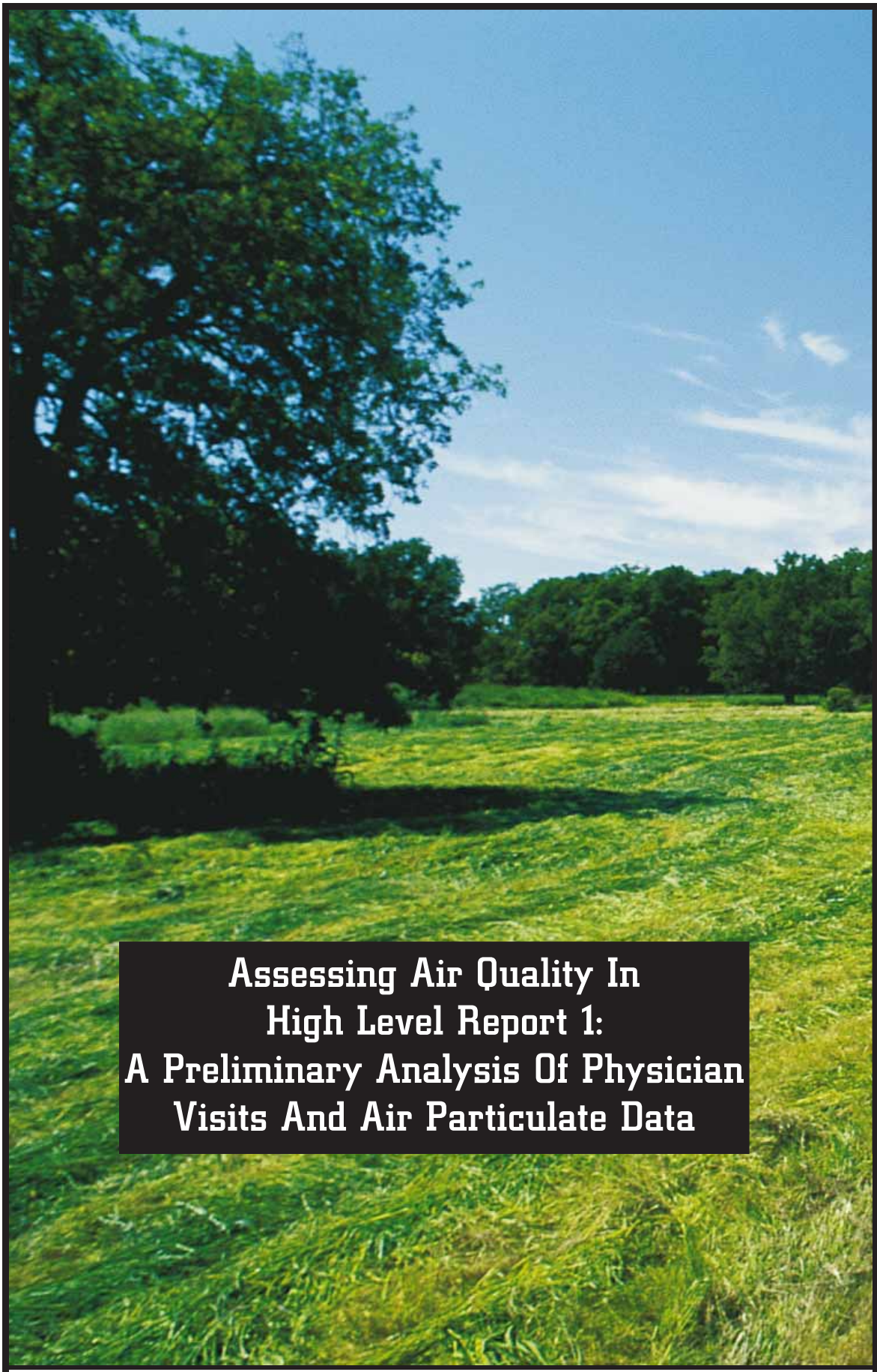

Assessing Air Quality In High Level Report 1: A Preliminary Analysis Of Physician Visits And Air Particulate Data

REPORT

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ASSESSING AIR QUALITY IN HIGH LEVEL
REPORT 1:

A PRELIMINARY ANALYSIS OF PHYSICIAN VISITS AND AIR PARTICULATE DATA

by
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for the

Northwestern Health Services Region # 17
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Executive Summary

A study was done to assess air quality from a human health perspective in High Level. The purpose of this study was to address some of the concerns with respect to air quality in High Level. There were two major components of the study. These involved an examination existing health data on selected respiratory diseases, and a collection of direct measures of air quality.

The air quality component of the study focused on estimates of the personal exposure levels to selected air pollutants and how these exposures related to ambient levels of the pollutants. This study was undertaken by the Northwestern Health Services Region with assistance from Health Surveillance, Alberta Health.

This study found that inhalable particulate levels in personal exposures were 60% to 70% higher than levels in indoor or outdoor air. The character of the particulates in personal exposures was also different with several elements present in higher concentrations on the particulates compared to indoor or outdoor air. These findings are not a cause for alarm as other studies have reported similar results. The reasons for the differences in inhalable particulate character were not clear but more may be learned to explain these differences with further sampling.

The study found the hospital roof (sampling location of the routine air monitoring done by the local forest products company) was representative of the particulate concentrations at the other outdoor sites but did not correlate with the personal samples. This indicates that the historical data collected from the hospital roof is a good indicator of the outdoor air quality in the area but caution should be used when predicting indoor or personal particulate concentrations based on this outdoor data.

The indoor air did not show significantly higher levels of PM 10 and 2.5 compared to the outdoor air. This is similar to findings in other studies. The composition of the indoor air particulate was however significantly different than the outdoor particulate.

The health data component of the study showed rates of physician claims for the respiratory disorders in High Level were less than the provincial average. Among the non-aboriginal population the rates were only slightly lower than the provincial average while among aboriginal people, the rates in High Level were less than half the provincial average for aboriginals. These results show that there was no evidence of higher rates of physician claims for the respiratory disorder investigated with the rates for the non-aboriginal population being near or below the provincial average and the aboriginal rates being well below the provincial average.

This study was an initial step in addressing the air quality concerns in High Level. The study showed that relationship between personal exposure and outdoor air quality was not readily apparent and further characterization of personal exposure to air borne pollutants in High Level is recommended with consideration for any seasonal variations that may be occurring.

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1.0 INTRODUCTION

The level of contamination from man-made pollutants in the environment and the impact it may have on human health is a concern to residents of many communities in Alberta. In High Level there has been some concern with respect to air quality. High Level Forest Products are to be commended for their work in air quality monitoring within the vicinity of High Level and providing reports on the ambient concentrations of dust and inhalable particulates. However, in addition to this information, data on personal exposures would be helpful because actual exposure to a pollutant does not always correlate well with pollutant exposures estimated using data from fixed ambient air monitoring stations.

This study collected air quality data in High Level to determine actual levels of personal exposure. The information will assist the Northwestern Health Services Region with the interpretation of the ambient data and enable better assessment of potential impact on human health. This human health air quality assessment is one of a number of initiatives of this type under way in the province of Alberta. Comparisons will be made to the data collected in other areas of the province.

