Midpeninsula Regional
Open Space District

R-14-126
Meeting 14-29
October 22, 2014

AGENDA ITEM 3

AGENDA ITEM

Rancho San Antonio Air Monitoring Study Final Report and Presentation

GENERAL MANAGER'S RECOMMENDATIONS

Receive the final presentation of the results from the air quality monitoring study conducted at Rancho San Antonio Open Space Preserve and accept final monitoring report.

SUMMARY

Eric Winegar, PhD, of Winegar Air Sciences, will present final results from the air quality monitoring study completed for the Rancho San Antonio Open Space Preserve (OSP). The study was initiated in January 2013 and continued until equipment was removed in mid-June, 2014. The purpose of the study was to assess perceived impacts from quarry activities on the public who regularly visit OSP and District employees who work there daily and/or live on site. The data collected during the study period shows that the air quality at Ranch San Antonio OSP reflected a low-impact environment, with some effect from the nearby industrial (Lehigh Southwest Cement Plant and Quarry) and urban areas. This is largely attributed to the overwhelming influence of a clean marine dominated air mass which typically blows into the area off of the Pacific Ocean, substantially diluting local pollution sources.

DISCUSSION

On January 9, 2013, the Midpeninsula Regional Open Space District (District) Board of Director's authorized an award of contract in the amount of $180,552 to Winegar Air Sciences, to undertake a year-long air quality monitoring study at Rancho San Antonio Open Space Preserve (R-13-11). This study was initiated in response to public and District staff concerns regarding potential air quality impacts within the Preserve from the adjacent Lehigh Permanente quarry and cement plant.

The Board was previously briefed on the project's progress at the Board meetings of February 13, 2013, June 26, 2013, July 24, 2013 (R-13-11), February 4, 2014, and August 6, 2014. Given the widespread interest in the study, these progress reports were also distributed to interested parties, including adjacent municipalities and the management of Lehigh Quarry.

Sample Sites and Parameters Measured

Two primary air quality monitoring stations were established within Rancho San Antonio OSP; one located at the Annex (main station), and the other located adjacent to the PG&E Trail, the

Preserve trail closest to the Point of Maximum Impact (PMI) as identified in Lehigh's 2011 Health Risk Assessment. The parameters monitored at these stations included the following:

- Continuous read monitoring instruments to measure:
  - PM10 (particulate matter less than 10 micrometers in diameter),
  - PM2.5 (particulate matter less than 2.5 micrometers in diameter, at the Annex site only),
  - Black Carbon (an established surrogate for diesel exhaust).
- Shorter duration, specific sampling events to measure specific elemental constituents (e.g. metals) and different particle sizes (particle size and elemental analysis can provide a unique signature of various air masses, useful in identifying plume origin).
- 24 hour integrated filter samples were also obtained for metals.
- Short-duration sampling instruments to screen for toxics which include: volatile organic compounds (VOC's), mercury, and chromium VI.

A third monitoring site was established at the Deer Hollow Farm. This location was set up to monitor PM10 to compare the data with the other two sites. After an initial monitoring period of approximately one month, data from this site indicated an overall low concentration average, without adding appreciable value to data being collected at the PG&E and Annex sites. Therefore monitoring at this location was discontinued.

Offsite "background" monitoring was also conducted to better understand the nature (constituents) and movement of the urban air masses that interact with the air at the adjacent Rancho San Antonio OSP. One background location was the roof of the District administrative office (named OSD), and one was in a residential area, north-west and upwind of Rancho San Antonio OSP (named BLN). Parameters monitored at the background locations include: PM10, Black Carbon, elements/metals, and toxics (VOC's, mercury, and chromium VI).

Additionally, the District employee residence at Rancho San Antonio OSP was monitored for PM10. This sample site was added to collect data to compare and correlate with the nearby Annex monitoring site given the importance and sensitivity of the residential use.

All monitoring sites were outfitted with weather sensors for wind speed and direction to help understand air mass movements and potential plume movement at the Preserve.

Additionally, in February 2013, letters were sent to adjacent municipalities and interested parties to inform them of the ongoing study and to inquire if there was interest in funding/expanding the study to areas outside of Rancho San Antonio OSP. No responses were received.

Results

The data collected during the study period show that the air quality at Ranch San Antonio OSP reflects a low-impact environment, with some effect from the nearby industrial (Lehigh Southwest Cement Plant and Quarry) and urban areas. This is largely due to the overwhelming influence of a clean marine dominated air mass which typically blows into the area off of the Pacific Ocean, substantially diluting local pollution sources. The data has been evaluated against State and Federal air quality standards established to protect human health.

Particulate matter (PM10 and PM2.5) levels measured during the study period were relatively low or consistent with concentrations measured in adjacent urban areas, and within the region.

Parameter	Sample Location	Average Concentration (ug/m^3)	CA Standard; (ug/m^3)	San Francisco Bay Air Basin Average Concentration (ug/m^3)
PM10	Annex	16	20	26-35
	PG&E Trail	22		
	Background OSD	26		
	Background BLN	13.2		
PM2.5	Annex	13	12	13-16

The PM10 data above indicates that the air upwind of Rancho San Antonio, as measured at Background location BLN, is well below the California standard. At the Annex site in Rancho San Antonio, PM10 is slightly higher than at the Background BLN location, but is still well below the standard. PM10 near the property line with the Lehigh cement plant and quarry at the PG&E Trail location however, is degraded when compared with the above sites, with concentrations exceeding the California standards. This finding indicates that Lehigh's operation is impacting the PG&E Trail location. The average PM10 concentration of $22ug/m^3$ measured at the PG&E location is higher than the upwind BLN background location, and the Annex, but is consistent with, and on the low end of, average concentrations documented within the San Francisco Bay Air Basin, as shown in the table above. The background OSD monitoring site PM10 concentration is consistent with urban locations measured within the Air Basin.

The PM 2.5 average concentration measured at the Annex is above the California standard, yet is also within the range of concentrations documented for the San Francisco Bay Air Basin.

Additional regional PM data is presented and discussed in the Final Report.

The data show that black carbon and most toxic parameters of potential concern were well below human health risk levels established by the California Office of Environmental Health Hazard Assessment. A sample of data for these parameters, from the sites with the highest measured values during the study, is presented in the table below:

Parameter	Sample Location	Average Concentration (ng/m^3)	Reference Exposure Limit (REL)
Black Carbon	Annex	235	5,000 ng/m^3
	PG&E Trail	332	
	Background BLN	269	
	Background OSD	602	
Mercury (Hg)	PG&E Trail	2.9	300 ng/m^3
Chromium VI	PG&E Trail	0.4	200 ng/m^3
Benzene*	Annex	2.3	3 ug/m^3
	PG&E Trail	2.7	
	Background BLN	2.5	
	Background OSD	1.6	
* Benzene data affected by average of 0.73 mg/m^3 in laboratory blank contamination. Results are therefore qualified; data is likely biased high. See report for details.			

A broad suite of metals, and volatile organic compounds (VOCs) /gasses were measured and analyzed as a part of this study. The concentration levels as a whole are representative of a minimally impacted zone, adjacent to potential major sources (Lehigh, Highway 280, and urban areas). The sampling results were below health risk levels, and are presented in the Final Report.

The air quality impacts associated with the neighboring Lehigh operations are low for most of the parameters measured. There are some impacts, particularly in airborne calcium dust measured in the DRUM sampler (Davis Rotating Unit for Monitoring) data, where calcium enrichment is clearly evident. The report concludes that there are elevated levels of calcium dust at Rancho San Antonio OSP, which is attributed to the Lehigh cement plant and quarry where large amounts of calcium dust are produced as part of their industrial processes. The enriched level of calcium is also a constituent of PM10, and is represented in that data as well. These impacts at RSA are considered to be nuisance level impacts as opposed to health risk level impacts.

The District has retained a third party Certified Industrial Health (CIH) specialist to review the report and provide an additional opinion. This review is currently in process and is unavailable at this time. Staff is anticipating completion in time to present at the Board meeting.

FISCAL IMPACT

The budget to conduct the air monitoring study was approved by the Board in the FY2013-14 and FY2014-15 budgets totaling $180,000. The study has been completed within the budget allocated.

BOARD COMMITTEE REVIEW

No Board committee review was needed for this item as this subject has been taken up by the full Board from inception.

PUBLIC NOTICE

Public notice was provided as required by the Brown Act.

CEQA COMPLIANCE

Presentation of the air quality monitoring study at Rancho San Antonio Open Space Preserve does not constitute a project under the California Environmental Quality Act (CEQA).

NEXT STEPS

When completed, the Rancho San Antonio Air Monitoring Study Final Report will be distributed to interested parties. Staff will continue to work with Lehigh, the BAAQMD, and Santa Clara County, to identify and reduce nuisance level dust impacts to Rancho San Antonio OSP, and continue to support the BAAQMD's permit requirements, regulations, and implementation of the Lehigh facility emissions and fugitive dust upgrades to improve local air quality and to achieve effective air quality monitoring of operations.

Attachment

1. Final Report of Air Monitoring at Rancho San Antonio OSP.

Responsible Department Head:
Kirk Lenington, Natural Resources Manager

Prepared by:
Matt Baldzikowski, Resource Planner III

WINEGAR AIR SCIENCES
OCTOBER 2014
EXECUTIVE SUMMARY

INTRODUCTION

In January 2013, Winegar Air Sciences was hired by the Midpeninsula Regional Open Space District to undertake an extensive air quality monitoring study at Rancho San Antonio Open Space Preserve. This study was initiated in response to public and District concerns regarding potential air quality impacts within the Preserve from the adjacent Lehigh Permanente quarry and cement plant. Air monitoring was conducted at the Rancho San Antonio Open Space Preserve located within Santa Clara County, near the cities of Cupertino and Los Altos Hills, California. Monitoring was undertaken at two main sites from January 1, 2013 to June 22, 2014: the Annex Building adjacent to the Midpeninsula Regional Open Space District (MROSD) Foothills Field Office, and at a point on the PG&E trail. Both these locations are noted in Figure 1. Data collection was performed at two other background locations off site; the Open Space District Offices in Los Altos, California, and within a residential area located in Los Altos Hills.

The objective of this monitoring was to collect data on a wide range of pollutants and other air quality observables in order to assess the possible impact to workers and park visitors from nearby and regional sources of pollution. As with other air quality standards, the primary emphasis was on possible health impacts, however, secondary impacts to property were included as well.

An extensive list of parameters, consisting of 110 separate substances or chemical species, was measured, and is detailed in Section 2 of this report. Site selection and the methods employed to collect the data are discussed in Sections 3 and 4 respectively. As much as possible, EPA promulgated methods were used. Other test methods utilized standard air monitoring approaches in terms of calibration and quality assurance.

Data was collected over a range of time resolutions--continuous, semi-continuous, episodic, and integrated, mostly on a 1-hr basis. A sufficiently high level of data capture from the various instruments was obtained such that seasonal trends could be examined as well as individual events, such as occurred.

Throughout the monitoring period, regular checks were made of the equipment to ensure good operation. Equipment failures occurred, as is normal, and substitutions or repair were made, however, some gaps in coverage did result. Overall, however, the capture rate provided a sufficient long-term picture of the sites.

RESULTS

The data collected was analyzed and summarized. Details will be presented in individual sections related to each parameter. Overall averages were computed in order to compare to long-term health standards and State and Federal air quality standards.

Tables ES-1 through ES-4 contain summaries of the different types of monitoring data as well as comparison to relevant agency-derived health-based standards. Four types of standards or reference concentration levels were used:

- US EPA National Ambient Air Quality Standards
- California Ambient Air Quality Standards
- Chronic Reference Exposure Level (REL)
- Regional Screening Level (RSL)

The key set of standards is the Reference Exposure Level (REL), which are based on California Office of Environmental Health Hazard Assessment (OEHHA) evaluation of lifetime risk from exposure. Chronic RELs are designed to address continuous exposures for up to a lifetime: the exposure metric used is the annual average exposure.

Another set of the health standards are the Regional Screening Levels (RSL), a concentration-based standard that is based on the assumed exposure period of 70 years. From the EPA Region 9 website:

> "They are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. SLs are considered by the Agency to be protective for humans (including sensitive groups) over a lifetime."[1]

A health-based review was performed on the results, comments from that review are presented later in report Section 5. The conclusion was that the majority of the measured targets were below applicable health or regulatory standards, mostly by large factors. The exceedances that did exist were only slightly above the standard, and for several of the detected chemical species, were present at all sites, including upwind. Therefore, from a health standpoint, the data set shows that there was no major exceedance of any relevant health standard that should cause concern to workers, the visiting community, and the onsite residences.

Major sources for exposure pathways were the Lehigh cement plant/ quarry, the nearby I-280 corridor, and the general urban area ("Silicon Valley") in the Santa Clara valley that borders the site to the east and north, with its attendant load of pollutants from many sources. Of course, a major concern for many at the site and in the community was the possible impact from the nearby cement plant and quarry. The data presented in this report shows that only minor impacts are attributable to the cement plant. Key pollutants that would be indicative of cement plant emissions were not detected at high levels, such as PM10, sulfur dioxide and various toxics, including mercury and hexavalent chromium, both chemicals of special concern. Similarly, another minor contributor was the combined other local sources, such as the highway and urban area.

Monitoring was also conducted over two extended periods by the Bay Area Air Quality Management District (BAAQMD)[2] in response to public concerns related to potential cement plant emissions. BAAQMD monitoring results concluded that the overall impact to the community was low, and the general pollutant levels were consistent to many local communities with an urban environment nearby. Tables ES-1 and ES-2shows the comparison of the results from the local study conducted in Cupertino (Monta Vista) concurrently with the current study.

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[1] http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/faq.htm#FAQ1

[2] http://www.baaqmd.gov/Divisions/Technical-Services/Special-Projects/Cupertino.aspx

Key reasons for these observations are local meteorology and topography. The dominant wind direction is from the west-south-west (avg. = 245 degrees) and the northwest. Both directions transport clean oceanic air over the mountains, though there is some potential for the southwest to transport quarry fugitives. The wind pattern for the Annex supports a lower wind speed than outside areas, suggesting a sheltering effect due to the topology. thus affecting some regional transport.

The topography of the main trail area near the Office, Annex and leading to Deer Hollow—a valley area with steep walls to the west, appears conducive to stagnant air and shielding from some regional influence. The transport of polluted air masses are affected by this topography, hence the regional upper atmosphere may become the method for transport of polluted air masses.

Thus, the aerosol data shows found excess levels of sodium and chloride from sea salt, showing the effect of the oceanic air influence. In fact, Table ES-2 shows that one of the few exceedance of the RSLs for elements was for chloride, from sea salt, found in all areas. All in all, the data shows the strong influence of cleaner air input mixed with minor influences from other nearby sources.

A particular concern at the site was the observed deposition of white particulate on surfaces in the area, particularly cars. This was observed as well during the study. Calcium enhancements were found in aerosol measurements, deposition tests, wipe tests, and soil analysis. Besides the results from the deposition samples, other aerosol results show an excess of calcium in the atmosphere, as compared to expected levels in normal soil, a major component of the measured aerosol. This confirms the previous examinations and conclusions regarding the source of this deposition: the Lehigh cement plant/quarry, which produces limestone, a calcium stone quarried at the site and used in the cement operation, leading to both source-based emissions and fugitive emissions.

CONCLUSION

The overall conclusion from this testing program was that the Rancho San Antonio Open Space Preserve is well-suited to recreation for a wide-range of the public due to its relatively clean atmosphere with minimal impact from near-by industrial and urban sources.

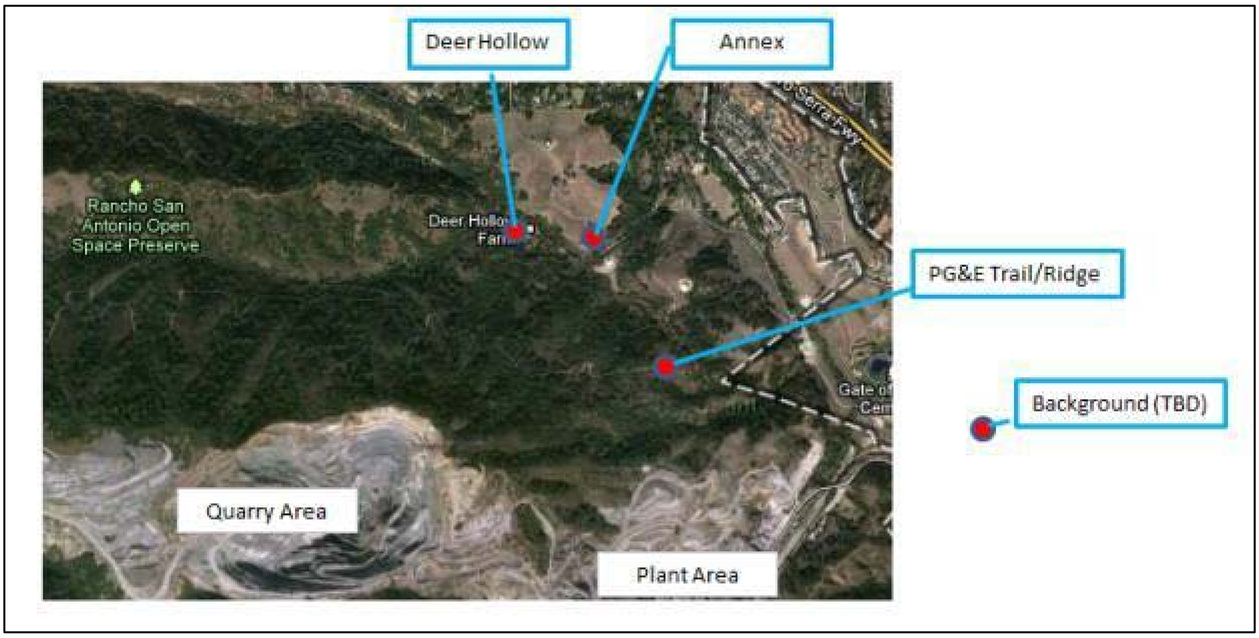

Figure 1. Map of monitoring locations
Background sites include OSD office in Los Altos and BLN residence in Los Altos Hills

. Summary Tables of Results

Table ES-1. Results of Criteria Pollutant Monitoring

Parameter	Monitoring Location	Average Concentration	CA Air Quality Standard	San Francisco Bay Air Basin Average Concentration
PM10	Annex	16 µg/m^3	20 µg/m^3— Annual avg.	26-35 µg/m^3
	PG&E Trail	22 µg/m^3		
	Background OSD	26 µg/m^3		
	Background BLN	13.2 µg/m^3		
	Cupertino[3]	13.5 µg/m^3		
PM2.5	Annex	13 (7.0)[4] µg/m^3	12 µg/m^3— Annual avg.	6.5-9.1 µg/m^3
	Cupertino	8.6 µg/m^3		
Sulfur Dioxide	Annex[5]	0.00048 ppmv	0.040 ppmv— 24 hr. avg.	0.0025-0.008 ppmv
	Cupertino	0.00076 ppmv		
Lead	Annex	0.001 µg/m^3	0.15 µg/m^3— 3 month rolling avg.	0.005-0.006 µg/m^3
	PG&E Trail	0.001 µg/m^3		
	Background OSD	0.016 µg/m^3		
	Background BLN	0.001 µg/m^3		
	Cupertino	0.023 µg/m^3		
Sulfate (Calc.)[6]	Annex	0.001 µg/m^3	25 µg/m^3— 24 hr. avg.	NA
	PG&E Trail	0.002 µg/m^3		
	Background OSD	0.15 µg/m^3		
	Cupertino	1.15 µg/m^3		
Vinyl chloride	Annex	<MDL (0.1 ppbv)	10 ppbv	<MDL (0.1 ppbv)
	PG&E Trail	<MDL (0.1 ppbv)		
	Background OSD	<MDL (0.1 ppbv)		
	Background BLN	<MDL (0.1 ppbv)		
	Cupertino	<MDL (0.1 ppbv)		

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[3] Cupertino site refers to Monta Vista monitoring site operated by BAAQMD.

[4] Estimated alternative concentration based on area PM2.5/PM10 ratio. See text for details.

[5] Annex was lone location for SO2 monitoring.

[6] Multiplied sulfur concentration by a factor of 3 to obtain sulfate estimate.

Table ES-2. Results of Non-criteria Pollutants/Toxics Monitoring

Parameter	Sample Location	Average Concentration	Reference Health Standard Concentration
Black Carbon	Annex	235 ng/m^3	5,000 ng/m^3 (REL)
	PG&E Trail	332 ng/m^3	
	Background BLN	269 ng/m^3	
	Background OSD	602 ng/m^3	
Mercury (Hg)	Annex	1.0 ng/m^3	300 ng/m^3 (REL)
	PG&E Trail	2.9 ng/m^3	
	Background OSD	0.25 ng/m^3	
	Background BLN	0.35 ng/m^3	
	Cupertino	2.0 ng/m^3	
Chromium VI	Annex	0.011 ng/m^3	100 ng/m^3 (REL)
	PG&E Trail	0.40 ng/m^3	
	Background OSD	0.008 ng/m^3	
	Background BLN	0.040 ng/m^3	
	Cupertino	NA	

ES-3. Results of Toxics Sampling

Target VOC	**OEHHA REL µg/m^3**	**Annex**		**PGE**		**OSD**		**BLN**		**Residential Air RSL (µg/m3)**	**Ind. Air RSL (µg/m3)**
	***--- =** No Standard/ Non-detected	(µg/m^3)	Exceeds REL?	(µg/m^3)	Exceeds REL?	(µg/m^3)	Exceeds REL?	(µg/m^3)	Exceeds REL?		
2,2,4-Trimethylpentane	---	1.22	NA	2.19	NA	---	---	0.92	NA	700	--
2-Butanone	---	3.21	NA	7.16	NA	---	---	---	---	520	2200
4-Ethyltoluene	---	0.76	NA	1.18	NA	---	---	---	---	0.97	260
Acetone	---	11.19	NA	8.99	NA	11.99	NA	10.87	NA	3200	14000
Benzene*	3	2.4	No	2.7	No	1.6	No	2.5	No	0.36	1.6
Bromomethane	5	0.62	No	1.05	No	--	---	---	---	0.52	2.2
Dichloromethane	400	1.30	No	1.98	No	1.24	No	---	---	63	260
Ethylbenzene	---	---	---	0.15	NA	---	---	---	---	1.1	4.9
Toluene	300	2.04	No	10.46	No	---	---	0.76	No	520	2200
Trichlorofluoromethane	---	1.38	NA	1.36	NA	1.29	NA	1.35	NA	73	310

*Benzene data affected by average of 0.73 µg/m^3 in laboratory blank contamination. Results are therefore qualified; data is likely biased high. See text for more details.

Table ES-4. Results of Elemental Monitoring

Parameter--elements	OEHHA REL (µg/m^3)	Annex		PGE		OSD		BLN	
		Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?
Arsenic	**0.015**	0.00020	No	0.00039	No	0.000001	No	0.00022	No
Cadmium	**0.02**	0.00042	No	0.00112	No	--	--	0.00065	No
Chlorine (sea salt)	**0.2**	0.85	Yes	1.5	Yes	0.43	Yes	0.82	Yes
Manganese	**0.09**	0.00523	No	0.00750	No	0.0016	No	0.00319	No
Mercury	**0.03**	0.00023	No	0.00018	No	--	--	0.00022	No
Nickel	**0.014**	0.00060	No	0.00073	No	0.0001	No	0.00060	No
Selenium	**20**	0.00084	No	0.0019	No	0.0007	No	0.00113	No

Notes:

1.Annex and PG&E Trail monitoring sites were located within Rancho San Antonio OSP. Background OSD location was located at the District Administrative Office, Background BLN was located in Los Altos Hills, typically upwind of Rancho San Antonio.

2. "California Air Quality Standard" refer to the statutory State of California ambient air quality standards.[7]

3. "REL" is the reference exposure limit, produced by the California Office of Health Hazard Assessments (OEHHA). The REL is defined as "an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level."[8]

4. San Francisco Bay Area Average concentrations are derived from a BAAQMD report.[9]

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[7] http://www.arb.ca.gov/research/aaqs/caaqs/caaqs.htm

[8] Office of Environmental Health Hazard Assessment 2007, Adoption of chronic reference exposure levels (RELS) for airborne toxicants [12/28/01], Office of Environmental Health Hazard Assessment Sacramento, accessed 31/1/2012, <http://www.oehha.ca.gov/air/chronic_rels/1201Crels.html>

[9] Initial Study/Negative Declaration for the Amendments to Bay Area Air Quality Management District Regulation 9, Rule 10: Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries, Environmental Audit, Inc.

Winegar Air Sciences

Final Report

Ambient Air Assessment at Rancho San Antonio Open Space Preserve

Prepared for:

Mid-Peninsula Regional Open Space District
Los Altos, California

Prepared by:

Eric Winegar, PhD
Winegar Air Sciences
Rancho Cordova, California

October 2014

Acknowledgements

Dr. Thomas A. Cahill of the UC Davis DELTA Group and Department of Physics provided portions of the sections relating to DRUM sampler data analysis. Dr. David Barnes, also of DELTA, provided assistance in DRUM sampler setup, data processing as well as field operations. Thanks go to both of them.

The Rancho San Antonio staff was always willing and helpful to provide equipment and personal transport to the PGE site. This was appreciated always.

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EXECUTIVE SUMMARY

INTRODUCTION

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the southwest to transport quarry fugitives. The wind pattern for the Annex supports a lower wind speed than outside areas, suggesting a sheltering effect due to the topology. thus affecting some regional transport.

The topography of the main trail area near the Office, Annex and leading to Deer Hollow—a valley area with steep walls to the west, appears conducive to stagnant air and shielding from some regional influence. The transport of polluted air masses are affected by this topography, hence the regional upper atmosphere may become the method for transport of polluted air masses.

Thus, the aerosol data shows found excess levels of sodium and chloride from sea salt, showing the effect of the oceanic air influence. In fact, Table ES-2 shows that one of the few exceedance of the RSLs for elements was for chloride, from sea salt, found in all areas. All in all, the data shows the strong influence of cleaner air input mixed with minor influences from other nearby sources.

A particular concern at the site was the observed deposition of white particulate on surfaces in the area, particularly cars. This was observed as well during the study. Calcium enhancements were found in aerosol measurements, deposition tests, wipe tests, and soil analysis. Besides the results from the deposition samples, other aerosol results show an excess of calcium in the atmosphere, as compared to expected levels in normal soil, a major component of the measured aerosol. This confirms the previous examinations and conclusions regarding the source of this deposition: the Lehigh cement plant/quarry, which produces limestone, a calcium stone quarried at the site and used in the cement operation, leading to both source-based emissions and fugitive emissions.

CONCLUSION

The overall conclusion from this testing program was that the Rancho San Antonio Open Space Preserve is well-suited to recreation for a wide-range of the public due to its relatively clean atmosphere with minimal impact from near-by industrial and urban sources.

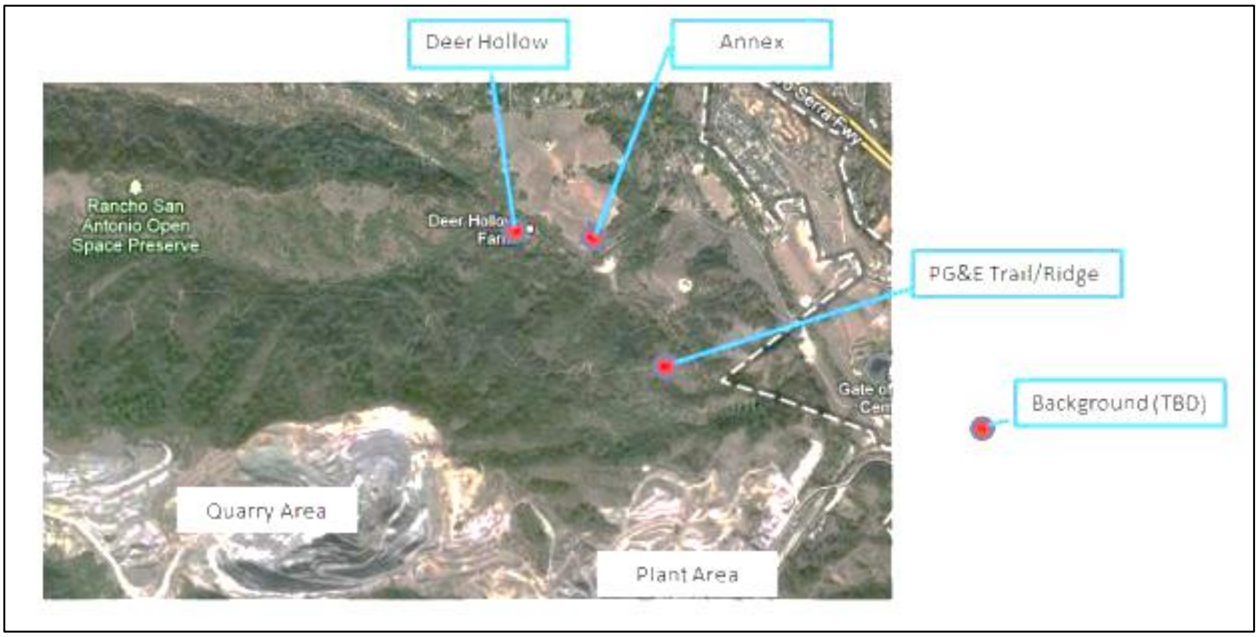

Figure ES-1. Map of monitoring locations
Background sites include OSD office in Los Altos and BLN residence in Los Altos Hills

SUMMARY TABLES OF RESULTS

Table ES-1. Results of Criteria Pollutant Monitoring

Parameter	Monitoring Location	Average Concentration	CA Air Quality Standard	San Francisco Bay Air Basin Average Concentration
PM10	Annex	16 µg/m^3	20 µg/m^3—Annual avg.	26-35 µg/m^3
	PG&E Trail	22 µg/m^3		
	Background OSD	26 µg/m^3		
	Background BLN	13.2 µg/m^3		
	Cupertino[3]	13.5 µg/m^3		
PM2.5	Annex	13 (7.0)[4] µg/m^3	12 µg/m^3—Annual avg.	6.5-9.1 µg/m^3
	Cupertino	8.6 µg/m^3		
Sulfur Dioxide	Annex[5]	0.00048 ppmv	0.040 ppmv—24 hr. avg.	0.0025-0.008 ppmv
	Cupertino	0.00076 ppmv		
Lead	Annex	0.001 µg/m^3	0.15 µg/m^3—3 month rolling avg.	0.005-0.006 µg/m^3
	PG&E Trail	0.001 µg/m^3		
	Background OSD	0.016 µg/m^3		
	Background BLN	0.001 µg/m^3		
	Cupertino	0.023 µg/m^3		
Sulfate (Calc.)[6]	Annex	0.001 µg/m^3	25 µg/m^3—24 hr. avg.	NA
	PG&E Trail	0.002 µg/m^3		
	Background OSD	0.15 µg/m^3		
	Cupertino	1.15 µg/m^3		
Vinyl chloride	Annex	<MDL (0.1 ppbv)	10 ppbv	<MDL (0.1 ppbv)
	PG&E Trail	<MDL (0.1 ppbv)		
	Background OSD	<MDL (0.1 ppbv)		
	Background BLN	<MDL (0.1 ppbv)		
	Cupertino	<MDL (0.1 ppbv)		

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[3] Cupertino site refers to Monta Vista monitoring site operated by BAAQMD.

[4] Estimated alternative concentration based on area PM2.5/PM10 ratio. See text for details.

[5] Annex was lone location for SO2 monitoring.

[6] Multiplied sulfur concentration by a factor of 3 to obtain sulfate estimate.

Table ES-2. Results of Non-criteria Pollutants/Toxics Monitoring

Parameter	**Sample Location**	**Average Concentration**	**Reference Health Standard Concentration**
Black Carbon	Annex	235 ng/m^3	5,000 ng/m^3 (REL)
	PG&E Trail	332 ng/m^3	
	Background BLN	269 ng/m^3	
	Background OSD	602 ng/m^3	
Mercury (Hg)	Annex	1.0 ng/m^3	300 ng/m^3 (REL)
	PG&E Trail	2.9 ng/m^3	
	Background OSD	0.25 ng/m^3	
	Background BLN	0.35 ng/m^3	
	Cupertino	2.0 ng/m^3	
Chromium VI	Annex	0.011 ng/m^3	100 ng/m^3 (REL)
	PG&E Trail	0.40 ng/m^3	
	Background OSD	0.008 ng/m^3	
	Background BLN	0.040 ng/m^3	
	Cupertino	NA	

Table ES-3. Results of Toxics Sampling

Target VOC	**OEHHA REL µg/m^3**	**Annex**		**PGE**		**OSD**		**BLN**		**Residential Air RSL (µg/m3)**	**Ind. Air RSL (µg/m3)**
	***--- =** No Standard/ Non-detected	(µg/m^3)	Exceeds REL?	(µg/m^3)	Exceeds REL?	(µg/m^3)	Exceeds REL?	(µg/m^3)	Exceeds REL?		
2,2,4-Trimethylpentane	---	0.71	NA	1.9	NA	---	---	0.59	NA	700	--
2-Butanone	---	1.2	NA	7.2	NA	---	---	---	---	520	2200
4-Ethyltoluene	---	0.86	NA	0.93	NA	---	---	---	---	0.97	260
Acetone	---	8.8	NA	9.4	NA	9.4	NA	6.5	NA	3200	14000
Benzene*	3	2.3	No	2.7	No	1.6	No	2.5	No	0.36	1.6
Bromomethane	5	0.62	No	0.32	No	--	---	---	---	0.52	2.2
Dichloromethane	400	0.78	No	1.4	No	0.49	No	---	---	63	260
Ethylbenzene	---	0.82	NA	1.6	NA	---	---	---	---	1.1	4.9
Toluene	300	6.9	No	16.3	No	---	---	3.9	No	520	2200
Trichlorofluoromethane	---	0.71	NA	1.4	NA	0.61	NA	0.93	NA	73	310

*Benzene data affected by average of 0.73 µg/m^3 in laboratory blank contamination. Results are therefore qualified; data is likely biased high. See text for more details.

Table ES-4. Results of Elemental Monitoring

Parameter--elements	OEHHA REL (µg/m^3)	Annex		PGE		OSD		BLN	
		Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?
Arsenic	**0.015**	0.00020	No	0.00039	No	0.000001	No	0.00022	No
Cadmium	**0.02**	0.00042	No	0.00112	No	--	--	0.00065	No
Chlorine (sea salt)	**0.2**	0.85	Yes	1.5	Yes	0.43	Yes	0.82	Yes
Manganese	**0.09**	0.00523	No	0.00750	No	0.0016	No	0.00319	No
Mercury	**0.03**	0.00023	No	0.00018	No	--	--	0.00022	No
Nickel	**0.014**	0.00060	No	0.00073	No	0.0001	No	0.00060	No
Selenium	**20**	0.00084	No	0.0019	No	0.0007	No	0.00113	No

Notes:

1.Annex and PG&E Trail monitoring sites were located within Rancho San Antonio OSP. Background OSD location was located at the District Administrative Office, Background BLN was located in Los Altos Hills, typically upwind of Rancho San Antonio.

2. "California Air Quality Standard" refer to the statutory State of California ambient air quality standards.[7]

3. "REL" is the reference exposure limit, produced by the California Office of Health Hazard Assessments (OEHHA). The REL is defined as "an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level."[8]

4. San Francisco Bay Area Average concentrations are derived from a BAAQMD report.[9]

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[7] http://www.arb.ca.gov/research/aaqs/caaqs/caaqs.htm

[8] Office of Environmental Health Hazard Assessment 2007, Adoption of chronic reference exposure levels (RELS) for airborne toxicants [12/28/01], Office of Environmental Health Hazard Assessment Sacramento, accessed 31/1/2012, <http://www.oehha.ca.gov/air/chronic_rels/1201Crels.html>

[9] Initial Study/Negative Declaration for the Amendments to Bay Area Air Quality Management District Regulation 9, Rule 10: Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries, Environmental Audit, Inc.

1.0 INTRODUCTION

Rancho San Antonio (RSA) is one of 26 public Open Space Preserves managed by the Mid-Peninsula Regional Open Space District. It comprises 3,988 acres to the northwest side of the City of Cupertino. Annual visits by the public are on the order of 500,000.

The RSA preserve is bounded to the west by the Santa Cruz Mountains, to the east by the City of Cupertino, to the north by Los Altos Hills, and the northeast by Los Altos. Along the southern boundary is the Lehigh Cement Plant and Quarry. Approximately one mile north is I-280, and Route 85 is approximately two miles to the Northeast. Beyond these highways is the general Silicon Valley urban area, consisting of a full range of residential and industrial entities, closest to the communities of Cupertino, Sunnyvale, and Mountain View. As neighbors sharing the same air basin with the Rancho San Antonio Preserve, these sites and regions are all potential sources for pollution transport to the Preserve.

Air quality at Rancho San Antonio has been a concern for both workers and visitors for many years due to its proximity to these potential sources of pollutants, particularly the Lehigh Permanente cement plant and quarry, the only cement plant in the area, and one of the largest industrial facilities in the South San Francisco Bay Area. In addition, both workers and residents adjacent to the park have experienced events of odors, and particulate deposition (dust) at their properties, such as on vehicles and other flat surfaces.

The Lehigh Cement facility has been the subject of recent permitting processes (BAAQMD Title V, and Santa Clara County Reclamation Plan EIR), as well as new regulatory rules aimed at reducing older cement plant emissions (USEPA, BAAQMD). These permitting and regulatory processes produced numerous reports (Health Risk Assessments, EIR, Air Toxic Hot Spot reporting), that identified substantial emissions, including toxic emissions, emanating from the facility, and identified the surrounding area, including Rancho San Antonio, as potentially impacted.

Due to these concerns, the Preserve administrator--the Mid-Peninsula Regional Open Space District (MROSD)--contracted with Winegar Air Sciences to assess the air quality at RSA. In consultation with MROSD staff and through review of other data sources and information, a technical approach was developed that would capture a variety of common pollutants as well as a subset of pollutants of particular concern. Many of these pollutants are of concern due to their presence as risk drivers from a recent risk assessment conducted by Lehigh Cement, the closest and likely highest potential nearby major pollution source.

The technical approach consisted of the collection of the concentration in air of 110 separate substances or chemical species.[10] These parameters consisted of a number of US EPA and California EPA Criteria Pollutants, other major urban and regional pollutants, and several chemical species associated with local and regional sources. Local meteorological data at each of the monitoring sites was also collected. Surface wipes, surface deposition, and soil sample

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[10] Several bonus target parameters were included: PM2.5, sulfur dioxide, and full-scan VOCs. In addition, the original length was extended by 3 months due to gaps in data during early data collection periods.

analyses were also incorporated into the approach. The major monitoring focus was on the two main sites—the Annex Building, and on the PG&E Trail at RSA, located near the Point of Maximum Impact (PMI) identified in Lehigh's 2013 Health Risk Assessment. Short-term series of data collection were conducted at Deer Hollow Farm and at the on-site ranger residences.

Two off-site background sites were used for the collection of background and comparison data. The rooftop at the MROSD administrative office in Los Altos was used as an 'urban' location comparison, and a residential location in the Los Altos Hills was used as an upwind residential area comparison site. These background monitoring sites were short-term (two months) compared to the longer-term monitoring conducted at RSA (15-18 months).

The data collected was compiled and validated using standard quality assessment tools. Short-term and long-term averages were used for comparisons to appropriate air quality or health-related standards. The final long-term compiled data was reviewed by a health scientist for assessment of the data in terms of appropriate health-driven concentration screening levels. These assessments resulted in two main tables (Tables 21 and 22) that show the comparison to these standards and screening levels. These comparisons and/or exceedances can be used for decisions related to possible personal health outcomes by workers and visitors.

One other noteworthy source of comparative data that was very useful in putting this study into a larger context was a special monitoring station operated by BAAQMD at Monta Vista Park. Direct comparisons to that dataset are shown in later sections of the report.

The remainder of this report presents the details and results of this study.

2.0 TECHNICAL APPROACH—TARGET SUBSTANCES

2.1. Target List Rationale

The approach for air monitoring was based on the following motivations:

1. Proximity to General Local Sources—Highway emissions and dust, urban influences, wood smoke, trail dust.

2. Potential exposure to local industrial emissions from Lehigh Cement Plant and quarry. The main MROSD field office in the Preserve is identified as a "receptor" in the 2013 Risk Assessment completed for Lehigh Cement Plant.

3. Observations of Particulate Deposition on surfaces, of plumes following blasts, observation of earth-moving activity, and visual observation of emission plumes from the plant.

Of special interest was the potential from the closest and largest potential source of emissions—the Lehigh cement plant and quarry. While the focus of the study was not to target this facility, it was obviously a large part of the concern due to the simple proximity and the type of source it represents.

Information relating to the emissions from Lehigh was based on their recent environmental impact report (EIR) and the recent health risk assessments (HRA) performed. Significant health risk, major constituents, identified were: benzene, arsenic, hexavalent chromium (chromium-6), and diesel particulate matter (DPM). Mercury is also present in the native limestone, and is a constituent of concern. Although these reports informed a more refined development of target substances, the majority of these pollutants would have been part of a normal air quality assessment, and were evaluated through this monitoring effort, along with nearly one-hundred other potential substances or chemical species.

2.2. Atmospheric Contaminants

Based on the above considerations, an approach for particulate and gas-phase sampling and monitoring was designed for a wide range of aerosols and gases.

2.2.1. Aerosols

2.2.1.1. PM10

Aerosols (particles in the atmosphere, particulates, particulate matter) consist of solid masses of different materials that are suspended in the atmosphere, and are transported various distances from their point of origin, depending on their density and the characteristics of the dispersing wind field. The effect of aerosols on human health is dependent on composition, size, and number of the particles as well as exposure parameters such as time and type. Therefore, in order to perform a complete assessment, a range of sizes and types of aerosols were collected in this program.

PM10 is the shorthand description for suspended solid aerosols in the atmosphere of less than 10 micron (10^{-6} meters) aerodynamic diameter (not the same as physical diameter). PM10 is also a common designation for ‘inhalable’ particulates—particles that can be drawn into the respiratory system, though much of the larger sizes is captured in the nose and throat. This classification is also called ‘coarse’ particles, to differentiate it from PM2.5, which is called ‘fine particulate.’ Smaller particulate fractions are referred to as very fine and ultra-fine.

PM10 originates from physical action—crushing, grinding, eroded soil, road dust. A majority of PM10 is frequently due to fugitive soil created by many types of physical activities across a diversity of sources.

