APPENDIX I

CORRELATION OF METAL CONTENT IN TSP AND PM^{10}

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APPENDIX I: CORRELATION OF METAL CONTENT IN TSP AND PM_{10}

I-1.0 INTRODUCTION

Atmospheric releases of emissions from the HBMS complex as well as wind-blown dust from tailing impoundments and exposed soils create the potential for exposure to chemicals of concern (COC) through the inhalation of ambient air. The size of ambient air particles ranges over a wide scale, from approximately 0.005 to 100 µm in aerodynamic diameter (that is, from the size of just a few atoms to about the thickness of a human hair). For convenience, particulate matter is operationally defined by three categories currently used by various agencies for purposes of the regulation of ambient PM. These are TSP (or total suspended particulate matter), PM_{10}, and $PM_{2.5}$. These terms refer to all measurable particles within ambient air (TSP), or particles ranging from about 50 µm to the very small micron size), or those that are of smaller diameters: PM_{10} particles having an aerodynamic diameter 10 µm and less (which are commonly referred to as coarse PM), and $PM_{2.5}$ particles having an aerodynamic diameter of 2.5 µm and less (which are commonly referred to as fine PM).

The respiratory tract is the prime target for effects of inhaled PM. The role of the respiratory tract is to move gases from the nose or mouth *via* the airways to the alveoli where the exchange of oxygen into, and carbon dioxide out of, the body occurs. When the inhaled breath is accompanied by PM, chemicals associated with PM can be distributed to sensitive respiratory tissues. A large fraction of the particles within TSP are too large to travel beyond the upper respiratory tract and enter the lung. Rather, they tend to get trapped in the upper respiratory tract (nose, throat, trachea, *etc*.), and get expelled through coughing or other clearing mechanisms. Particles represented by TSP (<44 microns in size) have a rapid settling velocity when compared to other forms of particulate matter (PM_{10} and $PM_{2.5}$), but can remain suspended in air for some time, reducing visibility and causing soiling (*e.g*., of laundry on washing lines, *etc*.). As a result, the guidelines established for TSP are not based on health impacts but rather are set to reduce the impacts related to visibility and soiling.

Although Health Canada (2006) indicates that, the inhalation of airborne respirable particulate is likely insignificant relative to the oral route of exposure, they recommend that respirable particulate be evaluated if the risk assessor deems it appropriate. When evaluated, concentrations of COC within the respirable fraction of airborne particulate (*i.e*., the PM_{10} fraction) should be used to predict exposure *via* inhalation (U.S. EPA, 1989; Health Canada, 2006). The use of TSP to evaluate exposures *via* inhalation is not supported by current scientific knowledge and would likely over estimate the amount of chemical entering the lower respiratory tissues.

Betts, Centoba Park, the Flin Flon Sewage Plant, and the Fire Hall and School in Creighton (Figure I-1) (Manitoba Conservation, 2006). Currently, only those monitors at Ruth Betts and Creighton School are used to monitor ambient air quality. HBMS reports data for TSP, PM_{10}, and $PM_{2.5}$ and metals associated with each of these fractions. Manitoba Conservation operates an ambient air monitor located on the Provincial building in Flin Flon. These samples are currently only analyzed for TSP and metals associated with TSP, although the PM_{10} component was measured from 1989 to December 1998. Concentrations of metals associated with TSP measured at the Provincial building are typically higher than those measured within TSP at Ruth Betts and Creighton School, likely a reflection of its close proximity to the HBMS complex.

To ensure that all relevant exposure pathways are addressed, the human health risk assessment (HHRA) will include an evaluation of exposure to COC resulting from the inhalation

of impacted ambient air in both indoor and outdoor environments. To address differences in exposures among residents of the Flin Flon-Creighton area, the HHRA will estimate exposure and risks to four separate communities within the study area:

- East Flin Flon (designated as the area east and northeast of Ross Lake);
- West Flin Flon (designated as the area west of Ross Lake);
- Channing; and,
- Creighton.

The following sections provide a rationale for the selection of air monitoring data to be used to predict conservative long-term exposure point concentrations for use in the HHRA.

Consideration of monitor station locations, the period in which data were collected relative to technological improvements at the HBMS complex, as well as confounding factors that may influence the ability of the data to reflect appropriate long-term exposure concentrations are discussed.

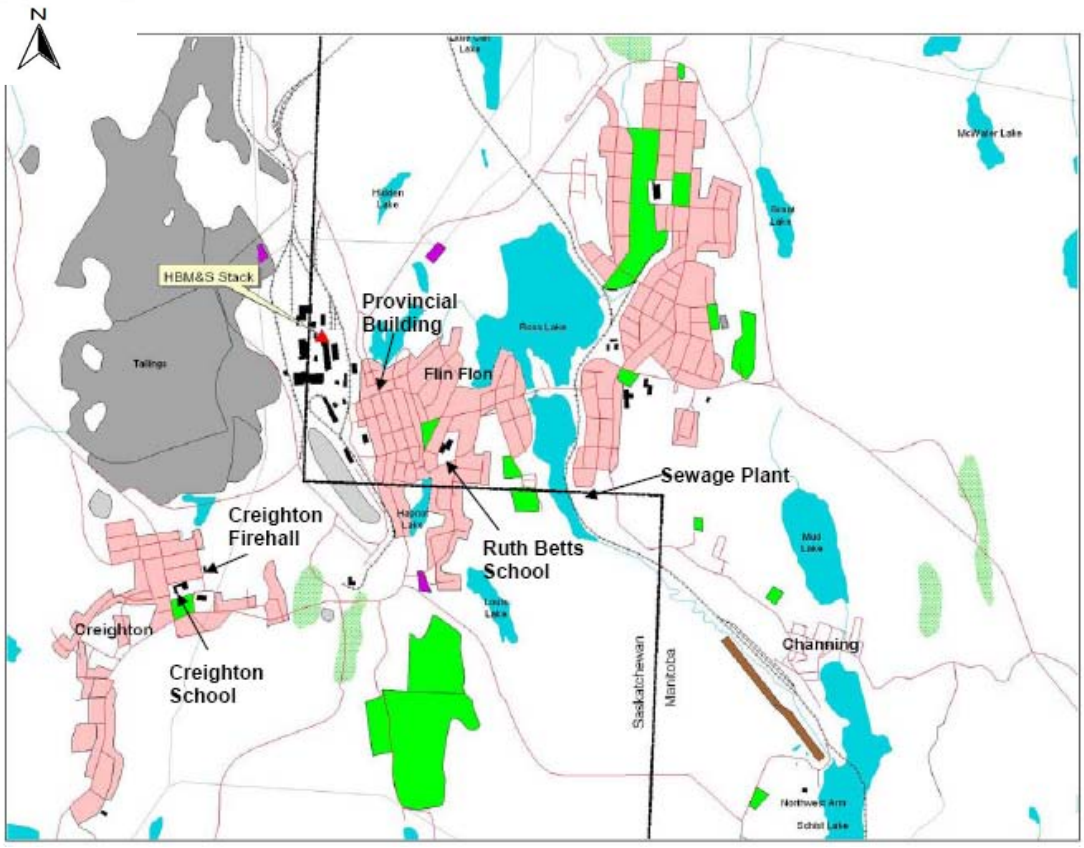

Figure I-1 Locations of Air Quality Monitoring Stations in Flin Flon and Creighton (Manitoba Conservation, 2006)

I-2.0 SELECTION OF DATA

The following sections discuss factors that should be considered during the derivation of appropriate exposure point concentrations (*i.e.*, air concentrations for use in the HHRA) from existing ambient air monitoring data.

I-2.1 Selection of Appropriate Time Frame

Numerous recent technological improvements have been made to the HBMS complex that have resulted in the reduction of emissions. These include the replacement of the zinc roaster with a zinc pressure leaching system in 1993 and an upgrade to the copper smelter gas handling system in 2000 (Manitoba Conservation, 2006). Since the primary intent of the HHRA is to predict exposure and risks under current conditions, use of air data collected prior to the improvements made to the spill gas handling system in 2001 is not recommended. Post 2001 air monitoring data are anticipated to be a more accurate reflection of the direct contribution of air emissions to current ambient air quality.

Based on annual average concentrations of arsenic, cadmium, copper, lead, and mercury from 2002 to 2006 measured at the Provincial building, Ruth Betts, and the Creighton School, concentrations of these metals have generally declined or remained constant over this period (Table I-1).

Table I-1 Annual Average Metal Concentrations Associated with TSP in Ambient Air (µg/m3)

Location	*Lead*	*Copper*	*Cadmium*	*Arsenic*	*Mercury*
Provincial Building					
2002	0.276	0.979	0.045	0.043	-
2003	0.225	1.042	0.032	0.054	-
2004	0.109	0.980	0.015	0.038	-
2005	0.175	0.894	0.022	0.043	-
2006	0.144	0.940	0.041	0.049	-
Ruth Betts School					
2002	0.150	0.688	0.019	0.037	0.0006
2003	0.136	0.799	0.018	0.037	0.0008
2004	0.040	0.576	0.006	0.016	0.0008
2005	0.089	0.764	0.014	0.023	0.0006
2006	0.059	0.742	0.020	0.024	0.0005
Creighton School					
2002	0.167	0.560	0.005	0.151	-
2003	0.036	0.647	0.004	0.009	0.0003
2004	0.028	0.495	0.003	0.006	0.0004
2005	0.039	0.417	0.007	0.011	0.0004
2006	0.024	0.446	0.005	0.008	0.0001

Note: From January, 1998 to mid-2005, samples from Ruth Betts and Creighton School were only analyzed when wind direction was from the facility.

From 1997 to 2002, HBMS only analyzed samples collected from their monitors that met certain wind direction and/or particulate loading criteria (Manitoba Conservation, 2006). These criteria excluded those samples that were collected when the prevailing wind was not from the direction of the HBMS complex as well as those samples that contained low particulate loadings (Manitoba Conservation, 2006). As a result, the data from this period represents an overestimation of the long-term concentrations of COC in ambient outdoor air. HBMS has indicated the wind direction criteria was followed until mid-2005 for samples from Ruth Betts, the Sewage Plant, and Creighton School with exception of samples collected at Creighton School after November 2002 when sampling frequency was increased.

Overall, use of data collected by HBMS at Ruth Betts and Creighton School prior to 2003 is not recommended for the derivation of chronic exposure point concentrations for use in the HHRA. Data collected from 2006 and 2007 is anticipated to provide a more accurate representation of current long-term conditions given that it was collected subsequent to all major technological improvements at the HBMS complex and is not biased by wind direction or minimum particulate loading requirements.

I-2.2 Selection of Monitoring Locations for HHRA Communities

The combined influence of local wind patterns in the Flin Flon-Creighton area and the proximity to the HBMS complex creates unique conditions for different communities within this area. While residents from these communities may spend time working or spending leisure time away from their primary residence, their exposure to COC in soil and ambient air may be most accurately characterized using concentrations measured near their home. To address the variability in soil and ambient air concentrations throughout the study area, the HHRA will assess exposure and risk to distinct communities that are defined based on geographical separation. The selection of ambient air data for use in the exposure assessment for each of these communities will be based on their proximity to the monitoring stations and the influence of the predominate wind direction on the dispersion of emissions from the HBMS complex.

Given that the most frequent wind direction is from the northwest (approximately seven months of the year), ambient air in the western portion of Flin Flin (*i.e.*, west of Ross Lake) is likely heavily influenced by direct releases of emissions from the stack. Air monitors stationed on the Provincial building and Ruth Betts School are located downwind of the HBMS complex and data collected at these stations are considered to be reflective of exposure conditions for residents of the community of western Flin Flon. Based on a comparison of metals associated with TSP at the Provincial building and Ruth Betts as shown in Table I-2, concentrations of several metals are higher in samples collected at the Provincial building. For the purpose of estimating conservative long-term exposure point concentrations for residents of the community of western Flin Flon, the HHRA will utilize data collected from the monitors located on the Provincial building. Although only TSP data is available for this location, chemical-specific correlating factors based on historical paired TSP and PM_{10} data will be used to predict concentrations of COC associated with the respirable PM_{10} fraction as discussed in Sections I-3.0 and I-3.1.

