Total TEQ		0.43

Homologue	pg	DL	NP
Total TCDD	N.D.	1.0	0
Total P5CDD	N.D.	0.7	0
Total H6CDD	N.D.	0.7	0
Total H7CDD	3.2	0.7	2
OCDD	9.0	0.7	1
Total PCDD	12.2		
Total TCDF	N.D.	0.6	0
Total P5CDF	1.2	0.4	2
Total H6CDF	0.6	0.4	1
Total H7CDF	1.2	0.5	1
OCDF	2.1	0.5	1
Total PCDF	5.1		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	86
13C12-TCDF	1.0	97
13C12-P5CDD	1.0	96
13C12-P5CDF	1.0	97
13C12-H6CDD	1.0	92
13C12-H6CDF	1.0	97
13C12-H7CDD	1.0	102
13C12-H7CDF	1.0	99
13C12-OCDD	2.0	94

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

14/11/2001

----- T:	ERMD	**PROJECT:**	Lachenaie PQ Landfill Engine	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	XAD	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-206
SAMPLE ID:	AAQ01-O-00723	**SAMPLING DATE:**	03-Oct-01	**ANALYSIS DAT**	25/10/2001
FIELD ID:	BFI-ORG#2-RAW-FTS7	**SAMPLE TYPE:**	XAD	**FILE:**	DFN14110199.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	1.0	0.01
OCDD	4.3	0.00
2378-TCDF*	[0.8]	[0.08]
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	1.2	0.00
Total TEQ		0.01

Homologue	pg	DL	NP
Total TCDD	N.D.	1.0	0
Total P5CDD	N.D.	0.7	0
Total H6CDD	N.D.	0.8	0
Total H7CDD	1.0	0.8	1
OCDD	4.3	1.0	1
Total PCDD	5.3		
Total TCDF	N.D.	0.7	0
Total P5CDF	N.D.	0.5	0
Total H6CDF	N.D.	0.5	0
Total H7CDF	N.D.	0.6	0
OCDF	1.2	0.7	1
Total PCDF	1.2		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	97
13C12-TCDF	1.0	90
13C12-P5CDD	1.0	94
13C12-P5CDF	1.0	105
13C12-H6CDD	1.0	99
13C12-H6CDF	1.0	98
13C12-H7CDD	1.0	108
13C12-H7CDF	1.0	100
13C12-OCDD	2.0	87

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY: _____

16/11/2001

r:	AAQD	**PROJECT:** QA/QC		**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	QA/QC	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-206
SAMPLE ID:	AAQ01-O-00743	**SAMPLING DATE:**	11-Oct-01	**ANALYSIS DAT**	25/10/2001
FIELD ID:	B11/10/01	**SAMPLE TYPE:**	Method Blank	**FILE:**	DFN16110131.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	N.D.	N.C.
OCDD	2.6	0.00
2378-TCDF*	N.D.	N.C.
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	[1.4]	N.C.
Total TEQ		0.00

Homologue	pg	DL	NP
Total TCDD	N.D.	1.9	0
Total P5CDD	N.D.	1.4	0
Total H6CDD	N.D.	1.3	0
Total H7CDD	N.D.	1.4	0
OCDD	2.6	1.4	1
Total PCDD	2.6		
Total TCDF	N.D.	1.2	0
Total P5CDF	N.D.	0.8	0
Total H6CDF	N.D.	0.8	0
Total H7CDF	N.D.	0.9	0
OCDF	[1.4]	1.1	0
Total PCDF	0.0		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	46
13C12-TCDF	1.0	49
13C12-P5CDD	1.0	50
13C12-P5CDF	1.0	51
13C12-H6CDD	1.0	66
13C12-H6CDF	1.0	76
13C12-H7CDD	1.0	70
13C12-H7CDF	1.0	78
13C12-OCDD	2.0	60

