

5.2.1.3 Particulate Matter

For the current sub-bituminous coal being used at the Brandon G.S., the maximum annual average suspended particulate matter (SPM) levels due to Unit #5 emissions are predicted to be $0.03 \mu\text{g}/\text{m}^3$ for OS2 and $0.02 \mu\text{g}/\text{m}^3$ for OS1. This represents less than 0.05% of the Manitoba Maximum Acceptable Objective of $70 \mu\text{g}/\text{m}^3$. On a 24-hour average basis, the maximum predicted concentration is $0.8 \mu\text{g}/\text{m}^3$ for OS2, and $0.5 \mu\text{g}/\text{m}^3$ for OS1. This is less than 1% of the provincial objective of $120 \mu\text{g}/\text{m}^3$.

Future sources of coal supply for the Brandon G.S. may have higher ash content than that which is currently burned at the plant. Based on an evaluation of 11 candidate coal mines that could be used to supply the plant, the highest ash content could be up to 35% higher than at present. Use of coal from this source (coal mine G, Table 3.4) could potentially increase the maximum predicted 24-hour average SPM concentration to $1.1 \mu\text{g}/\text{m}^3$ for OS3, which is still less than 1% of the provincial objective level.

Particulate Matter (PM_{10})

The maximum predicted 24-hour average PM_{10} concentrations due to Unit #5 emissions are shown in Figure 5.14. The maximum predicted level of $0.8 \text{g}/\text{m}^3$ for OS2 occurs close to the Brandon G.S. (see Figure 5.1), similar to the situation with exhaust gas concentrations (NO_2 & SO_2). The maximum concentration value is similar in magnitude to that for SPM, since the majority of emitted particulate matter from the stack is of the smaller size fractions. The predicted maximum is less than 2% of the Manitoba guideline value of $50 \mu\text{g}/\text{m}^3$. The predicted PM_{10} concentrations for OS1 are not shown. However, the maximum predicted 24-hour average PM_{10} concentration is lower than for OS2 at only $0.5 \mu\text{g}/\text{m}^3$, or 1% of the provincial guideline. For future operations with coal having up to 35% higher ash content, the maximum predicted 24-hour average PM_{10} concentration could increase to $1.1 \mu\text{g}/\text{m}^3$ for OS3.

Particulate Matter ($PM_{2.5}$)

Maximum predicted 24-hour average $PM_{2.5}$ concentrations for OS2 are provided in Figure 5.15. Although the predicted concentrations for OS2 would be approximately 57% higher than the values indicated in Figure 5.15, the absolute values for predicted concentrations of $PM_{2.5}$ under OS2 are still very low in comparison with ambient air quality criteria. Specifically, the CWS for $PM_{2.5}$ of $30 \mu\text{g}/\text{m}^3$ is based on the 98th percentile value, averaged over three consecutive years, with attainment of the CWS by the year 2010. However, Manitoba Conservation uses a value of $30 \mu\text{g}/\text{m}^3$ (24-hour average) when evaluating permit applications for major sources.

The maximum ground-level PM_{2.5} concentration due to Unit #5 emissions is predicted to occur near the Brandon G.S. (see Figure 5.1). For OS2, the maximum 24-hour average PM_{2.5} concentration is estimated at 0.5 µg/m³, compared with 0.3 µg/m³ for the preferred OS1 operating scenario. These values represent 1.7% and 1.0% of the criteria value used by Manitoba Conservation for permitting purposes. For future operations with coal having up to 35% higher ash content, the maximum predicted 24-hour average PM₁₀ concentrations could increase to 0.6 µg/m³ for OS3.

It should be noted that ambient air quality PM_{2.5} monitors are not capable of accurately measuring such small impacts. For example, the practical error limit range for reference method, filter-based, gravimetric PM₁₀ samplers is considered to be 5 µg/m³ at ambient concentrations of ≤100 µg/m³ (24-hour average). Studies of collocated continuous PM₁₀ sampling instruments have reported a precision of ±2.8 µg/m³ for hourly averaged PM₁₀ concentrations. Consequently, predicted incremental 24-hour average PM_{2.5} and PM₁₀ of less than 1 µg/m³ are generally acknowledged to be below the practical detection limit of available particulate matter monitors. This means that PM_{2.5} concentrations measured at a hypothetical monitoring station located at the maximum point of impingement of the plume from the Unit #5 exhaust stack would be indistinguishable with or without the emissions from the Brandon G.S.

Figure 5.14
Maximum Predicted Incremental 24-hour Average PM₁₀ Concentrations (µg/m³)
due to Unit #5 Emissions
(Operating Scenario OS2)

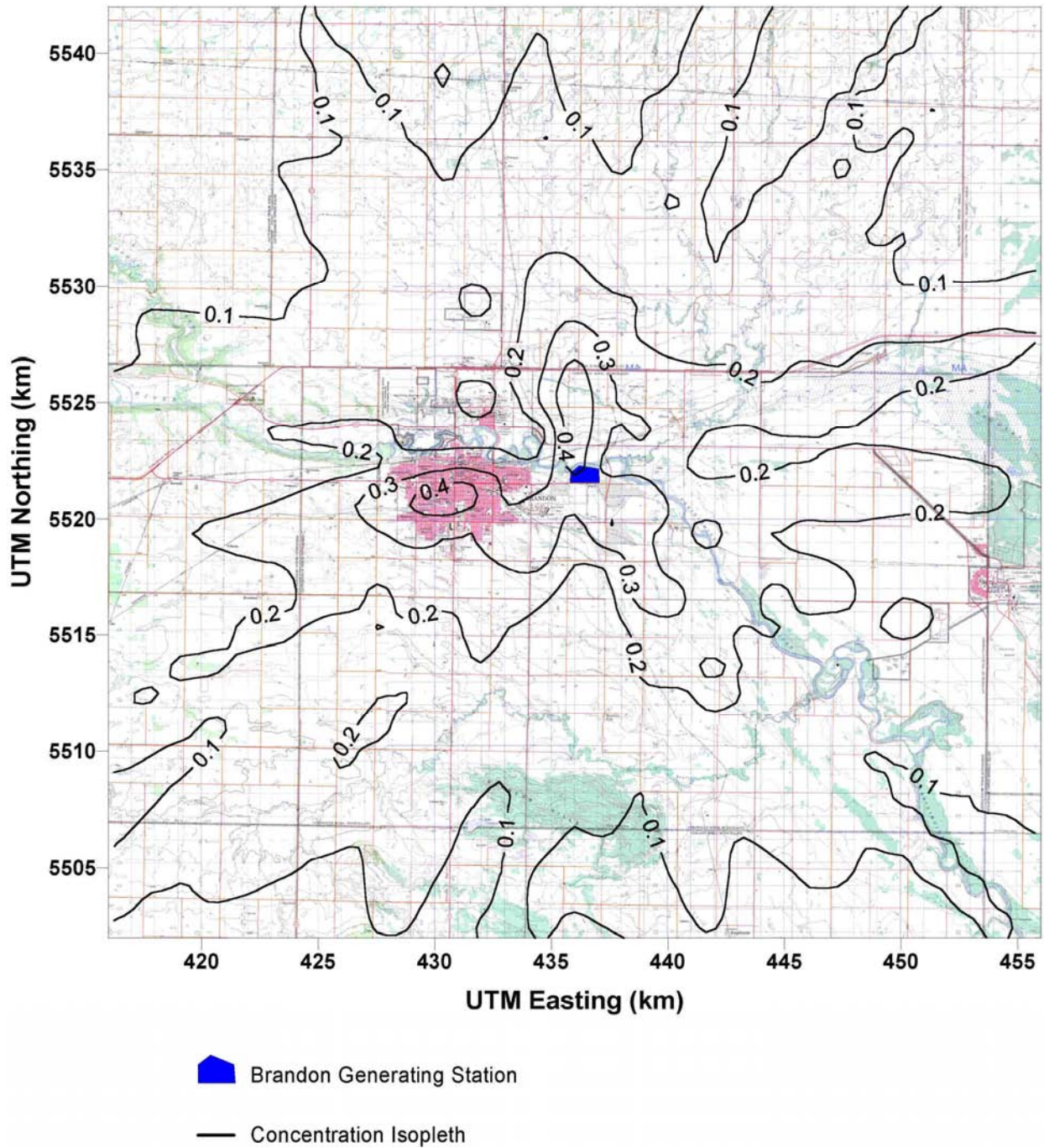
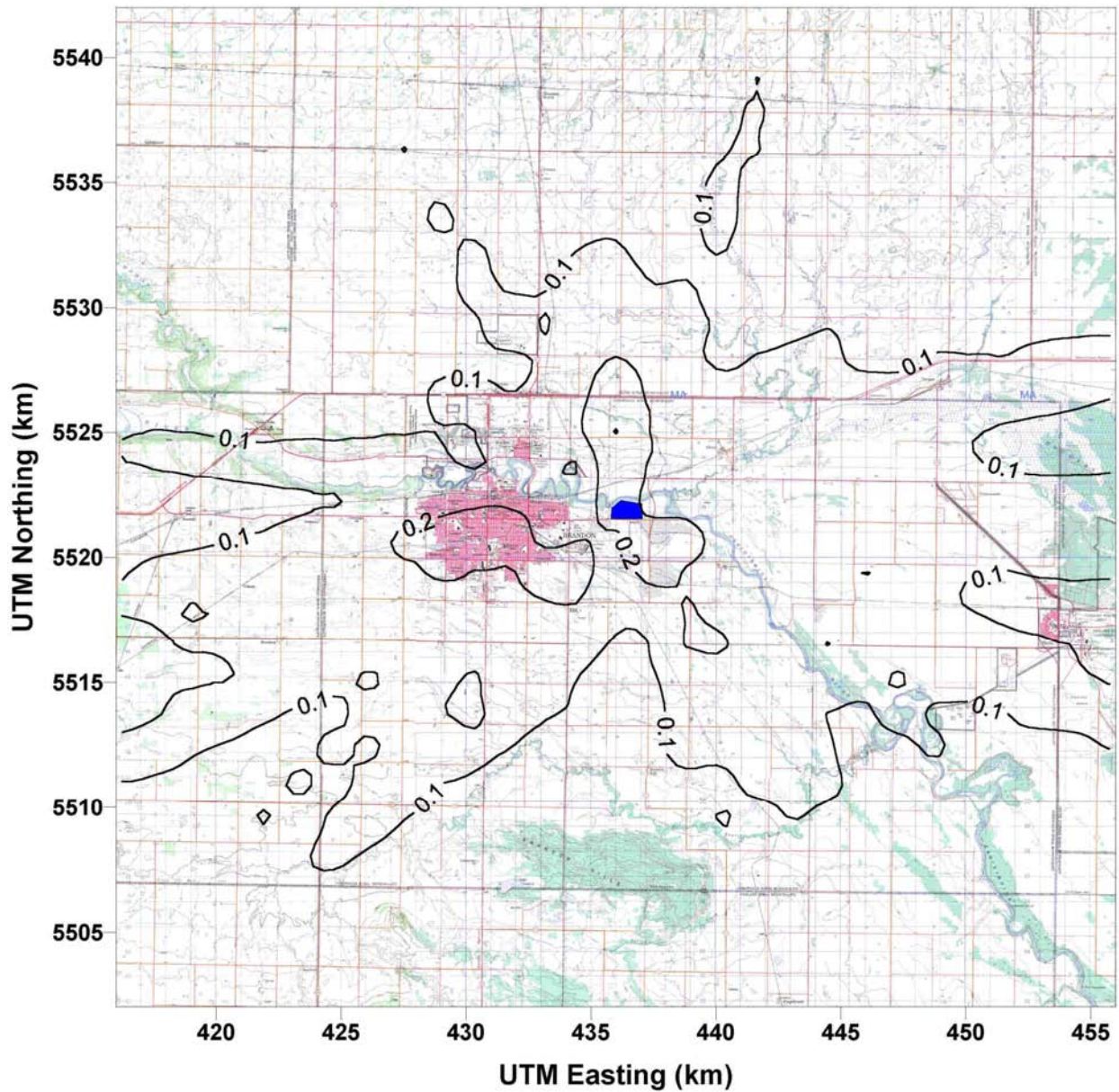