The eastern portion of Flin Flon (*i.e.*, east and northeast of Ross Lake) is not likely influenced by direct stack emissions to the same extent as the western community as a result of the predominate wind direction from the northwest. Since there are no air monitoring stations located to the north or east of Ross Lake, data collected from air monitors outside of this community must be utilized in the HHRA. Given that the Provincial building is located directly downwind from the HBMS complex and is the closest in proximity to the stack, it is not anticipated that data collected from this monitor are an accurate reflection of ambient air quality in eastern Flin Flon. Therefore, the HHRA will utilize data collected from the monitors located on Ruth Betts to estimate long-term ambient air exposure point concentrations for residents of the community of eastern Flin Flon. These data will also be used to represent air quality for residents of Channing located southeast of Ruth Betts.

The community of Creighton is located to the southwest of the HBMS complex. Although it is not directly downwind of the HBMS complex and will not receive the same level of direct smelter emissions as the community of western Flin Flon, it does receive significant particulate loadings from wind-blown dusts originating from the tailings impoundment. Data collected from air monitors located on the Creighton School are considered to provide an accurate representation of ambient air quality in this community and will be utilized within the HHRA.

I-3.0 DERIVATION OF CORRELATING FACTORS FOR PM10 DATA TO TSP DATA

As recommended by Health Canada (2006), and as typically used in the completion of risk assessments, the HHRA will use concentrations of COC associated with the PM_{10} component of ambient air in the assessment of inhalation exposures. For the derivation of exposure point concentrations, recent PM_{10} data is available for monitors located on Ruth Betts to be used for the communities of Eastern Flin Flon and Channing, and for monitors located on the Creighton School, to be used for the community of Creighton. However, as discussed previously, the monitors located on the Provincial building currently only collect data associated with TSP. Since it is recommended that data collected from the Provincial building be used in the exposure assessment for the community of Western Flin Flon, concentrations of COC measured in TSP at the Provincial building will be adjusted to estimate concentrations that are anticipated to be associated with the PM_{10} component.

Concurrent TSP and PM_{10} monitoring data from the Provincial building is available for arsenic, cadmium, copper, and lead from March 1991 to December 1998 (Table I-2). By examining the ratio between the concentrations of a chemical in PM_{10} to that in TSP, the contribution of the chemical associated with the PM_{10} component can be illustrated. As recommended by Manitoba Conservation (2006) within the *Assessment of Ambient Air Concentrations of Arsenic in the Flin Flon Area,* for any given day when concentrations of a given metal within the PM_{10} component was greater than its concentration within TSP, these data were excluded from the analysis since these data were ambiguous (Manitoba Conservation, 2006).

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
3/25/1991	0.027	0.018	0.667	0.016	0.005	0.313	0.645	0.318	0.493	0.17	0.12	0.71
3/31/1991	0.180	0.177	0.983	0.071	0.071	1.000	0.699	0.346	0.495	-	-	-
4/6/1991	-	-	-	0.007	0.007	1.000	0.066	0.027	0.409	0.18	0.18	1.00
4/12/1991	0.006	0.005	0.833	0.003	0.003	1.000	0.211	0.138	0.654	0.03	0.03	1.00
4/18/1991	-	-	-	0.012	0.012	1.000	0.230	0.093	0.404	0.12	0.12	1.00
4/24/1991	0.002	0.002	1.000	0.003	0.003	1.000	0.078	0.040	0.513	0.03	0.03	1.00
4/30/1991	-	-	-	-	-	-	-	-	-	-	-	-
5/6/1991	0.003	0.003	1.000	0.003	0.003	1.000	0.118	0.088	0.746	0.03	0.03	1.00
5/12/1991	0.007	0.002	0.286	0.004	0.003	0.750	0.373	0.079	0.212	0.04	0.03	0.75
5/18/1991	0.004	0.001	0.250	0.004	0.003	0.750	0.196	0.066	0.337	0.04	0.03	0.75
5/24/1991	0.138	0.111	0.804	0.084	0.076	0.905	4.007	1.926	0.481	1.69	1.59	0.94
6/5/1991	0.009	0.005	0.556	0.005	0.003	0.600	0.211	0.085	0.403	0.05	0.03	0.60
6/11/1991	0.007	0.003	0.429	0.004	0.003	0.750	0.118	0.051	0.432	0.04	0.03	0.75
6/23/1991	0.009	0.004	0.444	0.005	0.003	0.600	0.583	0.062	0.106	0.05	0.03	0.60
7/5/1991	0.033	0.023	0.697	0.020	0.018	0.900	0.560	0.212	0.379	0.31	0.29	0.94
7/11/1991	0.006	0.004	0.667	0.004	0.003	0.750	0.135	0.072	0.533	0.04	0.03	0.75
7/17/1991	0.069	0.062	0.899	0.055	0.043	0.782	1.409	0.627	0.445	0.86	0.71	0.83
7/23/1991	0.183	0.154	0.842	0.107	0.095	0.888	3.973	2.037	0.513	2.37	2.20	0.93
7/29/1991	0.046	0.029	0.630	0.020	0.013	0.650	8.000	0.247	0.031	0.34	0.27	0.79
8/4/1991	0.006	0.004	0.667	0.004	0.003	0.750	0.163	0.072	0.442	0.04	0.03	0.75
8/10/1991	0.006	0.005	0.833	0.004	0.003	0.750	0.135	0.110	0.815	0.04	0.03	0.75
8/16/1991	0.115	0.017	0.148	0.064	0.007	0.109	4.897	0.115	0.023	1.29	0.14	0.11
8/22/1991	0.042	0.031	0.738	0.014	0.009	0.643	0.865	0.311	0.360	0.40	0.30	0.75
8/28/1991	0.006	0.003	0.500	0.004	0.003	0.750	0.201	0.032	0.159	0.04	0.03	0.75
9/3/1991	0.289	0.229	0.792	0.180	0.131	0.728	2.051	0.816	0.398	2.34	1.82	0.78
9/9/1991	0.330	0.290	0.879	0.103	0.090	0.874	3.234	1.509	0.467	2.62	2.18	0.83
9/27/1991	0.013	0.002	0.154	0.005	0.002	0.400	0.244	0.016	0.066	0.07	0.02	0.29
10/3/1991	0.038	0.003	0.079	0.010	0.003	0.300	-	-	-	0.15	0.03	0.20
10/9/1991	0.146	0.121	0.829	0.093	0.080	0.860	1.530	0.545	0.356	1.14	0.73	0.64
10/15/1991	-	-	-	0.004	0.003	0.750	-	-	-	-	-	-
10/21/1991	-	-	-	0.004	0.003	0.750	-	-	-	0.04	0.04	1.00
11/8/1991	0.007	0.007	1.000	0.005	0.003	0.600	-	-	-	-	-	-
11/14/1991	0.049	0.039	0.796	0.028	0.023	0.821	0.485	0.304	0.627	0.31	0.25	0.81
11/20/1991	0.088	0.076	0.864	0.069	0.059	0.855	0.950	0.261	0.275	1.29	1.09	0.84
12/2/1991	0.101	0.092	0.911	0.077	0.069	0.896	0.933	0.384	0.412	0.84	0.73	0.87

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
12/8/1991	0.089	0.082	0.921	0.044	0.041	0.932	0.264	0.206	0.780	1.16	1.11	0.96
12/14/1991	0.181	0.167	0.923	0.074	0.070	0.946	1.104	0.526	0.476	2.51	2.42	0.96
12/20/1991	0.019	0.014	0.737	0.012	0.009	0.750	0.360	0.359	0.997	0.16	0.14	0.88
12/26/1991	0.006	0.002	0.333	0.003	0.002	0.667	0.140	0.049	0.350	0.03	0.02	0.67
1/1/1992	0.002	0.001	0.500	0.003	0.002	0.667	0.101	0.056	0.554	0.03	0.02	0.67
1/7/1992	-	-	-	0.003	0.002	0.667	-	-	-	-	-	-
1/13/1992	-	-	-	0.069	0.066	0.957	0.352	0.137	0.389	0.94	0.85	0.90
1/19/1992	0.004	0.003	0.750	0.003	0.002	0.667	0.227	0.125	0.551	0.03	0.02	0.67
1/25/1992	0.087	0.078	0.897	0.095	0.094	0.989	1.093	0.380	0.348	1.87	1.61	0.86
1/31/1992	0.006	0.005	0.833	0.003	0.002	0.667	0.233	0.058	0.249	0.03	0.02	0.67
2/6/1992	0.036	0.026	0.722	0.017	0.011	0.647	0.628	0.245	0.390	0.77	0.42	0.55
2/12/1992	0.151	0.132	0.874	0.234	0.206	0.880	1.192	0.524	0.440	2.28	1.98	0.87
2/18/1992	-	-	-	0.003	0.002	0.667	-	-	-	0.03	0.03	1.00
2/24/1992	0.003	0.002	0.667	0.003	0.002	0.667	0.220	0.007	0.032	0.04	0.02	0.50
3/1/1992	0.019	0.019	1.000	0.005	0.005	1.000	0.202	0.149	0.738	-	-	-
3/7/1992	0.025	0.022	0.880	0.012	0.010	0.833	0.612	0.139	0.227	0.27	0.14	0.52
3/13/1992	0.013	0.013	1.000	0.024	0.023	0.958	0.285	0.072	0.253	0.17	0.14	0.82
3/25/1992	0.010	0.008	0.800	0.004	0.003	0.750	0.544	0.243	0.447	0.11	0.04	0.36
3/31/1992	0.010	0.010	1.000	-	-	-	0.351	0.237	0.675	0.03	0.03	1.00
4/6/1992	-	-	-	-	-	-	-	-	-	0.06	0.04	0.67
4/12/1992	-	-	-	-	-	-	-	-	-	-	-	-
4/18/1992	-	-	-	-	-	-	-	-	-	-	-	-
4/24/1992	-	-	-	-	-	-	-	-	-	-	-	-
4/30/1992	-	-	-	-	-	-	-	-	-	-	-	-
5/6/1992	-	-	-	-	-	-	0.217	0.214	0.986	0.04	0.04	1.00
5/12/1992	-	-	-	-	-	-	-	-	-	-	-	-
5/18/1992	-	-	-	-	-	-	-	-	-	-	-	-
5/24/1992	-	-	-	-	-	-	-	-	-	-	-	-
6/5/1992	-	-	-	-	-	-	-	-	-	-	-	-
6/11/1992	-	-	-	-	-	-	1.435	1.394	0.971	-	-	-
6/17/1992	-	-	-	-	-	-	-	-	-	-	-	-
6/29/1992	0.062	0.058	0.935	0.133	0.119	0.895	0.997	0.308	0.309	0.48	0.43	0.90
7/5/1992	0.013	0.010	0.769	0.004	0.004	1.000	0.325	0.122	0.375	-	-	-
7/11/1992	0.043	0.017	0.395	0.025	0.006	0.240	0.937	0.099	0.106	0.19	0.04	0.21
7/17/1992	0.018	0.010	0.556	0.006	0.004	0.667	0.549	0.217	0.395	-	-	-

