Ted Stevens Anchorage International Airport
Air Toxics Monitoring Study

Environmental Quality Program
Environmental Services Division
Department of Health and Human Services
Municipality of Anchorage

April 21, 2003

Acknowledgements

The Municipality of Anchorage Environmental Quality Program thanks the American Lung Association of Alaska and the Alaska Department of Environmental Conservation (ADEC) for technical and financial support for this project. In particular, we thank American Lung Association of Alaska and Tom Chapple, Gerry Guay, Clint Farr, and Jeff Hickman of ADEC. We also thank JoEllen Lewtas, USEPA, John Williamson, Washington Department of Ecology, and Naydene Maycut, Puget Sound Clean Air Agency for their advice in the selection of the monitoring methods used in this study. For review of the plan and for serving as a forum for citizen input we thank the AMATS Citizens Air Quality Advisory Committee. The Committee expressed an interest in improving public input in the design of future studies. Finally we would like to thank Scott Lytle and the Ted Stevens Anchorage International Airport for their cooperation in this project. Scott helped to coordinate sampling on airport property and provided photographs utilized in this report.

Ted Stevens Anchorage International Airport Air Toxics Monitoring Study

Introduction and Purpose

The purpose of this ambient monitoring study was to address concerns about toxic air pollution and associated odors in parklands and neighborhoods adjacent to the Ted Stevens Anchorage International Airport. Odor complaints have led to citizen concern about toxic air pollution in the airport vicinity. The airport is bounded on the south and west by Kincaid Park (a large cross-country skiing park) and by residential areas on the north, east, and south. Complaints are most common in the winter. Park users and local residents complain about strong odors that are presumed to be related to airport activities.

The two primary objectives of this study were to:

1. characterize the "typical" range of 24-hour average concentrations for specific volatile organic compounds (VOCs) in the ambient air in the vicinity of the airport during the winter and compare these to other parts of Anchorage;
2. quantify the concentration of these VOCs during short-term odor events to determine whether there is a relationship between these odor events and elevated levels of one or more of these VOCs.

Monitoring was conducted from January 19, 2002 through February 28, 2002.

Methodology

Canister sampling system

Sampling was performed in conformance with EPA Compendium Method TO-15 using Summa canisters suitable for non-polar VOCs. Summa canisters were also used for concurrent carbon monoxide (CO) sampling. A "passive" flow restrictor system, requiring no power or shelter, was used to collect 24-hour and 30-minute "complaint-based" samples. Sample flow control was accomplished by using flow restrictors manufactured from 0.01 cm diameter GC capillary tubing cut to about 40 cm in length. Because the sample flow rate was a function of the vacuum in the canister, it declined slowly throughout the sample period. A previous Anchorage study showed that this flow control system provided an average flow of 2.3 cc/min at the beginning of the 24-hour sample period dropping to approximately 1.6 cc/min at the end. This same flow restrictor system was used successfully in three earlier Anchorage VOC studies conducted between 1993 and 1996.[1, 2,]

Laboratory Analysis

Canister samples were analyzed by Indaco Air Quality Services under contract with the Muncipal Department of Health and Human Services and the American Lung Association of Alaska. EPA Method TO-15 was used to quantify ambient concentrations of 31 different VOCs. Ethene and ethyne were quantified using a modified TO-15 method. Carbon monoxide (CO) was analyzed by gas chromatography with a methanizer and flame ionization detector. Analytical methods are summarized in Table 1.

Table 1. Analytical Methods

Analyte	Method
TO-15 VOCs	EPA Compendium Method TO-15
Ethene and Ethyne	TO-15 cryofocusing preconcentration technique followed by analysis using an HP-5890 Series II GC with a Carbosphere column and a flame ionization detector
Carbon monoxide	HP-5890 GC with a methanizer, mole sieve capillary column, and a flame ionization detector

A reporting limit of 0.5 ppbv is established in EPA Method TO-15 method. Reporting limits for the 34 target compounds evaluated in the study are listed in Table 2.

Table 2. Target Analytes

Analytes determined by Method TO-15:	Reporting Limit (ppbv)
1,1,1-Trichloroethane	0.5
1,1,2,2-Tetrachloroethane	0.5
1,1,2-Trichloroethane	0.5
1,1-Dichloroethane	0.5
1,1-Dichloroethene	0.5
1,2-Dichlorobenzene	0.5
1,2-Dichloroethane	0.5
1,2-Dichloropropane	0.5
1,3-Dichlorobenzene	0.5
1,4-Dichlorobenzene	0.5
Benzene	0.5
Bromomethane	0.5
Carbon Tetrachloride	0.5
Chlorobenzene	0.5
Chloroform	0.5
Chloromethane	0.5
cis-1,2-Dichloroethene	0.5
cis-1,3-Dichloropropene	0.5
Ethylbenzene	0.5
m,p-Xylene	0.5
Methylene Chloride	0.5
o-Xylene	0.5
Styrene	0.5
Tetrachloroethene	0.5
Toluene	0.5
trans-1,3-Dichloropropene	0.5
Trichloroethene	0.5
Trichlorofluoromethane	0.5
Vinyl Chloride	0.5
1,2,4-Trimethylbenzene	0.5
1,3,5-Trimethylbenzene	0.5

Compounds determine by other methods:	Reporting Limit
Ethene	0.5 ppbv
Ethyne	0.5 ppbv
Carbon Monoxide	0.2 ppmv

Site selection

A total of ten sampling sites were selected for study. These sites are shown in Figure 1.