Figure 5.15
Maximum Predicted Incremental 24-hour Average PM_{2.5} Concentrations (µg/m³)
due to Unit #5 Emissions
(Operating Scenario OS1)



 Brandon Generating Station

 Concentration Isopleth

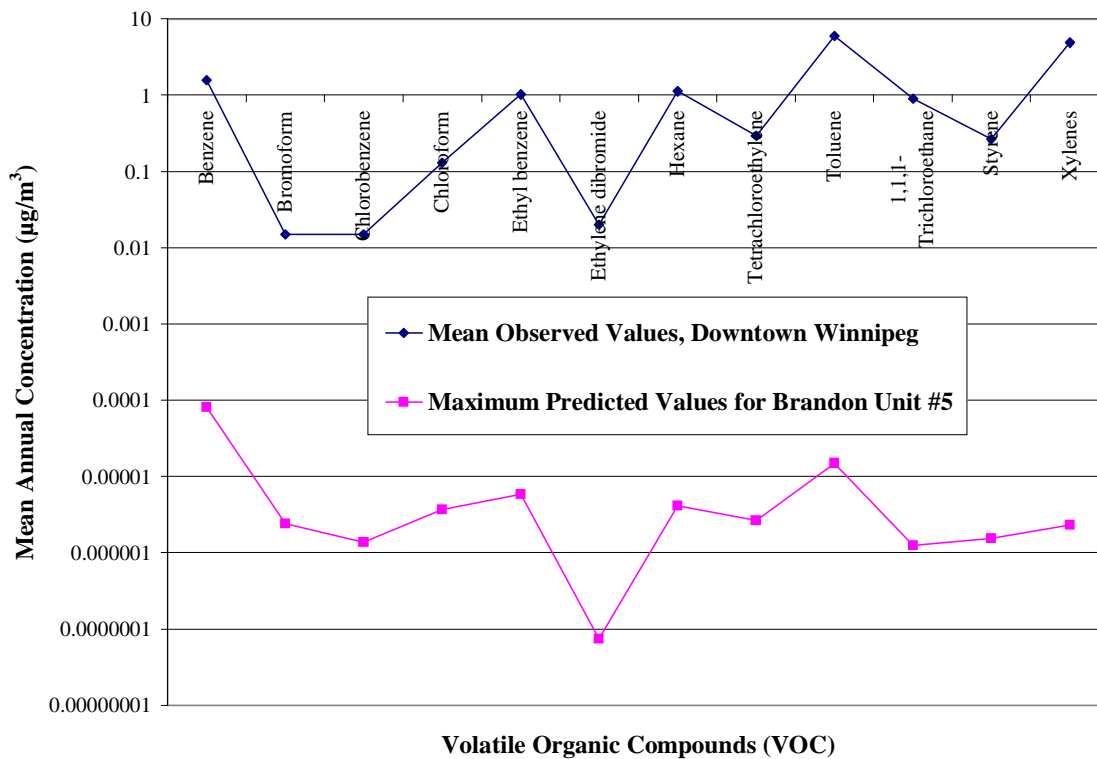
Canada Wide Standard: 30 ug/m3

5.2.2 Volatile Organic Compounds (VOCs)

Table 5.3 lists the annual average concentration for 42 VOCs that are likely to be emitted from the Unit #5 stack. Maximum predicted 1-hour and 24-hour averages are listed only for those compounds that are compared to ambient air quality criteria listed in Tables 5.1 and 5.2. The predicted concentrations for VOCs that have defined criteria are far below any applicable standards, guidelines or objectives. For example, the maximum predicted 1-hour average concentrations for benzene and formaldehyde are 0.1% and 0.01% of the ambient air quality criteria listed in Table 5.4. Similarly, the maximum 24-hour average concentration for toluene is 0.00002% of the limit adopted by the Province of Ontario.

VOC levels have not been measured in Brandon. Figure 5.16 provides a comparison between selected VOCs that have been measured in downtown Winnipeg (Station 9119) in 1995-96 with the maximum predicted annual average concentrations due to emissions from the Brandon G.S. The levels associated with the Unit #5 emissions are typically 4-5 orders of magnitude (i.e., 10,000 to 100,000 times) lower than levels observed in Winnipeg.

Figure 5.16: Maximum Predicted Incremental Mean Annual VOC Concentrations From Brandon G.S. versus Annual Mean Observed Levels in Downtown Winnipeg

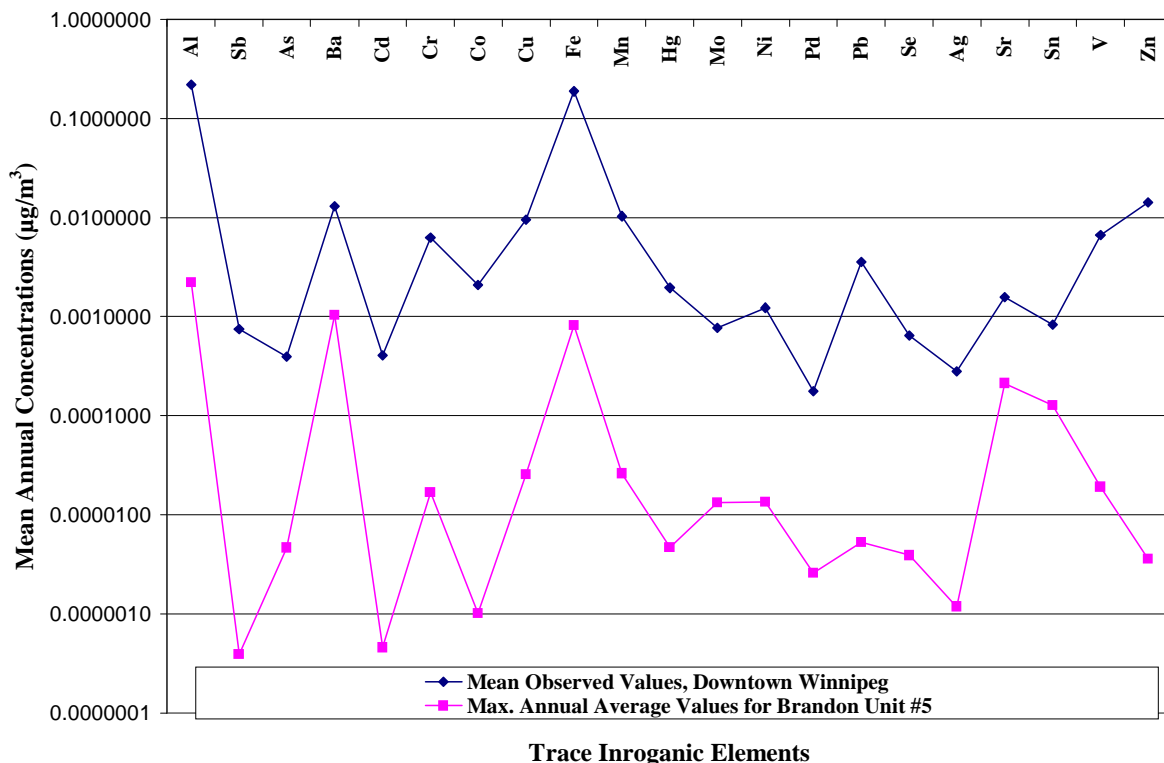


5.2.3 Trace Inorganics

As with the VOCs, Table 5.3 lists the annual average concentrations for the 27 trace inorganic elements emitted from the Brandon G.S. during Unit #5 operation under the OS2 operating scenario. Maximum predicted 1-hour and 24-hour averages are listed only for those elements with ambient air quality criteria listed in Tables 5.1 and 5.2. Table 5.4b shows that predicted maximum concentrations for all of the trace inorganic elements are insignificant when compared with established ambient air quality criteria in Manitoba, Ontario and/or Alberta. Maximum concentrations range from 0.6% of the criteria (1-hour average for chromium) down to as low as 0.0001% (24-hour average for zinc).

Trace element concentrations in particulate matter have not been measured in Brandon. Figure 5.17 provides a comparison between selected trace elements that have been measured in downtown Winnipeg (Station 70119) in 2004 and the maximum predicted annual average concentrations due to emissions from the Brandon G.S. based on OS3 emissions. For all elements except strontium (Sr) and tin (Sn), the maximum predicted levels associated with the Unit #5 emissions are a factor 10 or more lower than levels observed in Winnipeg.

