TYPICAL CONCENTRATIONS OF PETROLEUM COMPOUNDS IN MAINE RESIDENTIAL INDOOR AIR

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF REMEDIATION & WASTE MANAGEMENT

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Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Executive Summary

This document presents Maine Department of Environmental Protection's (ME DEP) sampling study of background chemical concentrations that may typically be present in indoor air from sources such as building materials, household products, fuel tanks and heating systems. This study presents a reference for indoor air volatile petroleum organic compound concentrations that are typical in a Maine residence heated by petroleum and unaffected by a petroleum release or a vapor intrusion pathway.

The indoor air of all residences sampled, despite having had no reported spills of petroleum, exceeded at least some of the health risk targets for volatile petroleum organic compounds and hydrocarbon fractions.

This document was revised in in January of 2014 to include 90% Upper Predictive Limits (90% UPLs) in order to provide a statistic of typical background that is consistent with evolving ME DEP rules and guidance.

Introduction

In December 2011, ME DEP Bureau of Remediation and Waste Management (BRWM) staff collected air samples in 27 Maine residences that heat with petroleum. Alpha Analytic Laboratory of Mansfield, Massachusetts (Alpha) and the ME DEP Bureau of Air Quality Laboratory (BAQ) provided laboratory services. The BRWM project chemist reviewed all data for project suitability.

Goals

The goal of this study is to identify typical indoor air results for petroleum compounds and air-phase petroleum hydrocarbons in homes that heat with either kerosene or fuel oil. Data may be used to clarify indoor air remediation goals to take "typical background" concentrations unrelated to a petroleum spill into account. Typical indoor air concentrations may be used as a line of evidence in evaluating whether measured concentrations of petroleum compounds in indoor air are the result of a home heating oil spill or whether remedial action has reached a cost-effective limit.

Background

ME DEP's Vapor Intrusion Evaluation Guidance, June 2010 specified Indoor Air Targets (IATs) that were set by the Maine Center for Disease Control (ME CDC). IATs for volatile organic compounds (VOCs) and air-phase hydrocarbon fractions (APH fractions) are Chronic and Sub-Chronic health risk-based thresholds for single-contaminant and multi-contaminant residential exposure.

Results from indoor air investigations at home heating oil spills since 2009 demonstrate APH test sensitivity issues. Some target compound detection limits are above risk thresholds. Additionally, interference from sources unrelated to the spills may complicate the investigations. Evidence suggests that cleanup to the risk-based indoor air targets may be unobtainable for some compounds due to this "background" interference and/or unable to be determined due to test sensitivity.

Other northeastern states with significant percentages of homes that heat with petroleum have conducted similar studies to determine "typical background" values for petroleum compounds in homes that heat with fuel oil and have not had a petroleum release. For example, Massachusetts Department of Environmental Protection's (Mass DEP) reviewed eight recent large-scale studies of indoor air concentrations in residences and the New York State Department of Health collected over 600 residential indoor air samples. Although these studies provide a relevant perspective on typical indoor air concentrations for over 69 individual VOCs, these studies do not address all of Maine's IATs.

Samples and Parameters

Twenty-seven single-family homes that heat with #2 fuel oil with basement tanks or with K1 with outside tanks were selected for inclusion in the study. Two duplicate samples were also collected. All samples were analyzed according to the Mass DEP "Method for the Determination of Air-Phase Petroleum Hydrocarbon" (APH). Additional testing was performed on all samples to meet lower detection limits for target compounds using US EPA "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air Method TO-15", Selected Ion Monitoring (TO-15 SIM) analysis. Eleven of the 27 locations and a duplicate were also sampled and analyzed for target compounds by BAQ using TO-15 SIM.

Sampling Methodology

Sample locations were selected randomly from DEP staff volunteer homes that heat with petroleum and that met the basic exclusion criteria that the homes had no past inside or neighborhood oil spills and no recent hobbies or renovation using products containing VOCs. In addition, a monitoring form was used at each home to document conditions of interest for the study including: age, construction, heating, and ventilation characteristics, location of fuel oil tank, and an inventory of VOC-containing products. The rooms and product containers were screened with a photoionization detector to identify potential chemical interference during sampling and readings were noted on the monitoring forms. A screening questionnaire and all monitoring forms are included in Appendix A.

Air samples were collected in 6-liter summa canisters according to standard ME DEP methods, "Draft Indoor Air Sample Protocol 2009". All air samples were collected as 24-

hour composites during the heating season with windows closed and doors opened only for entry and exit.