2.0 BACKGROUND AND RATIONALE

In general, exposure can be defined as any contact between a substance, biological agent or radiation and an individual or community. We are all exposed to low levels of contamination in the air we breathe, the food we eat, the water we drink, and the consumer products we use. Contaminants can interfere with the normal biological functions, causing effects ranging from subtle biochemical changes to clinical disease. The concept of a continuum from source of contamination to the final health effect is a basic feature of all contemporary risk models. Determining the risk posed by environmental contaminants to populations requires knowledge about the following fundamental components:

- source(s) of contaminants;
- transport of agents in the environment;
- exposure of individuals and communities to chemicals;
- dose received by those exposed (biological markers of exposure);
- early biological effects resulting from the dose (biological markers of effect); and
- health effects.

The output of each component in the chain of events serves as input to the next. The lack of information on any one component thus impairs our ability to make accurate assessments of the associated population health risks. Our knowledge about the source and transport of chemicals and other agents in the ambient environment is increasing as the result of environmental monitoring programs. However, additional evaluation is required to characterize regional and local variations in personal exposure.

In dealing with population health outcomes which may be attributable to long-standing exposures to low-levels of contaminants, we are confronted with the difficult and complex

problem of chronic health effects. A number of conditions, such as cancers, disorders of the cardiovascular system, neurological disease, chronic respiratory ailments, and many other diseases, have important environmental, behavioral, social, and genetic links. The causes of these conditions are multifactorial in nature. Other characteristics such as multistage development, long induction time, and the absence of information on individual and population exposure make progress in chronic disease prevention slow and tenuous. In order to be able to address these issues, more than ever, there is a need to look beyond one-time epidemiological studies.

Environmental health surveillance is a tool which can be used to gather data and information on the health of people for the purpose of tracking and detecting trends and associations among a broad range of environmental and health related variables. The process consists of an on-going, systematic collection, analysis, and interpretation of selected data on health outcomes, environmental quality parameters, and population exposure. In addition, data on behavioral, lifestyle, social, economic, and other confounding variables are also considered.

The monitoring study carried out in High Level focused on estimating the potential personal exposure levels to selected air pollutants and relating these exposures to ambient levels of the pollutants. This study was undertaken by the Northwestern Health Services Region and the Health Surveillance branch of Alberta Health.

2.1 Program Objectives

The High Level Human Health Air Quality Assessment program will gather information to describe the personal exposure to airborne particulates and summarize the existing health data from the area.

3.0 Methods

3.1 Air Quality Monitoring Procedures

The field monitoring program was intended to collect samples to help characterize the exposure of the population to sulfur dioxide (SO_2), volatile organic compounds (VOCs), nitrogen dioxide (NO_2), ozone (O_3), and inhalable particulates. Each compound of interest was monitored for 24-hour periods.

A summary of the laboratory and sampling requirements for the High Level air quality study include:

Inhalable Particulates:

> The same two houses were sampled each day for a period of ten days. The sampling plan for each house was one personal sample, two indoor samples (one 10 μm and one 2.5 μm) and two outdoor samples (one 10 μm and one 2.5 μm), yielding a total of 100 samples. In addition, 20 outdoor samples were planned to be collected on the roof of the local hospital to correlate to the ambient data that have been collected. A total of 120 samples were planned to be collected in High Level throughout the monitoring period.

Other parameters (VOCs, Ozone, SO_2, and NO_2):

Two houses were sampled each day for a period of ten days. For each house, one personal sample, one indoor sample and one outdoor sample was collected, yielding a total of 60 samples of each contaminant. In addition, 10 outdoor samples were collected on the roof of the local hospital. A total of 70 samples of each contaminant were collected in High Level throughout the monitoring period.

During each day of the monitoring period, personal, indoor, and outdoor samplers were placed and collected at selected houses.

Personal exposure monitors (PEMs) were used to collect VOCs, nitrogen dioxide, ozone, and particulates (less than 2.5 μm or 10 μm in aerodynamic diameter) in the participant's breathing zone. Stationary indoor monitors (SIMs) and stationary ambient monitors (SAMs) were used to collect VOCs, nitrogen dioxide, ozone, and particulates (2.5 μm and 10 μm in aerodynamic diameter) inside and outside of each home and on the hospital roof.

Exact locations of the study participants homes will not be given here but they were in the same area of town as the hospital.

3.2 Measurement of a Health Outcome

The health measure used to analyze the existing health data was the rate of physician claims. Although the incidence rate (the number of new cases over a given time in population at risk) would have been of most value for the risk quantification from exposure, its estimation from the available administrative data was not possible. Prevalence rates, as follows, were used:

Rate of physician claim (RPHYS): Total number of physician claims for a given disease in a postal code during 1994 and 1996 per 100,000 population. It is calculated as

$$\text{RPHYS} = \frac{\text{Total number of physician claims for disease, 1994-96}}{\text{Total population during 1994 to 1996}} \times 100{,}000$$

The health data base used in this study contained several levels of diagnosis (1^{st}, 2^{nd} , 3^{rd} etc.). The primary diagnosis was listed as the 1^{st} level. The health measures were made as sensitive as possible by including all claims that had the health disorder in question diagnosed at any level.

3.3 Schedule

The first day of sampling was May 22, 1997 and the last day was June 4,1997. There were ten sampling days during the period of study and four days where no samples were taken.

4.0 Results

4.1 Results of Air Quality Study

This is a preliminary analysis of the inhalable particulate data collected during the study. Further analysis of this and the other air contaminants data collected is planned in conjunction with the Oil Sands Community Exposure and Health Effects Assessment study in Fort McMurray.

The two aspects of the inhalable particulates that were analyzed are the mass concentration of the particulates and the composition of the particulates. The mass concentration of the particulate matter was determined in the laboratory by weighing particulates collected on a filter and dividing by the amount of air filtered to collect the particulates (mass particulate / vol. air). Further laboratory work was performed on the particulate matter to determine the weight of specific elements present which provides information on the composition of the particulates.

4.1.1 Particulate Mass Concentration

4.1.1.1 Analysis by sampler location

Table 1 and Figure 1 compare the mass concentrations of inhalable particulates collected from the sampling in High Level. The table and figure shows samples grouped by location and sample type. The table shows alpha values from t-tests used to determine the significance level of the differences in the means. The outdoor samples in Figure 1 a) indicate the three sampling locations had similar particulate concentrations. The figure also shows particulate concentrations varied considerably day to day during the study. Part c) of Table 1 shows a statistical comparison of the outdoor samples taken at the three locations and shows no significant difference between the locations.

Figure 1b indicates that the indoor samples do not correlate well between the two locations and it also show considerable variations in PM concentrations one day to the next. The figure indicates that Home B has higher readings of PM 10 and PM 2.5 when compared to Home A and Table 1b shows the average concentrations at the two locations are significantly different (alpha=1.2% and 0.2%) for both PM 10 and 2.5.

In Figure 1c the personal samples indicate considerable variation in particulate concentrations one day to the next and between the two study participants. There were fewer personal samples available for analysis making the trends weaker. It appears from the figure that Home B has higher personal exposure than Home A but due to the limited sampling this is not certain. Table 1d also shows the higher averages at Home B but does not indicate that these differences are significant (alpha=47% &12%)

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4.1.1.2 Sampler Type

Table 1a shows outdoor air has the lowest concentration for PM 2.5 followed by indoor and personal air with the highest concentrations. The differences between indoor and outdoor air were not significant (alpha=20%) while the differences with personal and indoor air were significant with alpha=0.9% and personal vs. outdoor alpha=0.1%. For PM 10 the table shows the lowest concentrations in indoor air followed by outdoor an personal air. The differences between indoor and outdoor air are not significant (alpha=31%). Again the personal samples were significantly different than both indoor and outdoor air (alpha=0.3% & 1.0).