Figure 5.17: Maximum Predicted Incremental Mean Annual Trace Element Concentrations from Brandon G.S. versus Annual Mean Observed Levels Winnipeg



5.2.4 Trace Organics

Table 5.3 lists the annual average concentration for trace organic compounds (i.e., PAH, dioxins and furans) emitted from the Brandon G.S. during operation at full capacity. The only trace organic with an established 24-hour average ambient air quality criterion is naphthalene. The maximum predicted 24-hour average concentration due to emissions from Unit #5 is 0.0006 $\mu\text{g}/\text{m}^3$, which represents 0.003% of the criterion adopted by Ontario (see Table 5.4b). Potential health risks from any of the other trace organic compounds are evaluated in the health risk assessment (Appendix N).

PAH levels have not been measured in Brandon. Figure 5.18 compares the maximum predicted annual average PAH concentrations due to emissions from Brandon G.S. Unit #5 under OS3 for each of the compounds with mean annual concentrations measured in downtown Winnipeg in 1995-96. Maximum predicted concentrations for all PAHs are about six to eight orders of magnitude (i.e., one million to one hundred million times) lower than those observed in Winnipeg. Similarly, Figure 5.19 shows that the maximum predicted annual average dioxin and furan concentrations due to emissions from Unit #5 under OS3 for each of the compounds with mean annual concentrations measured in downtown Winnipeg in 1995-96. The levels associated with emissions from the Unit #5 stack are typically nine to ten orders of magnitude (i.e., one billion to 100 billion) times lower than levels observed in Winnipeg.

Figure 5.18: Maximum Predicted Incremental Mean Annual PAH Concentrations From Brandon G.S. versus Mean Annual Observed Levels in Downtown Winnipeg

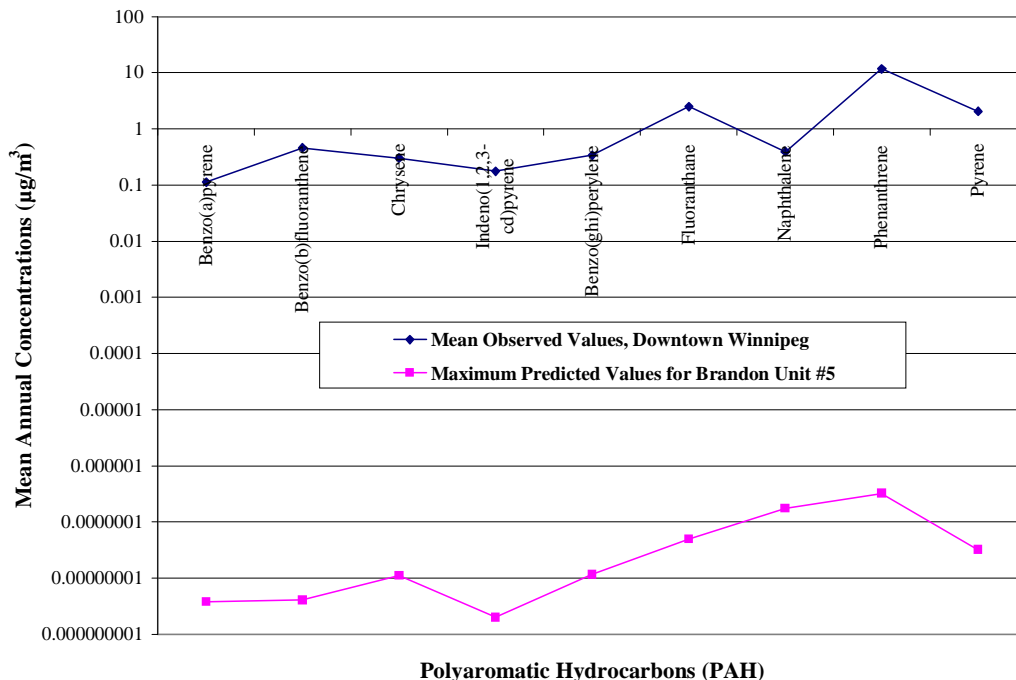
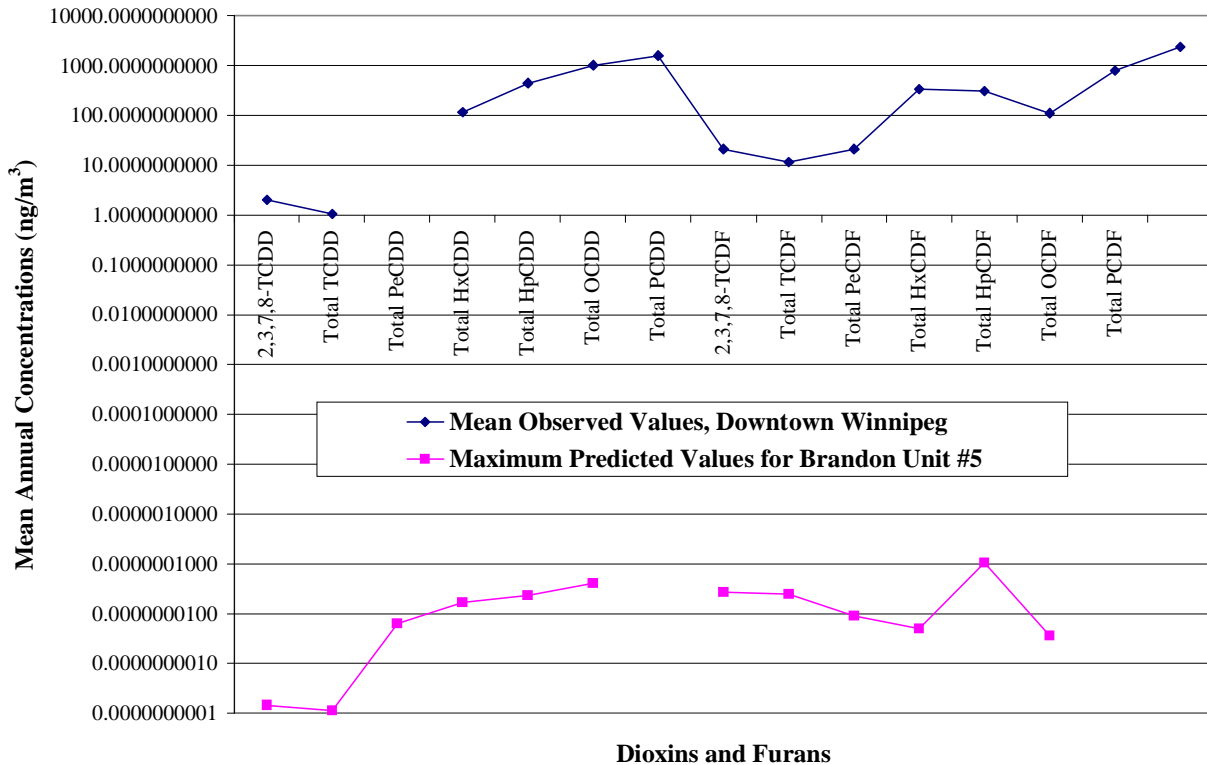


Figure 5.19:
**Maximum Predicted Incremental Mean Annual Dioxin/Furan Concentrations ($\mu\text{g}/\text{m}^3$)
From Brandon G.S. Unit #5 Versus Mean Annual Observed Levels
in Downtown Winnipeg**



Data for a limited number of PAHs and dioxins/furans are also available for Estevan, Saskatchewan for the period 1994-1997 (Environment Canada 1998). Estevan is a smaller community than Winnipeg, and the levels measured in Estevan may be more representative of levels likely to be encountered in Brandon.

Table 5.8 lists the maximum annual average concentrations due to Unit #5 emissions at the upper bound emission estimates (OS3) and the mean concentrations measured in Estevan. The comparison indicates that the maximum predicted mean annual concentrations of the three PAHs emitted by the Brandon G.S. are from 4 to 5 orders of magnitude (10,000 to 100,000 times) lower than levels mean levels observed in Estevan. Similarly, the maximum total annual average concentration of furans due to emission from the Unit #5 stack are at least 200 times lower than the individual concentrations of either of the two furan isomers recorded in Estevan.

**Table 5.8
Comparison Between Predicted Incremental Concentrations of Selected Trace Organics
in Brandon and Observed Concentrations in Estevan, SK**

Compound	Mean Concentration ($\mu\text{g}/\text{m}^3$)	
	Brandon (Predicted due to Unit #5)	Estevan (Observed 1994-1997)
Benzo(a)pyrene	3.80E-9	3.00E-5
Benzo(b)fluoranthene	4.10E-9	1.5E-4
Indeno(1,2,3-cd)pyrene	2.10E-9	9.00E-5
Total TCDF	2.67E-11	N/A
2,3,7,8-TCDF	N/A	9.8E-9
2,3,4,7,8-P ₅ CDF	2.44E-11	5.1E-9

N/A – not available

5.3 DEPOSITION DUE TO UNIT #5 EMISSIONS

5.3.1 Trace Inorganic Elements and Organic Compounds

Table 5.9 lists the maximum predicted rates of wet and dry deposition of trace inorganic elements and organic compounds due to coal combustion at the Brandon G.S. for the OS3 operating scenario. Predicted deposition amounts at selected discrete receptor locations were used in the assessment of human health and ecological risks (see Appendix N).

The deposition rates are calculated with the assumption that Unit #5 operates at full capacity (105 MW) throughout the year. As previously discussed, this is not realistic and therefore the deposition estimates are likely over-stated. Wet deposition occurs only on those days with precipitation, whereas dry deposition occurs every day of the year. The maximum rate of wet deposition is predicted to occur very close to the southern property line of the Brandon G.S., whereas the maximum dry deposition occurs at a distance of 5-6 km to the south-southwest of the plant.

The annual average deposition rate for trace inorganic constituents of particulate matter emissions were prorated to the total amount of particulate matter deposition (SPM) based on the relative concentration of each in the coal supply. Since the emission rate of PAH, dioxins and furans was based on emission factors for bituminous and sub-bituminous coal combustion, the emission rate is not directly related to any specific quality of the coal burned in the boiler. However, in order to account for the potentially higher ash content in coals that might be burned at the Brandon G.S. in future, the particulate matter emission rate and predicted maximum future concentrations and deposition rates of all trace organics (PAHs, dioxins and furans) were increased by 35%.

