Pueblo Air Toxics Special Study Around the Rocky Mountain Steel Mill

May 2002 through December 2002

December 2003

Prepared by the
Colorado Department of Public Health & Environment
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Executive Summary

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This report analyzes data collected in a special study from two sites near the Rocky Mountain Steel Mill (RMSM) in Pueblo. This study was conducted from May through December 2002. This study was performed by the Colorado Department of Public Health and Environment – Air Pollution Control Division (APCD) with funding from a special U.S. Environmental Protection Agency's (EPA) Enforcement Grant. The goal of the study was to determine concentrations of potentially hazardous particulates, metals and volatile organic compounds in the ambient air in two neighborhoods near the Rocky Mountain Steel Mill (RMSM).

Two monitoring sites were employed in the study, one to the east of the RMSM and one to the north. The eastern site was located at Fulton Heights School, at 1411 Santa Rosa. Sampling started on 23 May 2002 and ended on 31 December 2002. The northern site was located at Jeannie's Dance Studio, at 1141 S. Santa Fe. Sampling started on 5 September 2002 and ended on 31 December 2002. At both sites, 24-hour total suspended particulate (TSP) samples were collected on an every day schedule and 24-hour "10-microns in diameter and smaller" particulates (PM10) samples were collected on an every third day schedule. Filters from the TSP samplers were analyzed for metals concentrations. Volatile organic compounds (VOC's) were sampled for 24-hours at the Dance Studio site on an every third day schedule starting on 11 October 2003. All sampling was performed using established protocols and methods.

Fifty-eight VOC's were analyzed from whole-air sample canisters collected at the Dance Studio site. Thirty-four of these VOC's were never measured at detectable levels. Eleven VOC's were present in over 90% of the samples. Many of these eleven compounds are primarily attributed to motor vehicle emissions. Concentrations of individual compounds show a strong statistical correlation between the vehicle emission-related compounds. None of the compounds had an estimated non-cancer chronic hazard index level greater than one. Five of the compounds measured had concentrations at levels believed to represent a greater than one-in-a-million risk of cancer. These compounds are 1,3-butadiene, benzene, carbon tetrachloride, tetrachloroethylene and p-dichlorobenzene. However, carbon tetrachloride and p-dichlorobenzene were detected in less than seven percent of the samples and using one-half of the minimum detection level as a substitute for the non-detect levels is driving the increased risk. Benzene and 1,3-butadiene are primarily emitted from motor vehicles while tetrachloroethylene is a commonly used industrial solvent. Other areas of Colorado also show elevated levels of these compounds and most urban areas in the United States have concentrations of benzene and 1,3-butadiene that are above one-in-a-million risk levels.

PM10 levels were measured at less than one-half of the National Ambient Air Quality Standard (NAAQS) for both an annual mean and a 24-hour maximum. TSP concentrations exceeded the level of the former NAAQS at the Fulton Heights site on one occasion, probably due to high winds and blowing dust. Average TSP levels were below the level of the former NAAQS.

Ten metals were analyzed from TSP filters collected at both sites. Only two metals, lead and manganese, were detected in over 75 percent of the samples. Six metals were never detected at the Dance Studio site. With the exception of manganese, all metals concentrations were low. The only correlation that was statistically significant was between manganese and chromium at the Dance Studio site. Manganese had an estimated non-cancer chronic hazard quotient level greater than one. Four of the metals measured had estimated EPA "benchmark" concentrations at levels believed to represent a greater than one-in-a-million risk of cancer. These metals were arsenic, beryllium, cadmium and chromium. However, these metals were detected in less than fifteen percent of the samples and using one-half of the minimum detection level as a substitute for non-detect levels is driving the increased risk. In addition, the chromium risk is probably overstated as all of the chromium was assumed to be in the toxic hexavalent state and none in the more commonly found non-toxic trivalent form.

Comparisons were performed between the results from this special study and concentrations measured in other studies in Colorado. In general, VOC's were found to be present at similar levels to those measured in Grand Junction and Denver. Cancer risks from VOC's are also similar for most compounds. PM10 and TSP concentrations appear to be lower in Pueblo than in other urban areas of Colorado, except for some TSP values that are possibly high wind related. Metals concentrations are generally higher at the two study locations compared to those monitored in Grand Junction and Denver. However, none of the monitoring sites in these other areas was located next to a large source. Non-cancer risks from metals are higher in Pueblo than in Grand Junction and Denver, primarily due to higher manganese concentrations.

Section 1 – Introduction

Introduction

This report discusses results for ambient air toxics monitoring conducted at two sites near the Rocky Mountain Steel Mill in Pueblo during 2002. This study was performed by the Colorado Department of Public Health and Environment (CDPHE) – Air Pollution Control Division (APCD) with funding from a special U.S. Environmental Protection Agency's (EPA) Enforcement Grant. The goal of the study was to determine concentrations of potentially hazardous particulates, metals and volatile organic compounds in the ambient air in two neighborhoods near the Rocky Mountain Steel Mill (RMSM). Based on the results, risk analyses were performed to determine if there were any pollutant concentrations above EPA health benchmark levels.

Two monitoring sites were employed in the study, one to the east of the RMSM and one to the north. The eastern site was located at Fulton Heights School, at 1411 Santa Rosa. Sampling commenced on 23 May 2002 and continued through 31 December 2002. The northern site was located at Jeannie's Dance Studio, at 1141 S. Santa Fe. Due to difficulties in obtaining a site, sampling commenced on 5 September 2002 and continued through 31 December 2002. At both sites, 24-hour total suspended particulate (TSP) samples were collected on an every day schedule and 24-hour "10-microns in diameter and smaller" particulates (PM10) were collected on an every third day schedule. Filters from the TSP samplers were analyzed for metals concentrations. Volatile organic compounds were sampled for 24-hours (midnight-to-midnight) at the Dance Studio site on an every third day schedule commencing on 11 October 2003.

For the particulates sampling, EPA approved samplers were employed. These consist of hi-volume samplers drawing air through an 8" x 10" quartz fiber filter. The PM10 sampler is different from the TSP sampler in that a size-selective inlet head is used. The TSP samplers were manufactured by General Metal Works and the PM10 samplers were manufactured by Graseby-Andersen. Particulate filter weighings were performed by the CDPHE Laboratory Services Division following established APCD protocols. Analyses were performed for ten metals by the CDPHE Laboratory following the protocols in EPA Method IO-3.5. VOC's were collected by drawing air into an evacuated stainless steel canister. The VOC samplers that were used were modified Scientific Instrumentation Specialists sampling units. The canisters were provided by and analyzed by Eastern Research Group for 58 VOC's following the protocols in EPA Method TO-15.

This report presents results according to the monitoring method employed. Thus, one chapter discusses the VOC's, one presents particulate information, and the last one summarizes the metals. The monitoring results chapters begin with a presentation of summary statistics. Summary graphs analyses are presented. Correlation coefficients (a statistical measure of how well the presence of some compounds is associated with the presence of other compounds) are presented, as appropriate. The monitoring results chapters then provide a section entitled "Compounds of Significance: Sources and Health Effects". This is one of the most important portions of the report, for it discusses each of the air risk factors associated with each pollutant or compound, and compares these factors to the monitored concentrations. For those pollutants or compounds that are above these EPA health benchmark levels, a brief summary of their use, air emission sources, potential health effects, and concentrations in typical urban air are provided. At the end of the chapter is a reference section listing sources of information regarding toxicity and health effects for the chemical compounds that were discussed in the health effects section.

A chapter of meteorological data from nearby locations is also provided, as well as a chapter comparing the concentrations monitored at these two sites to the concentrations monitored at other APCD sites in other cities in Colorado. The report ends with a concluding chapter that summarizes results of this study.

Section 2 – Sites and Parameters Monitored

Sites

The Rocky Mountain Steel Mill (RMSM) is located in the southeast portion of Pueblo. With a long history dating back to the 1880's, this plant is the largest steel producer in Colorado and the largest recycler (by weight). The APCD has not specifically monitored for toxic air pollutants around the RMSM in the past, but has monitored the ambient air in Pueblo for a variety of pollutants at a number of locations. These sites and their operation dates are presented in Table 2.1.

Table 2.1 – Historic Air Monitoring Locations in Pueblo

Location	Dates of operation
151 Central Main (Pueblo Health Dept.)	1963 - 1988
Prairie & Summit (Sunset Park Fire Station)	1964 - 1968
Mesa & Evans (Fire Station)	1964 - 1985
Bonfort Blvd. & Liberty Lane (Fire Station)	1964 - 1968
24th St. & 6th Ave.	1965 - 1968
7th St. & Santa Fe Ave. (Fire Station)	1965 - 1967
32nd & Watts Place (Pumping Station)	1980 - 1988
1st St. & Magnuson Ave. (Airport)	1982 - 1988
400 W. 17th (Parkview Hospital)	1979 - 1982
Colo. Hwy. 78 (South Dump)	1980 – 1985
Grant & Michigan (School District 60)	1977 – 1979
Fulton Heights, 1411 Santa Rosa	2002
Jeannie's Dance Studio, 1141 S. Santa Fe Ave.	2002
Public Works, 211 D St.	1998 – current

For this study, two sites were employed, one to the east of the RMSM and one to the north. These locations were selected as they are in residential neighborhoods that are immediately or nearly adjacent to the RMSM property, and thus are potentially impacted by emissions from the RMSM. The eastern site was located at Fulton Heights School, at 1411 Santa Rosa. Sampling started on 23 May 2002 and ended on 31 December 2002. The northern site was located at Jeannie's Dance Studio, at 1141 S. Santa Fe. Due to difficulties in obtaining a site, sampling started on 5 September 2002 and ended on 31 December 2002. At both of these sites, samplers were located on the roofs, one-story above the ground.

In addition, the data from the existing particulate site located at 211 D Street in downtown Pueblo were used as a comparison. This site has both PM10 (particulates 10 microns in diameter and smaller) and PM2.5 (particulates 2.5-microns in diameter and smaller) samplers and is located at the Public Works facility. Figure 2.1 shows the locations of the two special study sites and also this pre-existing site.

Figure 2.1 – Study Monitoring Site Locations

Pollutants

Over the years, a variety of pollutants in the ambient air in Pueblo have been monitored. Table 2.2 provides a list of these pollutants. Due to the low concentrations that were recorded, most monitoring ended over a decade ago. Currently, only particulates are sampled on a routine basis at the 211 D Street site. This includes both PM10 and PM2.5.

Table 2.2 – Historical Pollutants Monitored

Pollutant	Sampling Periods
Total Suspended Particulates	1963 – 1988, 2002
Lead (TSP)	1968 – 1988, 2002
Other metals (TSP)	1968 – 1982, 2002
Benzene soluble organics (TSP)	1963 – 1988
Nitrate (TSP)	1968 – 1987
Sulfate (TSP)	1968 – 1987
PM_{10}	1987 – current
$PM_{2.5}$	1999 – current
Carbon monoxide	1976 – 1985
Sulfur dioxide	1977 – 1979
Volatile organic compounds	2002

For this special study, monitoring was conducted for particulates at both the Fulton Heights (eastern) site and the Dance Studio (northern) site. This particulate monitoring included 24-hour (midnight-to-midnight) TSP sampling on an every day frequency and 24-hour PM10 sampling on an every third day frequency. The TSP samples from both sites were also analyzed for ten metals. In addition, a VOC sampler collected 24-hour samples in stainless steel whole-air canisters on an every third day frequency at the Dance Studio site. Table 2.3 provides a list of the pollutants monitored and the dates that monitoring was conducted for the two sites. Table 2.4 provides a full list of the volatile organic compounds and metals that were speciated. Due to problems obtaining permission, monitoring at the Dance Studio site did not start until 5 September 2002. The compounds and metals analyzed are either known to be potentially hazardous to human health and/or are commonly found in urban air.

Table 2.3 – Sites and Parameters in Study

Site	**Parameter**	**Sampling Period**
Fulton Heights, 1411 Santa Rosa	TSP (+ metals analysis) every day	May – Dec 2002
	PM_{10} every 3rd day	May – Dec 2002
Dance Studio, 1141 S. Santa Fe Ave.	TSP (+ metals analysis) every day	Sep – Dec 2002
	PM_{10} every 3rd day	Sep – Dec 2002
	VOC every 3rd day	Oct – Dec 2002
Public Works, 211 D St.	PM_{10} every 3rd day	long-term CDPHE site

TSP = Total suspended particulates
PM10 = Particulates 10 microns in diameter and smaller
VOC = volatile organic compounds

Table 2.4 – List of VOC and Metals Species

Volatile Organic Compounds		
Acetylene	cis - 1,2 - Dichloroethylene	1,2 - Dibromoethane
Propylene	Bromochloromethane	n - Octane
Dichlorodifluoromethane	Chloroform	Tetrachloroethylene
Chloromethane	Ethyl tert-butyl ether	Chlorobenzene
Dichlorotetrafluoroethane	1,2 - Dichloroethane	Ethylbenzene
Vinyl chloride	1,1,1 - Trichloroethane	m,p - Xylene
1,3 - Butadiene	Benzene	Bromoform
Bromomethane	Carbon tetrachloride	Styrene
Chloroethane	tert-Amyl methyl ether	1,1,2,2 - Tetrachloroethane
Acetonitrile	1,2 - Dichloropropane	o - Xylene
Trichlorofluoromethane	Ethyl acrylate	1,3,5 - Trimethylbenzene
Acrylonitrile	Bromodichloromethane	1,2,4 - Trimethylbenzene
1,1 - Dichloroethene	Trichloroethylene	m - Dichlorobenzene
Methylene chloride	Methyl methacrylate	Chloromethylbenzene
Trichlorotrifluoroethane	cis - 1,3 - Dichloropropene	p - Dichlorobenzene
trans - 1,2 - Dichloroethylene	Methyl isobutyl ketone	o - Dichlorobenzene
1,1 - Dichloroethane	trans - 1,3 - Dichloropropene	1,2,4 - Trichlorobenzene
Methyl tert-butyl ether	1,1,2 - Trichloroethane	Hexachloro - 1,3 - butadiene
Methyl ethyl ketone	Toluene	
Chloroprene	Dibromochloromethane	
Metals		
Pb (lead)	Co (cobalt)	Se (selenium)
As (arsenic)	Cr (chromium)	Sb (antimony)
Be (beryllium)	Mn (manganese)	
Cd (cadmium)	Ni (nickel)	

Methods

All monitoring in this study was performed according to protocols and methods that have been established by either the EPA or APCD. In the case of APCD protocols, these have been reviewed and approved by EPA.

For both the TSP and PM10 particulate sampling, EPA approved samplers were employed. These consist of "high-volume" samplers drawing air through an 8" x 10" quartz fiber filter for a 24-hour period. The PM10 sampler is different from the TSP sampler in that a size-selective inlet head is used to eliminate the larger particles. The TSP samplers were manufactured by General Metal Works and the PM10 samplers were manufactured by Graseby-Andersen. Particulate filter weighings were performed by the CDPHE Laboratory Services Division following established APCD protocols. Analyses were performed for ten metals by the CDPHE Laboratory following the protocols in EPA Method IO-3.5. This and other inorganic methods are available on EPA's web site at: http://www.epa.gov/ttn/amtic/inorg.html.

VOC's were collected by drawing air into an evacuated, "Summa-polished" stainless steel canister for a 24-hour period. This provides a whole-air sample for analysis. The VOC samplers that were used were modified Scientific Instrumentation Specialists sampling units. The canisters were provided by and analyzed by Eastern Research Group for 58 VOC's following the protocols in EPA Method TO-15. This and other organic methods are available on EPA's web site at: http://www.epa.gov/ttn/amtic/airtox.html.

Section 3 - Volatile Organic Compounds at Dance Studio Site

October 2002 to December 2002

Summary Statistics – Volatile Organic Compounds

Minimum, Maximum, Mean – All Samples

Volatile organic compound (VOC) data collected at the Dance Studio site from October 2002 through December 2002 are presented in this section of the Pueblo Air Toxics Special Study Report. For the period, volatile organic compounds were sampled on a one-in-three day basis, for a total of 23 samples attempted. Of these, the laboratory successfully processed 15, for a percentage data recovery rate of 65%. (See Table 3.1) Data losses were primarily due to sampling equipment resulting in either no sample or inadequate canister pressure.

Table 3.2 summarizes the minimum, maximum, and mean concentrations for each of the 58 volatile organic compounds measured during the study. These compounds are a standard suite of VOC's that has been developed as being representative of what is potentially hazardous or what is likely to be found in urban air. Results show that acetylene, propylene and toluene were the compounds with the highest concentrations in ambient air. These compounds all had average concentrations greater than one part per billion (ppb), and were detected in all of the canister samples taken. Benzene, trichlorofluoromethane and m/p-xylene had average concentrations just under one ppb and were also detected in all of the samples.

Table 3.1 – Percentage Data Recovery For VOC Samples

Sample Days Scheduled	Samples Recovered	Percent Recovered
23	15	65.2

Table 3.2 – VOC Data Summary

Dance Studio Site October – December 2003							
Compound	**CAS #**	**Average (ppbv)**	**Maximum (ppbv)**	**Minimum (ppbv)**	**# of non-detects**	**% of non-detects**	**% of time detected**
Acetylene	74-86-2	5.38	16.11	0.58	0	0.0%	100.0%
Propylene	115-07-1	1.12	2.09	0.32	0	0.0%	100.0%
Dichlorodifluoromethane	75-71-8	0.60	1.14	0.42	0	0.0%	100.0%
Chloromethane	74-87-3	0.57	1.05	0.45	0	0.0%	100.0%
Dichlorotetrafluoroethane	76-14-2	0.03	0.03	0.03	14	93.3%	6.7%
Vinyl chloride	75-01-4	0.05	0.05	0.05	15	100.0%	0.0%
1,3-Butadiene	106-99-0	0.15	0.39	0.04	3	20.0%	80.0%
Bromomethane	74-83-9	0.06	0.06	0.06	15	100.0%	0.0%
Chloroethane	75-00-3	0.07	0.07	0.07	15	100.0%	0.0%
Acetonitrile	75-05-8	0.23	0.23	0.23	15	100.0%	0.0%
Trichlorofluoromethane	75-69-4	0.85	2.46	0.25	0	0.0%	100.0%
Acrylonitrile	107-13-1	0.26	0.26	0.26	15	100.0%	0.0%
1,1 -Dichloroethene	75-35-4	0.05	0.05	0.05	15	100.0%	0.0%
Methylene chloride	75-09-2	0.05	0.18	0.04	10	66.7%	33.3%
Trichlorotrifluoroethane	76-13-1	0.55	1.80	0.04	3	20.0%	80.0%
trans - 1,2-Dichloroethylene	156-60-5	0.03	0.03	0.03	15	100.0%	0.0%
1,1 - Dichloroethane	74-34-3	0.04	0.04	0.04	15	100.0%	0.0%
Methyl tert-butyl ether	1634-04-4	0.12	0.12	0.12	15	100.0%	0.0%

Dance Studio Site October – December 2003							
Compound	**CAS #**	**Average (ppbv)**	**Maximum (ppbv)**	**Minimum (ppbv)**	**# of non-detects**	**% of non-detects**	**% of time detected**
Methyl ethyl ketone	78-93-3	0.55	5.42	0.17	14	93.3%	6.7%
Chloroprene	126-99-8	0.03	0.03	0.03	15	100.0%	0.0%
cis - 1,2-Dichloroethylene	156-59-2	0.06	0.06	0.06	15	100.0%	0.0%
Bromochloromethane	74-97-5	0.06	0.06	0.06	15	100.0%	0.0%
Chloroform	67-66-3	0.03	0.03	0.03	15	100.0%	0.0%
Ethyl tert-butyl ether	637-92-3	0.09	0.09	0.09	15	100.0%	0.0%
1,2-Dichloroethane	107-06-2	0.05	0.05	0.05	15	100.0%	0.0%
1,1,1-Trichloroethane	71-55-6	0.03	0.10	0.03	12	80.0%	20.0%
Benzene	71-43-2	0.94	1.69	0.35	0	0.0%	100.0%
Carbon tetrachloride	56-23-5	0.07	0.21	0.03	4	26.7%	73.3%
tert-Amyl methyl ether	994-05-8	0.09	0.09	0.09	15	100.0%	0.0%
1,2-Dichloropropane	78-87-5	0.04	0.04	0.04	15	100.0%	0.0%
Ethyl acrylate	140-88-5	0.17	0.17	0.17	15	100.0%	0.0%
Bromodichloromethane	75-27-4	0.04	0.04	0.04	15	100.0%	0.0%
Trichloroethylene	79-01-6	0.05	0.05	0.05	15	100.0%	0.0%
Methyl methacrylate	80-62-6	0.18	0.18	0.18	15	100.0%	0.0%
cis - 1,3-Dichloropropene	10061-01-5	0.06	0.06	0.06	15	100.0%	0.0%
Methyl isobutyl ketone	108-10-1	0.13	0.34	0.11	14	93.3%	6.7%
trans - 1,3-Dichloropropene	10061-02-6	0.06	0.06	0.06	15	100.0%	0.0%
1,1,2-Trichloroethane	79-00-5	0.10	0.10	0.10	15	100.0%	0.0%
Toluene	108-88-3	1.88	3.21	0.44	0	0.0%	100.0%
Dibromochloromethane	124-48-1	0.05	0.05	0.05	15	100.0%	0.0%
1,2-Dibromoethane	106-93-4	0.06	0.06	0.06	15	100.0%	0.0%
n - Octane	111-65-9	0.08	0.22	0.05	11	73.3%	26.7%
Tetrachloroethylene	127-18-4	0.04	0.14	0.03	14	93.3%	6.7%
Chlorobenzene	108-90-7	0.05	0.05	0.05	15	100.0%	0.0%
Ethylbenzene	100-41-4	0.28	0.56	0.04	0	0.0%	100.0%
m,p - Xylene	108-38-3 / 106-42-3	0.83	1.81	0.17	0	0.0%	100.0%
Bromoform	75-25-2	0.07	0.07	0.07	15	100.0%	0.0%
Styrene	100-42-5	0.06	0.07	0.06	13	86.7%	13.3%
1,1,2,2-Tetrachloroethane	79-34-5	0.10	0.10	0.10	15	100.0%	0.0%
o - Xylene	95-47-6	0.36	0.73	0.06	0	0.0%	100.0%
1,3,5-Trimethylbenzene	108-67-8	0.11	0.19	0.06	5	33.3%	66.7%
1,2,4-Trimethylbenzene	95-63-6	0.29	0.63	0.07	0	0.0%	100.0%
m - Dichlorobenzene	541-73-1	0.09	0.09	0.09	15	100.0%	0.0%
Chloromethylbenzene	100-44-7	0.07	0.07	0.07	15	100.0%	0.0%
p - Dichlorobenzene	106-46-7	0.07	0.08	0.02	14	93.3%	6.7%
o - Dichlorobenzene	95-50-1	0.09	0.09	0.09	15	100.0%	0.0%
1,2,4-Trichlorobenzene	120-82-1	0.06	0.06	0.06	15	100.0%	0.0%
Hexachloro - 1,3-butadiene	87-68-3	0.08	0.08	0.08	15	100.0%	0.0%

ppbv = parts per billion (volume) CAS # = Chemical Abstracts Service number

NOTE: Average and maximum concentrations are calculated using ½ of minimum detection level as a substitute for non-detects. Thus, values will be displayed even though there were no detected samples.