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY: Poole

PAH ANALYTICAL REPORT

15/11/2001

T: ERMD
ECT: Lachenaie PQ Landfill Engine
LE MATRIX: Train

File: PAH15110188.rtf

Batch # :	UTL-206	UTL-206
Sample id :	AAQ01-O-00723	AAQ01-O-00743
Field id :	BFI-ORG#2-RAW-FTS7	B11/10/01
Sampling date :	03/10/01	11/10/01
SAMPLE TYPE:	XAD	Method Blank
Sample size :	1	1
Sample size units :	N/A	N/A
PAH result units :	ug	ug
AL	0.885	< 0.003
AE	45.555	< 0.001
FL	15.565	0.002
MFL	0.970	< 0.003
PHE	1.745	0.006
AN	0.262	< 0.003
FLT	< 0.003	< 0.003
PY	0.010	< 0.003
B(a)FL	< 0.003	< 0.003
B(b)FL	< 0.002	< 0.002
MPY	< 0.002	< 0.002
B(ghi)F	< 0.005	< 0.005
B(a)A	< 0.007	< 0.007
Tri	< 0.006	< 0.006
Chrysene	< 0.005	< 0.005
C&T	N.M.	N.M.
MB(a)A	< 0.006	< 0.006
B(b)FLT	< 0.010	< 0.010
B(k)FLT	< 0.010	< 0.010
B(b)F & B(k)F	N.M.	N.M.
B(e)P	< 0.008	< 0.008
B(a)P	< 0.010	< 0.010
PER	< 0.009	< 0.009
MCH	< 0.010	< 0.010
IP	< 0.010	< 0.010
D(ah)A	< 0.010	< 0.010
B(b)C	< 0.020	< 0.020
B(ghi)P	< 0.010	< 0.010
ANT	< 0.020	< 0.020
Total PAH	64.992	0.008
Recovery %		
d10-AE %	92	62
d10-AN %	100	66
d10-PY	96	78
d12-B(a)A %	96	84
d12-B(a)P %	94	73
d14-D(ah)A	95	82
d12-B(ghi)P %	89	83

Note: A < sign indicates the value is below the detection limit reported

Analysed by:_____ Reviewed

Approved by:_____

Instrument Analysis Lab: AAQD, ETC

PAH ANALYTICAL REPORT

15/11/2001

T: ERMD
:CT: Lachenaie PQ Landfill Engine
.E MATRIX: Train

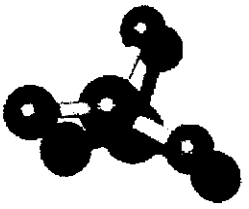
File: PAH15110188.rtf

Batch # :	UTL-206	UTL-206	UTL-206	UTL-206
Sample id :	AAQ01-O-00719	AAQ01-O-00720	AAQ01-O-00721	AAQ01-O-00722
Field id :	BFIOrg#1OC-ETS1 to 6	BFIOrg#2OC-ETS1 to 6	BFIOrg#3OC-ETS1 to 6	BFIOrg#4OB-ETS2 to 6
Sampling date :	02/10/01	03/10/01	04/10/01	03/10/01
SAMPLE TYPE:	Combined Train	Combined Train	Combined Train	Combined Train
Sample size :	1	1	1	1
Sample size units :	N/A	N/A	N/A	N/A
PAH result units :	ug	ug	ug	ug
AL	0.419	0.354	0.482	< 0.003
AE	0.478	0.477	0.562	< 0.001
FL	0.658	0.615	0.670	0.007
MFL	0.316	0.281	0.381	0.004
PHE	2.120	1.420	1.389	0.033
AN	0.181	0.184	0.186	0.007
FLT	0.433	0.437	0.367	0.007
PY	0.682	0.735	0.576	0.007
B(a)FL	0.055	0.050	0.052	< 0.003
B(b)FL	0.035	0.030	0.029	< 0.002
MPY	0.055	0.060	0.053	< 0.002
B(ghi)F	0.090	0.097	0.080	< 0.005
B(a)A	0.060	0.064	0.055	< 0.007
Tri	0.056	N.M.	N.M.	< 0.006
Chrysene	0.162	N.M.	N.M.	< 0.005
C&T	N.M.	0.180	0.187	N.M.
MB(a)A	< 0.006	< 0.006	< 0.006	< 0.006
B(b)FLT	N.M.	0.059	N.M.	< 0.010
B(k)FLT	N.M.	0.012	N.M.	< 0.010
B(b)F & B(k)F	0.073	N.M.	0.062	N.M.
B(e)P	0.070	0.071	0.060	< 0.008
B(a)P	< 0.010	0.011	< 0.010	< 0.010
PER	< 0.009	< 0.009	< 0.009	< 0.009
MCH	< 0.010	< 0.010	< 0.010	< 0.010
IP	0.036	0.039	0.030	< 0.010
D(ah)A	< 0.010	< 0.010	< 0.010	< 0.010
B(b)C	< 0.020	< 0.020	< 0.020	< 0.020
B(ghi)P	0.072	0.085	0.058	< 0.010
ANT	< 0.020	< 0.020	< 0.020	< 0.020
Total PAH	~~8.320~~ 6.05 /	5.261	~~5.323~~ 5.279	0.069
Recovery %				
d10-AE %	76	81	80	67
d10-AN %	82	79	79	83
d10-PY	94	91	90	88
d12-B(a)A %	94	93	95	93
d12-B(a)P %	71	63	60	67
d14-D(ah)A	93	91	92	80
d12-B(ghi)P %	89	88	85	76

Note: A < sign indicates the value is below the detection limit reported Analysed by:_____ Reviewed Approved by:_____

Instrument Analysis Lab: AAQD, ETC

Environmental Technology Center



Centre de Technologie Environnementale

Mylaine Tardif
Analysis and Air Quality Division
3439 River Road, Ottawa, Ontario K1A OH3
Tel. : (613) 990-8565 / Fax : (613) 990-8568
www.etcentre.org
File/Dossier:

MEMORANDUM - NOTE DE SERVICE

To/A:
Dominic Cianciarelli
ERMD

File/Dossier:
UTL-206

From/De:
Mylaine Tardif
Supervisor, Instrumental Analysis Lab

Date:
7 December 2001

Subject/Objet: PAH Results - Lachenaie Landfill

Attached are the amended HCB/OCS results of 5 samples including 1 method blank. Corrections were made to the detection limits. If you have any questions please don't hesitate to contact me.