This analysis showed that the hospital roof sampling location was representative of the PM concentrations at the other outdoor sites but does not correlate with the indoor and personal samples. This indicates that the historical data collected from the hospital roof can predict concentrations at some other outdoor sites but caution should be used when predicting indoor or personal PM concentrations based on these outdoor data.

4.1.2 Analysis of particulate composition

The two ways used to discuss the compositions of the particulate matter are the elemental concentration in air (mass element/vol. air) and the elemental concentration in the particulate (mass element/mass particulate). The concentration in air is the amount of the various elements in air associated with the inhalable particulates which relates directly to exposure. To relate elemental concentration in the particulate to exposure, the mass concentration of the particulate in air must be used. The elemental concentration in the particulate is useful in that it describes the character of the particulates which can be used to compare indoor, outdoor and personal air particulates.

The amount of selenium(Se), chlorine(Cl) and beryllium(Be) present in the particulate samples was lower than the detection limit. These elements are not included in further analysis.

In this analysis the samples are grouped by the type of sample (indoor, outdoor, or personal). Table 2 contains a summary of the air and particulate concentrations of the elements used in this analysis for both PM 10 and 2.5. Using the data in the table, the differences in the element concentrations between indoor, outdoor and personal air are plotted in Figures 2 to 5. In the figures, the vertical axis is the percent difference and the horizontal axis contains the list of elements.

4.1.2.1 PM 10

Figures 2 and 3 show the differences in the element concentrations in air and particulate associated with PM 10. Figure 2a shows the differences in the air concentrations for the elements between personal and indoor air samples. The figure shows many of the elements investigated had significantly higher air concentrations in personal air compared to indoor air and only four had lower, none of which were significant. This is as expected given the analysis of the previous section which indicated there was 70% more PM 10 in personal air than indoor air. The elements in Figure 2a that do not demonstrate 70% lower concentrations in indoor air are an indication that the particulate composition in personal air is different than indoor. Figure

3a demonstrates these composition differences in PM 10 compositions by showing the elements that have significantly different concentrations in personal PM 10 compared to indoor PM 10. Elements in Figure 3a that have a very different concentration in particulate are evident in Figure 2a by either being higher or lower than the 70% difference expected. This reflects the differences in the composition of the pm10 in the personal air and indoor air.

The comparison of personal to outdoor air for the air and particulate concentration has similar results to the personal vs. indoor comparison.

The analysis of the mass of PM 10 in indoor and outdoor air previously indicated no significant difference in the mass concentration. With the mass concentration of PM 10 between indoor and outdoor air the same, the differences in element concentrations in air shown in Figure 2b is due to the differences in composition of the particles as shown in Figure 3b. As expected, Figures 2 b) and 3 b) are very similar showing that the differences in the elements concentrations in air are due to the differences in the elements concentrations in the particulate.

4.1.2.2 PM 2.5

The results of the analysis of the PM 2.5 data are similar to the results for pm10 in the previous section.

Figure 4a and 5a show there are significant differences between personal and indoor air both in terms or air and particulate concentrations of the elements. The previous analysis showed there were roughly 60% more PM 2.5 particulates in personal air compared to indoor and outdoor air. The elements in Figure 4a that do not have the 60 % difference expected, generally have different particulate concentrations of the element (Figure 5a). This is also true for the personal air to outdoor air comparison (Figures 4c and 5c).

In the outdoor to indoor air comparison there were many significant differences shown in the air (Figure 4 b) and particulate (Figure 5 b) concentrations of the elements. These differences were consistent in both air and particulate concentrations (i.e. an element with a 50% higher air concentration also had 50% higher particulate concentration). The previous sections showed the mass concentration of PM 2.5 was not significantly different between indoor and outdoor air (Table 1a). The differences in the air concentrations of the elements were due to the differences in the particulate concentrations. While the mass of PM 2.5 was not significantly different between indoor and outdoor air, this analysis shows the character of the particulate was significantly different. Possible explanations for the different character are either the outdoor particles pick up more elements when they enter the house or a certain amount of the indoor particles are of a different origin with different concentrations or some combination of the two. There is not enough information to investigate this issue further in this study.

4.2 Results Of Health Data Analysis

These results have been taken from a study comparing solution gas flaring activities with respiratory disorders (Surveillance Branch of Alberta Health; Alberta Health, 1998). The data and text applicable to the High Level situation are provided here.

Table 3 provides the International Classification of Diseases (ICD) codes (ninth version) used for the study and the number of claims found in the entire province for each respiratory disorder during 1994 to 1996 fiscal years. Also shown is the distribution of the claims between single and multiple visits.

As shown in the table, the number of contacts with the health care system (health care providers/hospitals) can vary dramatically by person and disease with one year totals ranging from 1 to 282. Over 52 percent of individuals contacting the system during the study period only had one visit in a year.

The rates were estimated for each postal code and for the whole province. Physician claims rates were also estimated for the population according to Aboriginal status and urban/rural status. The postal codes in the High Level Area were classified as rural by Canada Post. Table 4 shows the estimated rates for the respiratory disorders in question. All the rates were standardized to the 1991 Alberta age distribution. This process removes the potential impact from differences in the age structure across comparison groups.

The estimated rates of physician claims for each health disorder at the postal code level were mapped and are shown in Figures 6 to 9. These maps show the pattern of physician claims rates through the province and allow a comparison of High Level rates with other areas near by.

Table 4 shows the rates of physician claims for the High Level and Fort Vermillion postal codes and the rural population of the entire province. The rural population in the province is defined for this study as people with a postal code beginning T0# ### which includes the small communities similar in size to High Level. The table also divides the population by aboriginal or non-aboriginal status because this was shown to be a significant factor in previous studies (Alberta Health, 1998).

Comparing the claims rates in the High Level postal code to rural Alberta shows that High Level was lower for every health disorder listed except pneumonia where High Level was slightly higher for non-aboriginal. Interestingly the aboriginal claims rates in the High Level postal code were only half of the rates for the rest of the province.

Comparing the claims rates in the High Level postal code area to the Fort Vermillion postal code area for non-aboriginal showed High Level had lower rates for respiratory infections and bronchitis and higher for pneumonia and asthma. Comparing the aboriginal population showed High Level lower for all disorders investigated except asthma when compared to Fort Vermillion.

5.0 Conclusions

This study found that concentrations of PM 10 and 2.5 were 60 to 70% higher in personal air compared to both indoor or outdoor air. Not only was there a higher mass of particulates in

the personal air, the composition of the particulates was different (resulting in the personal exposure to several elements contained in the particulates different than expected). These finding are not cause for alarm as other studies have reported similar results. The reasons for the differences in inhalable particulate character are not clear, however as more samples are taken in communities in Alberta, more may be learned to explain these differences.