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
7/23/1992	0.017	0.015	0.882	0.006	0.006	1.000	1.089	0.517	0.475	0.09	0.05	0.56
7/29/1992	0.044	0.025	0.568	0.022	0.012	0.545	1.390	0.460	0.331	0.17	0.09	0.53
8/4/1992	0.010	0.006	0.600	-	-	-	0.241	0.126	0.523	-	-	-
8/10/1992	0.004	0.003	0.750	0.003	0.003	1.000	0.142	0.046	0.324	0.03	0.03	1.00
8/16/1992	0.216	0.195	0.903	0.202	0.163	0.807	6.239	3.181	0.510	1.65	1.33	0.81
8/22/1992	0.005	0.002	0.400	0.003	0.003	1.000	0.256	0.040	0.156	0.03	0.03	1.00
8/28/1992	0.009	0.006	0.667	0.004	0.004	1.000	0.319	0.168	0.527	-	-	-
9/3/1992	0.186	0.143	0.769	0.157	0.122	0.777	2.472	0.957	0.387	0.73	0.57	0.78
9/21/1992	0.042	0.031	0.738	0.015	0.010	0.667	0.323	0.115	0.356	0.24	0.15	0.63
9/27/1992	-	-	-	0.196	0.182	0.929	2.779	1.511	0.544	2.45	2.28	0.93
10/3/1992	-	-	-	0.007	0.004	0.571	0.406	0.223	0.549	0.04	0.03	0.75
10/9/1992	0.018	0.009	0.500	0.011	0.008	0.727	0.567	0.290	0.511	0.12	0.06	0.50
10/15/1992	0.146	0.145	0.993	0.128	0.124	0.969	1.035	0.464	0.448	1.27	1.22	0.96
10/21/1992	0.035	0.029	0.829	0.028	0.019	0.679	0.257	0.132	0.514	0.33	0.23	0.70
10/27/1992	0.016	0.011	0.688	0.019	0.015	0.789	0.353	0.155	0.439	0.12	0.07	0.58
11/2/1992	0.003	0.003	1.000	0.003	0.003	1.000	0.098	0.045	0.459	0.03	0.03	1.00
11/20/1992	0.002	0.002	1.000	0.003	0.003	1.000	0.076	0.023	0.303	0.03	0.03	1.00
11/26/1992	-	-	-	0.113	0.109	0.965	3.109	0.880	0.283	1.24	1.19	0.96
12/8/1992	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
12/20/1992	-	-	-	-	-	-	0.386	0.250	0.648	-	-	-
1/1/1993	-	-	-	-	-	-	0.129	0.104	0.806	-	-	-
1/7/1993	0.241	0.213	0.884	-	-	-	-	-	-	-	-	-
1/13/1993	0.004	0.004	1.000	-	-	-	-	-	-	-	-	-
1/19/1993				0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
1/31/1993	0.063	0.005	0.079	0.101	0.003	0.030	0.770	0.191	0.248	0.39	0.03	0.08
2/6/1993	-	-	-	-	-	-	-	-	-	-	-	-
2/12/1993	-	-	-	-	-	-	0.540	0.291	0.539	-	-	-
2/18/1993	0.004	0.003	0.750	0.003	0.003	1.000	0.195	0.095	0.487	0.03	0.03	1.00
2/24/1993	-	-	-	0.068	0.060	0.882	0.699	0.227	0.325	0.38	0.33	0.87
3/8/1993	0.007	0.005	0.714	0.003	0.003	1.000	0.192	0.085	0.443	0.04	0.03	0.75
3/14/1993	-	-	-	0.012	0.011	0.917	0.904	0.413	0.457	0.15	0.03	0.20
3/20/1993	0.003	0.003	1.000	0.003	0.003	1.000	0.071	0.064	0.901	0.03	0.03	1.00
3/26/1993	0.019	0.014	0.737	0.014	0.010	0.714	2.066	0.478	0.231	0.15	0.10	0.67
4/1/1993	0.008	0.004	0.500	0.004	0.003	0.750	0.318	0.146	0.459	0.04	0.03	0.75
4/7/1993	0.009	0.004	0.444	-	-	-	0.315	0.127	0.403	0.05	0.03	0.60

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
4/13/1993	0.007	0.005	0.714	0.006	0.005	0.833	0.297	0.158	0.532	0.07	0.03	0.43
4/25/1993	0.005	0.004	0.800	0.003	0.003	1.000	0.205	0.132	0.644	-	-	-
5/1/1993	0.010	0.007	0.700	0.004	0.004	1.000	0.248	0.242	0.976	-	-	-
5/7/1993	0.009	0.005	0.556	0.005	0.004	0.800	0.617	0.135	0.219	0.05	0.04	0.80
5/13/1993	-	-	-	0.109	0.105	0.963	2.712	2.462	0.908	0.90	0.84	0.93
5/19/1993	0.018	0.016	0.889	0.013	0.010	0.769	0.835	0.469	0.562	0.14	0.11	0.79
5/25/1993	0.349	0.295	0.845	0.231	0.185	0.801	4.051	1.786	0.441	2.73	2.23	0.82
5/31/1993	0.021	0.017	0.810	0.011	0.009	0.818	0.692	0.423	0.611	0.14	0.10	0.71
6/6/1993	0.008	0.007	0.875	-	-	-	0.207	0.159	0.768	0.05	0.04	0.80
6/12/1993	0.004	0.004	1.000	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
6/18/1993	0.008	0.006	0.750	0.005	0.003	0.600	0.272	0.203	0.746	0.07	0.05	0.71
6/24/1993	0.047	0.046	0.979	0.240	0.024	0.100	0.428	0.208	0.486	0.33	0.33	1.00
6/30/1993	0.002	0.002	1.000	-	-	-	0.116	0.059	0.509	-	-	-
7/6/1993	0.018	0.015	0.833	0.009	0.007	0.778	0.575	0.267	0.464	0.23	0.18	0.78
7/12/1993	0.067	0.067	1.000	0.018	0.018	1.000	0.713	0.249	0.349	0.58	0.56	0.97
7/18/1993	0.002	0.002	1.000	0.003	0.003	1.000	0.164	0.058	0.354	0.03	0.03	1.00
7/24/1993	0.044	0.037	0.841	0.025	0.019	0.760	0.611	0.237	0.388	0.35	0.25	0.71
7/30/1993	0.032	0.021	0.656	0.006	0.005	0.833	0.560	0.465	0.830	0.19	0.14	0.74
8/5/1993	0.048	0.032	0.667	0.011	0.006	0.545	1.037	0.280	0.270	0.31	0.16	0.52
8/11/1993	0.324	0.250	0.772	0.124	0.113	0.911	2.812	0.952	0.339	2.92	2.69	0.92
8/17/1993	0.007	0.003	0.429	0.003	0.003	1.000	0.249	0.041	0.165	0.03	0.03	1.00
8/23/1993	0.032	0.023	0.719	0.019	0.017	0.895	0.664	0.212	0.319	0.31	0.26	0.84
8/29/1993	0.026	0.005	0.192	0.018	0.004	0.222	0.293	0.210	0.717	0.28	0.04	0.14
9/4/1993	0.214	0.180	0.841	0.133	0.088	0.662	4.730	1.832	0.387	1.99	1.40	0.70
9/10/1993	0.010	0.005	0.500	0.006	0.003	0.500	0.354	0.121	0.342	0.07	0.03	0.43
9/28/1993	0.178	0.151	0.848	0.186	0.171	0.919	1.683	0.527	0.313	0.82	0.65	0.79
10/4/1993	0.440	0.386	0.877	0.306	0.262	0.856	3.675	1.447	0.394	1.95	1.53	0.78
10/16/1993	0.010	0.005	0.500	0.005	0.003	0.600	0.356	0.116	0.326	0.03	0.03	1.00
10/22/1993	0.008	0.006	0.750	0.004	0.003	0.750	0.428	0.100	0.234	0.05	0.03	0.60
10/28/1993	0.041	0.006	0.146	-	-	-	-	-	-	-	-	-
11/3/1993	-	-	-	0.005	0.004	0.800	0.185	0.165	0.892	0.03	0.03	1.00
11/9/1993	0.062	0.034	0.548	0.008	0.006	0.750	0.522	0.231	0.443	0.23	0.12	0.52
11/15/1993	0.092	0.016	0.174	0.081	0.013	0.160	-	-	-	0.80	0.11	0.14
11/21/1993	0.038	0.019	0.500	0.014	0.011	0.786	1.471	0.725	0.493	0.23	0.14	0.61
11/27/1993	0.046	0.036	0.783	0.015	0.011	0.733	0.466	0.207	0.444	0.14	0.11	0.79

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
12/9/1993	-	-	-	0.003	0.003	1.000	0.132	0.036	0.273	0.03	0.03	1.00
12/15/1993	0.003	0.003	1.000	0.003	0.003	1.000	0.147	0.044	0.299	0.03	0.03	1.00
12/27/1993	0.004	0.004	1.000	-	-	-	0.187	0.138	0.738	0.03	0.03	1.00
1/2/1994	0.033	0.007	0.212	0.052	0.010	0.192	-	-	-	0.24	0.06	0.25
1/8/1994	-	-	-	0.003	0.003	1.000	0.135	0.058	0.430	0.03	0.03	1.00
1/26/1994	-	-	-	0.005	0.005	1.000	-	-	-	0.03	0.03	1.00
2/7/1994	0.134	0.078	0.582	0.072	0.034	0.472	0.472	0.355	0.752	1.00	0.53	0.53
2/13/1994	0.013	0.013	1.000	-	-	-	-	-	-	0.05	0.05	1.00
2/25/1994	-	-	-	-	-	-	-	-	-	0.11	0.11	1.00
3/3/1994	0.008	0.006	0.750	-	-	-	0.137	0.063	0.460	-	-	-
3/9/1994	-	-	-	0.027	0.026	0.963	1.014	0.643	0.634	-	-	-
3/15/1994	0.013	0.008	0.615	-	-	-	0.278	0.107	0.385	0.06	0.04	0.67
3/27/1994	0.038	0.032	0.842	0.060	0.058	0.967	0.255	0.131	0.514	0.41	0.39	0.95
4/2/1994	0.212	0.180	0.849	0.111	0.098	0.883	1.885	0.911	0.483	1.27	1.15	0.91
4/8/1994	0.014	0.010	0.714	0.004	0.004	1.000	0.416	0.186	0.447	0.10	0.06	0.60
4/14/1994	0.012	0.006	0.500	-	-	-	0.409	0.108	0.264	0.12	0.04	0.33
4/20/1994	0.010	0.008	0.800	-	-	-	0.375	0.204	0.544	0.07	0.06	0.86
5/2/1994	-	-	-	0.005	0.005	1.000	0.434	0.351	0.809	0.12	0.09	0.75
5/14/1994	-	-	-	-	-	-	0.117	0.070	0.598	-	-	-
5/26/1994	0.012	0.009	0.750	0.004	0.004	1.000	0.322	0.160	0.497	0.08	0.05	0.63
6/1/1994	0.010	0.007	0.700	0.006	0.004	0.667	0.341	0.055	0.161	0.07	0.04	0.57
6/7/1994	-	-	-	-	-	-	0.098	0.062	0.633	-	-	-
6/13/1994	0.009	0.007	0.778	-	-	-	0.181	0.092	0.508	0.04	0.04	1.00
6/19/1994	0.044	0.031	0.705	0.014	0.008	0.571	0.632	0.360	0.570	0.25	0.16	0.64
7/1/1994	0.279	0.214	0.767	0.317	0.180	0.568	6.462	2.697	0.417	3.07	2.05	0.67
7/7/1994	-	-	-	-	-	-	0.093	0.040	0.430	-	-	-
7/19/1994	0.002	0.002	1.000	-	-	-	0.052	0.029	0.558	-	-	-
7/25/1994	0.026	0.016	0.615	0.008	0.006	0.750	1.166	0.704	0.604	0.26	0.20	0.77
7/31/1994	0.003	0.003	1.000	0.004	0.004	1.000	0.111	0.043	0.387	0.04	0.04	1.00
8/12/1994	0.030	0.025	0.833	0.036	0.021	0.583	1.137	0.319	0.281	0.44	0.40	0.91
8/18/1994	-	-	-	-	-	-	0.879	0.397	0.452	-	-	-
8/24/1994	0.033	0.023	0.697	0.008	0.006	0.750	0.613	0.464	0.757	0.24	0.21	0.88
8/30/1994	0.012	0.009	0.750	0.006	0.006	1.000	0.219	0.128	0.584	0.08	0.07	0.88
9/5/1994	0.410	0.375	0.915	0.654	0.631	0.965	8.193	3.431	0.419	5.45	5.27	0.97
9/11/1994	0.029	0.022	0.759	0.019	0.013	0.684	0.636	0.207	0.325	0.26	0.16	0.62