The summa canisters were placed at the discretion of trained staff near where samples would be taken if these samples had been part of spill cleanup; for homes with indoor oil tanks, canisters were placed in the room with the oil tank, and for homes with outside kerosene tanks, canisters were placed in the room where the heater is located.

Quality Assurance/ Quality Control

Sampling

Sampling was performed by trained ME DEP staff according to ME DEP "Draft Indoor Air Sample Protocol 2009." All sampling canisters were tested prior to sampling and designated fit for use by the laboratories. Canister pressures were checked and recorded before and after the 24-hour test period to ensure that the valve functioned properly. Standard chain-of-custody procedures were followed and sampling times documented.

Two field duplicates were collected and analyzed at Alpha. One duplicate was collected and analyzed at BAQ. Duplicate precision was calculated as relative percent difference (RPD) and reported in the study report. The RPD goal was $\leq 20\%$ for target compounds and $\leq 30\%$ for APH fractions. Eleven split samples (plus a duplicate) were collected for target compound analysis by BAQ. Split sample precision was calculated as RPD. The split precision goal was $\leq 30\%$.

Analysis

Analyses were performed according to Mass DEP APH and EPA TO-15 SIM methodologies. Analytical protocols are listed in the References. There were no deviations from standard protocol except as provided in laboratory narratives for each sample batch in Appendix B, Laboratory Analytical Reports.

All quality control criteria listed in the analytical methods were used to evaluate data validity as discussed in Appendix C, Laboratory Data Quality Assessment.

Reporting, Data Verification and Validation

Both laboratories reviewed and verified results prior to submitting reports to the ME DEP chemist for validation.

All results were considered valid and usable, except that results for naphthalene did not meet split laboratory precision. Naphthalene results from BAQ were not used in the

statistical analysis because a laboratory control sample was not included as a quality control of the results. See Laboratory Data Quality Assessment, Appendix C, for detailed discussion of data quality.

Results

1. Residential IAT Exceedances

Despite having had no reported spills of petroleum, all 27 tested residences had some detections above the IATs for Chronic and Sub-Chronic Residential Multi-Contaminant IATs for at least some petroleum compounds. Over half of the samples exceed the Chronic IATs for 1,3-butadiene, benzene, naphthalene and C9-C12 aliphatics, and over half of the samples exceed the Sub-Chronic IATs for benzene and naphthalene.

Eight residences had exceedances of the Chronic Residential Single-Contaminant IATs for one or more of benzene, naphthalene, C5-C8 aliphatics, C9-C12 aliphatics or C9-C10 aromatics as shown in Table 1.

The 90% Upper Prediction Limits (90% UPLs) were computed by ProUCL 5.0, an EPA statistical software package. A 90% UPL represents the value above which individual measurements will be due to contamination above background with 90% confidence. A 90% UPL for a small size sample is roughly equivalent to a 90^{th} percentile.

As shown in Table 2, except for toluene and xylene, all of the 90% UPLs exceed Chronic Multi-Contaminant Exposure IATs. The 90% UPLs exceed the Chronic Single-Contaminant IATs only for naphthalene and the C9-C12 aliphatic fraction.

2. Sampling results, Reporting Limits and IATs

All of the 90% UPLs for target compounds are higher than Alpha and BAQ TO-15 SIM Reporting Limits as shown on Table 3. The 90% UPL for 1,3-butadiene and naphthalene are higher than TO-15 SIM Reporting Limits and below standard Alpha Reporting Limits. The 90% UPLs for benzene, ethyl benzene, toluene, xylene and the APH fractions (BAQ did not perform APH) were higher than the standard Reporting Limits of both laboratories.

3. Comparison of Maine with Massachusetts and New York

The typical concentrations of petroleum compounds found in the Maine study homes, as represented by the 90% UPLs, are comparable with and more conservative than those found in the studies conducted by Massachusetts and New York, shown on Table 4. Unfortunately, Massachusetts' study did not consider 1,3-butadiene, and its laboratory detection limit was above the Maine Multi-Contaminant IAT for naphthalene; the New

York study did not consider 1,3-butadiene, naphthalene or the APH fractions, for all of which Maine has targets.

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Table 1. Indoor Air Samples with Health Risk-Based Indoor Air Targets (IATs).

Alpha Analytic samples. **shaded values** exceed Chronic Single Contaminant IATs.