This analysis showed that the hospital roof sampling location was representative of the PM concentrations at the other outdoor sites but does not correlate with the personal samples. This indicates that the historical data collected from the hospital roof can predict concentrations at other outdoor sites but caution should be used when predicting personal particulate concentrations based on these outdoor data. This supports the findings in other studies that show ambient samples are not a good measure of personal exposure.

The indoor air did not show significantly higher levels of PM 10 and 2.5 compared to the outdoor as was found in other studies. The composition of the indoor air particulate was however significantly different than the outdoor particulate which means the exposures are different.

Generally the analysis of the health data showed that the rate of physician claims for the respiratory disorders in High Level was less than the provincial average. These results show that there was no evidence of higher rates of physician claims for the respiratory disorder investigated with the rates for the non-aboriginal population being near or below the provincial average and the aboriginal rates being well below the provincial average.

6.0 Recommendations

Another series of sampling personal exposure to air contaminants is recommended to further characterize personal exposure. The next sampling should take place in the winter (i.e. January) to investigate any seasonal variations that may be occurring.

References

Alberta Health, 1997, The Alberta Oil Sands Community Exposure and Health Effects Assessment Program. July 1997.

Alberta Health, 1998, The Alberta Oil Sands Community Exposure and Health Effects Assessment Program. July 1997.

Table 1: Comparison of mass concentrations of inhalable particulates

a) Sample Type Comparison								
	pm 2.5				pm 10			
Sample Type	mean ug/m^3	stdev	n	alpha	mean ug/m^3	stdev	n	alpha
indoor	10.8	4.4	16	20%	17.5	4.4	13	31%
outdoor	8.9	4.4	24	0.1%	22.1	15.6	17	1.0%
personal	26.5	21.8	10	0.9%	57.2	42.4	4	0.3%

b) Location Comparison for Indoor Samples								
	pm 2.5				pm 10			
Sample Location	mean ug/m^3	stdev	n	alpha	mean ug/m^3	stdev	n	alpha
Home A	7.8	3.1	7	1.2%	14.4	3.0	7	0.2%
Home B	13.1	4.0	9		21.0	3.0	6	

c) Location Comparison for Outdoor Samples								
	pm 2.5				pm 10			
Sample Location	mean ug/m^3	stdev	n	alpha	mean ug/m^3	stdev	n	alpha
Home A	9.1	5.5	7	96%	19.4	15.1	8	18%
Home B	9.0	4.6	8	87%	34.6	20.8	4	10%
Hospital	8.6	3.8	9	84%	16.4	5.7	5	68%

d) Location Comparison for Personal Samples								
	pm 2.5				pm 10			
Sample Location	mean ug/m^3	stdev	n	alpha	mean ug/m^3	stdev	n	alpha
Home A	31.8	29.4	5	47%	24.8	13.9	2	12%
Home B	21.1	11.7	5		89.5	32.0	2	

Table 2: Summary of air and particulate concentrations of elements analyzed in this study

		Element Particulate Concentration (units ng/mg)						Element Air Concentration (units ng/m$^{3)}$					
		pm 10			pm 2.5			pm 10			pm 2.5		
Elements	Symbol	outdoor	indoor	personal	outdoor	indoor	personal	outdoor	indoor	personal	outdoor	indoor	personal
Silver	Ag	0.63	5.16	7.26	0.67	6.97	4.39	0.01	0.09	0.48	0.01	0.08	0.25
Aluminum	Al	32,449.98	25,779.60	20,149.15	12,496.51	19,797.42	15,599.64	827.23	500.82	1,402.54	131.68	253.69	449.63
Arsenic	As	16.68	16.79	12.35	16.19	15.59	6.42	0.41	0.33	1.11	0.17	0.21	0.22
Boron	Bq	185.14	267.23	150.67	349.71	358.84	267.53	3.46	5.00	6.83	3.31	4.05	6.35
Barium	Ba	596.61	455.19	335.52	211.44	390.16	236.49	15.88	9.00	25.06	2.30	5.02	6.86
Bismuth	Bi	0.36	13.37	16.21	0.26	9.97	18.24	0.009	0.261	0.920	0.003	0.119	0.570
Calcium	Ca	42,035.01	1,591.58	90,362.02	15,671.91	-19,256.26	73,784.48	1,011.18	87.48	3,614.67	149.43	-151.59	1,270.30
Cadmium	Cd	3.27	5.84	4.27	2.53	4.28	7.70	0.05	0.10	0.24	0.02	0.05	0.20
Cobalt	Co	11.84	11.79	3.49	45.28	22.57	5.75	0.26	0.24	0.48	0.34	0.18	0.14
Chromium	Cr	42.90	86.32	74.23	5.46	84.69	48.80	1.08	1.63	4.10	0.11	1.09	1.34
Copper	Cu	117.74	70.73	396.32	108.60	-37.29	343.69	1.97	1.00	15.91	0.82	-0.12	6.60
Iron	Fe	30,039.85	22,788.99	14,656.60	13,171.64	18,022.69	12,485.94	791.57	456.57	1,077.54	136.64	234.25	318.33
Mercury	Hg	1.63	4.14	1.34	3.88	6.51	1.29	0.03	0.08	0.11	0.03	0.08	0.03
Potassium	K	13,275.60	9,014.98	9,571.01	9,646.27	7,910.09	8,604.49	332.17	178.31	596.80	87.17	100.05	249.85
Lithium	Li	26.07	20.42	13.12	11.42	19.63	12.77	0.70	0.40	0.98	0.12	0.24	0.34
Magnesium	Mg	7,868.70	5,561.31	6,456.75	2,180.82	4,385.59	4,887.92	208.09	111.32	392.60	26.04	58.51	154.93
Manganese	Mn	757.56	475.34	352.56	412.28	440.72	306.92	19.15	9.64	24.27	4.25	5.83	8.00
Molybdenum	Mo	2.98	3.53	1.99	2.46	17.28	4.48	0.071	0.070	0.114	0.026	0.240	0.107
Sodium	Na	4,330.77	6,571.00	7,278.47	1,997.61	7,541.33	4,574.31	106.85	126.56	505.59	19.56	95.92	173.52
Nickel	Ni	339.35	1,922.85	272.63	369.52	1,356.28	483.39	5.10	34.34	14.68	3.02	12.01	6.46
Phosphorus	P	1,750.73	1,337.47	1,607.36	939.81	1,320.41	1,277.87	39.45	26.76	109.74	10.04	16.30	32.55
Lead	Pb	52.35	64.07	63.67	66.95	44.67	42.45	1.10	1.13	4.01	0.62	0.59	1.24
Sulfur	Sq	20,226.42	5,286.02	26,892.17	48,538.13	-1,506.97	29,699.73	419.09	146.77	878.16	386.11	9.37	595.70
Antimony	Sb	3.30	2.94	3.47	4.31	4.22	3.83	0.07	0.06	0.21	0.04	0.05	0.09
Silicon	Si	113,360.9	100,565.0	64,031.73	49,758.00	91,940.80	50,452.16	2,991.13	2,003.36	4,920.70	485.88	1,166.77	1,590.65
Tin	Sn	42.93	84.37	30.18	1,398.55	104.63	123.00	1.38	1.56	0.96	13.58	1.22	2.42
Strontium	Sr	136.73	89.26	153.21	63.67	55.46	115.94	3.41	1.76	7.69	0.63	0.76	2.74
Thorium	Th	5.19	3.79	2.02	2.70	2.80	1.62	0.14	0.08	0.16	0.03	0.04	0.05
Titanium	Ti	1,021.58	739.73	716.35	462.75	595.45	592.29	27.58	14.42	47.36	4.71	7.86	15.87
Thallium	Tl	0.65	0.49	0.40	0.59	0.45	0.48	0.015	0.010	0.026	0.006	0.006	0.013
Uranium	U	1.78	1.29	0.80	0.65	1.12	0.69	0.047	0.025	0.059	0.007	0.014	0.019
Vanadium	V	77.60	56.51	38.08	32.27	45.39	31.16	2.08	1.12	2.83	0.34	0.58	0.82
Zinc	Zn	526.74	740.21	916.63	759.95	1,104.28	682.11	10.57	13.67	46.90	6.27	13.94	18.34

