Delta Air Quality Monitoring Study
June 2004 – March 2006

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Policy and Planning Department
Greater Vancouver Regional District:
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Executive Summary

A two-year ambient air quality study was undertaken in the Ladner and Tsawwassen area of Delta from 2004 until 2006. The purpose of the study was to:

- determine the existing levels of air contaminants at various locations and to compare those levels to GVRD health-based objectives; and
- compare the measured levels in the study area with other areas within the GVRD.

Monitoring was conducted using the GVRD mobile air monitoring unit (MAMU) which rotated between sites every few weeks during the study. Carbon monoxide, sulphur dioxide, nitrogen dioxide and fine ($PM_{2.5}$) particulates were monitored on a continuous basis.

Results of the study indicate that all measured parameters met the GVRD objectives. Carbon monoxide (CO) and sulphur dioxide (SO_2) levels were 10% or less of the GVRD objectives while nitrogen dioxide (NO_2) and fine particulate ($PM_{2.5}$) levels were generally 50% or less below the objectives. Levels did vary from site-to-site, and with changes in meteorological conditions, depending on the time of year.

Air quality levels in Delta were also compared to data collected at nearby GVRD monitoring stations. Average levels from the study area sites were less than those recorded at the nearby sites which included North Delta (T13), Richmond South (T17), Burnaby South (T18) and Vancouver International Airport (T31).

Within the study area, air quality differed amongst the sites. Generally measured values in Ladner (the urban center of the study area) were higher than those measured in the more rural locations. Some specific variations to this trend were noted however, such as sulphur dioxide.

Generally, ambient air quality in these areas of Delta, as measured by this study, met and exceeded all GVRD objectives and was better than other nearby areas of the GVRD.

1.0 Introduction

In the spring of 2004, the Greater Vancouver Regional District (GVRD) agreed to conduct an ambient air quality monitoring program at multiple sites in the Ladner and Roberts Bank foreshore area. The Corporation of Delta (Delta) expressed ongoing concern over emissions from agricultural operations, transportation corridors and growing port activity, and highlighted the lack of any information on baseline air quality in the area. With prospective future plans for transportation corridor upgrades and port facility expansion, it was determined that collecting baseline ambient air quality information was a high priority. With these future developments in mind, the study was designed to also provide data which may assist in the decision for the need for a new monitoring station in the area, provide data which may assist in determining what the issues of concern are and provide information which may assist in determining the optimum location(s) for such a station.

With the cooperation of Delta, Tsawwassen First Nation, Delta Hospital and Delta School District a program of air quality monitoring was initiated in June 2004. This report describes the project, presents a summary of information collected, presents an analysis of the data collected and provides conclusions arising from the study.

2.0 Purpose of Study

The study, as originally proposed, consisted of three objectives. These were:

1. Determine the existing levels of fine particulate (PM2.5), oxides of nitrogen (NOx) and carbon monoxide (CO) in the Delta / Ladner area and to compare measured levels to established objectives and/or standards;

2. Compare levels of PM2.5, NOx and CO in the Delta / Ladner area with other areas in the GVRD; and

3. Conduct monitoring in the vicinity of 60B Street and 44 Avenue to respond to residents' concerns about exposure to emissions from nearby transportation sources.

The third objective of this study was reported back to Delta in a separate report in November 2004 and as such will not be analyzed further in this report.

Carbon monoxide is produced by the incomplete combustion of fuels containing carbon. The principle source within the GVRD is motor vehicle emissions with nearly 90% coming from the transportation sector, and almost 70% being attributed to light duty, gasoline fueled vehicles (GVRD Emission Inventory for 2000, GVRD 2005). Other sources include fuel combustion for building heating and commercial and industrial operations.

Oxides of nitrogen are produced by the high temperature combustion of fossil fuels. Nitric oxide is the predominant oxide of nitrogen in combustion emissions, which rapidly undergoes chemical reactions in the atmosphere to produce nitrogen dioxide. Common nitrogen dioxide sources in the GVRD include boilers, building heating systems and internal combustion engines. In the GVRD about 81% of the nitrogen dioxide emissions come from light duty vehicles (24%), heavy-duty vehicles (16%), marine vessels (22%) and non-road emissions (19%).

Fine particulate matter (PM2.5) is emitted from a variety of sources including industrial, mobile and area sources. While some fine particulates may be directly related to specific sources (e.g.: elemental carbon from diesel fuel combustion) scientific investigations indicate that a considerable proportion of ambient fine particulate is secondary in nature, and is created in the atmosphere by the reaction of other constituents. In particular, ammonia emissions from agricultural operations can react with nitrogen dioxide and sulphur dioxide to produce ammonium nitrate and ammonium sulphate particles, which at times can represent up to two-thirds of the fine particulate. Exposure to fine particulate has been defined as one of the major air quality-health issues in Canada. In addition, it is a major cause of visibility degradation.

In addition to the three pollutants noted above, this report also presents data on sulphur dioxide (SO2). Early in the study this was identified as a possible marker for diesel emissions, and in particular ships which access Deltaport or transit through the Strait of Georgia. In addition, sulphur dioxide is a major emission from oil refineries, two of which are located just south of the study area in Washington State.

Ozone is not part of this air quality study. Ground level ozone is a secondary pollutant created by the interaction of nitrogen dioxide and volatile organic compounds in the presence of sunlight. Within the GVRD it has historically been an issue in the eastern portion of the region (downwind of the major source areas) during the summer. Generally, in the western portion of the GVRD close to the Strait of Georgia, ozone levels are low and therefore were not included as part of this investigation.

3.0 Monitoring Methods, Sites and Schedules

3.1 Monitoring Methods

The program was designed around the use of the GVRD Mobile Air Monitoring Unit (MAMU). MAMU is a mobile air quality monitoring station used to supplement the network of fixed stations when short-term data is required at more than one location for special air quality studies or air quality emergencies. It is equipped with the same instrumentation as a fixed monitoring station and is connected to the GVRD central data acquisition system using cellular technology. MAMU systems are subject to all the same quality control and quality assurance requirements as fixed stations operated as part of the Lower Fraser Valley Air Quality Monitoring Network.

Figure 1 presents a view of MAMU while deployed for this study.

Figure 1: MAMU located at Ladner Pump Station (looking southwest)

3.2 Monitoring Sites

Four locations were originally chosen for the study. The first site was located near a residential area in the vicinity of 45th Avenue and 60B Street. This site was selected to address the third objective of the study (which has already been reported on to Delta Council, March 22, 2005), and was not intended to be part of the longer term evaluation.

Table 1: Study Sites

	Site Name	Site Address	Site Description	Site Characteristics
1	Hospital	5800 Mountain View Blvd., Delta	Site surrounded by open fields with hospital immediately to the southwest, municipal buildings to the east (more distant) and the Ladner Transit Exchange (at distance) to the north	open grasslands surrounding the Ladner civic buildings with residences and major roads more distant to the west, north and east
2a	Ladner Elementary	5016 - 44th Avenue, Delta	Elementary School bounded on the east, west and north by residential community and on south by a park	single family homes and residential streets
2b	Pump Station	42A Avenue, Delta	Site on southern edge of Ladner bounded on the west and south by farmland and residential areas to the north and east	quiet residential community and active farmland surrounds site
3	TFN	Tsawwassen Drive North,Tsawwassen First Nation, Delta	Located at the sewage treatment plant, the site is bounded to the west by the Strait of Georgia and to the east by Tsawwassen First Nation lands	located midway between BC Ferries Causeway and Roberts Bank Causeway with some residential buildings and open farmland to the east
	45th Avenue	45th Ave. and 60B St., Delta	Residential community bounded on west side by Highway 17 (approx. 100m. from Hwy. 17	single family homes

Table 1 presents a summary of the locations and site characteristics of all the monitoring sites used during this study. The first of the three long-term monitoring sites selected was adjacent to the Delta Hospital. The Delta Hospital site (herein after called the "Hospital") is bounded on the north by the Ladner Bus Exchange and Ladner Trunk Road, on the west by Harvest Drive and residential areas, on the south by the Hospital, recreation facilities and farmland, and on the east by Delta City Hall, the Ladner Recreation Complex and Highway 17.

Figure 2 presents a photograph of MAMU at the Delta Hospital location during the study.