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Table 5.9: Annual Average Deposition

Pollutant	Maximum Emission Rate (g/s)	OS3 Annual Average Deposition Rate (mg/m ² /yr)		
	OS3	dry	wet	Total
Trace Inorganic Elements				
Aluminium	3.01E-01	1.23E+00	4.71E+00	5.95E+00
Antimony	5.25E-05	2.15E-04	8.23E-04	1.04E-03
Arsenic	6.25E-04	2.56E-03	9.79E-03	1.23E-02
Barium	1.41E-01	5.76E-01	2.20E+00	2.78E+00
Beryllium	7.78E-05	3.19E-04	1.22E-03	1.54E-03
Boron	2.40E-02	9.84E-02	3.76E-01	4.75E-01
Cadmium	6.17E-05	2.53E-04	9.67E-04	1.22E-03
Chromium	2.26E-03	9.28E-03	3.55E-02	4.47E-02
Cobalt	1.36E-04	5.59E-04	2.14E-03	2.69E-03
Copper	3.45E-03	1.41E-02	5.41E-02	6.82E-02
Iron	1.11E-01	4.54E-01	1.74E+00	2.19E+00
Lithium	2.45E-03	1.00E-02	3.84E-02	4.84E-02
Manganese	3.51E-03	1.44E-02	5.50E-02	6.94E-02
Molybdenum	1.78E-03	7.30E-03	2.79E-02	3.52E-02
Nickel	1.82E-03	7.45E-03	2.85E-02	3.60E-02
Palladium	3.50E-04	1.43E-03	5.49E-03	6.92E-03
Lead	7.12E-04	2.92E-03	1.12E-02	1.41E-02
Selenium	5.25E-04	2.15E-03	8.22E-03	1.04E-02
Silver	1.59E-04	6.52E-04	2.49E-03	3.14E-03
Strontium	2.86E-02	1.17E-01	4.48E-01	5.65E-01
Thallium	1.63E-03	6.66E-03	2.55E-02	3.21E-02
Thorium	5.69E-04	2.33E-03	8.92E-03	1.13E-02
Tin	1.70E-02	6.99E-02	2.67E-01	3.37E-01
Uranium	8.98E-05	3.68E-04	1.41E-03	1.78E-03
Vanadium	2.58E-03	1.06E-02	4.04E-02	5.10E-02
Zinc	4.83E-04	1.98E-03	7.57E-03	9.55E-03
Trace Organics (PAHs)				
Acenaphthene	5.67E-05	2.32E-04	8.89E-04	1.12E-03
Acenaphthylene	3.94E-07	1.61E-06	6.17E-06	7.79E-06
Anthracene	2.48E-06	1.02E-05	3.89E-05	4.90E-05
Benzo(a)anthracene	3.54E-07	1.45E-06	5.55E-06	7.01E-06
Benzo(b)anthracene	5.91E-07	2.42E-06	9.26E-06	1.17E-05
Benzo(b)fluoranthene	5.51E-07	2.26E-06	8.64E-06	1.09E-05
Benzo(k,j)fluoranthene	6.69E-07	2.74E-06	1.05E-05	1.32E-05
Benzo(a)flourene	8.66E-07	3.55E-06	1.36E-05	1.71E-05
Benzo(b)flourene	1.97E-07	8.07E-07	3.09E-06	3.89E-06
Benzo(g,h,i)perylene	1.58E-06	6.46E-06	2.47E-05	3.11E-05
Benzo(a)pyrene	5.12E-07	2.10E-06	8.02E-06	1.01E-05

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Pollutant	Maximum Emission Rate (g/s)	OS3 Annual Average Deposition Rate (mg/m ² /yr)		
	OS3	dry	wet	Total
Benzo(e)pyrene	2.28E-06	9.36E-06	3.58E-05	4.52E-05
Biphenyl	2.68E-05	1.10E-04	4.20E-04	5.29E-04
2-chloronaphthalene	8.27E-08	3.39E-07	1.30E-06	1.63E-06
Coronene	9.45E-07	3.87E-06	1.48E-05	1.87E-05
Dibenzo(a,c & a,h)anthracene	2.87E-08	1.18E-07	4.51E-07	5.68E-07
Dibenzo(a,j)acridine	1.42E-08	5.81E-08	2.22E-07	2.80E-07
7H-dibenzo(c,g)carbazole	2.21E-08	9.04E-08	3.46E-07	4.36E-07
Dibenzo(a,e)pyrene	3.94E-09	1.61E-08	6.17E-08	7.79E-08
Dibenzo(a,i)pyrene	5.12E-09	2.10E-08	8.02E-08	1.01E-07
9,10-dimethylantracene	2.17E-07	8.88E-07	3.39E-06	4.28E-06
7,12-dimethylantracene	6.69E-08	2.74E-07	1.05E-06	1.32E-06
1,2-dimethylnaphthalene	3.35E-07	1.37E-06	5.25E-06	6.62E-06
2,6 & 2,7-dimethylnaphthalene	1.30E-06	5.33E-06	2.04E-05	2.57E-05
Fluoranthene	6.69E-06	2.74E-05	1.05E-04	1.32E-04
Fluorene	7.88E-06	3.23E-05	1.23E-04	1.56E-04
Indeno(1,2,3-cd)pyrene	2.72E-07	1.11E-06	4.26E-06	5.37E-06
2-methylantracene	4.33E-07	1.78E-06	6.79E-06	8.56E-06
3-methylcholanthrene	1.18E-06	4.84E-06	1.85E-05	2.34E-05
1-methylnaphthalene	7.88E-06	3.23E-05	1.23E-04	1.56E-04
2-methylnaphthalene	1.18E-05	4.84E-05	1.85E-04	2.34E-04
1-methylphenanthrene	3.27E-06	1.34E-05	5.12E-05	6.46E-05
9-methylphenanthrene	2.91E-06	1.19E-05	4.57E-05	5.76E-05
Naphthalene	2.36E-05	9.69E-05	3.70E-04	4.67E-04
Perylene	1.61E-07	6.62E-07	2.53E-06	3.19E-06
Phenanthrene	4.33E-05	1.78E-04	6.79E-04	8.56E-04
Picene	2.64E-08	1.08E-07	4.13E-07	5.22E-07
Pyrene	4.33E-06	1.78E-05	6.79E-05	8.56E-05
Quinoline	3.27E-07	1.34E-06	5.12E-06	6.46E-06
m-Terphenyl	1.14E-06	4.68E-06	1.79E-05	2.26E-05
o-Terphenyl	1.81E-06	7.43E-06	2.84E-05	3.58E-05
p-Terphenyl	5.91E-07	2.42E-06	9.26E-06	1.17E-05
Tetralin	2.56E-06	1.05E-05	4.01E-05	5.06E-05
Triphenylene/chrysene	1.50E-06	6.13E-06	2.35E-05	2.96E-05
Tetrachlorodibenzo-p-dioxins	1.95E-11	5.91E-11	2.26E-10	2.85E-10
Pentachlorodibenzo-p-dioxins	1.53E-11	4.64E-11	1.77E-10	2.24E-10
Hexachlorodibenzo-p-dioxins	8.48E-10	2.57E-09	9.84E-09	1.24E-08
Heptachlorodibenzo-p-dioxins	2.27E-09	6.88E-09	2.63E-08	3.32E-08
Octachlorodibenzo-p-dioxins	3.18E-09	9.66E-09	3.69E-08	4.66E-08
Total Dioxins	5.49E-09	1.67E-08	6.37E-08	8.04E-08
Tetrachlorodibenzofurans	3.60E-09	1.09E-08	4.18E-08	5.27E-08

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Pollutant	Maximum Emission Rate (g/s)	OS3 Annual Average Deposition Rate (mg/m ² /yr)		
	OS3	dry	wet	Total
Pentachlorodibenzofurans	3.28E-09	9.96E-09	3.81E-08	4.80E-08
Hexachlorodibenzofurans	1.21E-09	3.67E-09	1.40E-08	1.77E-08
Heptachlorodibenzofurans	6.67E-10	2.03E-09	7.74E-09	9.77E-09
Octachlorodibenzofurans	1.43E-08	4.35E-08	1.66E-07	2.10E-07
Total Furans	4.86E-10	1.48E-09	5.65E-09	7.12E-09

As indicated in Table 5.9, nearly 80% of the trace constituents emitted from the Unit #5 stack are deposited as a result of precipitation events (i.e., wet deposition). The year 2003 that was considered in the modelling analysis was a relatively dry year, with total precipitation of only 334 mm, compared to the climate normal of 472 mm for the period 1971-2000. Therefore, wet deposition in Table 5.9 may underestimate total annual average wet deposition rates by about 40%, and total deposition (wet plus dry) may be underestimated by about 32%. On the other hand, the deposition rates listed in Table 5.9 assume that the Brandon G.S. operates all 8760 hours per year at 100% capacity factor, using the least efficient ABC burner row configuration for OS2 and OS3. The latter assumption would tend to overestimate particulate matter emission by 57% over the more typical OS1 emissions, while the deposition for OS3 further assumes that particulate emissions, and their associated trace constituents, are higher due to the use of alternative coal suppliers. As indicated in Table 1.1, over the most recent 5 year period (2000-2001), the plant operated at an average capacity factor of 47%, with the highest operations only reaching 69% C.F. Therefore, on balance, the underestimation of deposition rates in Table 5.9 are more than offset by the overestimation of emissions from the use of conservative assumption about the operation of the plant.

5.3.2 Mercury

As a toxic trace element that is to be regulated through Canada-Wide Standards, mercury emissions are a priority air issue. A separate deposition analysis was conducted for mercury because this trace element is emitted in both a gaseous and a particle-bound phase, and the amount of mercury deposited depends on the amount emitted in each phase. The results of the mercury deposition analysis are summarized for the sensitive receptor locations and at the point of maximum deposition in Table 5.10. All of the mercury deposition is based on a maximum annual emission cap of 20 kg/year. (The 20 kg/year value represents Manitoba's cap on existing coal-fired electric power generation (EPG) plants commencing in the year 2010 as part of the Canada-wide Standard (CWS) proposed by the Canadian Council of Ministers of the Environment.)

**Table 5.10
Maximum Predicted Incremental Annual Mercury Deposition Rates ($\mu\text{g}/\text{m}^2$)**

Mercury Species	Wet Deposition	Dry Deposition	Total Deposition
Elemental (gaseous)	0.01	0.08	0.09
Oxidized (gaseous)	0.86	0.49	1.34
Particle-bound	0.01	0.001	0.01
Total	0.88	0.57	1.45

Figure 5.20 shows that the maximum total mercury deposition at the maximum point of impingement is predicted to be $1.45 \mu\text{g}/\text{m}^2$ per year. Approximately 60% of the total deposition is attributable to wet deposition of oxidized mercury, while 92% of the total mercury deposition (wet + dry) is attributable to oxidized mercury even though oxidized mercury makes up less than 12% of the total mercury emitted from the Unit #5 stack. Therefore, the vast majority of the mercury emitted from the Brandon G.S. is transported well beyond the immediate vicinity of the plant.