2.2.1.2. PM2.5

PM2.5 refers to particulates less than 2.5 microns in diameter, also called ‘fine’ particles, in contrast to the ‘coarse’ particles in PM10. Fine particles originate from chemical and combustion sources such as power plant emissions, vehicle emissions, photochemical reactions in the atmosphere, wood burning, agricultural burning, and some industrial processes. Fine particles are of greater concern from a health perspective than PM10 due to their ability to be drawn deeper into the lungs, thus potentially transporting harmful materials into greater contact with active biological surfaces. PM2.5 is currently of more focus than PM10 from a regulatory perspective as it is a regional pollutant that indicates the possible impact of highly mechanized and industrialized emission processes on the public at large. Besides the chemical process emissions cited above, PM2.5 constitutes other important particulates such as black carbon that originate in vehicular exhaust, especially diesel exhaust, discussed below.

2.2.1.3. Black Carbon

Black carbon consists of densely linked cyclic carbonaceous structures, with some other chemical functional units on its surface, which facilitates chemical reaction, hence its toxicity. As part of diesel exhaust, it is mixed with sulfate and other constituents of diesel particulate matter (DPM). There is no natural source of black carbon, so any level detected originated from some anthropogenic activity.

Black carbon is a common pollutant that is not as well-known as other pollutants such as the criteria pollutants or toxics. However, as a major part of diesel exhaust (one half of diesel particulate matter mass), its significance becomes obvious. Indeed, the MATES series of micro-environment air quality testing that has been performed in the LA air basin has found that diesel exhaust is the source for upwards of 70% of the carcinogenic risk from the ambient air.[11]

In addition, black carbon has been implicated in climate change effects the world over, as it is generated by all manner of combustion.

In the urban environment, black carbon is a signature for vehicular activity, primarily diesel vehicles as gasoline/spark-type engines produce significantly less than heavy duty diesel vehicles. Therefore, the concentration of black carbon is a tracer for either localized diesel sources or general incursion of urban air masses into the area. The local contribution can be distinguished from more distant sources by the shape of the concentration peak that is detected. When close-by, the peak is sharp and short duration, as generally, the source is moving and would produce a small, puff-like plume. When urban air masses move into an area, the increase in concentration would be broader and less distinct. For the Annex site, local impact is not expected, except for short-term stops of vehicles near the site.

The black carbon monitoring provides information on three main sources: 1) urban air masses, 2) near-by major sources such as I-280 and the Lehigh quarry, and 3) short-term localized sources.

DPM is a California toxic air contaminant, with its reference exposure concentration (RfC) at 5µg/m^3 (5,000 ng/m^3).[12]

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[11] http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/matesivbrdmtg100314.pdf?sfvrsn=4

[12] RfC= Reference Concentration. Cfr: US EPA Integrated Risk Information System (IRIS)--http://www.epa.gov/iris/subst/0642.htm

2.2.1.4. Hexavalent Chromium

Hexavalent chromium refers to the +6 valence state of a chromium atom in a chromate, dichromate or trioxide ion. As a potent carcinogen in the inhalation pathway, it is a high risk driver. At the RSA site, hexavalent chromium is of concern due to its presence in the Lehigh Cement quarry material, so fugitive emissions would be an exposure pathway. Subsequent processing of that material would constitute another pathway via stack emissions.

Samples were collected for hexavalent chromium aerosols using modified EPA method, which incorporates a specially treated filter for the sampling media, sample collection for 24 hours, and subsequent analysis by ion chromatography. The detection limit for this process is significantly lower than the ambient air risk level, so data of high confidence levels can be obtained.

2.2.2. Gases

2.2.2.1. Sulfur Dioxide

As a criteria pollutant, along with PM10 and PM2.5, sulfur dioxide (SO_2) is useful to establish adherence to Federal and California air quality standards. In addition, however, for the Annex site, it may useful beyond the usual mode of determining general regional concentrations because of its value as a potential, specific tracer for emissions from the Lehigh facility.

As a common element in earth ores, Lehigh's processing of sulfur results in a major emission of sulfur dioxide. As the sole major source of sulfur dioxide in the area, it could be a tracer of direct emissions from the Lehigh stacks. Lehigh emits sulfur dioxide at a maximum of nearly 500 lbs per hour.[13] There are no other major point sources in the nearby area that also emits SO_2, so it could serve as a unique and easily monitored tracer gas.

2.2.2.2. Mercury

Elemental mercury can be emitted from industrial processing of earth ores due to commonly found trace amounts present, normally present in soil at approximately 0.08 ppm. As a potent neurotoxin, it is a key target in health risk assessment. For Lehigh, this product is a potential stack emission constituent due to its processing of raw earth materials.

2.2.3. Volatile Organic Compounds

Volatile organic compounds (VOC) originate in a wide variety of processes, from vehicle emissions, byproducts of both normal every day usage as well as industrial applications. In addition, the Lehigh process emissions contain several toxic VOCs. VOCs are present in the vapor phase, but are differentiated from the other inorganic gases such a mercury and sulfur dioxide.

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[13] BAAQMD CEM Report, Lehigh Cement.

2.3. Comprehensive Target List

From the review of potential emission and ambient air pollutants, a comprehensive list of target substances was developed, as shown in Table 1.

Table 1. Target Substances and Methodology
Air Monitoring and Sampling at Rancho San Antonio

Observable	Method	Sites			
		Annex	PGE	OSD	BLN
Aerosols					
PM10	Continuous-Beta Attenuation	●	●	●	●
PM2.5	Continuous-Beta Attenuation	●			
Black carbon	Continuous-aethalometer	●	●	●	●
Hexavalent chromium	Integrated-treated filter	●	●	●	●
Elements					
Al-aluminum	Mylar strip-DRUM Synchrotron X-ray Fluorescence	●	●	●	●
Sb-antimony		●	●	●	●
As-arsenic		●	●	●	●
Ba-barium	Teflon filter-Partisol Dispersive X-ray fluorescence	●	●	●	●
Br-bromine		●	●	●	●
Cd-cadmium		●	●	●	●
Ca-calcium		●	●	●	●
Cl-chlorine		●	●	●	●
Cr-chromium		●	●	●	●
Co-cobalt		●	●	●	●
Cu-copper		●	●	●	●
Ga-gallium		●	●	●	●
Ge-germanium		●	●	●	●
In-indium		●	●	●	●
Fe-iron		●	●	●	●
La-lanthanum		●	●	●	●
Pb-lead		●	●	●	●
Mg-magnesium		●	●	●	●
Mn-manganese		●	●	●	●
Hg-mercury		●	●	●	●
Mo-molybdenum		●	●	●	●
Ni-nickel		●	●	●	●
P-phosphorus		●	●	●	●
K-potassium		●	●	●	●
Rb-rubidium		●	●	●	●
Se-selenium		●	●	●	●
Si-silicon		●	●	●	●
Ag-silver		●	●	●	●
Na-sodium		●	●	●	●
Sr-strontium		●	●	●	●
S-sulfur		●	●	●	●
Sn-tin		●	●	●	●
Ti-titanium		●	●	●	●
V-vanadium		●	●	●	●
Y-yttrium		●	●	●	●
Zn-zinc		●	●	●	●

Observable	Method	Sites			
		Annex	PGE	OSD	BLN
Zr-zirconium		●	●	●	●
Gases					
Sulfur dioxide	UV-fluorescence	●	--	--	--
Mercury	Sorbent/UV photometry	●	●	●	●
Volatile Organic Compounds					
Dichlorodifluoromethane	Canister/GC-MS	●	●	●	●
Chloromethane		●	●	●	●
Freon 114		●	●	●	●
Vinyl chloride		●	●	●	●
1,3-Butadiene		●	●	●	●
Bromomethane		●	●	●	●
Chloroethane		●	●	●	●
Trichlorofluoromethane		●	●	●	●
Acetone		●	●	●	●
2-propanol		●	●	●	●
1,1-Dichloroethene		●	●	●	●
Acrylonitrile		●	●	●	●
Freon 113		●	●	●	●
Dichloromethane		●	●	●	●
Carbon disulfide		●	●	●	●
trans-1,2-Dichloroethene		●	●	●	●
Methyl tert butyl ether		●	●	●	●
1,1-Dichloroethane		●	●	●	●
Vinyl acetate		●	●	●	●
2-Butanone		●	●	●	●
Hexane		●	●	●	●
Bromochloromethane		●	●	●	●
Tetrahydrofuran		●	●	●	●
cis-1,2-Dichloroethene		●	●	●	●
2,2-Dichloropropane		●	●	●	●
Chloroform		●	●	●	●
1,1,1-Trichloroethane		●	●	●	●
1,2-Dichloroethane		●	●	●	●
1,1-Dichloropropene		●	●	●	●
Cyclohexane		●	●	●	●
Benzene		●	●	●	●
Carbon tetrachloride		●	●	●	●
2,2,4-Trimethylpentane		●	●	●	●
n-Heptane		●	●	●	●
1,2-Dichloropropane		●	●	●	●
1,4 Dioxane		●	●	●	●
Trichloroethene		●	●	●	●
Bromodichloromethane		●	●	●	●
4-Methyl-2-pentanone		●	●	●	●
cis-1,3-Dichloropropene		●	●	●	●
Toluene		●	●	●	●
trans-1,3-Dichloropropene		●	●	●	●
1,1,2-Trichloroethane		●	●	●	●
2-Hexanone		●	●	●	●
1,3-Dichloropropane		●	●	●	●
Dibromochloromethane		●	●	●	●

Observable	**Method**	**Sites**			
		Annex	**PGE**	**OSD**	**BLN**
1,2-Dibromoethane		●	●	●	●
Tetrachloroethene		●	●	●	●
Chlorobenzene		●	●	●	●
Ethylbenzene		●	●	●	●
m,p-Xylenes		●	●	●	●
Styrene		●	●	●	●
Bromoform		●	●	●	●
o-Xylene		●	●	●	●
1,1,2,2-Tetrachloroethane		●	●	●	●
1,2,3-Trichloropropane		●	●	●	●
n-Propylbenzene		●	●	●	●
Isopropylbenzene		●	●	●	●
4-Ethyltoluene		●	●	●	●
1,3,5-Trimethylbenzene		●	●	●	●
1,2,4-Trimethylbenzene		●	●	●	●
1,3-Dichlorobenzene		●	●	●	●
Benzyl chloride		●	●	●	●
1,4-Dichlorobenzene		●	●	●	●
1,2-Dichlorobenzene		●	●	●	●
Naphthalene		●	●	●	●
1,1-Difluoroethane		●	●	●	●

3.0 TECHNICAL APPROACH--SITE SELECTION

3.1. Site Descriptions

Using the above objectives, and in consultation with MROSD staff, several locations were selected for various aspects of the monitoring. Two main sites were selected: 1) The Annex building across from the main OSD onsite offices and facilities, 2) PGE Trail for the main onsite locations. In addition, two offsite locations were selected for background and upwind monitoring. The Open Space District Offices on Distal Circle in Los Altos was selected as an urban background location, and a residential location in Los Altos Hills was chosen as an upwind/residential site. Figure 1 shows the test sites amidst the potential emission sources that impact them. The Annex wind rose is represented as well. Figure 2 shows the equipment set up at these sites.

3.1.1. Annex Site

The Annex site was selected as a representative location for site workers (field office located approximately 200 yards across the valley), and for recreational visitors to the main Preserve access trail, and as later testing showed, also representative of the local ranger residences slightly higher up the hill on Mora Drive.

The Annex site was considered the main site, with a full complement of monitors and sensors: PM10, PM2.5, black carbon, sulfur dioxide, meteorology, elements—both DRUM and Partisol, VOCs, hexavalent chromium, and mercury. Monitoring at the Annex site went from December 31, 2012 to June 22, 2014.

3.1.2. PGE Site

Representative of visitors to this trail, and potentially indicative of emissions from the cement plant and quarry operations, as this location is the closest to that site. The point of maximum impact (PMI) from the Lehigh health risk assessment was slightly to the southeast of the PGE site. The PGE site was located at the top of a section of the PGE trail, near the base of one of the large power line towers. A clearing amidst a sea of poison oak was found, and the equipment was placed there. At the PGE site, PM10, BC, elemental composition by DRUM sampler, VOCs, hexavalent chromium, and mercury were all collected. Data collection at PGE site was conducted from April, 2013 to May, 2014.

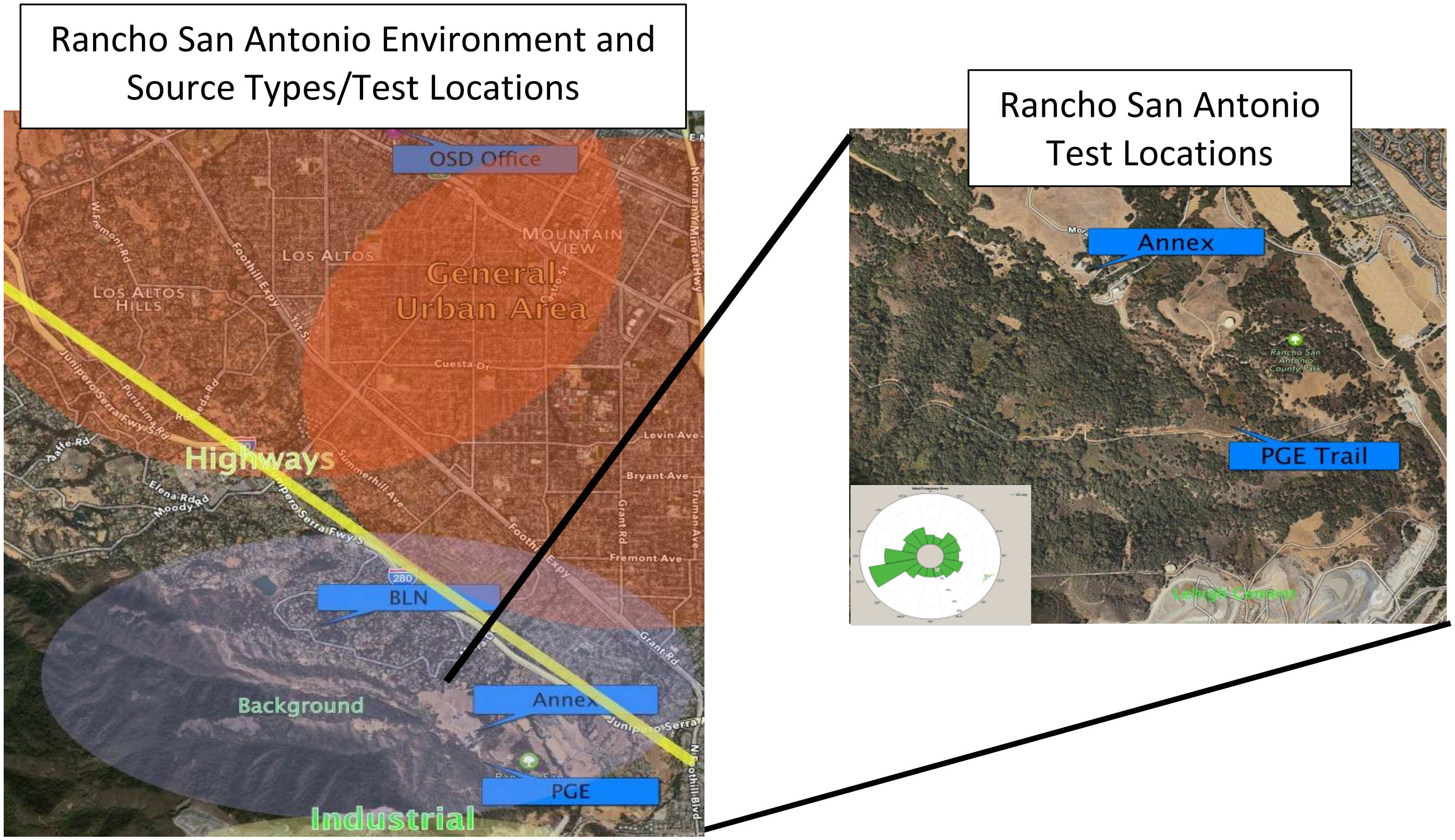
3.1.3. OSD Site

The OSD site was located on the roof of the MROSD administration offices on Distal Circle in Los Altos. It was located in the middle of the urban area, adjacent to a major traffic thoroughfare—El Camino Real. Therefore, this site is reflective of the main urban area.

At the OSD site, PM10, BC, elemental composition by DRUM sampler, VOCs, hexavalent chromium, and mercury were all collected. Monitoring and sampling was conducted from September 10, 2013 to November 7, 2013.

3.1.4. BLN Site

The BLN site was located in a Los Altos Hills residential area, directly north of RSA. Black carbon, PM10, elements, VOCs, hexavalent chromium, and mercury were sampled at this location from March 7, 2014 to April 17, 2014.



Rancho San Antonio Environment and Source Types/Test Locations

Rancho San Antonio Test Locations

Figure 1. Source Categories/Test Locations at Rancho San Antonio
(Wind rose inset is from Annex)

Figure 2. Photos of Monitoring instruments

From upper left, going clockwise: Annex trailer, Annex inlet array, PGE solar panels/EBAM, BLN site setup, and OSD site setup.

4.0 TECHNICAL APPROACH—METHODOLOGY

4.1. Aerosols

4.1.1. PM10/PM2.5--Fixed

PM10 and PM2.5 were monitoring using beta attenuation monitors—BAM, or beta gauges. This technique uses the attenuation (decrease) of energetic electrons emitted by a carbon-14 source, that impact the collected aerosols on a filter tape. These particles had been collected on a glass fiber tape for a portion of an hour, after which it is moved into the detection zone where it is exposed to the attenuation is measured. This attenuation is proportional to the mass of particulate collected, which is then divided by the amount of air that was sampled during the sampling period. The result is expressed at micrograms per cubic meter—$\mu g/m^3$.

The two size fractions are collected in separate instruments. For PM10, the standard EPA louvered virtual impactor was used on the inlet, while the PM2.5 instrument used the standard inlet plus a BGI Very Sharp Cut Cyclone to separate the fine particles. The PM10 inlet used the Smart Inlet heater, while the PM2.5 used a continuous heat tape on the inlet.

The MetOne BAM 1020 is an EPA Federal Equivalent Method (FEM), meaning that if the conditions of operation meet the definition, the data are equivalent to the federal reference method, thus rendering the data more credible as a recognized value. For this program those conditions were met, which included all the necessary accessories, plus a stable operating environment. Calibration was checked using a factory-calibrated BGI Delta calibrator, which uses differential pressure to assess temperature and pressure compensated flow rate. Flow was maintained at the standard 16.7 liters per minute.

An on-board data logger captured the concentration plus operational data, which was downloaded periodically.

Figure 3. BAM and EBAM PM10 Monitoring Instruments

4.1.2. PM10--Portable

The EBAM (Environmental Beta Attenuation Monitor) is a portable version of the BAM 1020, and was used at PGE and other sites on a short-term basis to collect real-time continuous PM10. While not a FEM, it has been shown to be comparable to reference methods. The BAM and EBAM were run concurrently for calibration/ comparison, prior to using the EBAM at other sites. As a portable instrument, the EBAM uses 12 volt DC power, thus allowing for the installation of solar panels as a source of continuous power. At the PGE site, several solar panels and deep-charge batteries were installed in order to provide sufficient power for the EBAM as well as other instruments at the site.

The EBAM provides two concentration values—a selectable ‘real-time’ (RT) value (the 15 minute setting was used) and a default 60 minute value. The RT value is a short-term estimate of typically higher concentrations. In addition to the particulate concentration, meteorological data was collected concurrently, thus allowing an examination of any correlation between concentration trends and wind data.

Figure 3 shows photos of the beta gauge instruments.

4.1.3. Elemental Composition and Size

Knowledge of both the composition and size of atmospheric aerosols is useful in understanding their origin as well as assessing their potential health impact. The composition is typically performed on an elemental basis. Two types of sampling were conducted in order to capture the range of elements in the sampled aerosol: The DRUM sampler and the Partisol sampler.

4.1.3.1. DRUM Sampler

One type of sampler for size and composition was the UC Davis DELTA Group DRUM[14] sampler, shown in Figure 4. The University of California, Davis designed and built rotating drum impactors, with the UC Davis 8[15] DRUM the dominant design. This sampler uses Lundgren impactors to collect aerosols onto sticky surfaces in 8 size modes[16], selected aerodynamically by a series of smaller and smaller slot orifices. The impaction surfaces are slowly rotating drums covered with mylar strips, allowing collection of aerosols continuously over extended periods, typically 5 weeks. This allows use of focused beam analytical techniques to analyze for mass, optical behavior, and elemental composition with typical time resolution of 3 hr. Thus, the 8 DRUM collects typically 2,500 aerosol samples in a 5 week period, at the rate of 48 samples/day (3 hr time resolution, 8 size cuts). These can be directly compared with meteorological information source activities, etc. to identify sources in a way impossible for a 24 hr averaging Federal Reference Method (FRM) filter.

The DRUM strips were analyzed for mass by soft beta ray transmission, and elements by the synchrotron-induced x-ray fluorescence (S-XRF) analytical at the Stanford Synchrotron Radiation Lightsource (SSRL) and at the Lawrence Berkeley National Laboratory Advanced Light Source (ARL).

S-XRF is a form of x-ray fluorescence using polarized x-ray beam microprobe white beam at 4 keV to 18 keV, with a spot size matched to the DRUM impactor impaction “footprint”. Typically, it is able to obtain about 0.1 ng/m^3 sensitivity in a 30 sec analysis run at a sampling time bite of typically 3 hrs. for elements sodium through lead.

For the RSA sampling, two configurations were used: One configuration consisted of the eight size fractions as described above, while the second configuration consisted of two size fractions that were combined into a separate PM10 size result. One eight-channel and one 2-channel sample were collected at Annex, two 2-channel samples were collected at PGE, and one 2-channel was collected at OSD.

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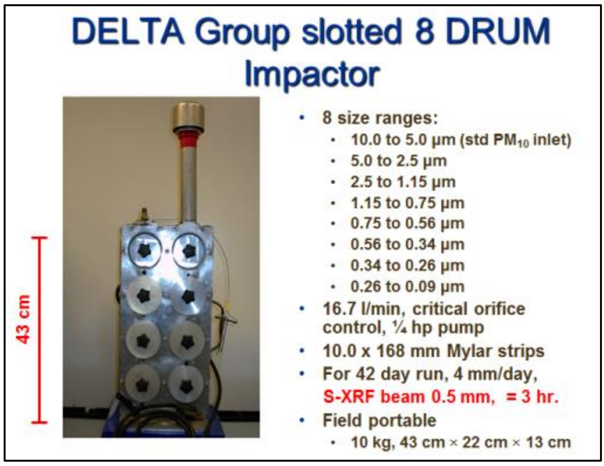
[14] Davis Rotating Unit Monitor

[15] Eight size cuts : 10, 5.0. 2.5, 0.75, 0.56, 0.34, 0.26, 0.09 µm diameter

[16] Size of various aerosol componentS is one of several identifying characteristics.



DELTA Group slotted 8 DRUM Impactor

- 8 size ranges:
  - 10.0 to 5.0 µm (std PM_{10} inlet)
  - 5.0 to 2.5 µm
  - 2.5 to 1.15 µm
  - 1.15 to 0.75 µm
  - 0.75 to 0.56 µm
  - 0.56 to 0.34 µm
  - 0.34 to 0.26 µm
  - 0.26 to 0.09 µm
- 16.7 l/min, critical orifice control, ¼ hp pump
- 10.0 x 168 mm Mylar strips
- For 42 day run, 4 mm/day, S-XRF beam 0.5 mm, = 3 hr.
- Field portable
  - 10 kg, 43 cm × 22 cm × 13 cm

Stage 8 of DRUM , 0.26 > D_p > 0.09 µm diameter, showing strong diurnal pattern; the deposit shown covers 3 weeks.

Figure 4. DRUM Sampler Size Cuts and Impactor

4.1.3.2. Partisol Sampler

Other aerosol composition samples were collected using the Partisol sampler. The Partisol is an EPA Federal Equivalence Method that provides 24-hr integrated data collection for subsequent analysis by laboratory methods, primarily XRF for elements. The Partisol 2025 sampler automatically collected PM10 size selected samples with a set of 16 47-mm Teflon filters contained in a storage magazine, advancing them on a 24-hour basis to provide a 16 day sampling period. These samples were then submitted to Chester LabNet of Portland, OR, for analysis using EPA IO Compendium Method IO-3, X-ray Fluorescence Analysis of Particulates. This analysis provides sub-nanogram per cubic meter concentrations for 38 elements. The Partisol sampler was employed at the Annex, PGE and BLN sites. Figure 5 shows a photo of the Partisol sampler at the Annex site.

Figure 5. Partisol Sampler at Annex Site/ Aethalometer at PGE Site

4.1.4. Black Carbon

Black carbon was measured using the Magee Scientific AE-16 aethalometer (Figure 5), which consists of the collection of aerosol on a quartz fiber tape followed by measurement of the absorption of 880 nm light from a light emitting diode, a wavelength that has been shown to be preferentially absorbed by black carbon .[17] See Figure 5 that shows the instrument onsite at PGE location. This method has been widely accepted as the most direct method for continuous, semi-real time for the measurement of black carbon. Each measurement is completed in 5 minutes, and longer term averages are simple arithmetic operations. Prior to the calculation of these averages, the raw data was processed using the Optimized Noise-Reduction Algorithm (ONA), which reduces inherent noise in the output through variable time averaging. The net effect is to reduce large fluctuations in the signal due to noise introduced into the data stream from large concentration fluctuations. Currently, this or similar noise-reduction schemes[18] are standard parts of aethalometer data reduction.

Starting in September, 2013, the PGE site utilized a AethLab Micro aethalometer while the AE-16 units were used at other sites. This instrument is a hand-size portable unit that collects full-size aethalometer-equivalent data for 1-2 week periods. This instrument was deployed from September, 2013 to May, 2014.

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[17] Mageesci.com.

[18] E.g., Aeth DataMasher.

4.1.5. Hexavalent Chromium

Chromium (Cr) compounds consists of two valance states—positive 3 (III) and positive 6 (VI). The hexavalent state in chromium compounds such as the salt sodium dichromate is recognized as a human carcinogen via the inhalation pathway. At RSA, the concern for this material is due to the presence of relatively elevated levels of hexavalent chromium in the geologic material at the Lehigh quarry. Therefore, this target material was included in the test matrix.

Samples of hexavalent chromium were collected at all sites using ASTM D7614-12, which consists of sampling at 10 liters per minute over 24 hrs. through a cellulose filter impregnated with sodium bicarbonate. This filter method has been shown to minimize losses of the highly reactive hexavalent material. Following sample collection, the samples are kept cold to enhance stability and analyzed by the laboratory using ion chromatography with post-column derivitization. The detection limit for this method was 0.004 ng/m^3, substantially below the RSL value of 100 ng/m^3 thus allowing for the detection of concentrations levels far below health impact concentrations.

4.2. Gases

4.2.1. Sulfur Dioxide

Sulfur dioxide concentrations were measured by Teledyne-API 101E configured in the sulfur dioxide mode,[19] calibrated with a five-point calibration line, and installed at the Annex monitoring trailer. It operated continuously from on September 9, 2013 until May 25, 2014. Data was collected on one-minute averages, with reports every five minutes. The internal data system was attached to an external laptop data system to which the data was downloaded approximately every week.

4.2.2. Mercury

Ambient air samples were collected using laboratory-prepared special charcoal sorbent tubes, which were sampled at a rate of 1 to 2.5 liters per minute over a period of 24 hrs. In the laboratory, the sorbent material was removed and extracted, and the resulting sorbent material analyzed by UV absorbance to provide a mass detected. The concentration is then calculated by taking this mass and dividing by the volume of air sampled, to yield ng/m^3 as a 24-hr average. The nominal detection limit for this method was less than 0.1 ng/m^3.

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[19] Sulfur dioxide was a 'bonus' target, added after the start of the program.

4.3. Volatile Organic Compounds

The toxics VOCs list is comprised of 67 volatile chemical species having boiling points under 100 degree C. All the major volatile air toxics species are present on this list. The volatile air toxics chemical species were collected using Summa canisters and flow controllers to meter in the sample over a 24-hr period. The collected samples were analyzed using cryofocus gas chromatography/mass spectrometry. The detection limit for these species averages approximately 0.2 ppbv. Table 1, above, shows the list of target VOCs.

5.0 RESULTS AND DISCUSSION

The results are presented as follows: Data from each site will be presented for meteorology, PM10, PM2.5, black carbon, sulfur dioxide, and elements. Because of the nature of the toxics results, they will be combined in a separate section.

5.1. Meteorology

The general regional wind pattern in the Cupertino area is driven by the persistent high pressure region in the northern pacific ocean, which causes a dominant wind to the Bay Area from the northwest. Some of that wind is channeled along the coastal mountain ranges through the opening to the San Francisco Bay. The other major influence is across the mountains from the southwest to west south-west. The presence of the mountains affects the localized wind speed and direction, so the region of representativeness of a given site is likely to be small because of the varied topography.

Regional trends and differences due to location are illustrated in Figures 6 through 17 that show the annual wind and other period wind roses for the Annex, PGE, Los Altos (RAWS), Cupertino (BAAQMD), Moffett Field (NWS), and Lehigh (local station/HRA report). As is shown below, the wind roses for the various locations indicate the effect of the complex topography and microenvironment for each site.

Each of the monitoring sites was equipped with its own set of meteorological sensors. For the most part, only wind speed and wind direction were examined, as they pertain primarily to the transport of pollutants. Not all sites covered the entire test period, however, particularly the outside locations. For these locations, regional public meteorological stations were used to provide annualized trends in addition to the short-term data sets.

5.1.1.1. Annex

At the Annex, the average wind direction was 245 degrees, with major components from the northwest, northeast and southeast. Figure 1 showed the wind rose superimposed on a satellite photo. Figure 6 shows a complete wind rose, with indications of high frequencies of low wind speed, particularly from the southwest direction. This direction intersects a vector directly from the Lehigh quarry area.

This major direction also indicates an origin of clean oceanic air; this effect is confirmed by the presence of high levels of chlorine in the aerosol samples.

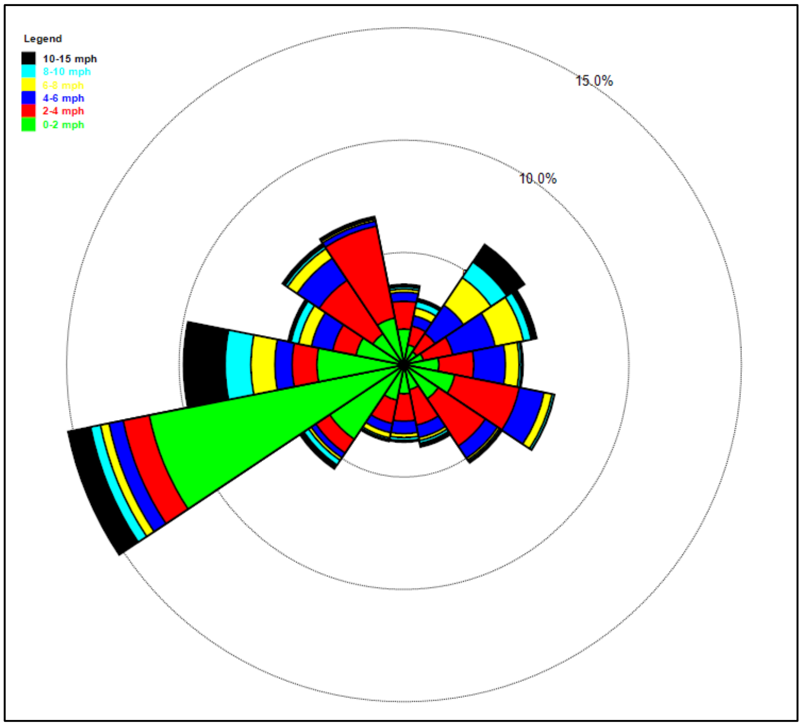

Figure 6. Annual Wind Rose for Annex
(Colors indicate frequency of direction.)

There is only a minor effect directly from the south. The daily pattern is shown in Figure 7 that breaks down the wind rose into two hour periods, indicating a daytime mostly northerly direction, with evening hours mostly southwest. This suggests the influence of urban areas by day and quarry emissions mixed with clean ocean air by night. This fits a basic mountain-valley breeze pattern.

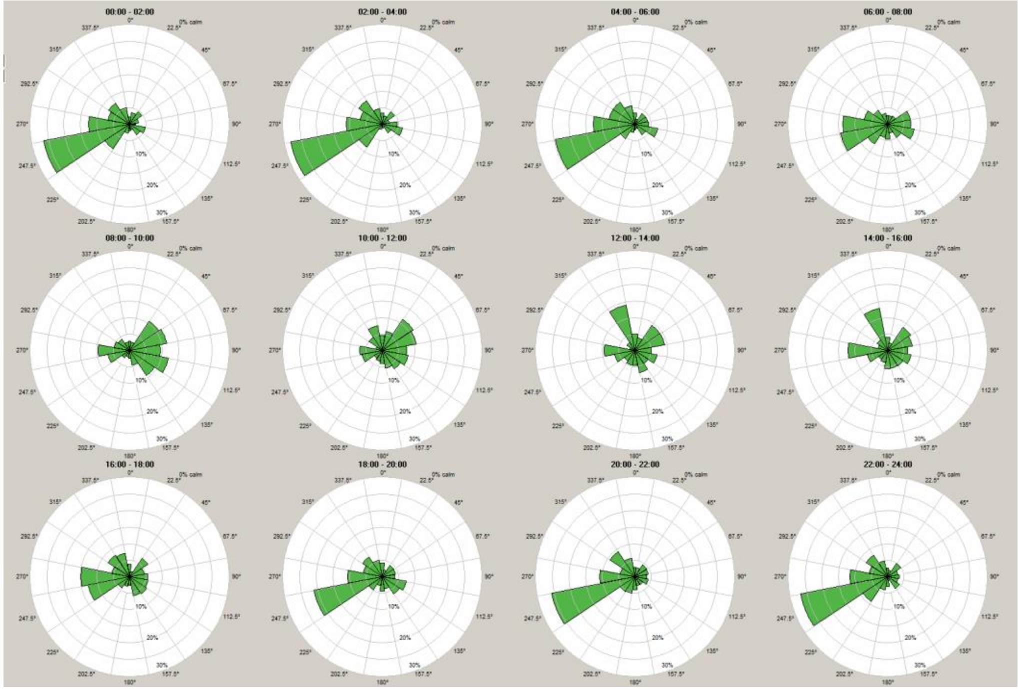

Figure 7. Annex wind roses by time of day.

Figure 8 shows the monthly trends, indicating diverse influence during different times of the year. There are long periods of lower wind speeds, particularly in the summer, thus damping the directional effects. Much of this due to this test location deep in the sheltered valley. The somewhat random pattern of directions during parts of the year is suggestive of the effects of the sheltered valley location, with diverse influences due to the complex terrain.

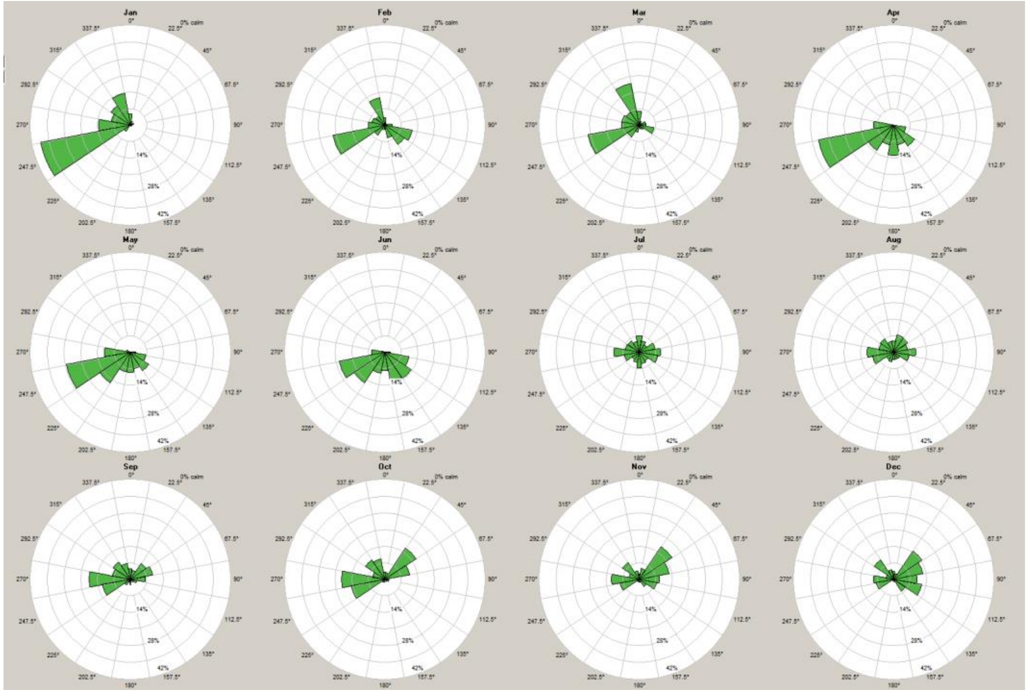

Figure 8. Annex Wind Rose by Month

Figure 9 shows the wind rose at the ranger residence at approximately 150 feet higher, showing a much more distinct pattern. This graphic shows the daily pattern that drives the influence of the different regional emission sources—the cycling between the southwest influence during the nighttime hours, but switching to northerly directions during the day time hours.   Most of the diurnal patterns for target substances show some part of the same time dependent influence.

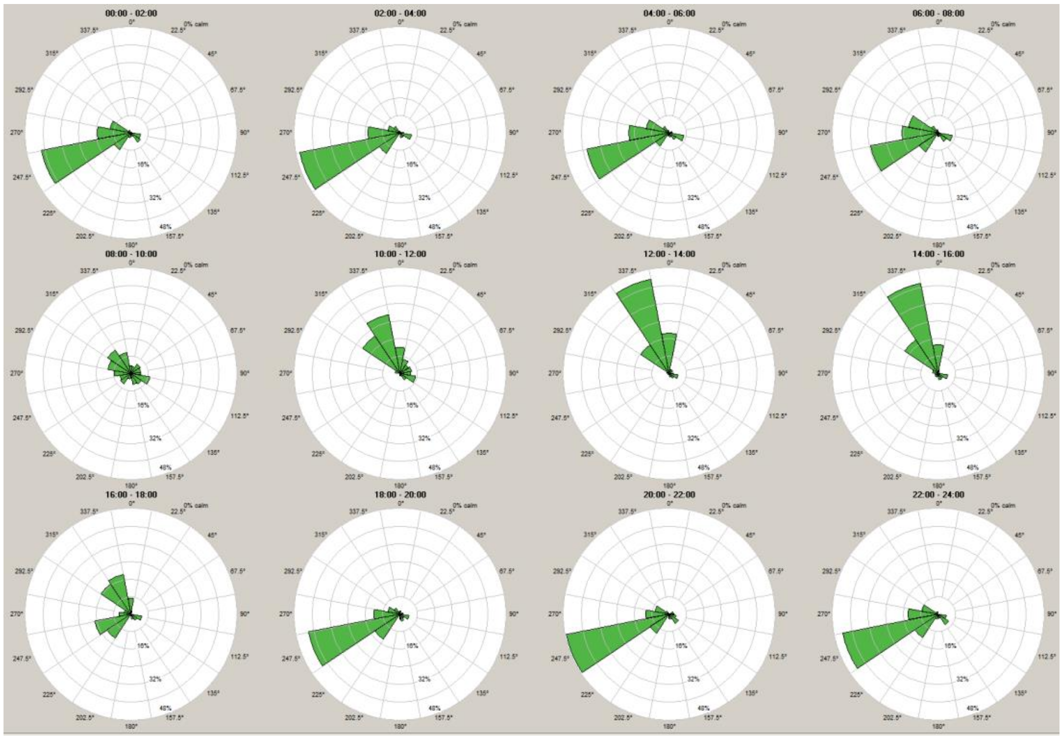

Figure 9. Wind rose by time of day at Residence

5.1.1.2. PGE

PGE—Figure 10 shows a variable influence, which is due to its location atop a ridge and directly adjacent to a large peak, both of which would channel the wind movement. Because of this factor as well as the height of the sensor (2 m), this wind data is representative for only this small environment.

The main influences are represented in the northwest lobe due to the effect of the mountains. The second largest lobe is consistent with other nearby sites data showing regional influence from the southwest. The southwest direction could potentially be affected by emissions from the Lehigh quarry, which is located beyond a ridge less than one-half mile from the monitoring site. The nighttime low wind speed conditions are represented in a dominant way in the wind rose, which results in a disproportionally high impact of fugitive dust during nighttime hours. Several examples of this phenomenon are presented in other sections of this report.

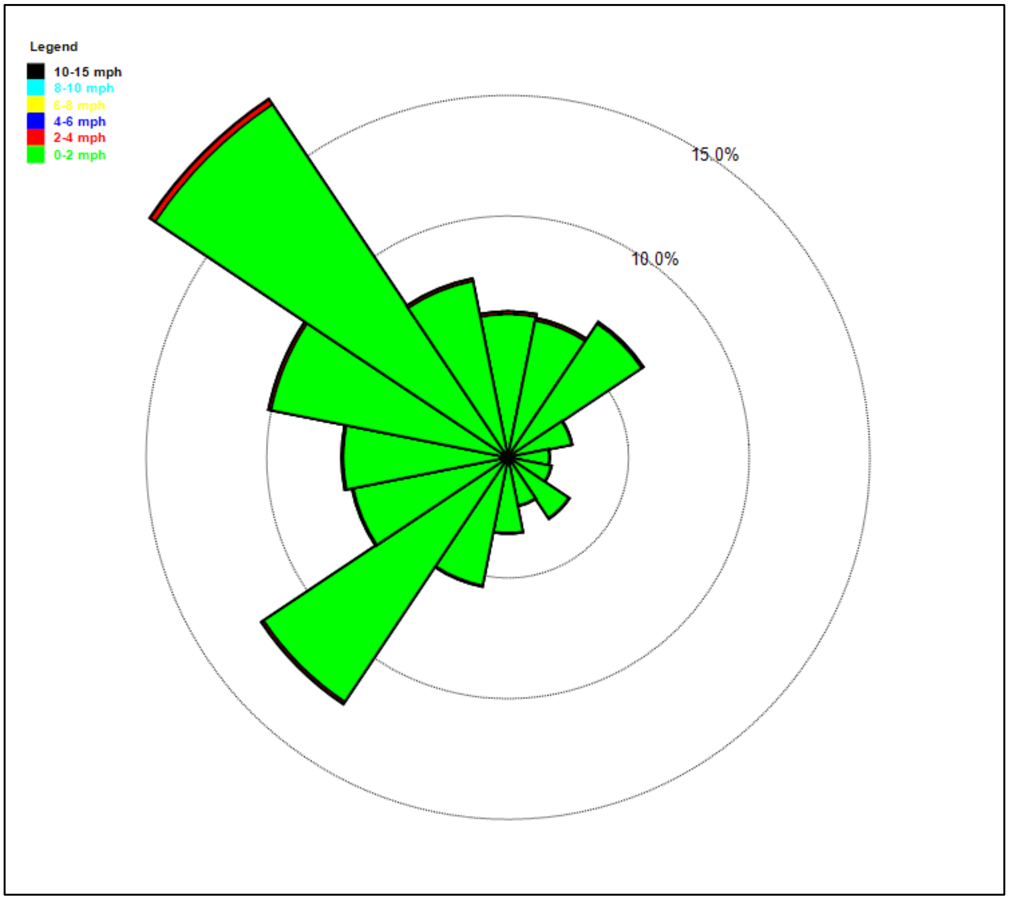

Figure 10. Annual Wind Rose—PGE

5.1.1.3. Lehigh

Lehigh—the Lehigh annual rose (Figure 11, from their HRA document) suggests two dominant directional influences: 1) a channeling of wind down the Permanente Creek canyon where it is located, with an absence of the dominant southwest feature seen in other nearby data sets, likely shielded by ridge to south, and 2) a northerly component that is likely due to channeling of the northwesterly wind that occurs frequently in this area.