	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene	c5-c8 aliphatics	c9-c12 aliphatics	c9-c10 aromatics
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Chronic IAT Multi-contaminant	**0.081**	**0.31**	**0.97**	**0.072**	**1000**	**21**	**130**	**42**	**10**
Sub-Chronic IAT Multi-contaminant	**0.350**	**1.30**	**4.20**	**0.31**	**1000**	**63**	**420**	**130**	**100**
Chronic IAT Single-contaminant	**0.81**	**3.1**	**9.7**	**0.72**	**5200**	**100**	**630**	**210**	**52**
BAS-01	0.053	0.55	1.31	0.26	13	nd	170	62	nd
BAS-02	0.148	0.82	0.31	nd	3	nd	54	82	nd
BAS-03	0.155	2.06	5.99	1.78	39	25.9	220	140	43
BAS-04	0.064	0.64	0.84	0.28	17	nd	52	90	nd
BAS-05	0.104	2.09	1.60	1.05	12	4.7	240	54	nd
BAS-06	0.376	1.90	2.01	0.79	18	8.9	180	230	20
BAS-07	nd	5.56	7.6	1.36	49	35.9	360	230	59
BAS-08	nd	0.39	0.30	nd	3.4	nd	100	24	nd
BAS-09	nd	0.55	0.37	0.54	nd	nd	34	46	17
BAS-10	0.069	4.47	1.95	3.95	17	10.8	400	270	56
BAS-11	0.137	13.3	14.1	2.38	110	73.0	680	56	59
BAS-12	0.044	1.13	1.54	0.47	8.5	5.5	38	140	nd
BAS-13	0.462	1.63	1.72	1.58	18.0	8.7	180	280	22
BAS-14	0.089	0.82	0.22	0.52	2.8	nd	72	26	nd
BAS-16	0.184	0.90	0.51	0.66	4.8	nd	57	340	18
BAS-17	nd	0.54	0.32	0.29	4.9	nd	40	34	nd
BAS-18	0.093	0.64	0.11	nd	nd	nd	nd	nd	nd
BAS-19	0.170	2.90	3.53	0.31	34	18.5	120	53	11
BAS-20	0.380	2.87	1.39	0.33	9	4.2	77	29	nd
BAS-21	0.075	1.0	0.23	0.28	nd	nd	26	nd	nd
BAS-22	0.115	1.0	0.73	0.38	4.3	nd	130	170	21
BAS-23	0.648	1.25	0.31	nd	2.8	nd	40	40	nd
BAS-24	0.069	2.45	1.80	0.27	14	6.1	120	nd	nd
BAS-26	0.582	2.05	0.31	0.39	2.5	nd	30	nd	nd
BAS-27	0.095	2.0	1.94	0.51	13	9.8	110	18	nd
BAS-28	0.243	1.11	0.52	nd	3.4	nd	44	nd	nd
Chronic Multi-contaminant Exceedances	**15**	**27**	**11**	**22**	**0**	**4**	**9**	**15**	**9**
Sub-Chronic Multi-contaminant	**5**	**14**	**3**	**17**	**0**	**1**	**1**	**7**	**0**
Chronic Single-contaminant	**0**	**3**	**0**	**6**	**0**	**0**	**1**	**4**	**3**

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Table 2. Statistical Summary with Chronic, Sub-Chronic Multi-Contaminant, and Chronic Single Contaminant Exposure IATs.

Bold values exceed Chronic IATs; **shaded values** exceed Sub Chronic IATs for Multi-Contaminant targets.

	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene	c5-c8 aliphatics	c9-c12 aliphatics	c9-c10 aromatics
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Chronic IAT [*1] Multi-contaminant	0.081	0.31	0.97	0.072	1000	21	130	42	10
Sub-Chronic IAT* [2] Multi-contaminant	0.35	1.3	4.2	0.31	1000	63	420	130	100
Chronic IAT* [3] Single-Contaminant	0.81	3.1	9.7	0.72	5200	100	630	210	52
90% UPL	0.39	2.9	2.6	1.4	23	13	210	220	33

[*1] Chronic IAT Multi-Contaminant, Table B1. ME DEP Vapor Intrusion Guidance
[*2] Sub-Chronic IAT Multi-Contaminant, Table B2. ME DEP Vapor Intrusion Guidance
[*3] Chronic IAT Single-Contaminant, Table B3. Interim Final Vapor Intrusion Guidance

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Table 3. Statistical Summary with Reporting Limits (Alpha Analytic Laboratory) with Chronic and Sub-Chronic **Multi-Contaminant** Exposure IATs