Cc R.Turle, C. Chiu, G.Poole

Approval Lims _____

HCB/OCS ANALYTICAL REPORT

30/11/:

CLIENT: ERMD
PROJECT: Lachenaie PQ Landfill Engine
SAMPLE MATRIX: Train

File: HPO30110162.rtf

BATCH #:	UTL-206	UTL-206
SAMPLE ID:	AAQ01-O-00723	AAQ01-O-00743
FIELD ID:	BFI-ORG#2-RAW-FTS7	B11/10/01
SAMPLING DATE:	03/10/01	11/10/01
SAMPLE TYPE:	XAD	Method Blank
SAMPLE SIZE:	1	1
SAMPLE SIZE UNITS:	N/A	N/A
RESULT UNITS:	ug	ug
HCB	< 0.002	< 0.002
OCS	< 0.002	< 0.002
Recovery %		
13C6-HCB	80	63

Note: A < sign indicates the value is below the detection limit reported

Analysed by:_____ Reviewed by:_____ Approved by:_____

Instrument Analysis Lab: AAQD, ETC

HCB/OCS ANALYTICAL REPORT

30/11/20

CLIENT: ERMD
PROJECT: Lachenaie PQ Landfill Engine
SAMPLE MATRIX: Train

File: HPO30110162.rtf

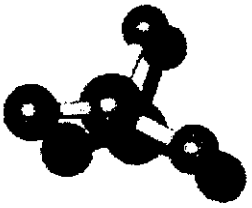
BATCH #:	UTL-206	UTL-206	UTL-206	UTL-206
SAMPLE ID:	AAQ01-O-00719	AAQ01-O-00720	AAQ01-O-00721	AAQ01-O-00722
FIELD ID:	BFIOrg#1OC-ETS1 to 6	BFIOrg#2OC-ETS1 to 6	BFIOrg#3OC-ETS1 to 6	BFIOrg#4OB-ETS2 to 6
SAMPLING DATE:	02/10/01	03/10/01	04/10/01	03/10/01
SAMPLE TYPE:	Combined Train	Combined Train	Combined Train	Combined Train
SAMPLE SIZE:	1	1	1	1
SAMPLE SIZE UNITS:	N/A	N/A	N/A	N/A
RESULT UNITS:	ug	ug	ug	ug
HCB	< 0.002	< 0.002	< 0.002	< 0.002
OCS	< 0.002	< 0.002	< 0.002	< 0.002
Recovery %				
13C6-HCB	81	77	88	57

Note: A < sign indicates the value is below the detection limit reported

Analysed by:_____ Reviewed by:_____ Approved by:_____

Instrument Analysis Lab: AAQD, ETC

Environmental Technology Center



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poole.gary@etc.ec.gc.ca

November 16, 2001

Dominique Cianciarelli
ERMD

Re: Dioxin, Results of Train and XAD Proofs

Dominique:

Attached please find the PCDD/PCDF results for 2 sets of train proof rinses and 2 XAD proofs. Also included are the results of a method blank that was processed along with the samples.

If you require further information, please let me know.

Sincerely,

Gary Poole
Supervisor, Organic Laboratories

cc C. Chiu, R.Turle, M. Tardif

14/11/2001

CLIENT:	ERMD	**PROJECT:**	Montreal-Lachenaie Engine/Flar	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	Solvent	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-205
SAMPLE ID:	AAQ01-O-00672	**SAMPLING DATE:**	01-Sep-01	**ANALYSIS DAT**	23/10/2001
FIELD ID:	PROOF1,2,3	**SAMPLE TYPE:**	Proof	**FILE:**	DFN14110193.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	N.D.	N.C.
OCDD	4.2	0.00
2378-TCDF*	N.D.	N.C.
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	N.D.	N.C.
Total TEQ		0.00

Homologue	pg	DL	NP
Total TCDD	N.D.	1.3	0
Total P5CDD	N.D.	1.0	0
Total H6CDD	N.D.	1.0	0
Total H7CDD	N.D.	1.1	0
OCDD	4.2	1.0	1
Total PCDD	4.2		
Total TCDF	N.D.	0.8	0
Total P5CDF	N.D.	0.6	0
Total H6CDF	N.D.	0.7	0
Total H7CDF	N.D.	0.8	0
OCDF	N.D.	0.8	0
Total PCDF	0.0		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	84
13C12-TCDF	1.0	91
13C12-P5CDD	1.0	88
13C12-P5CDF	1.0	94
13C12-H6CDD	1.0	99
13C12-H6CDF	1.0	107
13C12-H7CDD	1.0	110
13C12-H7CDF	1.0	105
13C12-OCDD	2.0	110