Table 3.2, completed.

Percentage of Samples For Which Compound Was Detected

Table 3.2 shows the percentage of the samples in which each VOC was detected. Eleven of the compounds were detected in over 90% of the samples. These compounds are listed in Table 3.3. In contrast, thirty-four VOCs were never detected at all during the study. These compounds are listed in Table 3.4. This is about 60% of the compounds that were sampled. It is interesting to note that vinyl chloride, which is considered to be very toxic and is on EPA's list of required compounds for air toxics monitoring, was not detected in any samples. Methyl tert-butyl ether (MTBE), ethyl tert-butyl ether (ETBE) and tert-amyl methyl ether (TAME), which are added to automotive fuels to increase oxygen, also were not detected in any samples.

Table 3.3 – Compounds Detected in Over 90% of the VOC Air Samples

Acetylene	Toluene
Propylene	Ethylbenzene
Dichlorodifluoromethane	m,p - Xylene
Chloromethane	o - Xylene
Trichlorofluoromethane	1,2,4 - Trimethylbenzene
Benzene	

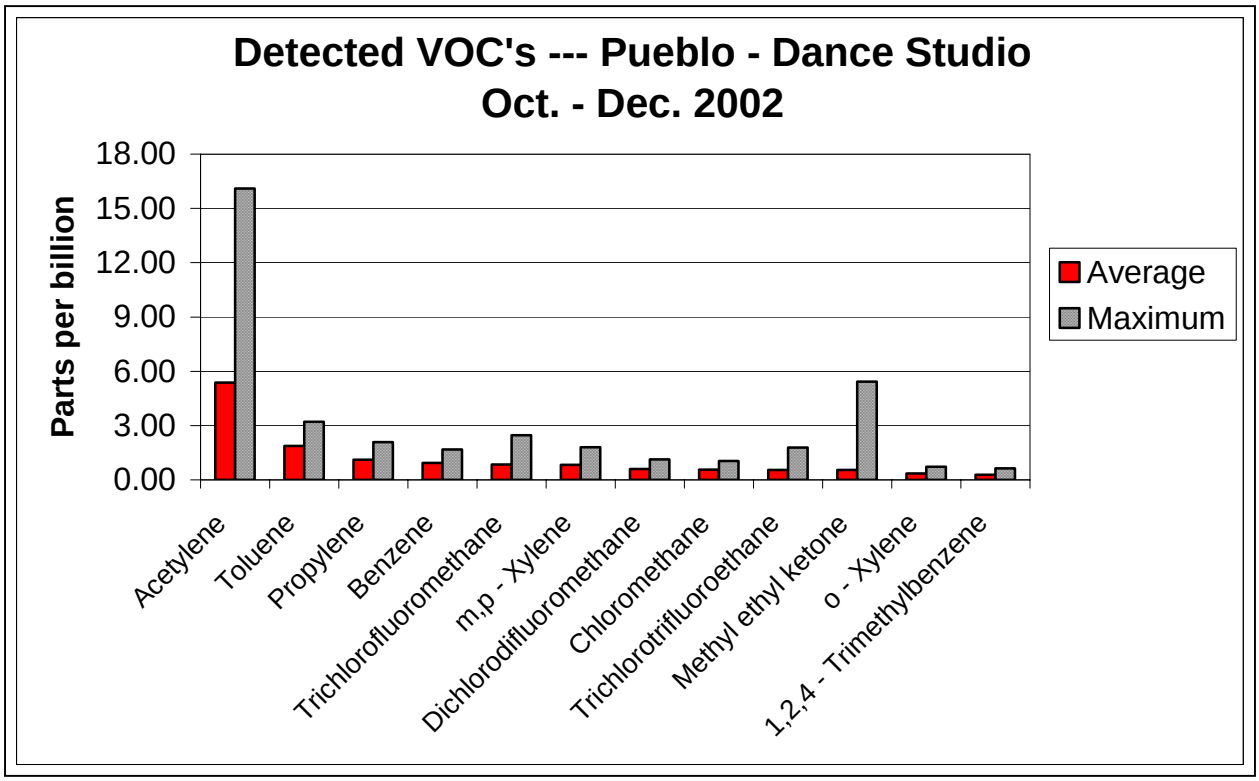
Table 3.4 – Compounds Never Detected in the VOC Air Samples

Vinyl chloride	Chloroform	Dibromochloromethane
Bromomethane	Ethyl tert-butyl ether	1,2 - Dibromoethane
Chloroethane	1,2 - Dichloroethane	Chlorobenzene
Acetonitrile	tert-Amyl methyl ether	Bromoform
Acrylonitrile	1,2 - Dichloropropane	1,1,2,2 - Tetrachloroethane
1,1 - Dichloroethene	Ethyl acrylate	m - Dichlorobenzene
trans - 1,2 - Dichloroethylene	Bromodichloromethane	Chloromethylbenzene
1,1 - Dichloroethane	Trichloroethylene	o - Dichlorobenzene
Methyl tert-butyl ether	Methyl methacrylate	1,2,4 - Trichlorobenzene
Chloroprene	cis - 1,3 - Dichloropropene	Hexachloro - 1,3 - butadiene
cis - 1,2 - Dichloroethylene	trans - 1,3 - Dichloropropene	
Bromochloromethane	1,1,2 - Trichloroethane	

Graphs – Volatile Organic Compounds

Graphs of the average and maximum values for the twenty-four compounds that were detected during the study are presented in Figure 3.2. Only six compounds had averages of greater than 0.80 ppb for the study. This is an arbitrary but definite break-point in average concentrations of compounds. The graphs of individual daily values for these compounds are presented in Figure 3.3 as "BTEX" and "non-BTEX" compounds. BTEX compounds are benzene, toluene, ethylbenzene and xylenes, all of which are predominantly attributed to motor vehicle emissions.

Figure 3.2 – Highest Concentration Volatile Organic Compounds



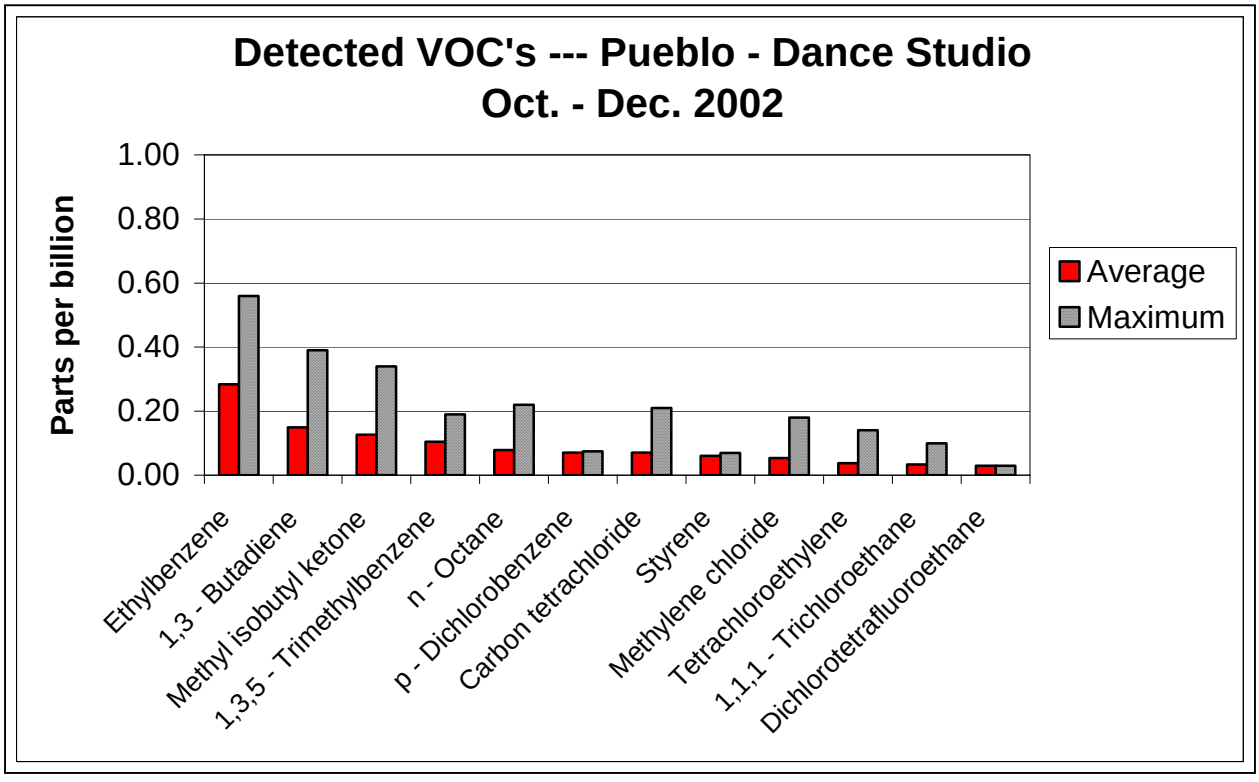
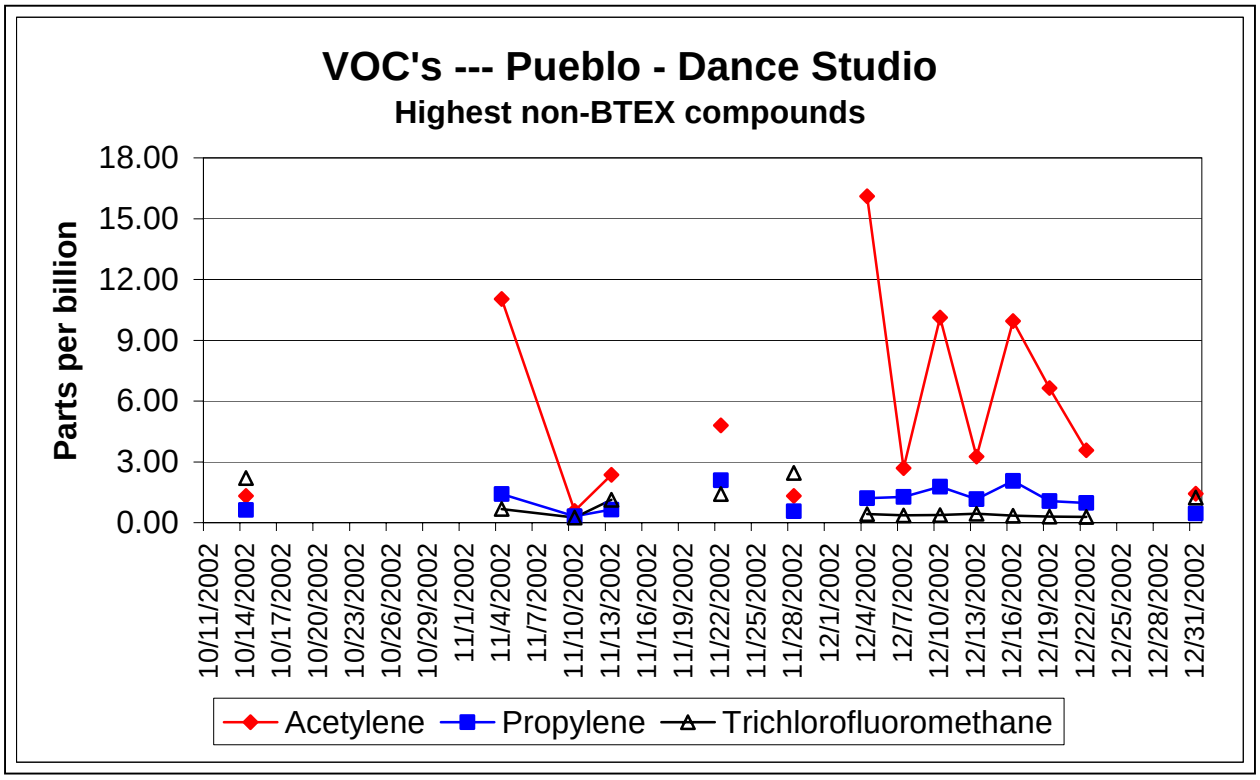
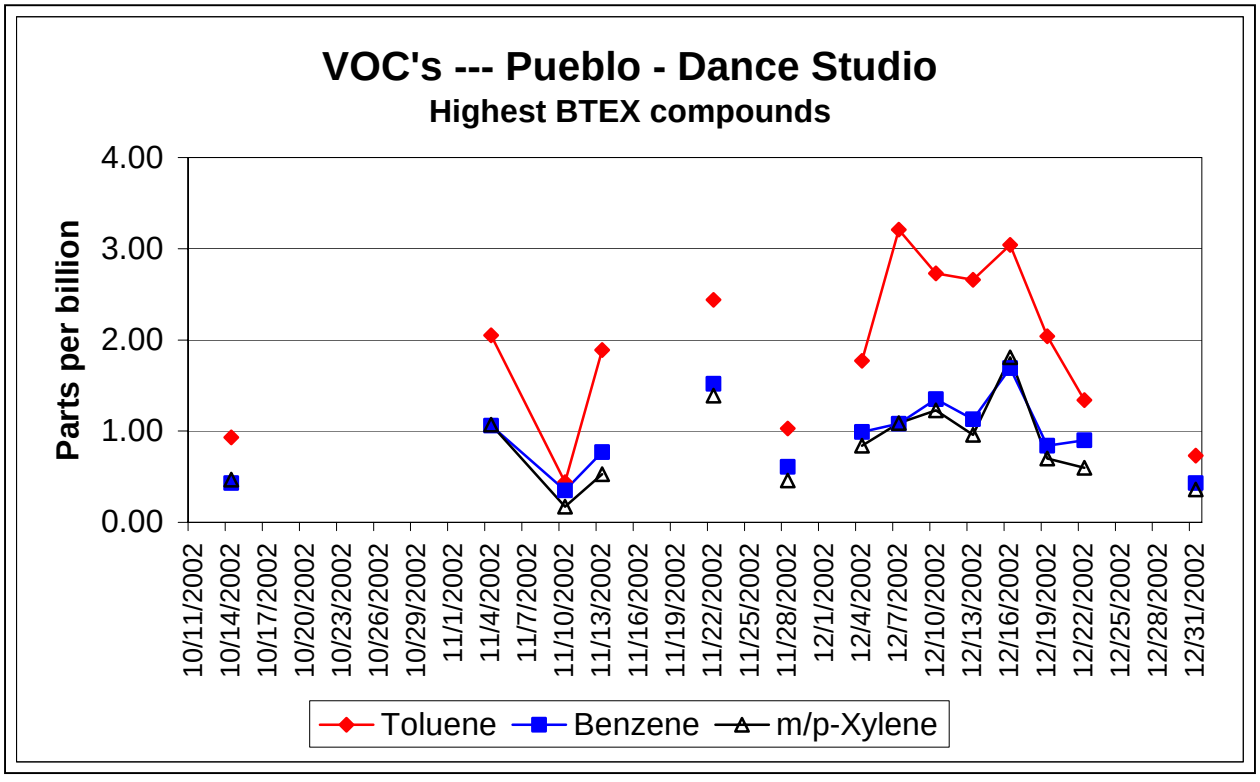


Figure 3.3 – Daily Values for Six Highest VOC's





Correlation Coefficients – Volatile Organic Compounds

A correlation coefficient analysis was conducted for the volatile organic compounds to determine if certain compounds track with each other and can be attributed to the same source. To simplify the calculations, only VOCs detected in over 75% of the air samples were analyzed for correlation to other compounds. Results are presented in Table 3.6, with correlation coefficients of 0.75 and higher being highlighted. The results show that propylene and 1,3-butadiene are correlated strongly to the benzene-toluene-ethylbenzene-xylenes (BTEX) group. The chlorofluorocarbons are not correlated to the BTEX suite, but show some correlation to one another. This is expected, because air emissions of different compound groups likely come from different sources. For example, the BTEX compounds and propylene are all emitted from vehicle exhaust.

Table 3.6 – Correlation Coefficients For VOCs Detected In Over 75% of the Samples

	Acetylene	Propylene	Dichlorodi-fluoro-methane	Chloro-methane	1,3-Butadiene	Trichloro-fluoro-methane
Acetylene	**1.00**					
Propylene	0.61	**1.00**				
Dichlorodi-fluoromethane	0.13	0.48	**1.00**			
Chloromethane	-0.14	0.42	**0.84**	**1.00**		
1,3-Butadiene	0.46	**0.90**	0.70	0.58	**1.00**	
Trichloro-fluoromethane	-0.43	-0.32	0.42	0.28	-0.07	**1.00**
Trichlorotri-fluoroethane	0.07	0.14	0.48	0.40	0.23	0.04
Benzene	0.57	**0.97**	0.38	0.36	**0.85**	-0.37
Toluene	0.43	**0.82**	0.15	0.21	0.66	-0.43
Ethylbenzene	0.58	**0.97**	0.47	0.37	**0.86**	-0.18
m,p - Xylene	0.57	**0.97**	0.35	0.29	**0.84**	-0.31
o - Xylene	0.49	**0.95**	0.43	0.38	**0.82**	-0.21
1,2,4-Trimethyl-benzene	0.58	**0.90**	0.34	0.16	**0.78**	-0.31

	Trichloro-trifluoro-ethane	Benzene	Toluene	Ethyl-benzene	m,p – Xylene	o – Xylene	1,2,4-Trimethyl-benzene
Trichlorotri-fluoroethane	**1.00**						
Benzene	0.10	**1.00**					
Toluene	-0.10	**0.88**	**1.00**				
Ethylbenzene	0.09	**0.94**	**0.81**	**1.00**			
m,p - Xylene	0.03	**0.97**	**0.87**	**0.98**	**1.00**		
o - Xylene	0.08	**0.94**	**0.84**	**0.99**	**0.98**	**1.00**	
1,2,4-Trimethyl-benzene	0.02	**0.87**	**0.75**	**0.92**	**0.94**	**0.93**	**1.00**

NOTE: Correlation coefficients greater than 0.75 are in **bold**.

Compounds of Significance: Sources and Health Effects

Of the fifty-eight volatile organic compounds sampled, only three showed average concentrations greater than 1 part per billion (ppb) in Pueblo's air at the Dance Studio location. These are: acetylene, propylene, and toluene. Table 3.7 lists those compounds analyzed in this study for which EPA has risk factors. (These risk factors are known as "reference concentrations" for non-cancer health effects and "unit risk" factors for cancer effects). These factors for the hazardous air pollutants may be found on the following EPA web page: http://www.epa.gov/ttn/atw/toxsource/summary.html.

This table also presents the calculated risks, based on the average concentrations measured in the study multiplied or divided by the appropriate risk factors. Five compounds had concentrations that were above the EPA one-in-a-million concern level for cancer health effects. None of the compounds had risk factors that were above the EPA non-cancer hazard quotient concern level of one. Information regarding the nature, sources, and potential health effects of each of these compounds is given below. Unlike national ambient air quality standards governing pollutants such as carbon monoxide or ozone, these EPA reference concentration and unit risk values do not have the force of law or regulation. They are simply levels at which EPA believes these pollutants may begin to cause health effects on sensitive members of the population. These reference concentration and unit risk values are for "chronic" health effects, meaning that exposure is considered to occur continuously for a 70-year lifetime.

The values presented in Table 3.7 use one-half of the minimum detection level as a substitute for non-detects. This is consistent with the values presented in Table 3.2. However, in cases where a compound was never detected, no risk calculations were performed and the average is listed as "ND".

Table 3.7 – VOC Risk Factors and Estimated Risk

Compound	Chronic Risk Factor (non-cancer) ug/m3	Chronic Risk Factor (cancer) 1/(ug/m3)	Average Concentration (ug/m3)	Non-Cancer Hazard Quotient	Cancer Risk (per million)
Chloromethane	90		1.18	0.0131	
Vinyl chloride	100	8.80E-06	ND		
1,3 - Butadiene	2	3.00E-05	0.33	0.1651	**9.91**
Bromomethane	5		ND		
Chloroethane	10000		ND		
Acetonitrile	60		ND		
Acrylonitrile	2	6.80E-05	ND		
1,1 - Dichloroethene	200		ND		
Methylene chloride	1000	4.70E-07	0.19	0.0002	0.09
Methyl tert-butyl ether	3000		ND		
Methyl ethyl ketone	1000		1.61	0.0016	
Chloroprene	7		ND		
Chloroform	98		ND		
1,2 - Dichloroethane	2.4	2.60E-05	ND		
1,1,1 - Trichloroethane	1000		0.19	0.0002	
Benzene	30	7.80E-06	3.00	0.1000	**23.41**
Carbon tetrachloride	40	1.50E-05	0.44	0.0111	**6.67**
1,2 - Dichloropropane	4	1.90E-05	ND		
Ethyl acrylate		1.40E-05	ND		
Trichloroethylene	600	2.00E-06	ND		
Methyl methacrylate	700		ND		
Methyl isobutyl ketone	80		0.52	0.0065	
1,1,2 - Trichloroethane	400	1.60E-05	ND		

Compound	Chronic Risk Factor (non-cancer) ug/m3	Chronic Risk Factor (cancer) 1/(ug/m3)	Average Concentration (ug/m3)	Non-Cancer Hazard Quotient	Cancer Risk (per million)
Toluene	400		7.08	0.0177	
1,2 - Dibromoethane	0.8	2.20E-04	ND		
Tetrachloroethylene	270	5.90E-06	0.26	0.0010	**1.51**
Chlorobenzene	1000		ND		
Ethylbenzene	1000		1.23	0.0012	
Bromoform		1.10E-06	ND		
Styrene	1000		0.26	0.0003	
1,1,2,2 - Tetrachloroethane		5.80E-05	ND		
Chloromethylbenzene		4.90E-05	ND		
p - Dichlorobenzene	800	1.10E-05	0.43	0.0005	**4.70**
1,2,4 - Trichlorobenzene	200		ND		
Hexachloro - 1,3 - butadiene	90	2.20E-05	ND		

ug/m3 = micrograms per cubic meter

NOTE: Average concentrations are calculated using ½ of minimum detection level as a substitute for non-detects. Substances which were never detected are noted as ND.