	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene	c5-c8 aliphatics	c9-c12 aliphatics	c9-c10 aromatics
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Chronic IAT Multi-contaminant	0.081	0.310	0.970	0.072	1000	21	130	42	10
Sub-Chronic IAT Multi-contaminant	0.35	1.30	4.20	0.31	1000	63	420	130	100
Chronic IAT Single-contaminant	0.81	3.12	9.73	0.72	5214	104	625	209	52
Alpha RL SIM	0.044	0.319	0.087	0.26	--	--	--	--	--
Alpha RL	2.0	2.0	2.0	2.0	2.0	2.0 & 4.0	12	14	10
BAQ RL SIM	0.009	0.026	0.035	0.37	0.015	0.096	--	--	--
BAQ RL	0.110	0.180	0.240	3.20	0.230	0.715	--	--	--
90% UPL	0.39	2.9	2.6	1.4	23	13	210	220	33

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Table 4. Comparison of Maine, Massachusetts and New York Typical Concentrations

	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene	c5-c8 aliphatics	c9-c12 aliphatics	c9-c10 aromatics
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Maine									
90% UPL[1]	0.39	2.9	2.6	1.4	23	13	210	220	33
Massachusetts[2]									
50th percentile	--	2.3	1.5	nd	11	5.9	58	68	nd
75th percentile	--	3.6	2.4	nd	21	9.4	130	110	nd
90 th percentile	--	11	7.4	2.7	54	28	330	220	44
New York[3]									
50th percentile	--	2.1	1.0	--	9.5	2.6	--	--	--
75th percentile	--	5.9	2.8	--	26	7.7	--	--	--
90th percentile	--	15	7.3	--	58	19.6	--	--	--

[1] Appendix D

[2] Massachusetts Department of Environmental Protection "Residential Typical Indoor Air Concentrations", 2008. http://www.mass.gov/dep/cleanup/laws/iatu.pdf

[3] New York State Department of Health, "CEH BEEI Soil Vapor Intrusion Guidance: Appendix C: Volatile Organic Chemicals in Air - Summary of Background Databases", 2006. http://www.health.ny.gov/environmental/investigations/soil_gas/svi_guidance/

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Appendices

Appendix A Indoor Air Sampling Survey Screening Questionnaire, Background VOC Monitoring Forms.

Appendix B Laboratory Analytical Results

Appendix C Laboratory Data Quality Assessment

Appendix D Derivation of 90% Upper Prediction Levels

Appendix A

Indoor Air Sampling Survey Screening Questionnaire pg 1 of 1

Do you heat this December with: #2 Fuel Oil ___ Kerosene ___

Tank is located in: Basement ___ Attached garage ___ Unattached garage/Outdoors ____

Primary heating appliance in December is: _____ rough % _____
Located in: basement ___ your living area ___

Secondary heating appliance is: _____ rough % _____
Located in: basement ___ your living area ___

Have there been spills of heating products or other volatile liquids in or around your home?

Are there open containers of volatile liquids in your home [including basement]?

Have you recently used an oil-based paint including varnish, stain, or urethane) anywhere in your home?

Do you use volatile liquids, adhesives or spray aerosols in hobbies in your home [including basement]?

Are there other activities in your home which could contribute to volatile organics in your indoor air?

Is there a bulk plant or facility that sells retail petroleum products within 1000' of your home?

Is your home located on a heavily traveled road?

Is your home located on the road less traveled?

Is there someone home most days?

Name: _____ Address:_____

Town: _____ Work Phone:_____

Work EMail:_____

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Appendix A

Background VOC Monitoring Form pg 1 of 4

Basement		basement	**Homeowner**		
		crawl	**Address**		
		slab-on-grade	**Date & time**		
		other	**Sampler**		

			Building Characteristics	
Openings		foundation windows		Ranch
		full size windows		Raised Ranch
		daylight entrance		Cape Cod
		bulkhead entrance		Colonial
		condition of openings		Contemporary
		notes		Apartment House
				Split Level
Ventilation		open windows		Modular Log Home
		numerous cracks		2-Family
		air/heat exchanger		3-Family
		humidifier		Duplex
		dehumifier		Townhouse/Condo
		air condition on?		Mobile Home
		other		Other
				Insulated, tight?
Floor		concrete		Number of floors
		stone		Year built
		soil		
		cracked concrete		**Attached garage**
		other	**Heating unit**	none
				wood
Foundation		stone		pellet
		concrete		electric
		concrete block		propane
		other		kerosene
			Storage	lawn mower
Moisture		seasonal flooding		snow mobile, ATV
		trickle		car
		damp		truck
		mildew		ventilation
		sump		gasoline
		drainage channels		paints, solvents
		other		other