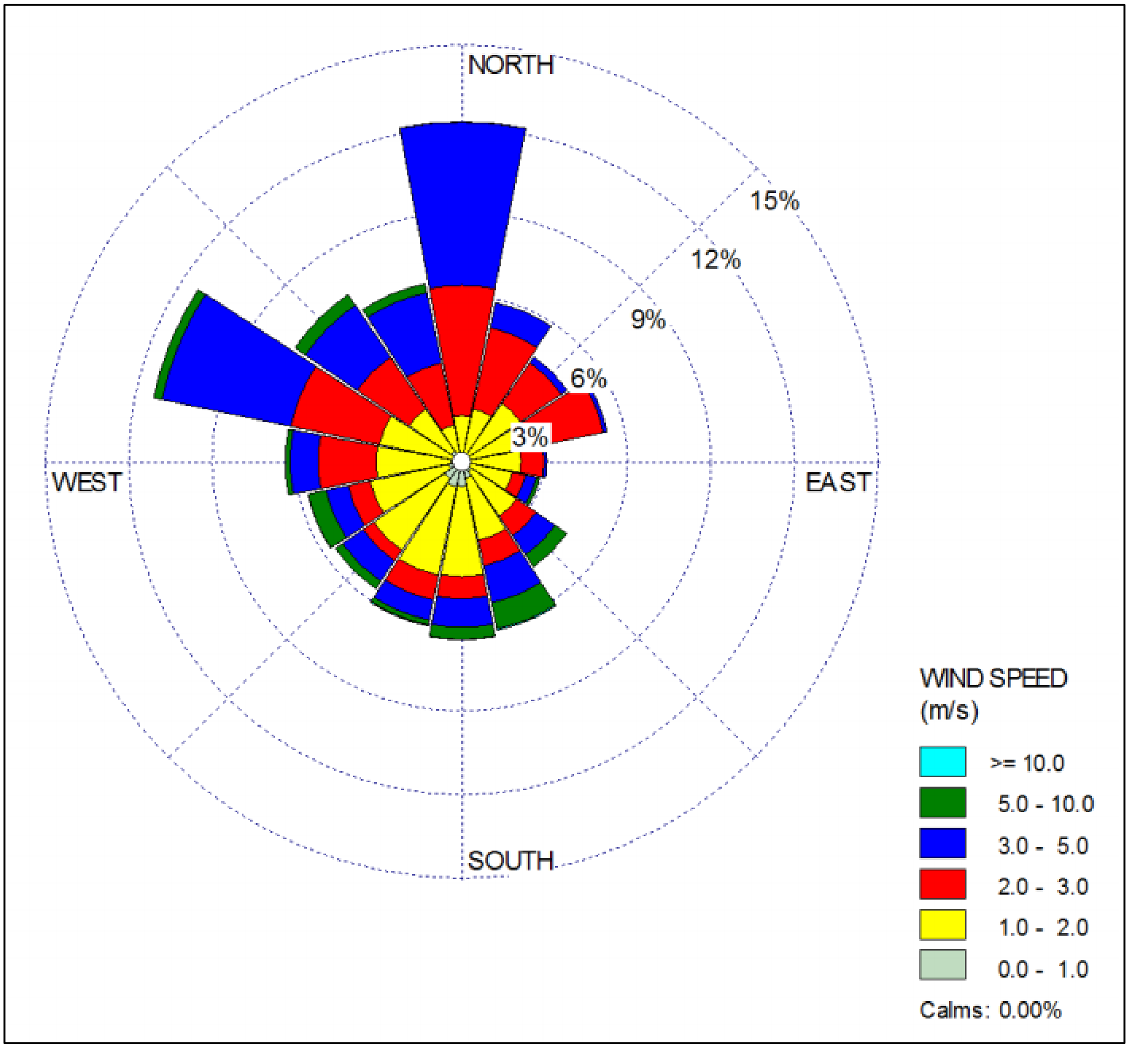

Figure 11. Annual Wind Rose--Lehigh

5.1.1.4. Cupertino/Monta Vista

BAAQMD’s monitoring station at Monta Vista Figure 12 shows the dual influence from the north/north-north west and from the south, presumably due to its location at the base of major mountainous features that direct wind flow. The effect of the canyon-driven drainage pattern will be shown in relation to sulfur dioxide data at the Monta Vista site.

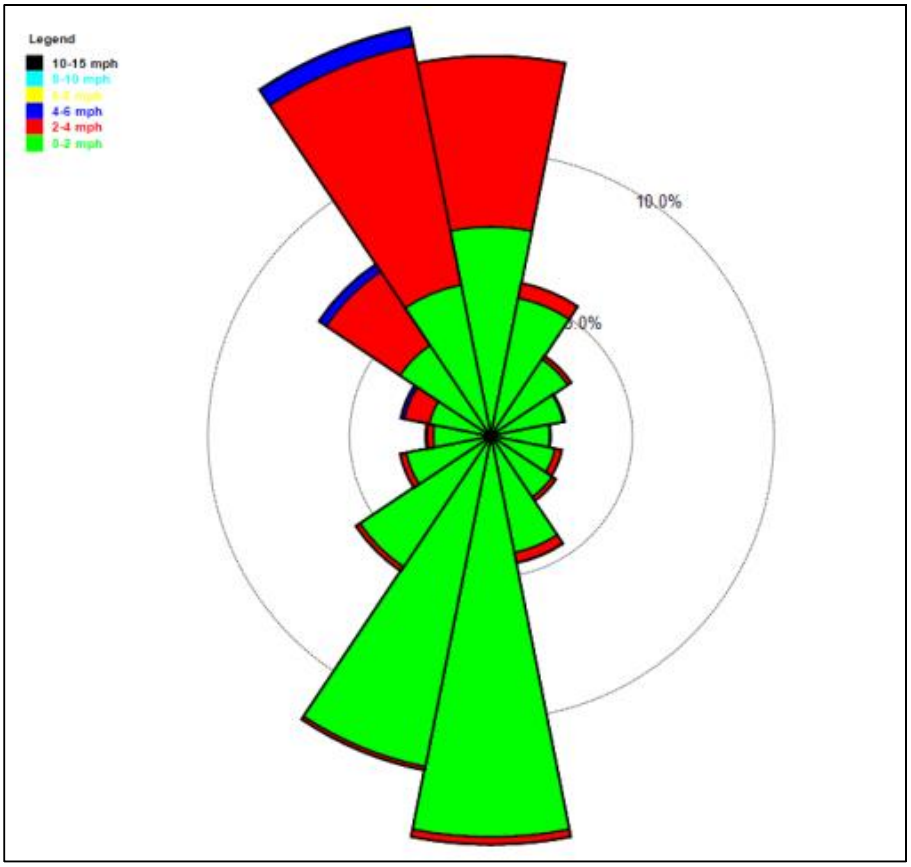

Figure 12. Annual Wind Rose—Cupertino (Monta Vista)

The time of day wind roses shown in Figure 13 show the diurnal pattern of daytime northerly directions and southerly directions during nighttime hours. As noted in the other regional wind direction data, this pattern is repeated throughout the area. This general pattern explains the measurement data showing nighttime impacts at PGE site with smaller effects at Annex.

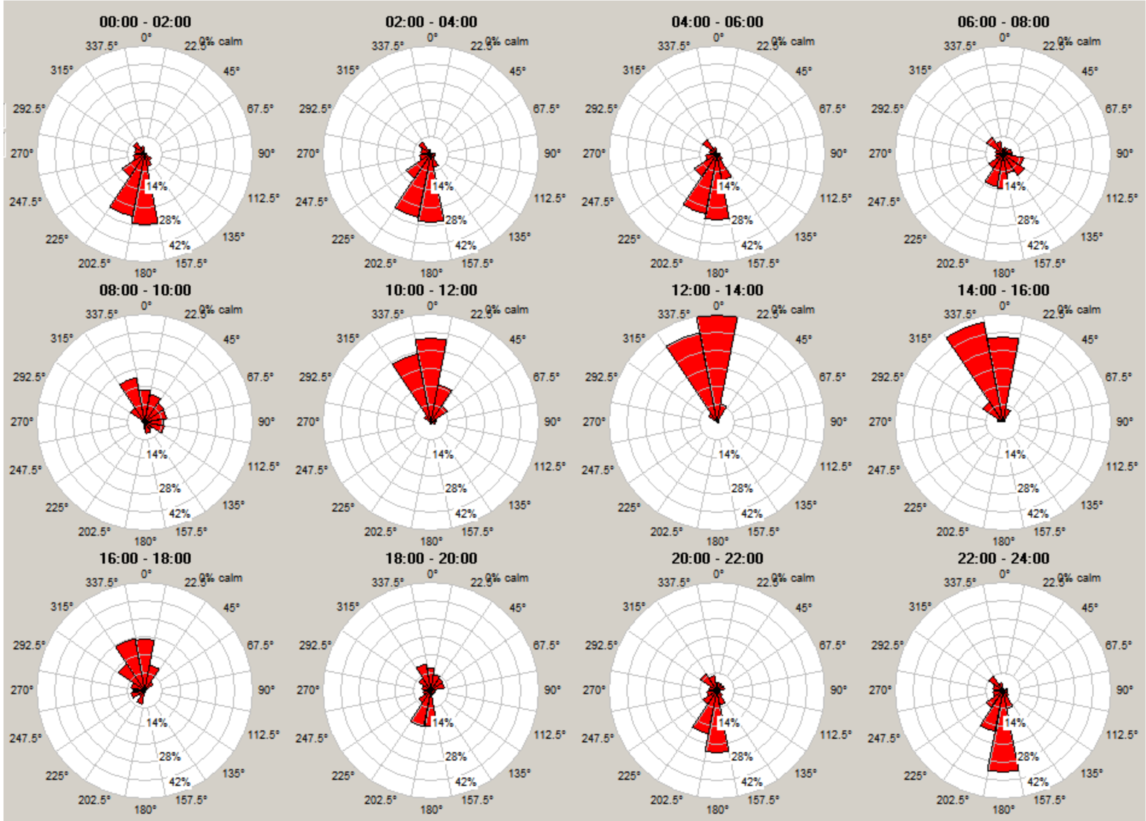

Figure 13. Cupertino Wind Rose by Hour of the Day

5.1.1.5. Los Altos Hills

The nearby RAWS site in Los Altos Hills—Figure 14 shows the general small-regional tendency for wind directions out of the southwest, with a secondary direction out of the northeast.

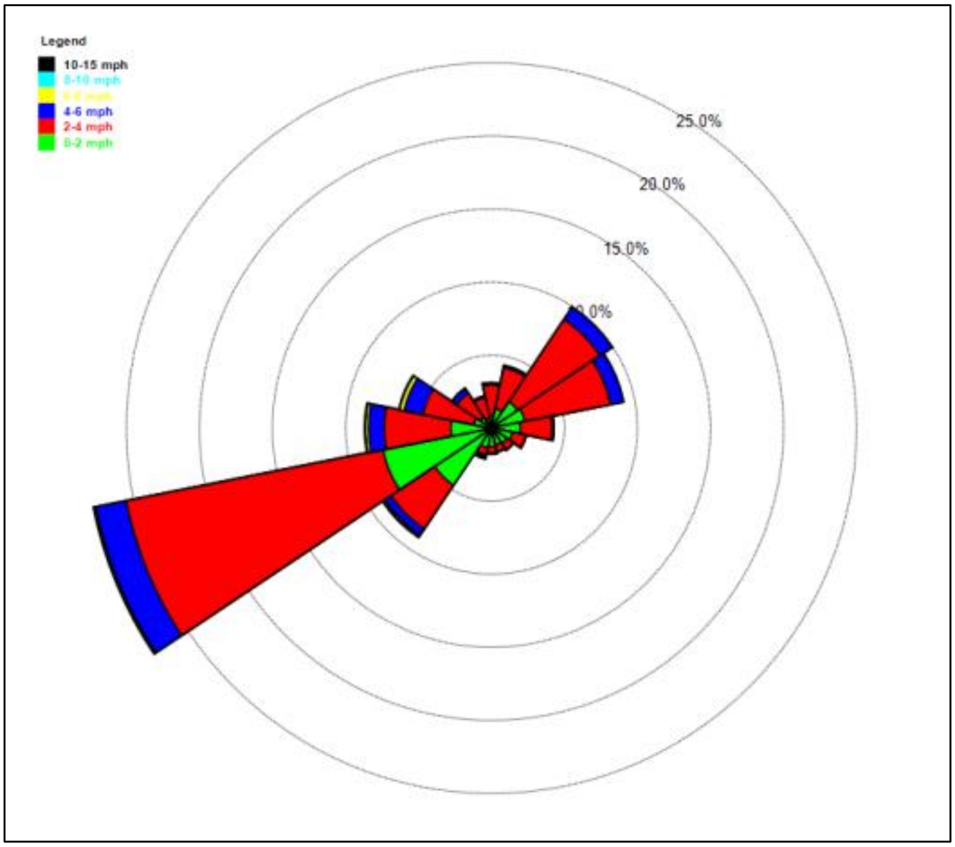

Figure 14. Annual Wind Rose for Los Altos Hills

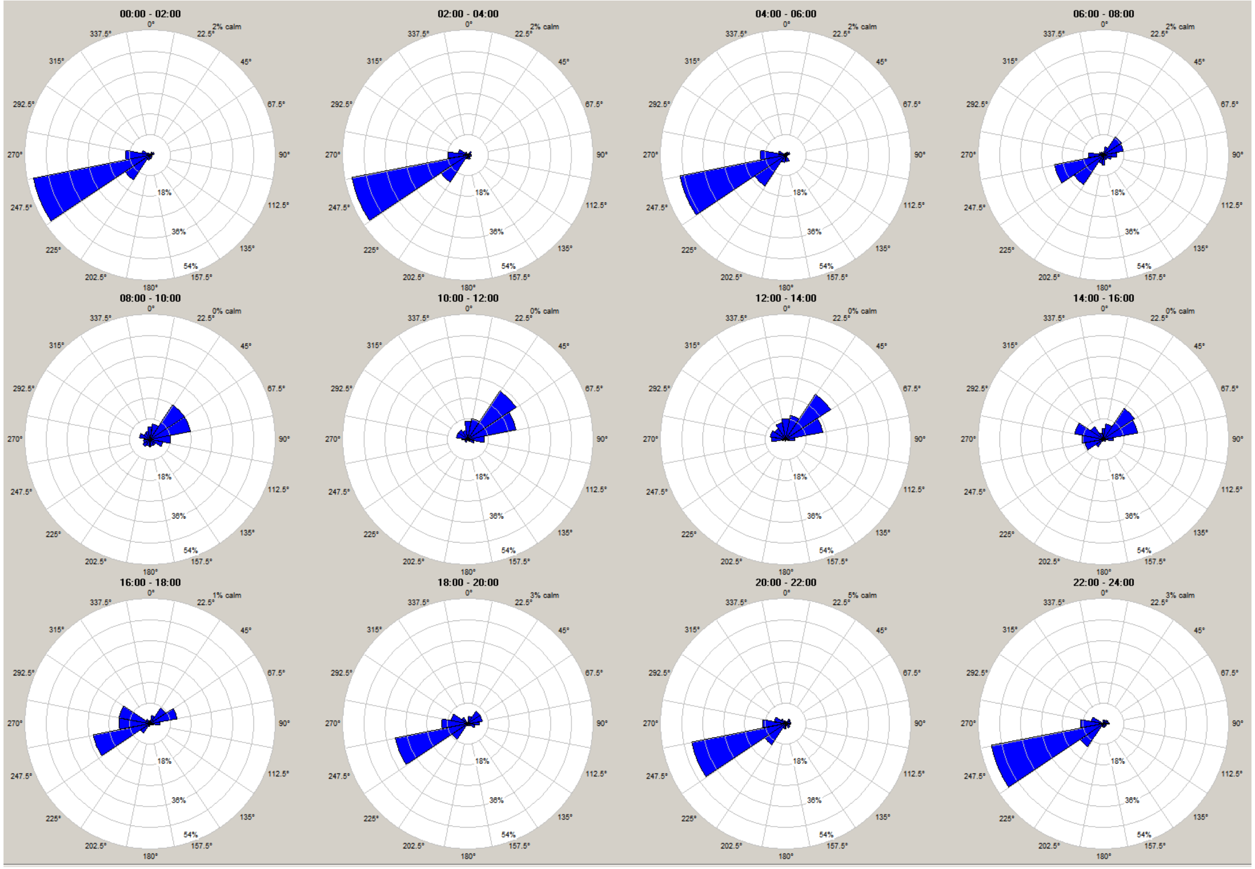

Figure 15. Wind Rose for Time of Day at Los Altos Hill RAWS station

The southwest direction follows the general regional trend, while the northeast direction misses the other dominant regional trend of a northwest directional input. This appears to be due to local topography, as other sites further away from the mountains (e.g., Moffett) gain the influence of the northwest air movement.

Figure 15 shows the time of day wind rose for the Los Altos Hills RAWS station. It has the same general northerly to southerly pattern as the other nearby stations. This factor explains the observation that residences in that area experience the deposition of calcium carbonate, as occurs on RSA and in nearby neighborhoods.

5.1.1.1. Moffet Field

Figure 16 shows data from Moffett field. This meteorology is what would have influenced the OSD location, away from the mountains. Located furthest from the mountain influence, it shows the dominant Bay Area northwesterly wind pattern, which is replicated up the west shore of the Bay, including SFO.

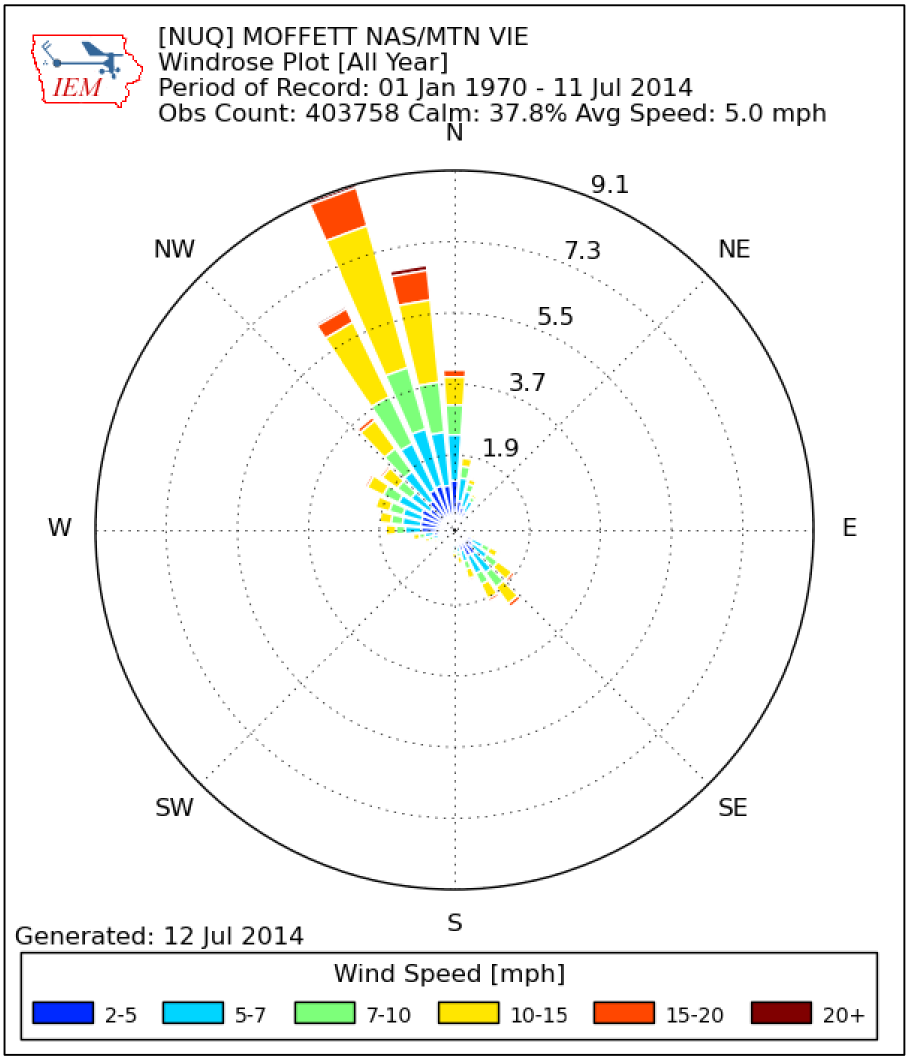

Figure 16. Annual Wind Rose for Moffett Field

5.1.1.2. Terrain Effects

The terrain is an obvious influence on the air movement, driven by the wind patterns, with both an uneven face along the north-south face of the mountains and the valleys along that front. All those factors influence the complexity of transport.

Figure 17 illustrates a direct comparison between the Los Altos Hills RAWS station and the Cupertino station, showing the effect of the local topography affects the wind directionality, with approximately two miles between the meteorological tower sites. Rancho San Antonio is located midway between these two locations and thus has components of both patterns. The cross-sectional elevation profile is also shown as another factor in the complexity of transport. With the quarry directly in line with the RSA sites, this profile combines with the overall wind patterns to determine the effect of emissions from that area as well as the rest of the plant production processes. The data contained in the report will examine that and other questions relating to the transport of emissions from the various sources via the wind field mechanism.

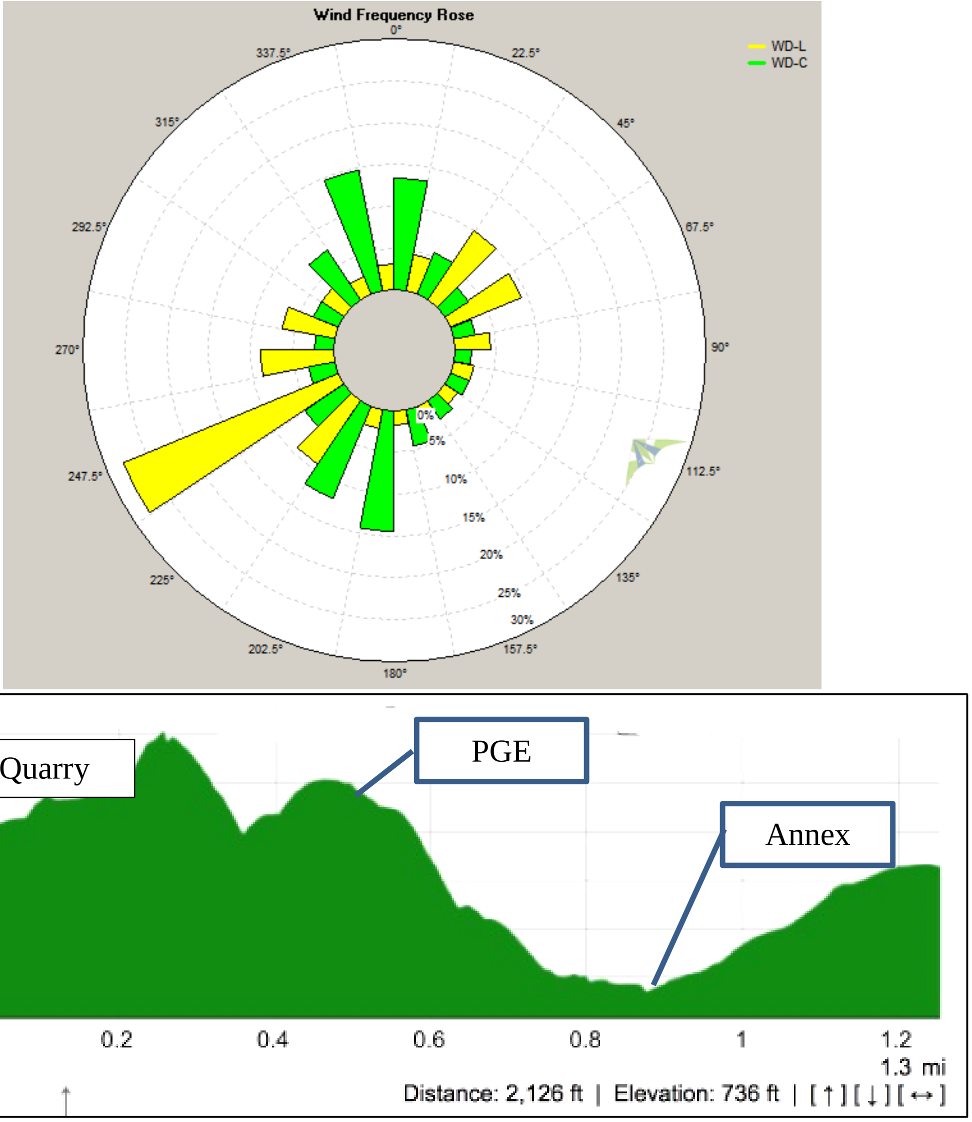

Figure 17. Effect of Location and Elevation on Transport of Pollution
Yellow is Los Altos, Green is Cupertino (Monta Vista)
Cross section is along transect between PGE site and Annex.

6.0 ANNEX RESULTS AND DISCUSSION

6.1. Annex PM10

6.1.1. BAM PM10 Results

Hourly PM10 measurements were collected at the Annex site from January 1, 2013 to June 22, 2014, with a capture rate of 91%, sufficient for a full characterization of exposure scenarios..[20] Gaps in the data record were due to power losses at the monitoring site and tape breakages or completion. There were more than 12,000 individual hourly data points collected, resulting in 539 daily averages. Figure 18 shows the validated hourly concentrations. Daily averages are shown in Figure 19, monthly averages are shown in Figure 20, and quarterly averages are shown in Figure 21.

Note that in the hourly plot for Figure 18, high concentration single hour values are shown as a peak, though mostly only of one point. Visually, this tends to skew the significance of those peaks. In all of the data, there were only 12 that exceeded 0.1 mg/m^3, which in itself is not an especially high concentration. There are no hourly standards for particulate matter; the shortest is for 24 hrs.—0.050 mg/m^3 for the California standard, and 0.150 mg/m^3 for the Federal standard.

The hourly values are of use in correlating with meteorological measurements, which typically are performed with hourly averages. Comparisons with regulatory standards for particulate matter are typically based on time period ranges from 24 hours to annual. In addition, other health-related comparisons for ambient air are mostly focused on long-term averages over a lifetime, defined as 70 years. Further discussion of the standards and health-risk concentrations are provided in later sections.

The overall grand average was 0.016 mg/m^3, with a 95% confidence interval of 0.0002 mg/m^3. This concentration is below the California Standard of 0.020 mg/m^3, as averaged over the 18 month period (as compared to annually). None of the 24-hr values at the Annex exceeded the California standard of 0.050 mg/m^3 or the Federal standard of 0.150 mg/m^3--the highest 24-hr period was 0.047 mg/m^3. Figure 19 contains the population distribution histogram, which shows that the majority of the values were close to the mean and indicative of a stable physical situation, with little impact from nearby variable sources. With a coefficient of variation of 0.0125 (1.25%), it shows that there were very few variations from the main tendency of the data set. Cumulatively, approximately 75% of the measurements were less than 0.030 mg/m^3.

A confirmatory set of gravimetric measurements using the Partisol sampler yielded an average of 0.0153 mg/m^3, an agreement of 0.0007 mg/m^3—a 3.3 percent difference.

Short-term events can sometimes be distinguished from distant impacts by the ‘shape’ of the peak. A sharp peak indicates a plume that has not dispersed or broadened significantly. When a plume is transported for a distance, it usually broadens and extends over a longer period of time.,

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[20] EPA standard is 75%.

resulting in lower concentrations for longer periods. With hourly values to affect the long-term average, a local event would need to be either very high concentration or be over an extended period.

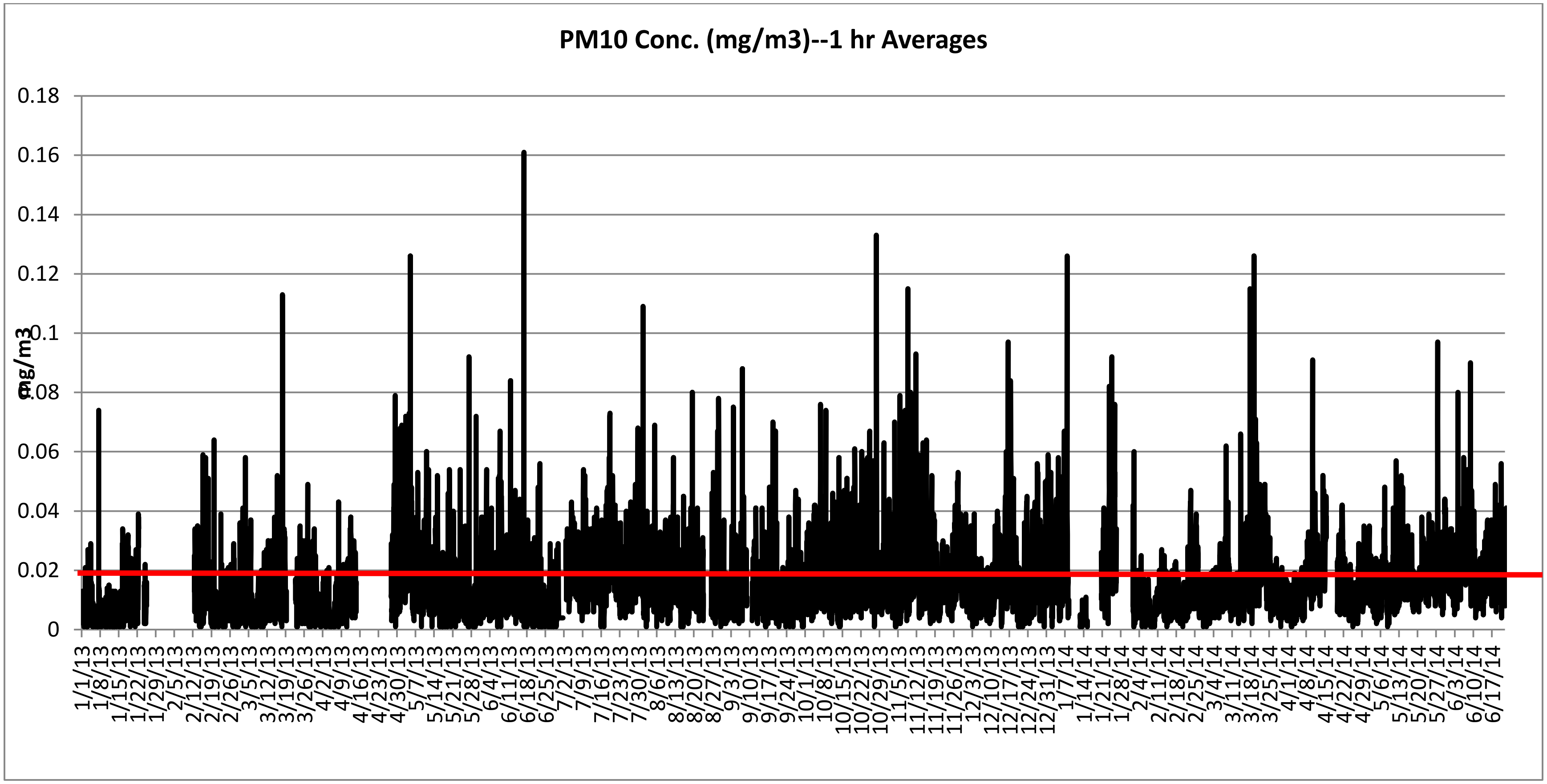

Figure 18. Hourly PM10 Measurements
Red line is California Annual Standard (0.020 mg/m^3)

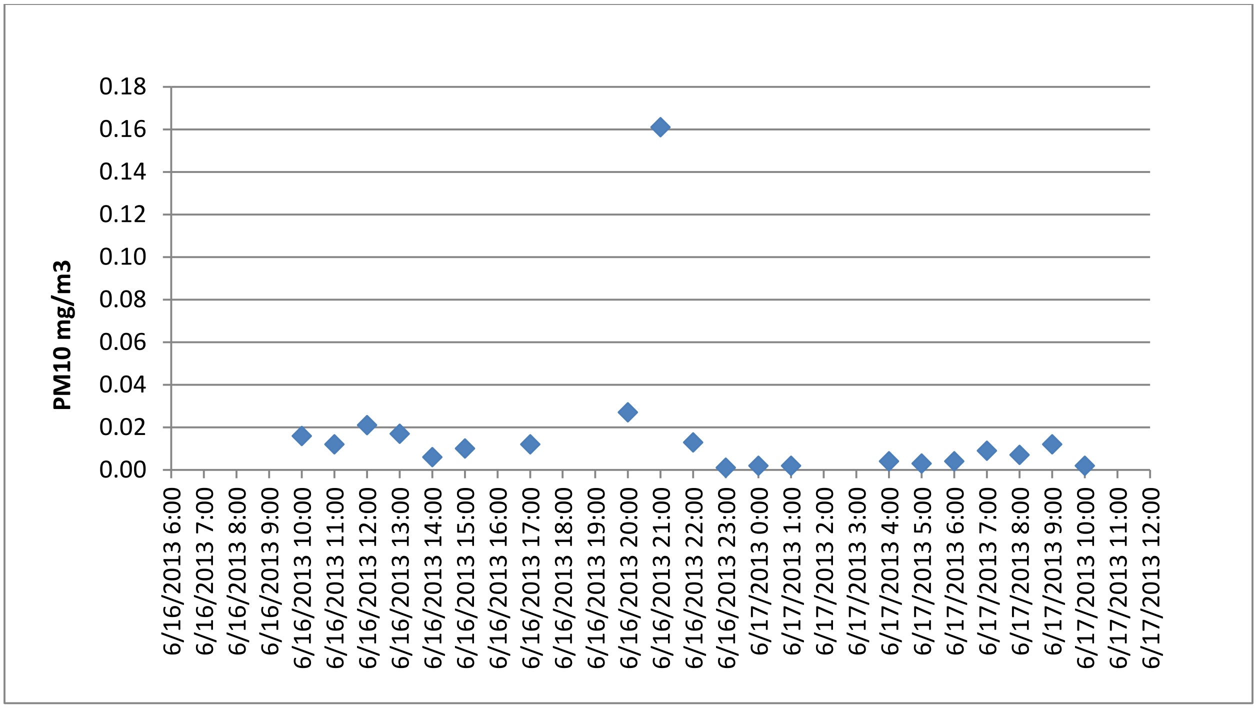

Figure 19. Representative short-term high PM10 concentration

One such instance that shows the impact of a short-term event is contained in Figure 19, which shows a single high hourly value of 0.160 mg/m^3. The periods before and after this hour show normal concentration levels, so some local event occurred or a distinct plume was captured. The noted concentrations are indeed high compared to most values, but when averaged together with routine concentrations, such higher levels do not change the daily average significantly. The majority of the short-term excursions from routine concentrations are difficult if not impossible to assign to a specific source, and they do not affect the overall average substantially. There were few of these instances, and they were relatively low concentrations on the order of just a few times the average.

Figure 20 shows an example of a combination of high and low concentrations along with wind direction data. It shows that some of the short-term peaks occur during both when the wind originates from the southwest direction (with possible impact from the plant and quarry sources) as well as when the wind originates in the northerly sectors (with possible impact from the urban and highway sources). In this case, the addition of these few relatively high concentration data points increased the daily average by 0.008 mg/m^3, which in the context of a few days, does not affect the overall long term average or trend significantly. This example was uncommon, but was discussed to illustrate the minor effect of the visually striking short-term peaks.

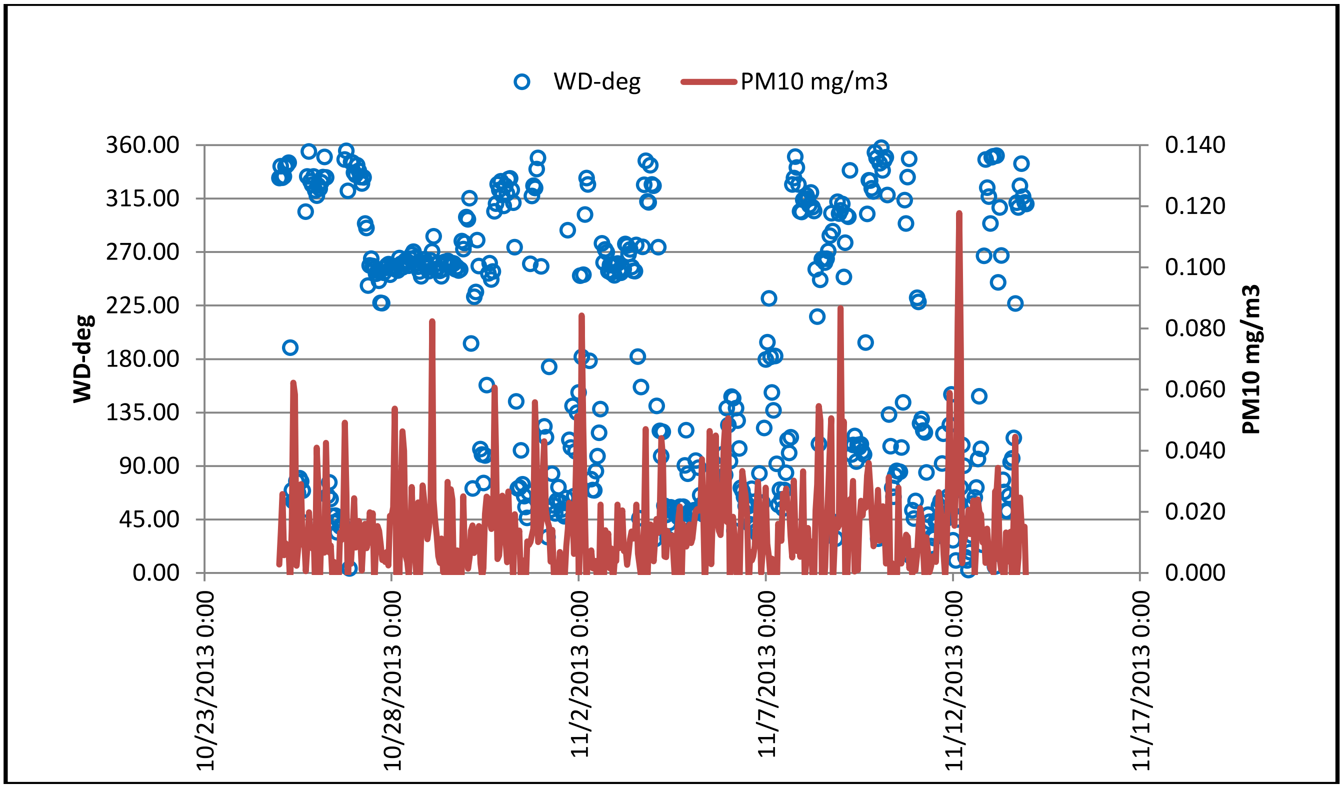

Figure 20. Detail of High and Low Values

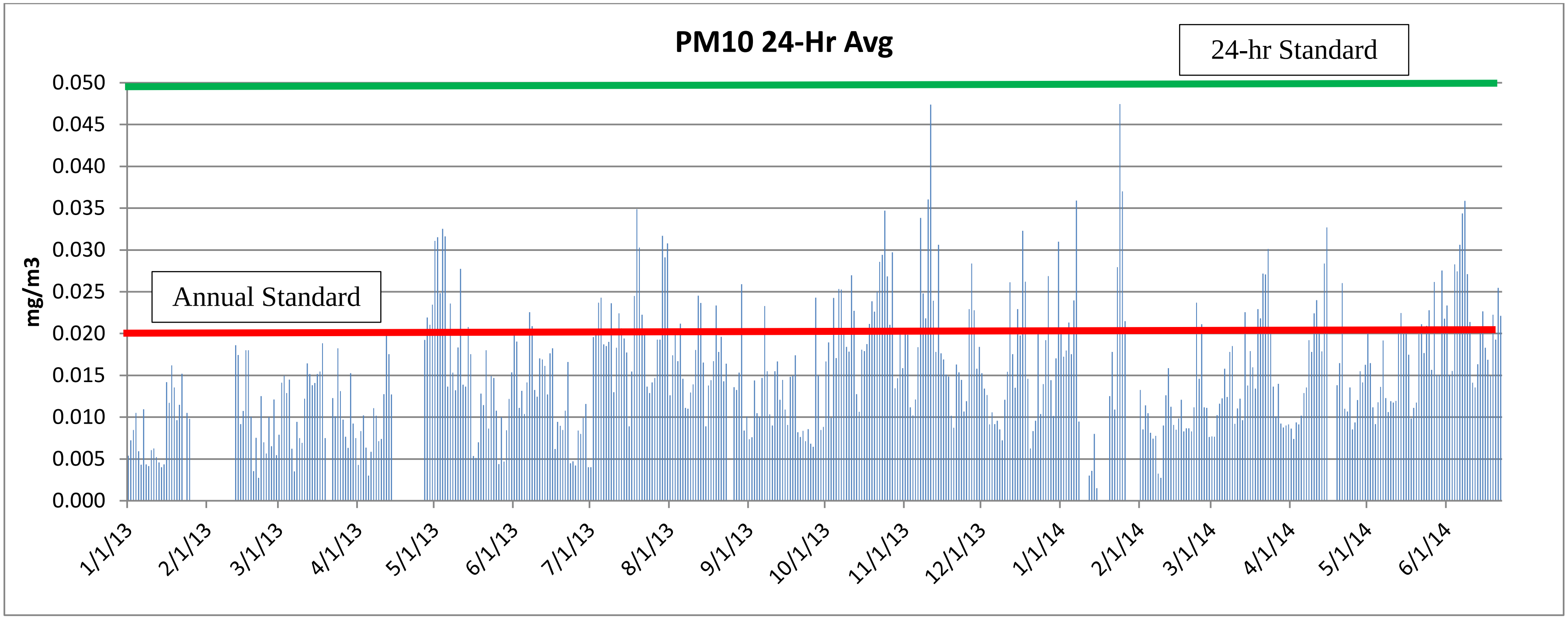

Figure 21. Daily PM10 Averages
California Standards: 24-hr Avg. = 0.020 mg/m^3, 24-hr Average = 0.050 mg/m^3.