Figure 1. Location of Canister Sampling Sites

Site No.	Site Name	Location / Description
1	Kincaid	Kincaid Park approx 300 meters north of ski chalet
2	Little Campbell Lake	On airport fence line approx 200 meters northeast of Little Campbell Lake
3	NWS	National Weather Service office complex, 6930 Sand Lake Road
4	B-Concourse	Roof of Concourse B Passenger Terminal
5	North Runway	End of North Runway along airport fence line
6	Jones Lake	Turnagain residential area near Jones Lake
7	Turnagain	Permanent CO monitoring station, 3201 Turnagain Blvd.
8	Seward Hwy	Permanent CO monitoring station, 3002 New Seward Hwy
9	Garden	Permanent CO monitoring station, 3000 E. 16th Street
10	Ocean Dock Road	Ocean Dock Road southwest of Port of Anchorage

Six sampling sites were located in close proximity to the airport or on airport property itself. One site was located on the roof of the B Concourse passenger terminal, three sites were located to the south of the airport and two to the north. On the south side of the airport, the Kincaid site was located in Kincaid Park approximately 300 meters north of the ski chalet. The National Weather Service (NWS) site was located at the NWS office on Sand Lake Road, and the Little Campbell Lake site was located on the fence line of the airport northeast of Little Campbell Lake. Two sites were located to the north of the airport. One was located adjacent to a residential area near Jones Lake. The other site was located just east of the north end of the north runway. This runway is heavily used for takeoffs during winter months when the predominant wind direction is from the north.

Three canister sites were collocated with permanent CO monitors at the Garden, Turnagain and Seward Highway stations. This allowed the canister CO measurements from the contract analytical laboratory to be compared with Federal reference method measurements collected at the permanent stations and provided an opportunity to evaluate the quality of the data collected using the canister method. The Garden CO station also served as a sampling site during three previous air toxics sampling studies.[i] Locating a canister sampling site at the Garden station allowed data collected during this study to be compared with these previous studies. These studies showed a very strong correlation between VOCs and CO. VOC concentrations tended to be highest on days with elevated CO. Emission inventory data suggest that the predominant source of CO and VOCs at the Garden, Turnagain, and Seward Highway sites is gasoline-fueled motor vehicles.

The final canister site was located on Ocean Dock Road near the Port of Anchorage. In contrast to the sites at Garden, Turnagain and Seward Highway, the predominant source of VOC emissions at the Ocean Dock Road site was presumed to be diesel emissions. Ocean Dock Road is a major truck route and heavy-duty diesel trucks comprise a large proportion of the vehicles on this roadway. During peak hour periods, single and double-trailer trucks comprise nearly 50% of all traffic on the road.[3] In comparison, on most other Anchorage roadways, heavy-duty truck volumes make up less than 2% of the traffic. The aim was to identify particular VOCs associated with diesel emissions. The diesel truck emission "VOC fingerprint" from this site would then be contrasted with the gasoline vehicle emission fingerprint in canisters collected at the Garden, Turnagain and Seward Highway sites. In addition, because of the similarities between diesel and jet fuel, the hope was that any distinguishing characteristics discovered in samples collected at the Ocean Dock Road site would be helpful in identifying aircraft emissions generated at the airport.

Photographs of a number of the sampling sites are shown in Figures 2(a-c). Arrows in these photographs indicate locations where canisters were deployed (canisters were not deployed when photos for the Kincaid and Ocean Dock Road sites were taken).

[i] VOC canister sampling was conducted here as part of the Anchorage VOC monitoring project in 1993-94 and then again in 1994-1996 as part of an indoor and outdoor VOC monitoring project.

Figure 2(a) Concourse B Site – canister shown deployed on far right hand side of roof

Figure 2(b) Kincaid Park Site

Figure 2(c) Ocean Dock Road Site

Sampling schedule

Prior to beginning the study, a sampling schedule was established to allow sampling to be performed mostly during weekday periods to minimize overtime, shipping and related costs. Evacuated canister samples were used to collect 24-hour samples during 14 separate sampling periods between January 19 and February 28, 2002. Although a prescribed sampling schedule was established prior to beginning the study, some deviations were made from the schedule due to weather. Sampling was generally not conducted on days when high winds were forecast because low concentrations of VOCs and CO were likely. When feasible, sampling was delayed until the weather changed so that collection of higher 24-hour concentrations of target analytes was more likely. Weather and ambient CO measurements collected during the study suggest that meteorological and pollution stagnation conditions during the 14 sampling periods were reasonably representative of the range of conditions encountered in a typical January and February in Anchorage. The weather and CO concentrations encountered during sampling periods were compared with the January- February norm. This comparison is provided later in the report.

A local environmental contractor was employed to perform the majority of the canister sampling. For security reasons, however, airport staff was utilized to collect samples on the airport property site at the Concourse B terminal. For the nine sites off airport property, the 24-hour canisters were generally deployed midday and retrieved 24 hours later. Logistics required that

the 24-hour samples collected at the Concourse B site start four to six hours earlier than the other samples.

For all samples, sampling was initiated by manually opening the canister valve at the beginning of the sample period and closing it at the end. For 24-hour samples, study protocol required the interval between opening and shutting the valve to be 24 hours plus-or-minus 30 minutes. Municipal Department of Health and Human Services staff provided oversight to ensure that the sampling protocol and documentation procedures were properly followed.

In addition to the 24-hour samples, canister sampling was also performed in response to odor complaints. Shorter-term (30-minute) samples were to be collected during these odor events. At the beginning of the study, it was anticipated that up to ten odor-related samples would be collected during the study period. However, very few odor complaints were received during the study period, and only two odor-related samples were collected. Both of these samples were collected over a 30-minute period.

Meteorological Data

Surface weather observations (e.g., wind speed and direction, temperature, cloud cover) for the Ted Stevens Anchorage International Airport (at Point Campbell) compiled by the National Climatic Data Center were obtained for the study period. These local climatological data reports provided surface weather observations at three-hour intervals. Temperature, wind speed and wind direction observations recorded during each of the 14 sampling periods are compiled in Table 5 which appears later in this report.

Results and Discussion

Summary of VOC and CO Results – 24-hour Canister Samples

Only eight of the 34 compounds analyzed appeared in concentrations above reporting limits in any of the canister samples taken during the study. These compounds were benzene, toluene, ethylbenzene, m,p-xylene, o-xylene, CO, ethene and ethyne. Although ethene and ethyne were found in reportable concentrations in more than half the samples, results for this analyte are not presented here because of questionable data quality. Quality assurance and data quality are discussed later in this report.