Table 3.7, completed.

Acetylene

Acetylene is a hydrocarbon compound with the formula C_2H_2. It exists in the atmosphere as a colorless and odorless gas. It is used in the production of organic chemicals such as vinyl chloride, vinyl acetate, and acrylates (Kirk-Othmer, Vol. 1, p 240). Another common use is in welding torches used to cut or solder metals.

Acetylene is emitted into the atmosphere from engines (CARB Fact Sheet on Acetylene) and from wood burning. (EPA CHIEF, Residential Wood Stove Chapter). As acetylene is produced by the thermal cracking of hydrocarbons (NIOSH Criteria Document on acetylene), petroleum refineries are another source.

Acetylene is an asphyxiant that can decrease the amount of available oxygen. Thus, the health effects of exposure to large concentrations of this compound involve oxygen deprivation and include headache, dizziness, lightheadedness, unconsciousness, and death. These concerns generally apply to workers using acetylene-powered welding torches in confined spaces. In outdoor air, acetylene is at much lower concentrations. According to the National Institute for Occupational Safety and Health, acetylene is not believed to have any toxic health effects beyond its asphyxiant properties. In fact, during the early twentieth century acetylene was used as an anesthetic for surgical patients. (NIOSH Criteria Document on Acetylene). Acetylene has not been investigated for carcinogenic effects, or ability to cause birth defects (New Jersey Hazardous Substance Fact Sheet on Acetylene).

The EPA AIRS system lists data from the state of California. Annual concentrations of acetylene in California typically range from 1 to 5.5 ppbv. The mean of the Pueblo data is 5.38 ppbv, within the California range. The EPA national air toxics analysis effort has not developed any recommended reference concentration or unit risk values for acetylene.

Benzene

Benzene is a hydrocarbon compound with the formula C_6H_6. It exists in the atmosphere as a colorless gas with a sweet odor. It is used in chemical manufacturing of medicines, detergents, explosives, shoes, dyes, leather, resins, paints, plastics and inks (CARB Fact Sheet on Benzene). It is also present in gasoline.

The largest sources of benzene in ambient air are automobiles, service stations, refineries, and chemical plants. Burning of vegetative matter in forest fires and woodstoves is also a source. In ambient air, benzene reacts with hydroxyl (OH) radicals within a few hours. This chemical transformation prevents the build-up of large concentrations in outdoor air.

From a toxicological standpoint, benzene is a serious concern. Unlike many of the compounds discussed here, benzene is a proven human carcinogen. It damages the blood-forming capacity of the body, leading to anemia or leukemia. Like the other volatile organic compounds, breathing large amounts can cause lightheadedness, headache, vomiting, convulsions, coma and death. It also irritates the skin and eyes, exerting a drying effect. However, these health effects are usually seen in workplaces, where levels are thousands of times higher than in outdoor air. Experiments with laboratory animals suggest that benzene exposure may be associated with numerous cancers. It may cause bone marrow damage and bone formation problems for a developing fetus (ATSDR Toxicological Profile for Benzene). Thus, EPA has had concerns about whether levels of benzene in outdoor air are associated with cancer and leukemia. While no link with outdoor air concentrations has been unequivocally proven, EPA has acted to reduce air concentrations of this pollutant.

ATSDR cites national 1984 to 1986 data from 300 cities, which indicate an average benzene level of 1.8 ppb for urban and suburban areas (ATSDR Toxicological Profile for Benzene). The Pueblo mean of 0.94 ppb observed in this study is somewhat lower. This may reflect recent national progress in reducing benzene emissions from motor vehicle fuel.

1,3-Butadiene

1,3-Butadiene is a hydrocarbon compound with the formula C_4H_6. It exists in the atmosphere as a colorless gas with an odor similar to gasoline. It is used in making rubber and plastics. The most important use is in tire production. It is also used in the production of chemicals such as 1,4-hexadiene (NIOSH Current Intelligence Bulletin 41).

According to the California Air Resources Board, most emissions of 1,3-butadiene come from combustion of fuels in diesel and gas-powered motor vehicles. Other sources that they list include petroleum refining, tire wear, residential wood heating, and forest fires. Rubber and chemical production plants also have emissions.

1,3-Butadiene is of concern toxicologically because it is a probable carcinogen that also has adverse effects on reproduction and fetal development. Exposure to high concentrations can cause irritation and central nervous system effects such as eye irritation, cough, sore throat, headache, drowsiness, nausea, unconsciousness, and death. Rats and mice exposed to this compound in laboratory tests developed multiple cancers within single individuals. The animals had damaged testes and ovaries, and offspring of the animals had skeletal problems. Generally, these health effects have not been seen at concentrations existing in outdoor air. However, EPA considers that the levels of 1,3-butadiene in air may represent a significant portion of the cancer risk related to airborne chemicals.

ATSDR estimates that urban and suburban areas in the United States have an average concentration of 0.3 ppb 1,3-butadiene, while rural areas have 0.1 ppb (ATSDR Toxicological Profile for 1,3-Butadiene). The annual average at Pueblo, 0.15 ppb, is within this range.

Carbon Tetrachloride

Carbon tetrachloride, also known as tetrachloromethane or methane tetrachloride, is a chlorinated hydrocarbon with the formula CCl_4. It exists in the atmosphere as a gas and it has a sweet odor. The primary uses of carbon tetrachloride were as a dry cleaning solvent, a grain fumigant, as a refrigerant, and as an aerosol propellant. Carbon tetrachloride has a long atmospheric half-life; it can travel to the higher reaches of the atmosphere and damage the earth's ozone layer. Due to its toxicity and ozone-damaging qualities, most uses of

carbon tetrachloride have been banned in the United States. It is still in use in industrial settings for producing refrigerants.

Carbon tetrachloride is emitted to the air from industrial sources and from petroleum refineries (California Air Resources Board Toxic Air Contaminant Identification List Summary for Carbon Tetrachloride). There are no natural sources of carbon tetrachloride; it is produced by man (ATSDR Toxicological Profile for Carbon Tetrachloride).

As is true for many of the chlorinated hydrocarbons, breathing large concentrations of carbon tetrachloride has central nervous system effects including lightheadedness, coma, convulsions, double vision, intoxication, and death. It can also cause vomiting. In animal studies, it had effects on the liver and kidney. Male rats exposed to carbon tetrachloride had lower sperm production. Female rats exposed to it had stunted offspring with birth defects. These health effects are generally observed in occupational settings, where peopla had exposure to very high levels over a number of years. Carbon tetrachloride has been associated with liver and kidney cancer in animals, but EPA considers it a Class B2 Carcinogen (probable human carcinogen).

The California Air Resources Board has monitored carbon tetrachloride at a number of locations, and found a mean value of 0.078 ppb (California Air Resources Board Toxic Air Contaminant Identification List Summary for Carbon Tetrachloride). The 0.07 ppb mean observed in this Pueblo study is at about the same level.

1,4-Dichlorobenzene

1,4-Dichlorobenzene, also known as para-dichlorobenzene, is a chlorinated hydrocarbon with the formula $C_6H_4Cl_2$. It exists in the atmosphere as a gas and it has a mothball-like odor. The primary uses of 1,4-dichlorobenzene are for mothballs, insecticide, or as a dry solid room/trash bin/toilet deodorant.

Most emissions of 1,4-dichlorobenzene in air come from its household uses as an insecticide and deodorant, or from factories that produce these household products. Industrial operations producing polyphenylene sulfide may also emit it, as 1,4-dichlorobenzene is used in the production process. There are no natural sources of 1,4-dichlorobenzene; it is produced by man (ATSDR Toxicological Profile for 1,4-Dichlorobenzene).

As is true for many of the chlorinated hydrocarbons, breathing large concentrations of 1,4-dichlorobenzene has central nervous system effects including lightheadedness, coma, convulsions, double vision, intoxication, and death. It also can cause vomiting. In animal studies, it had effects on the liver and kidney. 1,4-dichlorobenzene also effects the blood, leading to anemia and possibly, leukemia. (New Jersey Hazardous Substance Fact Sheet for 1,4-Dichlorobenzene). However, these health effects are generally observed in occupational settings. 1,4-dichlorobenzene has been associated with liver and kidney cancer in animals, but EPA considers it a Class C Carcinogen (possible human carcinogen).

The Environmental Protection Agency has monitored 1,4-dichlorobenzene at a number of locations, and found a mean value of 0.17 ppb during the period of 1976 – 1986 (California Air Resources Board Toxic Air Contaminant Identification List Summary for 1,4-Dichlorobenzene). The 0.07 ppb mean observed in this Pueblo study is lower.

Methyl Ethyl Ketone

Methyl ethyl ketone is a hydrocarbon compound with the formula C_4H_8O. In the atmosphere, it is a colorless gas with a sweet odor. Methyl ethyl ketone is commonly used as a solvent in glues, paints, plastics, printing inks, and cleaning solutions.

The California Air Resources Board states that the primary sources of this chemical in that state are motor vehicle exhaust, wood processing, wood furniture manufacturing operations, and footwear manufacturers (CARB

Air Toxics Profile for Methyl Ethyl Ketone). CARB states that the half-life of this chemical in air is 9 to 13 days. Therefore, it can be transported into an area from other places.

Like other volatile organic compounds measured in this study, methyl ethyl ketone has irritant and central nervous system effects. Methyl ethyl ketone can irritate the eyes, skin, and throat. Effects on the brain include headache, dizziness, and blurred vision. It also causes nausea (New Jersey Hazardous Substance Fact Sheet on Methyl Ethyl Ketone). However, these health effects are generally observed in occupational settings, where air concentrations are much higher than those seen outdoors. There is not enough information to determine whether this compound is carcinogenic. Animal testing indicates that high exposures to the mother may be associated with birth defects in the offspring.

In 1996 the average concentration for methyl ethyl ketone within the California Air Resources Board air monitoring network was 0.11 ppb (CARB Air Toxics Profile for Methyl Ethyl Ketone). This compares to a mean concentration of 0.55 ppb for monitoring at Pueblo.

Propylene

Propylene, also known as propene, is a hydrocarbon compound with the formula C_3H_6. As a gas, it has a slight odor and is colorless. Propylene is used in the manufacture of chemicals, resins, and plastics.

Propylene is emitted into the air from paper mills, petroleum refining, oil and gas extraction, and motor vehicle exhaust (CARB Air Toxics Profile on Propene). CARB lists an atmospheric half-life of 9 to 13 hours. Thus, propylene is unlikely to be transported for long distances. CARB states that it reacts with OH radicals to form formaldehyde, acetaldehyde, and other compounds.

Propylene is an explosive compound that decreases the amount of available oxygen by displacing the oxygen. These asphyxiant and explosive properties are mainly a concern to workers using propylene in confined spaces. In high concentrations, propylene may cause dizziness, unconsciousness, and death. Propylene is also an irritant to the eyes and lungs. It may also create heart and liver damage. It is not known whether propylene can damage a developing fetus. The cancer-causing potential of this compound is unknown because there has not been adequate research.

The EPA AIRS system lists data from the state of California. Annual concentrations of propylene in California typically range from 0.3 to 1.7 ppbv. The mean of the Pueblo data is 1.12 ppbv, within the California range. Unfortunately, there are no EPA propylene reference concentrations or unit risk factor estimates for cancer or chronic non-cancer health effects.

Tetrachloroethylene

Tetrachloroethylene, also known as perchloroethylene, is a chlorinated hydrocarbon with the formula C_2Cl_4. It exists in the atmosphere as a gas. It has a “chloroform-like” odor (NIOSH Pocket Guide to Chemical Hazards, Tetrachloroethylene). The primary uses of tetrachloroethylene are as a dry cleaning solvent, a metal cleaning solvent, or for chemical production. Tetrachloroethylene is used in paints, inks, aerosols, glues, polishes, silicones and rubber products (CARB Fact Sheet on Tetrachloroethylene and OPPT Chemical Fact Sheet on Tetrachloroethylene).

Most emissions of tetrachloroethylene come from degreasing, dry cleaning, or chemical production facilities. There are microorganisms that can produce tetrachloroethylene (ATSDR Toxicological Profile For Tetrachloroethyelene).

As is true for many of the chlorinated hydrocarbons, breathing large concentrations of tetrachloroethylene has central nervous system effects including lightheadedness, coma, convulsions, double vision, intoxication, and death. It also can cause vomiting. In animal studies, it had effects on the liver and kidney. It also is an irritant to

eyes, lungs, and skin. However, many of these health effects were observed in occupational settings, where exposure is much higher than in outdoor air. Some animal studies suggest that tetrachloroethylene exposure may lead to leukemia (NIOSH Registry of Toxic Effects of Chemical Substances Information for Tetrachloroethylene). Tetrachloroethylene has been associated with liver and kidney cancer in animals, but EPA considers it a Class B2 or C Carcinogen (probable or possible human carcinogen).

The California Air Resources Board has monitored tetrachloroethylene at a number of locations within their state, and found a mean value of 0.019 ppb during 1996 (California Air Resources Board Toxic Air Contaminant Identification List Summary for Tetrachloroethylene). The 0.04 ppb mean observed in this Pueblo study is significantly higher. As seen in Table 3.7, the chronic hazard index for this chemical is low. However, the cancer risk in air is 1.5 times higher than the EPA goal of one-in-a-million risk.

Toluene

Toluene is a hydrocarbon compound with the formula C_7H_8. It exists in the atmosphere as a gas with an odor similar to that of benzene. Toluene has a number of industrial uses. It is used in high-octane gasoline. Toluene is employed in production processes for paints, resins, glues, and rubber. The printing, plastics, and furniture industries frequently use toluene.

Automotive-related activities are one of the largest sources of toluene in the atmosphere. Toluene is emitted from automobile exhaust, and from gasoline stations and refineries. Toluene is a component of wood smoke. Furniture manufacturers emit toluene, due to its use in paints and coatings. Forest fires are a natural source of toluene emissions.

Toluene is an irritant, has central nervous system effects (both temporary and permanent), and can damage a developing fetus. As an irritant, it causes stinging eyes, coughing, and skin irritation. Toluene can affect the brain. Individuals with exposures to large amounts have experienced slower reflexes, memory loss, hearing loss, and difficulty concentrating. Headache, dizziness, unconsciousness and death may result from exposure to large concentrations. Nausea and appetite loss may also occur. However, many of these health effects were observed in occupational settings, where exposure is much higher than in outdoor air. Mothers who abused toluene as an inhalant had children with brain dysfunction, attention deficits, craniofacial problems, and limb abnormalities. However, the CARB Air Toxics Profile on toluene, which discusses these problems in offspring, notes that the mothers also had exposure to other chemicals. Toluene can cause problems in the liver and kidneys. Due to an inadequate number of studies, it is not known whether toluene can cause cancer.

ATSDR indicates that toluene occurs in polluted air at levels of 0.3 to 7.98 ppb (ATSDR Toxicological Profile on Toluene). Thus, the Pueblo mean level of 1.88 ppb is right within a typical US range. The ATSDR Toxicological Profile on Toluene indicates that children living in central urban core areas with large amounts of traffic had 56% more toluene detected in their blood than children living in rural areas. The health significance of this, if any, is not known.

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Section 4 – Particulates

May 2002 to December 2002

Summary Statistics – Particulates

Maximum, Mean – All Samples

Particulates were collected at the Fulton Heights School site from May 2002 through December 2002 and at the Dance Studio site from September 2002 through December 2002. Both PM10 (particulates 10 microns in diameter and smaller) and total suspended particulates (TSP) were sampled for 24-hours (midnight-to-midnight). For the period, TSP was sampled on an every day basis and PM10 was sampled on an every third day basis. In addition, metals analyses were performed on the TSP filters. The particulate data from both sites are presented in this section. Table 4.1 provides a summary of the number of samples taken at each site and the percent data recovery. Table 4.2 summarizes the maximum and mean concentrations for both PM10 and TSP for both sites.

Table 4.1 – Percentage Data Recovery For Particulate Samples

Site	Parameter	Sample Days Scheduled	Samples Recovered	Percent Recovered
Fulton Heights	PM10	75	73	97.3
Fulton Heights	TSP	223	205	91.9
Dance Studio	PM10	40	40	100.0
Dance Studio	TSP	118	110	93.2

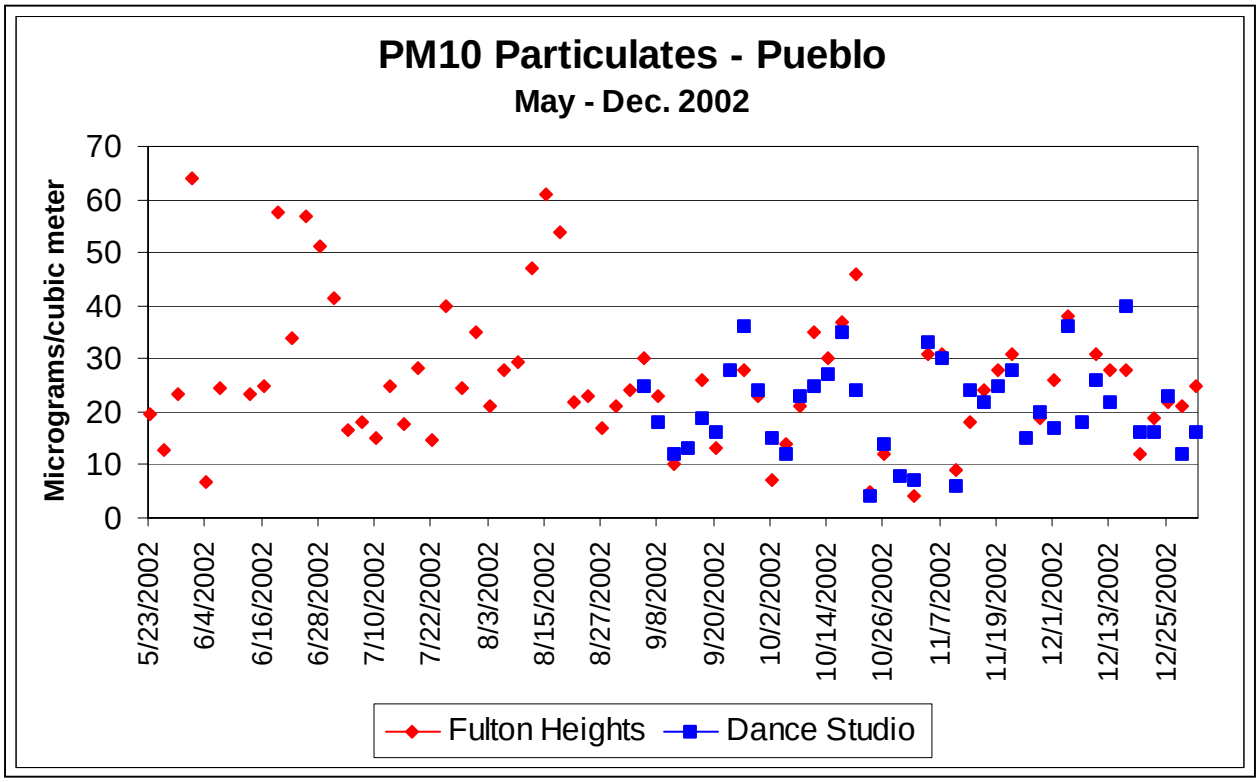
Table 4.2 – Particulate Data Summary

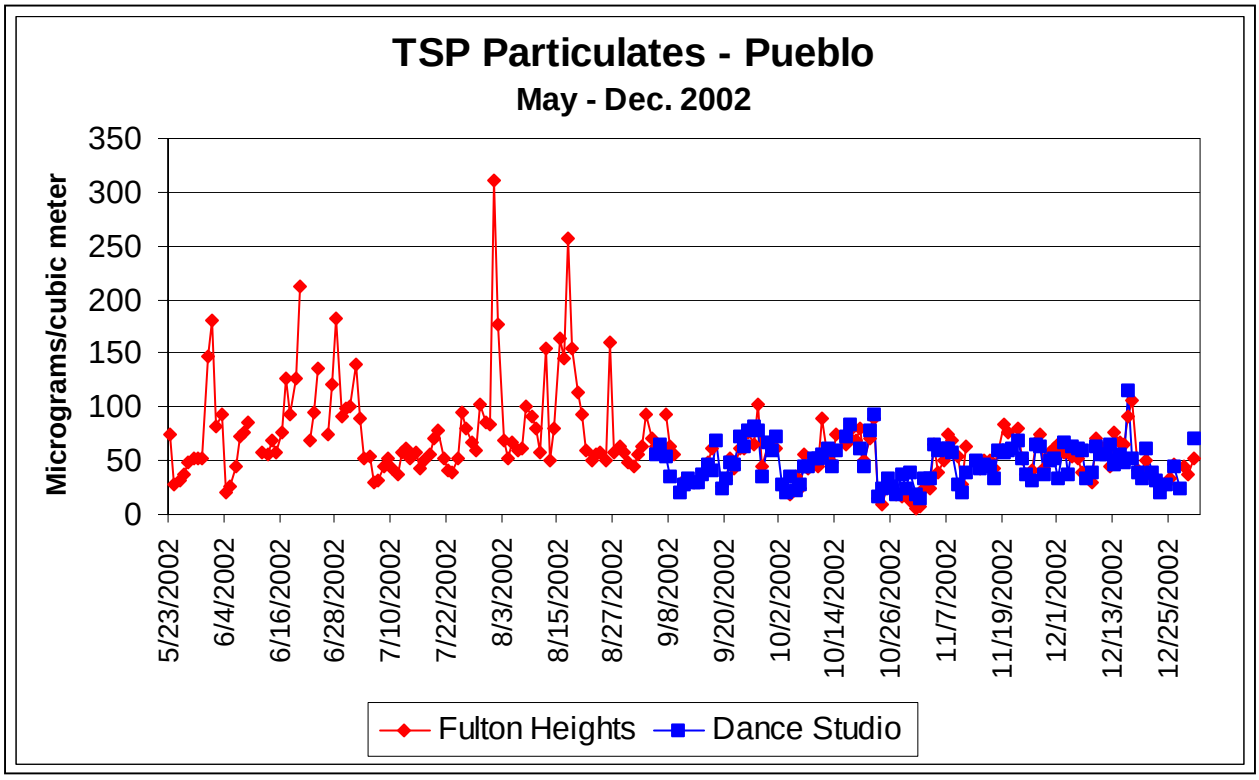
Site	Sampling Period	Parameter	Average (ug/m3)	Maximum (ug/m3)
Fulton Heights	May – Dec. 2002	PM10	26.0	64
Fulton Heights	May – Dec. 2002	TSP	65.9	311
Dance Studio	Sept. – Dec. 2002	PM10	20.8	40
Dance Studio	Sept. – Dec. 2002	TSP	47.8	116

Graphs – Particulates

The graphs of individual daily values for particulates are presented in Figure 4.1.