Taking an average of the 24 hourly concentrations yielded the overall average. Figure 21 shows the plot of 18 months of 24-hr data. This information is used for comparison against the State and Federal 24-hr standards. The extended period is useful to show variability between the same seasons one year apart.

Figure 22 shows the distribution of the 24-hr values, indicating the narrow spread of the values, but also showing the large percentage of averages that were less than half the annual standard.

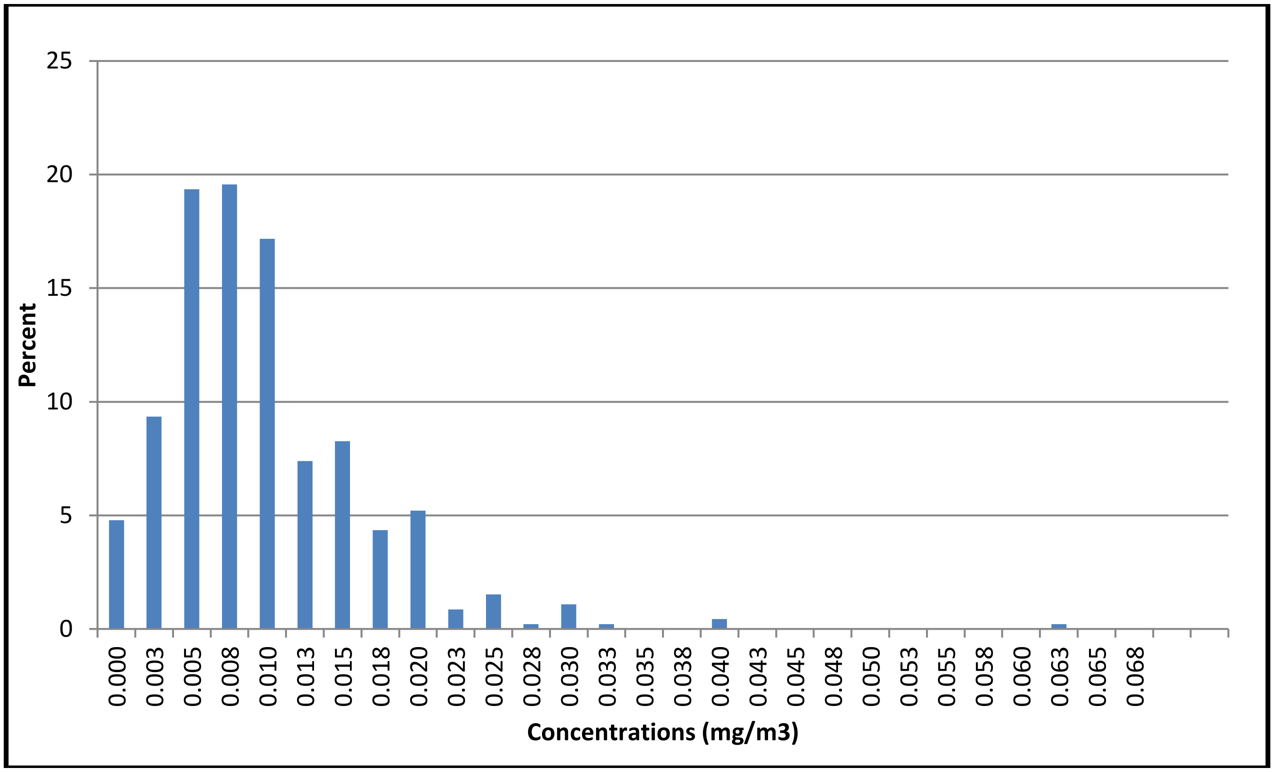

Figure 22. 24-Hr Concentration Histogram

Figure 23 contains the monthly averages. These data show some common general trends. Summer time months are somewhat higher due to lack of precipitation leading to higher dust levels. However, the winter months also can be higher due to winter time atmospheric conditions that do not favor dispersion as well as an increase in certain pollutants such as wood smoke.

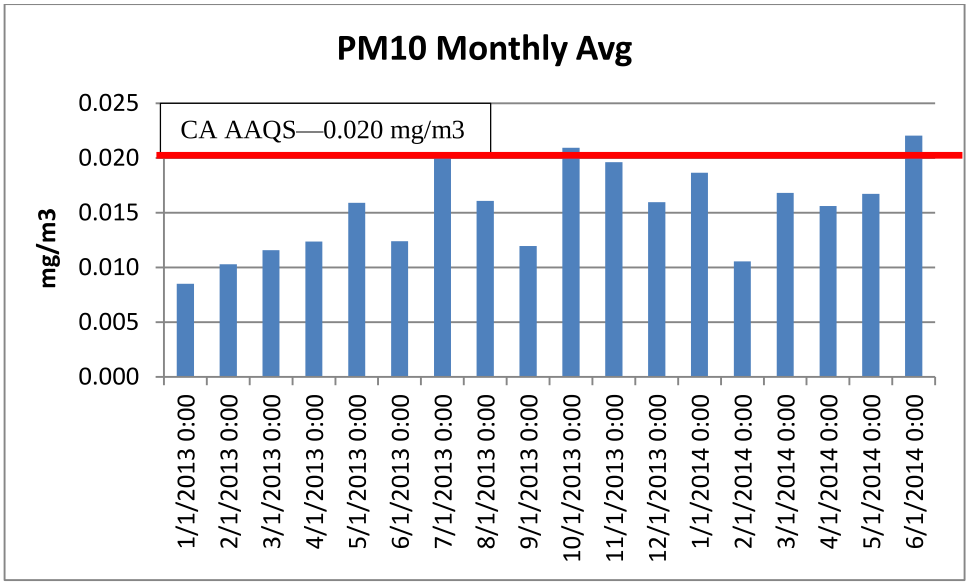

Figure 23. Annex PM10 Monthly Averages
Annual California Ambient Air Quality Standard (AAQS) = 0.020 mg/m^3.

6.1.2. Partisol PM10 Results

The average of the 24-hr filter samples for PM10 was 0.0153 mg/m^3. Figure 24 shows the time series of these data, which were collected in two periods, in February to March, 2014 and then in May to June 2014. It is also useful to see no difference between years.

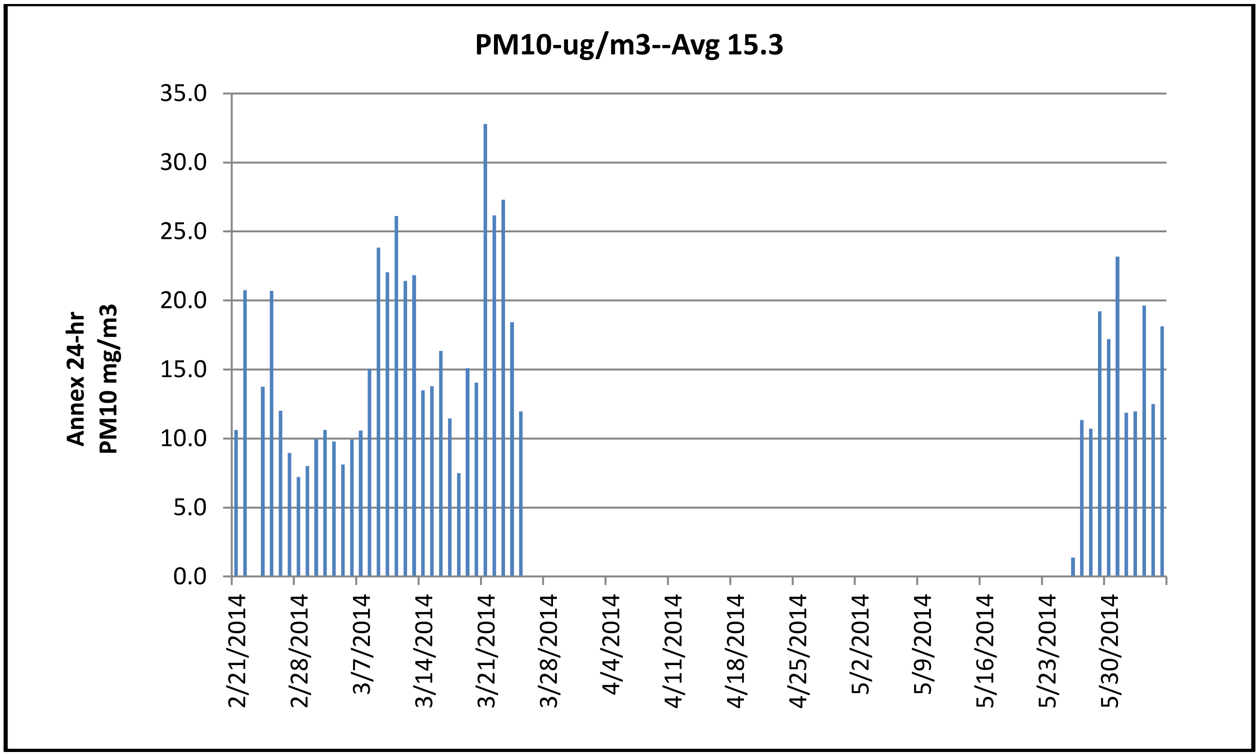

Figure 24. Annex Integrated PM10 Mass

6.2. Annex PM2.5

Figure 25 shows the hourly PM2.5 values that were collected from January 1, 2013 to May 19, 2014. The overall grand average for PM2.5 was 0.014 mg/m^3, 95% confidence limit of 0.00016 mg/m^3. This concentration was slightly above the California Ambient Air Quality standard and the Federal primary standard, both 0.012 mg/m^3. The California standard requires averaging of 24-hr values on an annual basis, while the federal standard uses a 3-year average and a 98th percentile of that period, not to exceed 35 µg/m^3. Therefore, while the California standard is exceeded in this case, it would not likely exceed the federal standard on a 3-year basis.

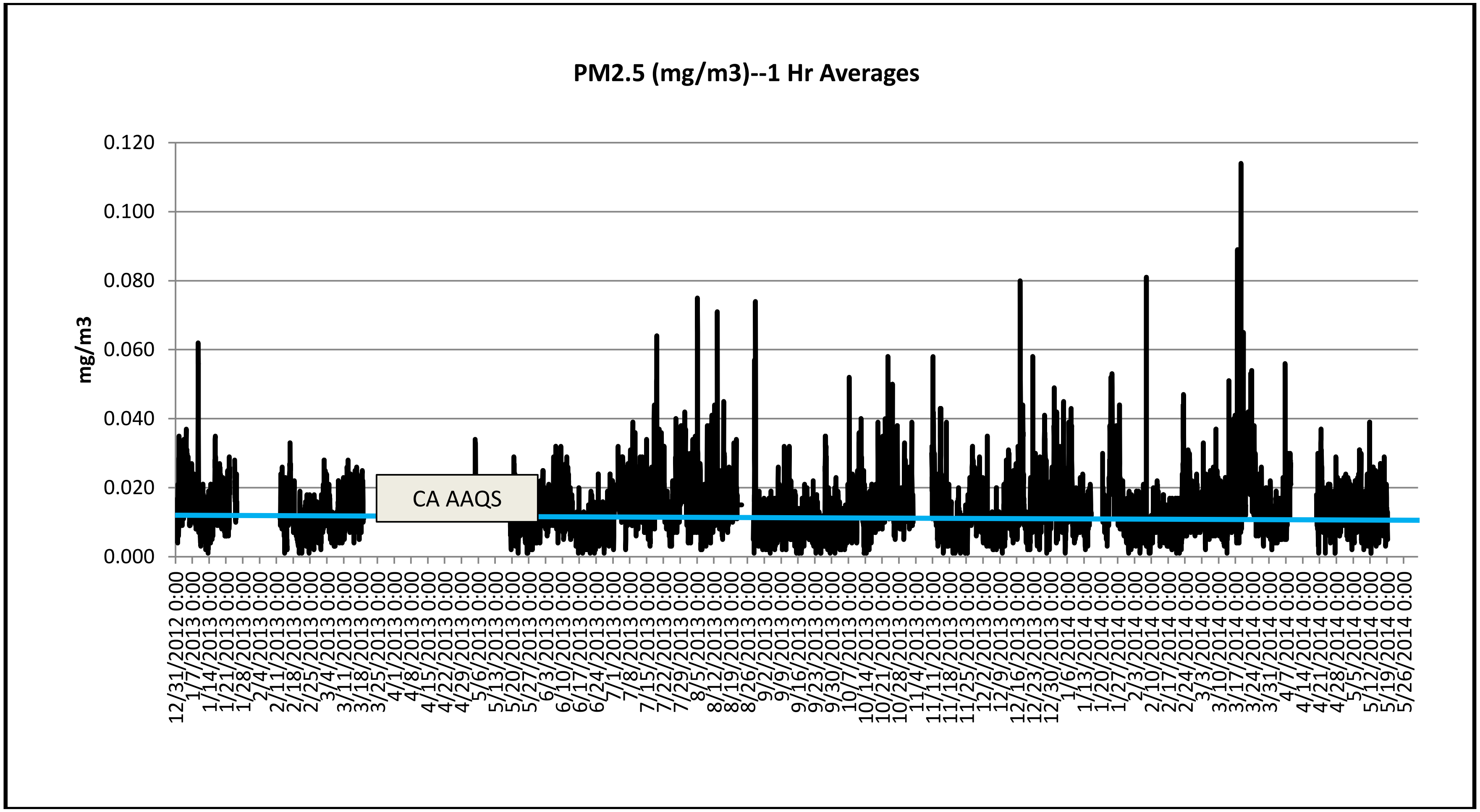

Figure 25. Hourly PM2.5 Results

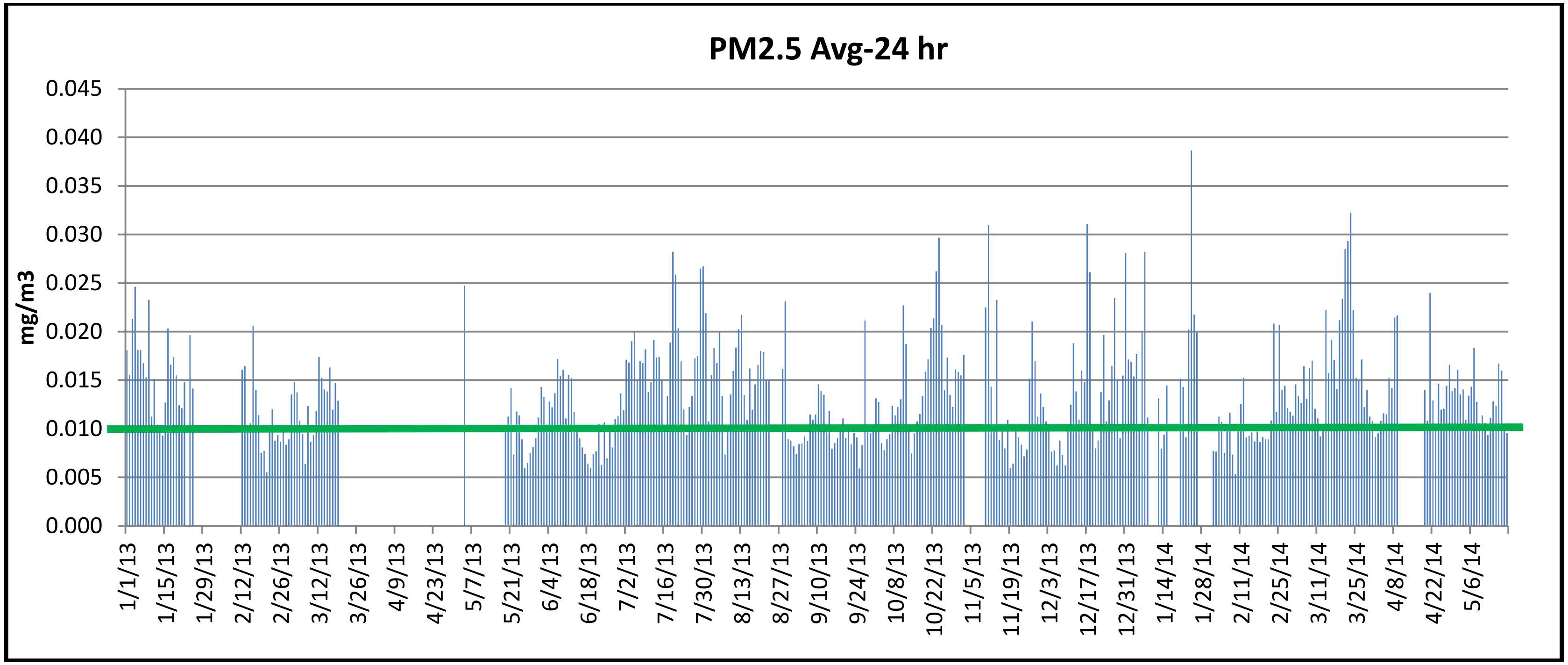

Figure 26. 24-hr. PM2.5 Averages
Green line is Annual standard of 0.012 mg/m^3.

Daily PM2.5 averages are shown in Figure 26, and monthly averages in Figure 27. There is a slight suggestion of a periodic trend, but this is not represented in the monthly data, shown in Figure 26. There are slight differences between months, but they are on the order of the 95% confidence limit, which is approximately 0.002 mg/m^3. The higher level in July and August could be due to regional pollution events, such as Spare the Air days that occur during periods of air stagnation and high temperatures. On the other end of the spectrum are the higher wintertime concentrations that are due to wood smoke and the generally less efficient dispersion that occurs in winter due to atmospheric conditions. The relatively low variability of these averages suggests a muted responsiveness to larger ambient air trends due the Annex's sheltered location as well as its wind direction pattern. Those trends will be examined more fully together with black carbon in another section.

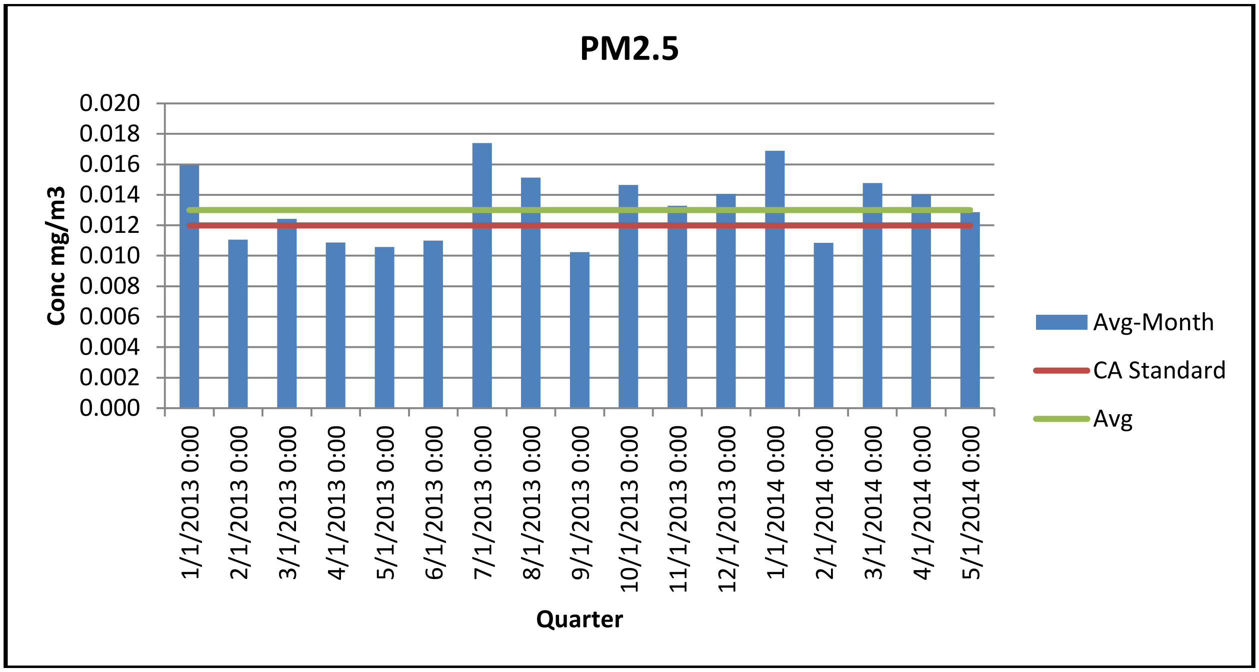

Figure 27. Annex PM2.5 Monthly Averages

6.2.1. Alternative Approach to PM2.5

The PM2.5 exceedance prompted a secondary review of the data and the process for both measurement and data analysis. In previous years before PM2.5 measurement was commonplace, one method for an indirect determination of PM2.5 concentrations was to use a previously determined ratio of PM2.5 to PM10 for a general type of aerosol (e.g., rural vs. urban) and then apply that to subsequent PM10 measurements.

This approach is also useful as a cross-check on current PM2.5 measurements. Using the typical PM2.5/PM10 ratio from other areas around the Bay Area, the predicted PM2.5 concentration would be on the order of 7.6 µg/m^3, as the ratio is approximately 0.54 that would be applied to the Annex PM10 level of 16 µg/m^3. The ratio of 0.54 is consistent with many other locations. This indirect value is substantially different from the measured value of 0.014 mg/m^3 but is consistent with other measurements from around the Bay Area. However, comparing the typical ratio with was measured suggests a much higher fraction of fine particulate than is justified from other observations. For example, the black carbon values are not substantially higher than expected. The possible impact due to the emissions from the cement plant is a possibility, however, there is no other indication of a substantial impact from the plant stacks (the coarse PM10 fugitives from the quarry would not be a factor for this PM2.5 measurement). For example, one possible indicator of impacts from the plant stacks is sulfur dioxide, the data from which showed no impact.

Table 2 shows a comparison of several locations where both parameters were measured.

Table 2. PM2.5/PM10 Ratios

Location	PM10-ug/m3	PM2.5-ug/m3	Ratio (PM2.5/PM10)
San Rafael	13.2	8.0	0.61
San Francisco	17.4	8.2	0.47
Concord	12.6	6.5	0.52
Los Gatos	18.8	9.1	0.48
Cupertino	13.5	8.6	0.64
Average	15.1	8.1	0.54
Annex-measured	16.0	14.0	0.88
Annex-recalculated	16.0	7.60	

Therefore, Table ES-1 shows the measured value with the estimated value in parentheses [0.014(7.6)] as an estimate using on this procedure. Based on the review shown here, it appears justified to show the PM2.5 as a range as opposed to a single measured value.

6.3. Annex—Black Carbon

The overall average of the 5 minute readings for BC at the Annex was 235 ng/m^3. This is a favorable level compared to the statewide California average of 1,100 ng/m^3.[21] A standard conversion from Black Carbon to diesel exhaust is to multiply by a factor of 2.0, so this results in a DPM equivalent of 470 ng/m$^{3.}$ As with the BC level, this is favorable in comparison to the reference concentration (RfC) of 5,000 ng/m^3. This concentration level is consistent with the low concentration of PM2.5—a similar fine particle pollutant. As an indicator of both near-by and regional sources, this average concentrations suggests a minor effect from these sources.

Figure 28 contains the full data record—a capture rate of 92.7%. The large spikes were cut down in the display in order to more fully show the more common lower level concentrations. The spikes were all single 5-minute values of several thousand ng/m^3, likely due to local on-site sources. These high values contribute only a few percent at most to the overall average for each day, so the visual impact is greater than the actual impact.

Figure 29 shows the 24-hr average. In this plot, the trends over various parts of the year can be seen. For example, the winter months show slightly higher concentrations, due to the addition of wood smoke to the black carbon from other sources. In addition, there is a regular wintertime change in atmospheric dispersion characteristics which reduces mixing, thereby increasing the ground-level concentration.

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[21] CARB research, http://www.arb.ca.gov/research/rsc/3-8-13/item8dfr08-323.pdf. Black Carbon and the Regional Climate of California, V. Ramanathan

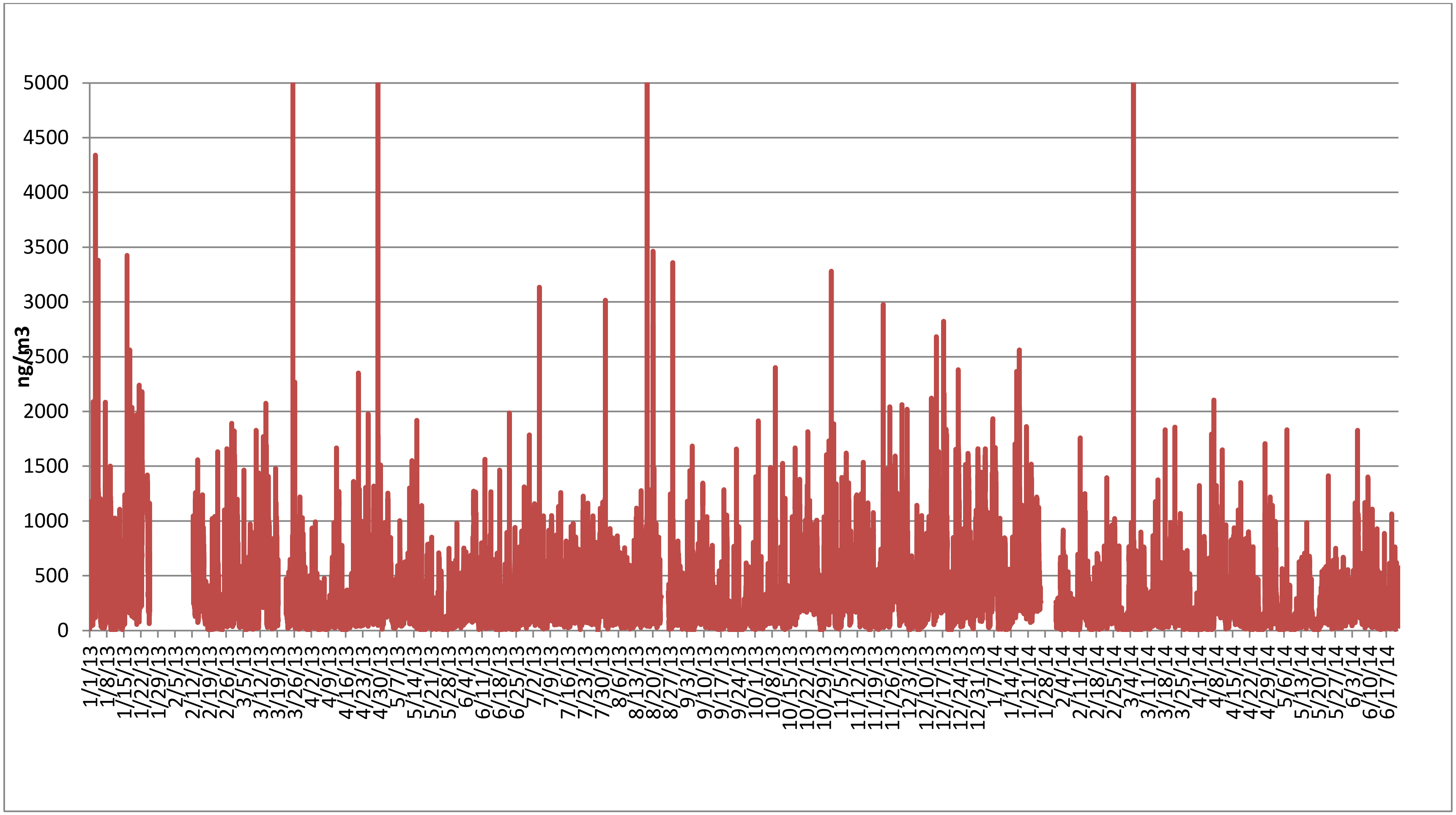

Figure 28. Black Carbon—5 minute concentrations

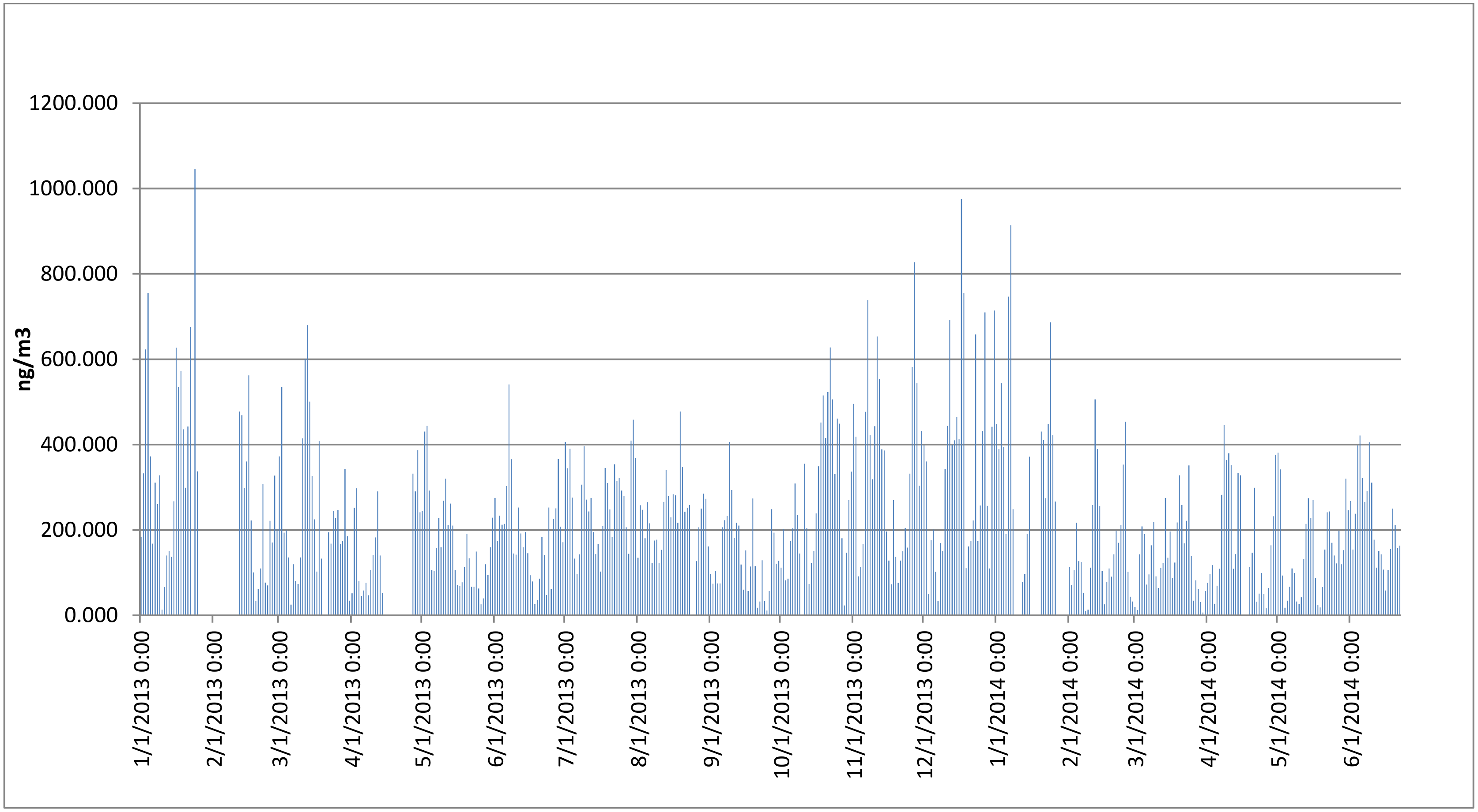

Figure 29. 24-hr Average Black Carbon.
Health-based standard is 5,000 ng/m^3

Figure 30 combines the monthly black carbon with the monthly PM2.5, showing a good agreement. This is not unexpected, as black carbon, as a fine particulate is part of PM2.5. This plot shows the same trends a PM2.5 in regards to periods of the year. The summertime, with its air quality challenges, shows higher levels of both constituents. The wintertime months experience the same atmospheric conditions that inhibit dispersion to the same level as the warm months. It is interesting to note that in the winter months, the black carbon increases its fraction of the PM2.5 concentration; this is indicative of wood smoke.

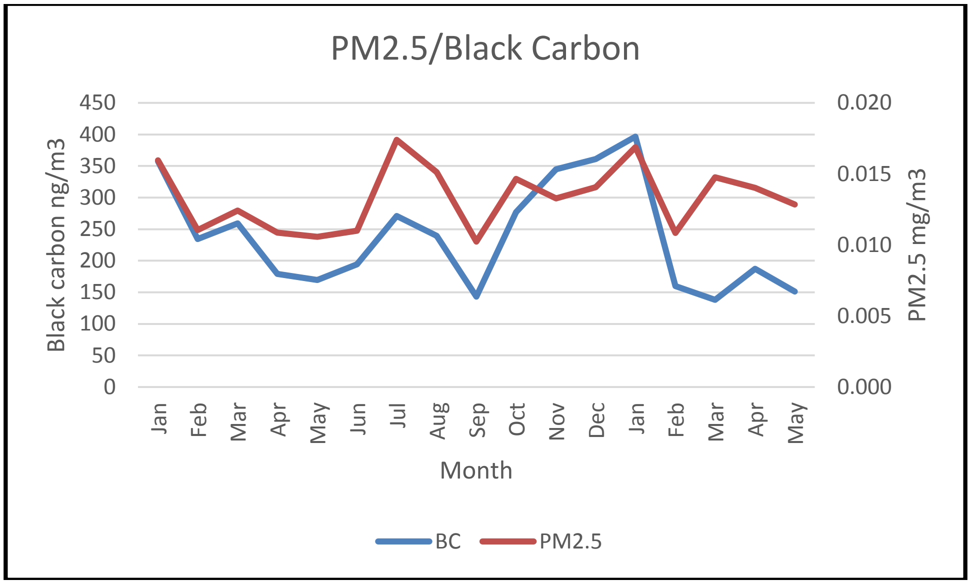

Figure 30. Monthly PM2.5 and Black Carbon Averages
Note the two different scales on double-Y axes; the BC does not exceed the PM2.5

6.4. Annex--Sulfur Dioxide

Sulfur dioxide (SO2) was added to the list of monitored parameters at the Annex site on September 20, 2013, continuing until May 24, 2014.[22] The average for SO2 was 0.76 ppbv. A plot of the 5 minute values is shown in Figure 31. These data show consistently low concentrations on the order of less than 1 ppbv, spiked with short-term higher concentrations. The highest concentration was 41 ppbv, but it was for a single period and dropped to normal levels quickly, suggesting a local source.

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[22] Sulfur dioxide was a 'bonus' parameter, as it was not included in the original scope and cost.

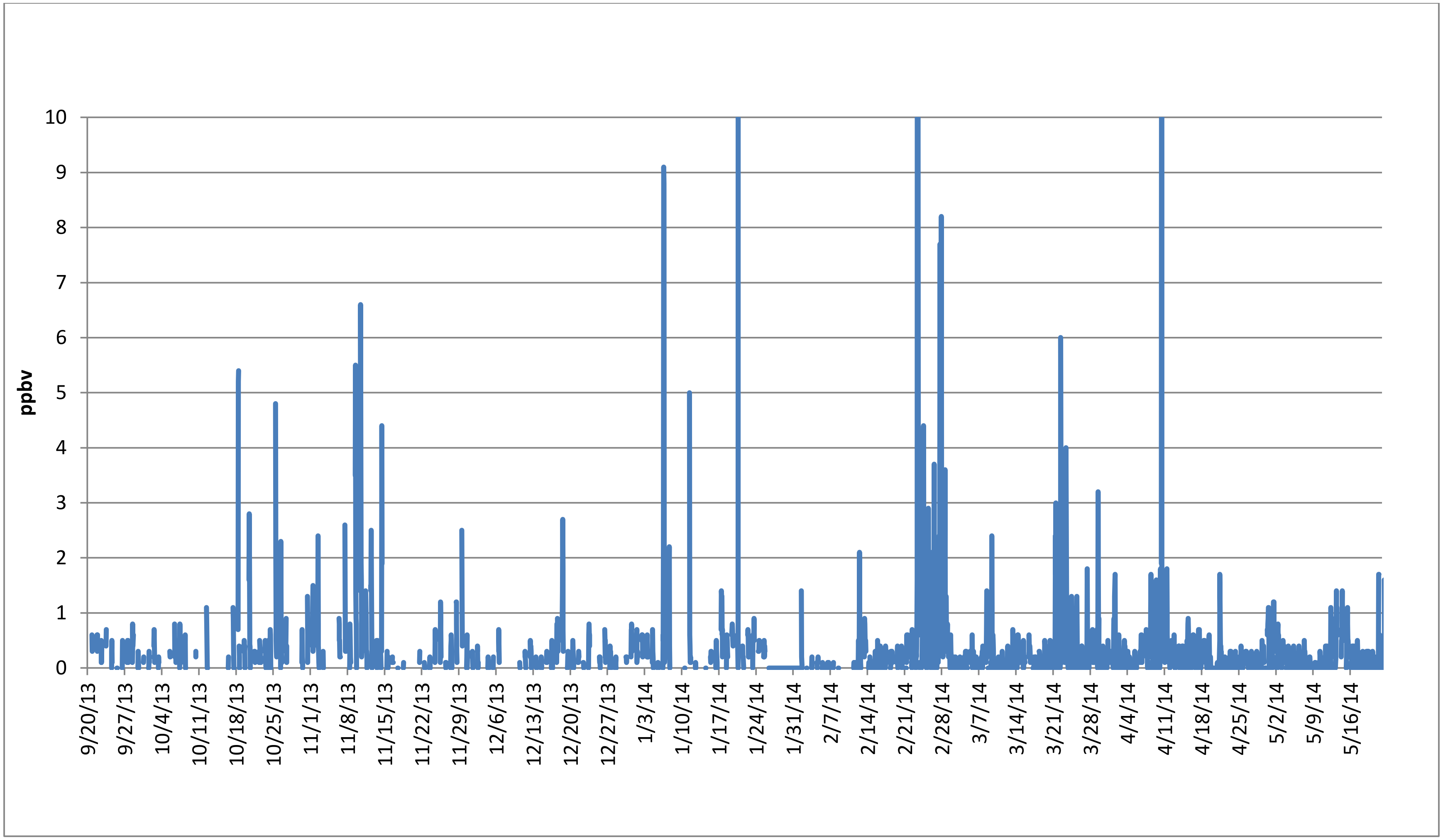


Figure 31. Sulfur Dioxide Concentrations.
Note 75 ppbv 1 hr. Federal standard; 40 ppbv 24-hr California standard

Many of these high spikes originated when the wind shifted from the usual origin from the northwest towards the north, which is more directly in line with urban sources. Figure 32 shows how the concentration varied over a 24-hr period in which the wind shifted from the usual westerly to northwesterly direction that carries clean oceanic air into the area to northerly directions that transports plumes from the local urban areas. This is also illustrated in the diurnal pattern in Figure 33 suggesting that the shift in wind direction towards the north during the day accentuates the contribution from urban sources, while in the evening, the combination of lower wind speed and a southwesterly direction, oriented towards the influx of clean oceanic air, results in a lower concentration. The sheltered location at the Annex provides some mitigation of the urban air masses that the Monta Vista site detects.

It is noteworthy that during the night time hours, both sites match, suggesting that the south-westerly wind trends are not affected by the Lehigh SO2 emissions.

In terms of possible exposure to sulfur dioxide at RSA, the concentrations average 0.76 ppbv, substantially less than any of the short- and long-term air quality standards, which range from 40 ppbv for 24-hr to 250 ppbv for 1 hour.