Average and maximum concentrations for each of the six compounds that were found above the reporting limit and met minimum data quality objectives are summarized in Table 3.[ii] The table also shows the number of samples above the laboratory reporting limit for each analyte as a proportion of the number of valid samples collected.

[ii] When an analyte was found below the reporting limit in a particular canister, the average concentration was calculated by assuming a concentration of half the reporting limit (i.e., 0.25 ppbv if the reporting limit was 0.5 ppbv).

Table 3. Average and Maximum Concentration of Analytes Found at Sampling Sites

	Kincaid	Little Campbell Lake	NWS	Concourse B	North Runway	Jones Lake	Turnagain	Seward Hwy	Garden	Ocean Dock Road
Toluene (ppbv)										
Average	0.47	0.44	0.89	1.88	0.95	1.91	2.83	4.99	4.22	2.03
Maximum	1.94	1.71	2.48	4.61	6.97	3.87	8.68	10.96	13.89	4.53
# above report limit	4/14	5/14	7/13	12/13	5/13	12/14	12/13	13/13	14/14	12/13
Benzene (ppbv)										
Average	0.30	0.33	0.57	1.10	0.35	0.73	2.02	2.76	2.27	0.99
Maximum	0.60	1.08	1.06	2.24	0.71	1.30	4.58	4.41	4.54	1.47
# above report limit	2/14	2/14	7/13	12/14	3/13	10/14	12/13	14/14	14/14	13/13
m,p-xylene (ppbv)										
Average	0.25	0.25	0.42	0.77	0.32	0.46	0.78	1.77	1.04	0.80
Maximum	0.25	0.25	1.02	2.48	0.81	1.18	3.23	4.38	3.30	1.89
# above report limit	0/14	0/14	4/13	6/13	2/13	5/14	5/13	11/13	8/14	7/13
o-xylene (ppbv)										
Average	0.25	0.25	0.30	0.36	0.25	0.27	0.44	0.72	0.48	0.38
Maximum	0.25	0.25	0.66	0.86	0.25	0.58	1.37	2.23	1.27	1.09
# above report limit	0/14	0/14	2/13	3/13	0/13	1/14	3/14	7/13	5/14	3/13
Ethylbenzene (ppbv)										
Average	0.25	0.25	0.25	0.34	0.25	0.25	0.38	0.58	0.43	0.36
Maximum	0.25	0.25	0.25	0.74	0.25	0.25	1.08	1.46	0.90	0.71
# above report limit	0/14	0/14	0/13	3/13	0/13	0/14	3/13	7/13	5/14	4/13
CO (ppmv)										
Average	0.21	0.16	0.40	0.76	0.23	0.36	0.95	1.28	0.88	0.42
Maximum	0.43	0.41	1.01	2.02	0.38	0.75	2.17	2.29	2.02	0.64
# above report limit	6/10	5/10	10/10	10/10	8/10	8/10	9/9	9/9	10/10	9/9

The highest concentrations of benzene, toluene, ethylbenzene, m,p-xylene, o-xylene (BETX compounds) and CO were found at the Seward Highway, Garden and Turnagain sites. The lowest concentrations of BETX and CO were found at the Kincaid, Little Campbell Lake and National Weather Service (NWS) sites. The data suggest that sites with the greatest influence from gasoline-fueled motor vehicles had the highest BETX concentrations. Sites in and around the airport tended to have lower BETX concentrations presumably because they were affected less by automobile emissions. Maximum and average 24-hour average BETX concentrations from each site are plotted in Figures 3(a-b). Sites are plotted in order of combined BETX concentration.