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
9/17/1994	0.044	0.031	0.705	0.029	0.021	0.724	1.514	0.409	0.270	0.33	0.24	0.73
9/23/1994	0.030	0.017	0.567	0.013	0.009	0.692	0.868	0.526	0.606	0.30	0.19	0.63
9/29/1994	0.144	0.112	0.778	0.104	0.092	0.885	2.264	0.751	0.332	0.95	0.80	0.84
10/5/1994	0.010	0.005	0.500	0.004	0.004	1.000	0.264	0.090	0.341	0.05	0.04	0.80
10/11/1994	0.155	0.151	0.974	0.079	0.074	0.937	2.372	0.900	0.379	1.05	0.88	0.84
10/17/1994	0.016	0.013	0.813	0.010	0.008	0.800	0.167	0.044	0.263	0.11	0.08	0.73
10/23/1994	-	-	-	-	-	-	0.079	0.076	0.962	-	-	-
10/29/1994	0.126	0.008	0.063	0.018	0.010	0.556	0.670	0.566	0.845	0.39	0.22	0.56
11/4/1994	-	-	-	0.004	0.004	1.000	0.135	0.075	0.556	0.04	0.04	1.00
11/16/1994	-	-	-	-	-	-	-	-	-	-	-	-
11/22/1994	0.174	0.174	1.000	0.143	0.109	0.762	1.819	0.679	0.373	1.37	1.25	0.91
12/28/1994	-	-	-	0.005	0.004	0.800	0.253	0.023	0.091	0.06	0.04	0.67
1/15/1995	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
1/21/1995	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
1/27/1995	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
2/2/1995	0.105	0.103	0.981	0.104	0.075	0.721	1.612	0.655	0.406	0.79	0.65	0.82
2/8/1995	-	-	-	0.245	0.245	1.000	1.603	0.813	0.507	2.49	2.45	0.98
2/20/1995	-	-	-	0.267	0.260	0.974	2.156	0.604	0.280	2.21	2.13	0.96
2/26/1995	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
3/10/1995	0.025	0.024	0.960	0.020	0.019	0.950	-	-	-	0.18	0.18	1.00
3/16/1995	0.005	0.003	0.600	0.003	0.003	1.000	0.108	0.042	0.389	0.03	0.03	1.00
3/22/1995	0.002	0.002	1.000	0.004	0.003	0.750	0.041	0.006	0.146	0.04	0.03	0.75
3/28/1995	-	-	-	0.003	0.003	1.000	0.115	0.043	0.374	0.03	0.03	1.00
4/3/1995	0.628	0.604	0.962	0.203	0.199	0.980	5.915	3.412	0.577	2.05	1.85	0.90
4/9/1995	0.044	0.029	0.659	0.004	0.003	0.750	0.622	0.489	0.786	0.13	0.12	0.92
4/15/1995	0.006	0.004	0.667	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
4/21/1995	0.016	0.012	0.750	0.009	0.007	0.778	0.444	0.169	0.381	0.08	0.07	0.88
4/27/1995	0.007	0.005	0.714	-	-	-	-	-	-	0.06	0.06	1.00
5/9/1995	0.088	0.060	0.682	0.015	0.009	0.600	2.310	1.054	0.456	0.51	0.35	0.69
5/15/1995	0.005	0.005	1.000	0.004	0.003	0.750	0.140	0.075	0.536	0.04	0.03	0.75
5/21/1995	0.043	0.040	0.930	0.051	0.044	0.863	1.004	0.425	0.423	0.24	0.18	0.75
5/27/1995	-	-	-	0.020	0.019	0.950	0.430	0.250	0.581	-	-	-
6/2/1995	0.006	0.004	0.667	0.004	0.004	1.000	0.376	0.102	0.271	0.04	0.04	1.00
6/8/1995	0.090	0.061	0.678	0.072	0.048	0.667	2.676	1.246	0.466	0.59	0.36	0.61
6/14/1995	0.098	0.072	0.735	0.082	0.057	0.695	3.254	1.080	0.332	0.31	0.18	0.58

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
6/20/1995	0.012	0.010	0.833	0.004	0.004	1.000	0.182	0.152	0.835	-	-	-
6/26/1995	-	-	-	-	-	-	-	-	-	-	-	-
7/2/1995	0.006	0.005	0.833	0.004	0.003	0.750	0.294	0.184	0.626	-	-	-
7/8/1995	0.096	0.042	0.438	0.029	0.023	0.793	1.919	0.614	0.320	0.35	0.19	0.54
7/14/1995	0.033	0.024	0.727	-	-	-	0.578	0.373	0.645	0.19	0.17	0.89
7/20/1995	-	-	-	-	-	-	1.103	0.376	0.341	-	-	-
7/26/1995	0.015	0.009	0.600	0.011	0.007	0.636	1.046	0.093	0.089	-	-	-
8/1/1995	0.013	0.006	0.462	0.005	0.004	0.800	0.433	0.128	0.296	0.08	0.04	0.50
8/7/1995	0.048	0.021	0.438	0.038	0.021	0.553	0.871	0.218	0.250	0.34	0.18	0.53
8/13/1995	0.047	0.041	0.872	0.044	0.041	0.932	1.016	0.335	0.330	0.40	0.34	0.85
8/25/1995	0.290	0.262	0.903	0.211	0.182	0.863	3.274	1.490	0.455	2.69	2.34	0.87
8/31/1995	0.053	0.041	0.774	0.040	0.034	0.850	1.260	0.536	0.425	0.40	0.31	0.78
9/6/1995	0.007	0.006	0.857	0.004	0.003	0.750	0.243	0.161	0.663	-	-	-
9/12/1995	0.107	0.087	0.813	0.172	0.155	0.901	2.730	2.057	0.753	1.46	1.31	0.90
9/18/1995	0.188	0.168	0.894	0.390	0.371	0.951	4.423	1.818	0.411	2.67	2.55	0.96
9/30/1995	0.108	0.103	0.954	0.126	0.124	0.984	2.516	1.008	0.401	0.32	0.30	0.94
10/6/1995	0.005	0.003	0.600	0.004	0.003	0.750	0.142	0.034	0.239	0.04	0.03	0.75
10/12/1995	0.003	0.002	0.667	0.004	0.003	0.750	0.099	0.023	0.232	0.04	0.03	0.75
10/18/1995	0.003	0.002	0.667	0.004	0.003	0.750	0.130	0.017	0.131	0.04	0.03	0.75
10/24/1995	-	-	-	0.004	0.003	0.750	0.501	0.143	0.285	0.07	0.05	0.71
10/30/1995	0.021	0.016	0.762	0.004	0.003	0.750	0.413	0.182	0.441	0.10	0.09	0.90
11/5/1995	-	-	-	0.004	0.003	0.750	0.386	0.384	0.995	0.04	0.04	1.00
11/11/1995	0.019	0.011	0.579	0.007	0.006	0.857	0.543	0.233	0.429	0.05	0.05	1.00
11/17/1995	0.038	0.038	1.000	-	-	-	0.934	0.222	0.238	-	-	-
11/23/1995	0.036	0.036	1.000	0.036	0.035	0.972	0.936	0.389	0.416	0.31	0.28	0.90
12/5/1995	0.565	0.022	0.039	0.733	0.007	0.010	5.452	0.259	0.048	3.83	0.07	0.02
12/11/1995	-	-	-	-	-	-	-	-	-	-	-	-
12/17/1995	-	-	-	-	-	-	-	-	-	-	-	-
12/23/1995	0.060	0.004	0.067	0.023	0.003	0.130	0.683	0.092	0.135	0.16	0.03	0.19
12/29/1995	-	-	-	-	-	-	-	-	-	-	-	-
1/1/1996	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
1/7/1996	-	-	-	-	-	-	0.576	0.491	0.852	-	-	-
1/13/1996	-	-	-	-	-	-	-	-	-	-	-	-
1/19/1996	-	-	-	-	-	-	-	-	-	-	-	-
1/31/1996	0.029	0.028	0.966	0.026	0.025	0.962	0.785	0.378	0.482	0.28	0.28	1.00

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
2/6/1996	0.005	0.004	0.800	0.004	0.003	0.750	0.301	0.089	0.296	0.03	0.03	1.00
2/12/1996	-	-	-	-	-	-	1.277	0.490	0.384	-	-	-
2/18/1996	-	-	-	0.003	0.003	1.000	-	-	-	-	-	-
3/1/1996	0.036	0.031	0.861	0.024	0.018	0.750	5.428	3.021	0.557	0.30	0.19	0.63
3/7/1996	0.275	0.256	0.931	0.193	0.154	0.798	4.415	2.433	0.551	2.63	2.62	1.00
3/13/1996	0.033	0.025	0.758	0.008	0.007	0.875	0.937	0.432	0.461	0.10	0.08	0.80
3/19/1996	0.004	0.004	1.000	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
3/25/1996	0.019	0.017	0.895	0.012	0.011	0.917	0.667	0.262	0.393	0.17	0.17	1.00
3/31/1996	0.252	0.245	0.972	-	-	-	3.790	2.284	0.603	-	-	-
4/6/1996	0.005	0.004	0.800	-	-	-	0.202	0.108	0.535	-	-	-
4/12/1996	0.020	0.012	0.600	0.012	0.004	0.333	0.855	0.352	0.412	0.13	0.08	0.62
4/18/1996	-	-	-	-	-	-	-	-	-	-	-	-
4/30/1996	0.005	0.004	0.800	-	-	-	0.203	0.097	0.478	-	-	-
5/6/1996	0.002	0.002	1.000	-	-	-	0.085	0.030	0.353	-	-	-
5/12/1996	0.110	0.091	0.827	0.092	0.082	0.891	2.000	0.891	0.446	0.93	0.81	0.87
5/18/1996	0.002	0.002	1.000	-	-	-	0.048	0.006	0.125	-	-	-
5/24/1996	0.022	0.013	0.591	0.004	0.004	1.000	0.523	0.235	0.449	0.09	0.07	0.78
5/30/1996	0.004	0.003	0.750	0.004	0.004	1.000	0.141	0.045	0.319	0.04	0.04	1.00
6/5/1996	0.006	0.003	0.500	0.004	0.004	1.000	0.199	0.073	0.367	0.04	0.04	1.00
6/11/1996	0.063	0.033	0.524	0.007	0.005	0.714	0.898	0.486	0.541	0.16	0.10	0.63
6/17/1996	0.004	0.004	1.000	0.004	0.004	1.000	0.254	0.046	0.181	0.04	0.04	1.00
6/23/1996	0.014	0.009	0.643	-	-	-	0.396	0.281	0.710	0.04	0.04	1.00
6/29/1996	0.022	0.014	0.636	0.004	0.004	1.000	0.562	0.187	0.333	0.08	0.04	0.50
7/5/1996	-	-	-	0.004	0.004	1.000	0.154	0.062	0.403	0.04	0.04	1.00
7/11/1996	0.070	0.059	0.843	0.042	0.040	0.952	0.708	0.308	0.435	0.75	0.74	0.99
7/17/1996	0.008	0.006	0.750	0.004	0.004	1.000	0.209	0.099	0.474	0.04	0.04	1.00
7/23/1996	0.011	0.009	0.818	0.006	0.004	0.667	0.475	0.048	0.101	0.15	0.14	0.93
7/29/1996	0.006	0.004	0.667	0.004	0.004	1.000	0.150	0.049	0.327	0.04	0.04	1.00
8/4/1996	-	-	-	0.004	0.004	1.000	0.113	0.065	0.575	0.04	0.04	1.00
8/10/1996	-	-	-	0.095	0.083	0.874	2.085	0.870	0.417	1.31	1.21	0.92
8/16/1996	0.003	0.003	1.000	0.004	0.004	1.000	0.084	0.003	0.040	0.04	0.04	1.00
8/28/1996	0.031	0.020	0.645	0.013	0.007	0.538	2.571	0.670	0.261	0.26	0.15	0.58
9/3/1996	0.315	0.247	0.784	0.237	0.194	0.819	3.208	1.439	0.449	2.99	2.49	0.83
9/9/1996	0.273	0.264	0.967	0.264	0.245	0.928	3.617	1.531	0.423	3.35	2.91	0.87
9/15/1996	0.003	0.002	0.667	-	-	-	-	-	-	-	-	-

