A coal fired power (SUMAS 2) station was proposed (but not bulit) 10 km south of Abbotsford on the USA side of the border. There was concern that the plume would directly impinge on Sumas mountain (10 km away). This study applies the Gaussian Plume model in screening mode, to determine the predicted impact of this facility in a worst case scenario; that is, at low wind speeds and no dispersion in the crosswind direction. Other details for this scenrio are as follows:

* Stack Diameter = 3m
* Plume Exit Velocity = 6m/s
* Plume Exit Temperature = 350K (77oC)
* Ambient air temperature= 293K (20oC)
* PM10 Emission rate =  15 g/s
* Downwind Distance = 10,000 m
* Average wind speed – 1 m/s
* Effective Stack Height – 55m

The general equation for the Gaussian Equation is given in Image 1, where c is the pollutant concentration at one point. It is also important to note that the model is not time dependent and an average instead. Therefore to screen for maximum concentration along the vertical profile, 10 km from the proposed site, the Gaussian Point Source Plume Model was run for an x of 10,000m, y of 0 and z of different heights between 1 to 400m. Table 1 summarizes the concentrations found at different heights along different stability classes. The classes are defined by the Pasquill Scale.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Height (m) | Concentrations (µg m-3) | | | | | |
|  | **A** | **B** | **C** | **D** | **E** | **F** |
| 1 | 0.010037 | 2.973107 | 11.523 | 60.10191 | 117.5259 | 192.9522 |
| 41 | 0.002273 | 0.673617 | 2.622966 | 14.66356 | 33.07409 | 82.19874 |
| 81 | 0.001731 | 0.512952 | 1.995718 | 11.02122 | 24.24023 | 55.9936 |
| 121 | 0.001474 | 0.436445 | 1.687377 | 8.483733 | 15.3818 | 20.27667 |
| 161 | 0.001315 | 0.388609 | 1.484824 | 6.264039 | 7.914856 | 3.655808 |
| 201 | 0.001203 | 0.354645 | 1.331841 | 4.345067 | 3.234509 | 0.321413 |
| 241 | 0.001119 | 0.328641 | 1.206412 | 2.805204 | 1.040051 | 0.013652 |
| 281 | 0.001052 | 0.307702 | 1.098089 | 1.677226 | 0.261828 | 0.000279 |
| 321 | 0.000998 | 0.290218 | 1.001341 | 0.925937 | 0.051451 | 2.73E-06 |
| 361 | 0.000952 | 0.27521 | 0.913043 | 0.471081 | 0.007877 | 1.28E-08 |
| 401 | 0.000913 | 0.262046 | 0.831366 | 0.220578 | 0.000938 | 2.85E-11 |

1. Very Unstable, B- Moderately Unstable, C- Slightly Unstable, D- Neutral, E - Somewhat Stable, F- Stable

any meteorological conditions which inhibit plume stretching and diffusion will decrease atmospheric dilution of pollutants and increase ambient concentrations • stable, low-wind conditions which lead to stagnation can be associated with poor AQ

From table 1 we can see that the highest concentrations are seen at ground level, in stable atmospheric conditions (Class F), at approximately 193 µg m-3.

The graphs in Fig. 2 show that the highest concentrations occurs at ground level in each of the stability regimes and decreases with height.

If a plume was intercepted by an obstacle (e.g. Sumas Mountain) at 10km downwind from the source, it will result in plume impingement and the concentration levels will be highest at ground level. The concentration at the peak of Sumas Mountain (400m) is close to 0 for all stability classes. Most of the pollutants would not have made it to the peak of the mountain, and would have been diluted and dispersed around 150m. There is more variation with height for stable conditions, due to higher concentrations near ground level. Unstable conditions have relatively low concentrations throughout, as there is more dispersion and mixing closer to the stack source and results in lower concentration of pollutants at further distances away (i.e. 10km). The predicted concentrations decreases with atmospheric stability. Looking at fig.1, we can see that the highest ground level concentrations at 10km downwind from the source occurs in the stable condition (F), which is 75 μg/𝑚3 . Under stable atmospheric conditions, the smoke plume tends to have an anisotropic coning dispersion and there is less convective mixing of the pollutants. Therefore, concentrations tends to be higher near the ground level, especially under light wind conditions. For more unstable conditions (e.g. A, B, and C), concentrations of pollutants are significantly lower. The concentration observed at 10km downwind is close to 0 for the more unstable classes, as most of the pollutants would have been dispersed or mixed due to the higher convective mixing in unstable conditions. The predicted concentrations were also significantly higher at lower wind speeds (< 5 m/s), as there is less dispersion and advection by wind. Highest concentrations were predicted to be much closer to the source (between 0.5 to 3km) as compared to 10km downwind, and can go up to 120 μg/𝑚3 and 213 μg/𝑚3 . As mentioned by McKendry (2000), it is not rare in the Lower Fraser Valley (LFV) to see spikes in hourly concentrations of PM10 that may exceed 0 20 40 60 80 100 0 50 100 150 200 250 300 350 400 450 Concentrations (μg/m3) Height (m) Variation in concentration levels with height for stability classes A to F A B C D E F 200 μg/𝑚3 , especially during light winds conditions with the development of a stable nocturnal boundary layer. This corresponds with the predicted maximum concentrations by the model. British Columbia’s (BC) acceptable daily concentration of PM 10 is 50 μg/𝑚3 is based on an 24-hour rolling average, which may obscure the short term peak values in concentrations due to the ‘arrow head’ diagram in the averaging of raw values. Therefore, we have to take into account that the CWS of 50 μg/𝑚3 is a daily average. The majority of the predicted concentrations at 10km does not exceed 50 μg/𝑚3 , with the exception of class F. This supports the observed concentrations that are usually seen in the LFV (McKendry, 2000). With a wind speed of 1m/s and a class F stability, the predicted concentration was 75 μg/𝑚3 which exceeds50 μg/𝑚3 (Fig. 1). The median values for PM10 concentrations from McKendry’s study seen in figure 2 are relatively low, between 10 to 20 μg/𝑚3 (McKendry, 2000). The observed values of PM10 concentrations in the LFV are relatively low, with peak concentration usually coinciding with the morning and evening rush hour (McKendry, 2000). The predicted values from the model at 10km appears to correspond to the range of values that were observed in the LFV. The maximum predicted value of 75 μg/𝑚3 is not uncommon in the hourly values observed, but is considered to be an outlier when compared to the median range of values (McKendry, 2000)