Figure 3(a) Maximum 24-hour BETX Concentrations at Canister Sites

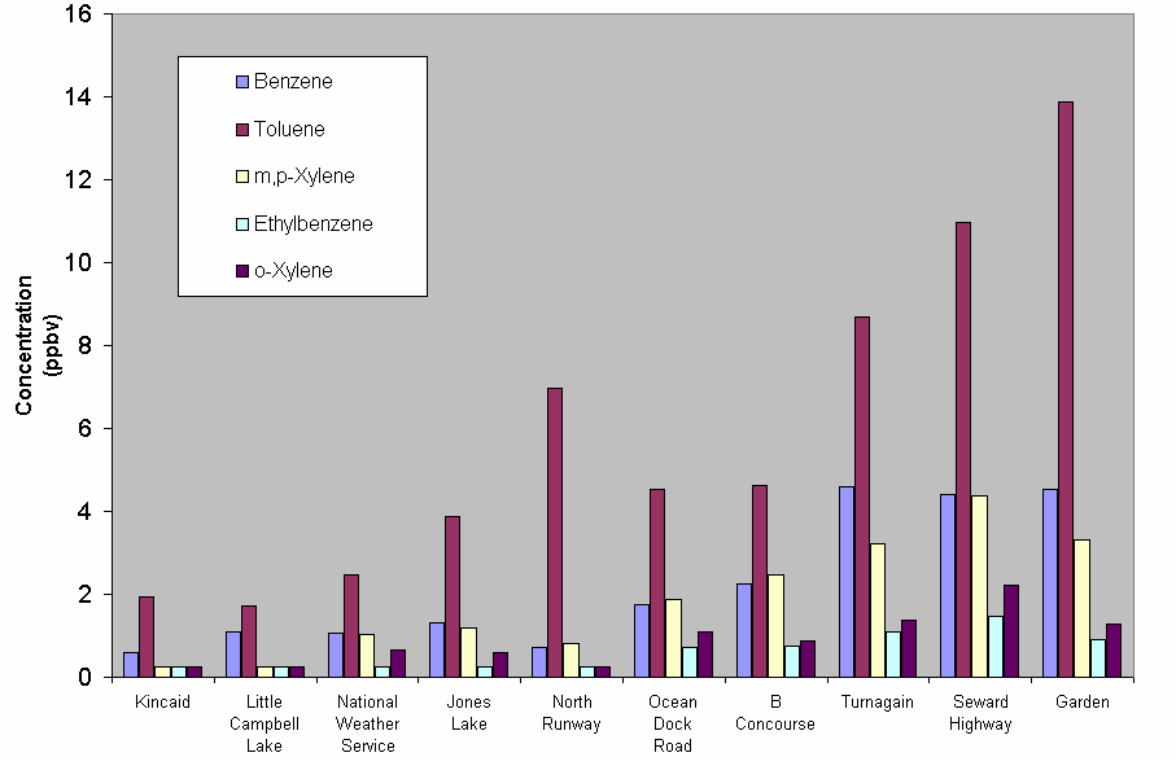
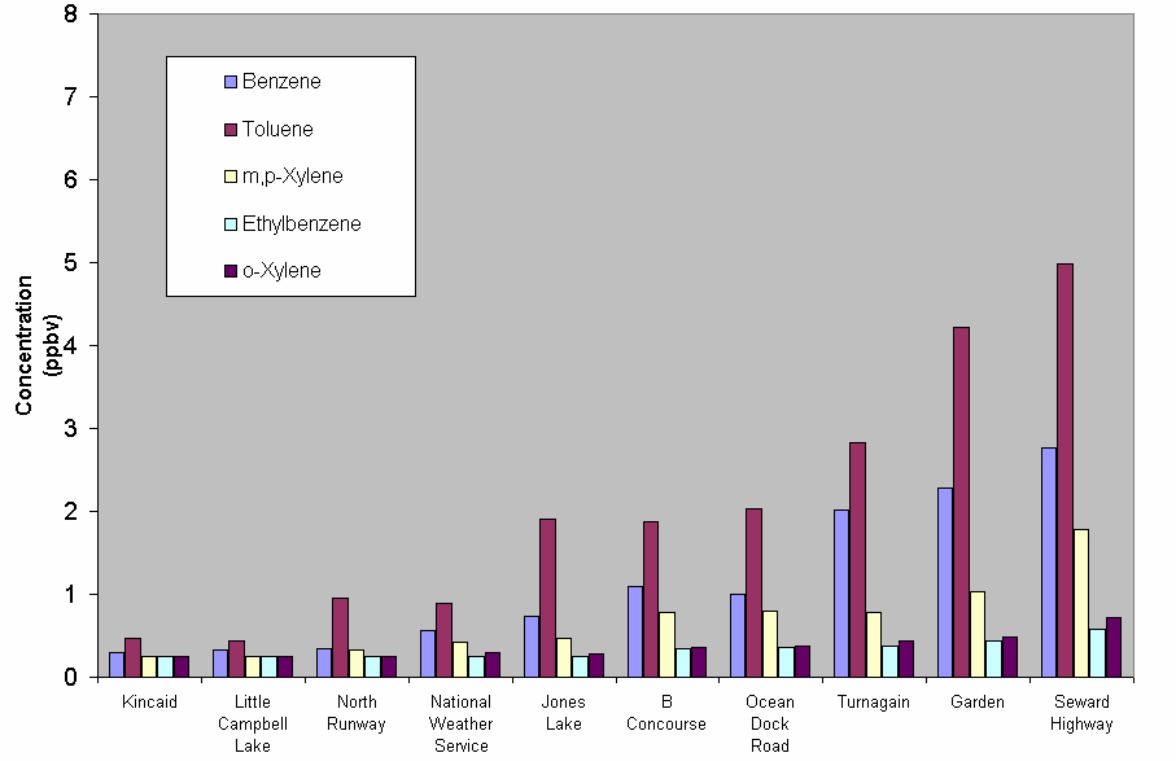


Figure 3(b) Average 24-hour BETX Concentrations at Canister Sites



Attempt to Link VOC Concentrations with Odor Complaints

The second objective of the study was to quantify the concentration of these VOCs during short-term odor events to determine whether there was a relationship between these odor events and elevated levels of one or more of the VOCs. As stated earlier, only one complaint was received during the study period. A 30-minute canister sample was collected in response to this complaint. A second 30-minute canister sample was collected when field sampling personnel smelled a strong diesel or jet exhaust odor at the NWS site. Detectable odors were present during at least a portion of each 30-minute period when canister samples were collected. Analytical results are presented in Table 4.

Table 4. VOC and CO Concentrations when Exhaust Odors were Detected (30-minute canisters)

	11:04 – 11:34 AM, Feb 13, 2002 7000 Tall Spruce	**1:52 – 2:20 PM, March 1, 2002 NWS site, 6930 Sand Lake Road**
Benzene	<0.5 ppbv	<0.5 ppbv
Toluene	0.99 ppbv	0.59 ppbv
m,p-Xylene	<0.5 ppbv	<0.5 ppbv
Ethylbenzene	<0.5 ppbv	<0.5 ppbv
o-xylene	<0.5 ppbv	<0.5 ppbv
CO	0.37 ppmv	0.25 ppmv

No inordinate or atypical values were found among any of the tested analytes in these two canisters even though odors were present when sampling was performed. In both canisters, only toluene and CO were present at levels above the reporting limit. Neither compound was found in high concentration. This suggests that either the compounds causing odors are not included among the compounds analyzed or, if one or more of the target compounds are associated with odors, the odor threshold for these compounds is below the reporting limit of the analytical method. Airport records showed no unusual activity during complaint sampling.

The 24-hour canister data were also examined to determine whether any of the VOCs tested in this study might be specifically associated with diesel and/or aircraft exhaust. The data were examined to see whether there were elevated concentrations of one or more specific analytes at the Ocean Dock Road site and/or airport sites. If found in elevated concentration, these analytes could serve as an indicator of diesel and/or aircraft exhaust emissions. No such "indicator analytes" were found. In addition, an extensive examination of analyte-to-analyte concentration ratios (e.g., benzene/ toluene ratio) was performed in hopes of identifying an indicator of diesel/aircraft exhaust. This effort was unsuccessful.