Figure 2: Delta Hospital site looking east

The second long-term site was located adjacent to Ladner Elementary School. This site was chosen due its proximity to the Ladner residential community and the residential-farmland interface on the southern boundary of Ladner. The site was used for a limited period however, due to security issues (MAMU break-in). With the assistance of staff from Delta, an alternate more secure location was identified within a short distance of the school at a Ladner pump station (the "Pump Station").

The Pump Station site is adjacent to residential properties on the residential-farmland interface and has good exposure in all directions. Figure 1 presents a photograph of MAMU at the Pump Station location.

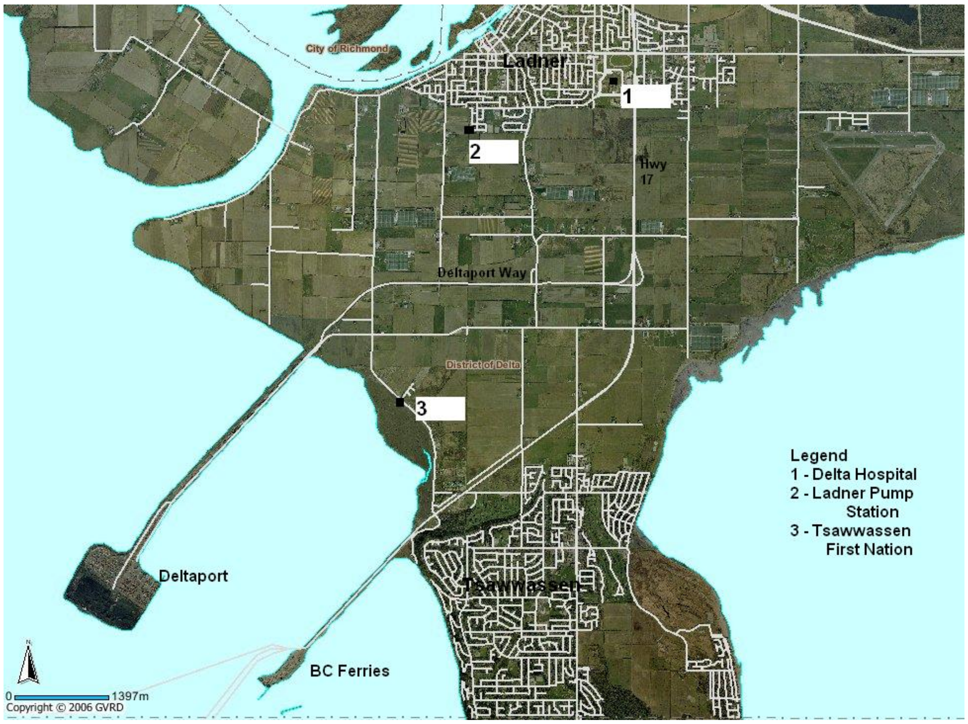
The third long-term monitoring location is situated on Tsawwassen First Nation land ("TFN") at the effluent treatment plant, adjacent to the northern extremity of the Tsawwassen First Nation community. It is positioned on the foreshore between Deltaport Way and Highway 17 and has good exposure from all directions. To the north and east the area is bounded by agricultural land. Figure 3 shows MAMU while monitoring at the TFN location.

Figure 3: Tsawwassen First Nation site looking southeast

Figure 4 presents an aerial view of the study area noting the three long term monitoring sites relative to other physical features and facilities in the Ladner / Delta area.

The sites selected were considered representative of the various areas in this portion of Delta, covering areas where the majority of people live, work and play, and are consistent with the requirements of other monitoring sites within the GVRD.

Figure 4: Aerial view of the study area



3.3 Monitoring Schedule

The schedule for monitoring in the study area was based on MAMU rotating between the monitoring sites every two to three weeks for two years. This schedule was periodically interrupted by other requirements for MAMU not foreseen at the time of project planning.

Table 2 presents an overview of the monitoring schedule, detailing the time periods when MAMU was monitoring at the respective locations within the study area.

Table 2: MAMU Monitoring Schedule

Monitoring Site	Date From	Date To
45th Avenue	June 1, 2004	June 11, 2004
Hospital	June 11, 2004	June 29, 2004
Ladner Elementary	July 8, 2004	July 19, 2004
45th Avenue	July 28, 2004	August 4, 2004
TFN	August 5, 2004	August 24, 2004
Hospital	August 24, 2004	September 13, 2004
TFN	November 9, 2004	November 26, 2004
Hospital	November 26, 2004	December 22, 2004
Pump Station	February 2, 2005	February 21, 2005
Hospital	February 22, 2005	March 11, 2005
TFN	June 10, 2005	June 28, 2005
Pump Station	June 28, 2006	July 19, 2005
TFN	July 28, 2005	August 16, 2005
Hospital	August 16, 2005	September 14, 2005
Pump Station	October 19, 2005	November 8, 2005
TFN	November 25, 2005	December 14, 2005
Hospital	December 14, 2005	January 3, 2006
Pump Station	January 27, 2006	February 17, 2006
TFN	February 17, 2006	March 8, 2006

4.0 Measured Levels of Air Quality

This section summarizes the air quality data and compares results to accepted objectives / standards as well as to other stations in the region. Table 3 lists the GVRD Health-Based Air Quality Objectives which were adopted in the fall of 2005 as part of the new GVRD Air Quality Management Plan (www.gvrd.bc.ca).

Table 3: Relevant GVRD Air Quality Objectives (GVRD AQMP, 2005)

Air Contaminant	Averaging Period	Objective (ug/m^3)	Objective (ppm/ppb)
Carbon Monoxide	1-hour	30,000	25.7 ppm
	8-hour	10,000	8.6 ppm
Sulphur Dioxide	1-hour	450	169 ppb
	24-hour	125	47 ppb
	Annual	30	11 ppb
Nitrogen Dioxide	1-hour	200	104 ppb
	Annual	40	21 ppb
Fine Particulate Matter ($PM_{2.5}$)	24-hour	25	
	Annual	12	

Data is also compared to nearby GVRD network stations. Figure 5 illustrates the location of the study sites relative to the existing GVRD air quality network stations used in the analysis. The study sites used in this analysis are the three long-term sites:

i) Delta Hospital;

ii) Ladner Pump Station; and

iii) Tsawwassen First Nation.

The network sites used in the analysis are:

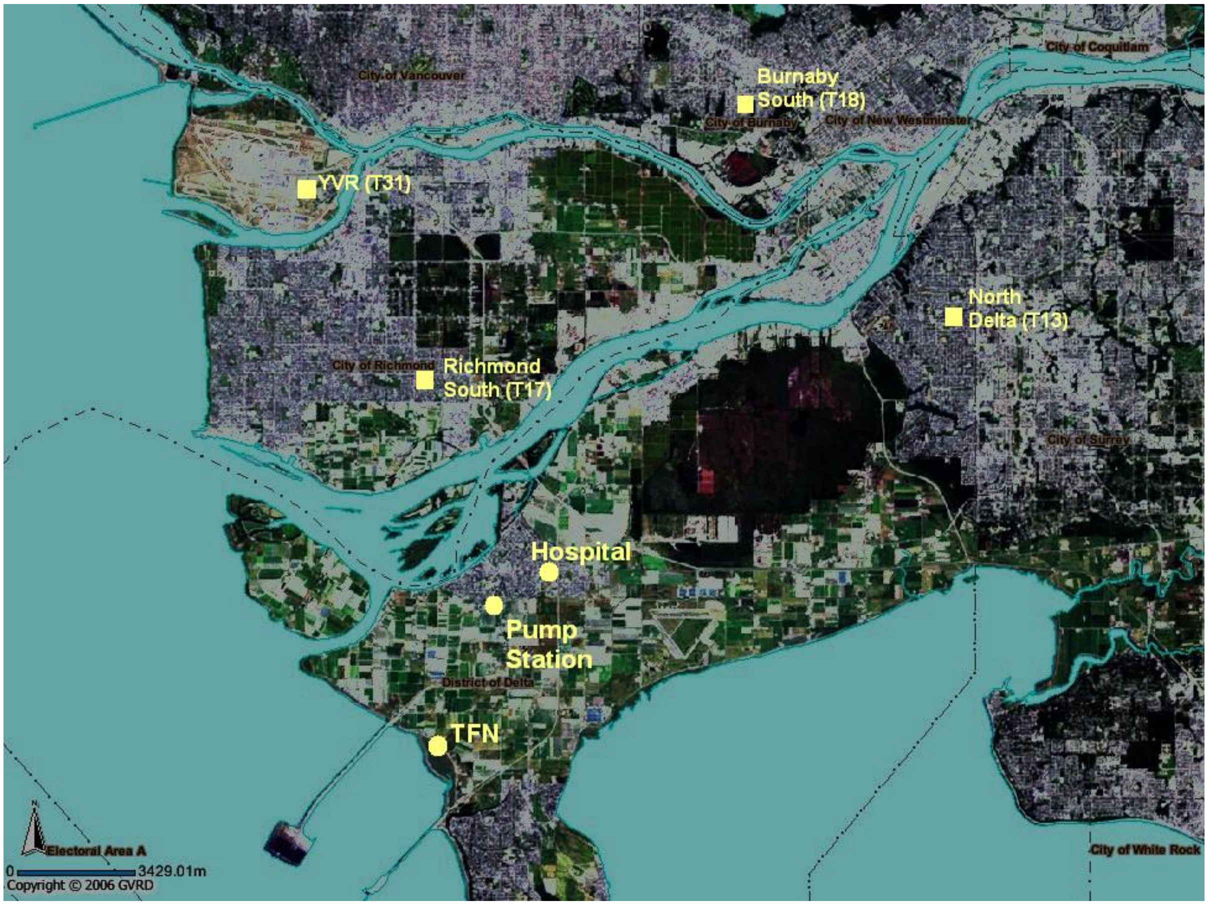
i) Richmond South (T17) – suburban / residential;