Figure 4.1 – Particulates





Health Implications – Particulates

PM10 is listed by EPA as a "criteria" pollutant. That is, a pollutant for which a national health-based standard has been developed. These standards are known as National Ambient Air Quality Standards (NAAQS). TSP was a criteria pollutant prior to the PM10 standard replacing it in 1987. Primary standards have been set to protect human health, with an adequate level of safety. Secondary standards have been set to protect human welfare from adverse levels of air pollution. Table 4.3 provides information on the levels of the current standards for PM10 and former standards for TSP.

Table 4.4 compares the mean and maximum values of PM10 and TSP to the EPA NAAQS. For this study, only the TSP maximum 24-hour level at Fulton Heights was above the level of the former standard. Since a full year of data were not collected at either site, comparisons to the annual average standards are not very meaningful.

Table 4.3 – National Ambient Air Quality Standards for PM10 and TSP

POLLUTANT	AVERAGING TIME	STANDARD
Particulates (PM_{10})		
Primary and Secondary Standards	Annual Arithmetic Mean [(a)]	50 $\mu g/m^3$
Primary and Secondary Standards	24 Hour [(b) prior to July 1997, (c) as of July 1997]	150 $\mu g/m^3$
Total Suspended Particulates (TSP)		
Primary Standard	Annual Geometric Mean [(d)]	75 $\mu g/m^3$
Primary Standard	24 Hour [(d)]	260 $\mu g/m^3$
Secondary Standard	Annual Geometric Mean [(d)]	60 $\mu g/m^3$
Secondary Standard	24 Hour [(d)]	150 $\mu g/m^3$

(a) The average of three years of annual averages (based on quarterly averages) is not to exceed this level.

(b) Statistically estimated number of days with concentrations above this level, averaged over a three-year period, is not to be more than 1 per year.

(c) The three-year average of the 99th percentile for each year is not to exceed this level.

(d) The TSP standard was replaced by the PM_{10} standard on July 1, 1987.

Table 4.4 – PM10 and TSP Comparison to National Ambient Air Quality Standards

			Fulton Heights (May – Dec. 2002)		Dance Studio (Sept. – Dec. 2002)	
Particulate Size Fraction	Averaging Time	Current or Former Standard (ug/m3)	Average Conc. (ug/m3)	Maximum Conc. (ug/m3)	Average Conc. (ug/m3)	Maximum Conc. (ug/m3)
PM10	Annual Arithmetic Mean	50	26.0	--	20.8	--
PM10	24-Hour Maximum	150	--	64	--	40
TSP	Annual Arithmetic Mean	75	65.9	--	47.8	--
TSP	24-Hour Maximum	260	--	311	--	116

Section 5 – Metals from Total Suspended Particulates

May 2002 to December 2002

Summary Statistics – Metals from Total Suspended Particulates

Maximum, Mean – All Samples

Metals data collected on TSP filters at the Fulton Heights School site from May 2002 through December 2002 and at the Dance Studio site from September 2002 through December 2002 are presented in this section. For the period, 24-hour TSP was sampled on an every day basis. The particulate data are presented in the Section 4. These metals were chosen as being representative of what is potentially hazardous or what is likely to be found in urban air. Table 5.1 provides a summary of the number of samples taken at each site and the percent data recovery. Table 5.2 summarizes the maximum and mean concentrations for metals from TSP for both sites.

Table 5.1 – Percentage Data Recovery For Metals Samples

Site	Sample Days Scheduled	Samples Recovered	Percent Recovered
Fulton Heights	223	204	91.5
Dance Studio	118	110	93.2

Table 5.2 – Metals Data Summary

	Metal	CAS #	Average (ug/m3)	Maximum (ug/m3)	# of non-detects	% of non-detects	% of time detected
Fulton Heights May – Dec. 2002	Pb (lead)	7439-92-1	0.0165	0.1244	71	34.8%	65.2%
	As (arsenic)	7440-38-2	0.0012	0.0341	195	95.6%	4.4%
	Be (beryllium)	7440-41-7	0.0049	0.0353	203	99.5%	0.5%
	Cd (cadmium)	7440-43-9	0.0011	0.0352	200	98.0%	2.0%
	Co (cobalt)	7440-48-4	0.0049	0.0436	203	99.5%	0.5%
	Cr (chromium)	7440-47-3	0.0056	0.0454	184	90.2%	9.8%
	Mn (manganese)	7439-96-5	0.0783	0.3424	8	3.9%	96.1%
	Ni (nickel)	7440-02-0	0.0049	0.0471	203	99.5%	0.5%
	Se (selenium)	7782-49-2	0.0048	0.0268	203	99.5%	0.5%
	Sb (antimony)	7440-36-0	0.0049	0.0220	202	99.0%	1.0%
Dance Studio Sept. – Dec. 2002	Pb (lead)	7439-92-1	0.0140	0.0878	28	24.4%	75.6%
	As (arsenic)	7440-38-2	0.0008	0.0019	108	98.2%	1.8%
	Be (beryllium)	7440-41-7	0.0039	0.0045	110	100.0%	0.0%
	Cd (cadmium)	7440-43-9	0.0008	0.0009	110	100.0%	0.0%
	Co (cobalt)	7440-48-4	0.0039	0.0045	110	100.0%	0.0%
	Cr (chromium)	7440-47-3	0.0042	0.0166	105	85.4%	14.6%
	Mn (manganese)	7439-96-5	0.0595	0.2279	2	1.8%	98.2%
	Ni (nickel)	7440-02-0	0.0039	0.0045	110	100.0%	0.0%
	Se (selenium)	7782-49-2	0.0039	0.0045	110	100.0%	0.0%
	Sb (antimony)	7440-36-0	0.0039	0.0045	110	100.0%	0.0%

NOTE: Average and maximum concentrations are calculated using ½ of minimum detection level as a substitute for non-detects. Thus, values will be displayed even though there were no detected samples.

Percentage of Samples For Which Metal Was Detected

Table 5.2 shows the percentage of the samples in which each metal was detected. Two of the compounds were detected in over 75% of the samples at both sites. These compounds are listed in Table 5.3. In contrast, six metals were never detected at all during the study at the Dance Studio site. These compounds are listed in Table 5.4. This is over one-half of the metals that were analyzed.

Table 5.3 – Metals Detected in Over 75% of the Particulate Air Samples

Lead (Dance Studio)	Manganese (Fulton Heights, Dance Studio)

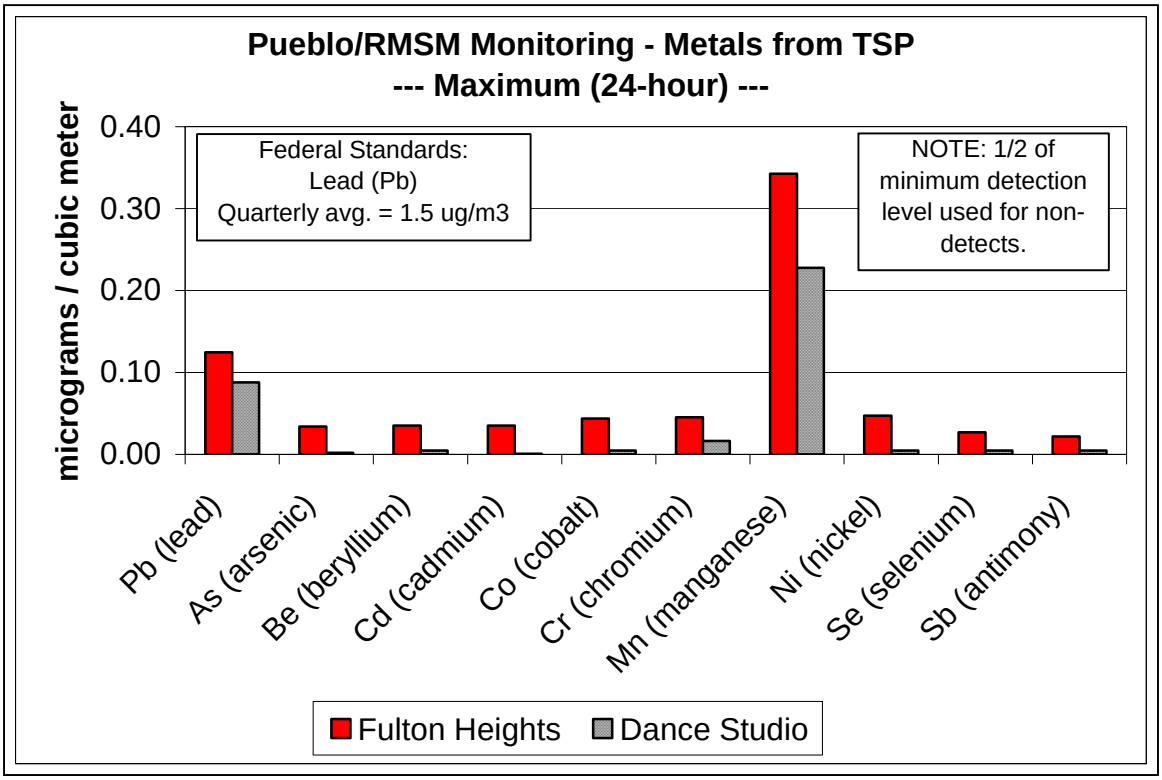
Table 5.4 – Metals Never Detected in the Particulate Air Samples

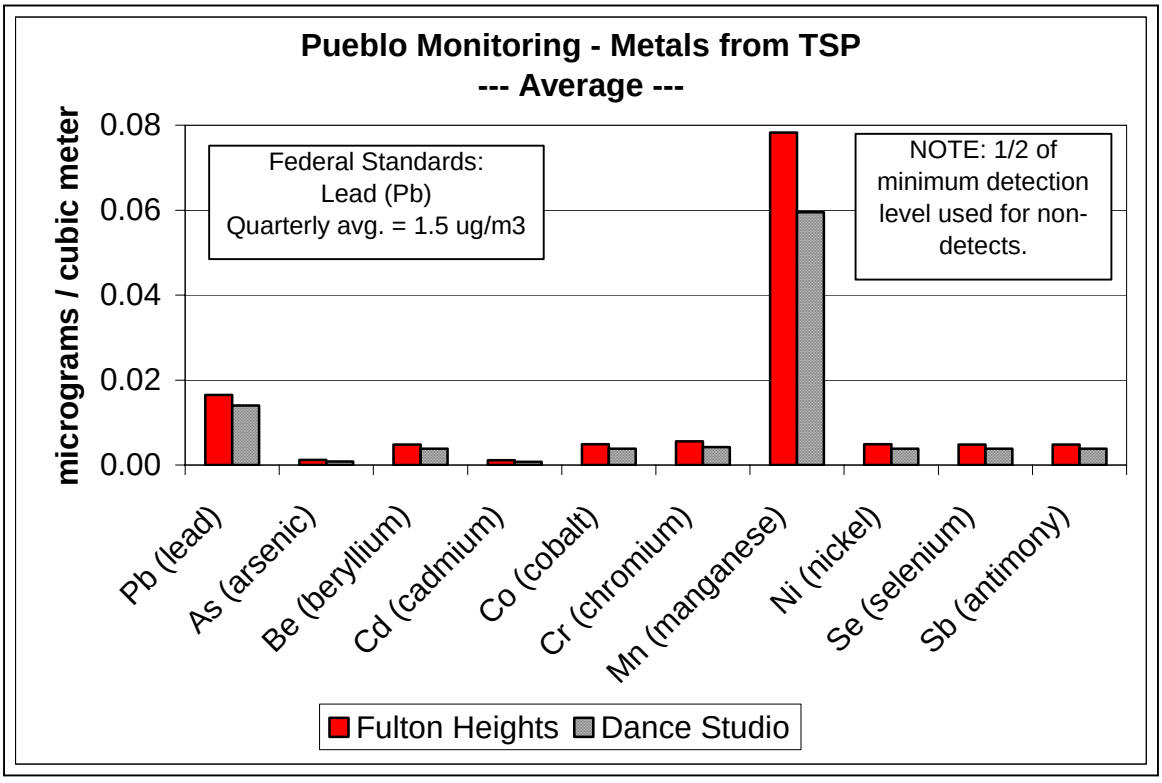
Beryllium (Dance Studio)	Nickel (Dance Studio)
Cadmium (Dance Studio)	Selenium (Dance Studio)
Cobalt (Dance Studio)	Antimony (Dance Studio)

Graphs – Metals from Total Suspended Particulates

The graphs of average and maximum metals concentrations from total suspended particulates are presented in Figure 5.1.

Figure 5.1 – Metals from TSP





Correlation Coefficients – Metals

A correlation coefficient analysis was conducted for the metals from total suspended particulates to determine if certain metals track with each other and can be attributed to the same source. To simplify the calculations, only metals detected in over 9% of the air samples were analyzed for correlation to other metals. Results are presented in Table 5.5, with correlation coefficients of 0.75 and higher being highlighted. Only the chromium to manganese correlation at the Dance Studio site is higher than 0.75, though the correlation between lead and manganese is greater than 0.50 at both sites.

Table 5.5 – Correlation Coefficients For Metals Detected In Over 9% of the Samples

		Lead (Pb)	Chromium (Cr)	Manganese (Mn)
Fulton Heights	**Lead (Pb)**	**1.00**		
May – Dec. 2002	**Chromium (Cr)**	0.42	**1.00**	
	Manganese (Mn)	0.67	0.21	**1.00**
Dance Studio	**Lead (Pb)**	**1.00**		
Sept. – Dec. 2002	**Chromium (Cr)**	0.37	**1.00**	
	Manganese (Mn)	0.57	**0.83**	**1.00**

NOTE: Correlation coefficients greater than 0.75 are in **bold**.

Metals of Significance: Sources and Health Effects

Of the metals from total suspended particulates that were analyzed, only two had average concentrations greater than 0.01 ug/m3 and maximum concentrations greater than 0.05 ug/m3 at both sites. These were: lead and manganese. Many of the metals were detected infrequently or not at all, making risk comparisons difficult.

Table 5.6 lists those metals analyzed in this study for which EPA has risk factors. (These risk factors are known as "reference concentrations" for non-cancer health effects and "unit risk" factors for cancer effects). These factors for the hazardous air pollutants may be found on the following EPA web page: http://www.epa.gov/ttn/atw/toxsource/summary.html.

This table also presents the calculated risks, based on the average concentrations measured in the study multiplied or divided by the appropriate risk factors. Four metals had concentrations that were above the EPA one-in-a-million concern level for cancer health effects. These are arsenic, beryllium, cadmium and chromium. However, these metals were rarely detected, and levels seen are typical of U.S. urban areas. The commonly used practice of using one-half of the minimum detection level as a substitute for the non-detect levels is driving the increased risk. Also, for chromium, it was assumed that it was all in the toxic hexavalent form and none in the more commonly found trivalent form. Thus, the risk is probably significantly overstated. Therefore, these four metals are not considered a local problem, and will not be discussed further.

One metal had a risk factor that was above the EPA non-cancer hazard quotient concern level of one. This metal, manganese, appears elevated above typical national urban air levels. Information regarding the nature, sources, and potential health effects of manganese is given below. Levels observed in Pueblo are compared to national EPA reference concentrations and unit risk factor concentrations, which are used to evaluate whether areas are meeting national EPA goals for reducing concentrations of hazardous air pollutants. However, unlike national ambient air quality standards governing pollutants such as carbon monoxide or ozone, these EPA values do not have the force of law or regulation. They are simply levels at which EPA believes these pollutants may begin to

cause health effects on sensitive members of the population. These reference concentration and unit risk values are for "chronic" health effects, meaning that exposure is considered to occur continuously for a 70-year lifetime.

The values presented in Table 5.6 use one-half of the minimum detection level as a substitute for non-detects. This is consistent with the values presented in Table 5.2. However, in cases where a metal was never detected, no risk calculations were performed and the average is listed as "ND".

Table 5.6 – Metals Risk Factors and Estimated Risk

	Metal	Chronic Risk Factor (non-cancer) ug/m3	Chronic Risk Factor (cancer) 1/(ug/m3)	Average Concentration (ug/m3)	Non-Cancer Hazard Quotient	Cancer Risk (per million)
Fulton Heights	Pb (lead)	1.5	1.20E-05	0.0165	0.0110	0.20
May – Dec. 2002	As (arsenic)	0.03	4.30E-03	0.0012	0.0396	**5.11** *
	Be (beryllium)	0.02	2.40E-03	0.0049	0.2426	**11.65** #
	Cd (cadmium)	0.02	1.80E-03	0.0011	0.0569	**2.05 #**
	Co (cobalt)	0.1		0.0049	0.0489	
	Cr (chromium)	0.1	1.20E-02	0.0056	0.0558	**66.96** @
	Mn (manganese)	0.05		0.0783	**1.5660**	
	Ni (nickel)	0.2		0.0049	0.0246	
	Se (selenium)	20		0.0048	0.0002	
Dance Studio	Pb (lead)	1.5	1.20E-05	0.0140	0.0093	0.17
Sept. – Dec. 2002	As (arsenic)	0.03	4.30E-03	0.0008	0.0264	**3.41**
	Be (beryllium)	0.02	2.40E-03	ND		
	Cd (cadmium)	0.02	1.80E-03	ND		
	Co (cobalt)	0.1		ND		
	Cr (chromium)	0.1	1.20E-02	0.0042	0.0421	**50.53** @
	Mn (manganese)	0.05		0.0595	**1.1904**	
	Ni (nickel)	0.2		ND		
	Se (selenium)	20		ND		

ug/m3 = micrograms per cubic meter

NOTES: Average concentrations are calculated using ½ of minimum detection level as a substitute for non-detects.
Metals never measured at detectable levels are shown as ND (non-detect).
Antimony is not included, as there is no EPA Reference Concentration or unit risk factor for this metal.

* Arsenic was detected less than 5 % of the time.
\# Beryllium and cadmium were detected less than 2 % of the time.
@ Chromium risk factor is for hexavalent chromium, Cr^{6+}. The project measured total chromium, so this assumption that it is all Cr^{6+} overestimates the cancer and non-cancer risks.
Chromium was detected less than 15 % of the time.

Chromium

Chromium is a metal that occurs naturally in the earth's crust. Its chemical symbol is Cr. It exists in the atmosphere as particulate matter and in compounds formed from combination with other atoms. Chromium may exist in several valence states, such as Cr^0, Cr^{+3}, and Cr^{+6}. The zero valence and trivalent forms are believed to have lower toxicity than the hexavalent form, Cr^{+6}. Chromium is used as an additive in metal processing and steel production, and also as a pigment in paints, rubber products, and plastics (California Air Resources Board Fact

Sheet on Chromium). It is also used in leather tanning, and in wood preservatives. In the past, industrial cooling towers employed rust-preventing solutions that contained chromium. These towers were one of the largest chromium emissions sources, until the solutions were changed to formulas that did not contain chromium. The bricks used to line high-temperature furnaces may also contain chromium.

Emission sources of chromium include petroleum refineries, steel producers, chrome production plants, cement producers, coal-fired power plants, wood-burning, metals operations, mining operations, and incinerators. Chromium occurs naturally in some soils, so wind-blown dusts from exposed land can contain it. Soils contaminated by smelter fall-out can also be a source of emissions during high winds. Burning wood treated with chromium also leads to emissions. Automobiles may emit small amounts of chromium from catalytic converters or the wearing of brake linings. Most chromium emitted to outdoor air is believed to be of the trivalent form, but some percentage is of the hexavalent form.

Chromium's toxicity varies, depending upon its valence state. Chromium $^{+3}$, the trivalent form, is believed to be an essential micronutrient in the human body. With regard to carcinogenicity, EPA classifies chromium $^{+3}$ in Group D, the unclassifiable compounds. This is due to lack of information regarding chromium $^{+3}$ exposures, which occur largely in industrial settings where chromium $^{+6}$ is also present. Chromium $^{+6}$, in contrast, has demonstrated health effects including lung cancer, allergic dermatitis, skin ulcers, and irritation of the nasal passages. It has also been shown to create holes in the nasal septum. It irritates the lungs and the gastro-intestinal tract. It can also damage the kidneys, lungs and blood. EPA classifies chromium $^{+6}$ in Group A, the known human carcinogens. However, it should be noted that these health effects have been observed in workers with long-term exposure to hexavalent chromium in industrial settings. These exposures were to chromium acid mists occurring at levels hundreds or thousands of times higher than chromium levels in outdoor air. Chromium in outdoor air is more likely to be the trivalent form, and to occur as particulate matter, rather than as a mist. Assessment of the health significance of outdoor levels is complicated by the fact that the monitoring method used in this study, chemical analysis of chromium in particulate matter collected on filters, is incapable of distinguishing between chromium $^{+3}$ and chromium $^{+6}$.

The California Air Resources Board monitored chromium in 1996. They report a network-wide average of 0.0039 ug/m3 total chromium, of which 0.00013 ug/m3 was hexavalent chromium. They estimate that the hexavalent form accounts for about 3 to 8 percent of the total chromium measured (CARB Fact Sheet on Chromium). The 0.0056 and 0.0042 annual means measured at the two Pueblo sites are close to the California results. Calculations in Tables 5.6 imply that the cancer risk for chromium is fifty to seventy times greater than the EPA guideline of one in a million. However, these calculations assume that all of the chromium present is in the hexavalent.form. This assumption probably overstates cancer risk, given the California estimates of only 8% chromium in the hexavalent form. This problem of not being able to differentiate between the two chromium forms has led to great uncertainly in risk estimates, with most urban areas of the United States showing cancer risk greater than one in a million. For this reason, EPA is recommending that future studies conducted for the national air toxics trends monitoring network use a more sophisticated sampling and laboratory technique that is able to distinguish between the two chromium forms. It is hoped that the development of new, more sophisticated sampling and laboratory techniques will permit better assessment of chromium risk.

Manganese

Manganese is a metal that occurs naturally in the earth's crust. Its chemical symbol is Mn. It exists in the atmosphere as particulate matter and in compounds formed from combination with other atoms. Manganese is used as an additive in metal processing and steel production. It is also used in ceramics, matches, glass, dyes, batteries, and as a pigment in paints (California Air Resources Board Fact Sheet on Manganese). It is also employed in wood preservatives. Organic forms of manganese are used as pesticides and for disease prevention in crops such as fruits, vegetables, and cotton.