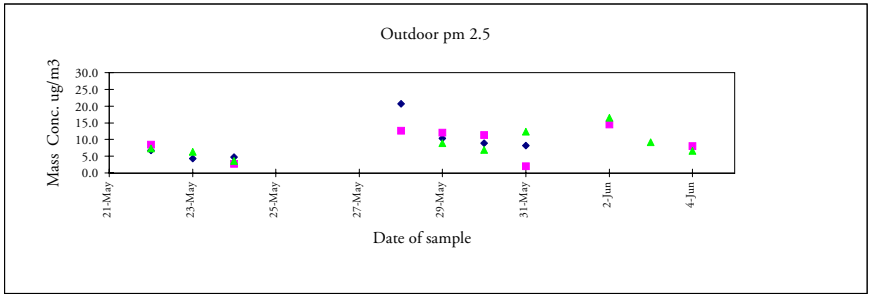
Table 3 **Distribution of Repeat Claims for Respiratory Disorders in Alberta, from March 1, 1993 to April 30, 1996**

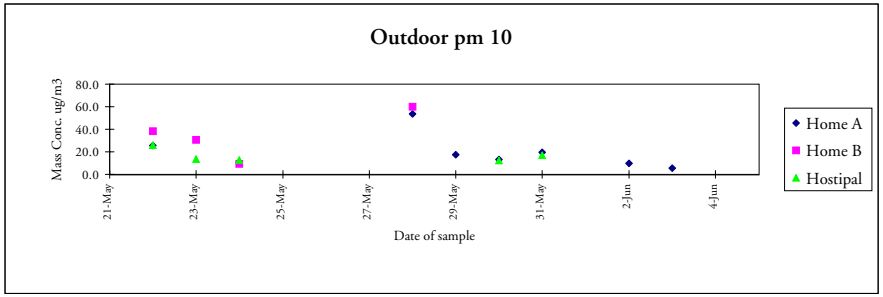
Disease Group (ICD9)	Total Claims	1 Claim	2 Claims	3+ Claims	Range
Upper Resp. Infections (460-469)	5,042,364	55.0	22.8	23.0	1 - 214
Pneumonia (480)	271,399	52.7	18.6	20.6	1 - 282
Asthma (493)	737,061	52.2	18.1	26.0	1 - 127
Bronchitis (490-491)	335,909	73.7	14.0	9.5	1 - 75
All Resp. Disorders (460-519)	7,519,453	57.1	20.4	20.4	1 - 282

Table 4 **Population and Standardized Rates (per 100,000 population) of Physician Claims for Selected Respiratory Disorders in Alberta and High Level, from March 1, 1993 to April 30, 1996.**

	Alberta (rural)		**High Level (T0H 1Z0)**		**Fort Vermillion (T0H 1N0)**	
Disease Group (ICD9)	Aboriginal	Non-Aboriginal	Aboriginal	Non-Aboriginal	Aboriginal	Non-Aboriginal
Population	55,142	612,554	1,006	4,281	1,592	1,850
All Resp. Disorders (460-519)	182,766	74,095	94,079	70,264	102,989	82,239
Resp. Infections (460-469)	126,926	48,355	66,357	43,768	72,581	54,089
Pneumonia (480)	9,895	2,977	3,663	3,377	4,168	1,855
Asthma (493)	9,215	6,652	4,168	6,398	1,889	4,516
Bronchitis (490-491)	15,603	4,716	6,897	3,534	7,208	4,233

part a)





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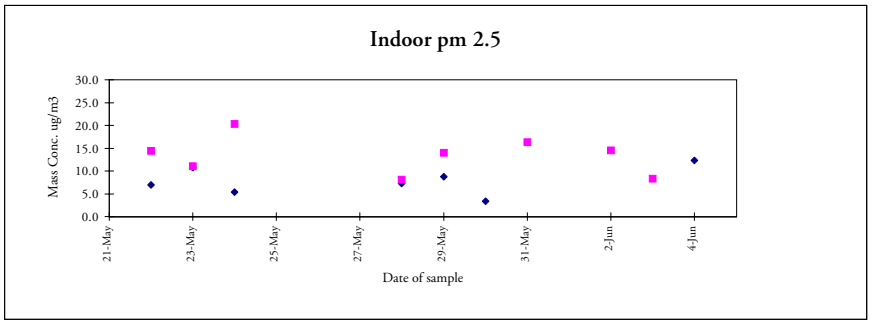

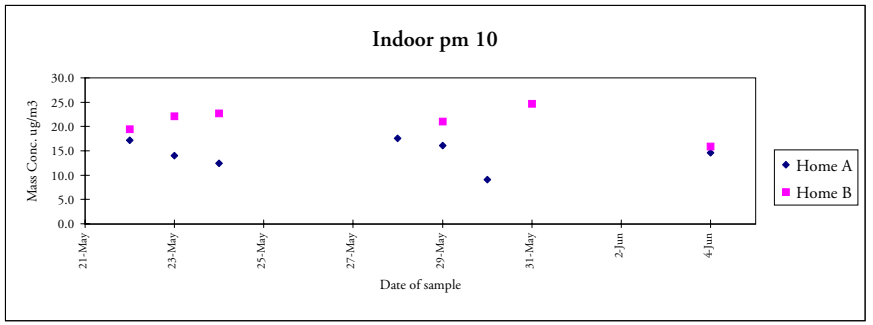

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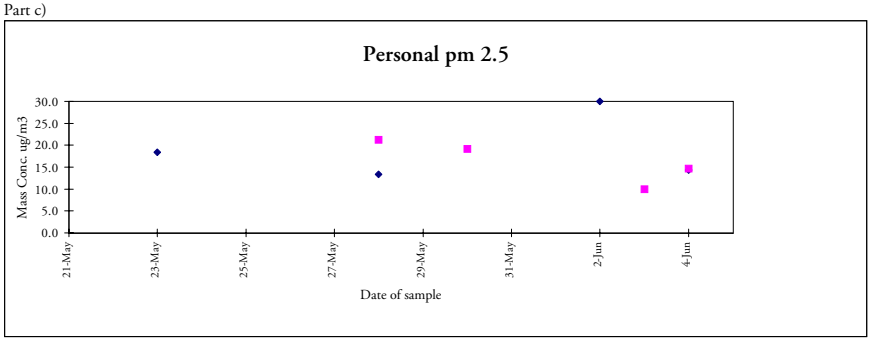