ii) Vancouver International Airport (YVR), Richmond (T31) – airport / transportation;

iii) Burnaby South (T18) – urban / residential; and

iv) North Delta (T13) – suburban / residential

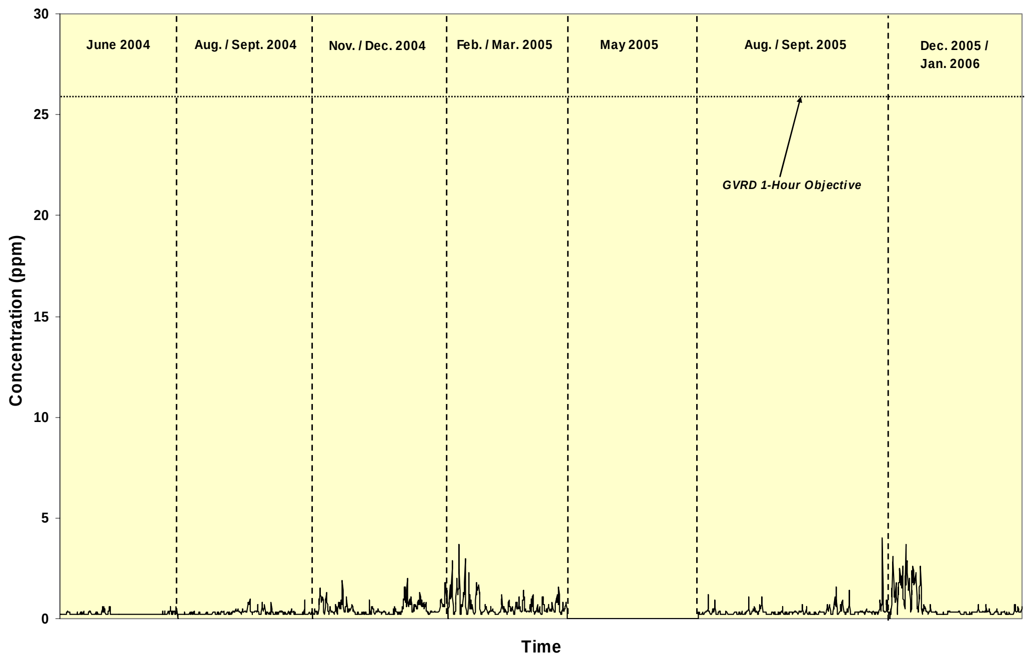
Figure 5: Map showing air quality sites used in analysis (circles are MAMU Delta study sites, squares are GVRD air quality network stations)



4.1 Carbon Monoxide

Carbon monoxide throughout the study area was generally very low when compared to the GVRD Objective. Figure 6 illustrates data from the Hospital for the period of the study. The other MAMU monitoring locations in the study area exhibited similar levels. For all sites in the study area, maximum 1-hour carbon monoxide levels were less than one-fifth of the GVRD Objective.

Figure 6: Hourly Carbon Monoxide at Delta Hospital

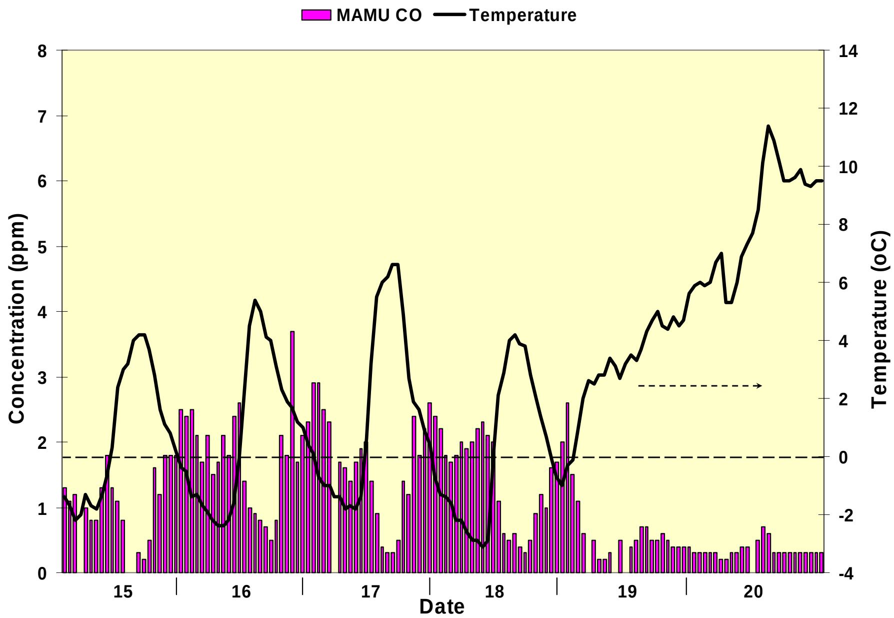


As carbon monoxide levels are low for a large portion of the year, it is only during the winter months that any clear difference between sites may be noticed. Higher carbon monoxide levels during the winter have been observed in the GVRD since monitoring for this pollutant became common during the 1970's. In the warmer periods of the year, carbon monoxide reacts more quickly with other chemicals in the atmosphere (i.e.: does not remain as carbon monoxide). During the winter the chemical reactions are slower and therefore higher levels of carbon monoxide are measured. In addition, emission inventories are now indicating that actual carbon monoxide emissions (emissions per kilometer traveled) are higher during the winter. The reason for this is not yet well understood.

Closer examination of these winter occurrences of higher carbon monoxide values reveals that they coincide with periods of stable air when the area is under the effects of a winter high pressure system.

Figure 7 illustrates a typical cold stable period while MAMU was at the Hospital site, a period characterized by cold clear nights and cool clear days (note the diurnal characteristics of temperature and carbon monoxide). When the system broke down (on the 19^{th}) temperatures rose and the carbon monoxide returned to normally low levels.