Comparison of Weather Conditions during Sampling Period to January and February Norms

One of the primary objectives of the study was to collect VOC samples during a range of typical Anchorage winter weather conditions. Because weather is such an important factor in determining pollutant concentrations, sampling during atypical conditions (e.g. unseasonably warm and windy, or conversely, unseasonably cold with light winds) could bias results. For this reason an analysis of the weather conditions during sample periods was performed to determine whether they were representative of typical January through February conditions.

Weather conditions encountered during the fourteen 24-hour sampling periods were compared to the historical norms reported from the NWS airport weather observatory at Point Campbell. Temperature, wind speed, and wind direction data for each sampling period are compiled in Table 5. The 24-hour average temperature recorded during the 14 sampling intervals ranged

from a low of –4 °F to +35 °F. Average wind speeds ranged from less than one mile per hour to 12 mph. The wind direction was predominantly from the north, northwest or northeast.

Over the course of the fourteen 24-hour sampling periods, average temperature and wind speeds were very close to January / February norms. The average temperature during the 14 sampling periods was 18.8 °F about 2 degrees higher than the historical norm. The average wind speed registered during the sample periods was 6.5 miles per hour, very close to the 6.6 mile per hour January / February norm.

Table 5. Weather Conditions during Canister Sampling Periods

Sample Number	Sample Date	Nominal Start Time	Average Temp (°F)	Average Wind Speed (mph)	Resultant Wind Direction
1	1/19/02	12 AM	27.3	6.1	N
2	1/20/02	12 AM	17.6	5.9	NE
3	1/25/02	1 PM	-4.3	2.4	N
4	1/26/02	1 PM	4.8	7.0	NE
5	1/31/02	11 AM	21.6	5.8	N
6	2/1/02	12 AM	18.3	5.9	N
7	2/6/02	11 AM	22.9	0.6	N
8	2/7/02	11 AM	21.8	3.3	N
9	2/13/02	2 PM	19.3	12.4	NW
10	2/14/02	1 PM	29.6	12.0	N
11	2/19/02	3 PM	12.9	5.3	N
12	2/20/02	3 PM	4.6	3.3	NE
13	2/27/02	2 PM	34.6	9.6	W
14	2/28/02	2 PM	31.6	11.1	S
Average over 14 sample periods			**18.8**	**6.5**	**N**
January / February Norm			**16.7**	**6.6**	**N**

Comparison of CO Concentrations during Canister Sampling Periods with Typical January/February Concentrations

The CO concentration measured at permanent monitoring stations provides a good indicator of the potential for build-up of VOCs and other pollutants. Three previous Anchorage studies have shown that CO concentrations are strongly correlated with VOC concentrations. Presumably, the same stagnant meteorological conditions that contribute to a build-up of CO also increase VOC concentrations. Thus, comparing the CO concentrations measured during canister sampling periods with historical norms can provide an indirect indication of how stagnation conditions during the 14 sampling periods compared with historical norms.

Three years of CO data from the Turnagain CO station were analyzed to determine the “normal” percentile distribution of the 24-hour average CO concentration during the January-February period. Data from 2000, 2001 and 2002 were examined and the 25th, 50th, 75th, 90th, and 99th percentile concentrations were calculated from the data set. Because these were calculated from a full three years of January/February data with varying weather, these percentile

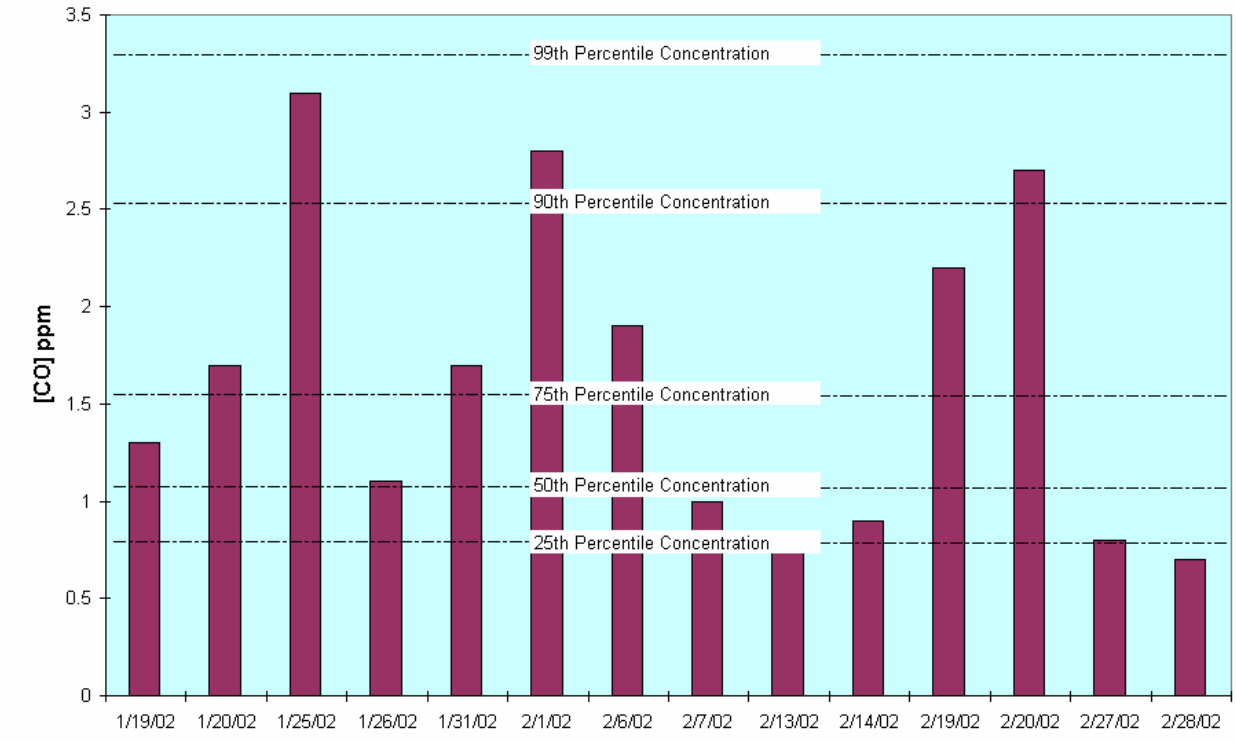
concentrations likely reflect the normal or typical distribution of 24-average values at Turnagain expected in January and February. These percentile concentrations are compiled in Table 6.