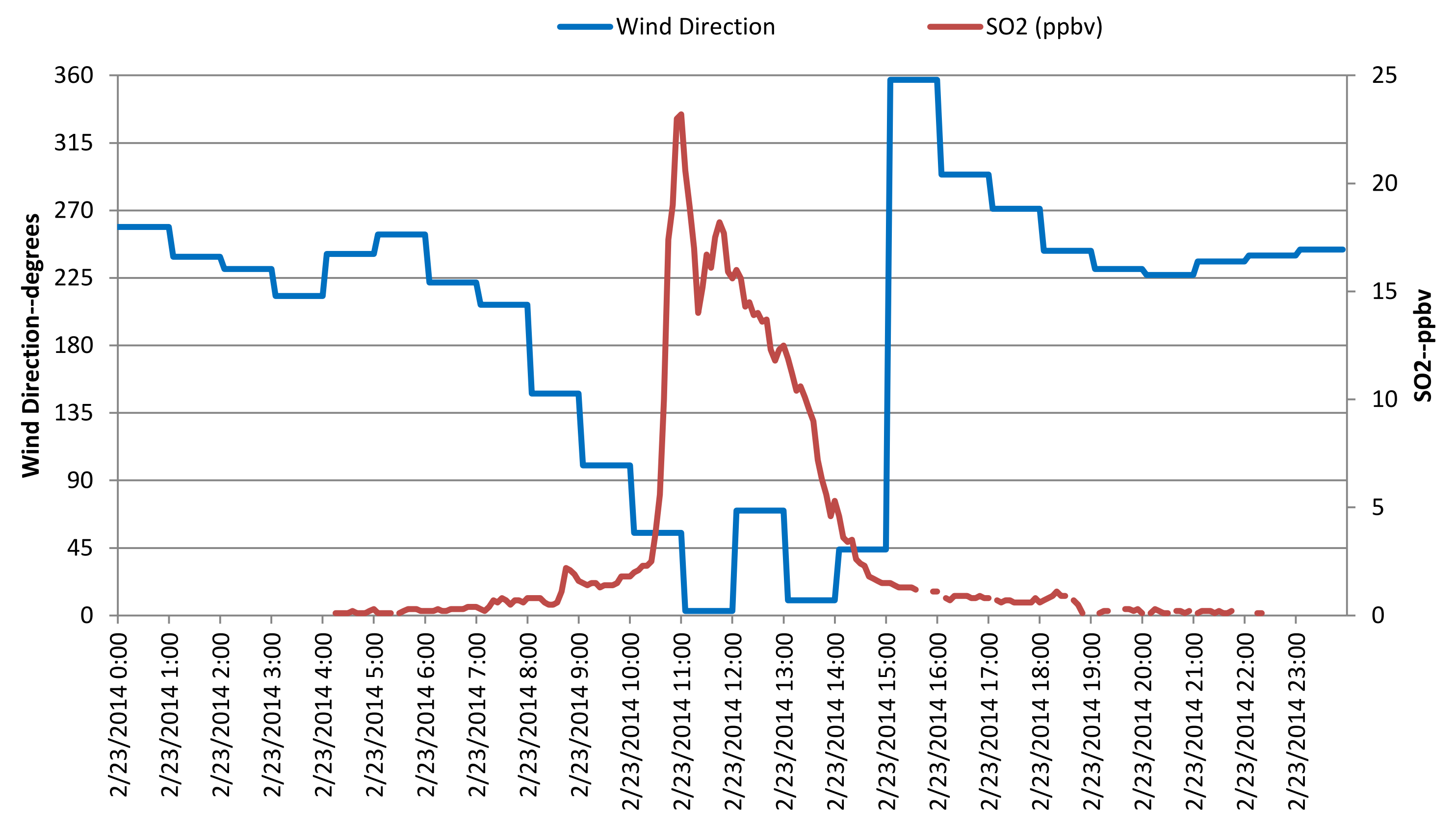


Figure 32. Short-term Concentration and Wind Direction Dependence

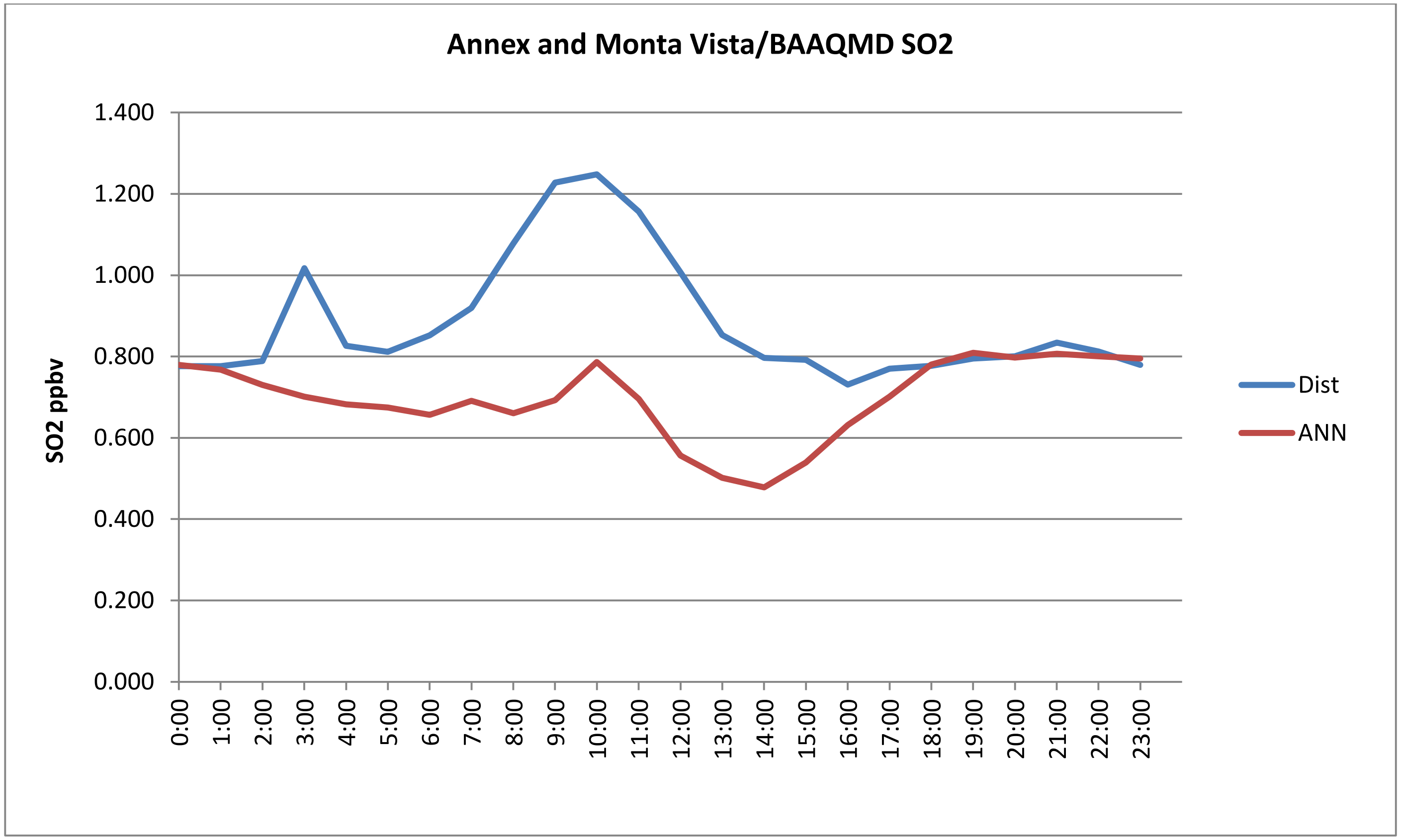


Figure 33. Diurnal Pattern Sulfur Dioxide—Annex and Monta Vista/BAAQMD
(Note: 3 AM spike is due to instrument calibration checks.)

6.5. Annex—Elements

Two types of data analysis were performed on the DRUM data sets. The first is a basic averaging of detected value for use in comparison with the health risk levels. The second is a more in-depth examination of the different size cuts in the sampler. Much of this information may be somewhat academic, however, there are multiple instances of conclusions regarding the impact of the clean oceanic air as well as the signature of the Lehigh operation in terms of excess Calcium.

6.5.1. Annex-8DRUM

The UC Davis DELTA Group 8 DRUM sampler ran from Dec. 31, 2012 to February 23, 2013. There were three major power outages – Jan 6 – 7, Jan 22 – 24, Jan 25 to Feb 12, and Feb 21 – 22, 2013 (depicted in the following graphics as periods of low/no readings). The DRUM sampler collected particles in 8 size modes between 10 and 0.09 µm aerodynamic diameter. Samples were analyzed in three hour increments for mass at UC Davis and 40 elements at the Advanced Light Source, Lawrence Berkeley National laboratory.

The results show:

- The dominant air mass present at the Annex site was of marine origins, as shown
- The coarse sulfur-chlorine ratio, identical to sea spray,
- The very low fine sulfur values, a robust urban-industrial signature,
- The lack of industrially derived elements from nickel to lead, and
- The wind rose data showing a dominant northwest origin.
  2.
- Into this air mass was added soil derived and calcium rich aerosols that were largely derived from the Permanente mining activities, as shown by
- The excess calcium spikes on top of the coarse soils,
- The high amounts of soil derived-elements, despite the suppression of other soil types by recent rainfall.
- Mining activities are constantly exposing and re-suspending soils that are not impacted by rainfall.
- The correlation with the strong afternoon wind peaks,
- The coarse size of the aerosols, indicating a local source, and
- Lack of any credible upwind site in the heavily vegetated coastal forest.
- (Forested areas absorb the coarsest particles, modifying the sizes).

<u>Results and Interpretation</u>

Average values of major aerosols are shown below in Table 3 for the entire 5 week sampling period. A comparison is made with average values at the Annex Site to an urban site in Redwood City near the San Francisco Bay, sampled in 2011, to put these values into context. The Redwood City data was available as an alternative background urban site for comparison with the RSA locations.

The rural nature of the Annex is shown most graphically by the very low values of sulfur at the Annex site. However, almost all of the industrial metals are far lower at the Annex Site than the Redwood City site, as shown by the ratios of much less than 1.0 in Table 3.

The exception is coarse soil derived elements. Despite the fact that the Annex Site sampling was done after rainfall in winter that should suppress local soils, the Annex Site soils are greater than those in Redwood City. This is consistent with mining activity that will constantly expose subsurface spoils not affected by rainfall.

Table 3. Comparison of Site Ratios
Average values of selected major and minor species, and ratio,
Annex site versus Redwood City site.

	PM$_{10}$	PM$_{10}$		PM$_{2.5}$	PM$_{2.5}$	
Soil	Annex site	Redwood City	Annex/ Red. City	Annex site	Redwood City	Annex/ Red. City
	ng/m^3	ng/m^3	Ratio	ng/m^3	ng/m^3	Ratio
Aluminum	247	141	1.76	60	30	2.01
Silicon	503	435	1.16	75	93	0.80
Calcium	301	247	1.22	29	69	0.42
Iron	220	193	1.14	46	58	0.79
Sulfur	167	569	0.29	117	452	0.26
Industrial						
Nickel	0.39	0.75	0.52	0.17	0.82	0.21
Copper	4.29	4.83	0.89	2.08	3.50	0.59
Zinc	7.61	10.09	0.75	4.23	4.99	0.85
Gallium	0.05	0.25	0.19	0.04	0.19	0.22
Arsenic	0.01	0.07	0.08	0.00	0.01	0.22
Selenium	0.52	1.14	0.46	0.51	1.03	0.49
Lead	6.48	20.72	0.31	4.92	14.11	0.35

Time derived information was obtained by the DRUM sampler that collected continuously in 8 size modes during the study. The UC Davis DELTA Group 8 DRUM sampler ran from Dec. 31, 2012 to February 23, 2013. There were three major power outages – Jan 6 – 7, Jan 22 – 24, Jan 25 to Feb 12, and Feb 21 – 22, 2013. In the first two cases, the battery back up kept the drum turning so timing was not lost. On Jan 25, the drum kept running for several days until the battery was exhausted

The samples were analyzed for mass and roughly 40 elements. First, all the soil derived elements (with one exception) behaved as shown below for silicon and iron. The soil was keyed to wind velocity, with a strong diurnal pattern. However, to have soil like this, there must be exposed soil without any vegetation. There is no information on other bare soil outside of the mine although satellite photos of the area suggest is it mostly forested.

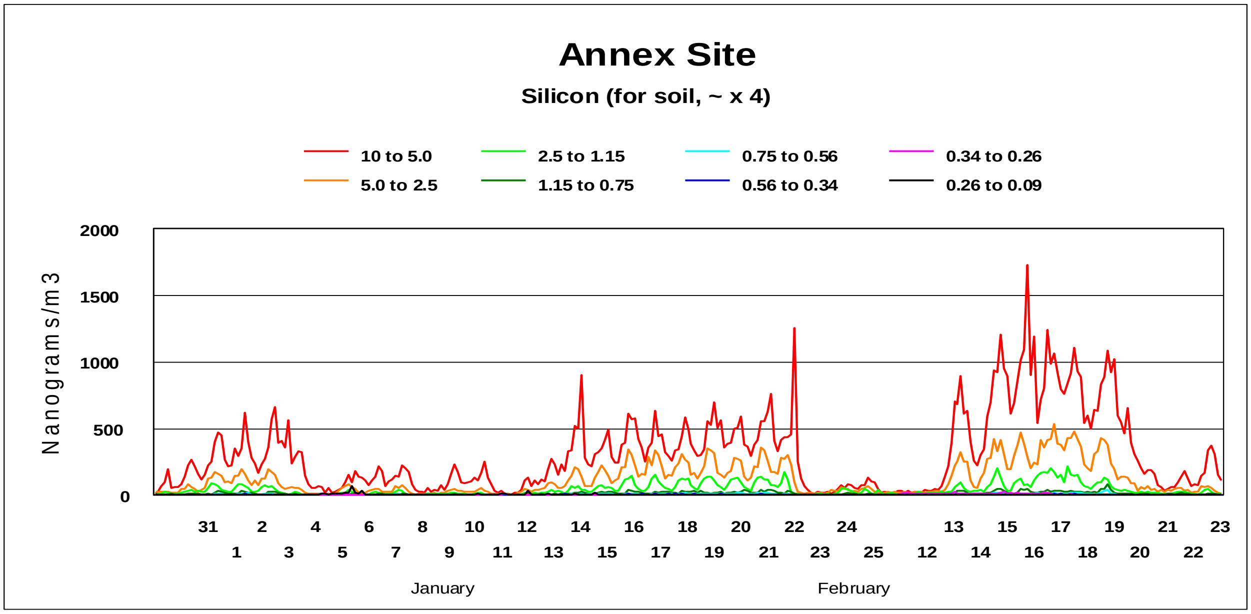


Figure 34. Silicon from soil versus time.

The coarse soil dominance in Figure 34 suggests a fugitive emission as opposed to a processing emission, which would result in higher of fine and ultra fine fractions.

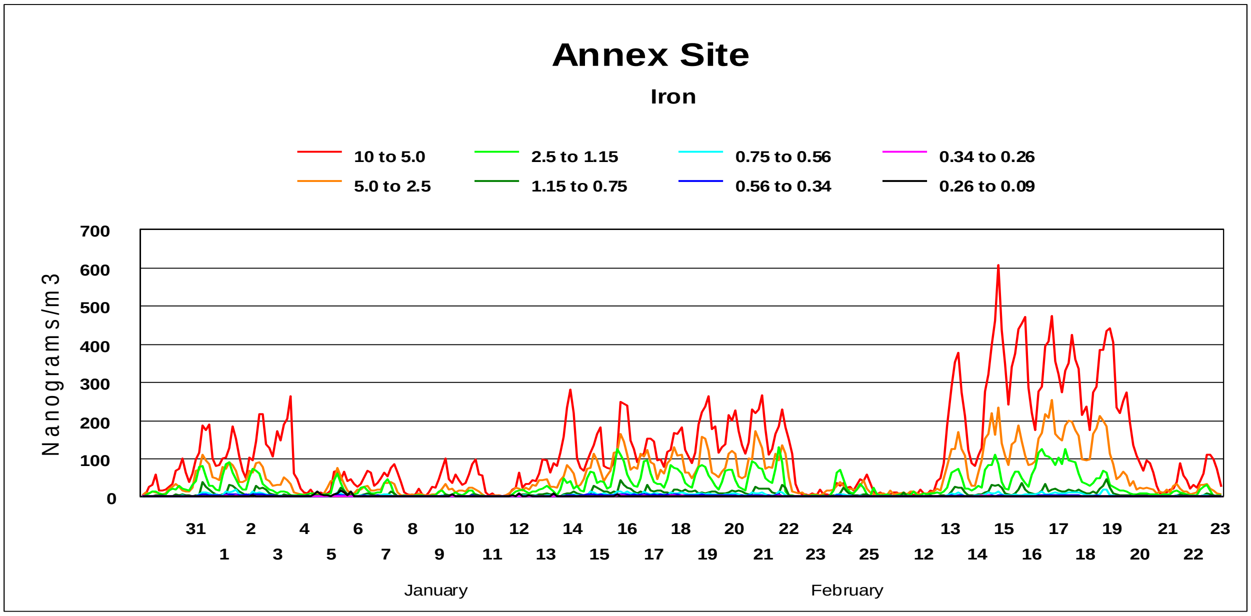


Figure 35. Iron from soil versus time.

Figure 35: Iron is the same as Silicon—processed emissions would be found in the fine fractions.

The situation is very different for calcium, as shown below. The pattern of all the other soils is not reproduced, indicating another source of calcium different than the resuspended soil. The larger particle sizes represent mechanical disturbance, attributed to quarry related activities, in contrast to processing emissions.

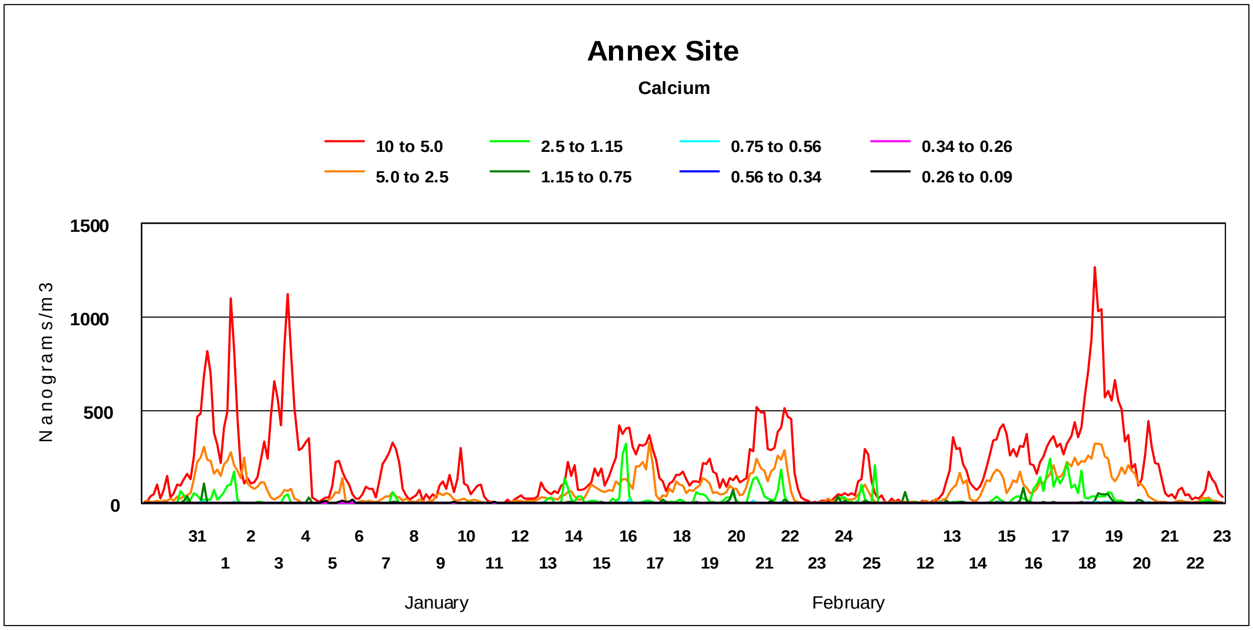


Figure 36. Calcium from soil and another calcium-rich source versus time.

For Figures 34-36, the peaks coincide with the afternoon winds.

To illustrate the difference, the silicon values have been divided by 3, which is the ratio used in the US IMPROVE network (Malm et al, 1994).

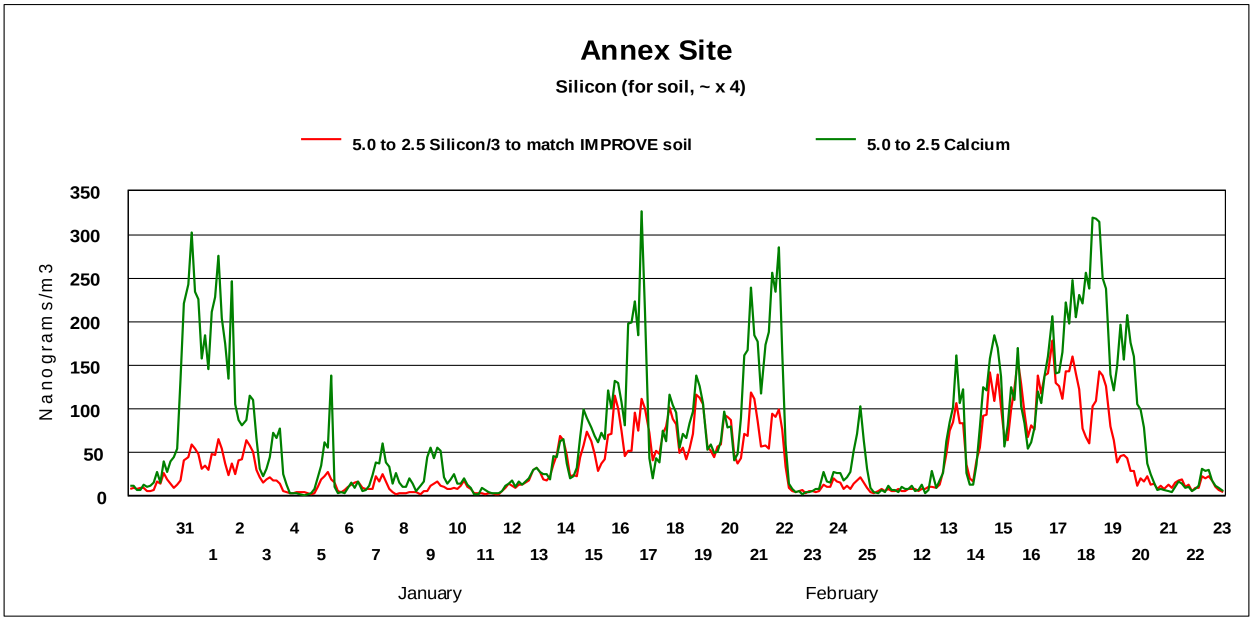


Figure 37. Calcium versus scaled silicon: Non-soil calcium, 35 to 10 µm.

If the calcium is all from soil, the two traces should lie directly on top of each other in Figure 37. In the three graphs below (Figures 38-40), this is done for particles 10 to 5.0. 5.0 to 2.5. 2.5 to 1.15, and 1.15 to 0.75 µm aerodynamic diameter.

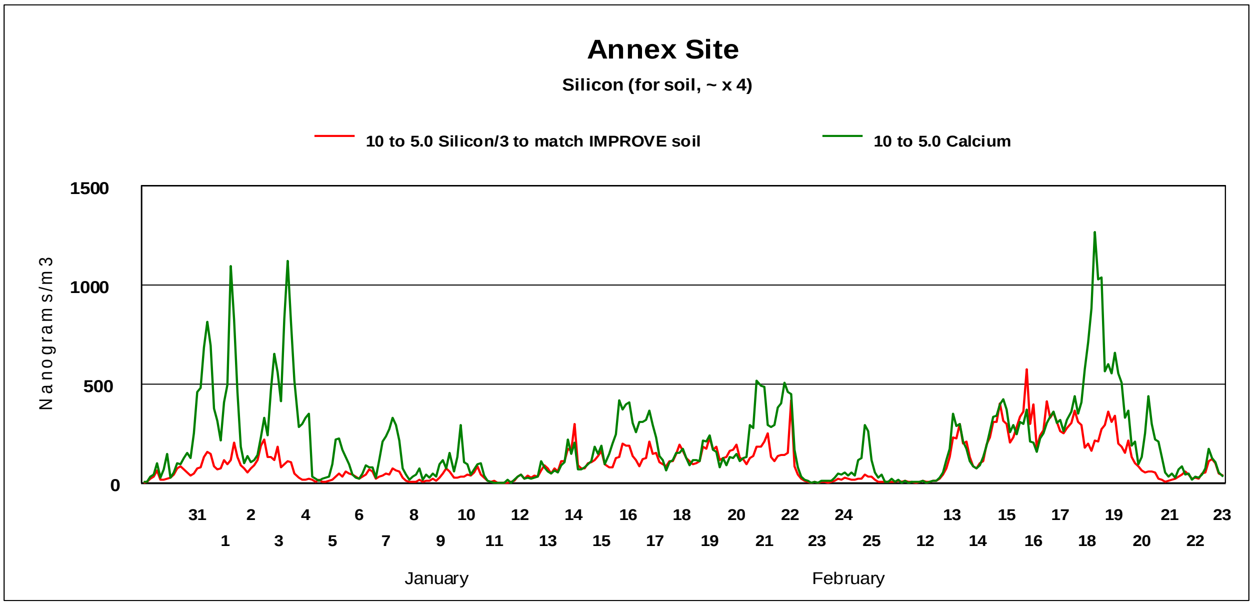


Figure 38. Calcium versus Coarse-scaled silicon
Shows the non-soil calcium source, 10 to 2.5 µm

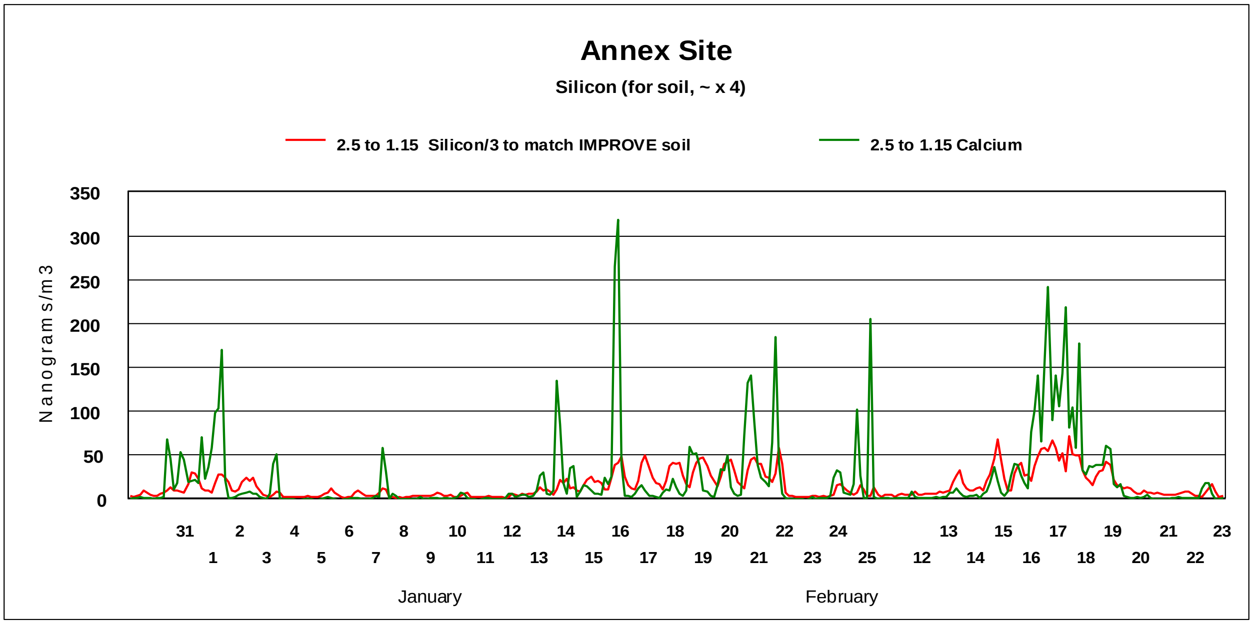


Figure 39. Calcium versus Fine-scaled silicon
Shows the non-soil calcium source. 2.5 to 1.15 µm.

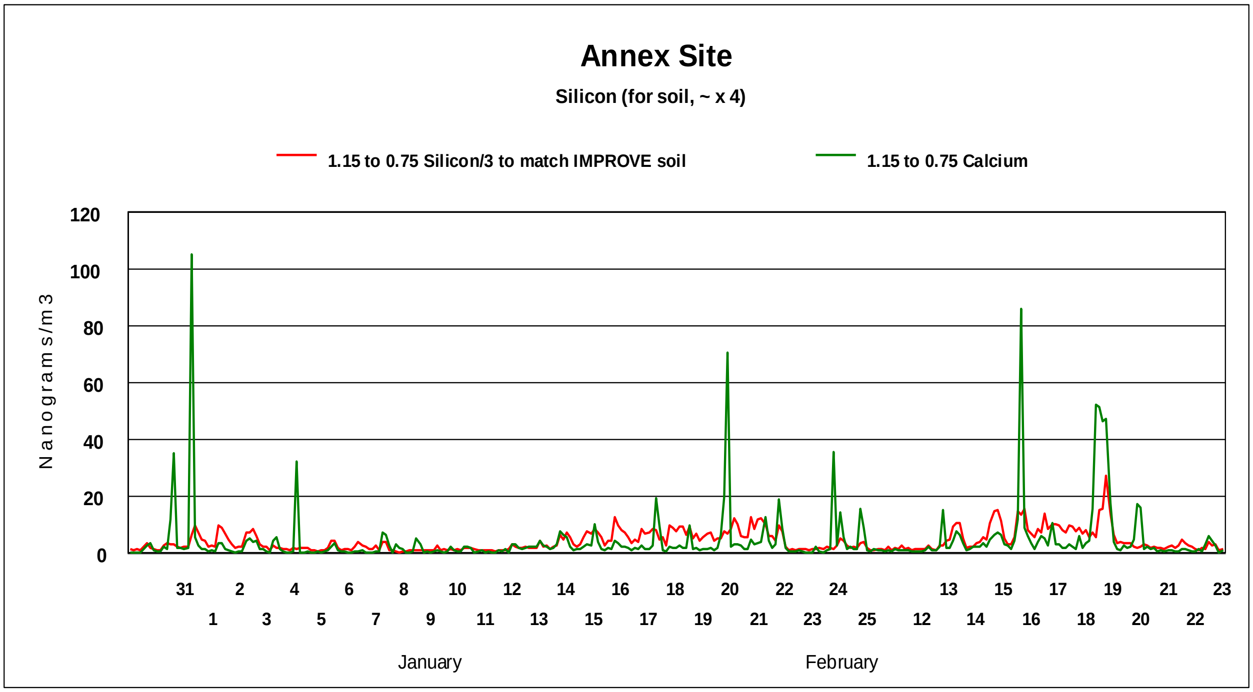


Figure 40. Calcium versus Very-fine scaled silicon,
Shows the non-soil calcium source, 1.15 to 0.75 µm.

In all cases, there is excess calcium, even to particle sizes much smaller than usual for unprocessed soil disturbance. These fine particles can get into the bronchial tract and upper lung, unlike the coarsest stages that are normally handled by nose and throat. They are also much more effective in forming hazes. This is a signature of processing, not mechanical emissions, and is attributed to the cement plant processing operations.

Annex Aerosol Size

The following plots (Figures 41-46) illustrate the size distribution and how it relates to elemental enhancement.

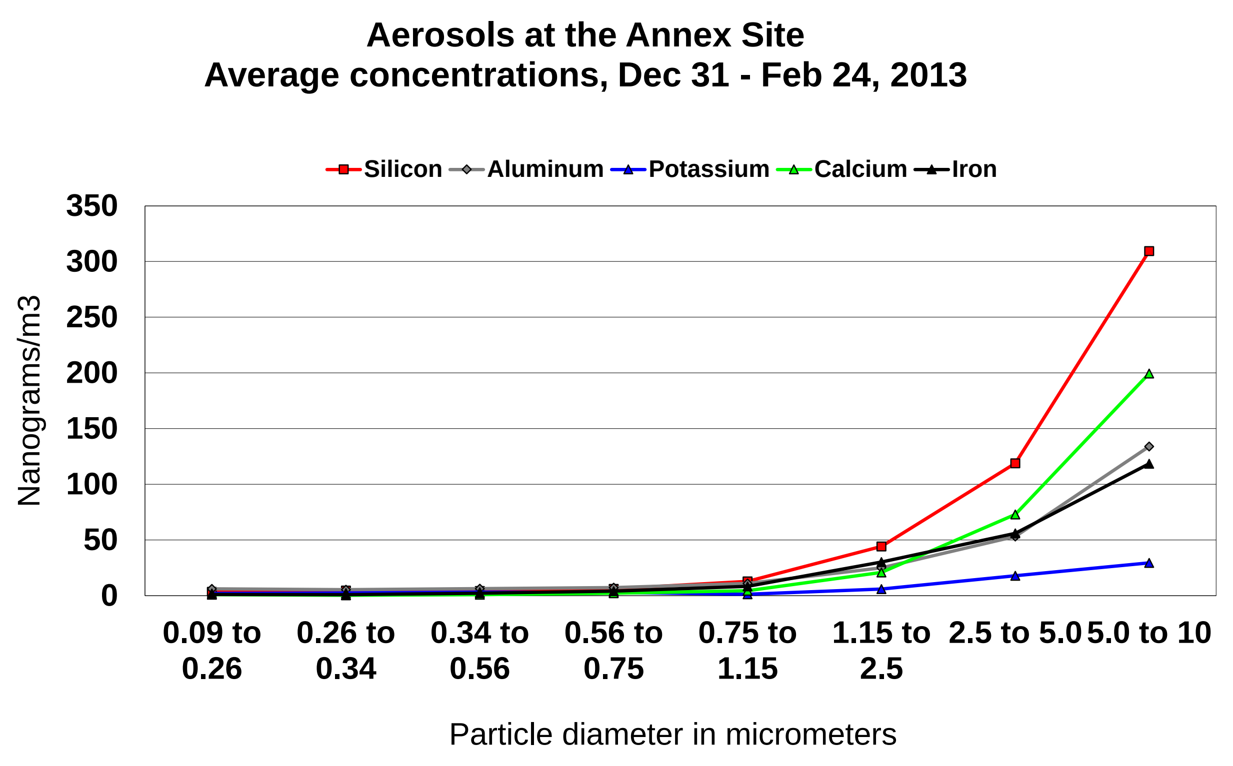


Figure 41. Size distribution of soil derived elements
Calcium enhanced by factor of 2.

Although silicon, aluminum and iron are added to the cement manufacturing process, the smaller size fractions are not enhanced relative to the coarse fractions. The aluminum, for example, is enhanced relative to potassium in the coarse mode, perhaps legacy material.

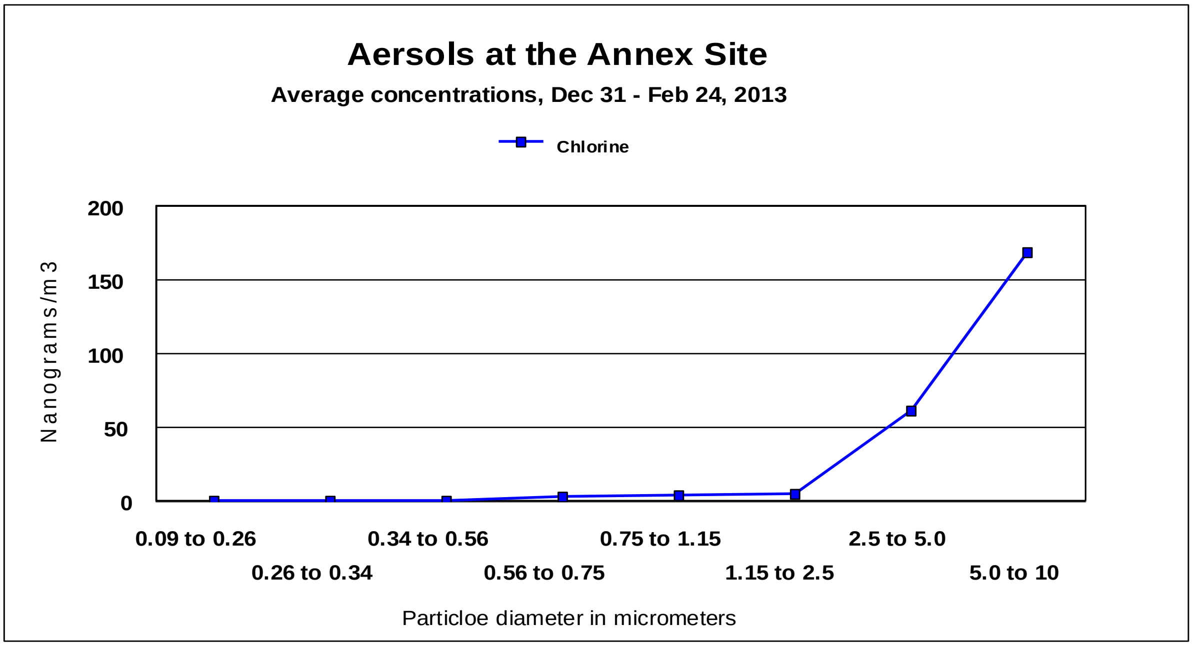


Figure 42. Coarse chlorine, typically oceanic in origin.

High levels of coarse chlorine indicates a marine dominated air mass.

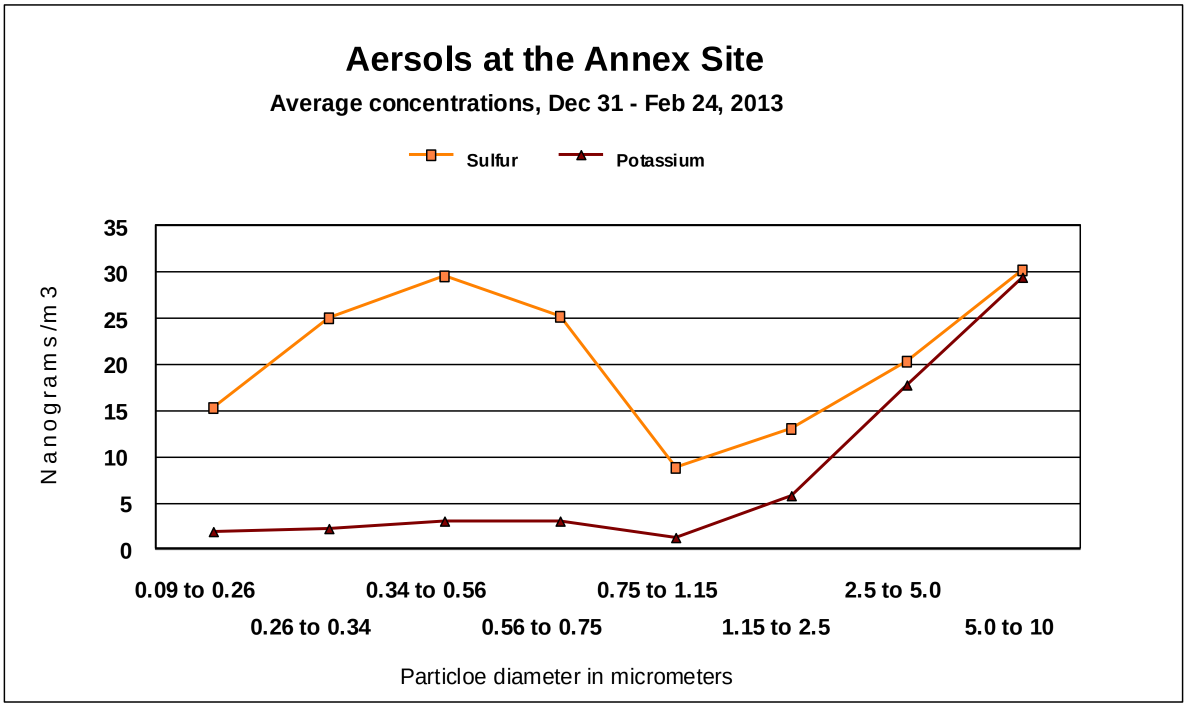


Figure 43. The coarse sulfur is confirmation of an oceanic source.

Very low levels of sulfur (double-digit ng/m^3) and very fine potassium – wood smoke. This is not an urban air mass.

The following plots show the average concentrations by size. When the trend in concentrations shows a change between different size fractions, it suggests a change in source profile. In particular, relatively large changes are made in the coarse size range for Calcium—known to be a fugitive dust problem--suggesting physical actions. Chlorine makes a big change, shown in Figure 44. The aluminum is a bit enhanced in the coarse mode, possibly indicating the detection of legacy aluminum residence from previous aluminum manufacturing operations.

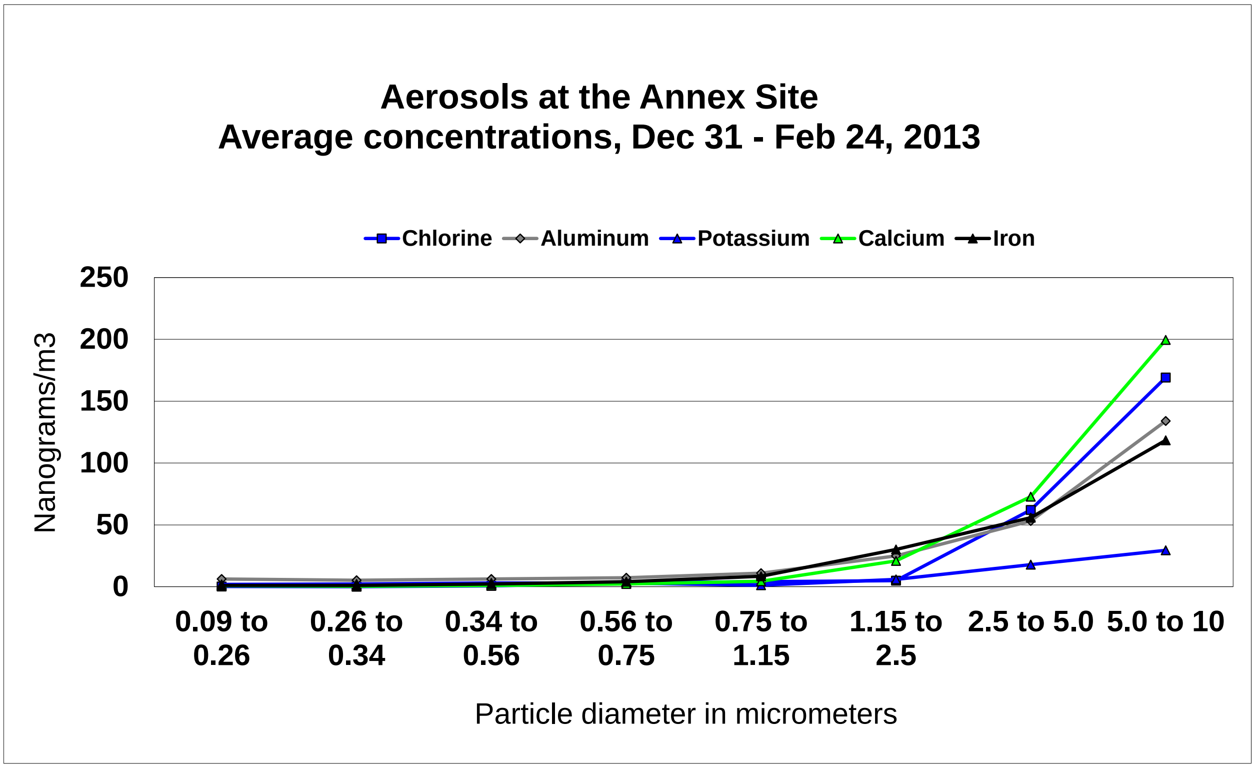


Figure 44. Average Concentrations of Crustal Elements by Size

Chlorine and Calcium show enhancements in fine and coarse modes.