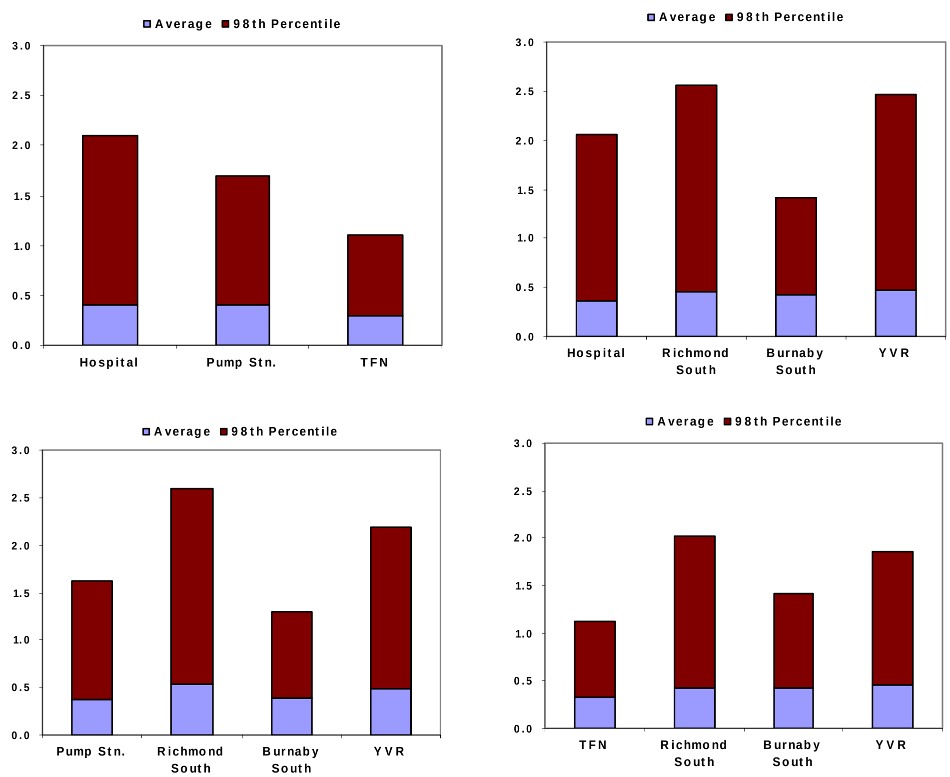
Figure 7: Temperature vs Carbon Monoxide at Hospital site December 15 – 20, 2005



Throughout this and following analyses, two terms are commonly used: (i) average and (ii) 98th percentile. The average is the arithmetic mean of the values being analyzed. The 98th percentile represents the value which 98 out of 100 values in the data series are equal to or fall below. It is a statistic that is commonly used within the air quality field and which is used extensively in air quality standards or objectives (eg: Canada-Wide Standards).

Figure 8 presents a comparison of average carbon monoxide readings between sites within the study area as well as a comparison of study area carbon monoxide levels with levels recorded at other GVRD stations.

Figure 8: Comparison of Hourly Carbon Monoxide (ppm)



Within the study area, the Hospital site recorded the highest (98^{th} percentile) carbon monoxide levels while TFN recorded the lowest. This may be related directly to the proximity of the Hospital site to major sources of carbon monoxide (e.g.: transportation corridors and domestic heating) and the lack of such sources close to the TFN site.

The other three plates in Figure 8 compare data from the three long-term study sites to data from nearby GVRD network sites, for the same time periods. The Richmond South location is in a residential neighbourhood just west of Highway 99 and is impacted by emissions from these sources. Similarly, the YVR site is close to major transportation routes on Sea Island. The Burnaby South site is located at Burnaby South Secondary School in a residential neighbourhood and more removed from major carbon monoxide sources.

The Hospital and Pump Station site 98^{th} percentile readings were lower than levels measured at Richmond and YVR but greater than levels measured in Burnaby. Average readings at all three study areas sites were the same as or slightly less than those recorded at the comparison sites. Both 98^{th} percentile and average readings at TFN, however, were the lowest of all the sites used in this analysis. These differences may be directly related to the proximity of any of the sites to transportation sources, the major source of carbon monoxide within the GVRD.

In summary:

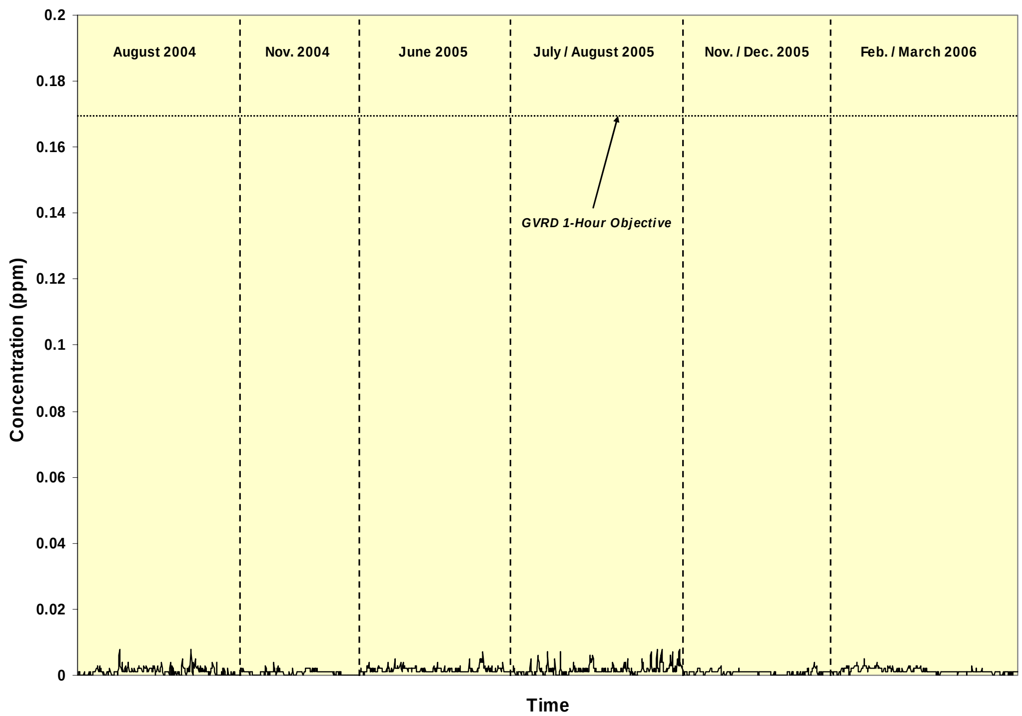
- carbon monoxide levels in the study area were very low compared to the GVRD Objective;
- higher levels were measured during the winter (the same as other areas in the GVRD);
- peak winter levels tend to be meteorologically driven;
- within the study area, highest carbon monoxide readings were recorded in areas close to major transportation routes and populated areas (Ladner area as opposed to TFN); and
- carbon monoxide levels in the study area were generally similar to or less than those measured at other stations in the region.

4.2 Sulphur Dioxide

Sulphur dioxide levels throughout the study area were very low when compared to GVRD objectives. Figure 9 illustrates hourly sulphur dioxide measurements recorded at the TFN site during the study. Other MAMU sites in the study area exhibited similarly low levels. Hourly sulphur dioxide levels were less than 10% of the GVRD Objective.

An analysis of 24-hour sulphur dioxide measurements also showed that all study sites were very low compared to the GVRD Objective.