Appendix A

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Background VOC Monitoring Form pg 2 of 4

Homeowner

Oil Heating System		Other Heating System	
	% used during test		% used during test
	normal % used		normal % used
fuel	fuel oil		wood stove
	kerosene		wood furnace
distribution	forced air		pellet stove/insert
	gravity air		Monitor
	hot water		solar, geothermal
	steam	**distribution**	steam
	source of combustion air		source of combustion air
	location of heater/furnace		location of heater/furnace
	age of system		age of system
	condition		condition
	year of last tune up		year of last tune up
	other		other
	vent		vent
	power vent		power vent
	block chimney		block chimney
	lined flue		lined flue
	gravity draft		gravity draft
	location of fuel tank		location of fuel tank
	condition of fuel tank		condition of fuel tank
	tank notes		notes

OtherVOC Sources		Vents	
	Urban area?		
	Has the building eve:		Clothes dryer vented outside
	Smoking in the building?		Kitchen exhaust fan.Vented where?
	Smoking how frequently?		Bathroom exhaust fan. Vented where
	Workshop or hobby/craft area?		Heat exchanger?
	What kind of hobby?		**Radon mitigation system**
	How frequently, hobby?		Date of Installation
	Odors in the building. Please describe		Active
	Cosmetic products used recently		Passive
	Painting/staining in the last 6 months,? Where?		
	New carpet, drapes, furniture/othertextiles Where & when		
	Pesticide application. When, where & type?		
	Air fresheners used recently. When & type?		

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Appendix A

Background VOC Monitoring Form pg 3 of 4

		Homeowner		
Potential VOC Source Characterization	Location	PID (**ppb**)	Product Description and Condition	Removal Date and Time
Paints or paint thinners				
Gas powered equipment				
Gasoline storage cans				
Cleaning solvents				
Furniture polish				
Moth balls				
Wood/pellet stove				
Fireplace				
Perfumes/colognes				
other				
other				

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Appendix A

Background VOC Monitoring Form pg 4 of 4

Outside temp (F)		Sample I.D.	
Inside temp (F)			
Wind speed & direction		Site Name	
Weather (sunny, cloudy, rain, ?)		Location (basement, living area, etc)	
Precipitation (>0.1") within 12 hrs		6-Liter Summa Cannister I.D.	
PID zero & 10 ppm calibration		Controller I.D.	
2' from tank filter	ppb	Sampling Start Time	
potential sources, list	ppb	Initial Vacuum	
gen living space	ppb	Sampling End Time	
Before PID at cannister	ppb	Final Vaccum	
After PID at cannister	ppb	Notes	

Appendix B

Laboratory Analytical Results

(contact project manager for reports)

Appendix C

Laboratory Data Quality Assessment

Twenty seven (27) homes were sampled by summa canisters with flow controllers set to collect 24-hour average samples and analyzed by Alpha Analytical Laboratory by two methods: the MA Airborne Petroleum Hydrocarbon (APH) method and the EPA TO-15 method in Selected Ion Monitoring (TO-15 SIM) mode. Duplicate samples were collected at two locations to evaluate field duplicate precision. A subset of eleven (11) homes had an additional sample collected in the same manner and sent to the Maine Bureau of Air Quality Laboratory (BAQ) to help evaluate variability among laboratories. One duplicate was also collected and analyzed for field duplicate precision at BAQ.

BAQ is reviewed and accredited by US EPA Region 1 for TO-15 SIM for all the analytes considered in this background study. Alpha Analytical Laboratory (Alpha) is accredited by NELAP for TO-15 and performs the APH test in conformance with the Massachusetts Compendium of Quality Assurance.

Review of the Alpha data included:

- Review of holding times.
- Review of report narrative.
- Accuracy: Surrogate recoveries.
- Bias: Method blank results.
- Accuracy: Laboratory control sample recoveries.
- Precision: Laboratory and Field duplicate relative percent difference (RPD).
- Canister certification (free of contaminants).

Review of BAQ data included:

- Review of holding times.
- Review of calibration records.
- Accuracy: Surrogate recoveries.
- Bias: Method blank results.
- Accuracy: Laboratory control sample recoveries.
- Precision: Laboratory and Field duplicate relative percent difference (RPD).
- Canister certification (free of contaminants).