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

16/11/2001

':	ERMD	**PROJECT:**	Montreal-Lachenaie Engine/Flar	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	Solvent	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-205
SAMPLE ID:	AAQ01-O-00673	**SAMPLING DATE:**	01-Sep-01	**ANALYSIS DAT**	23/10/2001
FIELD ID:	PROOF4,5	**SAMPLE TYPE:**	Proof	**FILE:**	DFN16110126.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	0.9	0.01
OCDD	4.9	0.00
2378-TCDF*	N.D.	N.C.
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	[1.0]	N.C.
Total TEQ		0.01

Homologue	pg	DL	NP
Total TCDD	N.D.	1.2	0
Total P5CDD	N.D.	0.8	0
Total H6CDD	N.D.	0.8	0
Total H7CDD	0.9	0.8	1
OCDD	4.9	0.9	1
Total PCDD	5.8		
Total TCDF	N.D.	0.8	0
Total P5CDF	N.D.	0.5	0
Total H6CDF	N.D.	0.6	0
Total H7CDF	N.D.	0.7	0
OCDF	[1.0]	0.7	0
Total PCDF	0.0		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	84
13C12-TCDF	1.0	91
13C12-P5CDD	1.0	88
13C12-P5CDF	1.0	94
13C12-H6CDD	1.0	99
13C12-H6CDF	1.0	107
13C12-H7CDD	1.0	110
13C12-H7CDF	1.0	105
13C12-OCDD	2.0	110

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

16/11/2001

T:	ERMD	**PROJECT:**	ERMD Train XAD Proof	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	XAD	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-198
SAMPLE ID:	AAQ01-O-00663	**SAMPLING DATE:**	24-Sep-01	**ANALYSIS DAT**	23/10/2001
FIELD ID:	X25/05/2001	**SAMPLE TYPE:**	Proof	**FILE:**	DFN16110127.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	N.D.	N.C.
OCDD	[2.5]	N.C.
2378-TCDF*	N.D.	N.C.
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	[0.7]	[0.35]
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	[0.8]	N.C.
Total TEQ		0.00

Homologue	pg	DL	NP
Total TCDD	N.D.	1.0	0
Total P5CDD	N.D.	0.8	0
Total H6CDD	N.D.	0.9	0
Total H7CDD	N.D.	0.9	0
OCDD	[2.5]	0.9	0
Total PCDD	0.0		
Total TCDF	N.D.	0.7	0
Total P5CDF	N.D.	0.5	0
Total H6CDF	N.D.	0.5	0
Total H7CDF	N.D.	0.6	0
OCDF	[0.8]	0.7	0
Total PCDF	0.0		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	94
13C12-TCDF	1.0	94
13C12-P5CDD	1.0	95
13C12-P5CDF	1.0	99
13C12-H6CDD	1.0	108
13C12-H6CDF	1.0	109
13C12-H7CDD	1.0	110
13C12-H7CDF	1.0	112
13C12-OCDD	2.0	108

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

16/11/2001

:	ERMD	**PROJECT:**	ERMD Train XAD Proof	**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	XAD	**SAMPLE SIZE:**	1 (**N/A**)	**BATCH #:**	UTL-198
SAMPLE ID:	AAQ01-O-00664	**SAMPLING DATE:**	24-Sep-01	**ANALYSIS DAT**	23/10/2001
FIELD ID:	25/05/2001	**SAMPLE TYPE:**	Proof	**FILE:**	DFN16110128.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	N.D.	N.C.
OCDD	[2.0]	N.C.
2378-TCDF*	N.D.	N.C.
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	[0.8]	N.C.
Total TEQ		0.00

Homologue	pg	DL	NP
Total TCDD	N.D.	1.1	0
Total P5CDD	N.D.	0.8	0
Total H6CDD	N.D.	0.9	0
Total H7CDD	N.D.	1.0	0
OCDD	[2.0]	1.0	0
Total PCDD	0.0		
Total TCDF	N.D.	0.7	0
Total P5CDF	N.D.	0.5	0
Total H6CDF	N.D.	0.6	0
Total H7CDF	N.D.	0.7	0
OCDF	[0.8]	0.6	0
Total PCDF	0.0		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	91
13C12-TCDF	1.0	95
13C12-P5CDD	1.0	93
13C12-P5CDF	1.0	99
13C12-H6CDD	1.0	100
13C12-H6CDF	1.0	110
13C12-H7CDD	1.0	110
13C12-H7CDF	1.0	113
13C12-OCDD	2.0	105