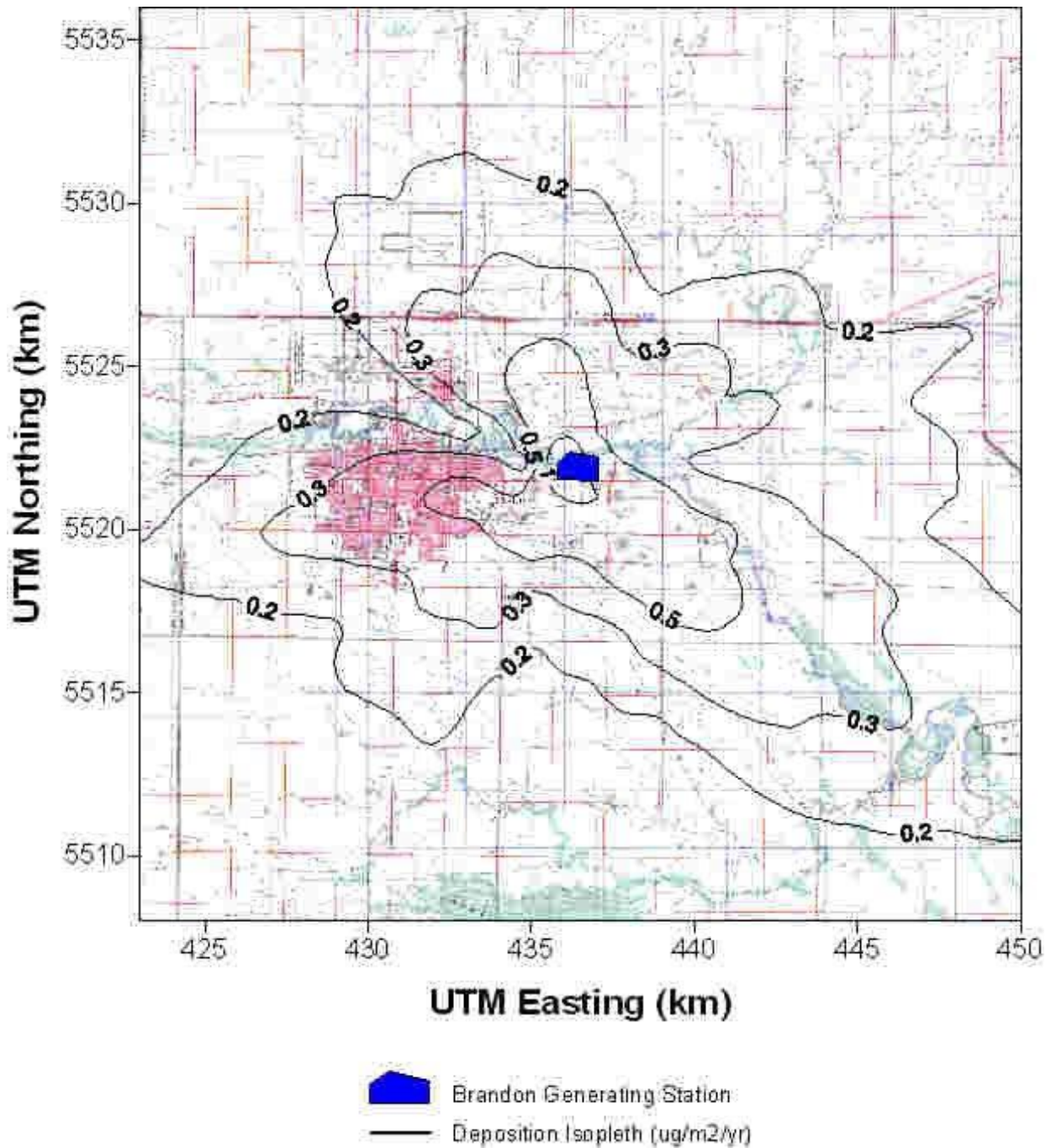
Table 5.11 lists the maximum annual mercury deposition rate at the eleven sensitive receptor locations selected for human health and ecological risk assessment. As can be seen from the table, mercury deposition rates from emissions at the Brandon G.S. are much lower than at the maximum point of impingement. In residential areas and at schools in the area, the maximum deposition rates are less than $0.5 \mu\text{g}/\text{m}^2$ per year.

**Table 5.11
Maximum Predicted Incremental Annual Mercury Deposition Rates ($\mu\text{g}/\text{m}^2$)
at Sensitive Receptor Locations**

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
0.47	0.22	0.34	0.31	0.36	0.42	0.39	0.24	0.14	0.08	0.18

For the modelling domain depicted in Figure 5.20, the area averaged mercury deposition rate is $0.21 \mu\text{g}/\text{m}^2$ per year. By comparison, the area averaged deposition rate from all global sources (natural and anthropogenic) in the region around the northern boundary of Minnesota/North Dakota and the southern boundary of Manitoba has been estimated to be about $5\text{-}10 \mu\text{g}/\text{m}^2$ per year (Seigneur et al 2004). Therefore, at an emission rate of 20 kg/year, the contribution of emissions from the Brandon G.S. to total mercury deposition in the area surrounding the plant represents approximately 2-4% of the total mercury deposition from all continental and other global sources.

Figure 5.20
Maximum Predicted Incremental Annual Average Mercury Deposition Rate ($\mu\text{g}/\text{m}^2$)
(based on emission cap of 20 kg/year)



5.4 FUGITIVE DUST EMISSIONS FROM COAL STORAGE PILE AND ASH LAGOON

5.4.1 Fugitive Dust Concentrations

Fugitive dust emissions occur from coal handling operations such as unloading the coal trains and transferring coal from a storage pile to the generating station and from suspension of material due to wind erosion. Coal dust from fugitive sources behaves very differently in the atmosphere compared to combustion-related particulate matter emitted from an elevated stack. Emissions originate at or near ground level, and as such air concentrations immediately surrounding the source(s) tend to be higher than points further away. In addition, fugitive dust is composed of larger particulate size fractions than combustion particulate, causing settling of the dust (deposition) to occur relatively close to the Brandon G.S.

Due to a much higher disturbance rate of the coal storage piles (by both human activities and wind), air concentrations due to fugitive dust from the storage piles tend to be much higher than those due to the ash lagoon. As discussed in Chapter 3, much of the fugitive coal dust emissions occur during infrequent gusts of relatively high wind speeds.

Maximum off-site ambient air concentrations of particulate matter due to fugitive dust emissions from the ash lagoon and coal handling area are provided in Table 5.12. Air concentrations due to emissions from the ash lagoon are relatively small and not problematic either on- or off-site. Short-term air concentrations due to coal handling and storage are considerably higher, but on their own do not exceed the Manitoba 24-hour criteria of 120 µg/m³ (SPM), the PM₁₀ 24-hour criteria held in other provinces of 50 µg/m³, or the Canada Wide Standard for PM_{2.5} of 30 µg/m³ (98th percentile).

**Table 5.12
Maximum Predicted Incremental Off-site Air Concentrations (µg/m³) of Particulate Matter
Due to Fugitive Dust Emissions**

Particulate Matter Fraction	Ambient Air Quality Criteria		Coal Storage and Handling		Ash Lagoon	
	24-hour Average	Annual Average	24-hour Maximum	Annual Average	24-hour Maximum	Annual Average
SPM	120	70	105	0.5	8	1.3
PM ₁₀	50	N/A	26	0.2	7	0.3
PM _{2.5}	30	N/A	15	0.1	1	0.1

Note: background concentrations not included
N/A – not applicable

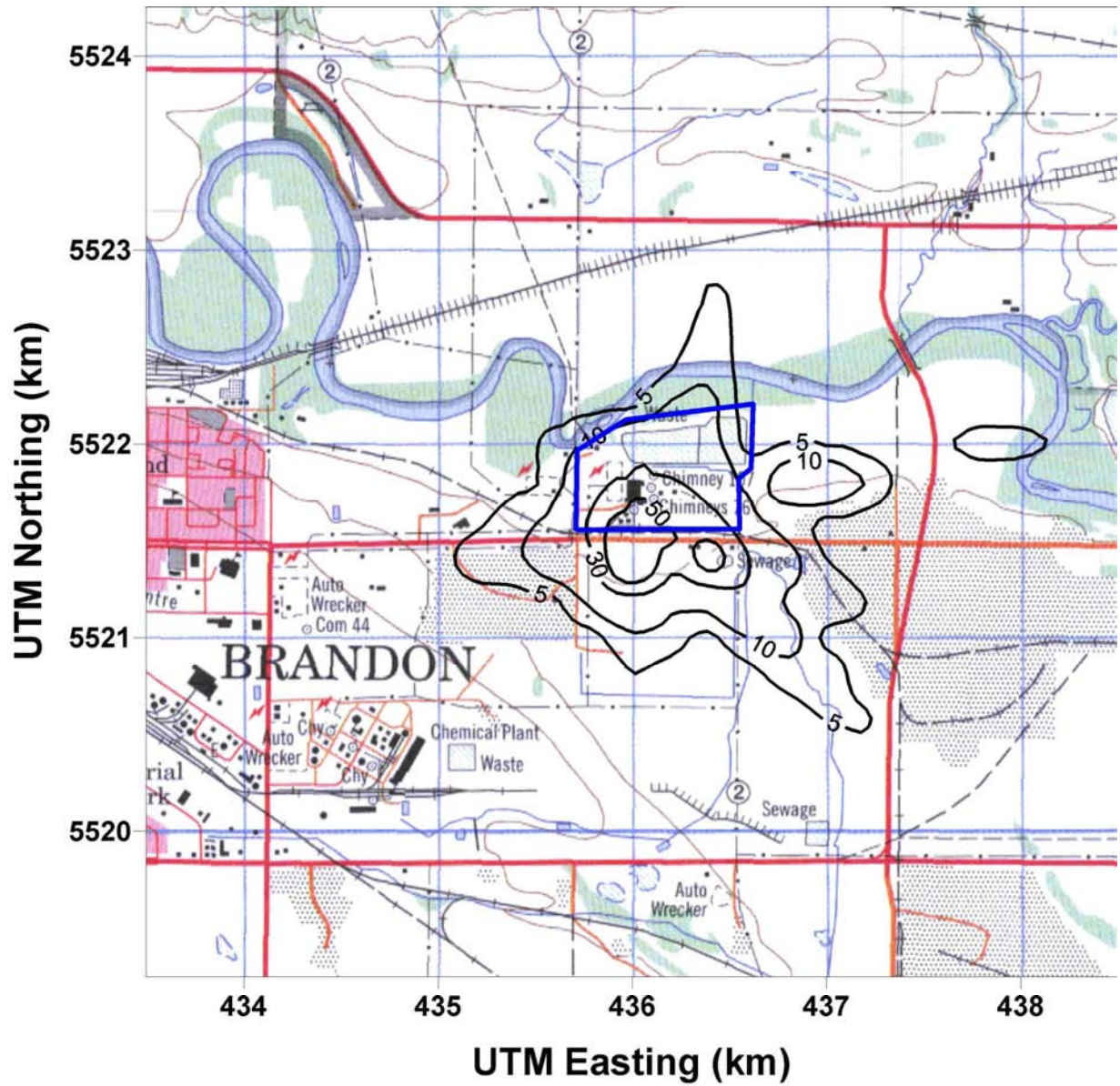
The maximum predicted PM_{2.5} concentrations for fugitive dust from coal and ash storage are conservatively estimated at 15 µg/m³ and 1 µg/m³, respectively. At the point of maximum predicted concentration, the 98th percentile 24-hour average PM_{2.5} concentration for fugitive coal dust is only 1.7 µg/m³, while that for ash is much less than 1 µg/m³. Although the maximum point of impingement for the Unit #5 stack emissions and fugitive coal/ash emissions do not occur at the same location, the CWS in the area would not be exceeded even if they did coincide and were added to the 98th percentile levels measured at the Assiniboine Community College in Brandon.