Emission sources of manganese include petroleum refineries, steel producers, cement producers, coal-fired power plants, wood-burning, metals operations, mining operations, and incinerators. Manganese occurs naturally in some soils, so wind-blown dusts from exposed land can contain it. Soils contaminated by smelter fall-out can also

be a source of emissions during high winds. Manganese is also used as a gasoline additive, in place of lead. Therefore, automobiles may also emit small amounts.

Manganese is considered an essential micronutrient in the human body. The body tends to regulate manganese concentrations, so exposure to small amounts naturally present in food is rarely a problem. Exposure of manganese by inhalation can lead to health effects. Manganese health effects on the respiratory system include lung irritation, chemical pneumonia, cough, and bronchitis. Manganese may damage the central nervous system. The disease known as "manganism", which results from manganese poisoning, includes psychological and nervous system damage. Individuals with manganism have a mask-like face, depression, uncontrollable laughter, and lethargy. The central nervous system effects include trouble with tremors, balance and walking that is similar to that of Parkinson's disease. Central nervous system damage can occur at exposure levels below those that lead to manganism. Examples are decreases in visual reaction time, hand steadiness, and eye-hand coordination. Manganese also affects the gastro-intestinal tract and the kidneys. However, it should be noted that these health effects have been observed in workers with long-term exposure to manganese fumes and dusts in industrial settings. These exposures were at levels hundreds or thousands of times higher than manganese levels in outdoor air. EPA classifies manganese as Group D, unclassifiable as to carcinogenic potential. This is because there is little evidence to link it to cancer health effects.

The California Air Resources Board monitored manganese in 1996. They report a network-wide average of 0.0212 ug/m3 total manganese (CARB Fact Sheet on Manganese). The 0.0783 and 0.0595 ug/m3 means measured at the two Pueblo sites are three to four times higher than the California results. These higher concentrations suggest the influence of localized sources. These concentrations are just above the non-cancer unit risk level of one at which EPA believes health effects could potentially occur.

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Section 6 – Meteorology

Meteorology

Wind Roses

No meteorological sensors were employed during this study. However, the RMSM did install meteorological sensors at one of their sites on the north side of the RMSM facility that started operation in September 2002. This site is less than three blocks to the south of the Dance Studio site. It has wind speed and wind direction sensors located at the top of a 10-meter tall tower, which is the standard height used for meteorological monitoring. In addition, Colorado State University (CSU) operates a meteorological site for agricultural uses at Vineland, approximately nine miles to the east-southeast of the RMSM. The wind speed and wind direction sensors on this tower, however, are only seven feet above the ground and are thus subject to surface effects. A topographical map showing the location of these sites and their proximity to drainages is presented in Figure 6.1. Wind Roses are used to depict the relationship between wind direction and wind speed. They provide a graphical representation of the direction from which the wind is blowing and the percentage of time that the wind is in a certain velocity range for that direction.

Figure 6.2 shows a wind rose for one complete year of data from the RMSM site, starting in September 2002. Figure 6.3 shows a wind rose for the CSU Vineland site for 2002. Figures 6.4 through 6.7 show wind roses for the two sites for different 6-hour periods of the day. As can be seen in all these wind roses, there are local differences between the sites, probably due to the different creek/river drainages near each site. In general, for the RMSM area, the wind tends to be a drainage flow down-valley (from the west-northwest or from the southwest) in the early morning due to cooler air sinking. The late morning is a mix of continued drainage flow as well as up-valley convection heating flow. This up-valley flow (from the east and east-southeast) continues through the afternoon before returning to a down-valley drainage flow in the evening.

Figure 6.1 – Meteorological Site Locations

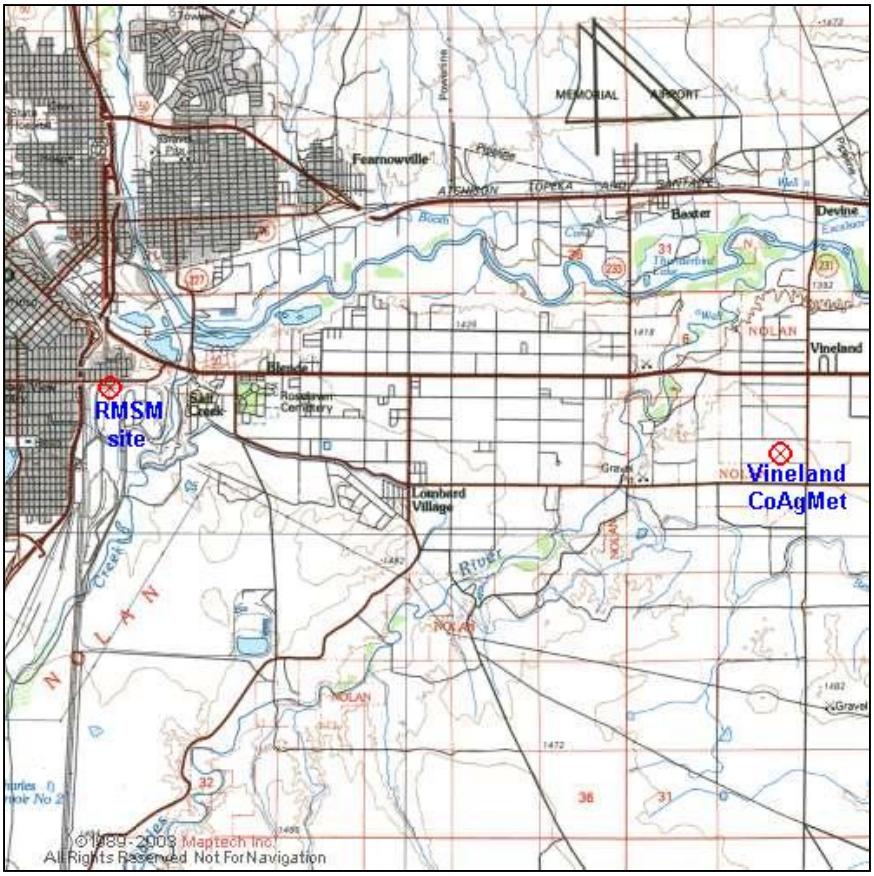
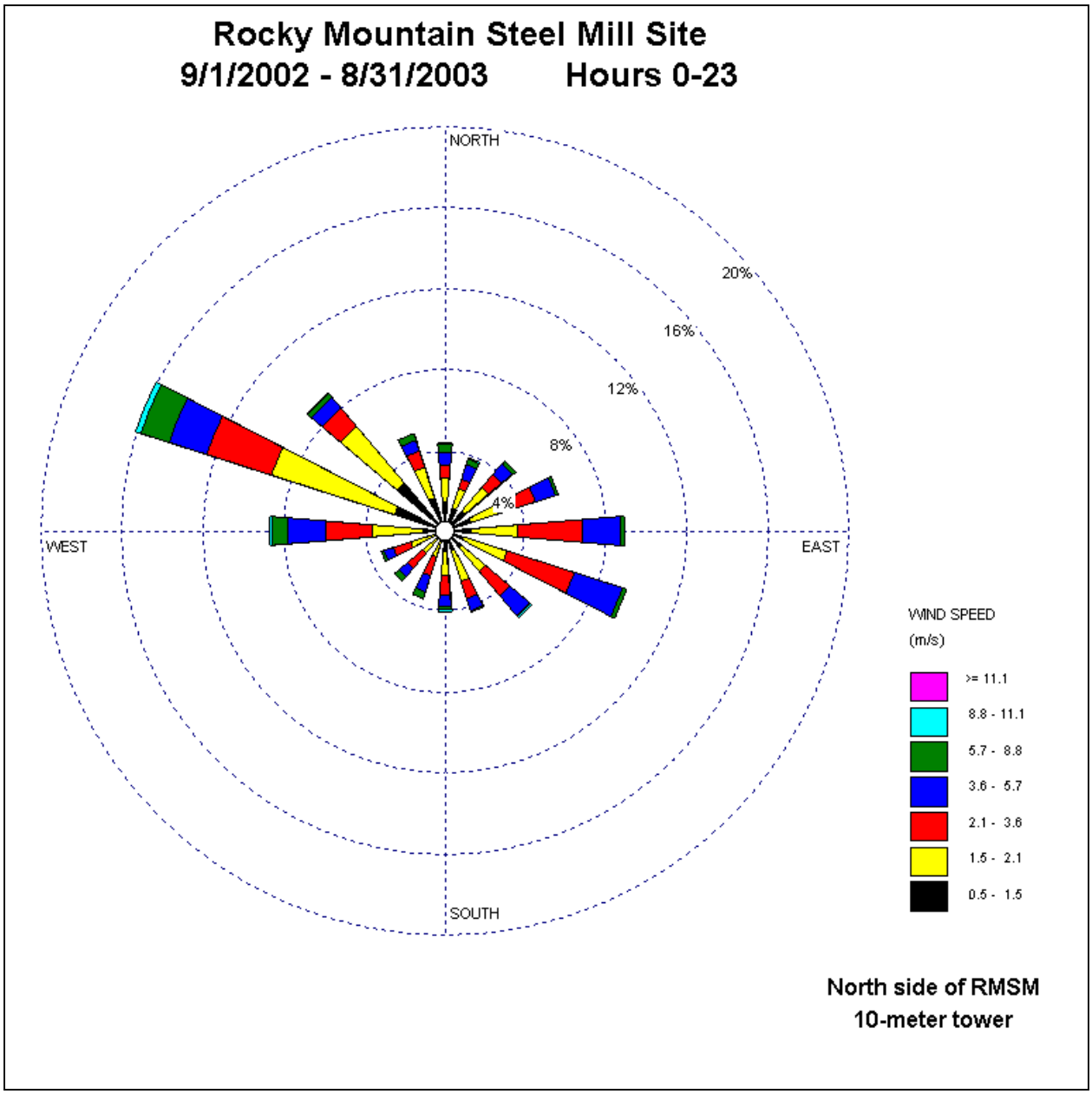
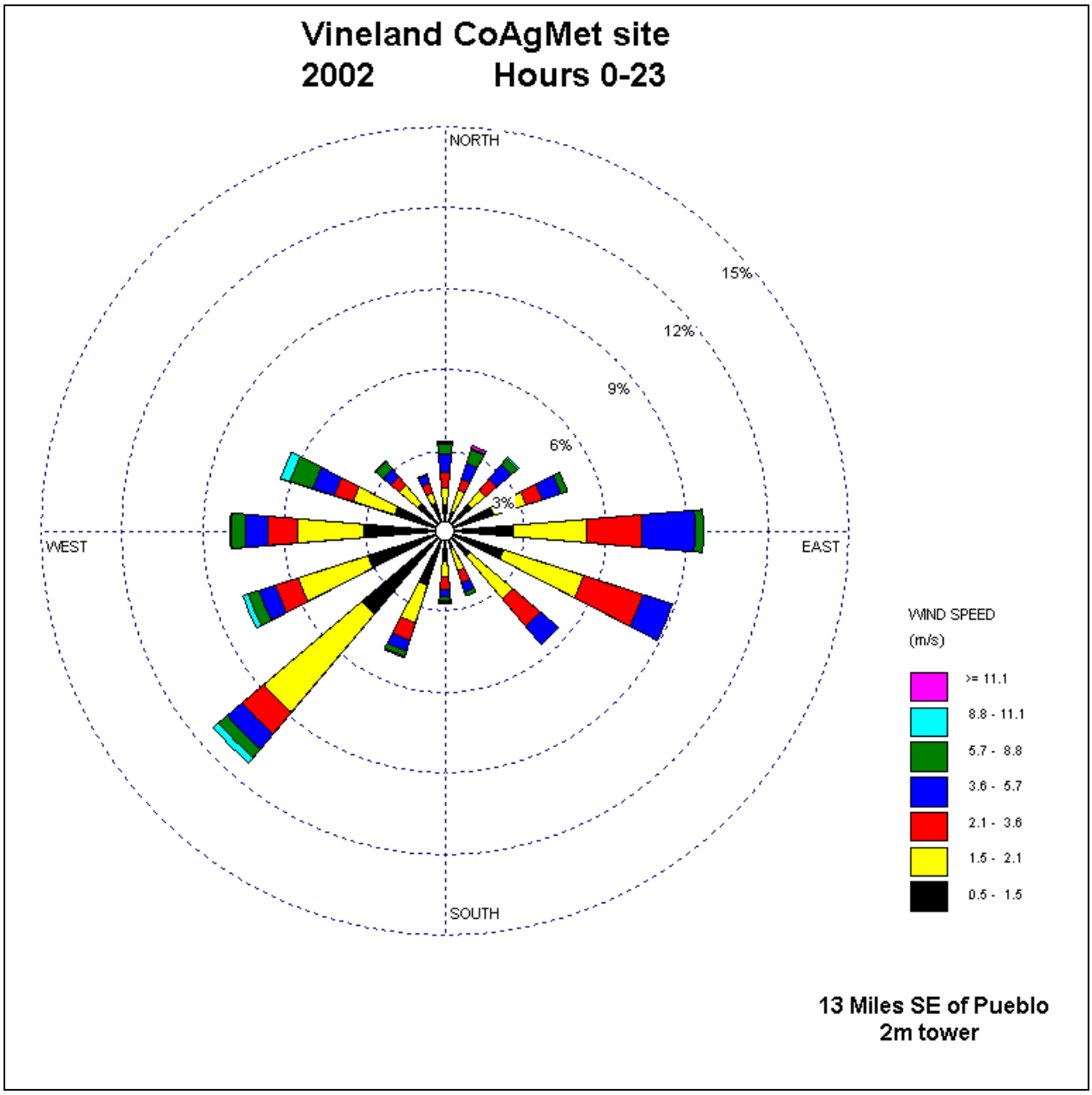


Figure 6.2 – Wind Rose for RMSM Site for Full Year



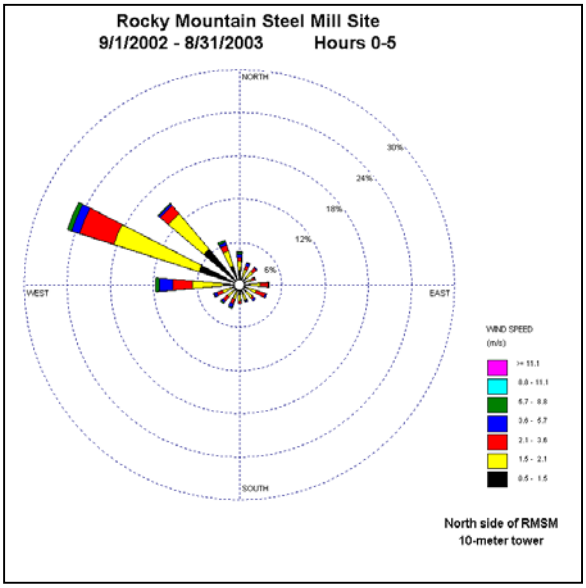
NOTE: Wedges are the directions **from** which the wind is blowing.

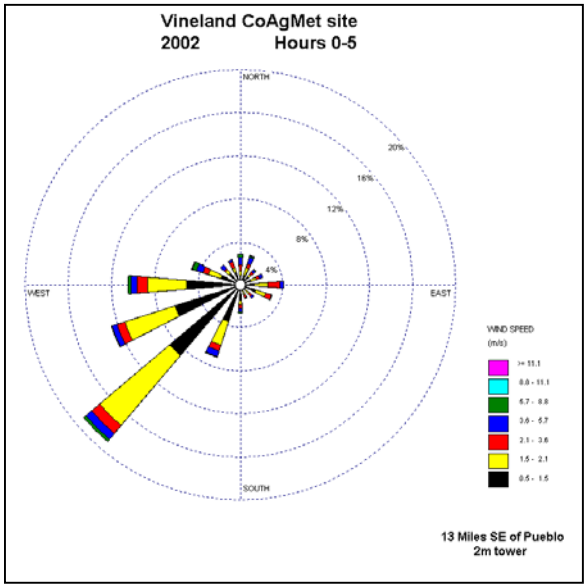
Figure 6.3 – Wind Rose for CSU Vineland Site for Full Year



NOTE: Wedges are the directions **from** which the wind is blowing.

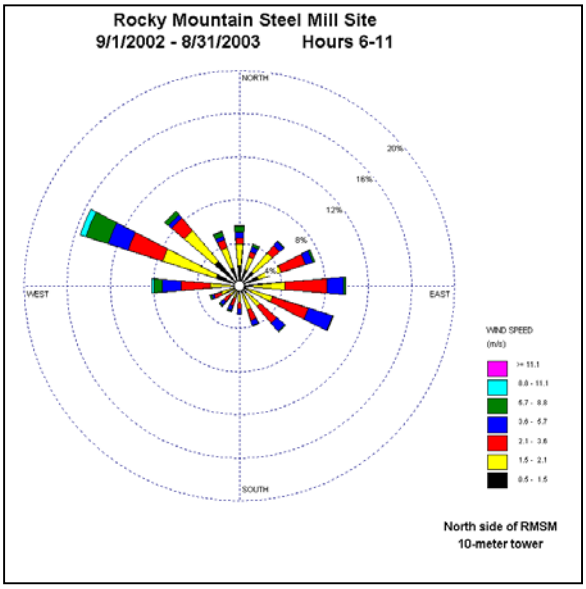
Figure 6.4 – Wind Roses for Early Morning from RMSM and CSU Vineland

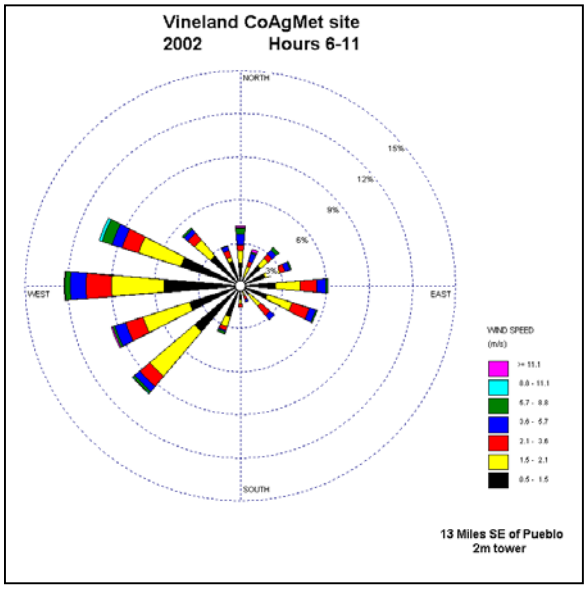




NOTE: Wedges are the directions **from** which the wind is blowing.

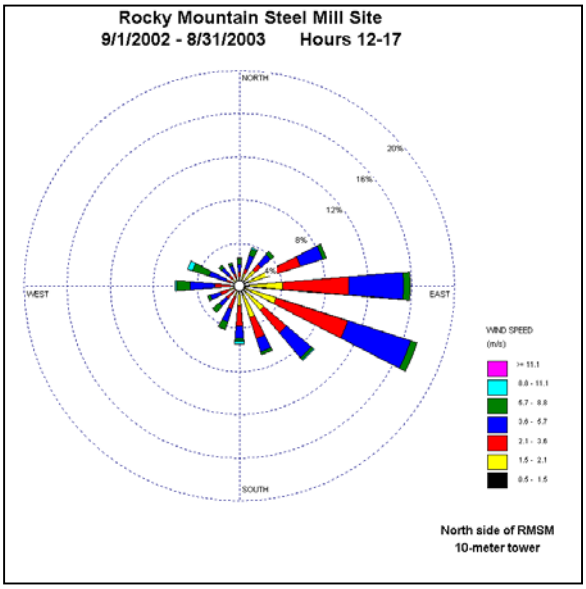
Figure 6.5 – Wind Roses for Late Morning from RMSM and CSU Vineland

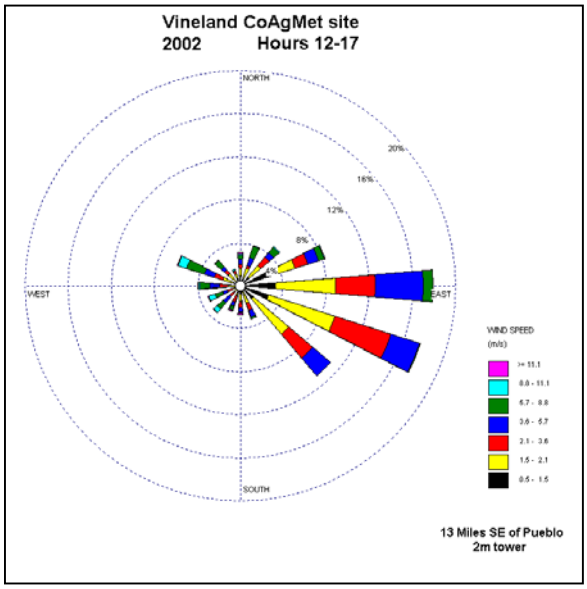




NOTE: Wedges are the directions **from** which the wind is blowing.

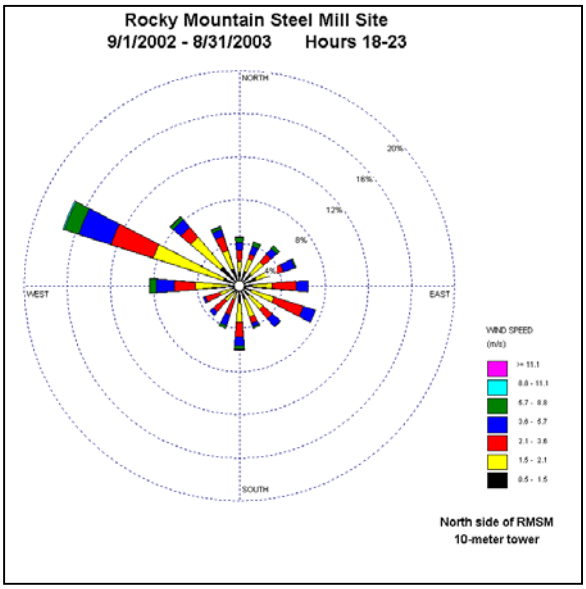
Figure 6.6 – Wind Roses for Afternoon from RMSM and CSU Vineland

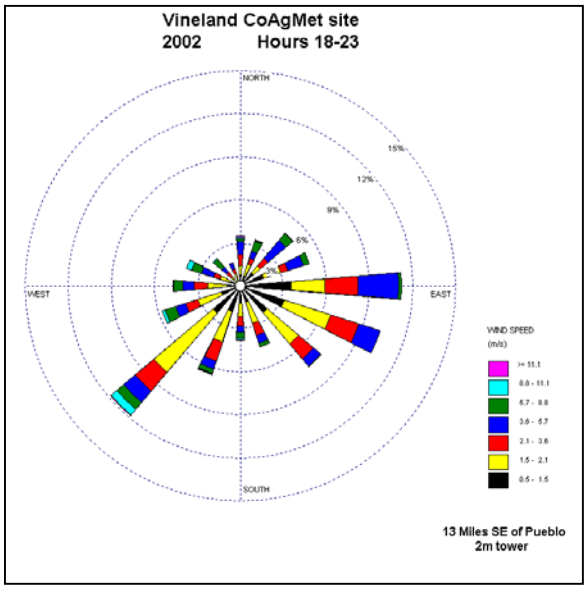




NOTE: Wedges are the directions **from** which the wind is blowing.