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY:

16/11/2001

Γ:	ERMD	**PROJECT:** QA/QC		**GC/MS:**	60M DB5/VG70S 10000
MATRIX:	THIMBLE	**SAMPLE SIZE:**	1 (N/A)	**BATCH #:**	UTL-198
SAMPLE ID:	AAQ01-O-00665	**SAMPLING DATE:**	27-Sep-01	**ANALYSIS DAT**	23/10/2001
FIELD ID:	B27/09/2001	**SAMPLE TYPE:**	Method Blank	**FILE:**	DFN16110129.rtf

Congener	pg	Maximum TEQ
2378-TCDD	N.D.	N.C.
12378-P5CDD	N.D.	N.C.
123478-H6CDD	N.D.	N.C.
123678-H6CDD	N.D.	N.C.
123789-H6CDD*	N.D.	N.C.
1234678-H7CDD	N.D.	N.C.
OCDD	9.2	0.01
2378-TCDF*	N.D.	N.C.
12378-P5CDF	N.D.	N.C.
23478-P5CDF*	N.D.	N.C.
123478-H6CDF*	N.D.	N.C.
123678-H6CDF	N.D.	N.C.
234678-H6CDF	N.D.	N.C.
123789-H6CDF	N.D.	N.C.
1234678-H7CDF	N.D.	N.C.
1234789-H7CDF	N.D.	N.C.
OCDF	[2.3]	N.C.
Total TEQ		0.01

Homologue	pg	DL	NP
Total TCDD	N.D.	2.6	0
Total P5CDD	N.D.	1.9	0
Total H6CDD	N.D.	1.9	0
Total H7CDD	N.D.	2.2	0
OCDD	9.2	2.1	1
Total PCDD	9.2		
Total TCDF	N.D.	1.7	0
Total P5CDF	N.D.	1.3	0
Total H6CDF	N.D.	1.5	0
Total H7CDF	N.D.	1.7	0
OCDF	[2.3]	1.6	0
Total PCDF	0.0		

Surrogate	Amount Added, ng	Recovery %
13C12-TCDD	1.0	38
13C12-TCDF	1.0	39
13C12-P5CDD	1.0	42
13C12-P5CDF	1.0	42
13C12-H6CDD	1.0	48
13C12-H6CDF	1.0	51
13C12-H7CDD	1.0	51
13C12-H7CDF	1.0	51
13C12-OCDD	2.0	46

Note: (1) Results are corrected for surrogate recovery.
(2) DL = detection limit (pg / analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D. = Not Detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
(6) TEQ = Toxic Equivalents as 2, 3,7,8 - TCDD using International Toxic Equivalency Factors.
(7) N.C. = Not Calculable.

APPROVED BY: _____

Environmental Technology Centre

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MEMORANDUM - NOTE DE SERVICE

To/A:
Dominic Cianciarelli
ERMD

File/Dossier:
UTL-198 & UTL-205

From/De:
Mylaine Tardif
Supervisor, Instrumental Analysis Lab

Date:
01 November 2001

Subject/Objet: Proof Samples

Attached are the PAH results for 2 Train Proofs and one method blank for UTL-198 and two proofs for the Montreal-Lachenaie Engine/Flare Project UTL-205. The only two analytes detected were phenanthrene and fluorene at levels < 10 x IDL. (IDL= instrument detection limit).