The maximum predicted PM₁₀ concentrations for fugitive dust emissions are conservatively estimated at 26 µg/m³ for coal dust and 7 µg/m³ for ash from the ash storage area. Ninety-nine percent (99%) of the time, the maximum contribution of fugitive coal dust to ambient PM₁₀ levels anywhere in the area would be less than 15 µg/m³. Therefore, fugitive emissions from the Brandon G.S. alone would not be sufficient to cause the high PM₁₀ concentrations measured at the Assiniboine Community College in Brandon. Moreover, the maximum predicted PM₁₀ concentrations are negligible at the Riverview Elementary School (i.e., in the closest residential area west of the Brandon G.S.), as well as at the nearest residence east of the plant.

Maximum predicted SPM concentrations for fugitive dust from the coal and ash storage areas are 105 µg/m³ and 8 µg/m³, respectively. The estimate of fugitive coal dust contributions to ambient SPM concentrations is considered to be conservative, in that the estimated SPM emission rates from the coal storage area likely overstate actual emission rates. Even so, conservatively predicted concentrations would be less than 80 µg/m³ on all but one day per year. Ninety-nine percent (99%) of the time (i.e., 361 of 365 days per year), the maximum predicted contribution to ambient SPM levels due to fugitive coal dust would be less than 27 µg/m³. Furthermore, the predicted SPM concentrations due to fugitive dust from coal and ash storage are negligible at the nearest residential areas east and west of the plant, the latter location being close to the monitoring station at the Assiniboine Community College. Therefore, fugitive dust emissions from the Brandon G.S. alone would not be sufficient to account for the high PM₁₀ (and by extension, SPM) concentrations that have been measured at the Assiniboine Community College in Brandon.

Figures 5.21 to 5.23 show the maximum estimated 24-hour average concentrations of SPM, PM₁₀ and PM_{2.5} due to fugitive coal emissions. The corresponding plots for emissions from the ash lagoon are shown in Figures 5.24, 5.25 and 5.26. Annual average concentrations are very low throughout the area.

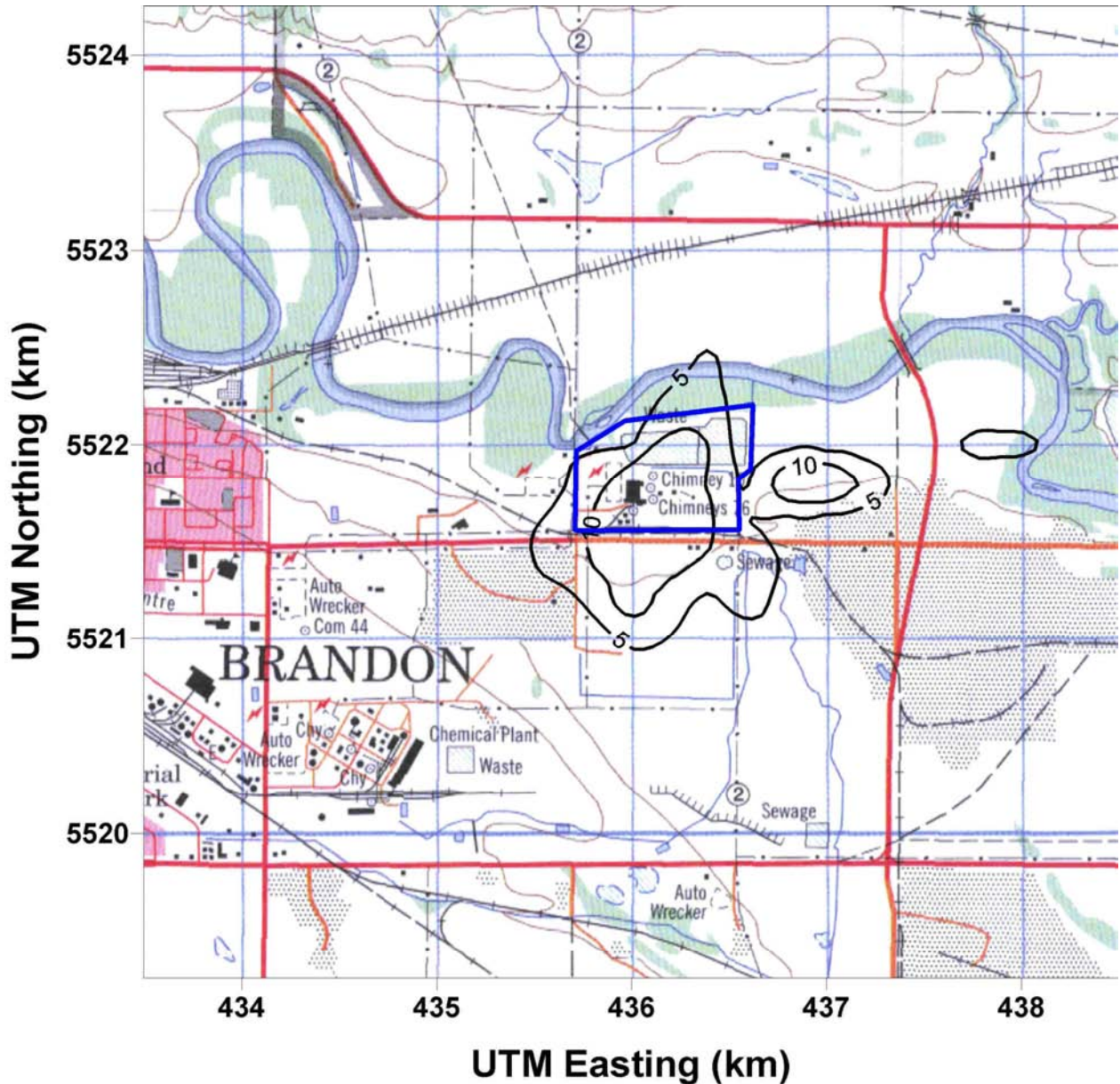
Figure 5.21
Maximum Predicted Incremental 24-hour Average SPM Concentrations ($\mu\text{g}/\text{m}^3$)



- Brandon G.S. Property Line
- Concentration Isopleth ($\mu\text{g}/\text{m}^3$)

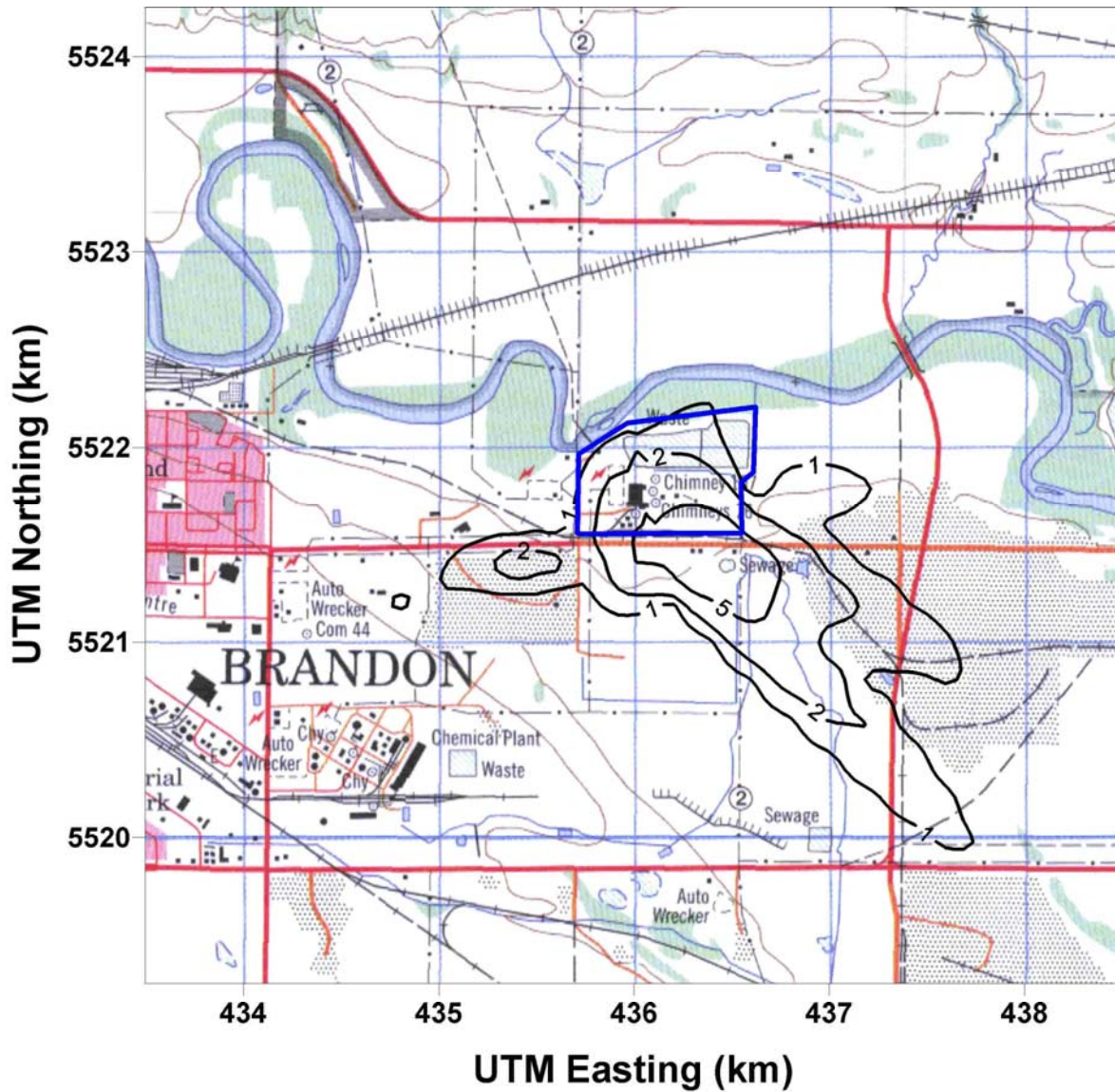
Provincial Objective: 120 $\mu\text{g}/\text{m}^3$