Figure 9: Hourly Sulphur Dioxide at TFN

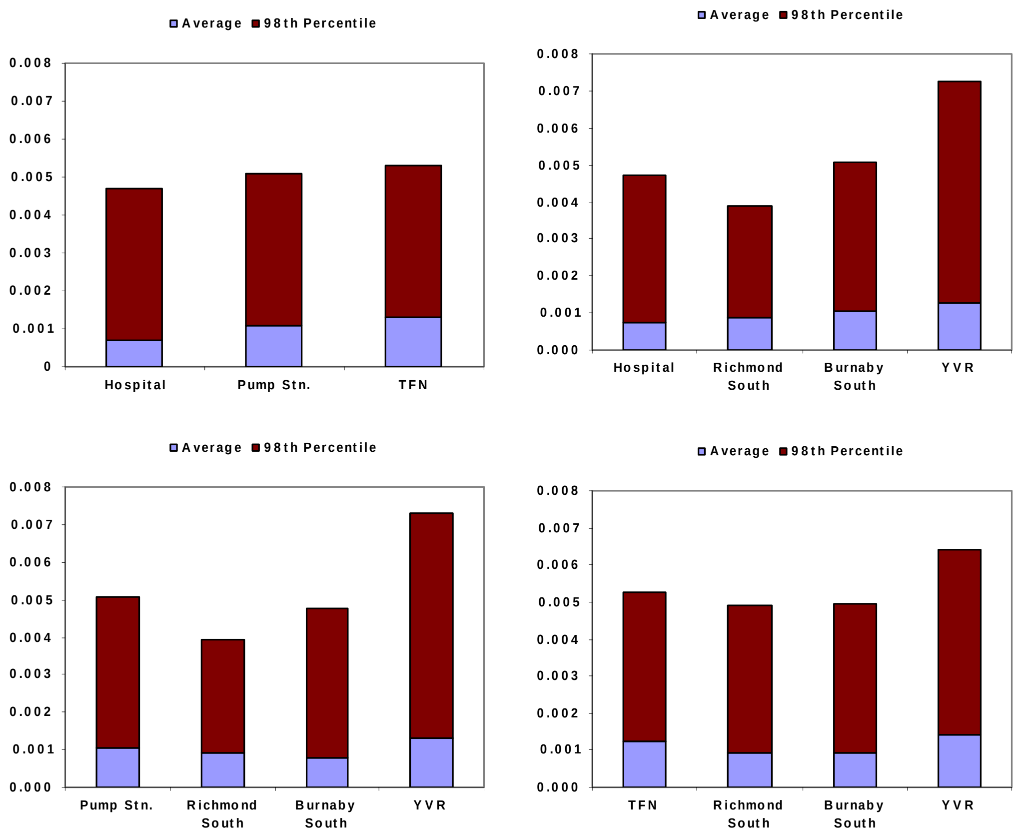


Both 1-hour and 24-hour sulphur dioxide measurements collected during the study exhibited no definitive seasonal trends. Differences in average and 98th percentile 1-hour sulphur dioxide measurements between the study sites were small (see Figure 10). Overall, values at the Hospital site were less than the other two sites and values at TFN were generally the highest of the three sites.

The last three plates in Figure 10 compare data from the three long-term study sites to data from nearby GVRD network sites, for the same time periods. Differences between the average sulphur dioxide levels across the sites used in this evaluation are small but of the comparison sites, YVR has the highest average and Richmond South the lowest. Average sulphur dioxide at the Hospital was lower than the comparison sites while average levels at the Pump Station and TFN were slightly higher than those at Richmond South and Burnaby South.

98th percentile values from the study sites and the Burnaby South location are similar. Data from the YVR location is higher than all other stations in this analysis and Richmond South was lower (Figure 10). 98th percentiles for the study sites were less than YVR, more than Richmond South and were the same as Burnaby South.

Figure 10: Comparison of Hourly Sulphur Dioxide (ppm)



The annual objective for ambient sulphur dioxide levels within the GVRD is 0.011 ppm (30ug/m^3). The annual averages for the Delta study area, as well as for Richmond South, Burnaby South and YVR for the same time frame were all about 0.001 ppm, or less than 10% of the GVRD Objective.

In summary:

- sulphur dioxide levels throughout the study area were very low and were less than 10% of relevant GVRD Ambient Air Quality Objectives;

- sulphur dioxide levels at TFN were the highest in the study area;

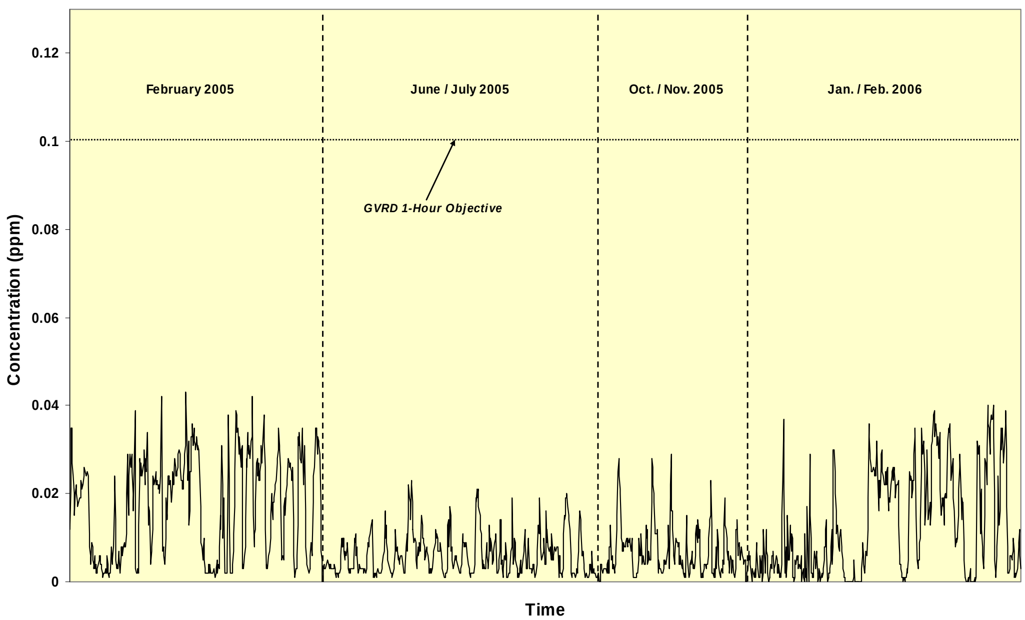
- no discernable temporal sulphur dioxide distributions could be distinguished within the study area; and

- sulphur dioxide levels in the study area were similar to those measured at other stations in the region generally falling between the highest and lowest comparison stations.

4.3 Nitrogen Dioxide

Throughout the study area, hourly nitrogen dioxide levels were consistently less than one-half the GVRD Objective but considerable temporal variation was noted at all study stations as illustrated in Figure 11. Figure 11 presents the hourly nitrogen dioxide measurements from the Pump Station site for the duration of the study.

Figure 11: Hourly Nitrogen Dioxide at Ladner Pump Station

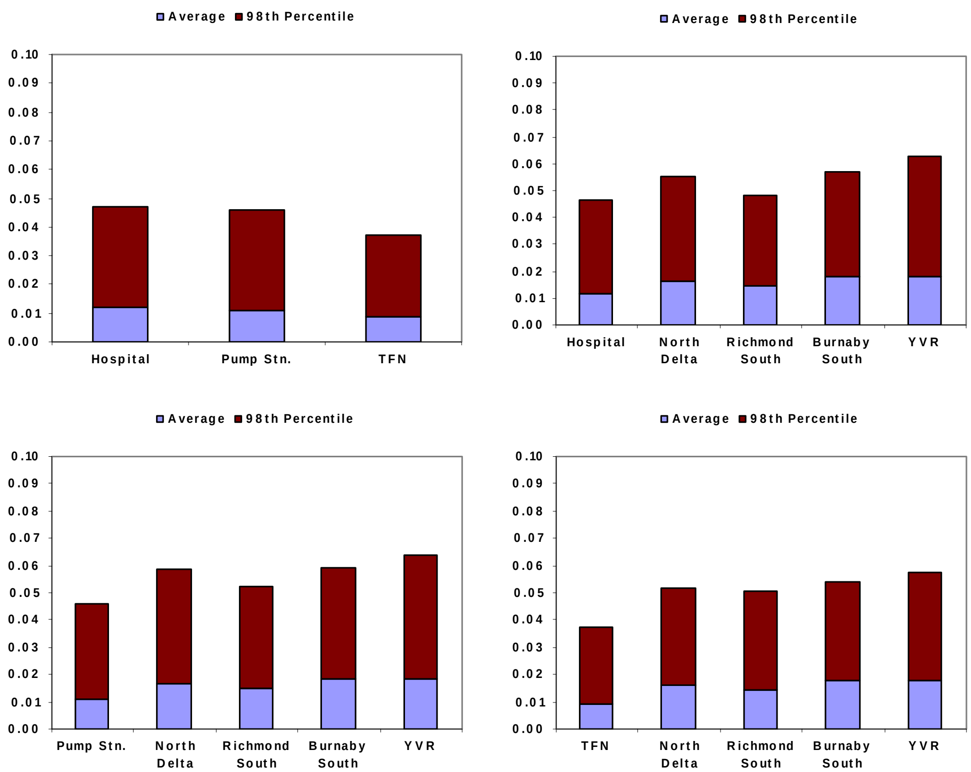


More short-term variability was noted during the cooler winter months than during the summer months. A more in-depth review of the data at this location (Pump Station) indicates that maximum nitrogen dioxide values were measured in the late afternoon and evening during the winter months. This would indicate that a major local influence at this site was local domestic heating. At the Hospital and TFN, this observation was much less pronounced indicating a higher influence of transportation and other non-seasonal sources.