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Criteria for reviewing data quality are given in the following tables.

Reporting Limits and Acceptance Criteria for Accuracy and Precision

Analyte	Alpha RL ug/m^3	BAQ RL ug/m^3	Chronic IAT ug/m^3	% Recovery	RPD %
1,3-butadiene	0.044	0.05	0.081	70-130	25
benzene	0.319	0.059	0.31	70-130	25
ethyl benzene	0.087	0.051	0.97	70-130	25
naphthalene	0.262	0.388	0.072	70-130	25
toluene	2	0.064	1000	70-130	30
m,p-xylene	4	0.1	21 as total X	70-130	30
o-xylene	2	0.05	21 as total X	70-130	30
c5-c8 aliphatics	12	NA	130	70-130	30
c9-c12 aliphatics	14	NA	42	70-130	30
c9-c10 aromatics	10	NA	10	70-130	30

Acceptance Criteria for Surrogates

Surrogate	Test	Acceptance Criteria
1,4-difluorobenzene	TO-15M	60-140
bromochloromethane	TO-15M	60-140
D,5-chlorobenzene	TO-15M	60-140
1,4-difluorobenzene	APH	50-200
bromochloromethane	APH	50-200
D,5-chlorobenzene	APH	50-200

Both laboratories successfully analyzed all collected samples and quality control information from both laboratories demonstrates data of acceptable quality.

Split laboratory samples did demonstrate differences, especially for naphthalene and to a lesser extent 1,3-butadiene between the two laboratories. The laboratory control sample for the BAQ did not contain naphthalene, therefore the naphthalene results from Alpha are deemed most appropriate to use in calculations of background.

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Split Laboratory Precision:

Samples↓Analyte→	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
BAS-6 / BAQ-1	65	**48.0**	27.1	**138**	**42.1**	39.6
BAS-7 / BAQ-2	na	**42.9**	**48.8**	**136**	29.0	**51.8**
BAS-8 / BAQ-3	na	14.3	3.3	-	1.7	na
BAS-9 / BAQ-4	na	28.8	11.2	**99**		na
BAS-13 / BAQ-5	na	23.8	16.0	**136**	**47.1**	34.0
BAS-14 / BAQ-6	na	7.7	3.5	**112**	0.0	na
BAS-15 / BAQ-7	na	15.7	12.6	**117**	18.3	na
BAS-16 / BAQ-8	54	11.7	12.5	**152**	10.7	na
BAS-17 / BAQ-9	na	8.3	112.4	**69**	**147.5**	na
BAS-18 / BAQ-10	**47**	7.7	12.2	na	na	na
BAS-22 / BAQ-11	63	26.4	12.3	**141**	24.3	na
BAS-22D / BAQ 11D	79	**40.0**	20.0	**142**	23.6	na

Precision is measured in Relative Percent Difference (RPD) and is calculated from the formula: 100*|BAS-BAQ|/Average. All values above 30% RPD are **bold** as outside criteria. RPD calculated from results above reporting limits are color coded green. RPD calculated from results above the method detection limit but below the reporting limit are color coded yellow.

Individual laboratory data quality assessments are summarized below. Laboratory data packages include information for the data quality assessments and are included as an Appendix C in theTypical Indoor Air Concentrations Study.

Alpha Laboratory QC

Field Duplicates: Precision criteria were met for field duplicates.

Analyte ug/m^3	Sample BAS-14	Duplicate BAS-14D	RPD %	Sample BAS-22	Duplicate BAS-22D	RPD %
1,3-butadiene	0.089	0.066	29.7	0.115	0.104	10
benzene	0.82	0.78	4.4	0.997	1.0	0.3
ethyl benzene	0.22	0.22	2.3	0.73	0.77	5.9
naphthalene	0.52	0.5	4.1	0.38	0.37	3.0
toluene	2.8	2.6	7.4	4.3	4.7	8.9
xylene	U	U	NA	U	U	NA
c5-c8 aliphatics	72	73	1.4	130	130	0
c9-c12 aliphatics	26	26	0	170	180	5.7
c9-c10 aromatics	U	U	NA	21	23	5.7

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Lab report: **L1121751** Samples: **BAS-21, BAS-20**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- Precision criteria were met for all field duplicates.
- All canisters were certified. The precision of the pre and post flow controller calibration check for BAS-21 was greater than 20% RPD. However, adequate sample was collected to perform the required analysis.