Figure 5.22
Maximum Predicted Incremental 24-hour Average PM₁₀ Concentrations (µg/m³)
Due to Fugitive Coal Dust Emissions



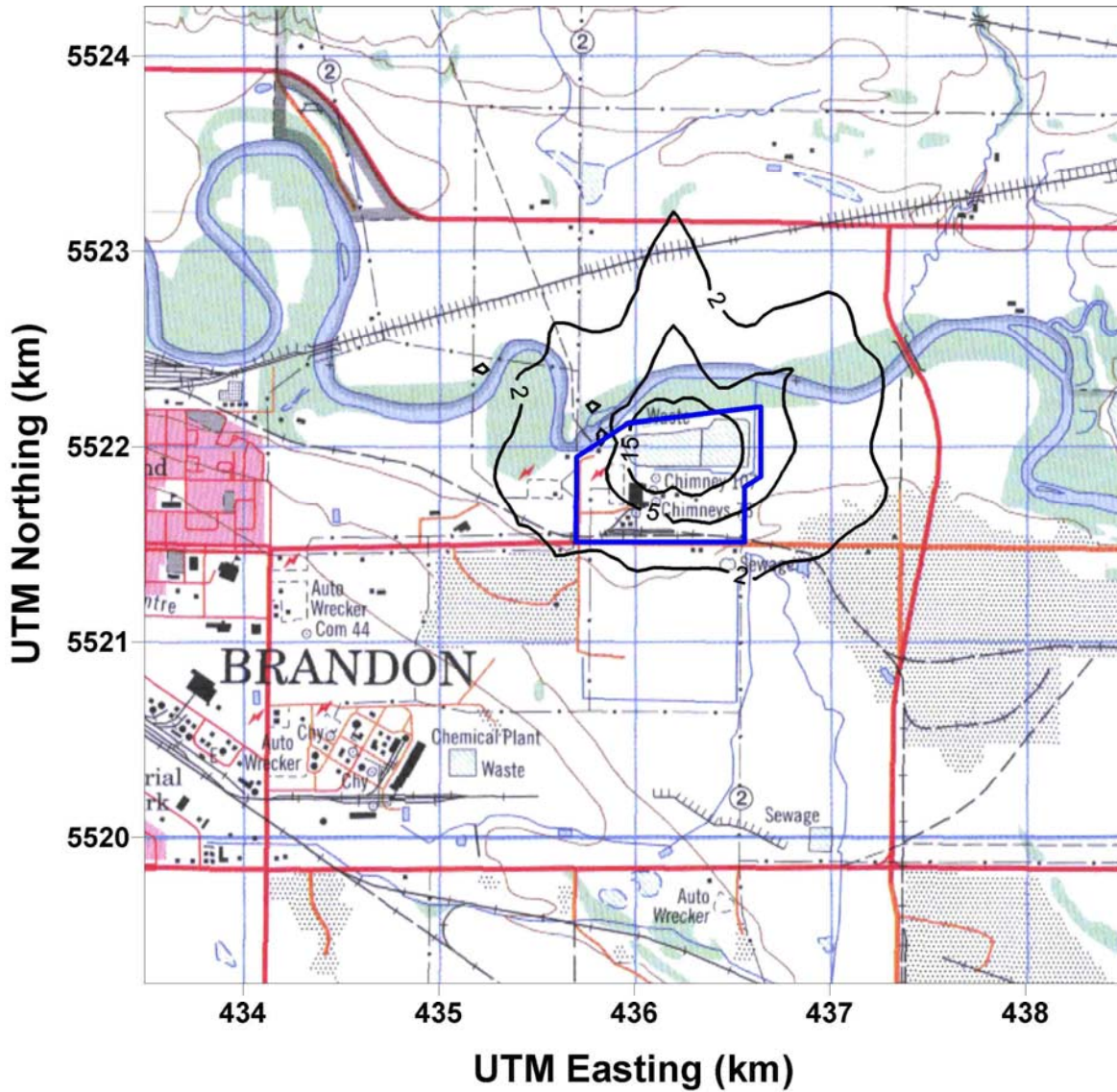
- Brandon G.S. Property Line
- Concentration Isopleth (ug/m3)

Figure 5.23
Maximum Predicted Incremental 24-hour Average PM_{2.5} Concentrations (µg/m³)
Due to Fugitive Coal Dust Emissions



- Brandon G.S. Property Line
 - Concentration Isopleth (ug/m3)
- Canada Wide Standard: 30 ug/m3

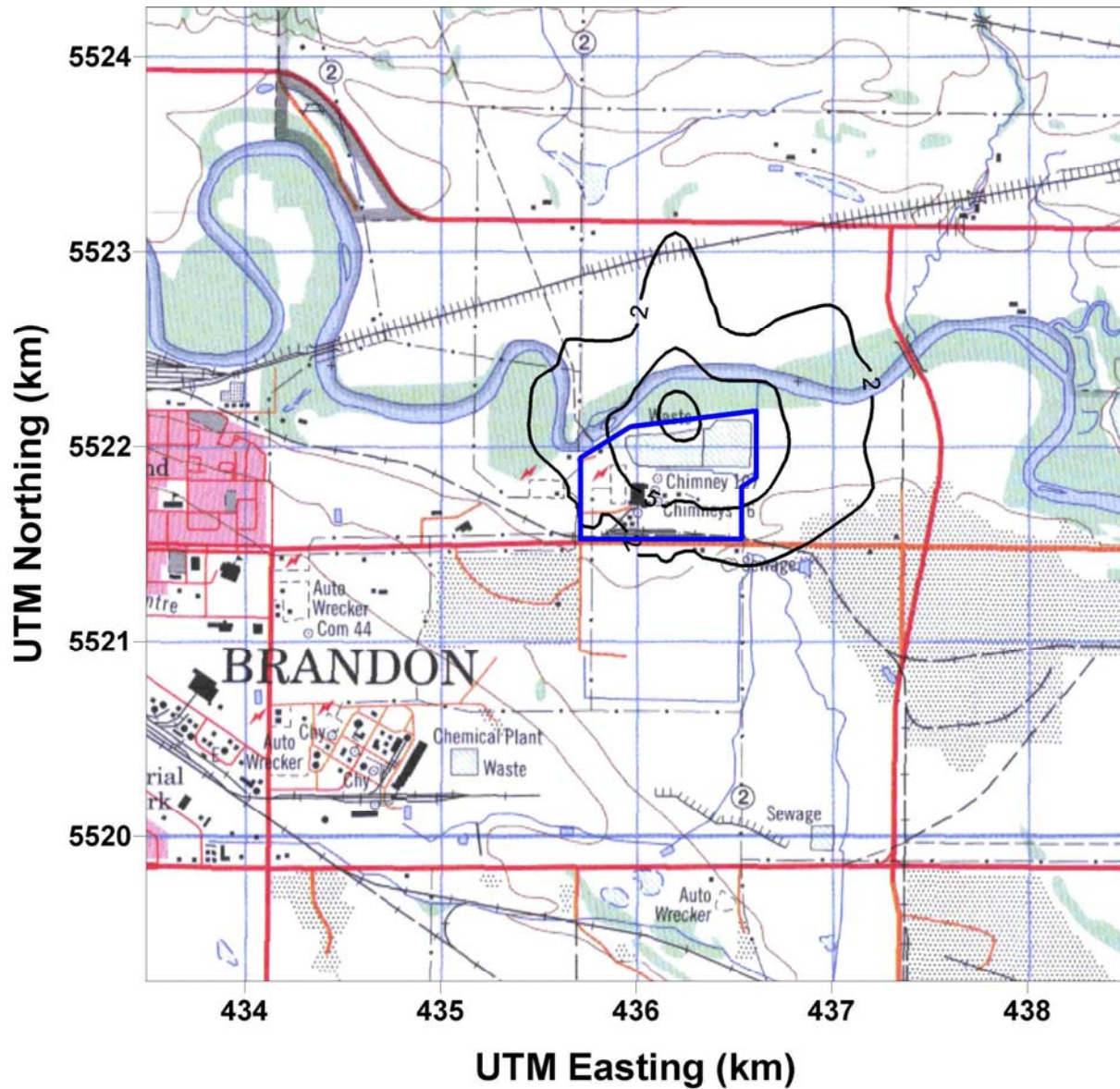
Figure 5.24
Maximum Predicted Incremental 24-hour Average SPM Concentrations ($\mu\text{g}/\text{m}^3$)
Due to Fugitive Dust Emissions from the Ash Lagoon



- Brandon G.S. Property Line
- Concentration Isopleth ($\mu\text{g}/\text{m}^3$)