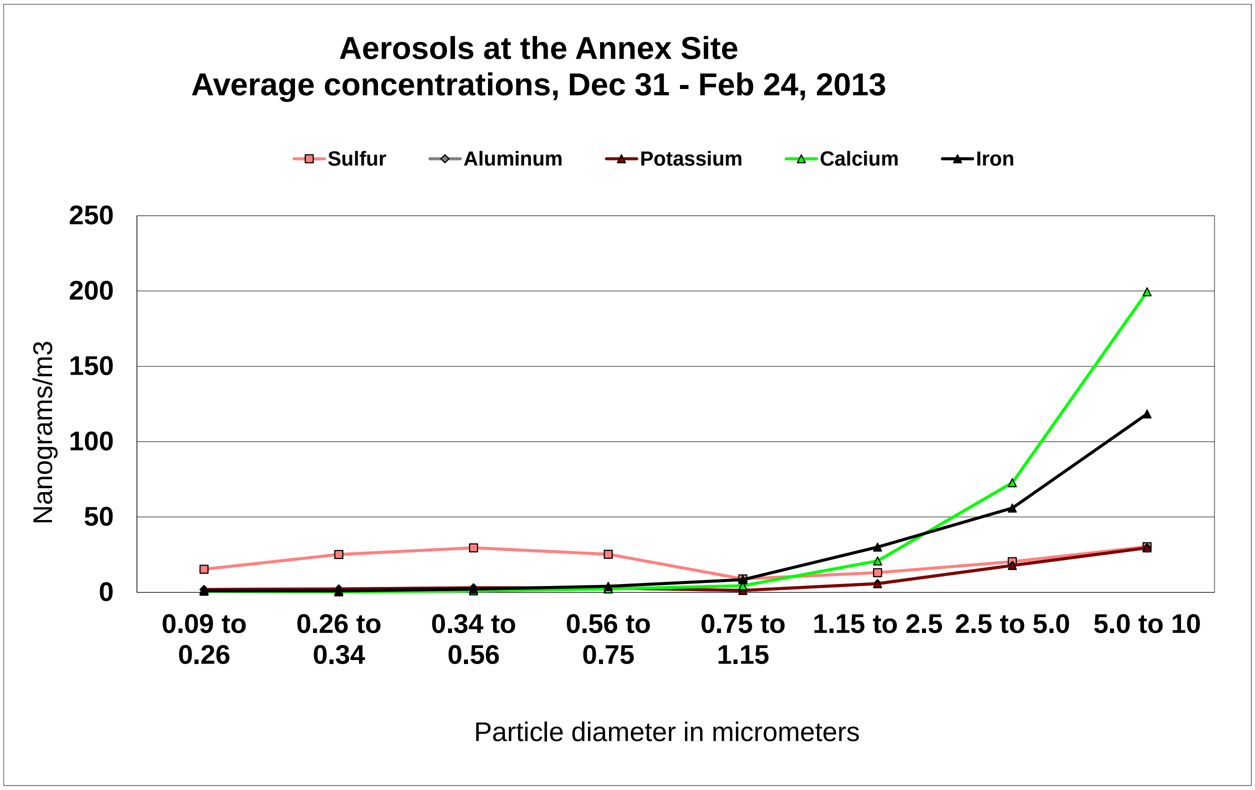


Figure 45. Average Concentrations of Crustal Elements Plus Sulfur by Size

The enhanced fine sulfur fraction in Figure 45 suggests a process source, either the plant or general ambient air, as fine sulfur is a common emission product.. Calcium as shows an enrichment in the fine to coarse ranges, particularly in the coarse mode, by a factor of two. Any coarse involvement of a crustal element is suggestive of fugitive dust, in this case quarry dust.

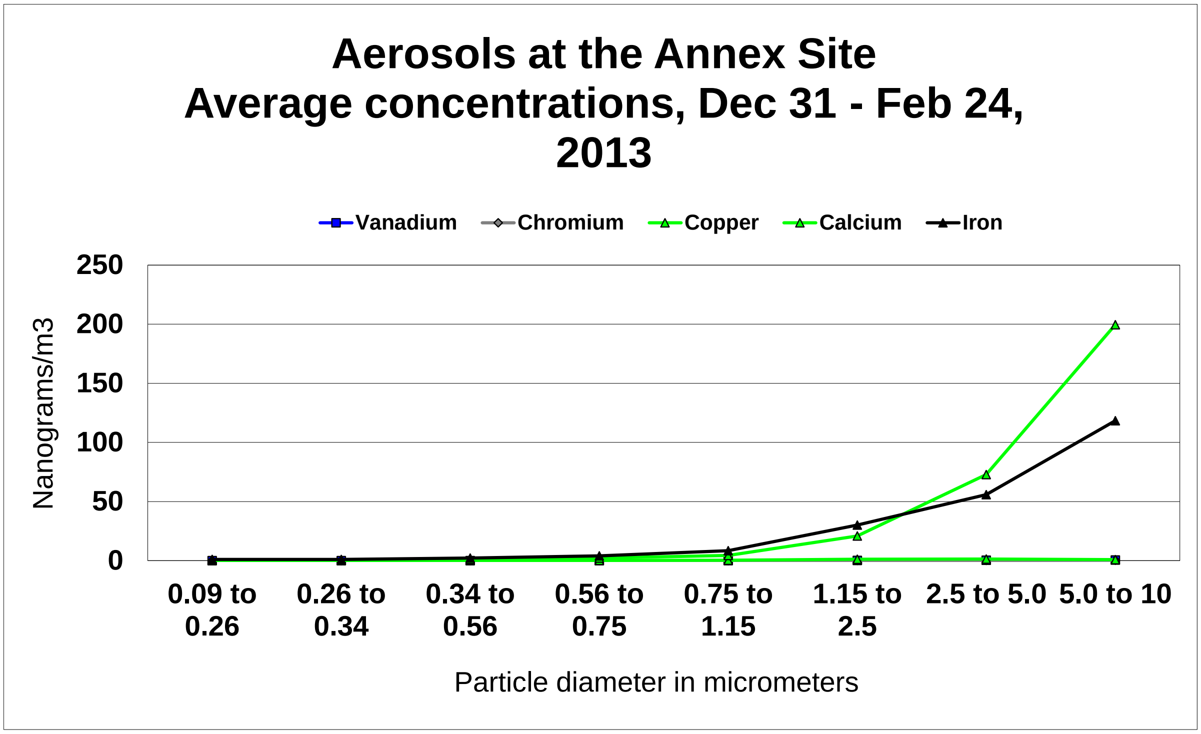


Figure 46. Average Concentrations Industrial Aerosols

Figure 46 shows there is no dominance of the industrial elements (e.g., non-crustal), compared to calcium, which shows an enhancement, as has been seen in other data plots.

Table 4 shows the average concentrations from the DRUM sampler, with a breakdown by size, both individual channels and the sum into PM10 and PM2.5 fractions. Note, however, that two latter fractions are just the total of the individual elements by size fraction, they are not comparable to the PM10 and PM2.5 total mass concentrations.

The column to the far right shows a rough picture of the size distribution. The main aspect from that view is to see if the distribution is dominated by one or more main size modes. A dominance by the coarse mode (5-10 um) suggests fugitive dust (e.g., quarry operations) while a smaller fraction suggests the process. A bi-modal element, such as sulfur, suggests both process and fugitive, fine comes from chemical or industrial processes, while the coarse material is likely due to oceanic contributions, as sulfur is not a dominant crustal element.

In the crustal elements (Si, Fe, Al, Ca), the coarse mode dominates, hence a likely soil origin related to quarry operations.

Table 4. Annex DRUM Concentrations by Size

Size in micrometers (um).

Annex 1	Size Fractions. Conc in ng/m3									Sum		Size Distribution
Element	0.09 to 0.2	0.26 to 0.3	0.34 to 0.5	0.56 to 0.7	0.75 to 1.1	1.15 to 2.5	2.5 to 5.0	5.0 to 10	Element	PM10	PM2.5	Small-->Large
Mg	31.08	30.76	27.54	27.64	37.08	39.04	38.87	87.41	Mg	319.41	193.13	
Al	6.14	5.27	6.23	7.16	10.86	24.93	53.04	133.95	Al	247.59	60.6	
Si	3.49	4.62	4.14	6.14	12.71	44.1	118.78	309.42	Si	503.4	75.2	
P	2.52	3.38	3.15	3.11	2.62	3.61	4.8	5.77	P	28.95	18.38	
S	15.33	25.07	29.5	25.21	8.9	13.03	20.39	30.22	S	167.66	117.05	
Cl	0.18	0.03	0.69	3.43	4.05	4.9	61.95	169.07	Cl	244.3	13.28	
K	1.91	2.25	3.03	2.93	1.2	5.81	17.77	29.48	K	64.38	17.13	
Ca	0.77	0.33	0.93	2.2	4.41	20.82	72.8	199.55	Ca	301.81	29.46	
Ti	0.38	0.87	0.78	0.53	0.95	2.88	5.59	12.42	Ti	24.39	6.38	
V	0.03	0.03	0.03	0.04	0.06	0.15	0.28	0.58	V	1.2	0.35	
Cr	0.12	0	0.02	0.03	0.02	0.1	0.18	0.37	Cr	0.84	0.29	
Mn	0.02	0.04	0.09	0.13	0.12	0.34	0.81	1.83	Mn	3.38	0.74	
Fe	0.99	0.93	2.14	4.01	8.38	30.07	55.88	118.37	Fe	220.76	46.52	
Co	0	0	0	0.02	0.05	0.13	0.26	0.54	Co	1.0	0.2	
Ni	0.07	0.02	0.02	0.02	0.01	0.03	0.07	0.15	Ni	0.39	0.17	
Cu	0.21	0.09	0.13	0.2	0.34	1.11	1.37	0.84	Cu	4.29	2.08	
Zn	0.56	0.59	0.75	0.86	0.58	0.88	1.13	2.25	Zn	7.61	4.23	
Ga	0.005	0.002	0.01	0.01	0.01	0.004	0.003	0.002	Ga	0.05	0.04	
As	0	0	0.0005	0.0005	0	0.0002	0.0027	0.0017	As	0.01	0	
Se	0.09	0.07	0.1	0.11	0.06	0.07	0.04	0	Se	0.52	0.51	
Br	0.48	0.58	0.44	0.41	0.33	0.44	0.56	0.89	Br	4.13	2.67	
Rb	0.64	0.71	0.73	0.66	0.44	0.53	0.77	0.64	Rb	5.13	3.71	
Sr	1.41	1.39	1.09	1.36	1.14	1.15	1.82	1.96	Sr	11.31	7.53	
Y	3.15	3.29	2.43	2.58	2.54	3.08	3.07	3.16	Y	23.29	17.06	
Zr	4.29	5.24	4.5	4.77	4.49	5.56	5.35	5.58	Zr	39.77	28.84	
Mo	11.27	10.9	12.03	10.6	9.54	11.2	12.35	12.92	Mo	90.81	65.54	
Pb	1.1	1.03	0.99	0.74	0.44	0.62	0.74	0.82	Pb	6.48	4.92	

It is understood that the Lehigh plant site has a history of various metal manufacturing, which may lead to legacy materials in the fugitive dust, besides what is due from the current operations. One way to distinguish this older material from current material is in the size and element ratios. The expected size distribution of this ‘legacy’ material is uncertain, as various physical and chemical processes could have altered its state. The magnesium size distribution was of interest—the smaller size components were all relatively equal, and the coarse mode was substantially higher in concentration, so perhaps a mixture of both aged material and recent coarse mode from quarry operations. The ratio between Magnesium and Silicon is 0.12 (earth crust is 0.08) which is indicative of an enhancement. As noted above, the Aluminum/Silicon ratio is slightly enhanced (0.49 vs. 0.30) as well, though the coarse mode dominates, both factors that make it less certain about the origin of all modes of those elements

.Figure 47 is an alternative plot of the DRUM data. The coarse fraction (5.0-10) has major dominance over other size fractions, indicating soil-related fugitive dust enhanced with calcium, thus a signature for quarry fugitive emissions. As noted above, this shows that Magnesium has an unusual size distribution, as well as the fine and coarse mode Sulfur, indicative of process emissions and sea salt aerosols respectively. Silicon dominates, as expected, since the major source for all the aerosols is soil.

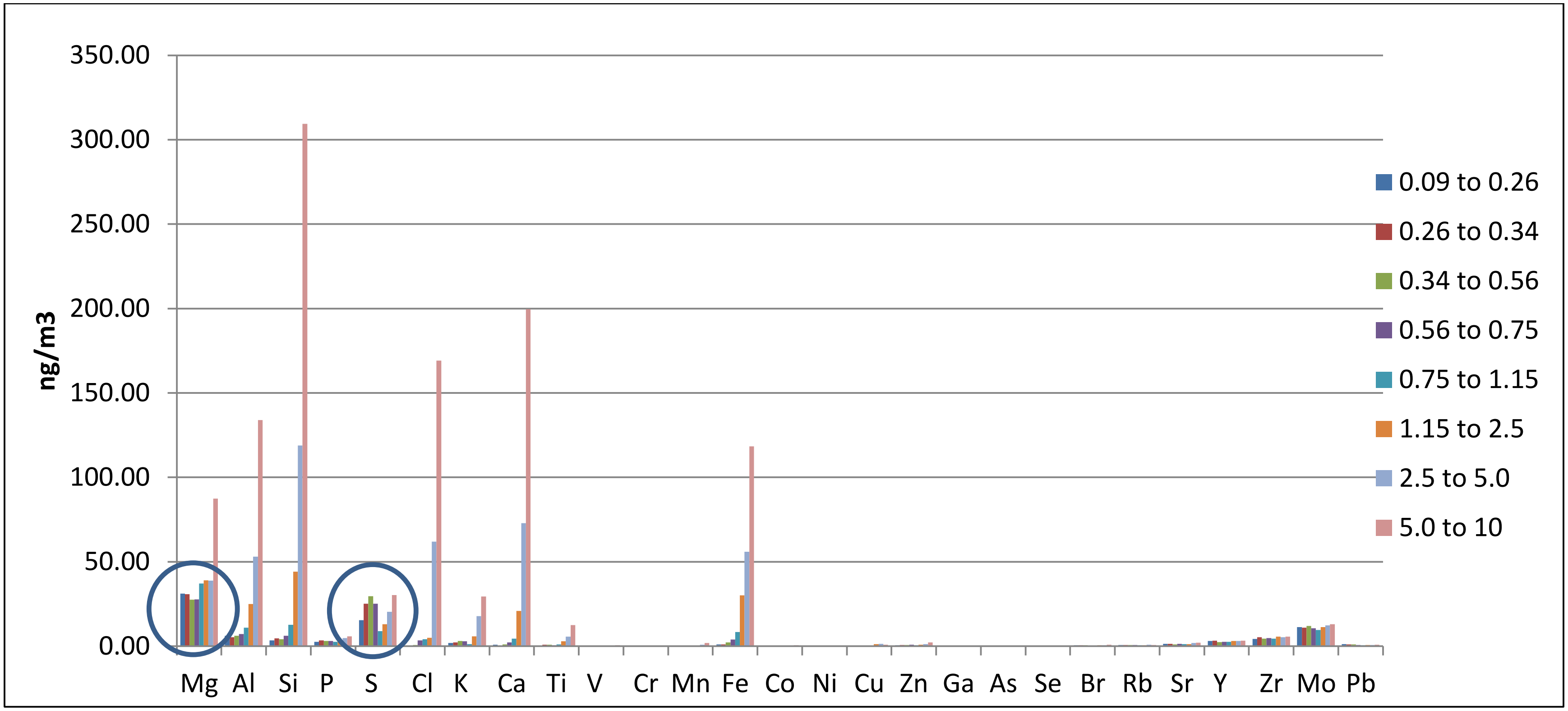


Figure 47. Plot of Annex Aerosol Elements Concentrations by Size

Legend shows the size fractions. Circled areas refer to the elemental distribution .

6.5.2. Annex- 2DRUM

A two channel DRUM sampler was placed amidst the other sampling gear on the roof of the Annex, where it ran from September 26, 2013 to November 4, 2013. The two frames were analyzed by the Lawrence Livermore Lab Advanced Light Source, and subsequently processed to yield the concentration values summarized in Table 5, and which have been incorporated into the risk comparison table for evaluation. A number of plots that follow show detail from the data set.

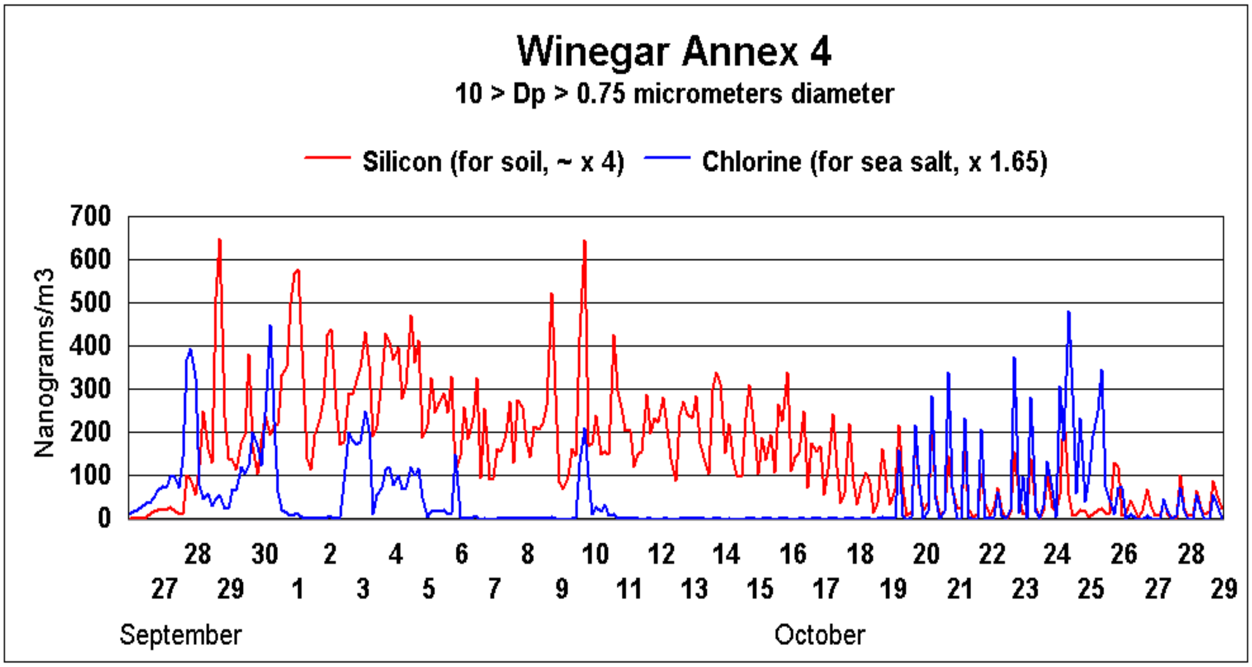


Figure 48. Annex—Fall Test Period/Coarse Fraction

Figure 48 shows the typical pattern that corresponds to the daily meteorological cycle. The peaks and valleys of the silicon trace shows the continuous emission of fugitive dust in the coarse mode. The silicon is continuous throughout most of the period, suggesting a continuous operation. Chlorine from sea salt appears at sporadic points in the first half of the sampling period, but the last two weeks is a daily occurrence. The sea salt chlorine is more dependent on regional meteorology, while the silicon is related to local activities.

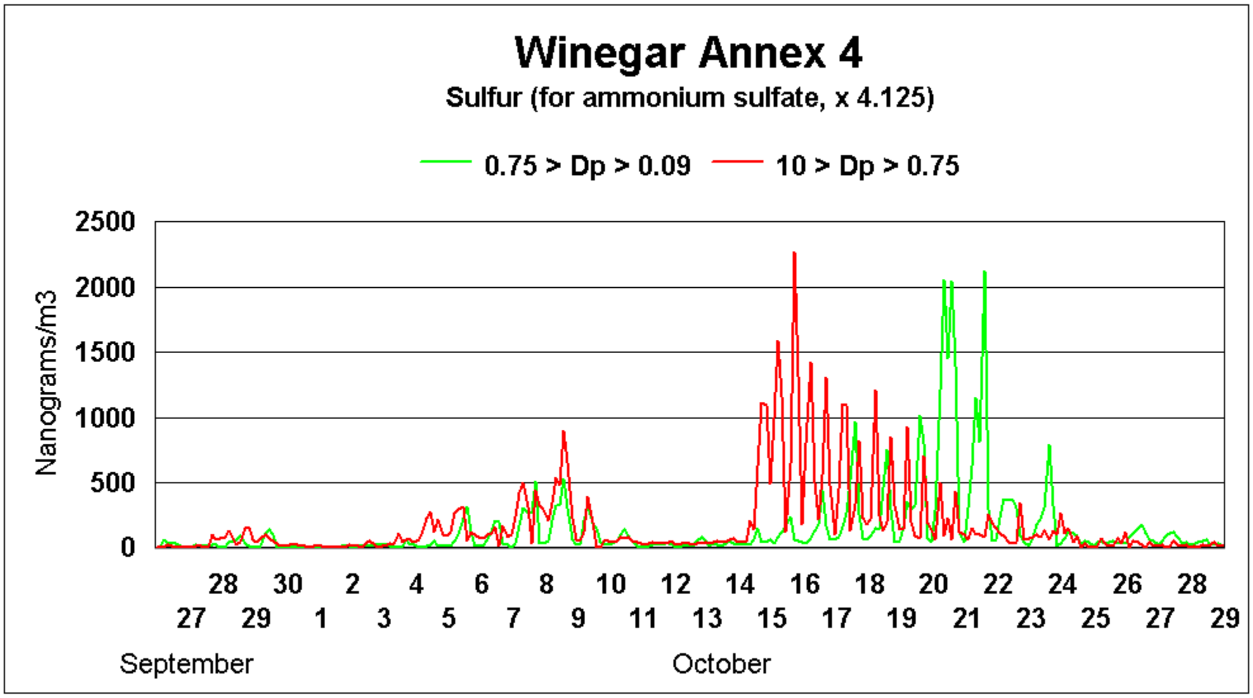


Figure 49. Annex—Fall. Coarse and Fine Sulfur

Figure 49 shows an unusual combination of coarse and fine sulfur that track at low levels during the first part of the test period, then diverge suddenly. Fine sulfur is associated with process conditions, and coarse sulfur from oceanic emissions, so the similar pattern during early October may just be a coincidence, as the two track for the first half, then diverge suggesting different processes. The pattern of the coarse sulfur from mid-October is suggestive of the daily wind pattern, which was not as clearly followed by fine chlorine.

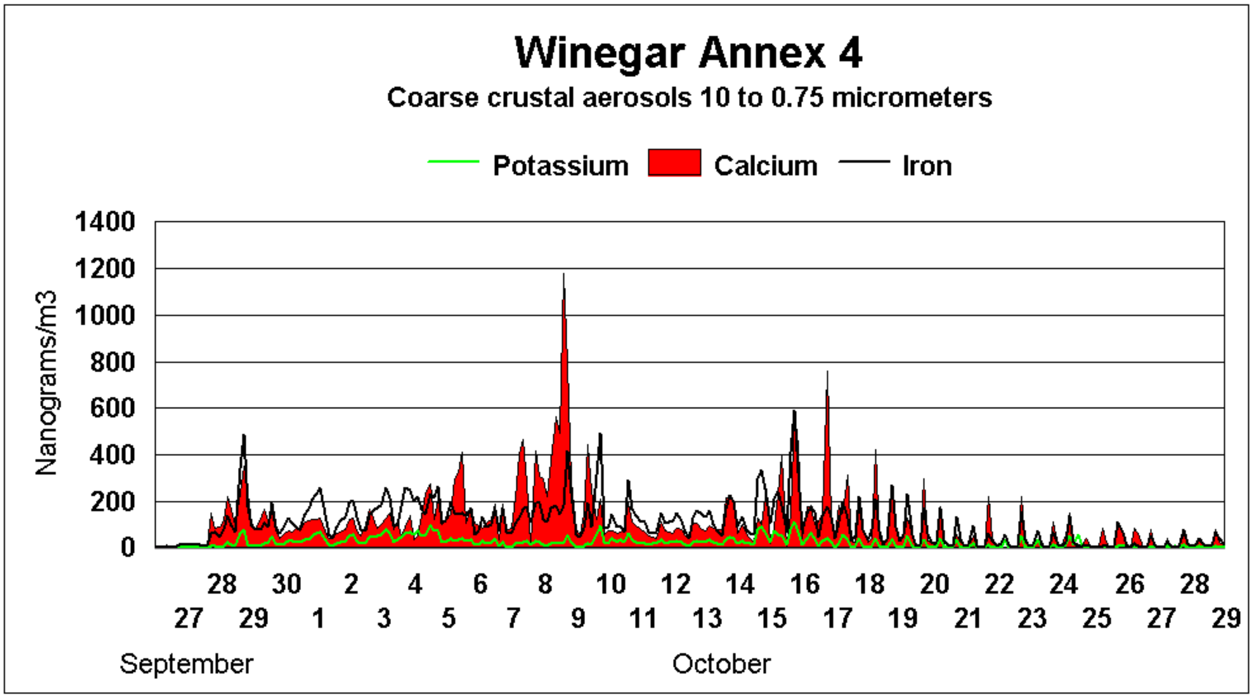


Figure 50. Annex—Fall, Coarse Crustal Elements

Figure 50 illustrates the large impact of calcium. The calcium mostly tracks the iron, so it is probably soil operations, and likely something active (as opposed to entrained dust by vehicles) such as loading or other material handling process. The fact that it occurs on a non-continuous basis also suggests a loading type scenario. During most of the days, the daily cycle continues, which can be used to synchronize the timing of the sampler,

The fine trace metals are part of the health impact process, as they constitute part of the 'heavy metal' category. When emitted as fine material, they can cause a larger impact due to their size, which allows a deeper incorporation into the body when inhaled.

Table 5 contains the average concentration of the two size fractions as well as the sum of the two, which makes it the elemental equivalent of PM10. A ranking of the various elements sheds insight into trends that were suggestive in the plots. For example, the low levels of chlorine suggest little sea salt incursion, which was seen only sporadically. The relative amounts of fine vs. coarse fractions is a clue into the how much processing occurred. Both silicon and titanium show a large coarse to fine ratio, suggesting little processing of soil materials.

Other crustal elements (Al, Si, Ca, Fe) showed dominance of the coarse fraction, due to soil operations. Sulfur showed similar fine and coarse concentrations, reflective of both process and sea salt emissions, respectively.

The industrial elements (Zn, Pb, Cu) and the remaining trace elements were at sub-nanogram concentrations, which provided less information about source while showing low risk impact, as indicated in the risk comparison tables in Section

Table 5. DRUM Annex-4: September 26-November 4, 2013

Annex-4: Sept.26-Nov. 4, 2013			
Average ng/m3			
Element	**Stages 1 - 4**	**Stages 5 - 8**	**Sum**
S	172.8	144.60	317.44
Si	154.1	10.51	164.62
Ca	106.6	2.51	109.10
Fe	100.8	4.04	104.79
Al	69.1	0.65	69.76
Cl	48.3	0.98	49.24
K	21.4	8.10	29.52
Mg	18.0	0.90	18.85
Ti	12.0	0.33	12.36
Na	ND	9.48	5.01
Zn	1.7	0.80	2.46
Cu	1.9	0.18	2.05
Pb	1.1	0.56	1.62
Mn	1.5	0.08	1.58
Br	0.2	0.55	0.77
P	ND	1.27	0.68
V	0.5	0.02	0.48
Cr	0.3	0.09	0.40
Co	0.3	0.03	0.31
Zr	0.0	ND	0.28
Ni	0.0	0.20	0.24
Se	0.1	0.11	0.18
Ga	ND	ND	ND
As	ND	ND	ND
Rb	0.1	ND	ND
Sr	0.4	ND	ND
Y	ND	ND	ND
Mo	ND	ND	ND

7.0 PGE RESULTS AND DISCUSSION

The PGE site operated from April 2013 to June, 2014. Its operation was more difficult to maintain due to its reliance on solar panels for power, which is dependent on time of year, health of the batteries, the number of instruments in operation, etc. In addition, a secondary instrument was used as a substitution for periods of repair and maintenance on the main EBAM units. However, its data was seen to be problematic and variable due to its optical scattering measurement principle. Therefore, that data was not used. Therefore, there were a number of down times and data gaps during the July-August period of 2013. However, regardless, there still was sufficient coverage to provide a complete picture of possible pollutant exposure.

7.1.1. PGE PM10

The hourly PM10 data is shown in Figure 51 and 24-hr averages in Figure 52. The data shows two periods of varying concentration—early 2013, and then from September, 2013 to April 2014. The pre-summer 2013 data is substantially higher than the remainder of the data set, from September 2013 to April 2014—greater than 30%. An examination of all available data suggests this difference is real and that a higher level of activity at the quarry site was creating the higher levels of fugitive dust.

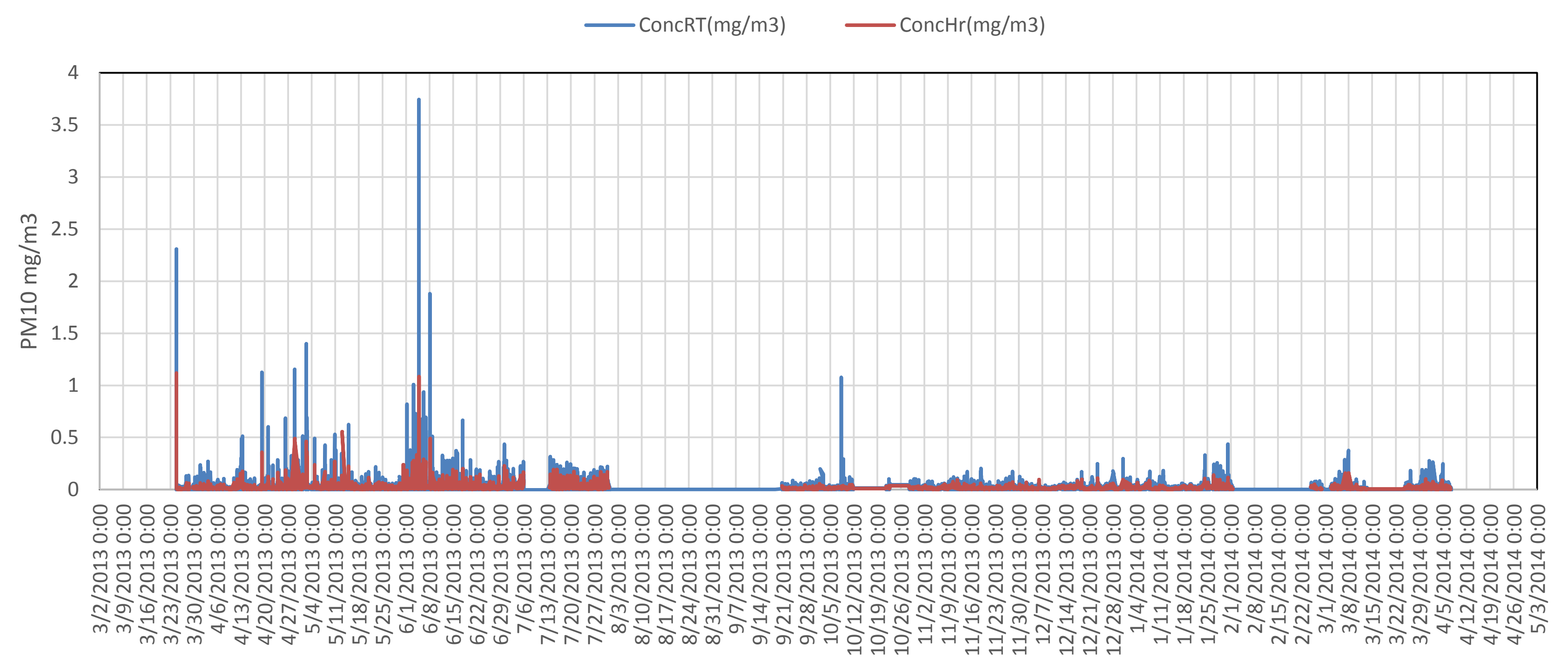


Figure 51. RT and Hourly PM10 at PGE Site
(RT = Real-time (15-min) values; Hr. = 1 hour values).

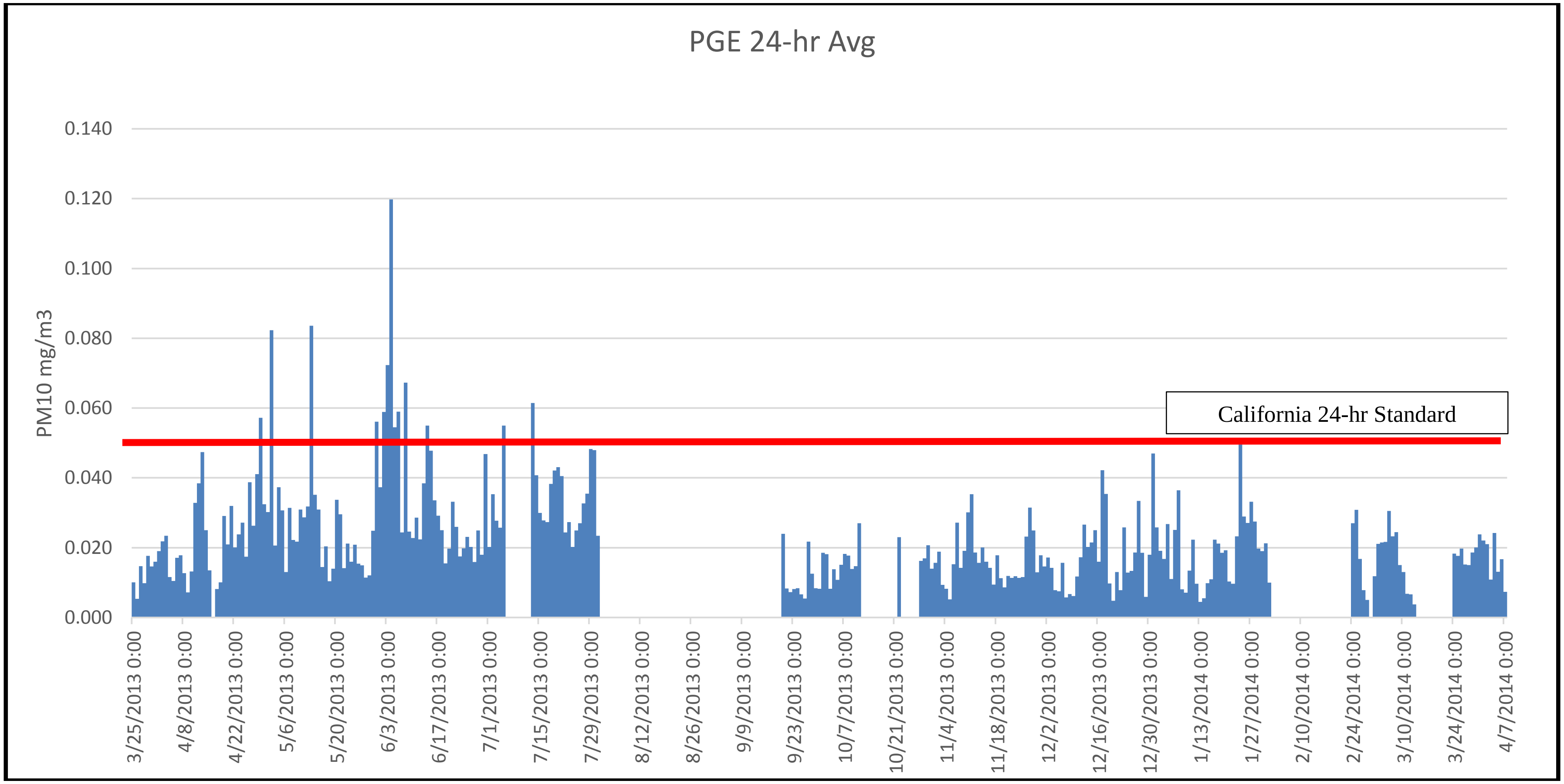


Figure 52. PGE PM10 24-Hr Averages

(Red line is California 24-hr Standard = 0.050 mg/m^3)

The November 4, 2013 Mine Inspection Report, completed by PMC, for the County of Santa Clara documents the quarry activity likely associated with period of higher concentrations. The report states that during the September inspection, mining was ongoing, “mostly along the upper portion of the eastern highwall”. This was substantial reclamation-related grading at quarry location closest to the PGE monitoring location. It was also conducted at the highest elevation, up to the top of the quarry rim/ ridge-top.

7.1.1.1. Daytime vs. Night Time Emissions

The trends in the PM10 suggest that much of the fugitive dust is transported during the evening hours when the winds are relatively calm. The detailed 15 minute and 60 minute averages both show a night time dominance of high concentrations, as shown in Figure 53 which shows a 15 minute peak of over 3.5 mg/m^3 as well as hourly averages over 0.5 mg/m^3. This period resulted in violations of the 24-hr. air quality standard.

Figure 54 shows a detail of the wind and PM10 data for a smaller time period.

Night time is typically a time of low particulate matter concentrations in most micro-environments, such as residential communities. However, in this case, conditions for dispersion often become poor during the evening hours due to the absence of the daytime convective forces, leading to the stable nocturnal boundary layer-- lower winds, lower turbulence, and a lower mixing height. With emission-generating activities, such as occur at the Lehigh quarry, even at night, these conditions facilitate transport. The result is that emissions that may be easily dispersed in the daytime are transported to nearby receptors. This circumstance has been documented in many instances during this study.

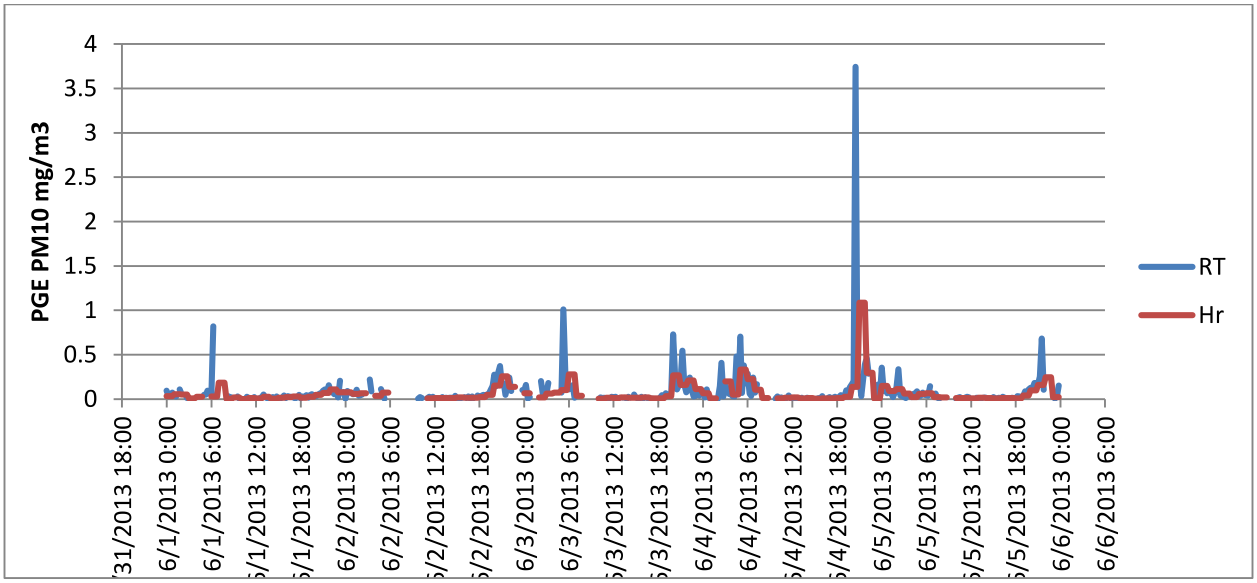


Figure 53. PGE June 2013
(RT = Real-time (15-min) values; Hr = 1 hour values).

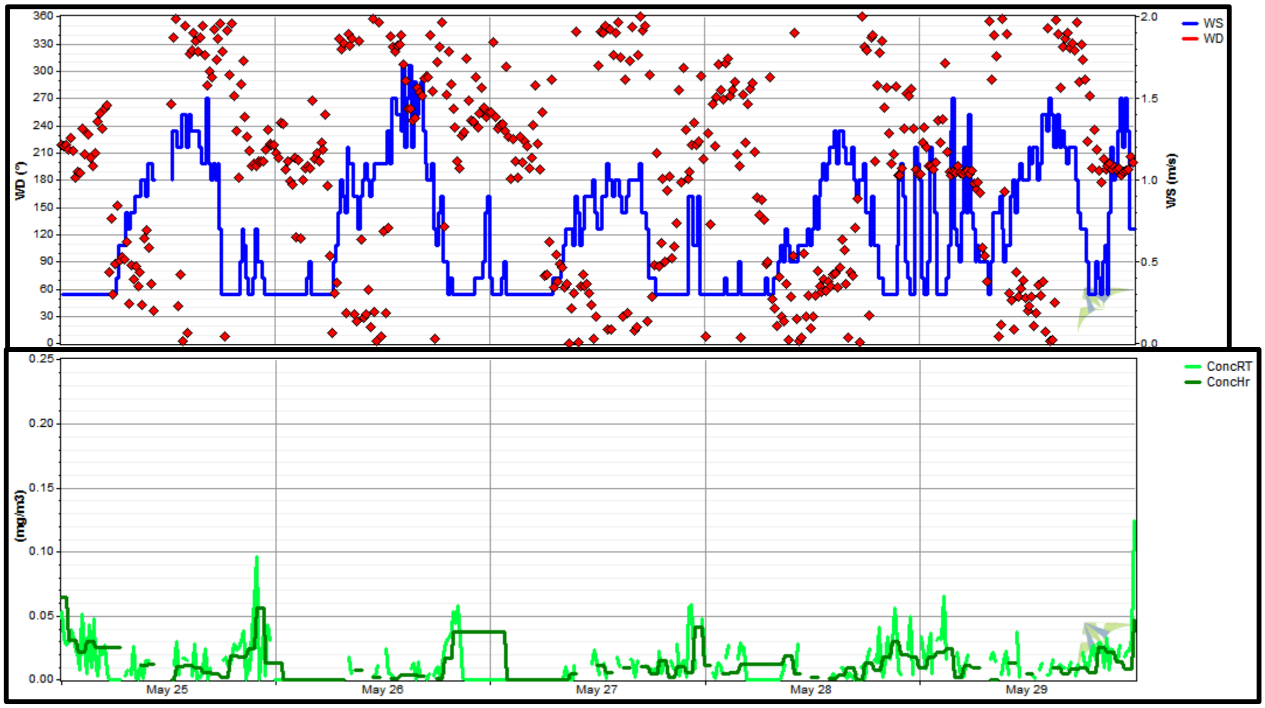
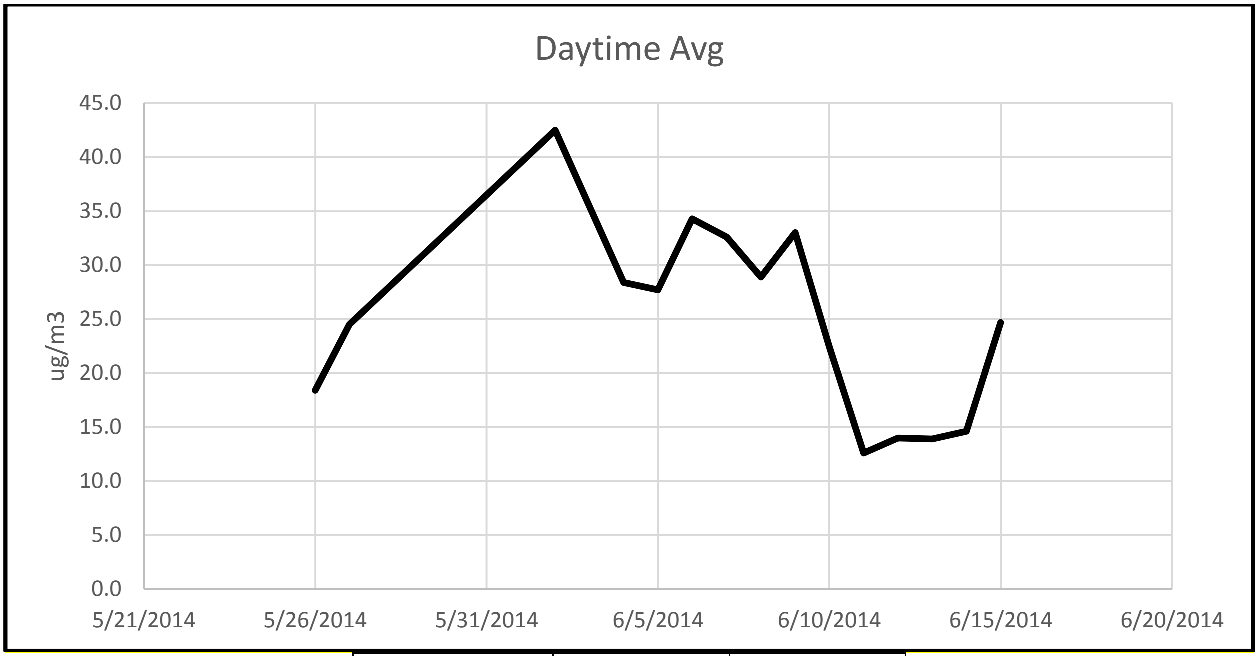


Figure 54. Low wind speed effect at PGE
Correlated with higher PM10 concentrations

If the daytime hours are compared to the 24-hr periods, one can see the increment for the night time period. Figure 55 shows the daytime concentrations, and Figure 56 shows the breakdown of the daytime and night time, including the data from Annex . As shown in the table below, the increase is by a factor of 2.5. Figure 57 shows both the daytime and 24-hour periods, as well as the Annex value, to show what a 'baseline' concentration should be. In many cases, the daytime Annex concentration is close to or the same as PGE, however, the 24-hr value is substantially larger. Indeed, the period of the first week of June shows very concentrations and a large enhanced nighttime emission. As Figure 53 showed, the a high 15 minute concentration of greater than 3 mg/m^3 (or, >3,000 μg/m^3, factor of 60 times the 24-hr California standard.