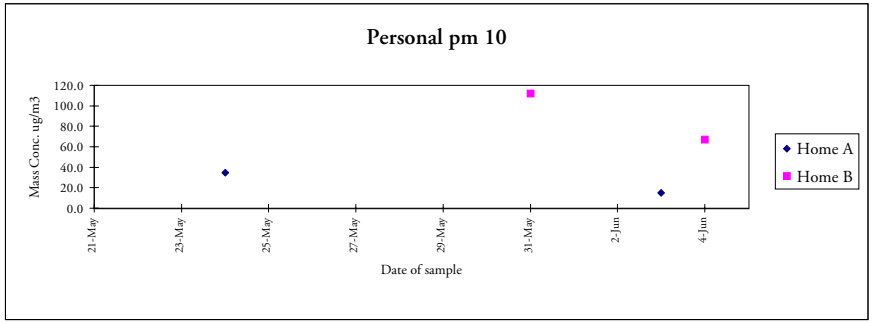

Figure 1: Plots of mass concentrations of Inhalable particultates from the High Level Study

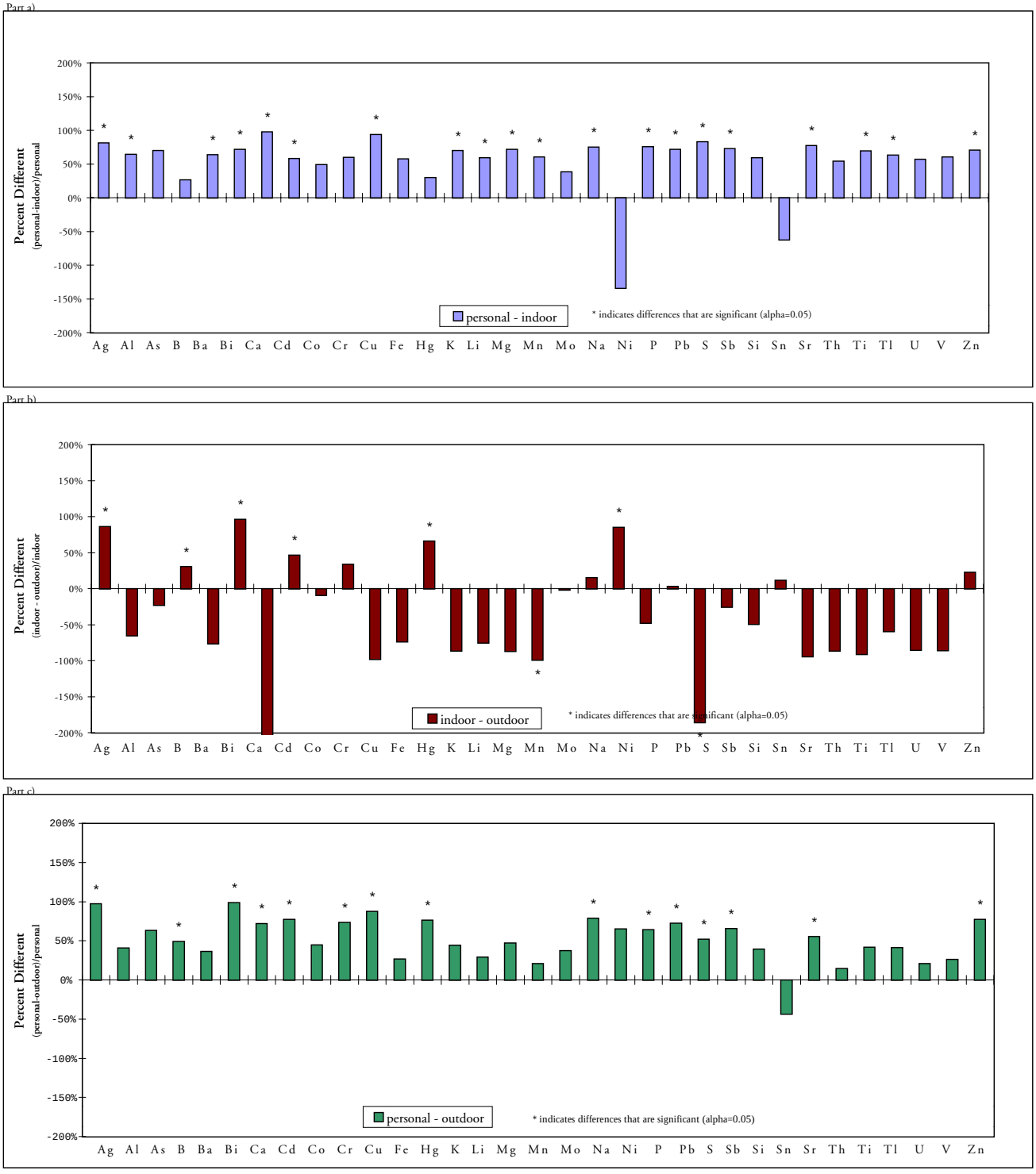

Figure 2: Comparison of the element concentrations in air associated with pm 10 particulate, all samples