Cc R.Turle, C.Chiu, G.Poole

Approval Lims _____

PAH ANALYTICAL REPORT

18/10/2001

: ERMD
CT: ERMD Train XAD Proof
E MATRIX: XAD

File: PAH18100180.rtf

Batch # :	UTL-198	UTL-198	UTL-198
Sample id :	AAQ01-O-00663	AAQ01-O-00664	AAQ01-O-00665
Field id :	X25/05/2001	25/05/2001	B27/09/2001
Sampling date :	24/09/01	24/09/01	27/09/01
SAMPLE TYPE:	Proof	Proof	Method Blank
Sample size :	1	1	1
Sample size units :	N/A	N/A	N/A
PAH result units :	ug	ug	ug
AL	< 0.003	< 0.003	< 0.003
AE	< 0.001	< 0.001	0.001
FL	0.002	0.003	0.002
MFL	< 0.003	< 0.003	< 0.003
PHE	0.010	0.011	0.009
AN	< 0.003	< 0.003	< 0.003
FLT	< 0.003	< 0.003	< 0.003
PY	< 0.003	< 0.003	< 0.003
RET	< 0.002	< 0.002	< 0.002
B(a)FL	< 0.003	< 0.003	< 0.003
B(b)FL	< 0.002	< 0.002	< 0.002
MPY	< 0.002	< 0.002	< 0.002
B(ghi)F	< 0.005	< 0.005	< 0.005
B(a)A	< 0.007	< 0.007	< 0.007
Tri	< 0.006	< 0.006	< 0.006
Chrysene	< 0.005	< 0.005	< 0.005
C&T	N.M.	N.M.	N.M.
MB(a)A	< 0.006	< 0.006	< 0.006
B(b)FLT	< 0.010	< 0.010	< 0.010
B(k)FLT	< 0.010	< 0.010	< 0.010
B(b)F & B(k)F	N.M.	N.M.	N.M.
B(e)P	< 0.008	< 0.008	< 0.008
B(a)P	< 0.010	< 0.010	< 0.010
PER	< 0.009	< 0.009	< 0.009
MCH	< 0.010	< 0.010	< 0.010
IP	< 0.010	< 0.010	< 0.010
D(ah)A	< 0.010	< 0.010	< 0.010
B(b)C	< 0.020	< 0.020	< 0.020
B(ghi)P	< 0.010	< 0.010	< 0.010
ANT	< 0.020	< 0.020	< 0.020
Total PAH	0.012	0.014	0.012
Recovery %			
d10-AE %	63	72	59
d10-AN %	68	73	59
d10-PY	77	78	69
d12-B(a)A %	80	80	78
d12-B(a)P %	67	71	70
d14-D(ah)A	72	73	76
d12-B(ghi)P %	73	75	76

Note: A < sign indicates the value is below the detection limit reported

Analysed by: D B Reviewed by: Approved by:

Instrument Analysis Lab: AAQD, ETC

PAH ANALYTICAL REPORT

18/10/2001

: ERMD
CT: Montreal-Lachenaie Engine/Flar
E MATRIX: Solvent

File: PAH18100177.rtf

Batch # :	UTL-205	UTL-205
Sample id :	AAQ01-O-00672	AAQ01-O-00673
Field id :	PROOF1,2,3	PROOF4,5
Sampling date :	01/09/01	01/09/01
SAMPLE TYPE:	Proof	Proof
Sample size :	1	1
Sample size units :	N/A	N/A
PAH result units :	ug	ug
AL	< 0.003	< 0.003
AE	< 0.001	< 0.001
FL	0.002	0.001
MFL	< 0.003	< 0.003
PHE	0.005	0.003
AN	< 0.003	< 0.003
FLT	< 0.003	< 0.003
PY	< 0.003	< 0.003
RET	< 0.002	< 0.002
B(a)FL	< 0.003	< 0.003
B(b)FL	< 0.002	< 0.002
MPY	< 0.002	< 0.002
B(ghi)F	< 0.005	< 0.005
B(a)A	< 0.007	< 0.007
Tri	< 0.006	< 0.006
Chrysene	< 0.005	< 0.005
C&T	N.M.	N.M.
MB(a)A	< 0.006	< 0.006
B(b)FLT	< 0.010	< 0.010
B(k)FLT	< 0.010	< 0.010
B(b)F & B(k)F	N.M.	N.M.
B(e)P	< 0.008	< 0.008
B(a)P	< 0.010	< 0.010
PER	< 0.009	< 0.009
MCH	< 0.010	< 0.010
IP	< 0.010	< 0.010
D(ah)A	< 0.010	< 0.010
B(b)C	< 0.020	< 0.020
B(ghi)P	< 0.010	< 0.010
ANT	< 0.020	< 0.020
Total PAH	0.007	0.004
Recovery %		
d10-AE %	69	64
d10-AN %	72	74
d10-PY	82	87
d12-B(a)A %	83	88
d12-B(a)P %	69	76
d14-D(ah)A	85	83
d12-B(ghi)P %	84	84

Note: A < sign indicates the value is below the detection limit reported

Analysed by: D. B Reviewed by: Approved by:

Instrument Analysis Lab: AAQD, ETC

	VOC CONCENTRATION (ug/m3)							
	INLET		OUTLET					
			SVOC 1	SVOC 1	SVOC 2	SVOC 2	SVOC 3	SVOC 3
Compounds								
Propene	4650	4040	789	828	696	681	926	1042
Propane	11940	10910	42	56	41	41	66	67
Freon 22 (Chlorodifluoromethane)	1420	1500	7	7	7	6	9	8
Freon 12 (Dichlorodifluoromethane)	3000	2830	21	22	20	19	25	23
Propyne	70	70	38	38	33	33	43	54
Chloromethane	370	150	8	7	7	7	10	11
Isobutane (2-Methylpropane)	9650	7960	30	29	29	29	38	45
Freon 114 (1,2-Dichlorotetrafluoroethane	410	400	3	3	3	3	4	3
Vinylchloride (Chloroethene)	6910	5600	32	33	32	31	40	39
1-Butene/2-Methylpropene	2850	2270	309	309	271	279	359	417
1,3-Butadiene	0	0	0	9	12	8	16	31
Butane	3290	2730	11	10	10	10	13	15
t-2-Butene	0	0	33	34	30	29	39	44
2,2-Dimethylpropane	0	0	0	0	0	0	0	0
Bromomethane	0	0	11	10	11	11	17	14
1-Butyne	0	0	4	4	3	3	4	4
c-2-Butene	360	280	25	23	21	21	27	30
Chloroethane	540	430	2	2	2	2	3	3
3-Methyl-1-Butene	340	290	26	27	23	23	30	28
2-Methylbutane	2290	1860	6	6	7	7	9	7
Freon 11 (Trichlorofluoromethane)	470	490	3	3	3	3	4	3
1-Pentene	300	250	123	123	106	108	140	129
2-Methyl-1-Butene	2140	1320	34	36	32	33	43	37
Pentane	4610	3550	10	9	10	10	13	12
Isoprene (2-Methyl-1,3-Butadiene)	410	310	4	4	3	3	6	4
t-2-Pentene	220	190	16	16	14	14	18	16
Ethylbromide	0	0	0	0	0	0	0	0
1,1-Dichloroethene	120	120	2	2	2	2	2	2
c-2-Pentene	160	120	11	10	9	9	12	11
Dichloromethane	3390	3020	13	12	16	14	16	15
2-Methyl-2-Butene	770	650	8	10	9	9	11	10
Freon 113 (1,1,2-Trichlorotrifluoroethane	210	150	1	1	1	1	1	1
2,2-Dimethylbutane	910	670	2	0	2	4	5	3
Cyclopentene	70	40	28	32	26	26	32	24
t-1,2-Dichloroethene	300	220	4	4	4	4	5	4
4-Methyl-1-Pentene	0	0	15	16	14	15	18	17
3-Methyl-1-Pentene	0	0	13	13	12	12	15	13
1,1-Dichloroethane	2430	1480	6	6	6	6	8	6
Cyclopentane	460	260	0	0	0	1	0	1
2,3-Dimethylbutane	1150	640	0	2	3	3	3	3
t-4-Methyl-2-Pentene	0	0	1	1	1	1	1	1
2-Methylpentane	3080	2480	11	11	11	11	15	10
c-4-Methyl-2-Pentene	0	0	4	4	3	3	4	3
3-Methylpentane	2800	2470	8	8	9	9	12	9
1-Hexene/2-Methyl-1-Pentene	0	0	140	144	130	131	153	138
c-1,2-Dichloroethene	8450	8380	36	37	37	38	47	38
Hexane	5340	4410	17	16	17	17	21	17
Chloroform	0	0	0	0	0	0	0	0
t-2-Hexene	110	100	9	9	8	8	0	8
2-Ethyl-1-Butene	510	410	0	0	0	0	0	0
t-3-Methyl-2-Pentene	90	50	4	4	4	4	5	4
c-2-Hexene	70	50	6	6	5	5	6	5
c-3-Methyl-2-Pentene	100	70	0	0	0	0	0	0
2,2-Dimethylpentane	220	210	1	1	1	1	1	1
1,2-Dichloroethane	40	0	0	0	0	0	0	0
Methylcyclopentane	440	380	6	5	5	5	7	6
2,4-Dimethylpentane	430	320	1	1	1	2	2	2
1,1,1-Trichloroethane	280	300	1	1	1	1	1	1
2,2,3-Trimethylbutane	0	0	0	0	0	0	0	0
1-Methylcyclopentene	120	110	10	15	14	13	15	14