Table 6. 24-hour Average CO Concentrations by Percentile at the Turnagain Station

Percentile	24-hour Average CO Concentration
25th percentile	0.76 ppm
50th percentile	1.05 ppm
75th percentile	1.53 ppm
90th percentile	2.52 ppm
95th percentile	2.78 ppm
99th percentile	3.38 ppm

The percentile concentrations listed Table 6 are compared to the 24-hour CO concentrations measured during study sampling periods in Figure 4. Three of the 14 sampling periods had CO concentrations that fell above the 90th percentile concentration. This is an indicator that relatively strong inversion or stagnation conditions were in place during these sampling periods and elevated concentrations of VOCs and other toxic pollutants would be expected. CO concentrations during half (7 of 14) of the sampling periods were above the 75th percentile. Nine were above the median or 50th percentile. Fewer samples were collected on low CO concentration days. Five of the 14 sampling periods were below the 50th percentile and two were below the 25th percentile.

Figure 4. 24-hour CO Concentration at Turnagain Monitor on Canister Sampling Days



This analysis suggests that the distribution of CO encountered during sampling days was reasonably representative of the range of CO concentrations expected during January and February. It also implies that the range of stagnation conditions encountered was also representative, including a number of days when VOC concentrations would be expected to be high.

Quality Assurance

Pre-Study Precision Assessment

The first two days of canister sampling were dedicated to validation of the laboratory method. Canisters were paired (collocated) at five sites the first day and six sites the second day. Some of the sites selected for this pre-study precision assessment were located in garages and inside homes where detectable levels of some analytes were more likely to be found than at outdoor locations. Results reported by the laboratory were evaluated for precision. In order to meet data quality objectives, Method TO-15 requires that the average difference between analyte concentration measured in paired canisters differ by no more than 25%. This requirement was applied only when an analyte concentration of one or both canisters was at least three times the reporting limit. For TO-15 compounds, at least one of the canisters in the pair had to have a concentration of at least 1.5 ppbv (three times the reporting limit of 0.5 ppbv) to be included in the precision evaluation.[iii] A summary of the pre-study precision assessment is presented in Table 7.

[iii] Only paired results with at least one of the values at 1.5 ppbv or more were evaluated because of the large % variance resulting from a small differences in values below 1.5 ppbv. For example, a canister pair with values of 0.5 ppbv and 0.8 ppbv has an absolute difference of only 0.3 ppbv but a percentage difference of 46%. The reasonable analyst would consider the precision in this case acceptable because values are at or near the reporting limit.

Table 7. Results of Pre-Study Precision Assessment

Analyte	Number of canister pairs with analyte concentrations ≥ 3x the reporting limit	Average absolute % difference between paired canisters	Range of Differences	% of canister pairs differing by less than 25%
Benzene	4	5%	0% to 13%	100%
Toluene	7	24%	1% to 50%	43%
Ethylbenzene	3	20%	0% to 47%	67%
m,p-Xylene	4	24%	2% to 57%	75%
o-Xylene	3	24%	0% to 58%	67%
Ethene	3	39%	9% to 55%	33%
Ethyne	3	40%	35% to 46%	0%
Methylene Chloride*	2	19%	6% to 32%	50%
1,1,1 –Trichloroethane*	2	12%	8% to 15%	100%
1,3,5-Trimethylbenzene*	2	15%	1% to 29%	50%
1,2,4-Trimethylbenzene*	2	13%	2% to 24%	100%
Trichlorofluoromethane*	1	17%	---	100%
Tetrachloroethene	2	3%	2% to 3%	100%
Styrene	1	22%	---	100%
Total (all analytes)	**39**	**21%**	**0% to 58%**	**64%**

* Reportable concentrations of Methylene Chloride, 1,1,1 –Trichloroethane, 1,3,5-Trimethylbenzene, 1,2,4-Trimethylbenzene, and Trichlorofluoromethane (CFC 11) were only found at sites where canister pairs were deployed inside homes or garages.

Table 7 shows that the 25% average precision requirement was met among the majority of analytes. The only analytes not meeting this requirement were ethene and ethyne, neither of which are TO-15 compounds. Carbon monoxide precision was not assessed because of a laboratory mix-up.

Precision Evaluation Performed During Sampling Rounds

Precision evaluation continued during the January 19 through February 28 sampling period. During each of the 14 sampling rounds, collocated sampling was performed at one of the ten sampling sites. The sampling site where paired samples were collected was changed every sampling period. The laboratory was unaware of where the collocated sample was taken.

During the study, only eight analytes were found at levels above the reporting limit. Precision evaluation results are presented in Table 8. Again, paired results were included in this evaluation only when the analyte concentration from one or both canisters was at least three times the reporting limit.