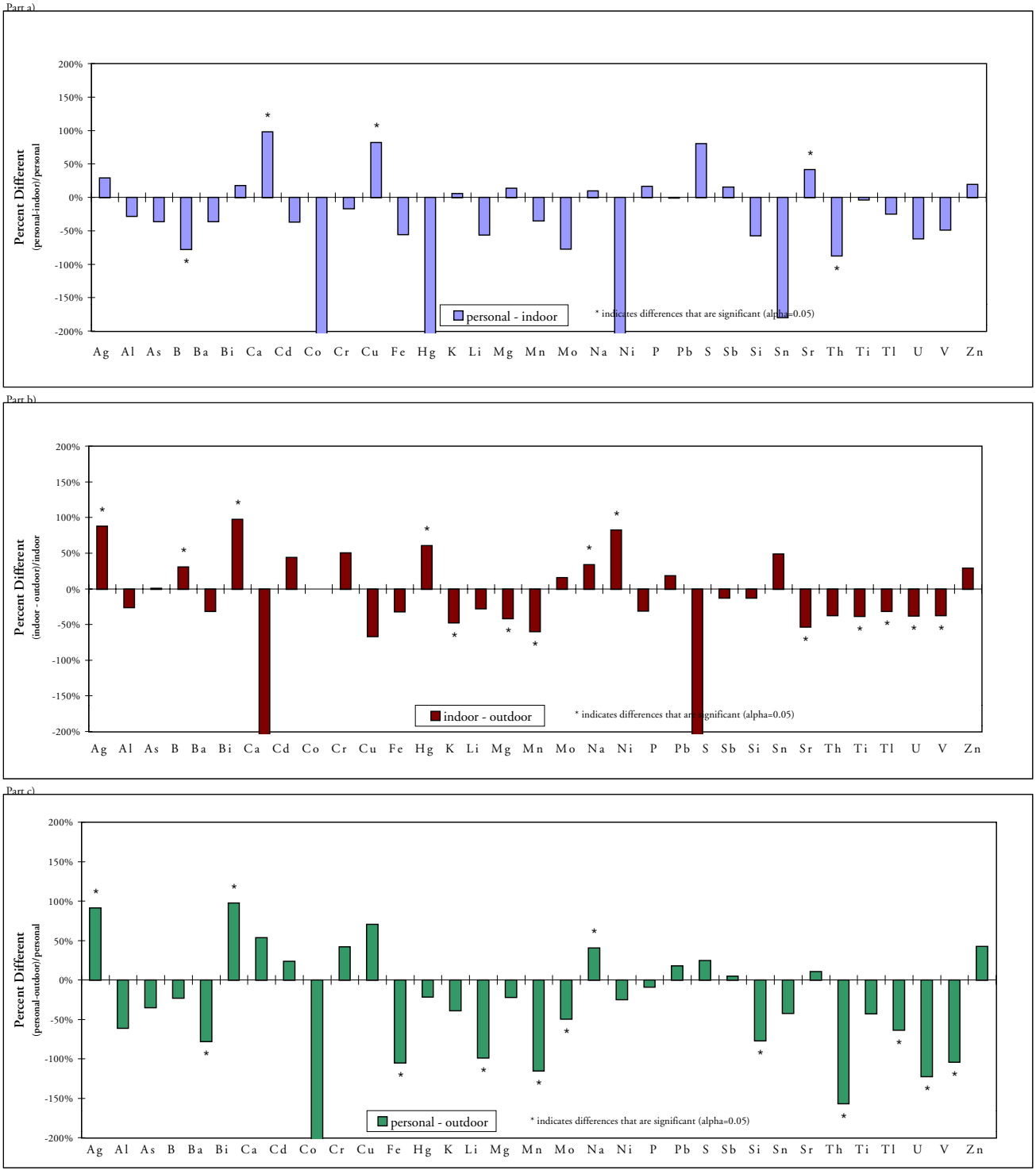

Figure 3: Comparison of the element concentrations in the particulate associated with pm 10 particulate, all samples

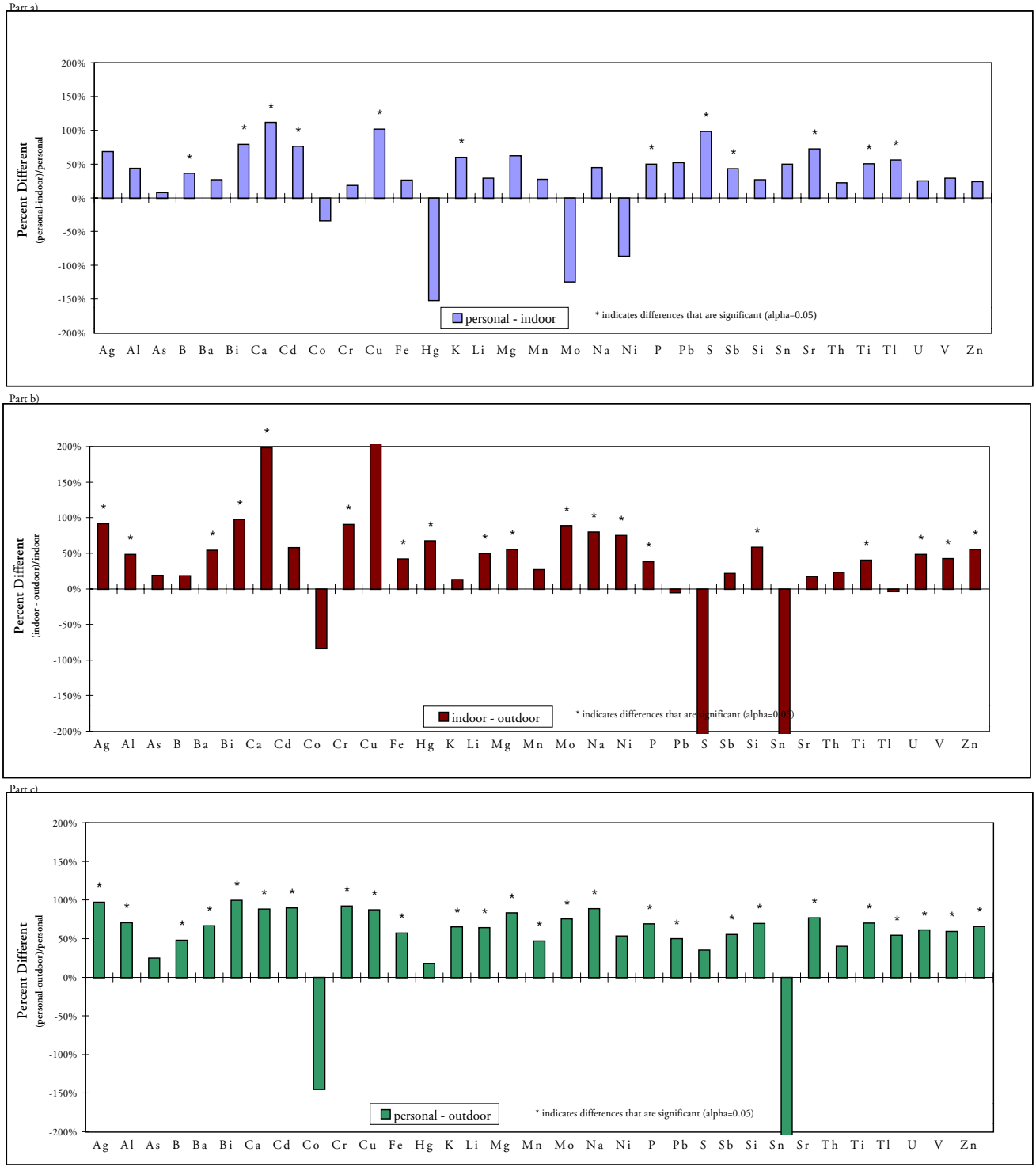

Figure 4: Comparison of the element concentrations in air associated with pm 2.5 particulate, all samples