Figure 6.7 – Wind Roses for Evening from RMSM and CSU Vineland





NOTE: Wedges are the directions **from** which the wind is blowing.

High Particulate Days

In addition to general meteorology, data from a few days with high particulate concentrations were examined. These days were 20 June, 01 August and 17 August 2002. Table 6.1 provides the particulate concentrations on these days. The table also provides meteorological information from the National Weather Service (NWS) office located at Pueblo Airport. From these data, it is likely that the high particulate values were due to high winds and blowing dust. This is also likely in that there was very little moisture recorded for the year and it was warmer than normal.

Table 6.1 – Meteorology for High Particulate Events

	20 June 2002	**01 August 2002**	**17 August 2002**
Fulton Heights: TSP concentration	212 ug/m3	311 ug/m3	257 ug/m3
NWS: Maximum wind speed	36 mph	48 mph	41 mph
NWS: Maximum wind gust	44 mph	54 mph	51 mph
NWS: Average wind speed	13.0 mph	15.4 mph	13.1 mph
NWS: Maximum temperature	86 deg. F	85 deg. F	84 deg. F
NWS: Minimum temperature	64 deg. F	56 deg. F	59 deg. F
NWS: Average temperature	75 deg. F	71 deg. F	72 deg. F
NWS: Yearly precipitation to date	1.21 inches	2.19 inches	2.19 inches

Section 7 – Comparisons to Other Locations

Comparisons to Other Locations

Volatile Organic Compound Comparisons

Table 7.1 provides a comparison of the average and maximum concentrations of VOC's monitored during the Pueblo study to average concentrations monitored at other locations in Colorado, including Grand Junction and Denver. These data are sorted on average decreasing concentrations for the Pueblo study. Figure 7.1 provides two graphs that present the highest concentration VOC's monitored in Pueblo and the corresponding VOC data from other studies. As can be seen, the concentrations of VOC's monitored in Pueblo are quite similar to those monitored in other locations. Each location obviously has its own unique sources as some compounds were detected at some sites but not at others. However, the majority of the compounds are very similar in average concentration. It should be noted that due to the expense of VOC monitoring, the sampling timeframes are not identical. All VOC data used in the comparisons were corrected for non-detects by using one-half of the minimum detection level as a substitution. This is a common practice that provides a more conservative value, but can increase the average concentrations significantly for those compounds that are not frequently detected.

Particulates

Table 7.2 provides a comparison of particulate levels monitored in the Pueblo study to concentrations recorded in other locations during the same time period. These other locations are in the urban areas of Denver, Colorado Springs and Grand Junction. Figures 7.2 and 7.3 provide a monthly graphical representation of the PM10 and TSP comparisons between the Pueblo sites and other areas. In general, PM10 particulate levels in Pueblo appear to be similar to those monitored in Colorado Springs and lower than those monitored in Grand Junction and Denver. The maximum monthly TSP values are higher in Pueblo, probably due to high wind events and blowing dust, but the monthly averages are generally the same as Colorado Springs and lower than Denver.

Metals

Table 7.3 provides a comparison of metals concentrations monitored in Pueblo around the RMSM to concentrations monitored in other areas of Colorado, including Denver and Grand Junction. All of these metals concentrations were from analyses of TSP filters. Figure 7.4 provides a graphical representation. In general, the metals concentrations monitored at Fulton Heights and the Dance Studio sites are higher than concentrations monitored in either Grand Junction or Denver. This is probably due to the proximity to the RMSM, where the sites in Grand Junction and Denver were not as close to a known source of metals. It should be noted that due to the expense of metals analyses, the sampling timeframes are not identical. All metals data used in the comparisons were corrected for non-detects by using one-half of the minimum detection level as a substitution. This is a common practice that provides a more conservative value, but can increase the average concentrations significantly for those compounds that are not frequently detected.

Risks

Tables 7.4 and 7.5 provide a comparison on chronic cancer risks from VOC's and metals. Table 7.5 also provides a comparison of chronic non-cancer risks from metals. Non-cancer risks from VOC's were not included as the individual hazard indices are all less than one. As can be seen in Table 7.4, the cancer risks associated with individual VOC's are often similar across different cities in Colorado. Some compounds were only detected at certain sites, and this drives up the sum of the risks to nearly one-hundred in a million for certain locations in Denver and Grand Junction. The sum of the cancer risks from VOC's in Pueblo was forty-six in a million. This is equal to the sum of the risks at some other sites and about one-half of the sum of the risk at the remaining sites.

For metals, in Table 7.5, the cancer risks appear to be very high for Pueblo. However, arsenic, beryllium, cadmium and chromium were detected in less than 15 % of the samples. Thus, the practice of using one-half of the minimum detection level as a substitute for the non-detects is driving up the average and thus driving up the risk.

Otherwise, the cancer risk from metals would be very similar. One caveat is that for this comparison, it was assumed that all the chromium was in the toxic hexavalent form and none in the more common and non-toxic trivalent form, which artificially increases the perceived cancer risk. For the chronic non-cancer risk from metals, Pueblo has a higher hazard index than Denver or Grand Junction. At all sites, manganese is the driving factor for non-cancer risks from metals. In Pueblo, the manganese concentrations at both the Fulton Heights and Dance Studio sites are higher than at the other sites. The sum of the non-cancer hazard indices is 1.3 at the Dance Studio site and 2.1 at the Fulton Heights site. These are slightly higher to about twice the sum of the non-cancer hazard indices at the other sites.

Rocky Mountain Steel Mill

Figure 7.5 presents a graphical comparison of the PM10 and TSP data collected at the RMSM to the data collected during the special study by the CDPHE. The RMSM commenced sampling at two locations in September 2002. Both the RMSM sites are located along the northern border of the facility. In general, the particulate concentration at the RMSM are slightly higher than either the Fulton Heights or Dance Studio sites. This is expected due to the proximity to the plant and also due to the lack of vegetative or paved ground cover.

Figure 7.6 presents a comparison of the metals data from TSP collected at the RMSM to the data collected during the special study by CDPHE. The RMSM commenced metals sampling from TSP at one location in September 2002. As with the particulates, the metals concentrations are generally higher at the RMSM site than at either the Fulton Heights or Dance Studio sites for the same reasons.

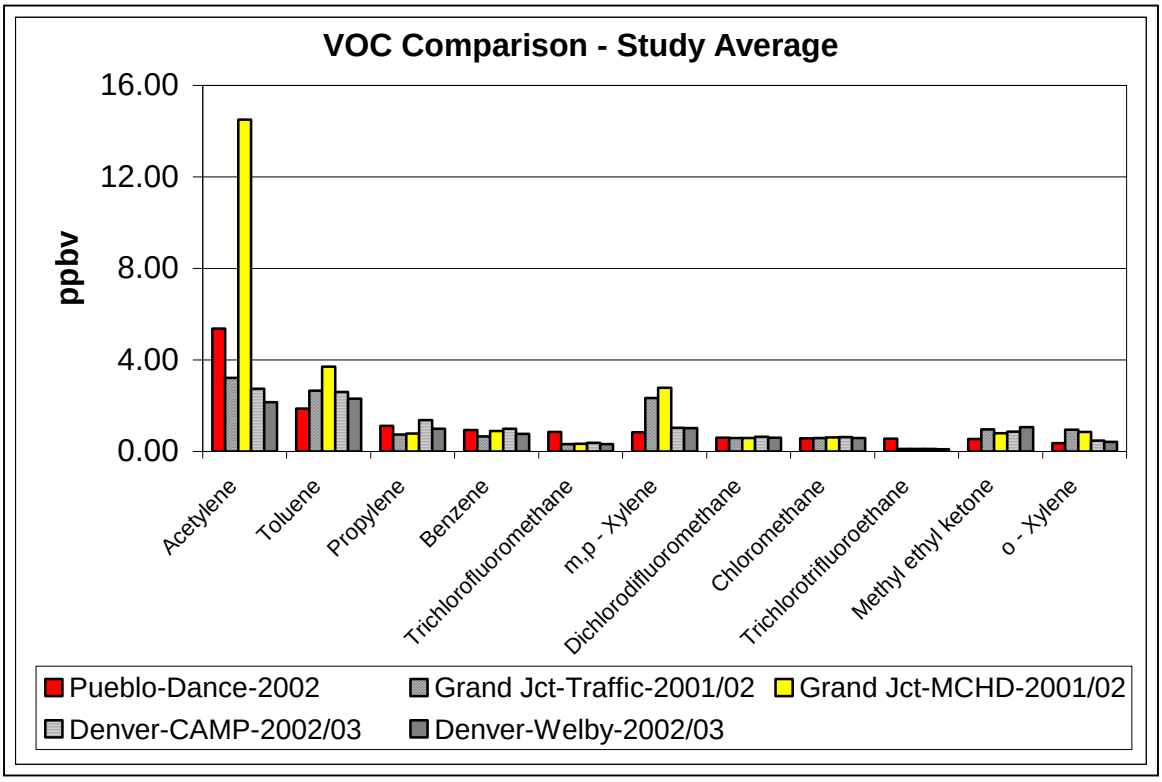
Table 7.1 – Volatile Organic Compound Comparison

Compound	Pueblo Dance Studio Oct.-Dec. 2002		Grand Junction Traffic Services May 01-Apr. 2002		Grand Junction MCHD May 01-Apr. 2002		Denver CAMP May 02-Apr. 2003		Denver Welby May 02-Apr. 2003		Denver Swansea July-Dec. 2002	
	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)
Acetylene	5.38	16.11	3.22	13.52	14.50	82.59	2.74	10.29	2.16	6.97	2.72	10.25
Toluene	1.88	3.21	2.66	9.39	3.70	33.26	2.60	13.36	2.31	18.26	2.99	16.88
Propylene	1.12	2.09	0.74	2.21	0.78	2.65	1.36	3.06	0.99	3.38	1.19	3.65
Benzene	0.94	1.69	0.66	2.12	0.90	2.72	0.99	2.31	0.77	2.25	0.87	2.20
Trichlorofluoromethane	0.85	2.46	0.32	1.36	0.34	1.42	0.38	0.83	0.32	1.33	0.40	2.53
m,p-Xylene	0.83	1.81	2.34	14.32	2.78	33.98	1.03	2.37	1.03	2.78	1.65	3.38
Dichlorodifluoromethane	0.60	1.14	0.59	0.85	0.59	0.75	0.65	1.06	0.60	0.87	0.63	0.96
Chloromethane	0.57	1.05	0.59	0.81	0.61	1.58	0.64	1.10	0.59	0.96	0.56	0.80
Trichlorotrifluoroethane	0.55	1.80	0.11	0.16	0.11	0.17	0.11	0.26	0.10	0.20	0.09	0.18
Methyl ethyl ketone	0.55	5.42	0.96	3.13	0.79	4.96	0.87	11.83	1.06	11.26	1.00	8.38
o-Xylene	0.36	0.73	0.95	4.14	0.85	9.69	0.48	1.16	0.42	0.93	0.68	1.32
1,2,4-Trimethylbenzene	0.29	0.63	0.33	1.73	0.24	0.84	0.62	1.03	0.23	0.69	0.31	0.94
Ethylbenzene	0.28	0.56	0.64	4.16	0.84	10.68	0.35	0.72	0.33	0.81	0.53	1.47
Acrylonitrile	0.26	0.26	0.18	1.03	0.16	0.26	0.28	2.56	0.23	0.26	0.28	0.96
Acetonitrile	0.23	0.23	0.91	27.69	8.37	83.81	1.46	51.90	66.98	1122.22	128.95	238.64
Methyl methacrylate	0.18	0.18	0.14	0.45	0.14	0.53	0.15	0.20	0.15	0.18	0.17	0.18
Ethyl acrylate	0.17	0.17	0.11	0.17	0.11	0.17	0.16	0.17	0.15	0.17	0.16	0.17
1,3-Butadiene	0.15	0.39	0.09	0.33	0.10	0.41	0.14	0.43	0.10	0.42	0.13	0.47
Methyl isobutyl ketone	0.13	0.34	0.14	0.58	0.09	0.11	0.13	0.66	0.36	10.14	0.13	0.46
Methyl tert-butyl ether	0.12	0.12	0.13	1.08	0.50	2.13	0.10	0.12	0.50	2.07	0.11	0.12
1,3,5-Trimethylbenzene	0.11	0.19	0.11	0.54	0.08	0.28	0.22	0.36	0.08	0.22	0.11	0.29
1,1,2-Trichloroethane	0.10	0.10	0.06	0.10	0.06	0.10	0.08	0.10	0.08	0.10	0.09	0.10
1,1,2,2-Tetrachloroethane	0.10	0.10	0.06	0.10	0.06	0.10	0.08	0.10	0.08	0.10	0.09	0.10
Ethyl tert-butyl ether	0.09	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.09	0.09
tert-Amyl methyl ether	0.09	0.09	0.07	0.09	0.07	0.09	0.09	0.09	0.09	0.09	0.09	0.09
m-Dichlorobenzene	0.09	0.09	0.05	0.09	0.05	0.10	0.08	0.09	0.08	0.09	0.09	0.09
o-Dichlorobenzene	0.09	0.09	0.05	0.09	0.05	0.09	0.08	0.09	0.08	0.09	0.08	0.09
n-Octane	0.08	0.22	0.11	0.89	0.11	1.02	0.15	1.16	0.11	0.30	0.12	0.36
Hexachloro-1,3-butadiene	0.08	0.08	0.05	0.08	0.05	0.08	0.08	0.10	0.08	0.10	0.08	0.10

Compound	Pueblo Dance Studio Oct.-Dec. 2002		Grand Junction Traffic Services May 01-Apr. 2002		Grand Junction MCHD May 01-Apr. 2002		Denver CAMP May 02-Apr. 2003		Denver Welby May 02-Apr. 2003		Denver Swansea July-Dec. 2002	
	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)	Avg. (ppbv)	Max. (ppbv)
p-Dichlorobenzene	0.07	0.08	0.05	0.08	0.06	0.08	0.07	0.08	0.07	0.08	0.08	0.08
Carbon tetrachloride	0.07	0.21	0.08	0.12	0.08	0.12	0.07	0.18	0.07	0.16	0.07	0.16
Chloromethylbenzene	0.07	0.07	0.05	0.07	0.05	0.07	0.06	0.07	0.06	0.07	0.07	0.07
Chloroethane	0.07	0.07	0.05	0.07	0.05	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Bromoform	0.07	0.07	0.05	0.07	0.05	0.07	0.06	0.07	0.05	0.07	0.06	0.07
Styrene	0.06	0.07	0.08	0.31	0.07	0.17	0.08	0.34	0.06	0.61	0.09	0.86
Bromochloromethane	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.11	0.08	0.11	0.06	0.11
Bromomethane	0.06	0.06	0.05	0.06	0.05	0.06	0.06	0.07	0.10	1.47	0.06	0.07
cis-1,2-Dichloroethylene	0.06	0.06	0.05	0.06	0.05	0.06	0.06	0.07	0.06	0.07	0.06	0.07
cis-1,3-Dichloropropene	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.06
tran -1,3-Dichloropropene	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.06	0.07
1,2-Dibromoethane	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.06
1,2,4-Trichlorobenzene	0.06	0.06	0.04	0.06	0.04	0.06	0.06	0.08	0.06	0.08	0.06	0.08
Methylene chloride	0.05	0.18	0.16	1.29	0.14	1.11	0.40	9.18	0.19	1.66	0.23	0.89
1,1-Dichloroethene	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.06	0.05	0.06
1,2-Dichloroethane	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.06	0.05	0.06	0.05	0.06
Trichloroethylene	0.05	0.05	0.04	0.08	0.05	0.34	0.08	0.59	0.06	0.09	0.05	0.09
Dibromochloromethane	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.04	0.05	0.05	0.05
Vinyl chloride	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.07	0.05	0.07	0.05	0.07
Chlorobenzene	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
1,1-Dichloroethane	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Tetrachloroethylene	0.04	0.14	0.05	0.30	0.04	0.23	0.09	1.56	0.05	0.28	0.11	0.44
1,2-Dichloropropane	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Bromodichloromethane	0.04	0.04	0.03	0.04	0.03	0.04	0.04	0.05	0.04	0.05	0.04	0.05
1,1,1-Trichloroethane	0.03	0.10	0.04	0.11	0.05	0.93	0.05	0.76	0.04	0.09	0.03	0.05
Dichlorotetrafluoroethane	0.03	0.03	0.03	0.03	0.02	0.03	0.04	0.06	0.04	0.06	0.03	0.06
trans-1,2-Dichloroethylene	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.06	0.04	0.06	0.03	0.06
Chloroform	0.03	0.03	0.03	0.07	0.03	0.06	0.04	0.17	0.04	0.09	0.04	0.16
Chloroprene	0.03	0.03	0.04	0.05	0.04	0.05	0.03	0.04	0.03	0.04	0.03	0.04

Table 7.1, completed.

Figure 7.1 – Highest Concentration Volatile Organic Compounds Comparison



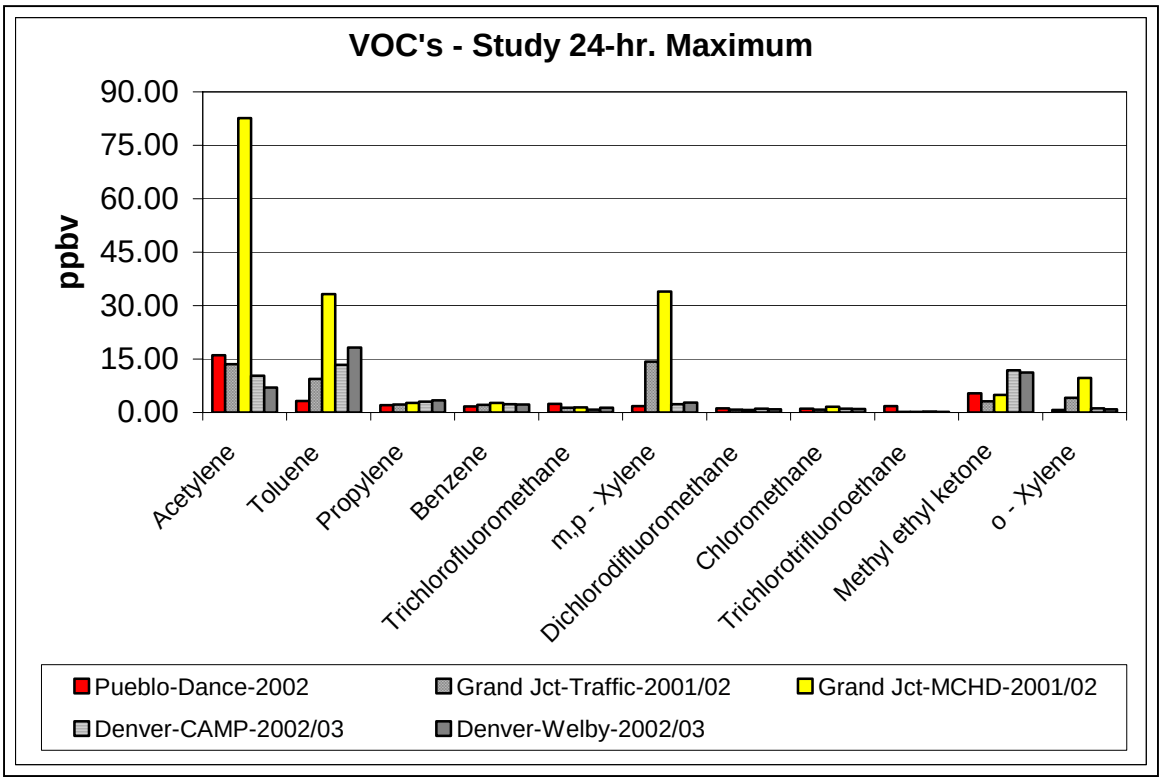
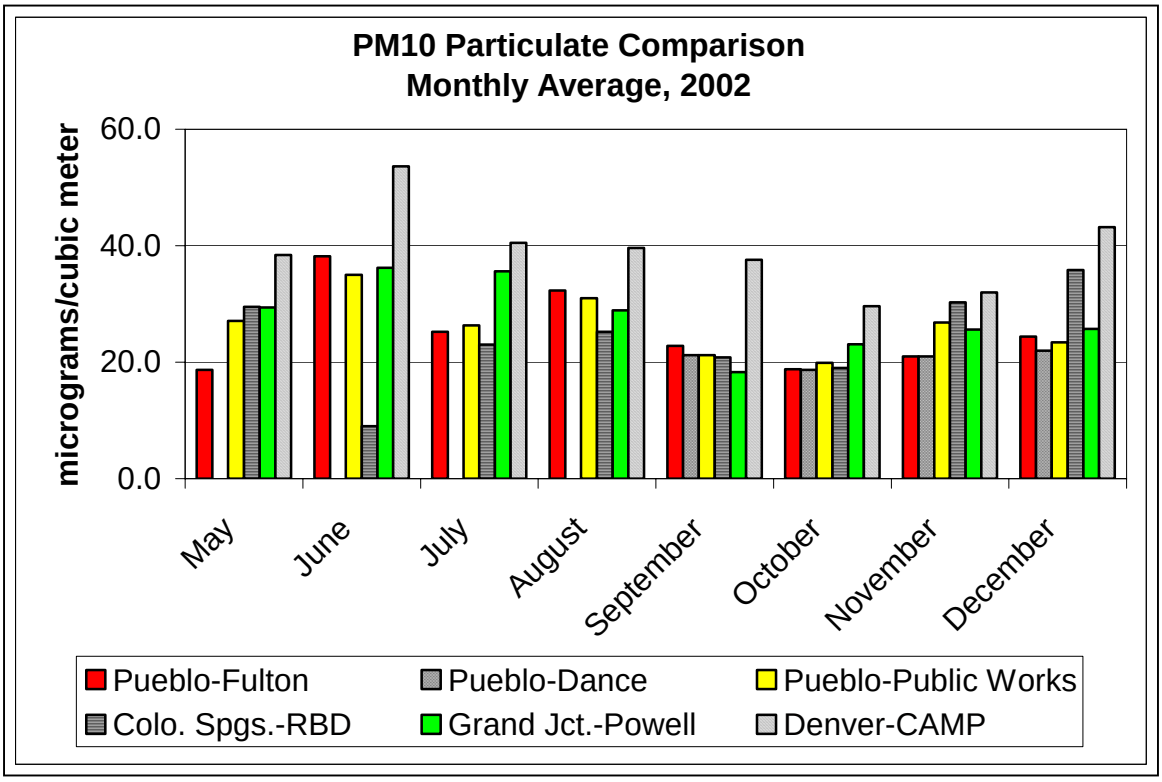