Table 8. Results of Precision Evaluation during Sample Rounds

Analyte	Number of canister pairs with analyte concentrations ≥ 3x the reporting limit	Average absolute % difference between paired canisters	Range of Differences	% of canister pairs differing by less than 25%
Benzene	4	16%	5% to 33%	75%
Toluene	5	28%	17% to 59%	60%
Ethylbenzene	0	--	--	--
m,p-Xylene	1	28%	28%	0%
o-Xylene	0	--	--	--
Ethene	9	30%	0% to 148%	78%
Ethyne	6	41%	8% to 159%	67%
Carbon monoxide	4	17%	0% to 57%	75%
Total (all analytes)	**29**	**28%**	**0% to 159%**	**69%**

Table 8 shows that only benzene and carbon monoxide met the 25% average precision requirement. Toluene and m,p-xylene nearly met this requirement; both analytes had an average difference of 28% between collocated canister pairs, just over the 25% criteria. Neither ethylbenzene or o-xylene appeared in concentrations above the 1.5 ppbv threshold established for inclusion in the precision evaluation so precision results were unavailable for these compounds.

Precision results for ethene and ethyne were poorer than other analytes. For ethene, the average percent difference between collocated canisters was 30%, and for ethyne, 41%. For some canister pairs, differences sometimes approached or exceeded 150%. Sampling results for ethene and ethyne were not included in the report because of questionable data quality.

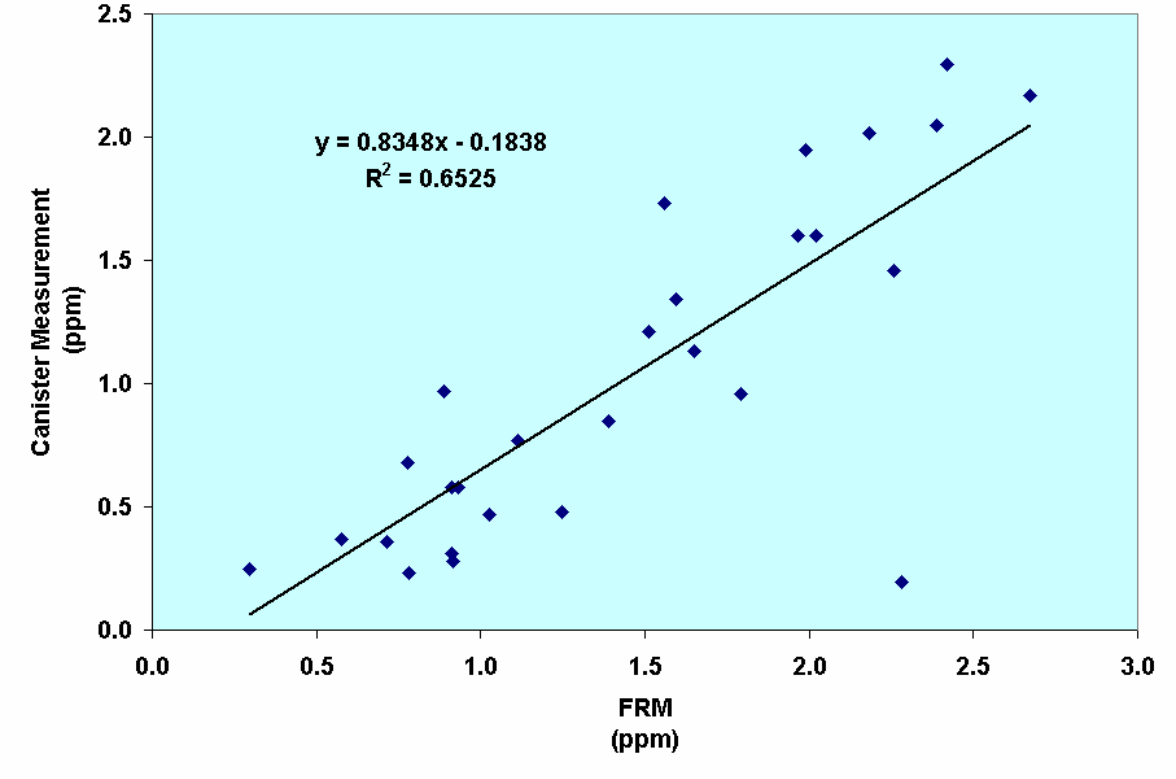
Assessment of Conformance with Field Sampling Protocols

HMH Consulting, LLC performed field deployment and collection activities. HMH personnel deployed canisters on a routine schedule starting with site number 1 (Kincaid Park) and ending with site 10 (Ocean Dock Road). Canisters remained in place for 24 hours, with the collection time required to be within 15 minutes of the deployment time. This objective was achieved for all but one sample canister when collection was delayed several minutes by an obstinate moose! Field personnel routinely reported to their MOA coordinator immediately after retrieval or whenever problems were encountered.

Comparison of Canister CO Measurements with Reference Method

Canisters were collocated with Federal Reference Method (FRM) CO monitoring instruments at three sites, Turnagain, Seward Highway, and Garden. This allowed the CO determined from the canisters to be compared with CO from the FRM instruments. Given the fact that many of the CO values observed were near reporting limits for the canister method, fairly good agreement between the canister and FRM was observed ($R^2 = 0.64$). On average, canister measurements of CO were approximately 30% lower than the FRM. Canister and FRM measurements are compared in Figure 5.

Figure 5. FRM CO vs. Canister CO Concentration



Assessment of Field Blanks

A field blank was deployed during each of the 14 sample rounds as a control for contamination. Eleven of the fourteen canister blanks had no detectable contamination. On three occasions, however, the blank showed evidence of significant contamination. Toluene contamination was noted in two of the canisters and carbon tetrachloride in the other. In two of the three cases where contamination occurred, the amount of contaminant found in the blank canisters exceeded the maximum concentration found in any of the sample canisters deployed during that round. Interestingly, in the two canisters where toluene contamination was found, other VOCs normally associated with toluene (i.e. other BETX compounds) were not detected. Although significant carbon tetrachloride contamination was found in one canister field blank, it was never found in any of the samples during the study. The source of contamination in these three cases could not be determined.

A "blank correction" could not be made because there was no consistent or systematic means to account for these isolated cases of contamination. The contamination values are shown in Table 9.