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
9/21/1996	0.008	0.006	0.750	-	-	-	0.436	0.362	0.830	-	-	-
9/27/1996	0.018	0.011	0.611	0.006	0.004	0.667	0.932	0.379	0.407	0.18	0.15	0.83
10/3/1996	0.057	0.004	0.070	-	-	-	0.419	0.349	0.833	-	-	-
10/9/1996	0.007	0.007	1.000	0.005	0.004	0.800	-	-	-	-	-	-
10/15/1996	0.011	0.008	0.727	0.011	0.009	0.818	-	-	-	0.06	0.06	1.00
10/21/1996	0.002	0.001	0.500	-	-	-	-	-	-	-	-	-
10/27/1996	0.022	0.018	0.818	0.018	0.017	0.944	-	-	-	0.18	0.16	0.89
11/2/1996	0.010	0.006	0.600	-	-	-	-	-	-	-	-	-
11/8/1996	0.318	0.173	0.544	0.275	0.180	0.655	6.058	2.326	0.384	5.24	3.37	0.64
11/14/1996	0.002	0.002	1.000	-	-	-	-	-	-	-	-	-
11/20/1996	0.018	0.003	0.167	0.014	0.003	0.214	0.362	0.361	0.997	0.13	0.03	0.23
11/26/1996	0.042	0.038	0.905	0.070	0.067	0.957	0.836	0.386	0.462	0.78	0.75	0.96
12/2/1996	0.002	0.002	1.000	-	-	-	-	-	-	-	-	-
12/8/1996	0.006	0.005	0.833	0.005	0.005	1.000	-	-	-	0.04	0.04	1.00
12/14/1996	0.025	0.016	0.640	0.010	0.008	0.800	0.526	0.358	0.681	0.18	0.15	0.83
12/20/1996	0.086	0.077	0.895	0.049	0.043	0.878	1.464	0.431	0.294	0.50	0.44	0.88
12/26/1996	0.007	0.003	0.429	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
1/1/1997	-	-	-	-	-	-	-	-	-	-	-	-
1/7/1997	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
1/13/1997	0.003	0.002	0.667	-	-	-	-	-	-	-	-	-
1/19/1997	0.140	0.138	0.986	-	-	-	-	-	-	-	-	-
1/25/1997	0.008	0.004	0.500	0.003	0.003	1.000	0.503	0.177	0.352	0.03	0.03	1.00
1/31/1997	-	-	-	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
2/6/1997	0.002	0.002	1.000	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
2/12/1997	0.004	0.002	0.500	0.007	0.003	0.429	0.400	0.179	0.448	0.03	0.03	1.00
2/18/1997	0.010	0.009	0.900	0.005	0.004	0.800	0.355	0.278	0.783	0.09	0.09	1.00
2/24/1997	0.005	0.003	0.600	0.003	0.003	1.000	0.199	0.136	0.683	0.03	0.03	1.00
3/2/1997	0.043	0.035	0.814	0.025	0.023	0.920	0.512	0.282	0.551	0.17	0.16	0.94
3/8/1997	0.005	0.003	0.600	0.005	0.003	0.600	0.354	0.152	0.429	0.03	0.03	1.00
3/14/1997	-	-	-	-	-	-	2.469	0.987	0.400	-	-	-
3/20/1997	0.003	0.002	0.667	-	-	-	0.222	0.174	0.784	-	-	-
3/26/1997	0.168	0.142	0.845	0.232	0.199	0.858	5.014	2.232	0.445	1.87	1.53	0.82
4/1/1997	0.004	0.004	1.000	0.004	0.004	1.000	-	-	-	0.04	0.04	1.00
4/7/1997	0.018	0.011	0.611	0.003	0.003	1.000	0.200	0.195	0.975	0.04	0.03	0.75
4/13/1997	0.006	0.006	1.000	-	-	-	-	-	-	-	-	-

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
4/19/1997	0.025	0.018	0.720	0.017	0.014	0.824	0.577	0.450	0.780	0.16	0.14	0.88
4/25/1997	0.026	0.014	0.538	0.009	0.007	0.778	0.766	0.491	0.641	0.16	0.11	0.69
5/1/1997	0.033	0.021	0.636	0.021	0.019	0.905	1.083	0.881	0.813	0.27	0.26	0.96
5/7/1997	0.005	0.004	0.800	-	-	-	-	-	-	-	-	-
5/13/1997	0.025	0.004	0.160	0.006	0.005	0.833	-	-	-	0.05	0.05	1.00
5/19/1997	0.003	0.002	0.667	-	-	-	-	-	-	-	-	-
5/25/1997	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
5/31/1997	0.047	0.039	0.830	0.042	0.037	0.881	1.167	0.629	0.539	0.22	0.17	0.77
6/6/1997	0.006	0.003	0.500	-	-	-	0.269	0.241	0.896	-	-	-
6/12/1997	0.005	0.004	0.800	-	-	-	0.198	0.146	0.737	-	-	-
6/18/1997	0.004	0.003	0.750	-	-	-	0.167	0.149	0.892	-	-	-
6/30/1997	-	-	-	-	-	-	0.617	0.430	0.697	-	-	-
7/6/1997	-	-	-	-	-	-	-	-	-	-	-	-
7/12/1997	0.051	0.029	0.569	0.028	0.027	0.964	0.720	0.377	0.524	0.18	0.14	0.78
7/18/1997	0.004	0.003	0.750	-	-	-	0.150	0.137	0.913	-	-	-
7/24/1997	0.074	0.050	0.676	0.085	0.074	0.871	1.489	0.836	0.561	0.48	0.38	0.79
7/30/1997	0.021	0.011	0.524	0.005	0.004	0.800	0.500	0.220	0.440	0.07	0.04	0.57
8/5/1997	0.169	0.146	0.864	0.193	0.168	0.870	6.044	2.312	0.383	0.86	0.72	0.84
8/17/1997	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
8/23/1997	0.088	0.070	0.795	0.265	0.233	0.879	2.181	0.968	0.444	0.99	0.85	0.86
8/29/1997	0.021	0.014	0.667	0.027	0.023	0.852	0.825	0.646	0.783	0.22	0.19	0.86
9/4/1997	0.004	0.004	1.000	-	-	-	-	-	-	-	-	-
9/10/1997	0.081	0.078	0.963	0.135	0.135	1.000	1.038	0.727	0.700	1.43	1.40	0.98
9/16/1997	-	-	-	0.064	0.061	0.953	0.588	0.332	0.565	0.45	0.43	0.96
9/22/1997	-	-	-	-	-	-	1.630	0.899	0.552	-	-	-
9/28/1997	0.228	0.181	0.794	0.202	0.195	0.965	1.857	1.270	0.684	1.61	1.56	0.97
10/4/1997	0.104	0.088	0.846	0.139	0.120	0.863	2.529	1.438	0.569	1.28	1.09	0.85
10/10/1997	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
10/16/1997	-	-	-	-	-	-	-	-	-	-	-	-
10/22/1997	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
10/28/1997	-	-	-	-	-	-	1.416	0.994	0.702	-	-	-
11/3/1997	0.004	0.003	0.750	-	-	-	-	-	-	-	-	-
11/9/1997	0.219	0.030	0.137	0.164	0.159	0.970	1.372	0.573	0.418	0.95	0.89	0.94
11/15/1997	-	-	-	0.010	0.005	0.500	0.446	0.339	0.760	0.11	0.06	0.55
11/21/1997	-	-	-	-	-	-	-	-	-	-	-	-

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
11/27/1997	-	-	-	-	-	-	0.151	0.098	0.649	-	-	-
12/3/1997	0.005	0.004	0.800	-	-	-	0.160	0.105	0.656	-	-	-
12/9/1997	0.014	0.011	0.786	0.020	0.013	0.650	0.302	0.168	0.556	0.10	0.08	0.80
12/15/1997							1.245	0.804	0.646	1.80	1.69	0.94
12/21/1997	0.006	0.005	0.833	0.004	0.004	1.000	0.242	0.138	0.570			
12/27/1997	0.004	0.004	1.000									
1/14/1998	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
1/20/1998	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
2/1/1998	0.010	0.009	0.900	-	-	-	-	-	-	-	-	-
2/7/1998	0.002	0.002	1.000	-	-	-	-	-	-	-	-	-
2/13/1998	-	-	-	-	-	-	-	-	-	-	-	-
2/19/1998	-	-	-	0.018	0.017	0.944	-	-	-	0.11	0.10	0.91
2/25/1998	0.005	0.003	0.600	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
3/3/1998	0.010	0.009	0.900	0.009	0.009	1.000	-	-	-	0.05	0.03	0.60
3/9/1998	0.085	0.063	0.741	0.028	0.023	0.821	2.033	1.029	0.506	0.24	0.17	0.71
3/15/1998	0.008	0.007	0.875	0.003	0.003	1.000	-	-	-	0.03	0.03	1.00
3/21/1998	0.012	0.012	1.000	0.011	0.011	1.000	0.242	0.238	0.983	0.06	0.05	0.83
3/27/1998	0.006	0.005	0.833	0.004	0.004	1.000	-	-	-	-	-	-
4/2/1998	0.005	0.004	0.800	-	-	-	-	-	-	-	-	-
4/8/1998	0.009	0.005	0.556	0.004	0.003	0.750	-	-	-	0.03	0.03	1.00
4/14/1998	0.006	0.005	0.833	0.004	0.003	0.750	-	-	-	0.03	0.03	1.00
4/20/1998	0.068	0.050	0.735	0.045	0.041	0.911	1.461	1.195	0.818	0.33	0.29	0.88
4/26/1998	0.009	0.007	0.778	-	-	-	0.260	0.252	0.969	-	-	-
5/2/1998	0.010	0.007	0.700	-	-	-	-	-	-	0.04	0.04	1.00
5/8/1998	0.013	0.006	0.462	-	-	-	-	-	-	0.04	0.04	1.00
5/14/1998	0.009	0.005	0.556	0.025	0.005	0.200	0.535	0.248	0.464	-	-	-
5/20/1998	-	-	-	-	-	-	-	-	-	-	-	-
5/26/1998	0.006	0.005	0.833	0.005	0.005	1.000	-	-	-	0.04	0.04	1.00
6/1/1998	0.005	0.004	0.800	0.004	0.004	1.000	-	-	-			
6/7/1998	0.082	0.036	0.439	0.031	0.015	0.484	0.635	0.554	0.872	0.33	0.16	0.48
6/13/1998	0.266	0.222	0.835	0.254	0.216	0.850	3.171	1.671	0.527	1.61	1.30	0.81
6/19/1998	0.002	0.002	1.000	-	-	-	-	-	-	-	-	-
6/25/1998	0.003	0.003	1.000	0.004	0.004	1.000	-	-	-	0.04	0.04	1.00
7/1/1998	0.022	0.016	0.727	0.015	0.013	0.867	0.394	0.310	0.787	0.11	0.09	0.82
7/7/1998	0.013	0.006	0.462	0.006	0.004	0.667	0.366	0.359	0.981	0.10	0.05	0.50

Table I-2 Concentrations of COC in PM10 and TSP in Samples Collected from the Provincial Building in Flin Flon

Sampling Date	Arsenic			Cadmium			Copper			Lead		
	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP	TSP µg/m³	PM_{10} µg/m³	PM_{10}/TSP
7/13/1998	0.018	0.009	0.500	0.005	0.004	0.800	0.470	0.407	0.866	0.09	0.06	0.67
7/19/1998	0.071	0.062	0.873	0.026	0.022	0.846	1.011	0.667	0.660	0.68	0.59	0.87
7/25/1998	0.013	0.006	0.462	-	-	-	0.485	0.305	0.629	-	-	-
7/31/1998	0.007	0.005	0.714	0.004	0.004	1.000	-	-	-	0.04	0.04	1.00
8/6/1998	0.008	0.006	0.750	0.004	0.004	1.000	-	-	-	-	-	-
8/12/1998	0.743	0.348	0.468	0.230	0.142	0.617	6.046	2.912	0.482	2.48	1.56	0.63
8/18/1998	0.005	0.004	0.800	-	-	-	-	-	-	-	-	-
8/24/1998	0.088	0.038	0.432	0.026	0.020	0.769	1.779	1.053	0.592	0.40	0.28	0.70
8/30/1998	0.039	0.036	0.923	0.024	0.019	0.792	1.121	0.534	0.476	0.18	0.17	0.94
9/5/1998	0.371	0.328	0.884	0.123	0.121	0.984	4.269	2.051	0.480	1.14	1.06	0.93
9/11/1998	0.036	0.017	0.472	-	-	-	0.765	0.594	0.776	0.09	0.05	0.56
9/17/1998	0.434	0.333	0.767	-	-	-	7.038	3.342	0.475	1.85	1.56	0.84
9/23/1998	0.507	0.457	0.901	-	-	-	6.043	2.625	0.434	2.42	2.37	0.98
9/29/1998	0.014	0.010	0.714	0.013	0.009	0.692	-	-	-	0.09	0.06	0.67
10/11/1998	0.005	0.004	0.800	-	-	-	-	-	-	-	-	-
10/17/1998	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
10/23/1998	0.035	0.020	0.571	0.009	0.005	0.556	1.863	0.950	0.510	0.15	0.07	0.47
10/29/1998	0.065	0.039	0.600	0.027	0.026	0.963	0.778	0.414	0.532	0.20	0.18	0.90
11/4/1998	0.003	0.002	0.667	-	-	-	-	-	-	-	-	-
11/10/1998	0.047	0.028	0.596	0.029	0.017	0.586	-	-	-	-	-	-
11/16/1998	0.809	0.613	0.758	0.632	0.258	0.408	4.992	2.335	0.468	4.09	1.60	0.39
12/4/1998	-	-	-	-	-	-	-	-	-	-	-	-
12/10/1998	0.003	0.003	1.000	-	-	-	-	-	-	-	-	-
12/28/1998	-	-	-	-	-	-	-	-	-	-	-	-
# Samples			**319**			**292**			**300**			**289**
Arithmetic Mean			**0.737**			**0.812**			**0.490**			**0.80**

- Indicates that the concentration associated with PM_{10} was greater than the concentration associated with TSP. Therefore, this data was excluded from analysis.