Annex 24 hr BAM	PGE 10-hr Partisol	PGE 24-hr EBAM
0.012	**0.015**	**0.037**

Figure 55. PGE Daytime concentrations vs. Night time

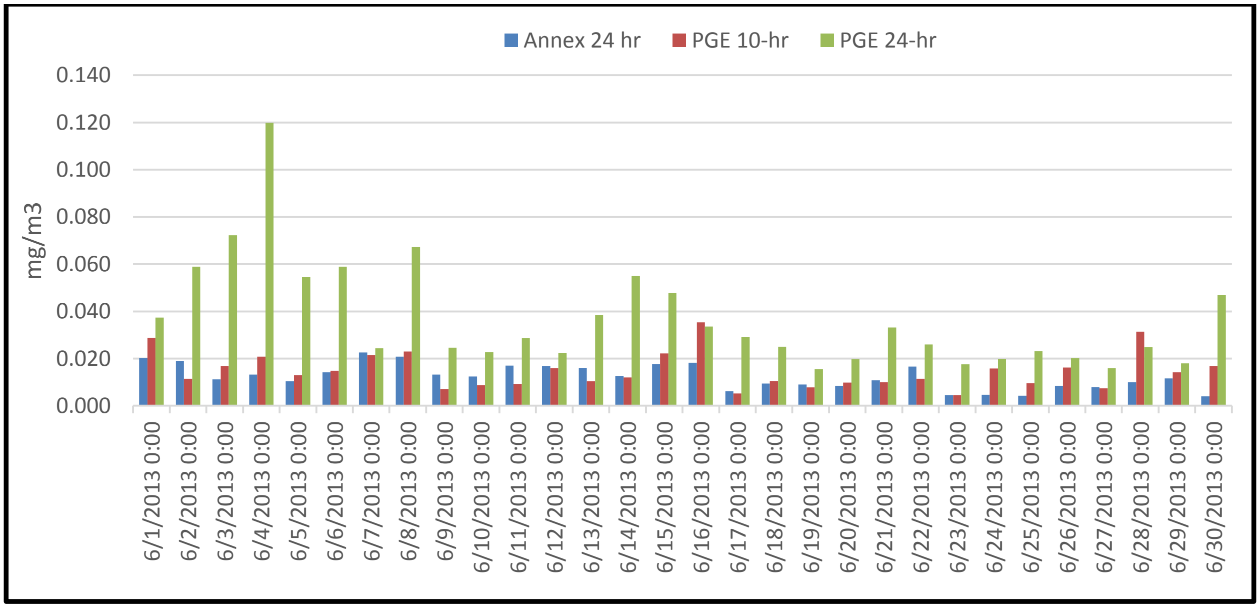


Figure 56. PGE Evening Emissions Comparison
Annex values included for comparison.

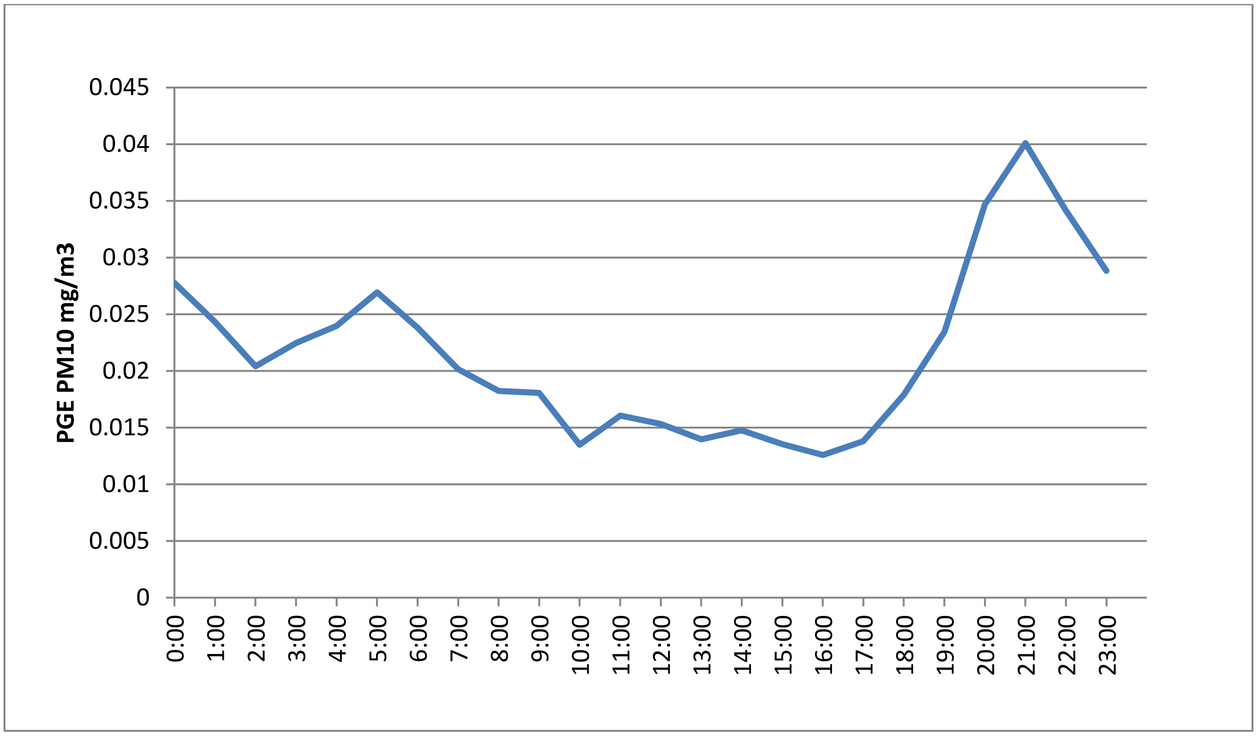


Figure 57. PGE PM10 Diurnal Pattern.
Average of total monitoring period.

The diurnal plot is used to show what occurs at each hour of the day on average. This is done by separating the hours from each daily period and averaging along each hour. It is much more instructive than looking at time series plots, in which normal variability can obscure information.

7.1.2. PGE-Black Carbon

Black carbon at PGE was collected in three sections, shown in Figures 58-60 From May 2013 to September 2013, an AE-16 rack aethalometer was used, at which time that unit was put into service at the background field sites—OSD and BLN. A new microAethalometer was obtained and put into service at PGE. This unit has the advantage of requiring very little power, as it was designed for personal sampling.   The downside of that portability was that it needed to be downloaded and re-loaded with sampling tape approximately once every week.

These three portions of time had the following averages:

- May 2013-August 2013: 338 ng/m^3
- September 2013-November 2013: 276 ng/m^3
- December 2014-April 2014: 384 ng/m^3

The overall average for these three periods is 332 ng/m^3.

The black carbon concentration is both used by itself and an indication of traffic sources, particularly heavy duty diesel, but it also can easily be converted to diesel particulate matter (multiply by factor of two), which is what the health standard is based on.

The data plots in Figures 58-60 are similar to other parameters in that the daily concentration is affected by the daily meteorological cycle. This can be seen even in the standard 5-minute data plots. The diurnal pattern often shows peaks in the morning and in the afternoon from commute times. As is shown later, there are instances where the morning peak is detected at Annex, but it was not detected at PGE.

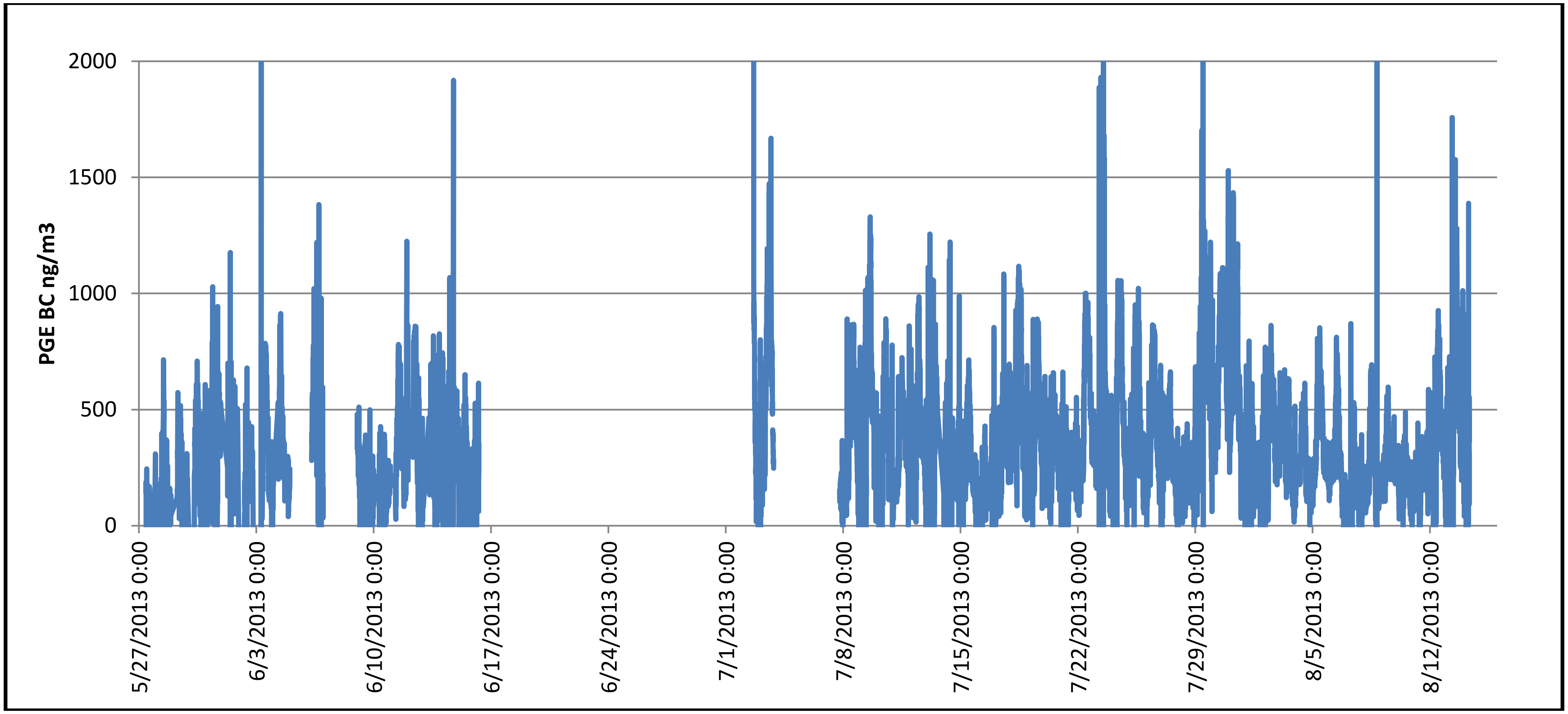


Figure 58. PGE BC—May 2013-August 2013

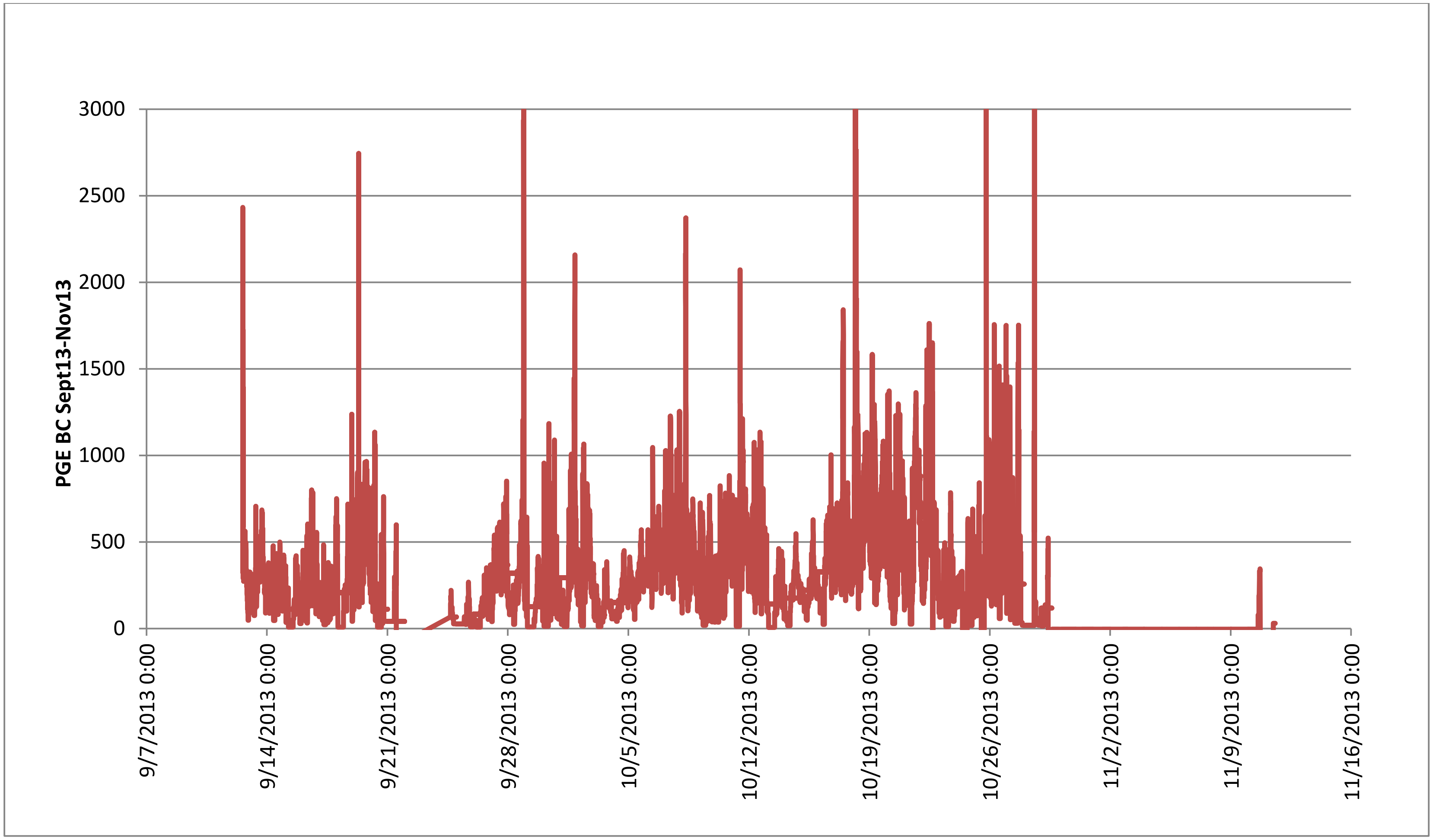


Figure 59. PGE BC, September 2013-November, 2013

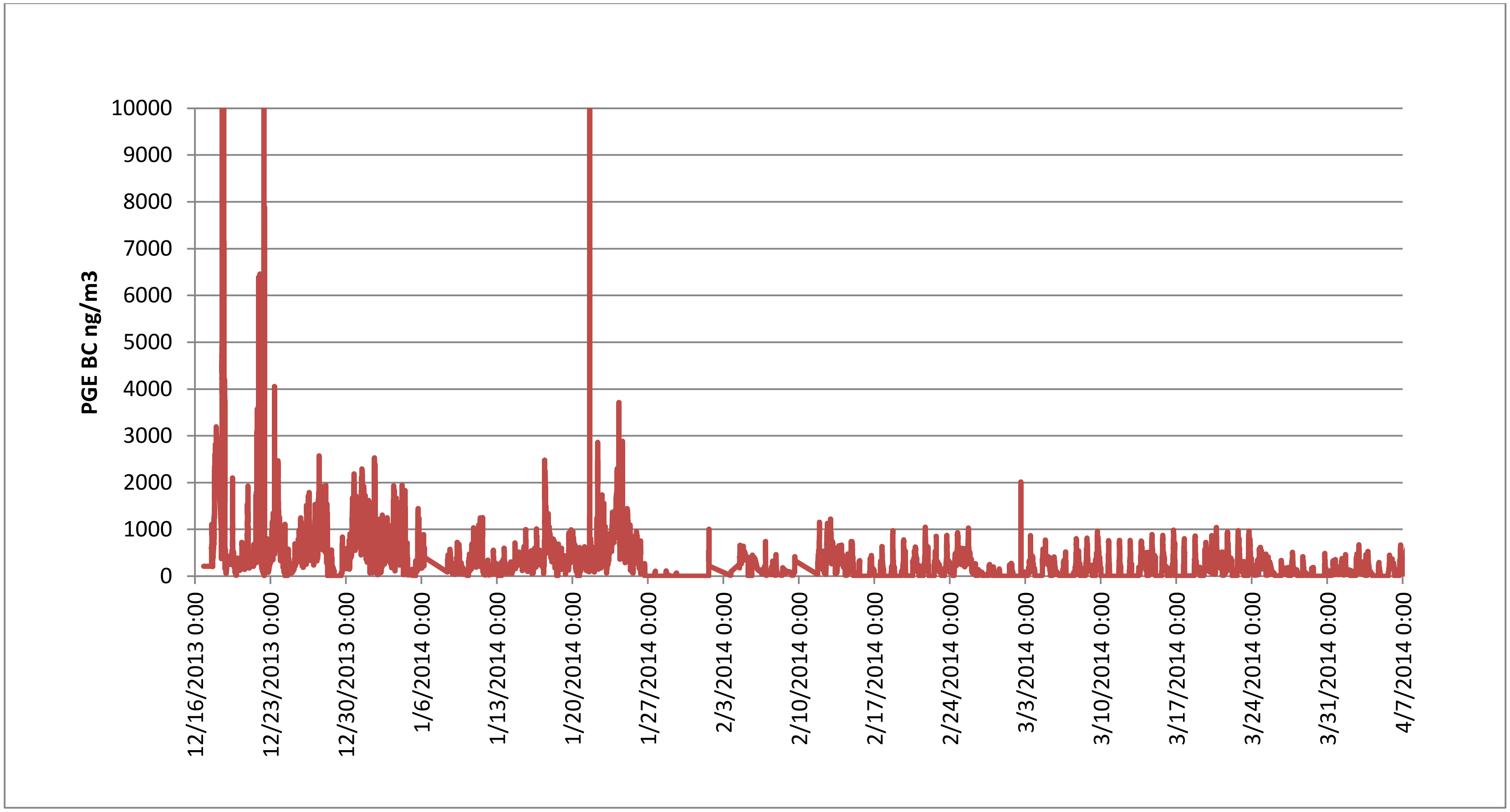


Figure 60. PGE BC: January 2014-Apr 2014

7.1.3. PGE-Elements

Two sample sets using the DRUM sampler were run—May-June, 2014 (PGE1), and October-November, 2013 (PGE2). In addition, a daytime Partisol sampling was conducted in May to June, 2014.

7.1.3.1. PGE1 DRUM

DRUM sampling was conducted at the PGE site from May 24, 2013 to June 21, 2013 using a 2-channel sampler, which provides 3-hr time resolved concentration at two size cuts: 0.09 um to 0.75 um and from 0.75 um to 10 um, categorized as very fine and coarse, although usually a coarse fraction is limited to just the sizes between 2.5 um and 10 um. Together, the sum of these concentrations is PM10 size selected. However, the two individual channels can provide other information about the source of the detected elements. As with the Annex DRUM data, very fine fraction is associated with process emissions, and therefore is reflective of stack emissions in contrast to coarse size fractions that are associated with fugitive dust such as from quarry operations, from which the PGE site would be expected to experience an impact.

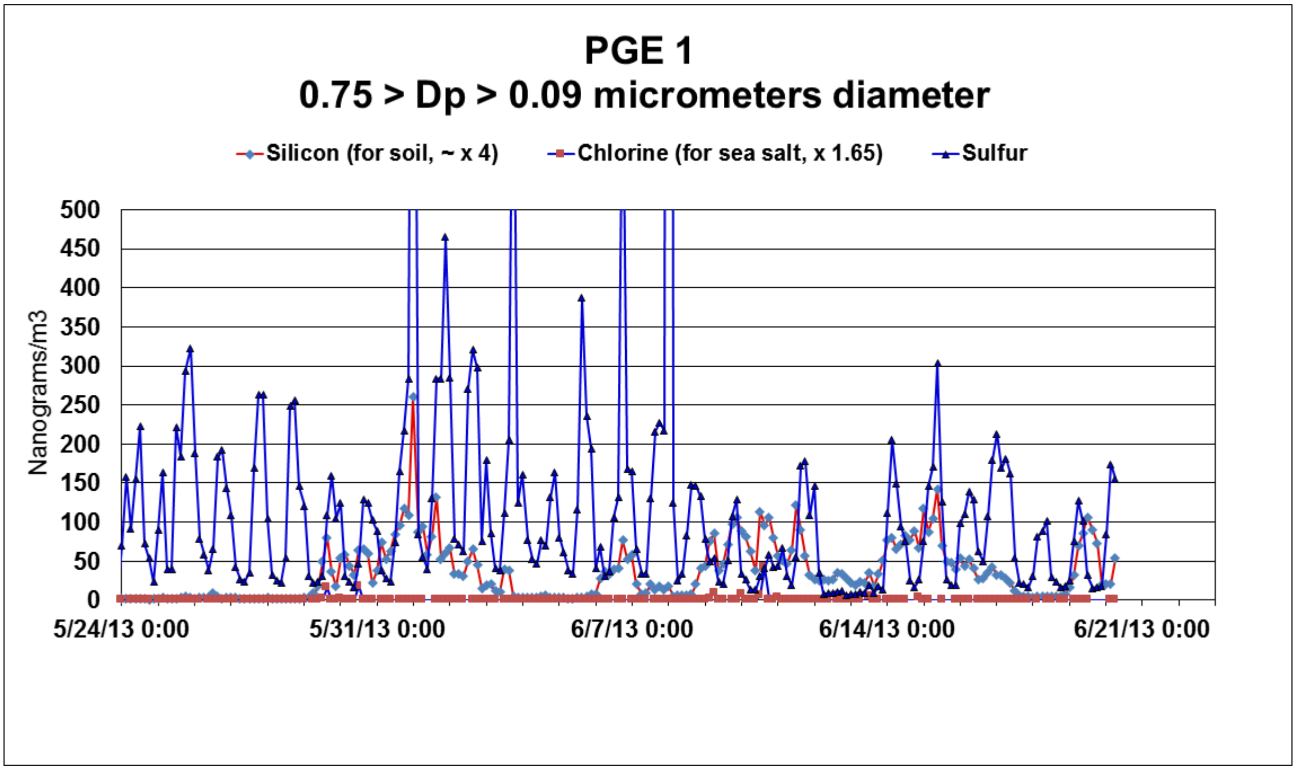


Figure 61. Fine Crustal Elements and Sea Salt

Fine sulfur shows that a process is underway in Figure 61. The relatively high concentrations—up in the hundreds of nanograms per cubic meter—suggest this is a primary process. Since quarry operations were underway during this same period, it suggests a major process run.

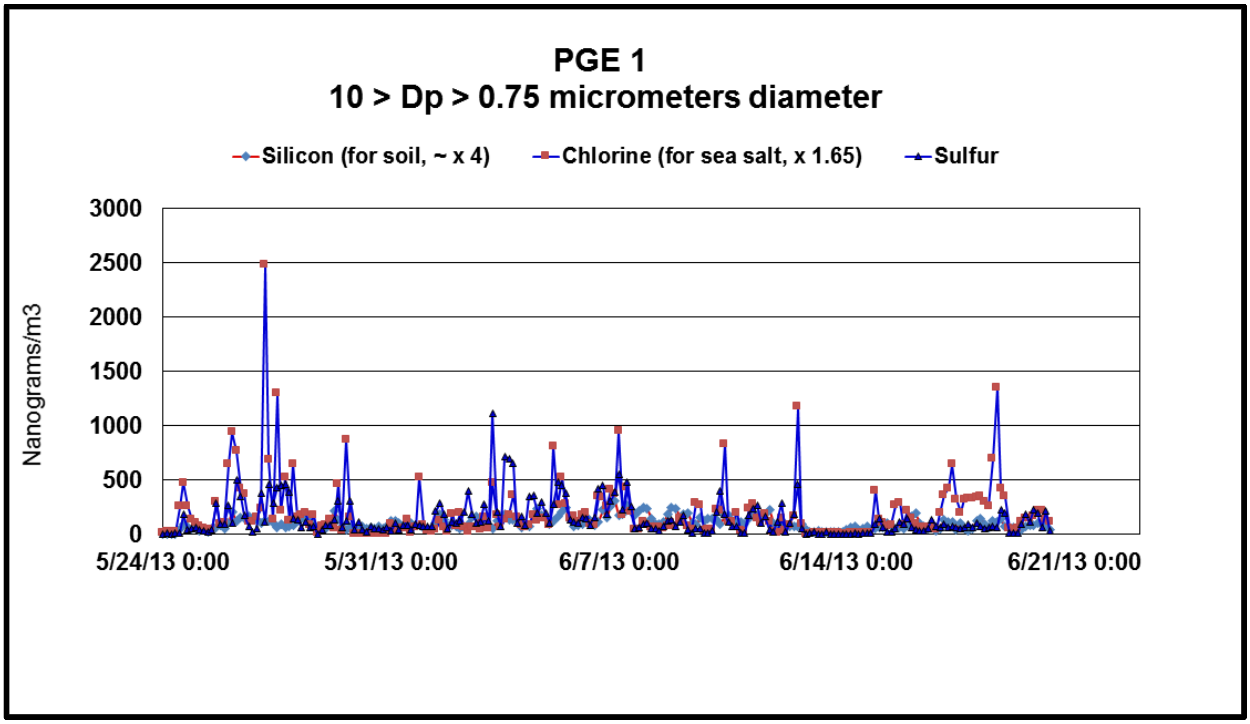


Figure 62. Coarse Silicon, chlorine and sulfur

The coarse sulfur is low in Figure 62, so relatively unimportant. Sporadic incursions of sea salt, though at relatively high concentrations, suggest summer time stagnant air conditions, followed by a breakthrough of the usual on-and off-shore pattern.

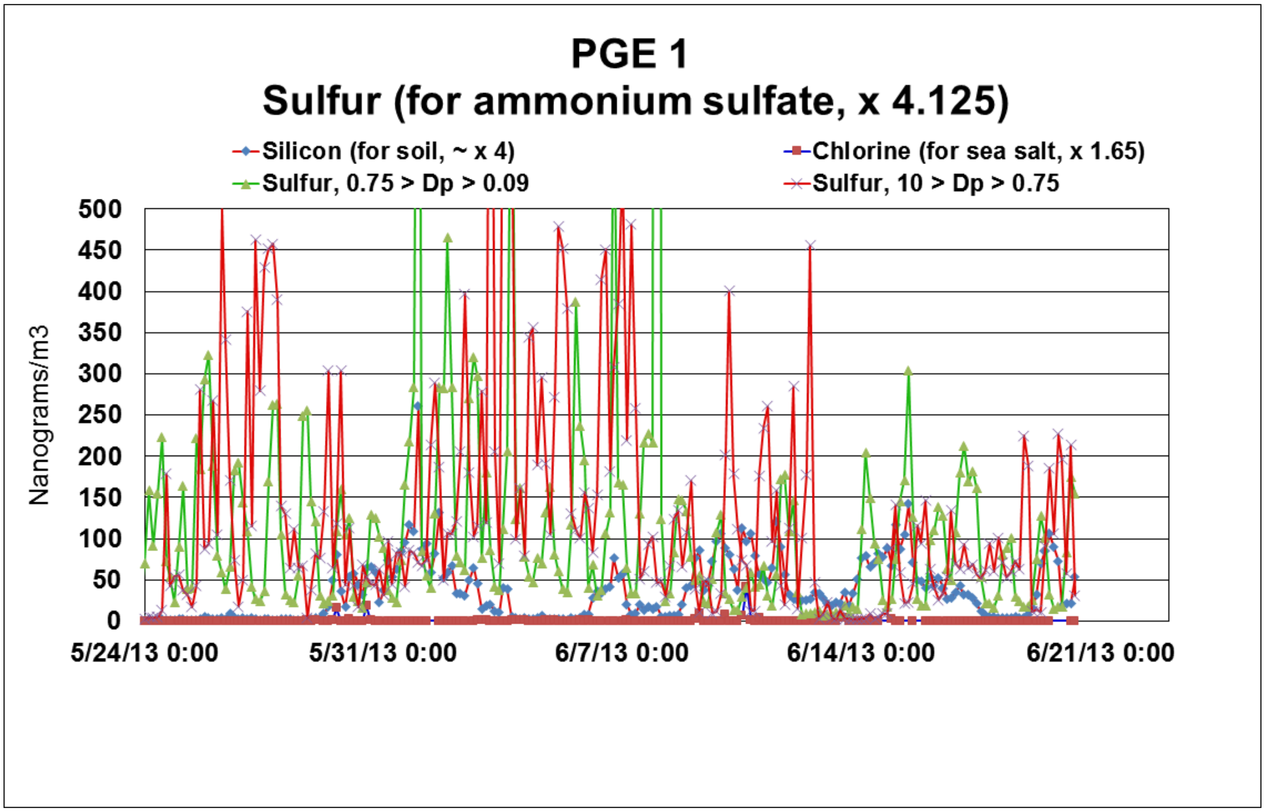


Figure 63. Coarse and Fine Fractions

The combination of different size fractions in Figure 63 is a diagnostic of what processes are occurring. There are two processes: fine sulfur coming from a combustion source, and coarse sulfur and chlorine from sea salt.

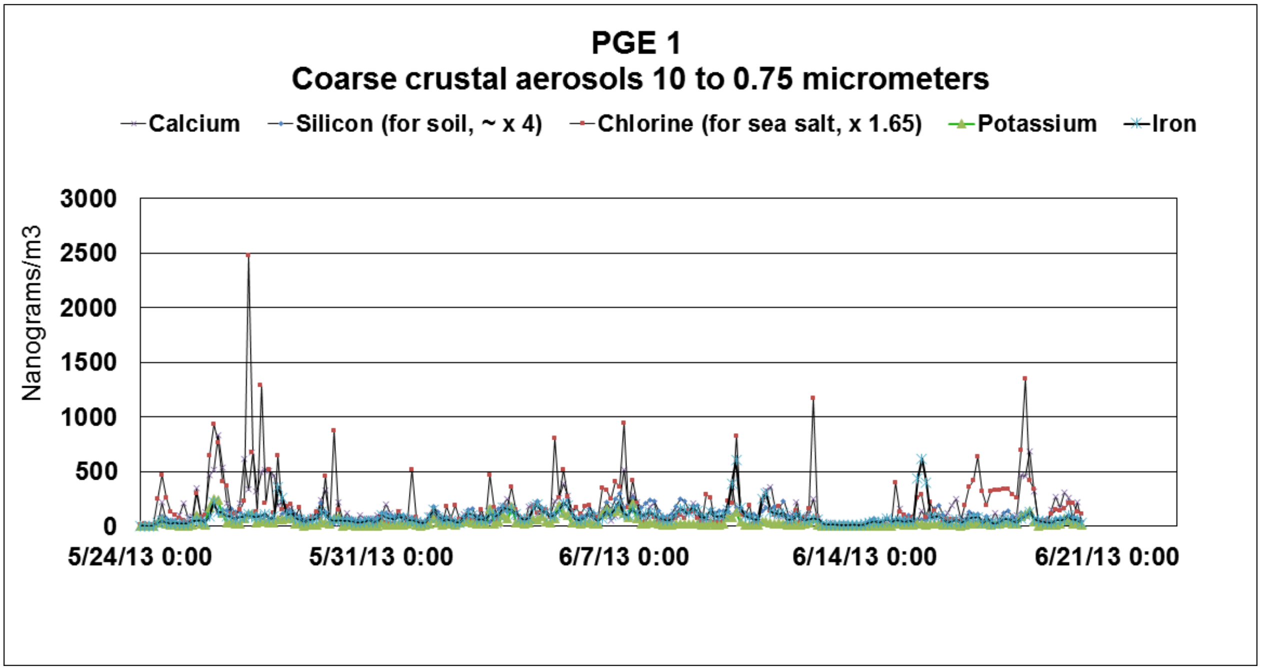


Figure 64. Coarse crustal elements

Similar to Figure 62, with sporadic sea salt occurrences. Other soil elements are present only at low level, and there is little calcium enrichment. Therefore, not much soil processing occurring from what this data is saying, though that is contradicted by other elemental comparisons.

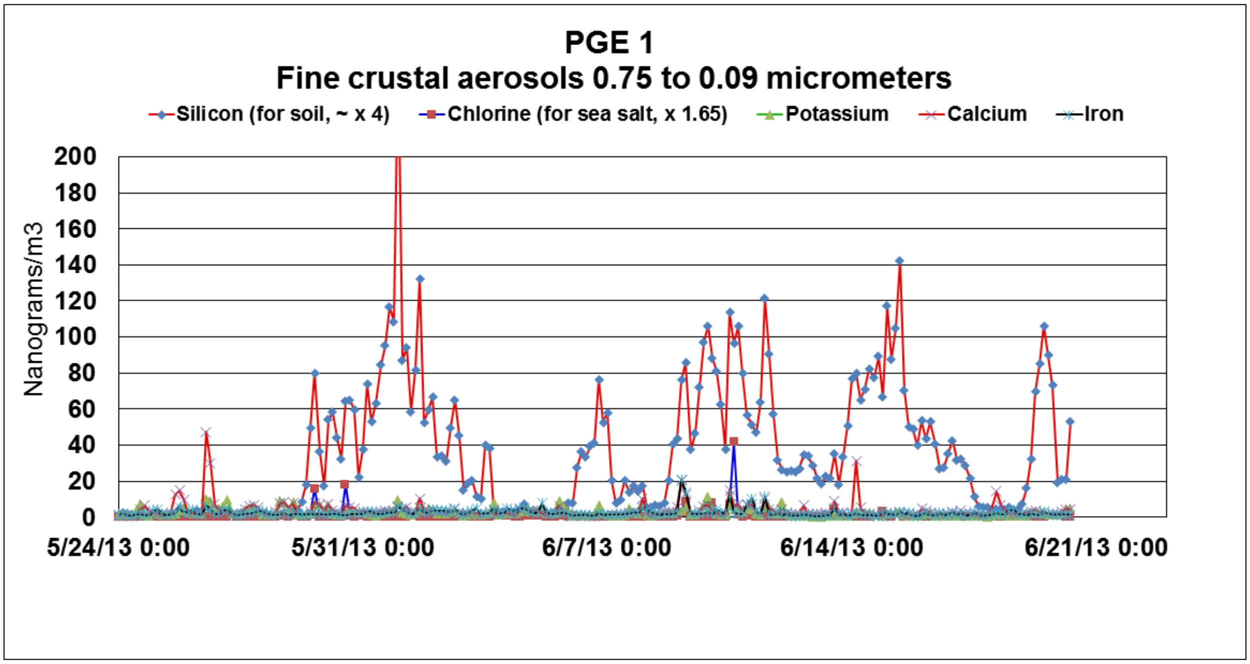


Figure 65. Fine Crustal Elements

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Fine sea-salt chlorine dominates this data subset in Figure 65. The other crustal elements show low concentrations, indicating no processing is occurring.

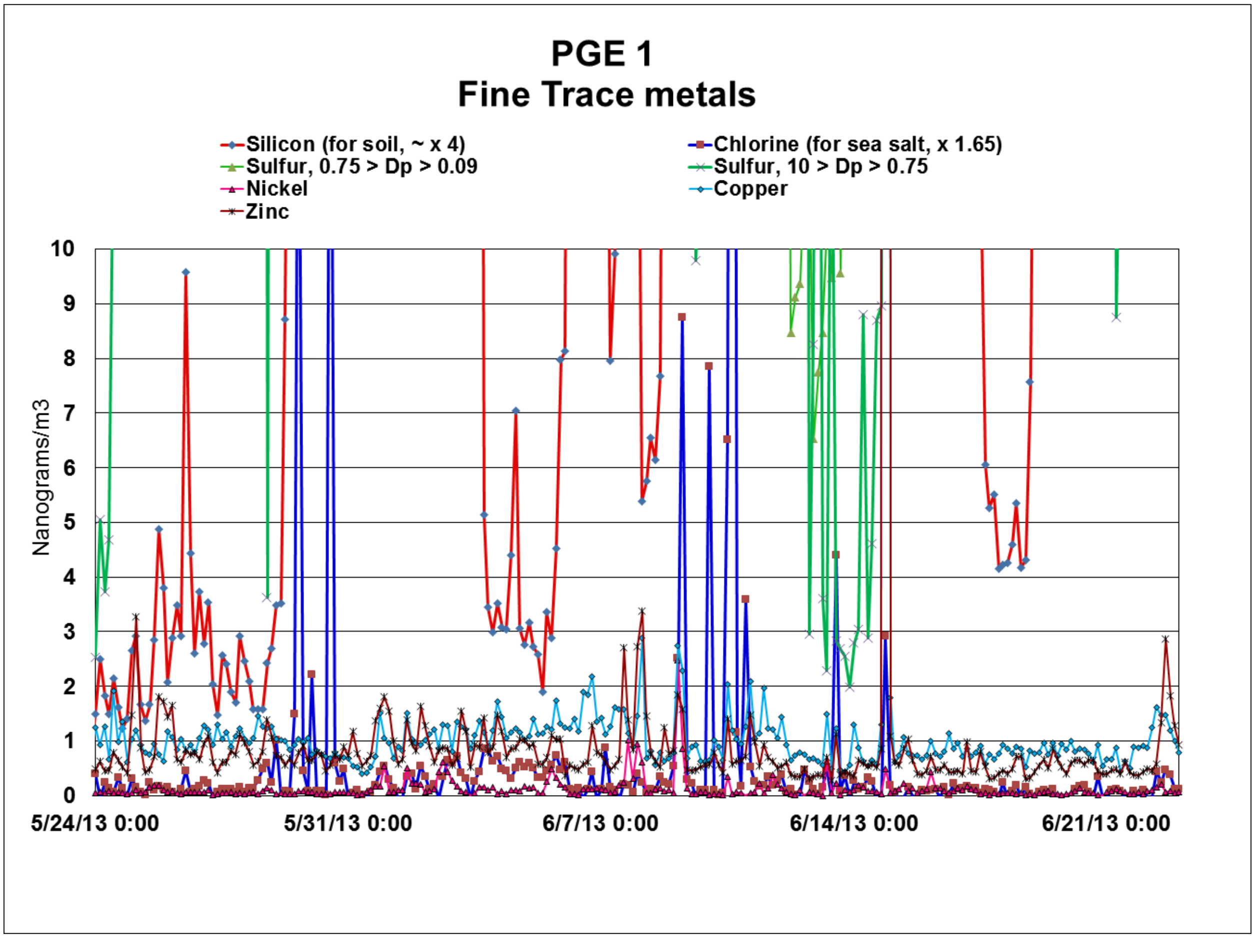

Figure 66. Fine Trace Metals

Figure 66 shows that the amount of fine industrial emission metals are low. The soil elements and other higher concentration crustal materials are out of range, with the remaining elements down at the single digit nanogram per cubic meter range. This is useful to know that little of the process emissions are detectable at this site.

Table 6. PGE1 DRUM Average Concentrations

ng/m3	Size Channels		Total
Element	**0.09 to 0.75 um**	**0.75 to 10 um**	**10 um**
S	124.15	133.4	257.54
Cl	0.80	187.0	187.80
Ca	3.82	132.7	136.47
Si	34.70	98.3	133.03
Fe	2.43	87.4	89.79
Mg	2.51	77.0	79.50
Na	30.47	41.3	71.73
K	2.62	37.2	39.79
Al	0.59	36.1	36.69
Mo	17.40	14.3	31.72
Y	6.45	7.8	14.29
Zr	3.36	9.1	12.43
Ti	0.34	8.4	8.73
Sr	4.01	3.8	7.81
Cu	2.85	3.6	6.48
Pb	2.63	3.5	6.18
Rb	2.11	1.8	3.87
Zn	1.82	1.8	3.63
P	2.53	0.4	2.91
Br	1.08	1.4	2.43
Mn	0.07	0.9	0.95
V	0.11	0.6	0.66
Se	0.37	0.3	0.63
Cr	0.11	0.2	0.32
Co	0.01	0.3	0.28
Ni	0.12	0.1	0.22
Ga	0.01	0.0	0.01
As	0.01	0.0	0.01

Table 6 shows that sulfur was at the highest concentration, in both fine and coarse modes. This suggests a high temperature process is underway. Chlorine is present in the coarse mode in a heavy way, with nearly no fine fraction—strong oceanic air contribution. Also, calcium appears enriched, as is higher than both silicon and iron.