Table 9. Blank analysis

Sample Round	Contaminant	Contaminant Concentration (ppbv)	Maximum Concentration found in 24-hour Samples (ppbv)
9	Toluene	1.62	7.50
13	Toluene	7.96	4.53
14	Carbon tetrachloride	12.9	None detected
No detectable blank contamination in sample rounds 1-8, and 10-12.			

Accuracy - Audit Sample Performance

Audit samples of typical concentrations of TO-15 analytes were purchased from ERG in Research Triangle Park to assess contract laboratory accuracy. Six canisters from the contract testing laboratory were sent from Anchorage to the audit lab. The audit lab filled two canisters with zero air and four with different mixtures of 31 VOCs. The six canisters were returned to Anchorage and sent to the contract lab for analysis together with a normal shipment of 24 canisters. The contract laboratory was unaware of which canisters contained the audit samples. The two zero air canisters were determined by the lab to be below the detection limit for all analytes. Results from the other four audit canisters are presented in Table 10.

Table 10. Audit Results (31 analytes in each audit sample)

Audit canister number	Average audit concentration (ppbv)	Average lab result (ppbv)	Average difference (%)
1	2.04	1.31	43%
2	3.14	2.15	38%
3	4.73	3.27	37%
4	9.25	7.24	24%
		Average:	**36%**

The analyte concentrations reported by the contract laboratory were consistently lower than the value purported by the laboratory that prepared the audit canisters. The average difference between the contract laboratory and audit value exceeded the acceptable TO-15 audit criterion of 30% for three of the four canisters.

There are a number of possible explanations for these differences. One explanation is that the audit canisters were held for a longer period of time before analysis than the sample canisters. Because they had to be shipped to Anchorage before they were shipped to the contract lab, they were prepared six weeks before they were analyzed. It is possible that this long holding time resulted in poor recovery for some analytes, particularly for the more polar compounds. Indeed, styrene, the most polar of the analytes tested, had the poorest recovery and failed to meet the 30% TO-15 audit criteria in any canister. Audit performance among less polar compounds was better; toluene and benzene audit results were acceptable in three of the four canisters. Higher recovery rates were found in canisters containing the highest VOC concentrations. Higher concentration samples are generally less prone to recovery losses over time. This supports the possibility that long holding times affected audit performance.

Unfortunately, after the contract laboratory concluded their analysis, the canisters were not retested by the audit laboratory. This might have revealed whether long storage times contributed to the poor audit results. It would also have been desirable to have a third, independent laboratory analyze the audit canisters. As it stands now, there is no way of knowing whether the audit canisters were properly prepared. Poor audit performance could have been the fault of the audit laboratory that prepared the canisters rather than the contract analytical laboratory. Without an independent analysis by a third laboratory, results of the audit are inconclusive.

Conclusions

Of the 34 compounds analyzed in this study, only eight appeared in concentrations above the reporting limit. These compounds were benzene, toluene, ethylbenzene, m,p-xylene, o-xylene, CO, ethene and ethyne. Ethene and ethyne were not reported because of questionable data quality.

Generally, BETX and CO concentrations were lower at airport sites than at sites away from the airport. BETX and CO concentrations measured at the Turnagain, Garden and Seward Highway sites were typically two to ten times higher than sites near the airport. The Turnagain and Garden sites were located in residential areas and the Seward Highway site was located at a major midtown intersection. Recent emission inventories have shown that motor vehicle emissions are the predominant source of CO and BETX near these sites.[4] Presumably, relatively low concentrations of BETX were found near the airport because there was less motor vehicle activity near the airport sites. This is particularly true of the more remote sites in Kincaid Park (i.e., the Kincaid and Little Campbell sites). Among airport sites, Concourse B had the highest levels of BETX and CO. This site was likely influenced by motor vehicle emissions at the passenger terminal pick-up and drop-off and aircraft ground service equipment, which is largely gasoline-fueled.

This study was unable to establish a link between specific analytes and odor complaints. Only one odor complaint was received during the study period and the 30-minute sample taken during the odor event did not show evidence of elevated levels of any of the 34 compounds targeted in the study. A second odor-associated sample was taken by field personnel who noticed a jet exhaust odor during regular sample rounds. No inordinate or atypical values were found among any of the analytes tested in this sample canister either.

The data were examined to determine whether any of the VOCs tested in this study might be specifically associated with diesel and/or aircraft exhaust. Data collected from the Ocean Dock Road site, located immediately adjacent to a heavily used diesel truck route, were examined to determine whether specific analytes or analyte-to-analyte ratios could serve to as an indicator of diesel or aircraft emissions. Despite an extensive effort, no indicators could be found. This suggests that the compounds causing odors were not among the compounds analyzed or that the compounds creating odors are present at levels below the reporting limit of the analytical method employed in this study.

Currently there are no universally accepted methods for evaluating odors associated with diesel and/or aircraft exhaust emissions. Because this study did not associate jet exhaust odors with specific analytes or combinations of analytes, our recommendation is to test for diesel exhaust odors using another method, when one has been proven.

The Health Effects Institute's Diesel Working Group has recently established the identification of a diesel exhaust signature as an important research need. They plan to initiate a research program aimed at identifying a chemical component or components that specifically represents diesel in an air pollution mixture. This effort will be important for any future studies of the airport contribution to ambient air toxics in Anchorage.

References

---

[1] Final Report on the Operations and Findings of the Anchorage VOC Monitoring Project, L. Taylor, S. Morris, Document #95-RA110.04, presented at the 88th Annual Meeting of the Air & Waste Management Association (San Antonio, TX), June 1995

[2] Architectural, Behavioral and Environmental Factors Associated with VOCs in Anchorage Homes, A. Schlapia, S. Morris, Document # 98-A504, presented at the 91st Annual Meeting of the Air & Waste Management Association (San Diego, CA), June 1998

[3] Ship Creek Multi-Modal Transportation Plan, Municipality of Anchorage Traffic Department, December 2000

[4] Anchorage Carbon Monoxide Inventory and Attainment Projections, prepared by the Department of Health and Human Services, Municipality of Anchorage, October 2001