As shown in Table I-2, the average PM_{10}/TSP ratios varied from chemical to chemical in samples measured at the Provincial building. Consistent with the analysis for arsenic completed by Manitoba Conservation (2006), approximately 74% of all arsenic in TSP is associated with the PM_{10} component. Similarly, approximately 81% of cadmium and 80% of lead in TSP is associated with PM_{10}. A smaller portion of copper (49%) appears to be associated with PM_{10}, indicating that copper is primarily found associated with particles larger than 10 µm.

To ensure that the HHRA is not unnecessarily overestimating the metal content of respirable particulate in ambient air, these data were used to establish a relationship that expresses the concentration of a specific metal in PM_{10} as a function of the concentration of the same metal in TSP. The analysis was derived using measured data from 1991 to 1998 to predict the metal concentration in PM_{10} as function of the metal content in TSP. This assessment allowed the HHRA to use the most recent TSP data collected from the Provincial building to predict metal concentrations within the respirable particulate fraction in the assessment of inhalation exposure to residents of Western Flin Flon.

I-3.1 Correlation of Metal Content in TSP and PM10

The following log-log scatter plots (Figure I-2 to I-6) identify correlations between TSP and PM_{10} for each of arsenic, copper, cadmium, lead and zinc. For each element, a positive correlation between TSP and PM_{10} concentrations is apparent. The observation of residuals in regression analysis identified that residual values are non-homogeneous and indicated that the normality assumption required for regression analysis may not be satisfied. Therefore, simple ratio analysis of PM_{10} to TSP was used in the assessment of correlating metal content in TSP to PM_{10}.

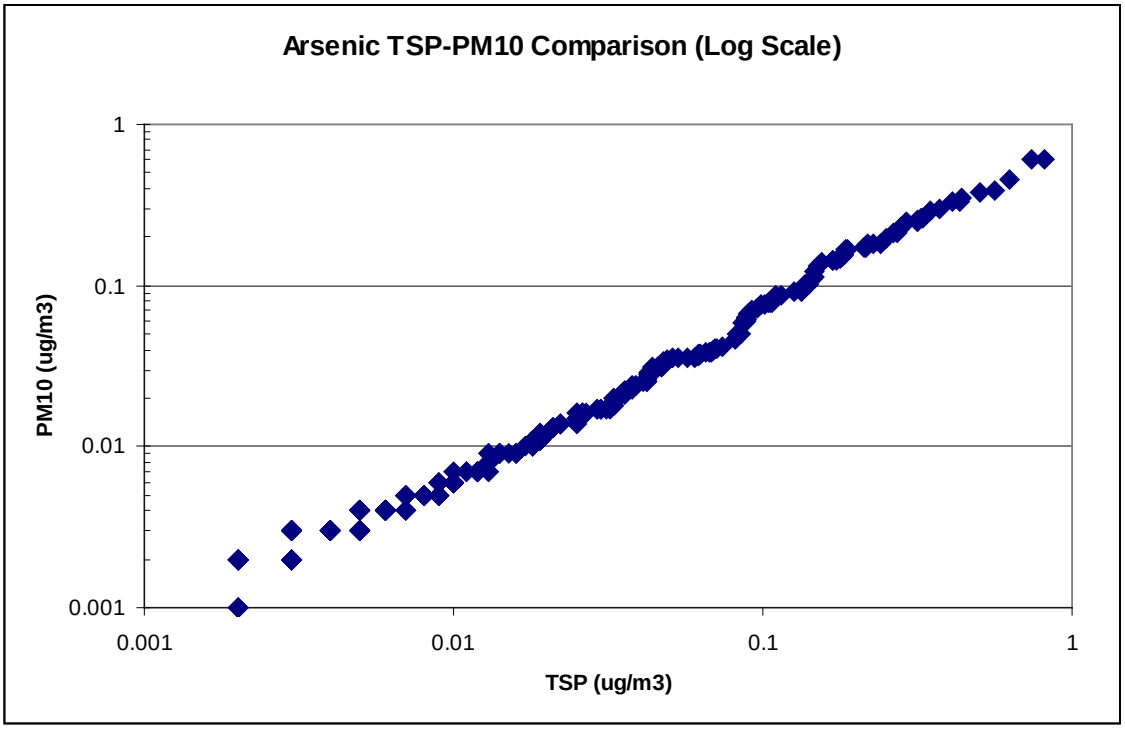

Figure I-2 Comparison of Arsenic TSP to PM10 Concentrations (µg/m3, Log scale)

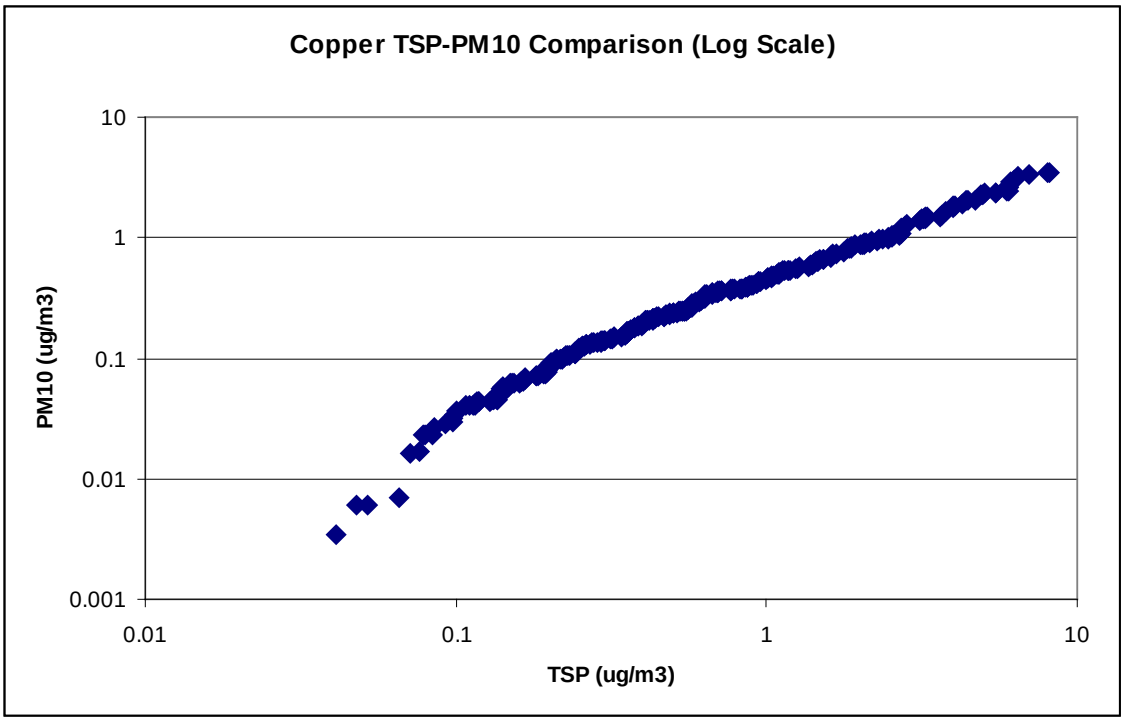

Figure I-3 Comparison of Copper TSP to PM10 Concentrations (µg/m3, Log scale)

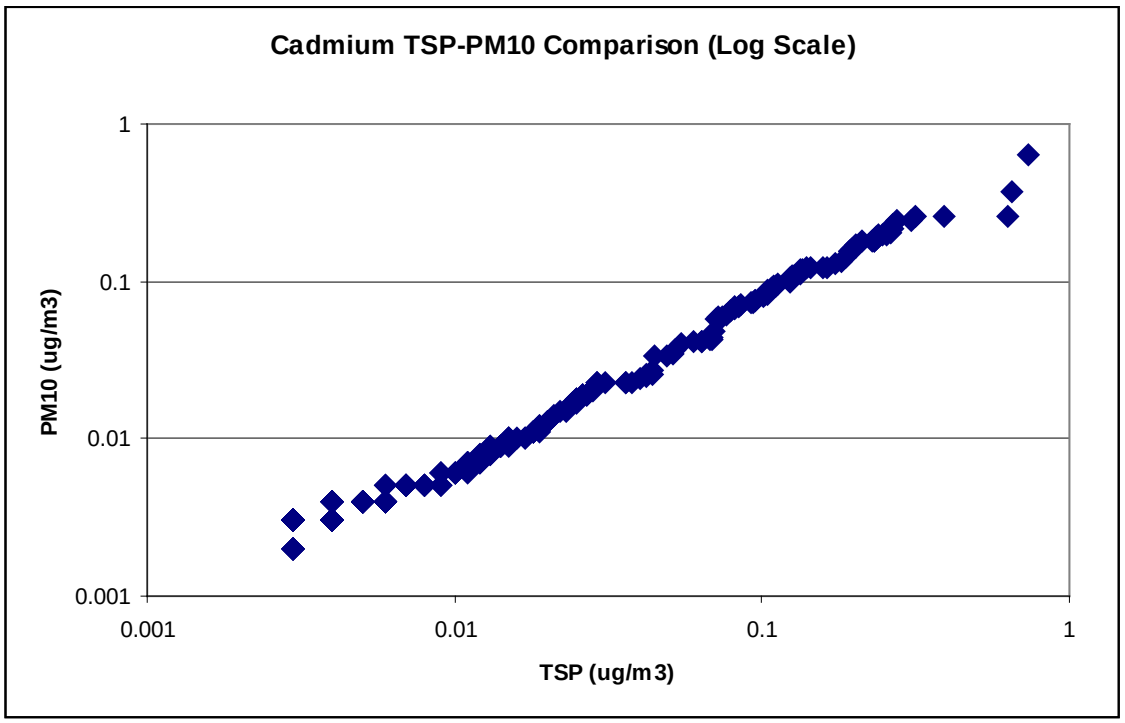

Figure I-4 Comparison of Cadmium TSP to PM10 Concentrations (µg/m3, Log scale)

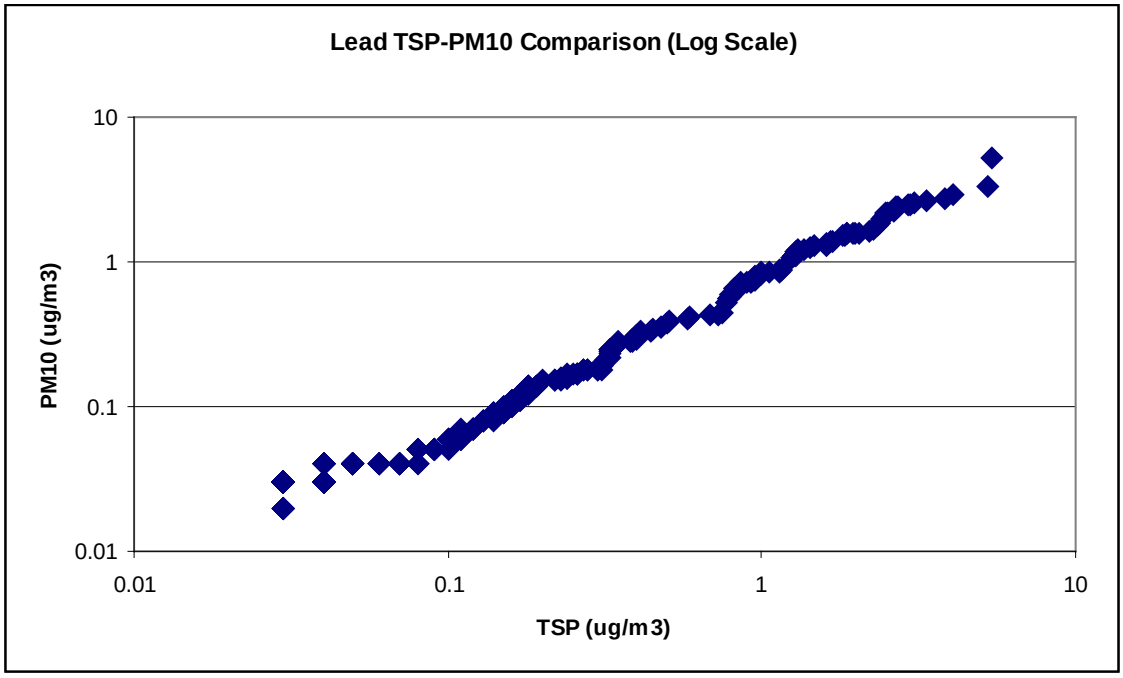

Figure I-5 Comparison of Lead TSP to PM10 Concentrations (µg/m3, Log scale)