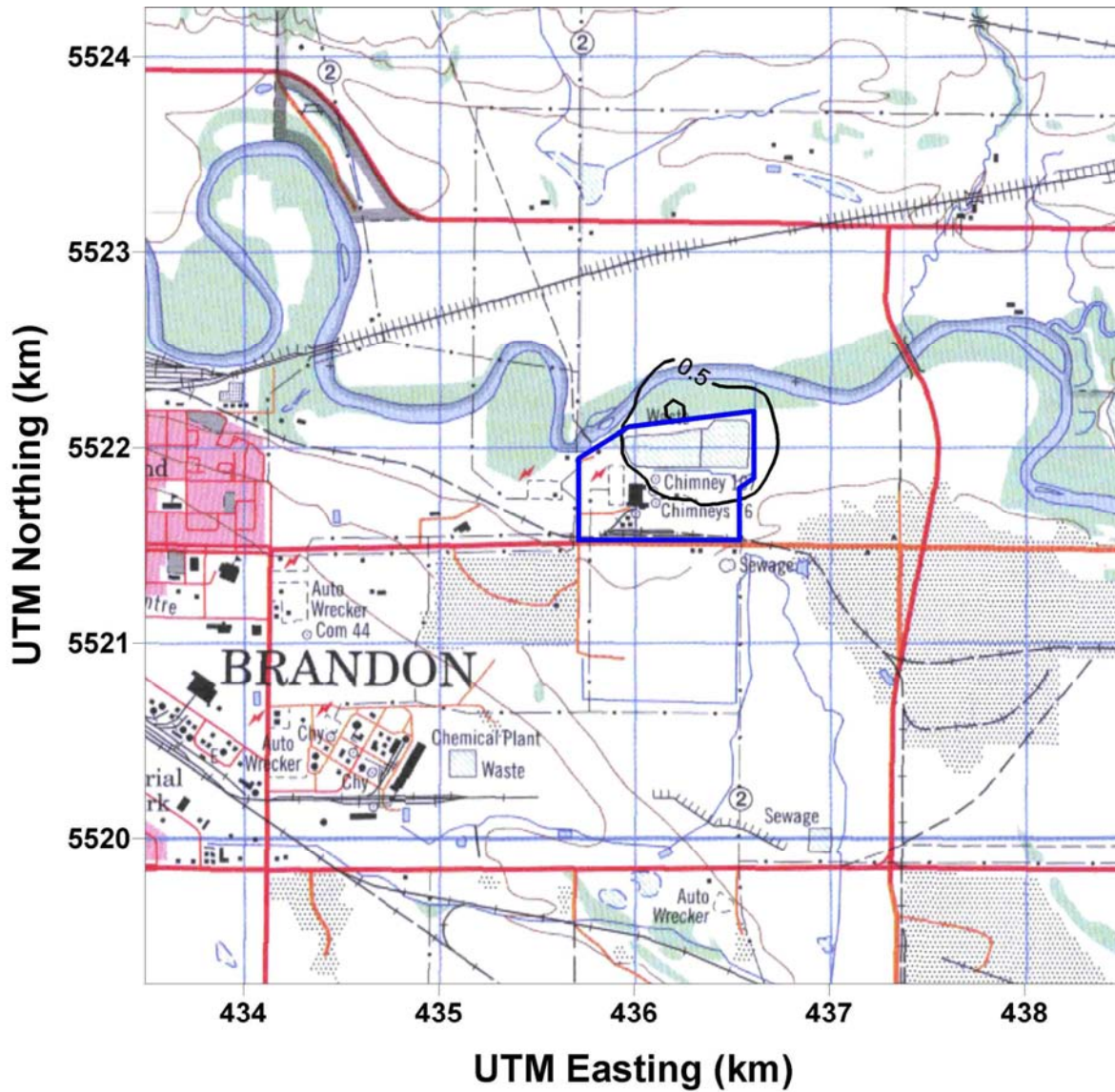
Provincial Objective: 120 $\mu\text{g}/\text{m}^3$

Figure 5.25
Maximum Predicted Incremental 24-hour Average PM₁₀ Concentrations ($\mu\text{g}/\text{m}^3$)
Due to Fugitive Dust Emissions from the Ash Lagoon



- Brandon G.S. Property Line
- Concentration Isopleth ($\mu\text{g}/\text{m}^3$)

Figure 5.26
Maximum Predicted Incremental 24-hour Average PM_{2.5} Concentrations (µg/m³)
Due to Fugitive Dust Emissions from the Ash Lagoon



- Brandon G.S. Property Line
 - Concentration Isopleth (ug/m³)
- Canada Wide Standard: 30 ug/m³

5.4.2 Fugitive Dust Deposition

Annual deposition rates of coal dust and ash were determined from air quality modelling. The trace constituent concentrations in $\mu\text{g/g}$ for coal and combustion ash (provided in Table 3.14) can be used to scale the total deposition rates to provide estimates of trace pollutant deposition. Tables 5.13 and 5.14 provide the total estimated annual deposition of coal and ash constituents for both the current coal supply and the upper-bound projected future coal supply. The maximum off-site deposition rates occur very near the Brandon G.S. property line.

**Table 5.13
Maximum Annual Deposition of Trace Elements due to Coal Handling**

Pollutant	OS3 Total Annual Deposition ($\mu\text{g}/\text{m}^2$)	Pollutant	OS3 Total Annual Deposition ($\mu\text{g}/\text{m}^2$)
Coal Dust (SPM)	2.58		
Trace Inorganic Elements		Trace Inorganic Elements	
Aluminium	1.67E-02	Mercury	2.32E-07
Antimony	4.38E-06	Molybdenum	5.52E-06
Arsenic	3.87E-06	Nickel	1.50E-05
Barium	2.12E-03	Lead	8.10E-06
Beryllium	1.55E-06	Phosphorus	3.89E-05
Boron	1.40E-04	Potassium	1.20E-03
Bromine	6.71E-05	Selenium	3.22E-06
Cadmium	6.96E-07	Silver	3.29E-06
Calcium	2.70E-02	Sodium	7.78E-03
Chloride	5.16E-04	Strontium	1.12E-03
Chromium	1.58E-05	Thallium	1.66E-05
Cobalt	7.74E-06	Thorium	5.54E-06
Copper	3.73E-05	Tin	2.93E-05
Fluoride	2.01E-04	Titanium	1.09E-03
Iron	1.36E-02	Uranium	1.96E-05
Lithium	1.32E-05	Vanadium	5.60E-05
Magnesium	6.58E-03	Zirconium	9.11E-05
Manganese	6.29E-05	Zinc	4.09E-05

**Table 5.14
Maximum Annual Deposition of Trace Elements and Compounds
Due to Fugitive Emissions from the Ash Lagoon**

Pollutant	OS3 Total Annual Deposition ($\mu\text{g}/\text{m}^2$)	Pollutant	OS3 Total Annual Deposition ($\mu\text{g}/\text{m}^2$)
Ash (SPM)	0.25		
Trace Inorganic Elements		Trace Inorganic Elements	
Aluminium	1.10E-02	Manganese	1.41E-04
Antimony	7.12E-07	Mercury	2.46E-08
Arsenic	4.75E-06	Molybdenum	1.84E-06
Barium	1.15E-03	Nickel	3.55E-05
Beryllium	1.64E-06	Lead	6.34E-06
Boron	1.25E-04	Potassium	5.70E-06
Bismuth	6.03E-08	Selenium	4.01E-07
Cadmium	2.30E-07	Silver	1.60E-06
Calcium	3.09E-02	Sodium	3.59E-03
Chloride	5.25E-05	Strontium	7.01E-04
Chromium	3.60E-05	Thallium	2.26E-05
Cobalt	2.59E-06	Tin	1.43E-05
Copper	4.78E-05	Titanium	7.44E-04
Fluoride	1.70E-04	Uranium	2.13E-05
Iron	3.52E-03	Vanadium	6.86E-05
Magnesium	4.75E-03	Zinc	1.56E-05
Dioxins		Furans	
2,3,7,8-TCDD	4.27E-11	1,2,3,7,8-PeCDF	4.27E-11
1,2,3,7,8-PeCDD	6.28E-11	2,3,4,7,8-PeCDF	4.27E-11
1,2,3,4,7,8-HxCDD	8.80E-11	1,2,3,4,7,8-HxCDF	6.28E-11
1,2,3,6,7,8-HxCDD	7.04E-11	1,2,3,6,7,8-HxCDF	4.52E-11
1,2,3,7,8,9-HxCDD	7.54E-11	2,3,4,6,7,8-HxCDF	7.04E-11
1,2,3,4,6,7,8-HpCDD	1.48E-10	1,2,3,7,8,9-HxCDF	6.03E-11
OCDD	2.65E-09	1,2,3,4,6,7,8-HpCDF	7.29E-11
2,3,7,8-TCDF	4.77E-11	1,2,3,4,7,8,9-HpCDF	8.80E-11
		OCDF	1.48E-10

5.5 COOLING TOWER EMISSIONS

There are no set criteria with which to quantitatively assess the effects of cooling tower emissions. Instead, a qualitative approach is typically used to assess the changes in environmental conditions that can be associated with water vapour releases to the air. Conditions such as fogging, icing and salt deposition are discussed in Chapter 3 with greater detail. The potential effects, which are largely contained to a small area surrounding the cooling tower, are described here with accompanying figures.

5.5.1 Fogging and Icing

Fogging and icing occur when a visible plume intersects the ground. These effects are more likely to occur during winter months when the ambient air typically has a lower saturation vapour pressure and condensation can readily occur. Fog or ice generated across a public thoroughfare may become a hazard and mitigation measures such as warning signs and application of salt or other materials to remove ice may need to be considered.

Figure 5.27 shows the annual hours that ground-level fog is predicted to occur. Fogging occurs very infrequently to the north and to the south of the cooling tower. The SACTI model predicts that off-site fogging can occur up to approximately 1 hour per year, and is more likely to occur south of the Brandon G.S. property line.

Figure 5.28 shows the predicted annual hours of icing. Icing occurs very infrequently and only to the south of the cooling tower. Icing is predicted to occur off-site up to approximately 1 hour per year, in a small area immediately outside the southern boundary of the Brandon G.S.

The modelling results indicate that northerly winds during the winter months can lead to very infrequent icing and fogging conditions along a short stretch of Victoria Avenue East, along the southern boundary of the Brandon G.S. Therefore, if not already in place, it is recommended that a warning sign be posted along this portion of Victoria Ave and a remediation plan be developed to deal with potential icing.

5.5.2 Visible Plumes

The frequency of occurrence of different plume lengths is shown in Figure 5.29. For 2% of the time, or 175 hours a year, a cooling tower plume of approximately 500m may be visible over the Brandon G.S. For 88 hours a year, a plume of approximately 2 km in length will be visible. Visible plumes of length greater than 2 km are predicted to occur very infrequently. This means that it is unlikely residents of Brandon will observe visible plumes directly overhead, but will infrequently see a visible plume at a distance.