Lab report: **L1121518** Samples: **BAS-10, BAS-11, BAS-12, BAS-27**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified. The precision of the pre and post flow controller calibration checks for BAS-11 & BAS-12 were greater than 20% RPD. However, adequate sample was collected to perform the required analyses.

Lab report: **L1121193** Samples: **BAS-22, BAS-22D, BAS-23**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.

- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified.
- Sample BAS-22D is a field co-located duplicate of BAS-22.

Lab report: **L1121190** Samples: **BAS-16, BAS-17, BAS-18, BAS-15, BAS-14, BAS-14D, BAS-13**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified.
- Sample BAS-14D is a field co-located duplicate of BAS-14.

Lab report: **L1121195** Samples: **BAS-8, BAS-9, BAS-6, BAS-7**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified.

Lab report: **L1120878** Sample: **BAS-3**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.

- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified. The precision of the pre and post flow controller calibration check was above 20% RPD.

Lab report: **L1120877** Sample: **BAS-2**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified. The precision of the pre and post flow controller calibration check was above 20% RPD.

Lab report: **L1120874** Sample: **BAS-1**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.
- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified.

Lab report: **L1120879** Samples: **BAS-4, BAS-5**

- All samples were analyzed within holding times.
- MADEP MCP met all requirements except reporting limits for benzene and naphthalene. All samples had measurable amounts of benzene and naphthalene above the laboratory reporting limits.
- Surrogate Recoveries for all tests, both TO-15M and APH are within acceptance limits.

- No analytes were detected in the method blanks for either TO-15M or APH analysis.
- Accuracy criteria were met for all laboratory control sample analytes for both TO-15M and APH tests.
- Precision criteria were met for all laboratory duplicate analytes for both TO-15M and APH tests.
- All canisters were certified.

Bureau of Air Quality (BAQ) Laboratory QC

Field Duplicate Precision: Precision criteria were met for the field duplicate.

Analyte ug/m^3	Sample BAQ-11	Duplicate BAQ-11D	RPD %
1,3-butadiene	0.22	0.24	8.7
benzene	1.3	1.5	14.3
ethyl benzene	0.82	0.94	13.6
naphthalene	2.18	2.18	0
toluene	5.49	5.96	8.2
xylene	4.43	4.98	11.7

Batch: 122011 Samples: **BAQ-3, BAQ-6, BAQ-7, BAQ-8, BAQ-10**

- All samples were analyzed within holding times.
- Calibration Standards met QC criteria.
- Surrogate recoveries met criteria for all samples.
- One compound, toluene, was detected in the method blank above the method detection limit but below the reporting limit. All sample results for toluene were more than 10 times the amount detected in the method blank.
- Accuracy criteria were met for all laboratory control sample analytes.
- Precision criteria were met for all laboratory duplicate analytes.
- All canisters were certified.

Batch: 010312 Samples: **BAQ-9, BAQ-5, BAQ-4, BAQ-1, BAQ-2, BAQ-11, BAQ-11D**

- All samples were analyzed within holding times.
- Calibration Standards met QC criteria.
- Surrogate recoveries met BAQ criteria for all samples except BAQ9. One surrogate, D4 1,2-dichloroethane, was slightly outside the acceptance criteria at 133% recovery. The acceptance criterion for Alpha is 60-140%, which has been used to set the project criteria, so it does meet the criteria for the project.
- No compounds were detected in the method blank above laboratory method detection limits.
- Accuracy criteria were met for all laboratory control sample analytes.
- Precision criteria were met for all laboratory duplicate analytes.
- All canisters were certified.

Appendix D

Derivation of 90% Upper Prediction Levels

In order to derive a statistic that is consistent with ME DEP rules and guidance and that is comparable to the use of percentiles by similar states, the laboratory results were analyzed using US EPA software ProUCL 5.0 in order to establish 90% Upper Prediction Limits (90%UPLs).

The ProUCL 5.0 Technical Guide suggested that the data included outliers that the project team must evaluate in order to determine whether or not the outliers should be included in the UPL computations. Inclusion of the outliers would preserve the entire data set, yet lead to typical indoor air concentration values that are less conservative than those computed without use of outliers. As recommended in the ProUCL 5.0 Technical Guide, 90% UPLs were computed both with and without inclusion of the outliers identified by the ProUCL 5.0 software. 90% UPLs that were computed without the inclusion of two outliers for benzene, ethylbenzene, naphthalene, toluene, xylene and the C5-C8 aliphatic fractions are included here to use as much of the analytic data as possible and to establish conservative typical indoor air concentration values. See Tables D.1 and D.2 below.