Table 7.2 – Particulate Comparisons

PM10	Pueblo Fulton Heights		Pueblo Dance Studio		Pueblo Public Works		Colo. Spgs. RBD		Denver CAMP		Grand Jct. Powell	
Month	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)
May	18.7	23			27.1	47	29.5	38	38.4	64	29.4	39
June	38.2	64			35.0	52	9.0	9	53.6	67	36.2	59
July	25.2	41			26.3	47	23.0	31	40.5	67	35.6	63
August	32.3	61			31.0	64	25.2	33	39.6	70	28.9	41
September	22.8	30	21.2	36	21.2	33	20.8	28	37.6	65	18.3	32
October	18.8	37	18.7	35	19.9	38	19.0	34	29.6	56	23.1	45
November	21.0	31	21.0	33	26.8	38	30.3	44	32.0	70	25.6	39
December	24.4	38	22.0	40	23.4	35	35.8	53	43.2	88	25.7	51

TSP	Pueblo Fulton Heights		Pueblo Dance Studio		Colo. Spgs. RBD		Denver CAMP	
Month	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)
May	58.3	147			68.5	93	106.8	163
June	93.3	212			60.2	86	141.6	168
July	63.0	139			71.0	113	108.0	153
August	98.2	311			70.2	98	94.0	172
September	58.1	103	49.2	81	47.0	55	81.2	105
October	43.4	90	44.6	94	48.0	86	75.8	128
November	53.8	88	47.8	68	63.0	101	75.4	134
December	51.6	106	49.9	116	59.0	76	104.8	196

Figure 7.2 – PM10 Particulate Comparison



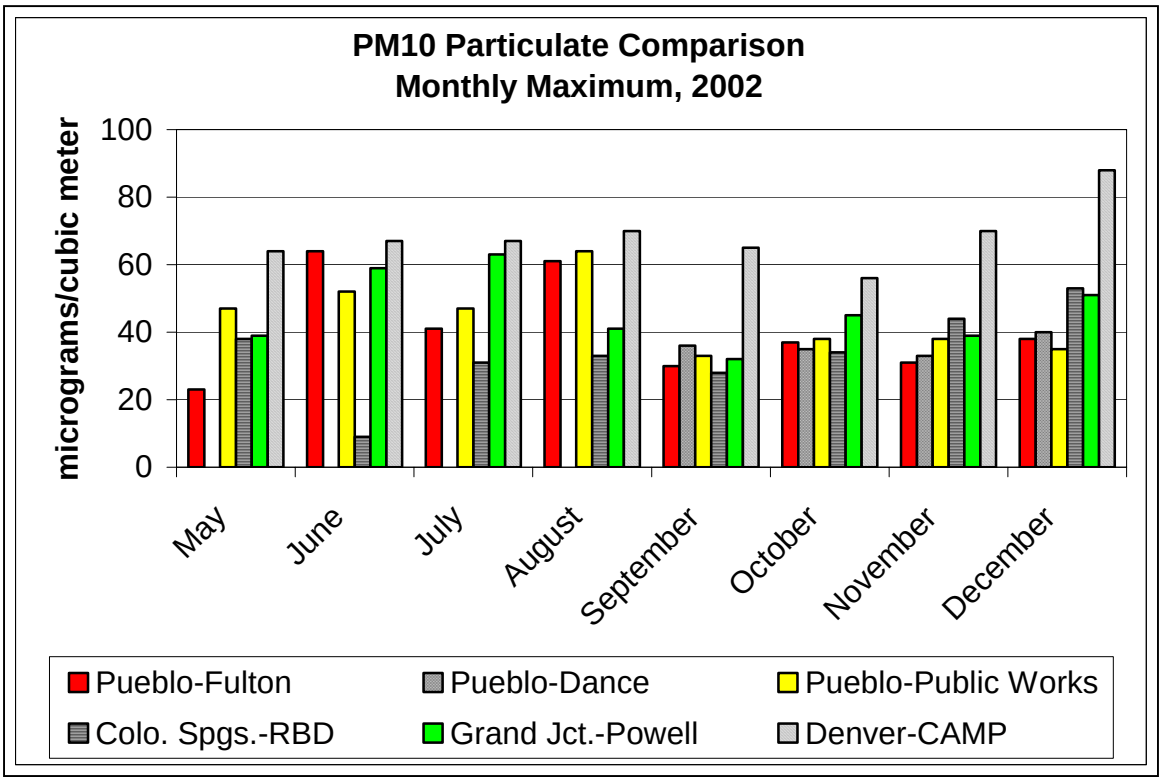
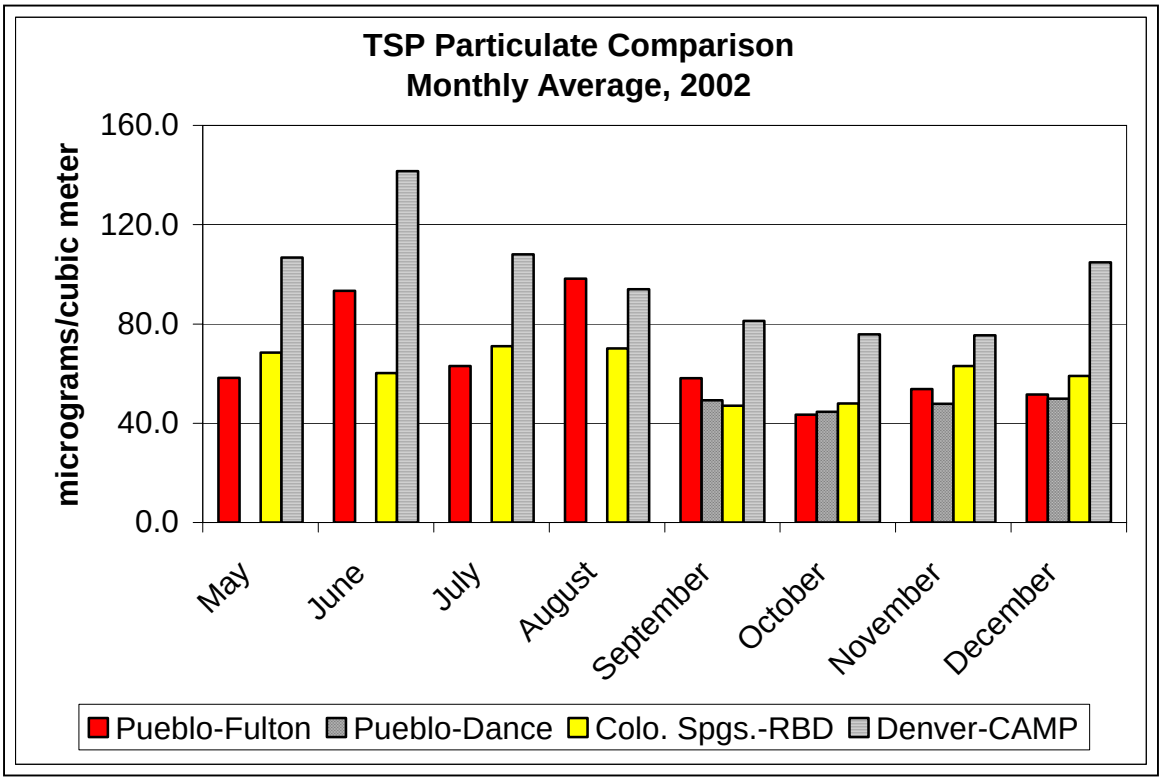


Figure 7.3 – TSP Particulate Comparison



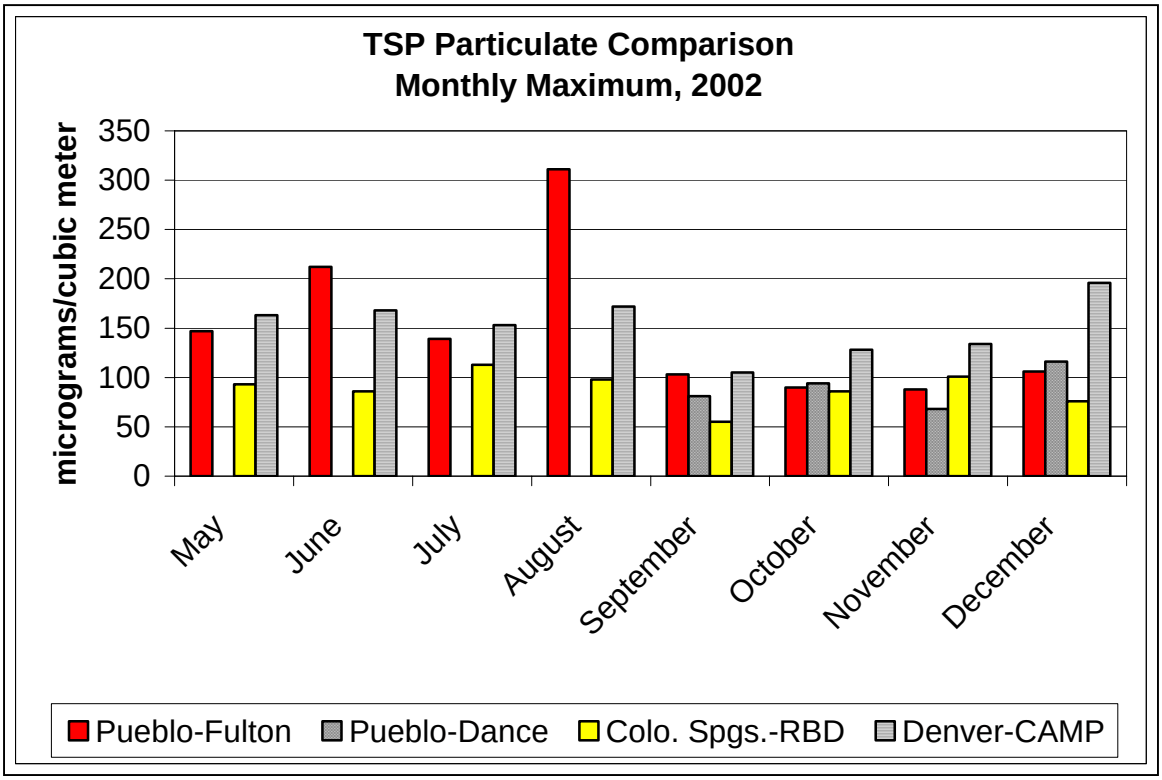
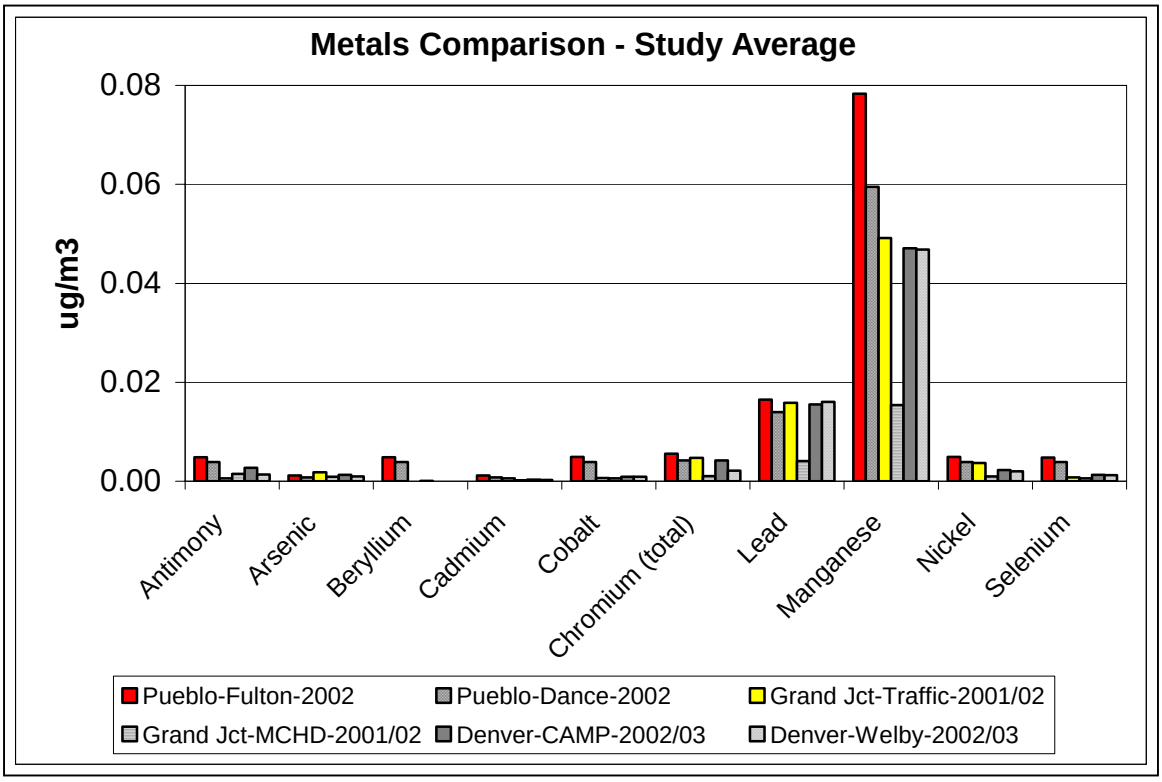


Table 7.3 – Metals Comparisons

Compound	Pueblo Fulton Heights May-Dec. 2002		Pueblo Dance Studio Sept.-Dec. 2002		Grand Jct. Traffic Services May 01-Apr. 2002		Grand Jct. MCHD May 01-Apr. 2002		Denver CAMP May 02-Apr. 2003		Denver Welby May 02-Apr. 2003		Denver Swansea Jul.-Dec. 2002	
	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)	Avg. (ug/m3)	Max. (ug/m3)
Antimony	0.0049	0.0220	0.0039	0.0045	0.0006	0.0015	0.0015	0.0230	0.0027	0.0076	0.0014	0.0079	0.0022	0.0061
Arsenic	0.0012	0.0341	0.0008	0.0019	0.0018	0.0046	0.0009	0.0022	0.0013	0.0059	0.0010	0.0041	0.0011	0.0064
Beryllium	0.0049	0.0353	0.0039	0.0045	0.0000	0.0001	0.0001	0.0011	0.0000	0.0001	0.0000	0.0002	0.0000	0.0003
Cadmium	0.0011	0.0352	0.0008	0.0009	0.0006	0.0018	0.0002	0.0006	0.0004	0.0009	0.0003	0.0007	0.0005	0.0028
Cobalt	0.0049	0.0436	0.0039	0.0045	0.0006	0.0017	0.0006	0.0108	0.0009	0.0019	0.0009	0.0127	0.0009	0.0026
Chromium (total)	0.0056	0.0454	0.0042	0.0166	0.0047	0.0829	0.0010	0.0020	0.0042	0.0086	0.0021	0.0063	0.0034	0.0103
Lead	0.0165	0.1244	0.0140	0.0878	0.0159	0.4959	0.0041	0.0092	0.0155	0.0493	0.0160	0.0598	0.0247	0.0786
Manganese	0.0783	0.3424	0.0595	0.2279	0.0491	0.1062	0.0154	0.0340	0.0471	0.1362	0.0469	0.1478	0.0552	0.1397
Nickel	0.0049	0.0471	0.0039	0.0045	0.0037	0.0087	0.0010	0.0019	0.0022	0.0045	0.0020	0.0044	0.0024	0.0059
Selenium	0.0048	0.0268	0.0039	0.0045	0.0007	0.0028	0.0006	0.0020	0.0013	0.0024	0.0012	0.0024	0.0014	0.0025

Figure 7.4 – Metals Comparisons



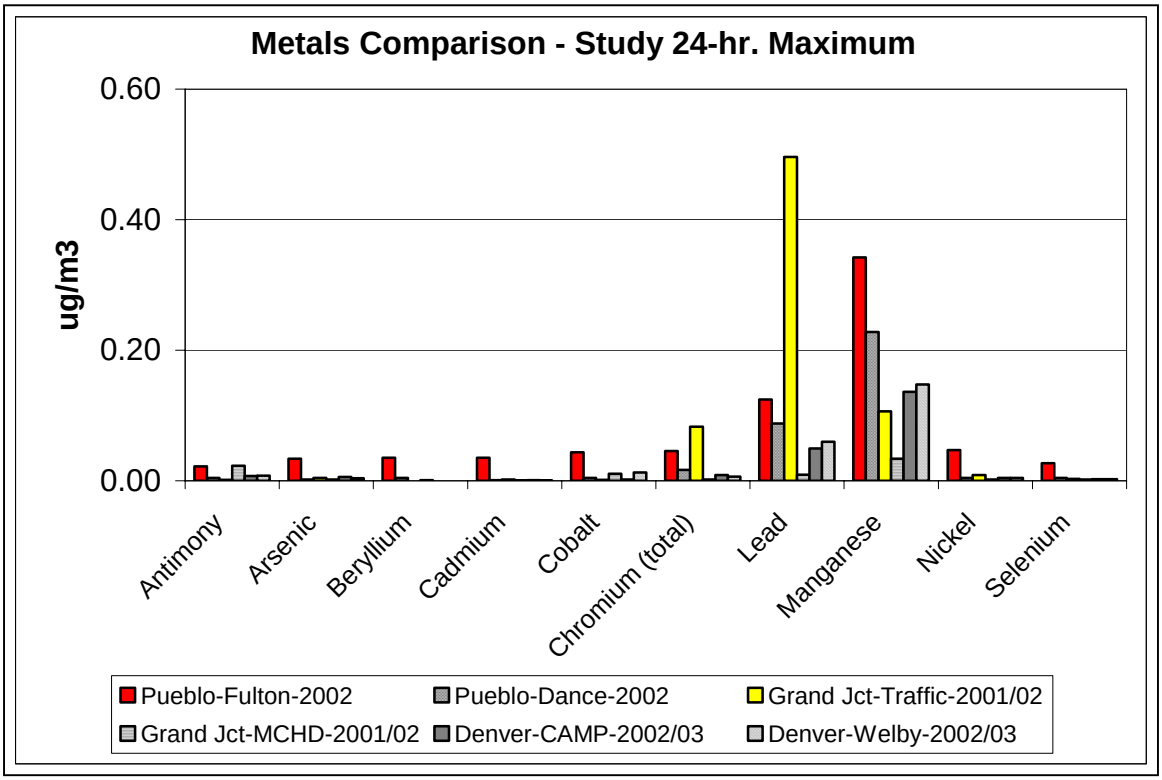


Table 7.4 – Risk Comparison for Volatile Organic Compounds

Compound	Chronic Risk Factor (cancer) 1/(ug/m3)	Pueblo Dance Studio Oct.-Dec. 2002 Avg. (ug/m3)	Pueblo Dance Studio Oct.-Dec. 2002 Cancer Risk (1/million)	Grand Jct. Traffic May 01-Apr. 2002 Avg. (ug/m3)	Grand Jct. Traffic May 01-Apr. 2002 Cancer Risk (1/million)	Grand Jct. MCHD May 01-Apr. 2002 Avg. (ug/m3)	Grand Jct. MCHD May 01-Apr. 2002 Cancer Risk (1/million)	Denver CAMP May 02-Apr. 2003 Avg. (ug/m3)	Denver CAMP May 02-Apr. 2003 Cancer Risk (1/million)	Denver Welby May 02-Apr. 2003 Avg. (ug/m3)	Denver Welby May 02-Apr. 2003 Cancer Risk (1/million)	Denver Swansea Jul.-Dec. 2002 Avg. (ug/m3)	Denver Swansea Jul.-Dec. 2002 Cancer Risk (1/million)
Vinyl chloride	8.80E-06	ND		ND		ND		ND		ND		ND	
1,3 - Butadiene	3.00E-05	0.33	**9.91**	0.19	**5.82**	0.23	**6.93**	0.32	**9.47**	0.22	**6.48**	0.28	**8.51**
Acrylonitrile	6.80E-05	ND		0.40	**27.02**	ND		0.61	**41.22**	ND		0.60	**40.79**
Methylene chloride	4.70E-07	0.19	0.09	0.56	0.26	0.50	0.23	1.40	0.66	0.67	0.32	0.78	0.37
1,2 - Dichloroethane	2.60E-05	ND		ND		ND		0.21	**5.40**	ND		ND	
Benzene	7.80E-06	3.00	**23.41**	2.12	**16.53**	2.87	**22.39**	3.17	**24.76**	2.47	**19.24**	2.80	**21.80**
Carbon tetrachloride	1.50E-05	0.44	**6.67**	0.51	**7.62**	0.51	**7.69**	0.47	**7.05**	0.43	**6.45**	0.47	**7.03**
1,2 - Dichloropropane	1.90E-05	ND		ND		ND		ND		ND		ND	
Ethyl acrylate	1.40E-05	ND		0.46	**6.47**	ND		ND		ND		ND	
Trichloroethylene	2.00E-06	ND		0.23	0.45	0.25	0.49	0.41	0.81	0.34	0.68	ND	
1,1,2 - Trichloroethane	1.60E-05	ND		ND		ND		ND		ND		ND	
1,2 - Dibromoethane	2.20E-04	ND		ND		ND		ND		ND		ND	
Tetrachloroethylene	5.90E-06	0.26	**1.51**	0.31	**1.82**	0.30	**1.76**	0.64	**3.78**	0.36	**2.14**	0.72	**4.22**
Bromoform	1.10E-06	ND		ND		ND		ND		ND		ND	
1,1,2,2 - Tetrachloroethane	5.80E-05	ND		0.39	**22.45**	ND		ND		ND		ND	
Chloromethylbenzene	4.90E-05	ND		ND		ND		ND		ND		ND	
p - Dichlorobenzene	1.10E-05	0.43	**4.70**	0.33	**3.59**	0.33	**3.64**	0.43	**4.77**	0.45	**4.93**	ND	
Hexachloro - 1,3 - butadiene	2.20E-05	ND		ND		ND		ND		ND		ND	
Sum of Cancer Risk from VOC's:			**46.29**		**92.03**		**43.14**		**97.92**		**40.22**		**82.72**

ug/m3 = micrograms per cubic meter Risks greater than one-in-a-million are in **bold**.