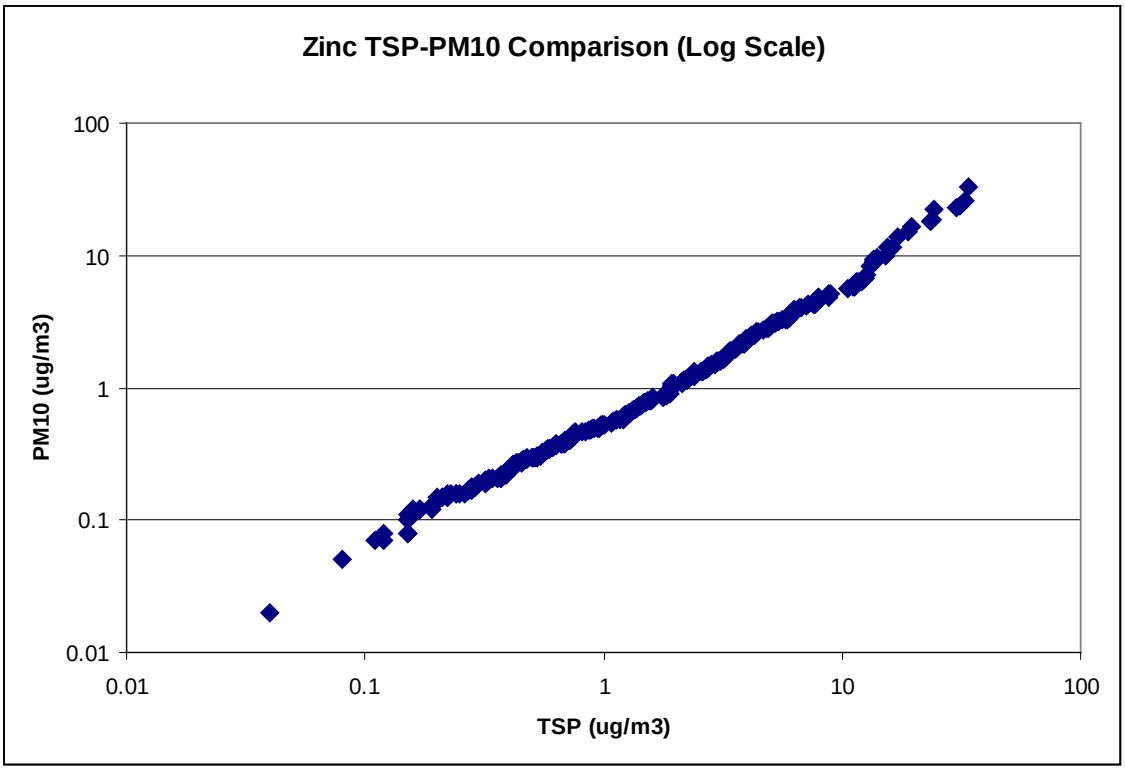

Figure I-6 Comparison of Zinc TSP to PM10 Concentrations (µg/m3, Log scale)

I-3.2 TSP- PM_{10} Ratio Comparisons

The following distributions and summary statistics compare ratios of measured PM_{10} concentrations to TSP concentrations to describe if possible correlations, if any, exist between the two parameters. Specifically, each unique PM_{10} concentration was divided by its associated TSP concentration for each sampling date, with the resulting ratio representing a value between 0 and 1.0 (Table I-2). This ratio employs the assumption that the TSP concentration represents the maximum amount of metal associated with the sample, and the PM_{10} value represents a variable portion of the total sample. The frequencies of each ratio were then compiled into a histogram to provide a graphic representation of the distribution range of data for each metal's PM_{10} to TSP ratio for years in which data were available (*i.e.*, 1991 to 1998).

U.S. EPA (1992) states that because of the uncertainty associated with estimating the true average concentration for a dataset, the 95% upper confidence limit of the arithmetic mean (95% UCLM) should be used for this variable. The confidence in the distribution of means defined by the 95% UCLM was estimated using ProUCL Version 3.0 Software (U.S. EPA, 2004). Several parametric and distribution-free non-parametric methods are included in ProUCL and cover a wide range of skewed data distributions. ProUCL provides the 95% UCLM of the mean based upon the most suitable distribution model.

PM_{10} to TSP distributions and annual statistics, including the 95% UCLM data for each of arsenic, copper, cadmium, lead and zinc are provided below. Figure I-7 outlines the distribution of PM_{10} to TSP ratios for all available arsenic data, which included over 300 unique data points. Within this figure, the bars represent the frequency of samples in which a particular ratio occurs, and the line represents the cumulative percentage of samples that are equal to or less than a particular ratio. Table I-3 identifies annual PM_{10} to TSP ratio summary statistics for arsenic, and indicates how most of the annualized data (*i.e.*, 6 of 8 years) is non-parametrically distributed, with only the 1992 data considered normally distributed. The average of annual 95% UCLM values is 0.85 or a PM_{10} to TSP ratio of 85%. This value is recommended for predicting arsenic concentrations in PM_{10} based on current TSP data for the HHRA.

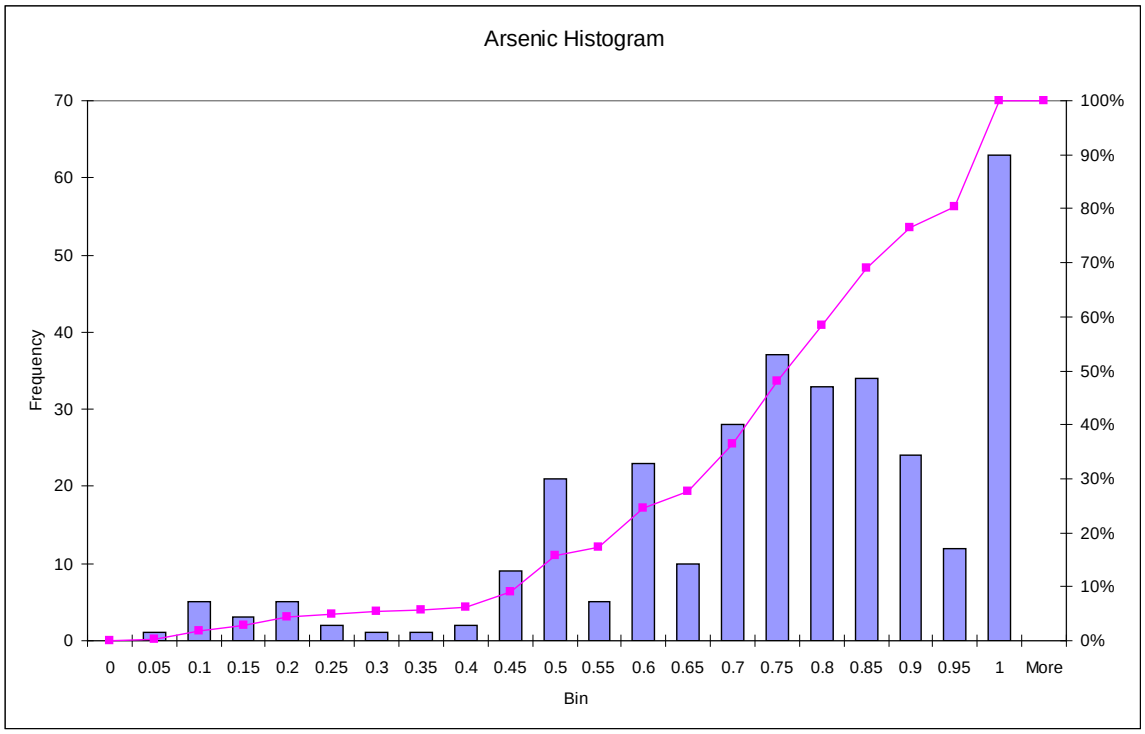

Figure I-7 Histogram of Arsenic PM10 to TSP Ratios (n=319)

Table I-3 Annualized PM^{10} to TSP Ratio Summary Statistics for Arsenic

Years	*Count*	*Min*	*Max*	*Avg*	*StDev*	*CofV*	*95%UCLM*	*Distribution*	*Type*
1991	34	0.08	1.0	0.68	0.27	0.40	0.88	Non-Parametric	Chebyshev
1992	31	0.40	1.0	0.77	0.18	0.24	0.83	Normal	Student's-t
1993	44	0.08	1.0	0.72	0.25	0.34	0.88	Non-Parametric	Chebyshev
1994	31	0.06	1.0	0.73	0.21	0.29	0.89	Non-Parametric	Chebyshev
1995	38	0.04	1.0	0.73	0.23	0.31	0.89	Non-Parametric	Chebyshev
1996	47	0.07	1.0	0.75	0.21	0.28	0.81	Non-Parametric	Student's-t
1997	46	0.14	1.0	0.76	0.21	0.28	0.81	Non-Parametric	Student's-t
1998	48	0.43	1.0	0.75	0.18	0.24	0.80	Gamma	Gamma
Average of Annual 95% UCLM Values							**0.85**		

Figure I-8 below outlines the distribution of PM_{10} to TSP ratios for all available copper data, which included 300 unique data points. Table I-4 identifies annual PM_{10} to TSP ratio summary statistics for copper, and indicates how most of the data (*i.e.*, 6 of 8 years) is normally distributed. The average of the annual 95% UCLM values is 0.56 (or PM_{10} to TSP ratio of 56%). This value is recommended for predicting copper concentrations in PM_{10} based on current TSP data for the HHRA.

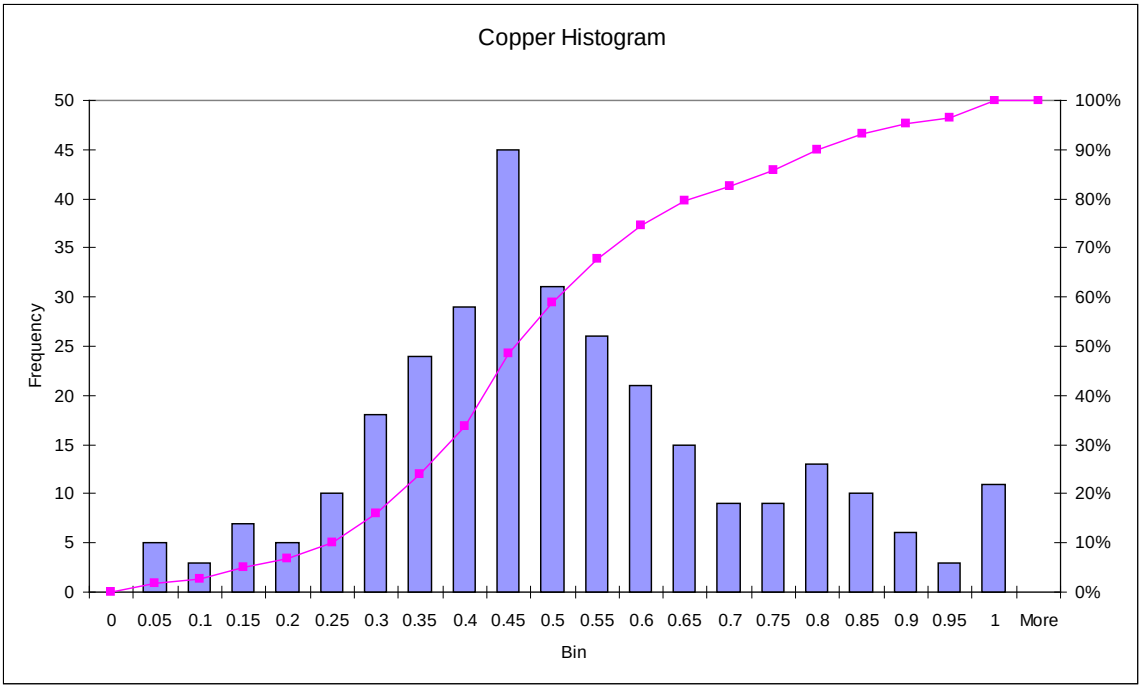

Figure I-8 Histogram of Copper PM10 to TSP Ratios (n=300)