Within the study area, the highest average and highest 98th percentile nitrogen dioxide levels were noted at the Hospital site and the lowest levels were recorded at TFN (Figure 12, plate 1). This reflects the differences in the proximity of the various study sites to the sources of oxides of nitrogen in the area (i.e.: TFN is more rural while the Hospital site is surrounded by transportation facilities, and commercial and residential buildings).

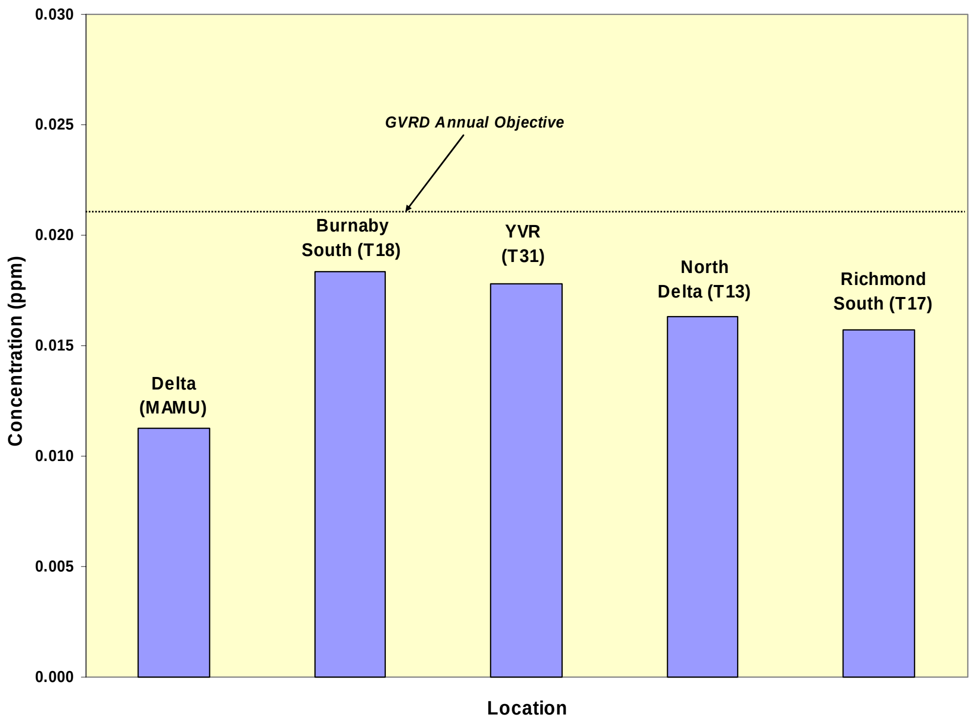
Figure 12 (plates 2-4) compare data from the three long-term MAMU monitoring locations with data from other sites in the GVRD. In all cases, nitrogen dioxide data from the study area was less than other locations.

Figure 12: Comparison of Hourly Nitrogen Dioxide (ppm)



Annual nitrogen dioxide levels and their relation to the GVRD objective are presented in Figure 13. This figure illustrates that annual nitrogen dioxide levels in the Delta study area are substantially less than other areas within the GVRD at approximately one-half the GVRD Objective. This is reflective of the more rural (i.e.: less urbanized) nature of this region of Delta (compared to other sites used in the study) and the lower level of oxides of nitrogen sources.

Figure 13: Annual Nitrogen Dioxide



In summary:

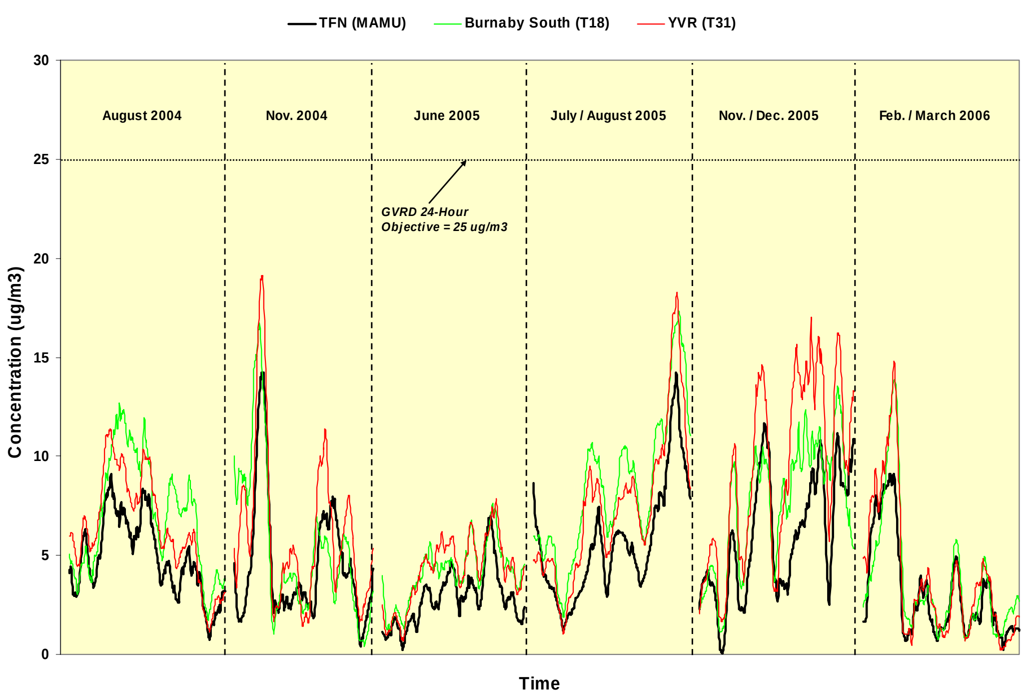
- hourly and annual nitrogen dioxide levels in the study area were less than or equal to one-half the GVRD Objective;
- slightly higher hourly levels were measured during the winter;
- within the study area, highest hourly nitrogen dioxide readings were recorded in areas close to major transportation routes and populated areas (Ladner area as opposed to TFN); and
- nitrogen dioxide levels in the study area were generally less than those measured at other stations in the GVRD.

4.4 Fine Particulate ($PM_{2.5}$)

Objectives for fine particulate ($PM_{2.5}$) are based on a 24-hour average. Within the GVRD, fine particulate is measured continuously (hourly) with a rolling 24-hour average being calculated every hour. Figure 14 presents the 24-hour rolling averages for the TFN site (as well as Burnaby South and YVR), for the period of the study.

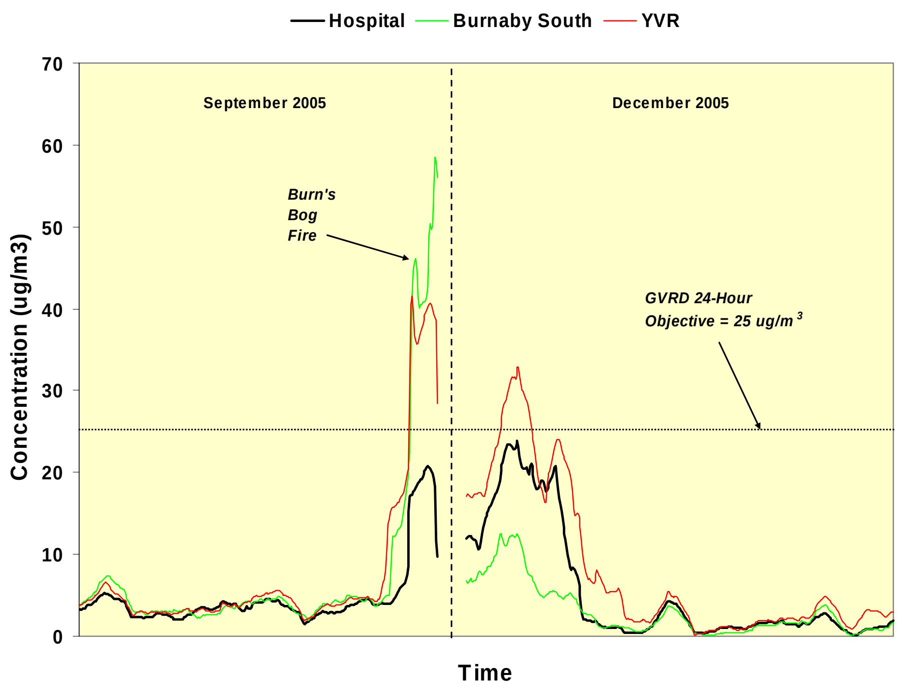
From this figure, it is evident that fine particulate levels can vary greatly over time, with levels going up and down together between the sites. Correlation coefficients between the study sites shown in Figure 14 range from 0.83 to 0.90 with the relationship between the study sites and comparison sites showing similar results. This indicates that changes in fine particulate are a regional phenomenon, rather than a phenomenon driven by local sources.