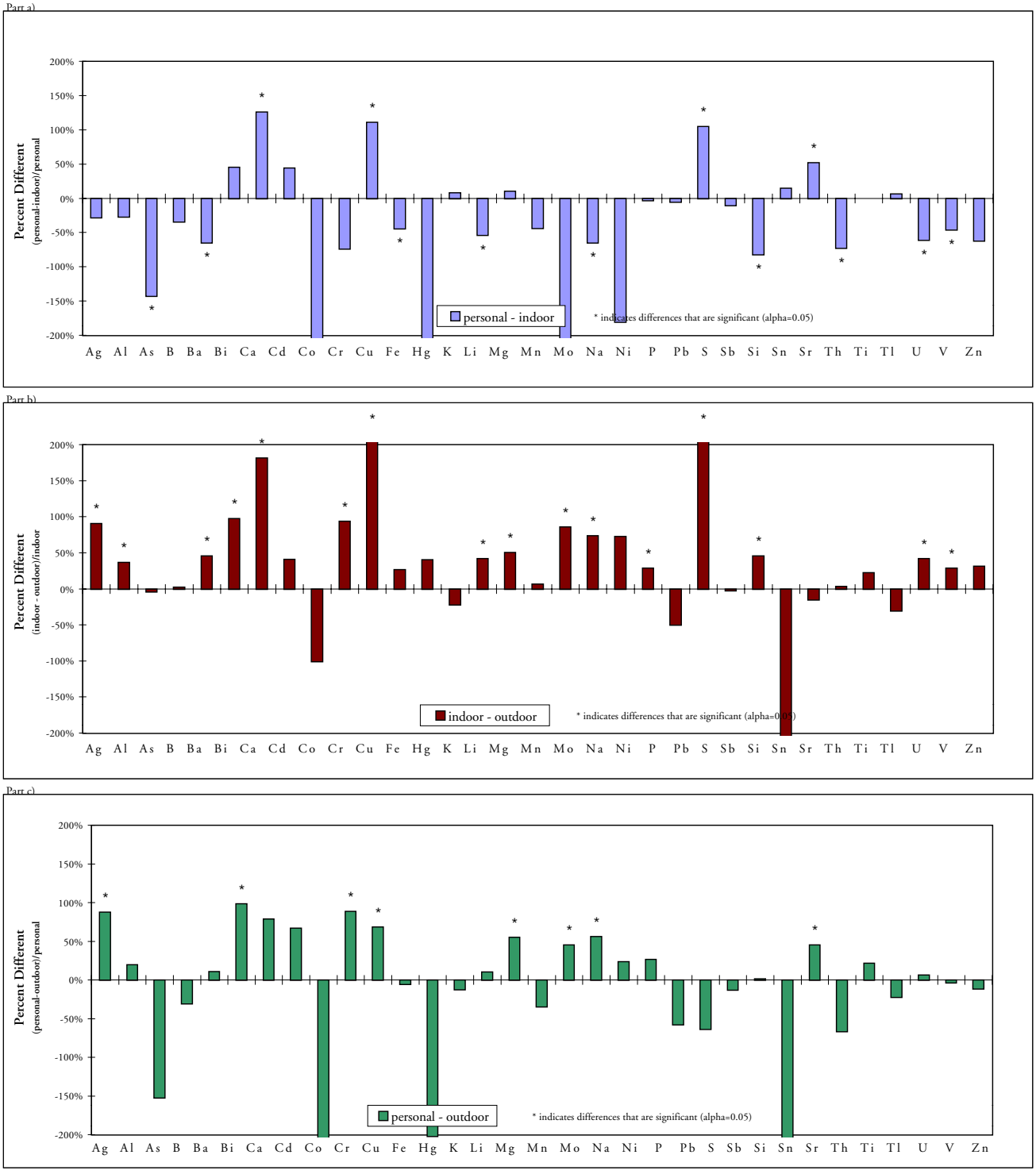

Figure 5: Comparison of the element concentrations in the particulate associated with pm 2.5 particulate, all samples

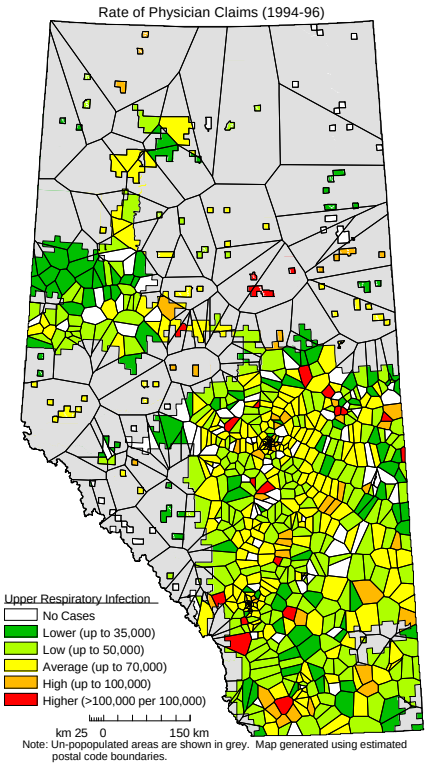

Figure 6 Physician Claim Rates for Upper Resp. Infection in Postal Code Areas

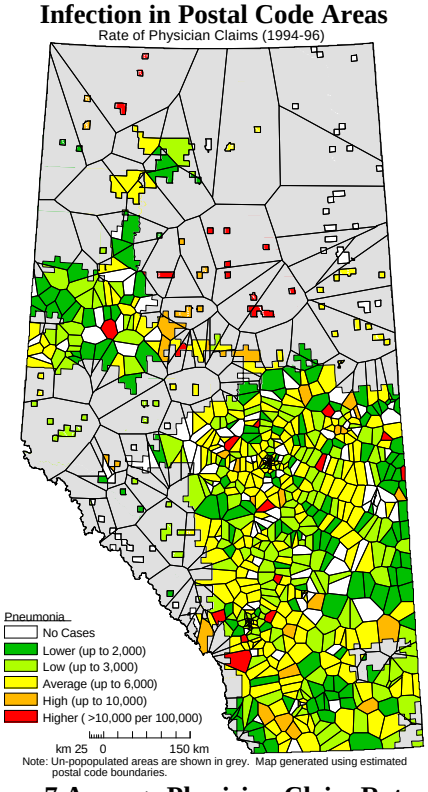

Figure 7 Average Physician Claim Rates for Pneumonia in Postal Code Areas

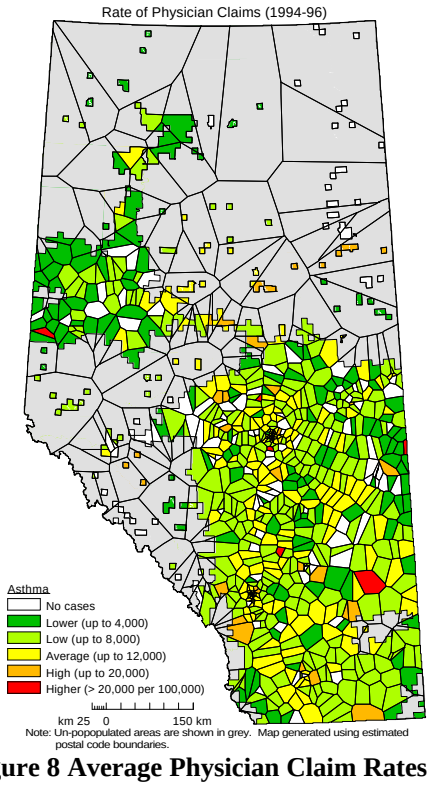

Figure 8 Average Physician Claim Rates for Asthma in Postal Code Areas

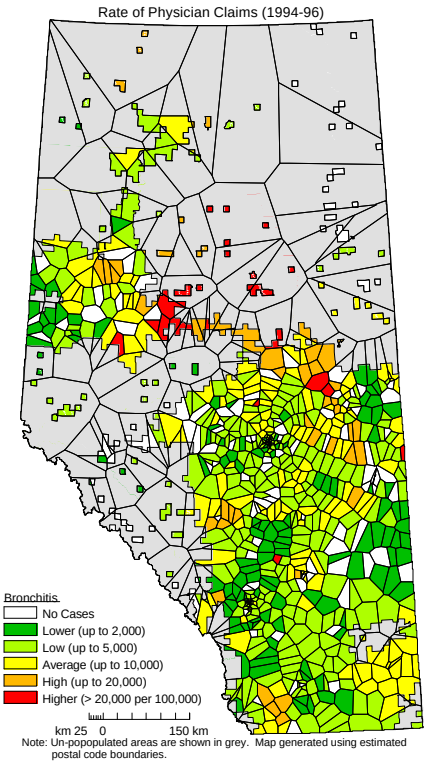

Figure 9 Average Physician Claim Rates for Bronchitis in Postal Code Areas