Table I-4 Annualized PM10 to TSP Ratio Summary Statistics for Copper

Years	*Count*	*Min*	*Max*	*Avg*	*StDev*	*CofV*	*95% UCLM*	*Distribution*	*Type*
1991	34	0.02	1.0	0.43	0.22	0.51	0.49	Normal	Student's-t
1992	38	0.03	0.99	0.44	0.20	0.45	0.49	Normal	Student's-t
1993	46	0.16	0.98	0.49	0.21	0.42	0.55	Gamma	Gamma
1994	39	0.09	0.96	0.49	0.19	0.38	0.54	Normal	Student's-t
1995	42	0.05	0.99	0.41	0.20	0.49	0.48	Gamma	Gamma
1996	41	0.04	1.0	0.45	0.20	0.44	0.51	Normal	Student's-t
1997	38	0.35	0.98	0.63	0.16	0.26	0.67	Normal	Student's-t
1998	22	0.43	0.98	0.65	0.19	0.30	0.72	Normal	Student's-t
Average of Annual 95% UCLM Values							**0.56**		

Figure I-9 below outlines the distribution of PM_{10} to TSP ratios for all available cadmium data, which included over 290 unique data points. Table I-5 identifies annual PM_{10} to TSP ratio summary statistics for cadmium, and indicates how a majority of the data (*i.e.*, 5 of 8 years) is normally distributed, with the remaining years non-parametrically distributed. The average of annual 95% UCLM values is 0.90 (or PM_{10} to TSP ratio of 90%). This value is recommended for predicting cadmium concentrations in PM_{10} based on current TSP data for the HHRA.

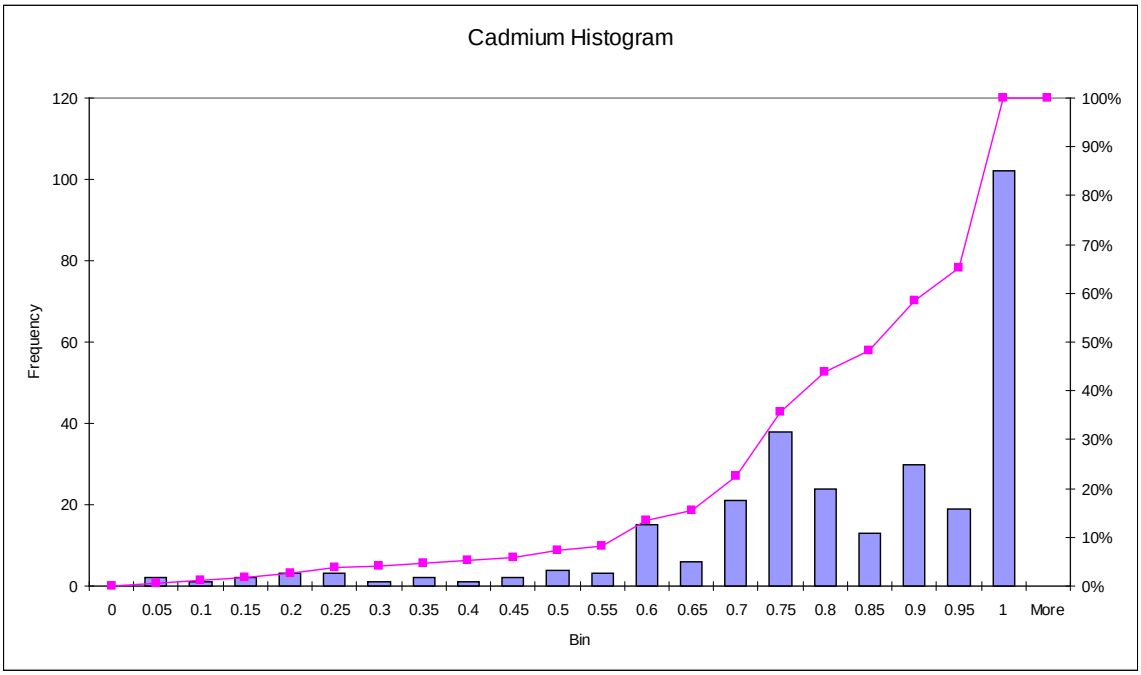

Figure I-9 Histogram of Cadmium PM10 to TSP Ratios (n=292)

Table I-5 Annualized PM10 to TSP Ratio Summary Statistics for Cadmium

Years	*Count*	*Min*	*Max*	*Avg*	*StDev*	*CofV*	*95% UCLM*	*Distribution*	*Type*
1991	38	0.11	1.0	0.76	0.21	0.27	0.81	Normal	Student's-t
1992	36	0.24	1.0	0.81	0.18	0.22	0.86	Normal	Student's-t
1993	43	0.03	1.0	0.78	0.25	0.32	0.94	Non-Parametric	Chebyshev
1994	30	0.19	1.0	0.81	0.20	0.25	0.95	Non-Parametric	Chebyshev
1995	45	0.01	1.0	0.81	0.21	0.25	0.95	Non-Parametric	Chebyshev
1996	39	0.21	1.0	0.86	0.19	0.22	0.91	Normal	Student's-t
1997	30	0.43	1.0	0.87	0.15	0.17	0.91	Normal	Student's-t
1998	31	0.20	1.0	0.81	0.21	0.25	0.88	Normal	Student's-t
Average of Annual 95% UCLM Values							**0.90**		

Figure I-10 below outlines the distribution of PM_{10} to TSP ratios for all available lead data, which included 289 unique data points. Table I-6 identifies annual PM_{10} to TSP ratio summary statistics for lead, and indicates how a majority of the data (*i.e.*, 5 of 8 years) is normally distributed, with only the 1993 and 1995 data being non-parametrically distributed. The average of annual 95% UCLM values is 0.89 (or PM_{10} to TSP ratio of 89%). This value is recommended for predicting lead concentrations in PM_{10} based on current TSP data for the HHRA.

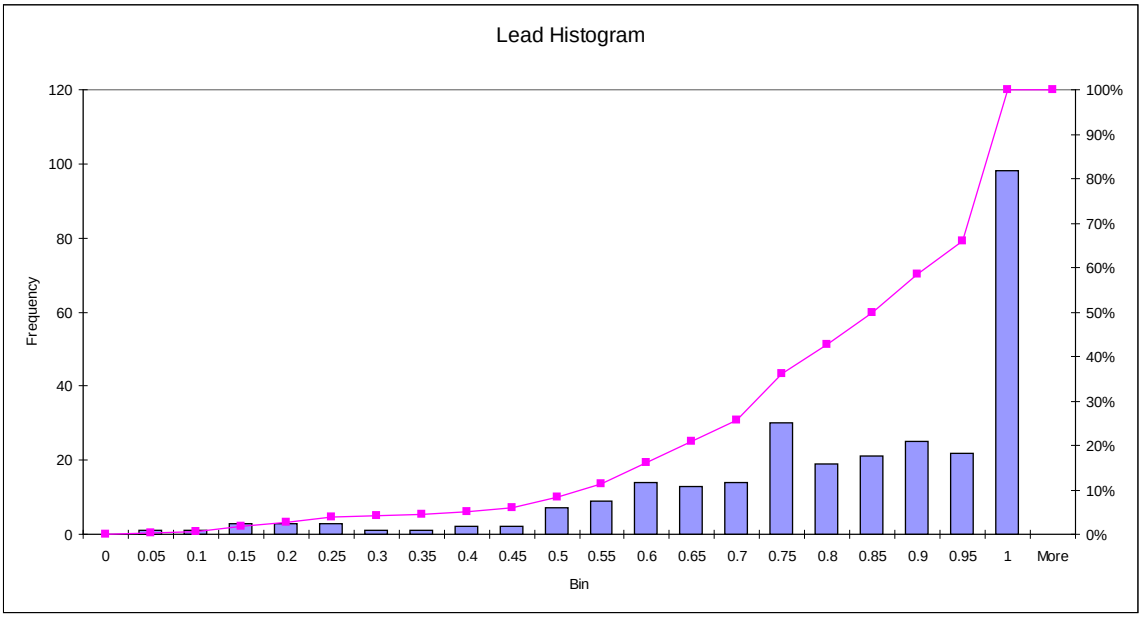

Figure I-10 Histogram of Lead PM10 to TSP Ratios (n=289)

Table I-6 Annualized PM10 to TSP Ratio Summary Statistics for Lead

Years	*Count*	*Min*	*Max*	*Avg*	*StDev*	*CofV*	*95% UCLM*	*Distribution*	*Type*
1991	35	0.11	1.0	0.78	0.22	0.28	0.84	Normal	Student's-t
1992	34	0.21	1.0	0.76	0.21	0.28	0.82	Normal	Student's-t
1993	44	0.08	1.0	0.75	0.25	0.34	0.91	Non-Parametric	Chebyshev
1994	35	0.25	1.0	0.77	0.19	0.25	0.84	Gamma	Gamma
1995	42	0.02	1.0	0.82	0.22	0.27	0.97	Non-Parametric	Chebyshev
1996	38	0.23	1.0	0.87	0.18	0.21	0.92	Normal	Student's-t
1997	30	0.55	1.0	0.88	0.13	0.14	0.92	Normal	Student's-t
1998	31	0.39	1.0	0.81	0.19	0.24	0.87	Normal	Student's-t
Average of Annual 95% UCLM Values							**0.89**		

I-4.0 CONCLUSIONS

To address the unique exposure conditions of residents living in different areas within the Flin Flon-Creighton region, the HHRA will assess exposure and risks in four distinct communities:

- East Flin Flon (designated as the area east and northeast of Ross Lake);
- West Flin Flon (designated as the area west of Ross Lake);
- Channing; and,
- Creighton.

The inhalation exposure assessment will use ambient air data collected from one of three monitoring stations (*i.e.*, Ruth Betts, Creighton School, or the Provincial building) depending on their proximity to the community and their location relative to the predominant wind direction. Based on these factors, air data collected from Ruth Betts will be used to predict exposure point concentrations for East Flin Flon and Channing, air data collected from Creighton School will be used for Creighton, and air data collected from the Provincial building will be used for West Flin Flon. Technological improvements made to the HBMS complex which have resulted in

decreased atmospheric releases support the exclusion of data collected prior to 2002 for the purposes of characterizing current exposure and risk levels. In addition, particulate loading and wind direction criteria used to restrict the analysis of samples collected at Ruth Betts and Creighton School prior to mid-2005 indicate that these data are likely skewed and not representative of long-term ambient air quality. As a result, data collected from these monitors from 2007 and 2008 will be utilized in the HHRA.

Since airborne particulates greater than 10 µm in diameter are not likely to reach the tissues of the lower respiratory system, concentrations of metals associated with the PM_{10} component will be used in the derivation of the exposure point concentrations. Given that air monitors located on the Provincial building currently only collect data associated with TSP, correlation factors were derived using historical data for concurrent PM_{10} and TSP concentrations. These factors will be used to estimate the COC content of PM_{10} using recent TSP measurements collected from monitors on the Provincial building (Table I-7). Since this relationship could only be established for arsenic, cadmium, copper, and lead, concentrations of mercury and selenium in ambient air for the community of West Flin Flon will be based on measurements of content in PM_{10} at Ruth Betts and the Creighton School.

Table I-7 Correlating Factors Used to Predict COC Content of PM10 Based on Concentrations Measured in TSP

Metal	***PM_{10} / TSP Factor***
Arsenic	0.85
Cadmium	0.90
Copper	0.56
Lead	0.89

I-5.0 REFERENCES

Health Canada. 2006. Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). Version 2.0. Contaminated Sites Division. Health Canada. December, 2006.

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