	VOC CONCENTRATION (ug/m3)							
	INLET		OUTLET					
			SVOC 1	SVOC 1	SVOC 2	SVOC 2	SVOC 3	SVOC 3
Compounds								
Benzene	1630	1560	100	106	89	88	110	88
Carbontretrachloride	0	0	0	0	0	0	0	0
Cyclohexane	3330	2920	9	9	10	10	12	9
2-Methylhexane	2480	2490	7	7	8	9	10	9
2,3-Dimethylpentane	920	1000	3	3	4	5	6	5
Cyclohexene	0	0	20	22	19	20	23	23
3-Methylhexane	3180	3240	8	9	10	11	14	12
Dibromomethane	0	0	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0	0	0
Bromodichloromethane	0	0	0	0	0	0	0	0
1-Heptene	0	0	64	62	59	64	71	90
Trichloroethene	2790	2890	17	16	17	17	21	19
2,2,4-Trimethylpentane	2380	2490	7	7	9	10	14	10
t-3-Heptene	0	0	6	5	5	6	7	7
Heptane	4470	4670	25	24	28	32	36	44
c-3-Heptene	0	0	5	6	6	6	7	7
t-2-Heptene	0	0	9	9	8	9	10	12
c-2-Heptene	0	0	6	5	5	6	7	7
c-1,3-Dichloropropene	0	0	0	0	0	0	0	0
2,2-Dimethylhexane	0	0	0	0	0	0	0	0
Methylcyclohexane	5030	5120	14	15	17	18	24	19
2,5-Dimethylhexane	750	810	2	2	3	3	4	4
2,4-Dimethylhexane	960	980	3	3	4	5	6	4
t-1,3-Dichloropropene	0	0	0	0	0	0	0	0
1,1,2-Trichloroethane	0	0	0	0	0	0	0	0
Bromotrichloromethane	0	0	0	0	0	0	0	0
2,3,4-Trimethylpentane	940	1100	2	2	5	4	5	4
Toluene	147020	148860	462	440	424	464	642	651
2-Methylheptane	2460	2790	8	8	11	10	12	13
4-Methylheptane	860	1140	3	3	3	3	4	3
1-Methylcyclohexene	80	110	7	8	8	8	9	10
3-Methylheptane	2000	2480	7	7	8	9	12	10
Dibromochloromethane	0	0	0	0	0	0	0	0
c-1,3-Dimethylcyclohexane	2020	2430	5	6	7	8	9	7
t-1,4-Dimethylcyclohexane	790	920	3	3	4	4	5	4
2,2,5-Trimethylhexane	590	690	0	0	0	0	0	0
1,2-Dibromoethane (EDB)	0	0	0	0	0	0	0	0
1-Octene	0	0	38	38	34	38	42	51
Octane	4170	5020	21	15	16	18	27	21
t-2-Octene	0	0	6	7	7	8	9	10
t-1,2-Dimethylcyclohexane	1640	1940	0	0	0	0	0	0
Tetrachloroethene	4690	5720	39	38	39	40	48	46
c-1,4/t-1,3-Dimethylcyclohexane	700	820	2	2	3	3	3	3
c-1,2-Dimethylcyclohexane	0	0	0	0	0	0	0	0
Chlorobenzene	0	0	2	3	2	2	3	2
Ethylbenzene	34120	34910	169	158	158	163	194	185
m,p-Xylene	84120	87990	360	333	333	343	409	395
Bromoform	0	0	0	0	0	0	0	0
1,4-Dichlorobutane	0	0	0	0	0	0	0	0
Styrene	1470	1330	6	12	15	13	18	22
1,1,2,2-Tetrachloroethane	0	0	5	4	4	0	5	0
1-Nonene	0	0	31	27	27	28	33	33
o-Xylene	22110	23710	104	94	98	100	120	114
Nonane	13490	14110	32	30	31	31	37	36
iso-Propylbenzene	1440	1420	10	9	9	9	11	10
3,6-Dimethyloctane	0	0	0	0	0	0	0	0
n-Propylbenzene	2110	2110	14	12	11	11	14	13
3-Ethyltoluene	5390	5490	33	29	28	29	36	32
4-Ethyltoluene	2810	2880	16	14	14	13	15	14
1,3,5-Trimethylbenzene	2920	3090	18	15	15	15	18	17

	VOC CONCENTRATION (ug/m3)							
	INLET		OUTLET					
			SVOC 1	SVOC 1	SVOC 2	SVOC 2	SVOC 3	SVOC 3
Compounds								
2-Ethyltoluene	2000	2080	16	14	13	13	16	14
1-Decene	0	0	34	22	21	22	26	27
tert-Butylbenzene	0	0	0	0	0	0	0	0
1,2,4-Trimethylbenzene	8240	8910	47	41	40	40	50	46
Decane	23660	24830	52	46	45	47	57	54
Benzyl Chloride	0	0	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0	0	0
1,4-Dichlorobenzene	2190	2310	20	18	17	17	21	19
iso-Butylbenzene	290	280	2	2	2	2	2	2
sec-Butylbenzene	420	480	3	2	0	2	3	3
1,2,3-Trimethylbenzene	2770	3170	19	16	15	15	19	18
p-Cymene (1-Methyl-4-Isopropylbenzene)	17110	18050	61	53	49	48	60	54
1,2-Dichlorobenzene	0	0	1	1	1	1	1	1
Indan (2,3-Dihydroindene)	390	420	4	4	3	3	4	4
1,3-Diethylbenzene	410	460	3	3	2	2	3	3
1,4-Diethylbenzene	1260	1440	0	8	0	8	0	9
n-Butylbenzene	530	590	1	1	1	1	0	1
1,2-Diethylbenzene	450	140	1	0	0	1	0	0
1-Undecene	0	0	18	16	16	19	18	23
Undecane	13640	15220	28	23	23	24	30	29
1,2,4-Trichlorobenzene	30	50	0	0	0	0	0	0
Naphthalene	1010	1400	18	15	13	12	17	16
Dodecane	3900	4210	8	7	6	8	9	8
Hexachlorobutadiene	0	0	0	0	0	0	0	0
Hexylbenzene	0	0	3	3	2	0	0	3
Total	532650	537810	3987	3938	3656	3745	4776	4864