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Table D.1 Analytic Results in Ascending Order by Compound.

Outliers are identified in bold font at bottom.
(n>=25, Rosner Test; n<25, Dixon Test. ProUCL 5.0)

	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene	c5-c8 aliphatics	c9-c12 aliphatics	c9-c10 aromatics
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Reporting Limit	0.044	0.319	0.087	0.26	2.0	2, 4	12	14	10
1	nd	0.390	0.113	nd	nd	nd	nd	nd	nd
2	nd	0.543	0.217	nd	nd	nd	26	nd	nd
3	nd	0.546	0.230	nd	nd	nd	30	nd	nd
4	nd	0.549	0.282	0.262	2.5	nd	34	nd	nd
5	0.053	0.639	0.300	0.267	2.8	nd	38	nd	nd
6	0.06	0.639	0.308	0.278	2.8	nd	40	18	nd
7	0.064	0.815	0.308	0.283	2.8	nd	40	24	nd
8	0.069	0.824	0.313	0.288	3.4	nd	44	26	nd
9	0.069	0.898	0.321	0.309	3.4	nd	52	29	nd
10	0.07	0.997	0.369	0.315	4.3	nd	54	34	nd
11	0.075	1.00	0.512	0.33	4.8	nd	57	40	nd
12	0.089	1.00	0.517	0.378	4.9	nd	72	46	nd
13	0.093	1.11	0.725	0.393	5.8	nd	77	53	nd
14	0.095	1.13	0.838	0.450	8.5	nd	100	54	nd
15	0.104	1.25	1.31	0.472	9.0	nd	100	56	nd
16	0.115	1.63	1.39	0.514	12	4.2	110	62	nd
17	0.137	1.90	1.54	0.519	13	4.7	120	82	nd
18	0.148	2.00	1.60	0.54	13	5.5	120	90	11
19	0.155	2.05	1.72	0.661	14	6.1	130	120	17
20	0.17	2.06	1.80	0.786	17	8.7	170	140	18
21	0.184	2.09	1.94	0.870	17	8.9	180	140	20
22	0.243	2.45	1.95	1.05	18	9.8	180	170	21
23	0.376	2.87	2.01	1.36	18	10.8	220	230	22
24	0.38	2.90	3.53	1.58	**34**	**18.5**	240	230	43
25	0.462	**4.47**	**5.99**	1.78	**39**	**25.9**	360	270	56
26	0.582	***5.56***	***7.6***	***2.38***	***49***	***35.9***	***400***	280	59
27	0.648	***13.3***	***14.1***	***3.95***	***110***	***73***	***680***	340	59
Outliers identified	0	**3**	**3**	**2**	**4**	**4**	**2**	0	0
Outliers dropped	0	***2***	***2***	***2***	***2***	***2***	***2***	0	0

Typical Petroleum Compound Concentrations in Maine Residential Indoor Air

Table D.2 General Statistics of Sample Set Used to Compute 90% UPLs

	1,3-butadiene	benzene	ethyl benzene	naphthalene	toluene	xylene	c5-c8 aliphatics	c9-c12 aliphatics	c9-c10 aromatics
NumObs	27	25	25	25	25	25	25	27	27
Num Ds	24	25	25	22	22	10	24	22	10
NumNDs	3	0	0	3	3	15	1	5	17
% NDs	11%	0%	0%	12%	12%	60%	4%	19%	63%
Reporting Limit	0.044	0.319	0.087	0.26	2.0	2.0 / 4.0	12	14	10
Minimum	0.044	0.390	0.113	0.262	2.5	4.2	26	18	11
Maximum	0.648	4.47	5.99	1.78	39	25.9	360	340	59
Skewness	1.61	1.40	2.33	1.55	1.58	1.60	1.48	1.01	0.55
CV	0.93	0.66	1.08	0.71	0.87	0.67	0.76	0.84	0.59
Distribution	normal	gamma	gamma	non parametric	normal	normal	normal	gamma	lognormal
ProUCL 5.0	90% KM UPL (t)	90% UPL	90% UPL	90% KM UPL (t)	90% KM UPL (t)	90% KM UPL (t)	90% KM UPL (t)	90% Approx. Gamma UPL WH	90% KM UPL (t)
90% UPL	0.393	2.88	2.62	1.448	23.06	13.11	213.4	219.7	32.73