Figure 14: 24 Hour Fine Particulate at TFN



At all study sites within Delta, $PM_{2.5}$ was less than the GVRD Objective of $25ug/m^3$. The only occasions when the 24-hour $PM_{2.5}$ value approached the GVRD Objective in the study area was during the fall and winter of 2005-2006. These occurrences were during the 2005 Burn's Bog fire and an extended period in late 2005 when the region was under a stable high pressure weather pattern. This pattern led to stagnation in the area and a subsequent build-up of pollutants (see Figure 15).

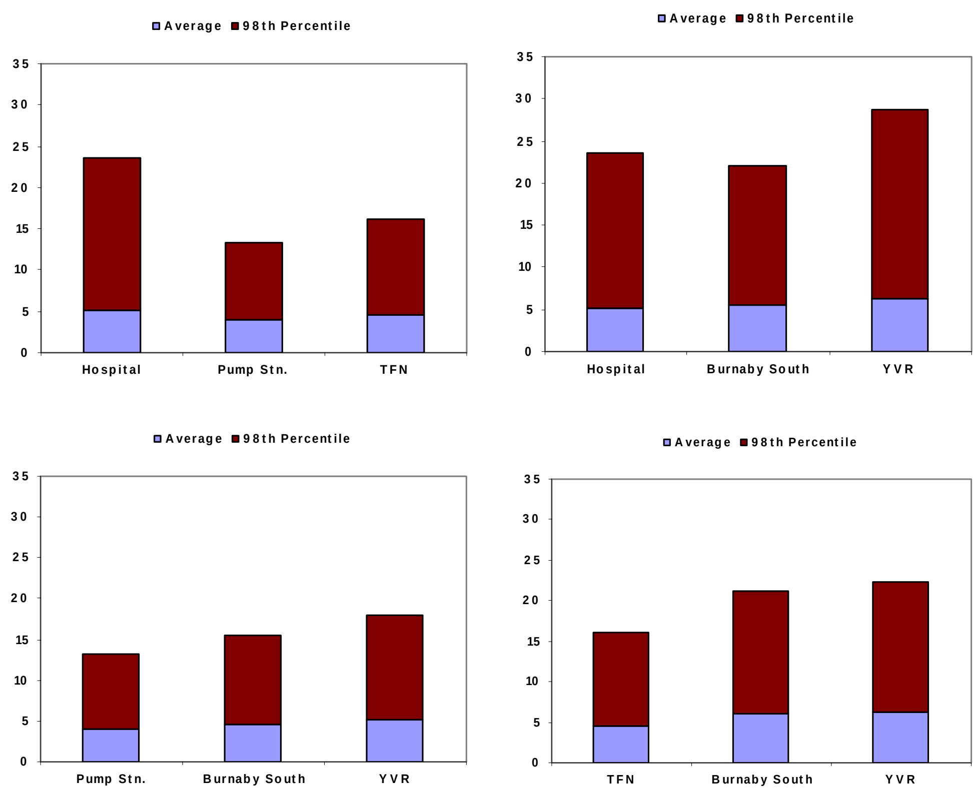
Figure 15: 24-Hour Fine Particulate: September – December, 2005



These elevated $PM_{2.5}$ occurrences took place while MAMU was at the Hospital location. The Burn's Bog Fire plume never directly impacted the Hospital site but did directly impact the other two locations, the results of which may be seen in Figure 15. For the stagnation period in December, the impact was more pronounced at YVR and the Hospital site which are near sea level, as opposed to the Burnaby South site which is more elevated. This indicates that low-level inversion conditions were present trapping pollutants close to the ground in more low lying areas of the region.

Figure 16 presents a summary of average and 98^{th} percentile 24-hour fine particulate readings for the study sites and the network comparison sites. Average fine particulate levels at the study sites were 5ug/m^3 or less. The 98^{th} percentile value at the Hospital location was considerably higher than the other two locations, primarily due to the two episodes noted above. TFN readings were slightly higher than those measured at the Pump Station. A review of the detailed results indicates that this is particularly true during the winter period.

Figure 16: Comparison of 24-Hour Fine Particulate (ug/m^3)

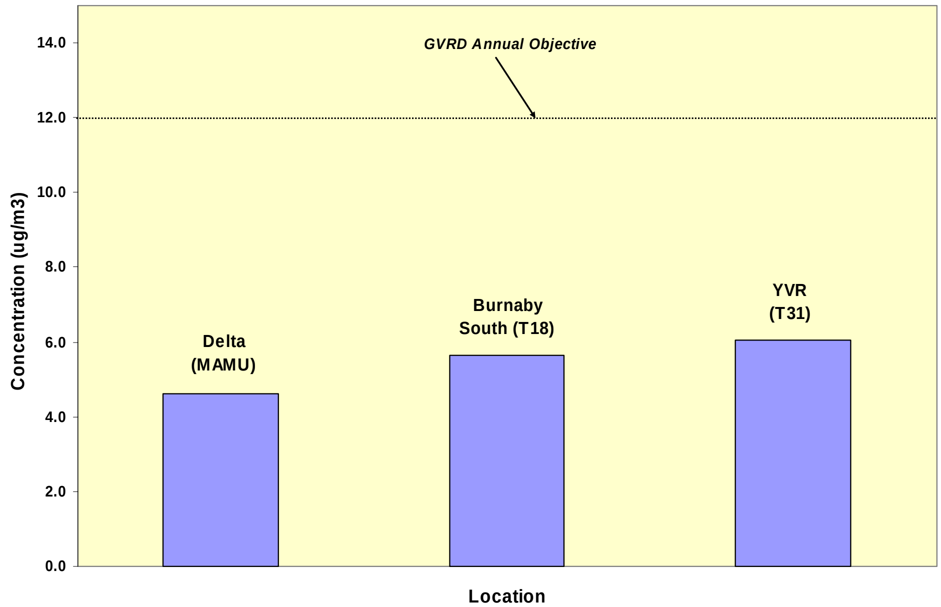


The impact of the fall / winter elevated levels on 98th percentile readings are also evident when data from the Hospital location is compared to data from Burnaby South and YVR, while average levels between these three sites were similar (Figure 16).

For the Pump Station and TFN, average and 98th percentile fine particulate readings were lower than the comparison sites in neighbouring municipalities. This may be due to the more rural nature of these two sites, more distant from major urban sources of primary fine particulate.

Figure 17 presents mean annual levels of fine particulate for the study area and the comparison sites. Average annual levels of fine particulate for the study area were lower than the comparison sites, and were 50% or less of the GVRD Annual Objective.

Figure 17: Annual Fine Particulate



In summary:

- 24-hour average fine particulate levels in the study area were less than the GVRD Objective of 25 ug/m^3;
- the lowest levels were measured in south Ladner at the Pump Station location;
- 24-hour fine particulate levels were the same as or less than levels measured at other stations within the GVRD; and
- annual average fine particulate levels in the study area were less than 50% of the GVRD Objective and less than levels observed in neighbouring municipalities.

5.0 Summary and Conclusions

In summary, the two-year study of ambient air quality in the Ladner / Tsawwassen area of Delta concluded that:

- all short-term (1-hour and 24-hour) and long-term (annual) air quality levels in the study area met the relevant GVRD objectives;

- air quality levels in the study area were generally lower than levels recorded in surrounding portions of the GVRD; and

- air quality levels tended to be higher in the more urbanized zones (eg: Hospital site) than in the more rural zones (eg: TFN and Pump Station sites) of the study area.