NOTES: Average concentrations are calculated using ½ of minimum detection level as a substitute for non-detects. Compounds never measured at detectable levels are shown as ND (non-detect).

Table 7.5 – Risk Comparison for Metals

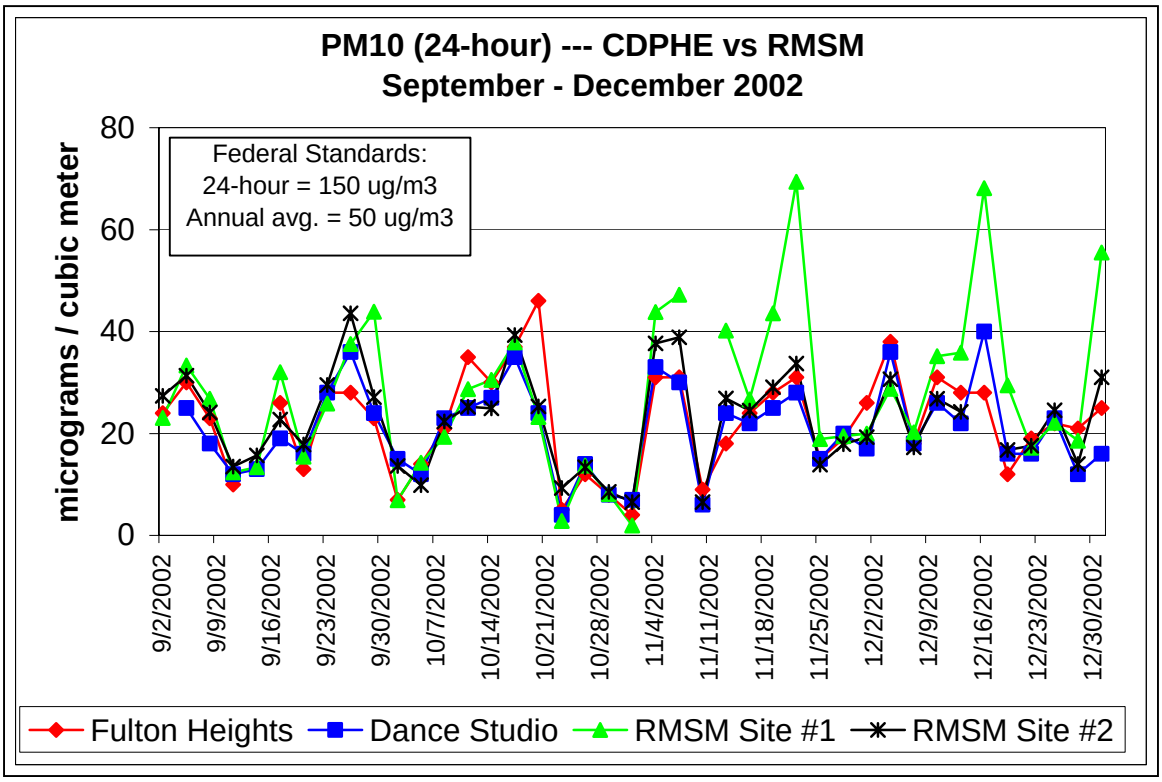
Metal	Chronic Risk Factor (cancer) 1/(ug/m3)	Pueblo Fulton Heights May-Dec. 2002 Avg. (ug/m3)	Pueblo Fulton Heights May-Dec. 2002 Cancer Risk (1/million)	Pueblo Dance Studio Sep.-Dec. 2002 Avg. (ug/m3)	Pueblo Dance Studio Sep.-Dec. 2002 Cancer Risk (1/million)	Grand Jct. Traffic May 01-Apr. 2002 Avg. (ug/m3)	Grand Jct. Traffic May 01-Apr. 2002 Cancer Risk (1/million)	Grand Jct. MCHD May 01-Apr. 2002 Avg. (ug/m3)	Grand Jct. MCHD May 01-Apr. 2002 Cancer Risk (1/million)	Denver CAMP May 02-Apr. 2003 Avg. (ug/m3)	Denver CAMP May 02-Apr. 2003 Cancer Risk (1/million)	Denver Welby May 02-Apr. 2003 Avg. (ug/m3)	Denver Welby May 02-Apr. 2003 Cancer Risk (1/million)	Denver Swansea Jul.-Dec. 2002 Avg. (ug/m3)	Denver Swansea Jul.-Dec. 2002 Cancer Risk (1/million)
Lead	1.20E-05	0.0165	0.20	0.0140	0.17	0.0159	0.19	0.0041	0.05	0.0155	0.19	0.0160	0.19	0.0247	0.30
Arsenic	4.30E-03	0.0012	**5.11**	0.0008	**3.41**	0.0018	**7.65**	0.0009	**3.89**	0.0013	**5.68**	0.0010	**4.20**	0.0011	**4.63**
Beryllium	2.40E-03	0.0049	**11.65**	ND		0.0000	0.08	0.0001	0.12	0.0000	0.07	0.0000	0.07	0.0000	0.12
Cadmium	1.80E-03	0.0011	**2.05**	ND		0.0006	**1.06**	0.0002	0.40	0.0004	0.63	0.0003	0.45	0.0005	0.95
Chromium	1.20E-02	0.0056	**66.96**	0.0042	**50.53**	0.0047	**56.46**	0.0010	**12.26**	0.0042	**50.82**	0.0021	**25.49**	0.0034	**40.51**
Sum of Cancer Risk From Metals:			**85.97**		**54.10**		**65.44**		**16.72**		**57.38**		**30.40**		**46.51**

Metal	Chronic Risk Factor (non-cancer) (ug/m3)	Pueblo Fulton Heights May-Dec. 2002 Avg. (ug/m3)	Pueblo Fulton Heights May-Dec. 2002 Non-Cancer Hazard Index	Pueblo Dance Studio Sep.-Dec. 2002 Avg. (ug/m3)	Pueblo Dance Studio Sep.-Dec. 2002 Non-Cancer Hazard Index	Grand Jct. Traffic May 01-Apr. 2002 Avg. (ug/m3)	Grand Jct. Traffic May 01-Apr. 2002 Non-Cancer Hazard Index	Grand Jct. MCHD May 01-Apr. 2002 Avg. (ug/m3)	Grand Jct. MCHD May 01-Apr. 2002 Non-Cancer Hazard Index	Denver CAMP May 02-Apr. 2003 Avg. (ug/m3)	Denver CAMP May 02-Apr. 2003 Non-Cancer Hazard Index	Denver Welby May 02-Apr. 2003 Avg. (ug/m3)	Denver Welby May 02-Apr. 2003 Non-Cancer Hazard Index	Denver Swansea Jul.-Dec. 2002 Avg. (ug/m3)	Denver Swansea Jul.-Dec. 2002 Non-Cancer Hazard Index
Lead	1.5	0.0165	0.01	0.0140	0.01	0.0159	0.01	0.0041	0.00	0.0155	0.01	0.0160	0.01	0.0247	0.02
Arsenic	0.03	0.0012	0.04	0.0008	0.03	0.0018	0.06	0.0009	0.03	0.0013	0.04	0.0010	0.03	0.0011	0.04
Beryllium	0.02	0.0049	0.24	ND		0.0000	0.00	0.0001	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
Cadmium	0.02	0.0011	0.06	ND		0.0006	0.03	0.0002	0.01	0.0004	0.02	0.0003	0.01	0.0005	0.03
Cobalt	0.1	0.0049	0.05	ND		0.0006	0.01	0.0006	0.01	0.0009	0.01	0.0009	0.01	0.0009	0.01
Chromium	0.1	0.0056	0.06	0.0042	0.04	0.0047	0.05	0.0010	0.01	0.0042	0.04	0.0021	0.02	0.0034	0.03
Manganese	0.05	0.0783	**1.57**	0.0595	**1.19**	0.0491	0.98	0.0154	0.31	0.0471	0.94	0.0469	0.94	0.0552	**1.10**
Nickel	0.2	0.0049	0.02	ND		0.0037	0.02	0.0010	0.00	0.0022	0.01	0.0020	0.01	0.0024	0.01
Selenium	20	0.0048	0.00	ND		0.0007	0.00	0.0006	0.00	0.0013	0.00	0.0012	0.00	0.0014	0.00
Sum of Non-Cancer Risk From Metals:			**2.05**		**1.27**		**1.16**		0.38		**1.08**		**1.03**		**1.24**

ug/m3 = micrograms per cubic meter Risks greater than one-in-a-million are in **bold**.

NOTES: Average concentrations are calculated using ½ of minimum detection level as a substitute for non-detects. Compounds never measured at detectable levels are shown as ND (non-detect). Chromium risk factor is for hexavalent chromium, Cr^{6+}. The projects measured total chromium, so this assumption that it is all Cr^{6+} overestimates the cancer and non-cancer risks.

Figure 7.5 – Particulate Comparison for RMSM and CDPHE



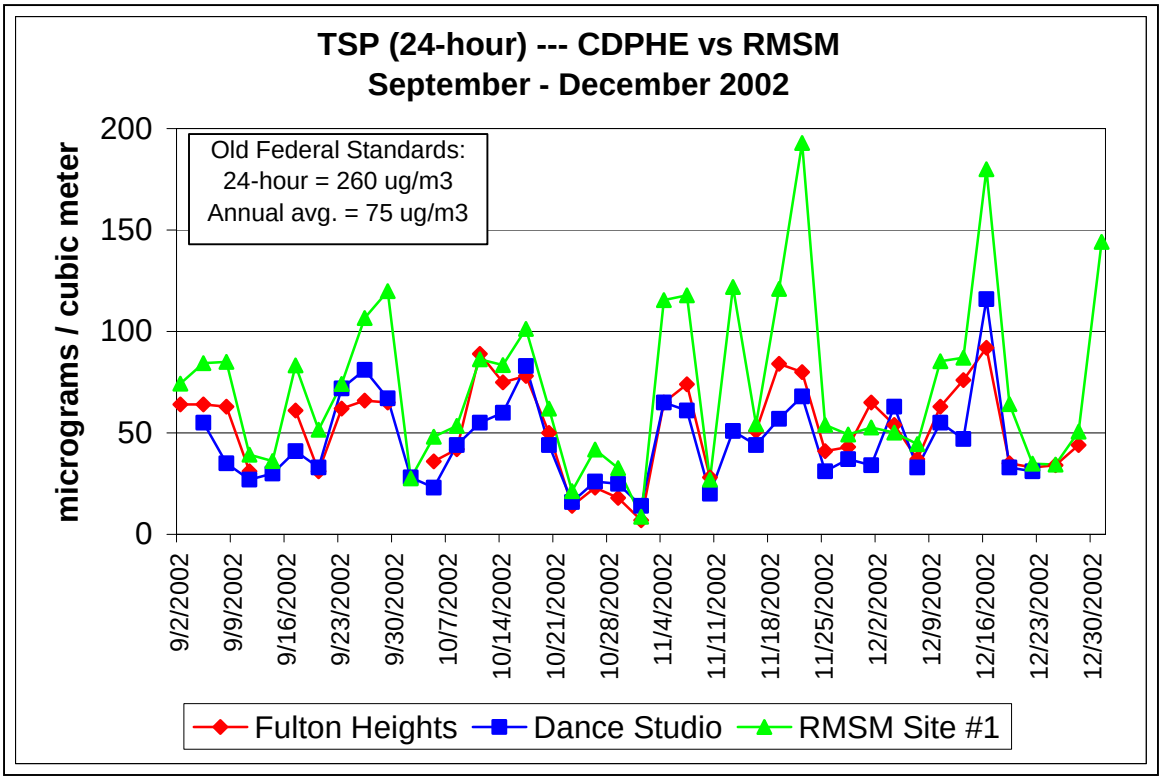
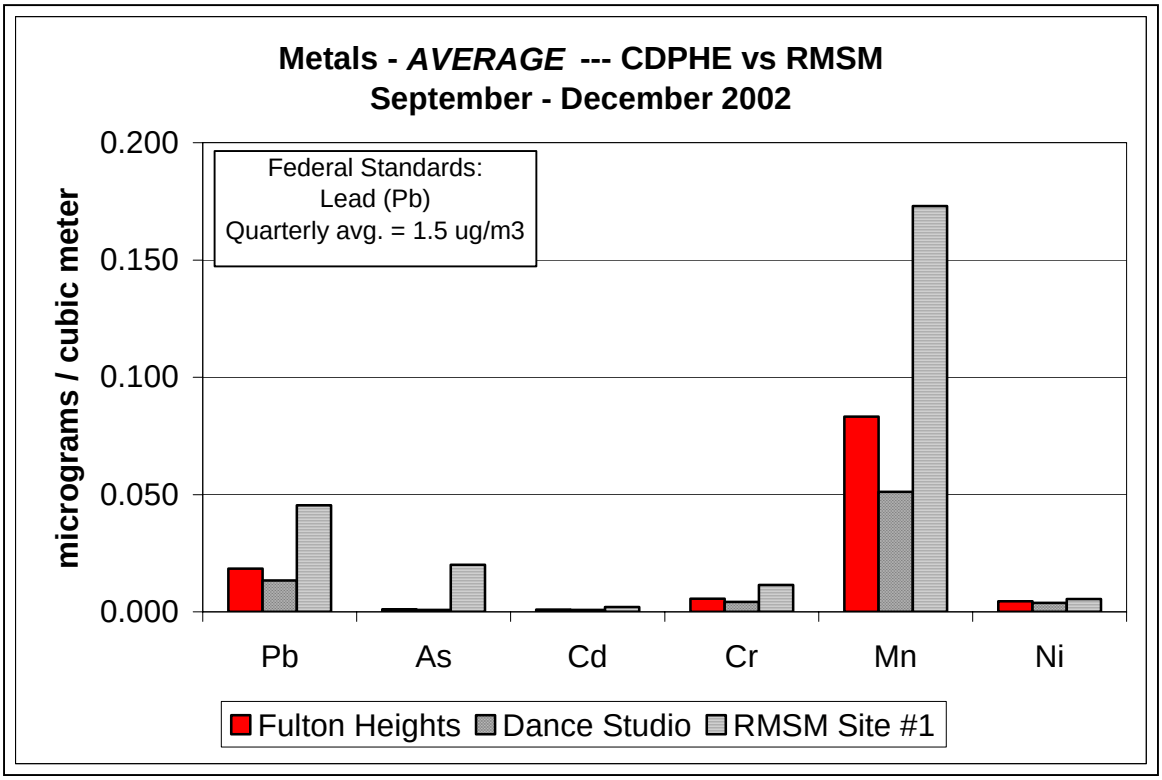
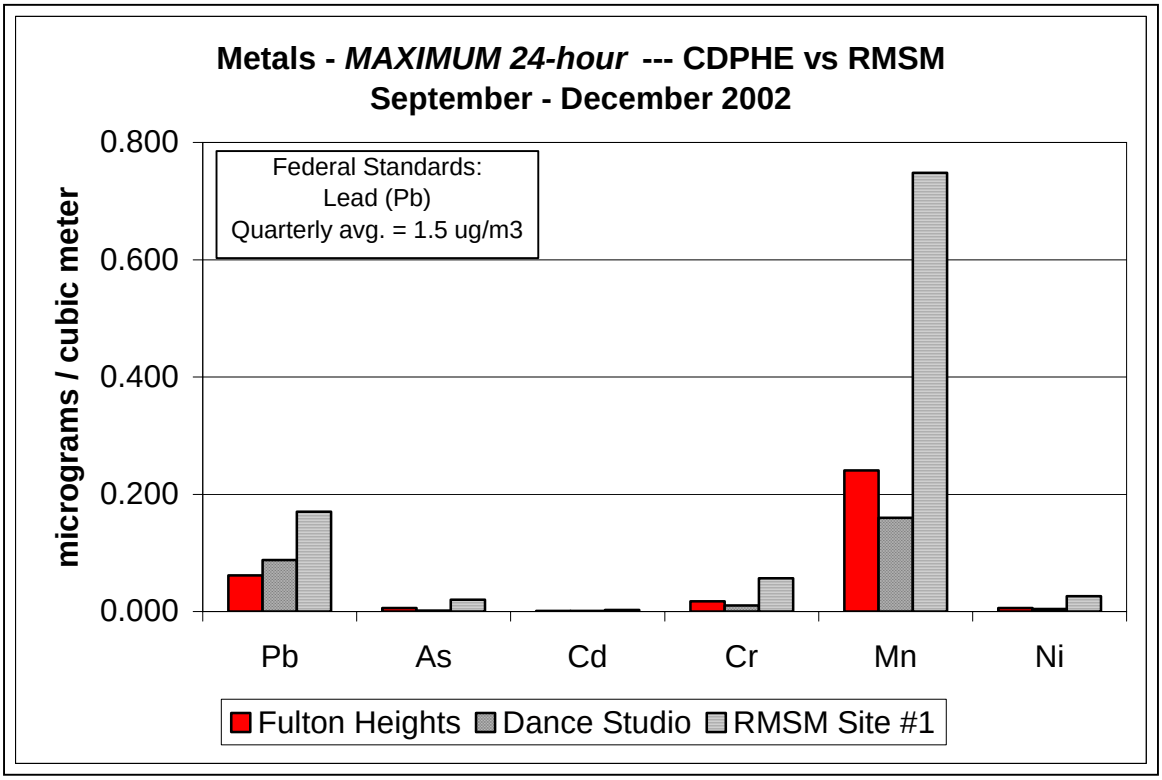


Figure 7.6 – Metals Comparison for RMSM and CDPHE





Section 8 - Conclusion

Conclusion

This report analyzes data collected in a special study from two sites near the Rocky Mountain Steel Mill (RMSM) in Pueblo. This study was conducted from May through December 2002. This study was performed by the Colorado Department of Public Health and Environment – Air Pollution Control Division (APCD) with funding from a special U.S. Environmental Protection Agency's (EPA) Enforcement Grant. The goal of the study was to determine concentrations of potentially hazardous particulates, metals and volatile organic compounds in the ambient air in two neighborhoods near the Rocky Mountain Steel Mill (RMSM).

Two monitoring sites were employed in the study, one to the east of the RMSM and one to the north. The eastern site was located at Fulton Heights School, at 1411 Santa Rosa. Sampling started on 23 May 2002 and ended on 31 December 2002. The northern site was located at Jeannie's Dance Studio, at 1141 S. Santa Fe. Due to difficulties in obtaining a site, sampling did not start until 5 September 2002 and ended on 31 December 2002. At both sites, 24-hour total suspended particulate (TSP) samples were collected on an every day schedule and 24-hour "10-microns in diameter and smaller" particulates (PM10) samples were collected on an every third day schedule. Filters from the TSP samplers were analyzed for metals concentrations. Volatile organic compounds (VOC's) were sampled for 24-hours at the Dance Studio site on an every third day schedule starting on 11 October 2003 and ending on 31 December 2002. All sampling was performed using established protocols and methods. The compounds and metals analyzed are either known to be potentially hazardous to human health and/or are commonly found in urban air.

Fifty-eight volatile organic compounds (VOCs) were analyzed from whole-air sample canisters collected at the Dance Studio site. Thirty-four of these VOCs were never measured at detectable levels. In contrast, eleven VOCs were present in over 90% of the samples. Many of these eleven compounds are primarily attributed to motor vehicle emissions. These include benzene, toluene, ethylbenzene, xylene, 1,3-butadiene and propylene. Concentrations of individual compounds show a strong statistical correlation between the vehicle emission-related compounds. Comparisons were made to EPA "health benchmark" levels. None of the compounds had an estimated non-cancer chronic hazard quotient level greater than one. Five of the compounds measured had concentrations at levels believed to represent a greater than one-in-a-million risk of cancer. These compounds are 1,3-butadiene, benzene, carbon tetrachloride, tetrachloroethylene and p-dichlorobenzene. However, carbon tetrachloride and p-dichlorobenzene were detected in less than seven percent of the samples and using one-half of the minimum detection level as a substitute for the non-detect levels is driving the increased risk. Benzene and 1,3-butadiene are primarily emitted from motor vehicles. Tetrachloroethylene, also known as perchloroethylene or "perc" is a commonly used industrial solvent. Other areas of Colorado also show elevated levels of these compounds and most urban areas in the United States have concentrations of benzene and 1,3-butadiene that are above one-in-a-million risk levels.

PM10 levels were measured at less than one-half of the National Ambient Air Quality Standard (NAAQS) for both an annual average and a 24-hour maximum. TSP concentrations exceeded the level of the former NAAQS at the Fulton Heights site on one occasion, probably due to high winds and blowing dust. Average TSP levels were below the level of the former NAAQS, which was replaced with the PM10 NAAQS in July 1987.

Ten metals were analyzed from the TSP filters collected at both sites. Only two metals, lead and manganese, were detected in over 75 percent of the samples. Six metals were never detected at the Dance Studio site. With the exception of manganese, all metals concentrations were low. Statistical correlations of individual metals were performed on a limited basis due to the large number of non-detects. The only correlation that was statistically significant was between manganese and chromium at the Dance Studio site, though some correlation exists between lead and manganese at both sites. Comparisons were made to EPA "health benchmark" levels. Manganese had an estimated non-cancer chronic hazard quotient level greater than one. Four of the metals measured had estimated EPA "benchmark" concentrations at levels believed to represent a greater than one-in-a-million risk of cancer. These metals were arsenic, beryllium, cadmium and chromium. However, these metals were detected in less than fifteen percent of the samples and using one-half of the minimum detection level as a substitute for non-detect levels is driving the increased risk. In addition, the chromium risk is probably overstated as all of the chromium was assumed to be in the toxic hexavalent state and none in the more commonly found non-toxic trivalent form.

Comparisons were performed between the results from this special study and concentrations measured in other studies in Colorado. In general, VOC's were found to be present at similar levels to those measured in Grand Junction and Denver. Most of the compounds that are generally associated with motor vehicles such as benzene and toluene are also found at elevated levels in other urban areas in the United States. PM10 and TSP concentrations appear to be lower in Pueblo than in other urban areas of Colorado, except for some TSP values that are possibly high wind related. Metals concentrations are generally higher at the two study locations compared to those monitored in Grand Junction and Denver. However, none of the monitoring sites in these other areas was located next to a large source. Cancer risks from VOC's are similar to those for other sites in Colorado and fairly similar for cancer risks from metals. With metals, a valid determination is difficult due to the large number of non-detects. For non-cancer risks from metals, Pueblo is higher than at other sites, mainly due to the higher manganese levels.

Colorado Department
of Public Health
and Environment