Specifically,

- carbon monoxide and sulphur dioxide levels were very low when compared to GVRD Objective levels (i.e.: less than 10%);

- higher carbon monoxide levels in the winter near to transportation routes (the same as other sites within the GVRD) were meteorologically driven;

- levels of nitrogen dioxide in the study area were less than 50% of GVRD objectives and were lower than other comparable GVRD monitoring sites;

- higher levels of nitrogen dioxide were recorded in the more urbanized areas and closer to transportation routes;

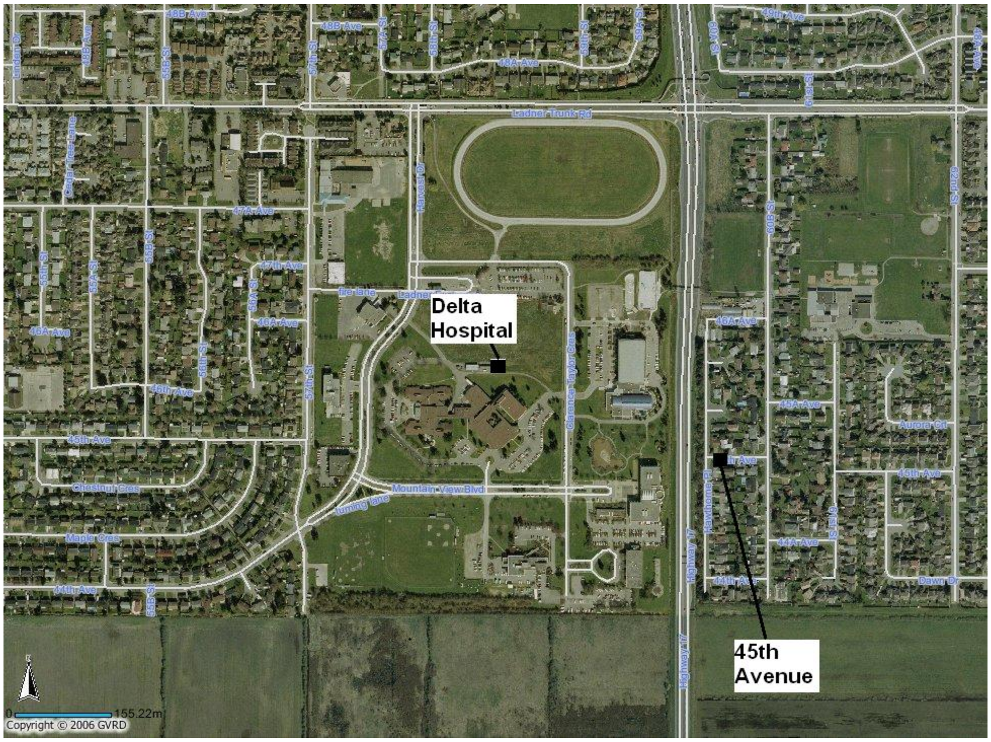
- fine particulate levels measured within the study area were the same as or less than other areas in the GVRD; and

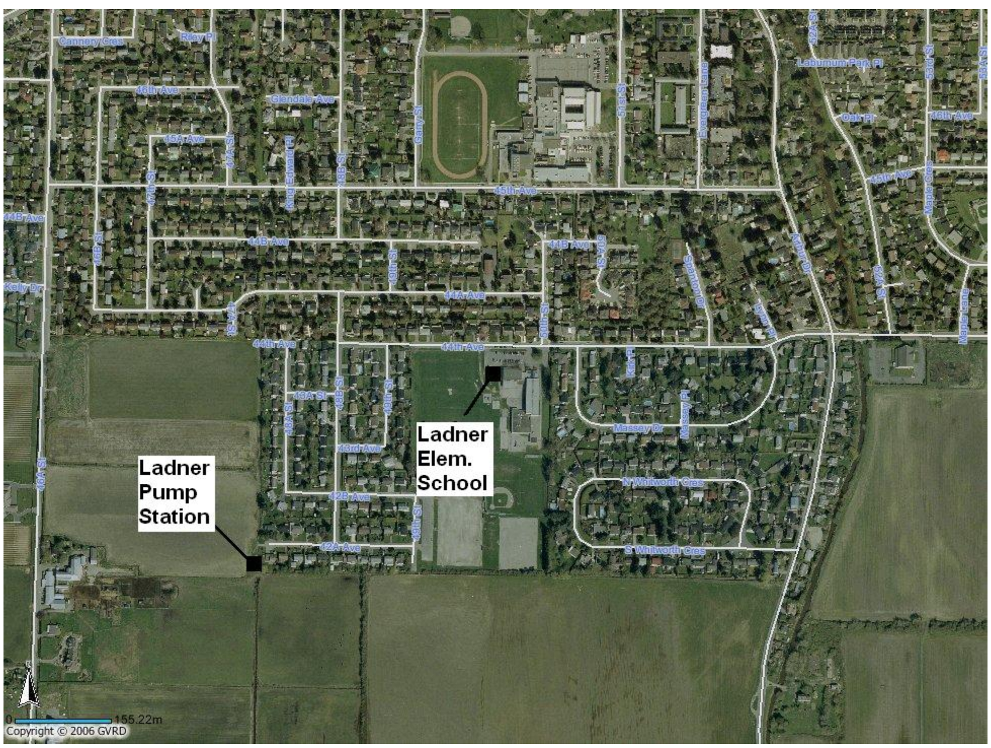
- higher levels of fine particulates were measured in the more urbanized areas and closer to transportation routes.

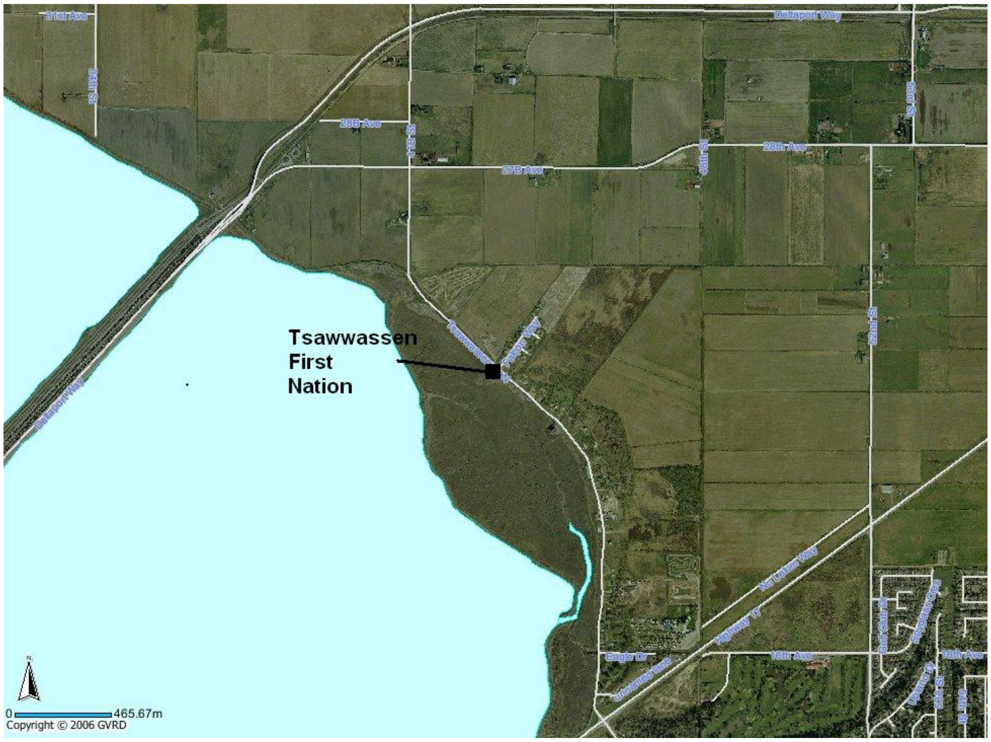
In conclusion, measured air quality within the Delta study area was generally good. Occurrences of higher concentrations tend to be related to the proximity of the study sites to population concentration areas and transportation routes, as well as to meteorological conditions at the time of measurement.

Appendix A

Detailed Aerial Photographs of Study Site Monitoring Stations


Delta
Hospital
45th
Avenue
155.22m
Copyright © 2006 GVRD


Ladner
Elem.
School
Ladner
Pump
Station
155.22m
Copyright © 2006 GVRD



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