7.1.3.2. PGE 2 DRUM

The PGE site was almost continuously impacted by excess calcium (limestone) that included re-suspended deposits. Periodically, the site was impacted by massive CA episodes, Figure 67.

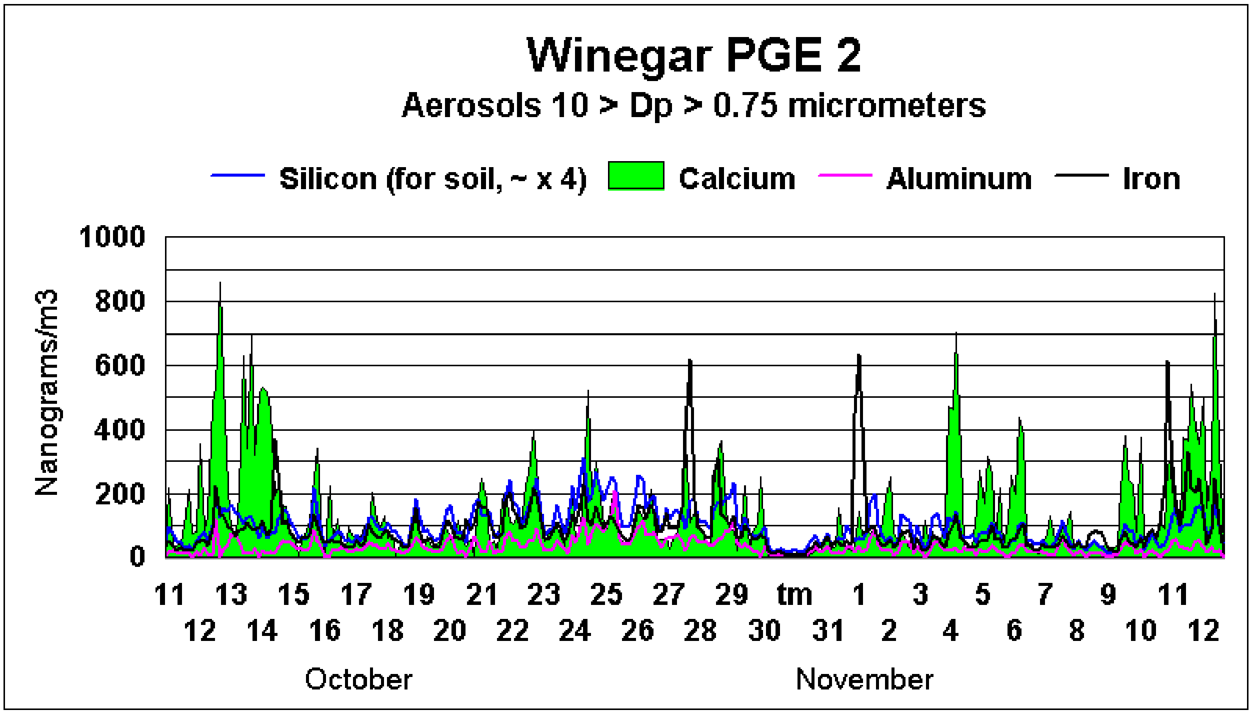

Figure 67. Coarse Crustal Elements

Heavy influence of soil and calcium, though greater at various periods. The silicon and aluminum seem relatively constant, so it must be source material related, not just soil emissions.

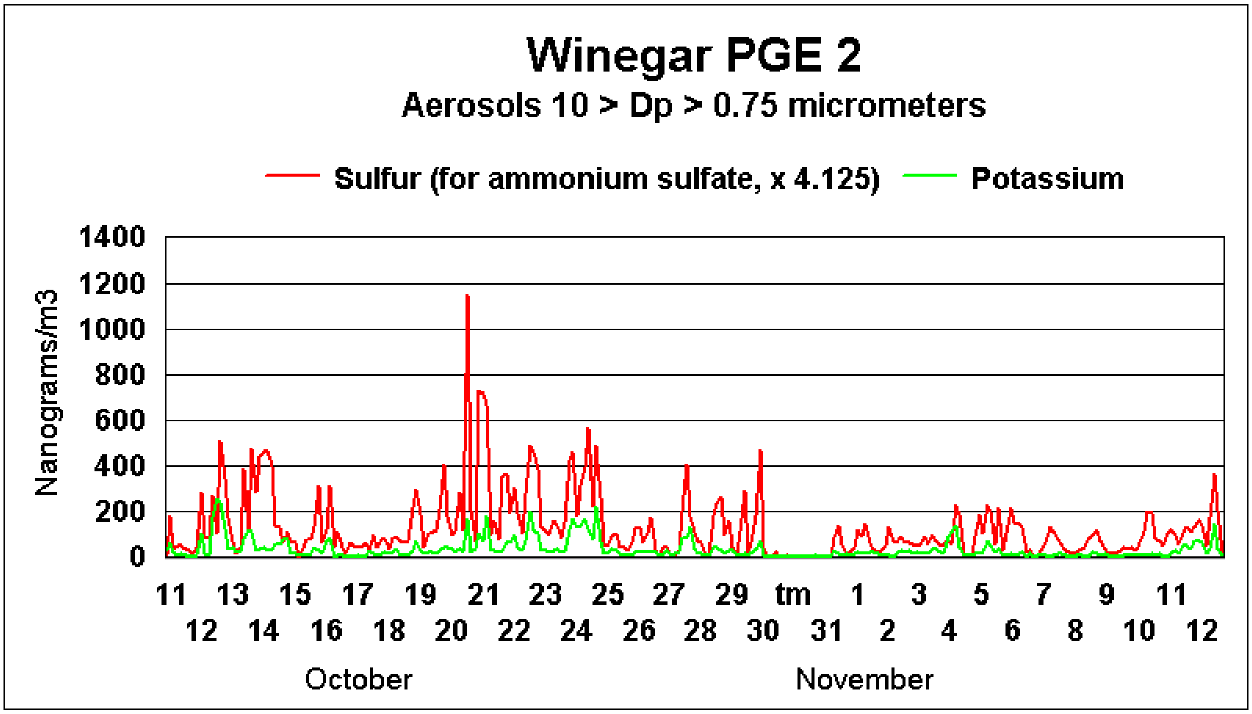

Figure 68. PGE Coarse Sulfur

Coarse sulfur is associated with sea salt. The large amount of coarse sulfur is unusual in Figure 68, and on some occasions matches coarse calcium, as one might see for gypsum. The diurnal fine sulfur peak has many sources, with several known fires during that time. There are a few occasions of enhanced fine calcium, coincident with coarse episodes but at much lower concentrations.

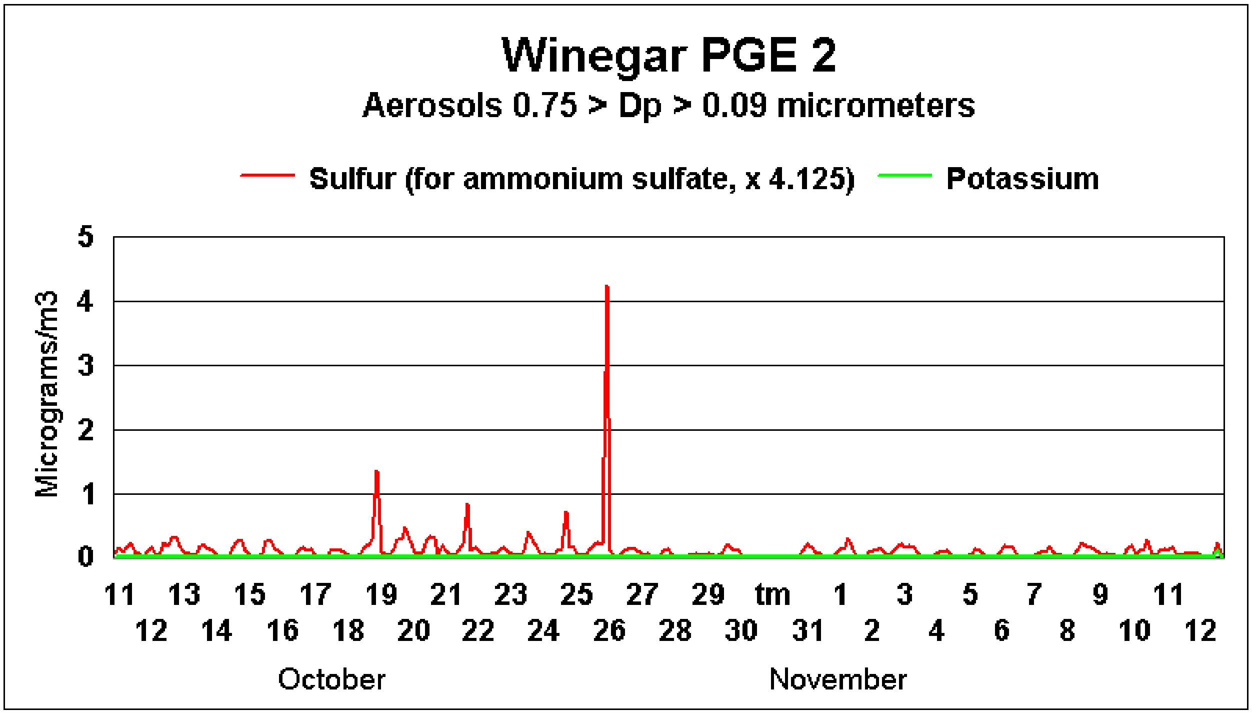

Figure 69. Fine Sulfur and Potassium

Figure 69. The very high peak on October 26 is indicative of a combustion-related emission, as the fine peak dominates. However, there is no potassium, which is a tracer for wood smoke.

Table 7. Summary of PGE 2 DRUM data

Element	Stages 1 to 4	Stages 5 to 8	10 um
	Average	average	Sum: ng/m3
Cl	169.08	0.28	169.36
Ca	144.45	3.48	147.92
S	130.95	117.96	248.91
Si	97.64	--	97.64
Fe	91.78	2.26	94.03
Mg	68.76	-0.39	68.37
K	35.45	2.77	38.22
Al	34.15	-0.46	33.69
Na	9.57	9.46	19.04
Ti	8.33	0.26	8.59
Mo	3.63	7.31	10.93
Cu	3.39	2.07	5.46
Zr	3.04	2.66	5.71
Zn	1.58	1.44	3.02
Y	1.53	2.29	3.82
Sr	1.51	2.05	3.56
Mn	0.84	0.08	0.92
V	0.59	0.10	0.69
Pb	0.59	0.88	1.47
Br	0.58	0.46	1.05
Rb	0.42	0.67	1.10
Co	0.29	0.01	0.30
Cr	0.22	0.08	0.30
Se	0.21	0.27	0.48
Ni	0.07	0.06	0.13
Ga	0.01	0.01	0.01
As	0.00	0.01	0.01
P	--	1.04	1.04

8.0 OSD SITE DATA

8.1.1. OSD Meteorology

The onsite meteorology data collected was found to be in error, with a wrong direction orientation after a shift in the mast.. Therefore, offsite data was used to provide wind speed and direction information. Specifically, Moffett Field, as the closest air field to OSD, it is more representative of that area than the sites closer to the mountains, several miles away.

8.1.2. OSD PM10

Figure 70 shows the data from the OSD rooftop. The usual pattern of mostly moderate concentrations is mixed with a number of short-term spikes. As with all air quality assessments, the major importance is in the long-term trends. For this period of time, which was expected to be nominally consistent with annual conditions, the PM10 average was 26 µg/m^3, which exceeds the California standard. However, this is not unexpected due to its urban location, only 25 yards from a major traffic source.

In addition, BAAQMD data shows that the overall average for urban areas is 28 µg/m^3, so this area is consistent with other locations in the area.

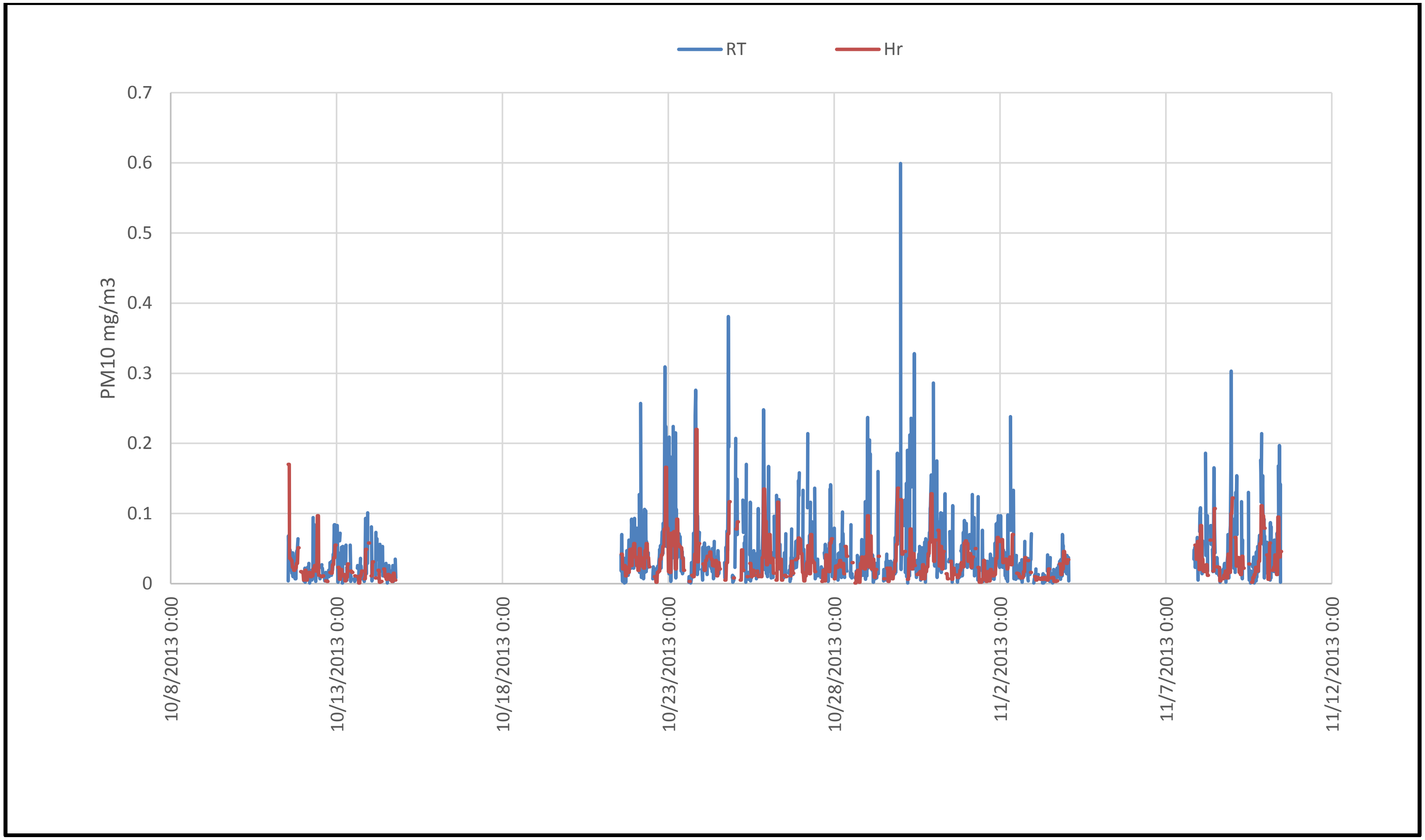

Figure 70. PM10 Data from OSD Office

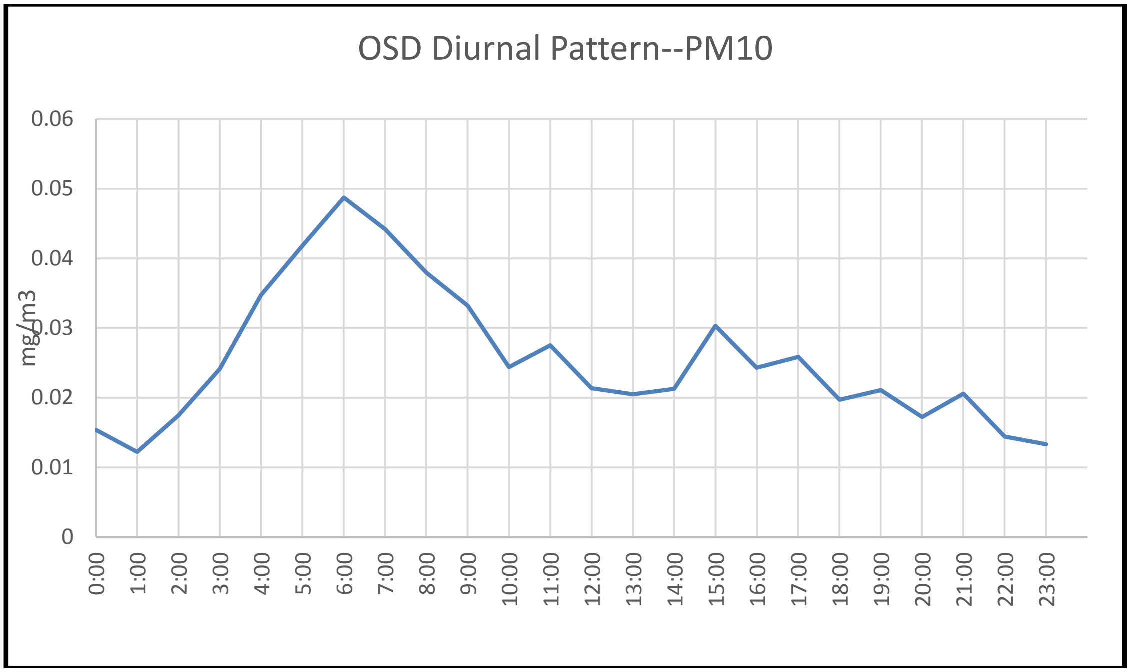

Figure 71. OSD Diurnal Pattern

Figure 71 shows the daily diurnal pattern that is representative of the inclusion of daily traffic effects in the morning hours.

8.1.3. OSD Black Carbon

As with PM10, the urban location implies more sources with higher emissions. Black carbon, as an indicator of vehicle traffic, particularly diesel vehicles, is expected to be higher than at RSA. The average for the September to November period was 601 ng/m^3, which is consistent with other Bay Area black carbon concentrations. Figure 72 shows the 5 minute data.

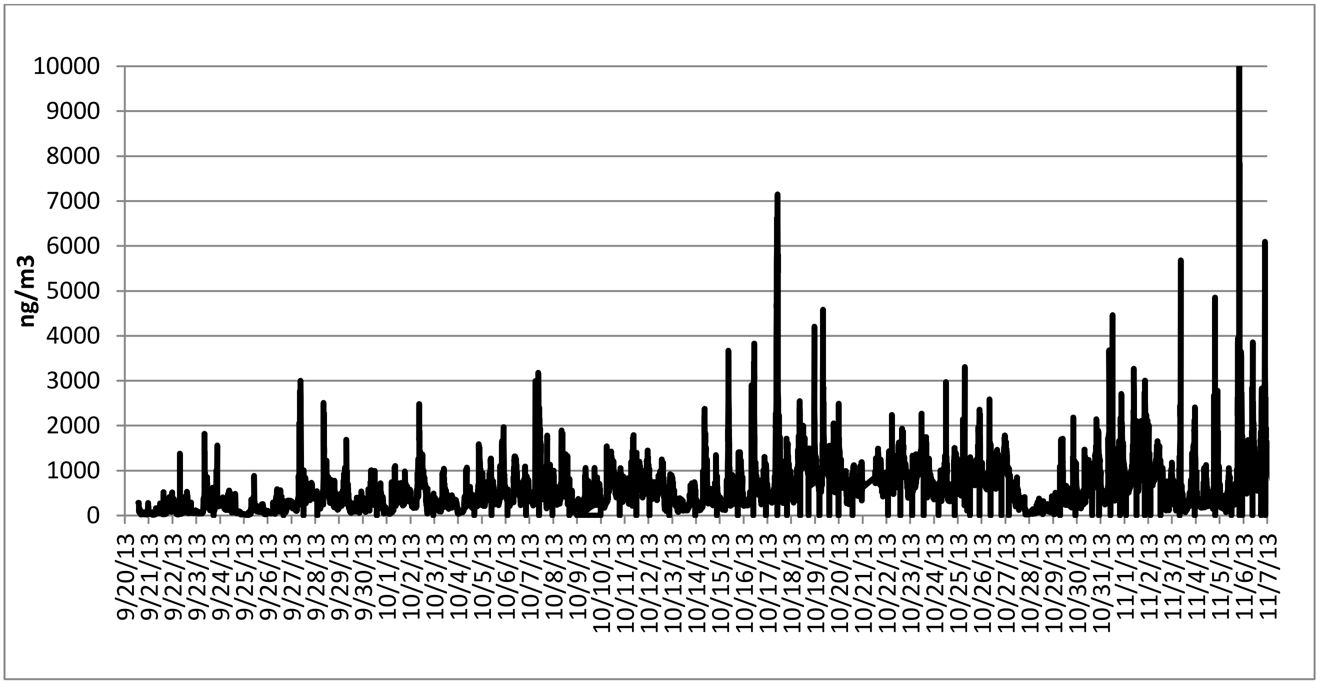

Figure 72. OSD Black Carbon—5 minute

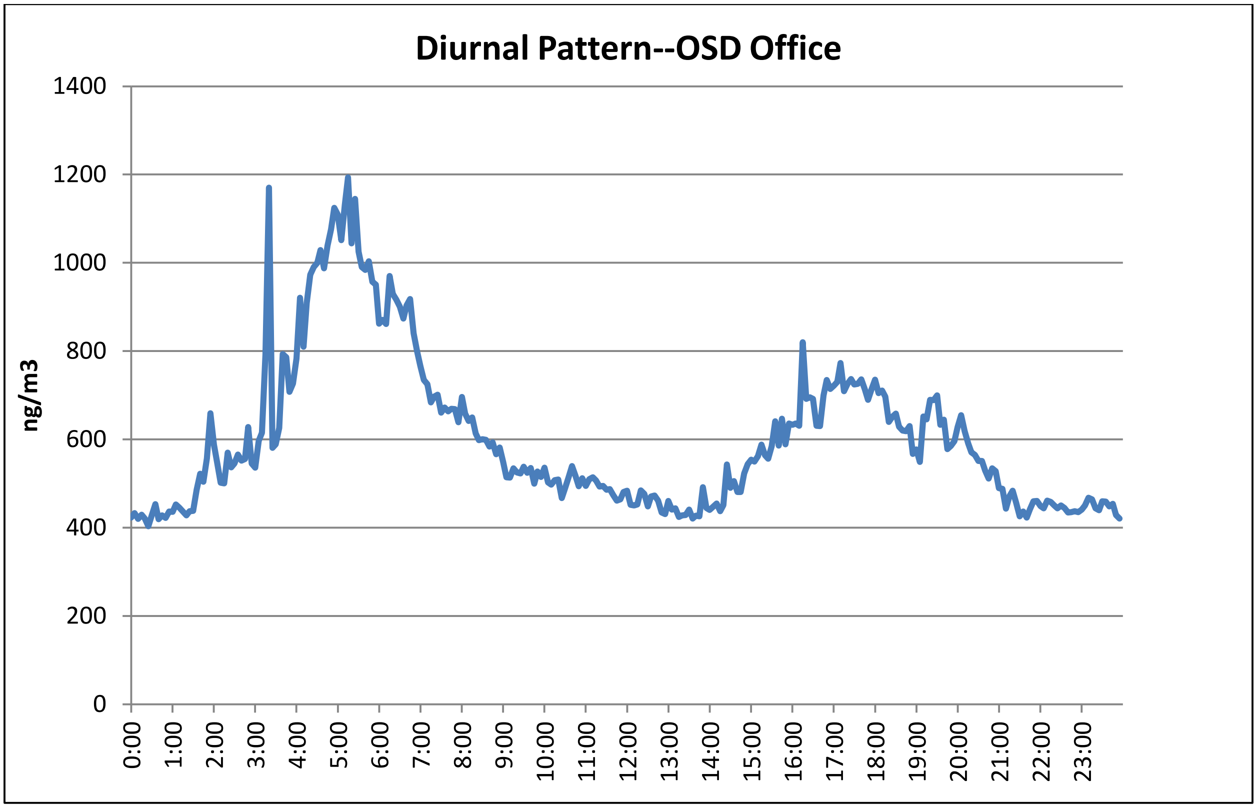

Figure 73. BC Diurnal Pattern at OSD
Shows commute periods.

Figure 73 shows the diurnal pattern, including both the morning and afternoon commute periods. This is in contrast to the lack of these indications at RSA, which is shielded from those influences.

8.1.4. OSD Elements

8.1.4.1. OSD DRUM

A two channel DRUM sampler collected coarse and fine size particulate for 35 days, from September 19 to October 20. Figures 75 through 79 show various aspect of results from these samples.

Figure 74 shows the effect of long-range transport of potassium from a fire around September 29. A forest fire from the southern coastal area was implicated as the source for this peak. Potassium as detected in the fine mode with the high sensitivity of the S-XRF is a sensitive tracer for combustion events.

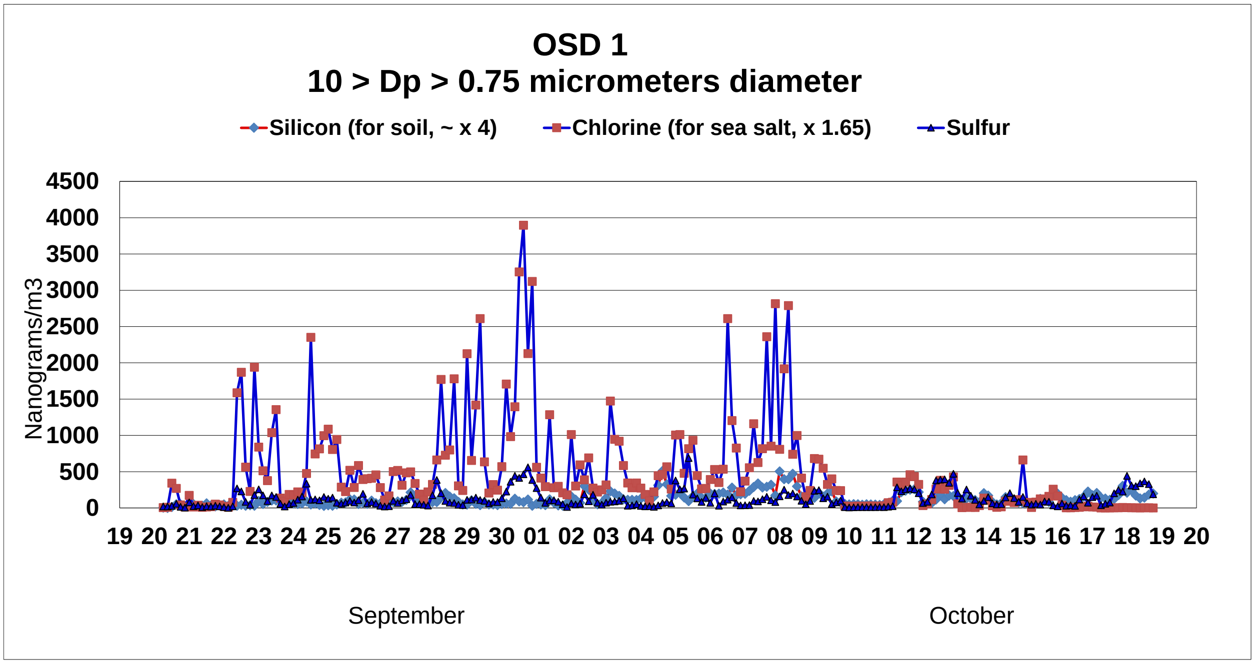

Figure 74. Coarse Source Category Elements

These three elements are indicators of major influence: silicon for soil, chlorine for sea salt, and sulfur for sea salt.

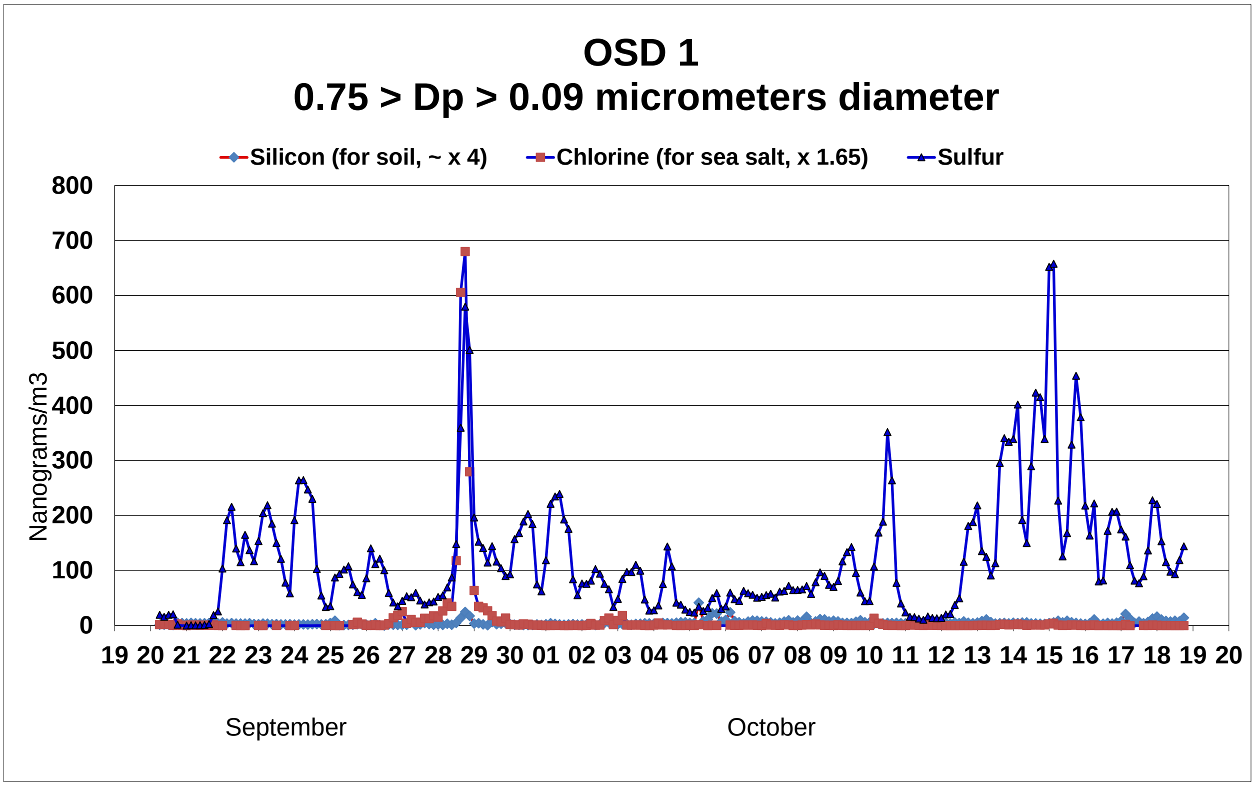

Figure 75. Fine Source Category Elements

Figure 75: Same as previous plot, but for fine fraction. The fine sulfur shows a peak on October 28th, suggesting a combustion source.

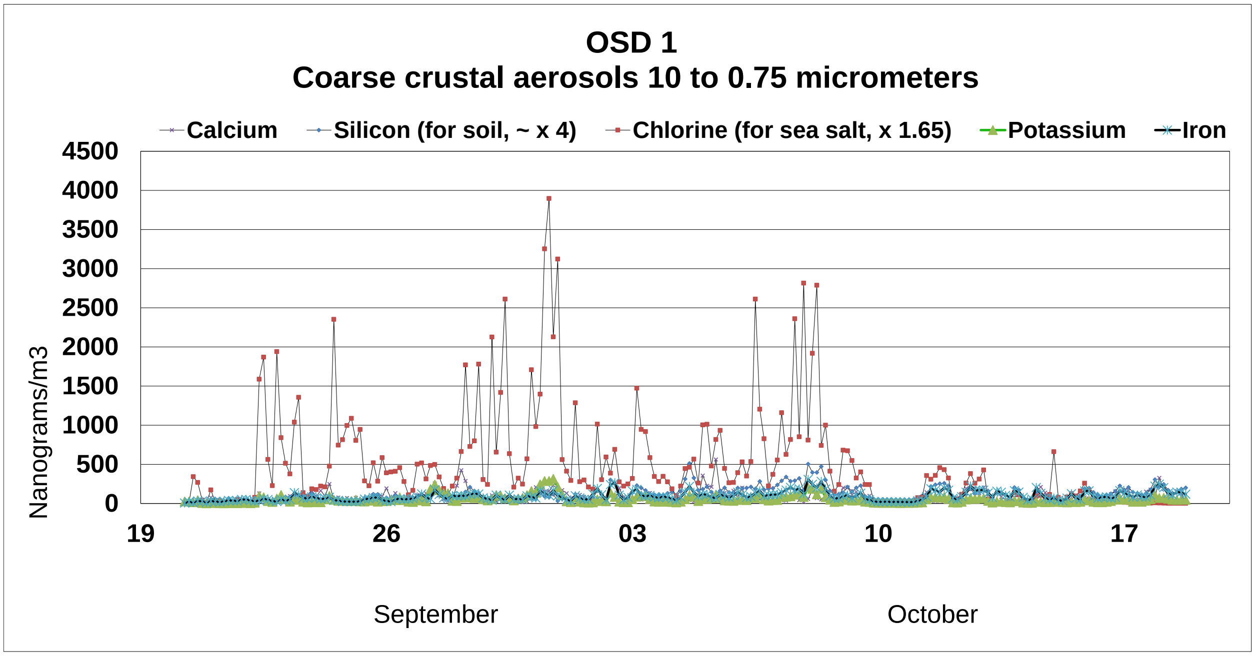

Figure 76. Coarse Crustal Aerosols

Coarse crustal aerosols show the influence of soil-related materials. The chlorine levels are relatively high compared to other influences.

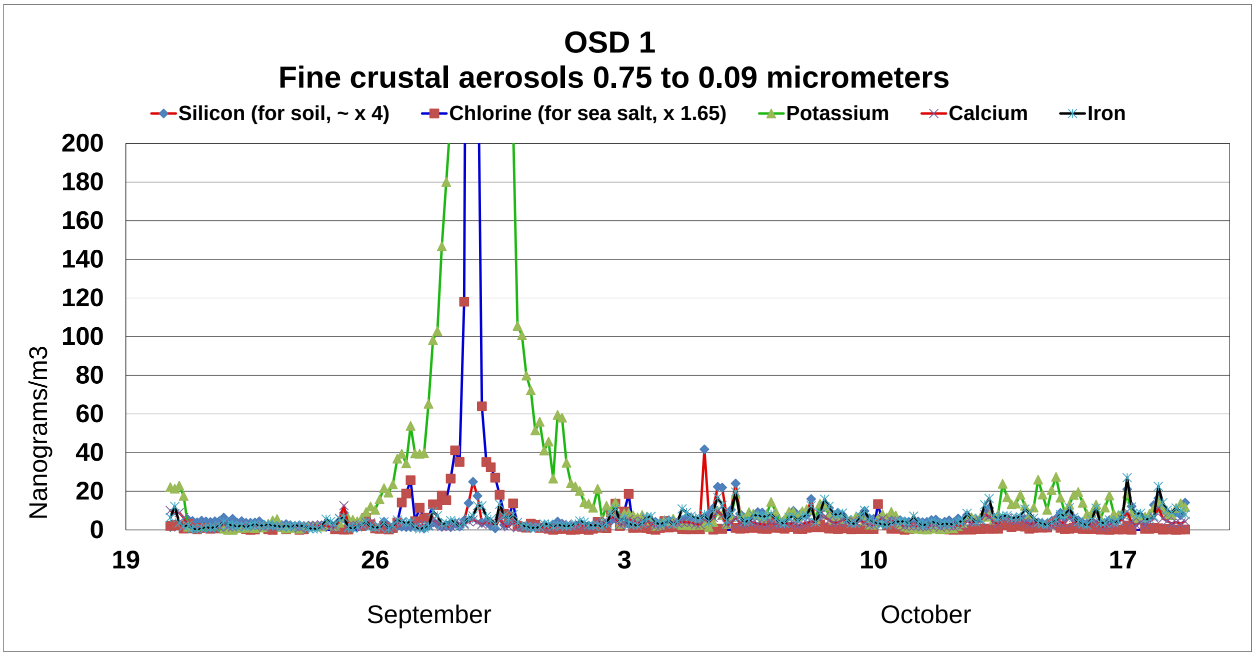

Figure 77. Fine Crustal Aerosols

High levels of potassium were not detected at PGE DRUM, so source was very directional (northerly). The high levels of potassium indicate a wood smoke source.

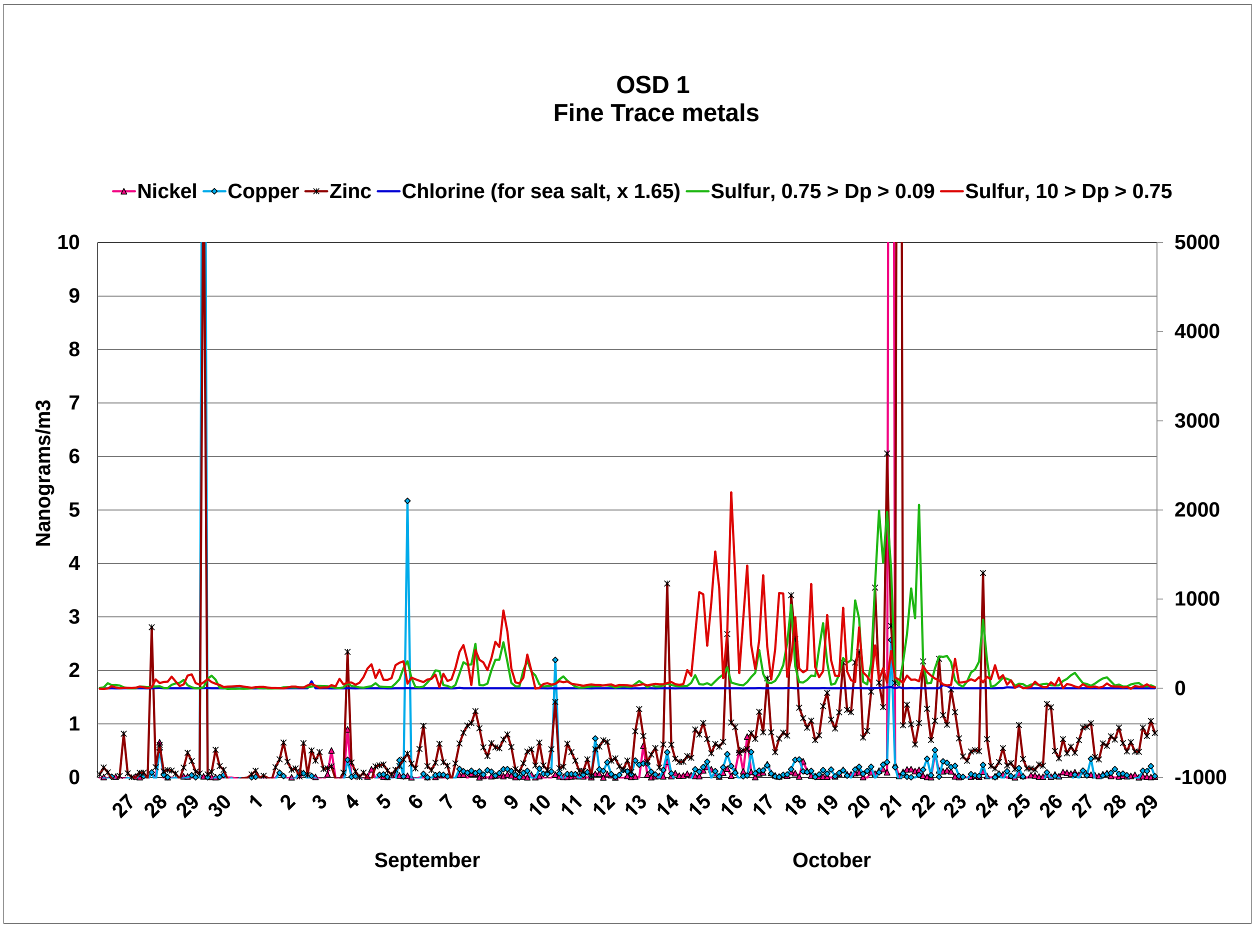

Figure 78. Fine Trace Metals

The fine trace metals are indicators of industrial emissions. The metals show a very low influence amidst much larger effects from fine sulfur (from combustion) and coarse sulfur and chorine from sea salt.

The average concentrations are shown in Table 8. These values will be combined with the other DRUM data for evaluation.

Table 8. DRUM Results at OSD Site
(ng/m^3)

Element	Coarse	Fine	Sum
Na	232.9	37.27	270.1
Mg	74.4	2.80	77.2
Al	44.7	0.85	45.6
Si	124.3	5.30	129.6
P	1.3	2.77	4.1
S	126.7	121.92	248.6
Cl	509.2	10.54	519.7
K	53.4	70.56	123.9
Ca	86.9	3.37	90.3
Ti	10.0	1.55	11.5
V	0.5	0.05	0.5
Cr	0.3	0.06	0.4
Mn	1.3	0.13	1.5
Fe	93.1	5.21	98.3
Co	0.3	0.02	0.3
Ni	0.0	0.06	0.1
Cu	6.0	1.01	7.0
Zn	3.4	1.64	5.1
Ga	0.0	0.00	0.0
As	0.0	0.00	0.0
Se	0.2	0.26	0.4
Br	1.4	1.52	2.9
Rb	1.7	2.60	4.3
Sr	4.2	4.76	8.9
Y	8.5	7.17	15.7
Zr	10.4	5.95	16.3
Mo	17.1	20.42	37.5
Pb	3.0	2.48	5.5

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9.0 BLN SITE DATA

9.1.1. BLN Meteorology

The meteorological data collected a the BLN site was determined to be faulty due to a shift in the wind direction sensor. Therefore, the local RAWS in Los Altos (LOAC1) station was used for meteorology. This station is less than one-half mile from the BLN site. The wind rose for this site was shown in Figure 82. The typical trend is for a southwest and northeast daily pattern.

9.1.2. BLN PM10

PM10 data was collected as part of the Partisol filter sampling. In addition to the XRF analysis for elements, a gravimetric measurement of the collected aerosol was made. These results will be presented alongside the elemental data.

9.1.3. BLN Black Carbon

Figure 79. The average for black carbon at BLN was 269 ng/m^3, which is representative of a residential area, and very close to the RSA value. Located at an elevated position, approximately 1 mile from I-280, the site would be expected to be affected mainly by regional trends.

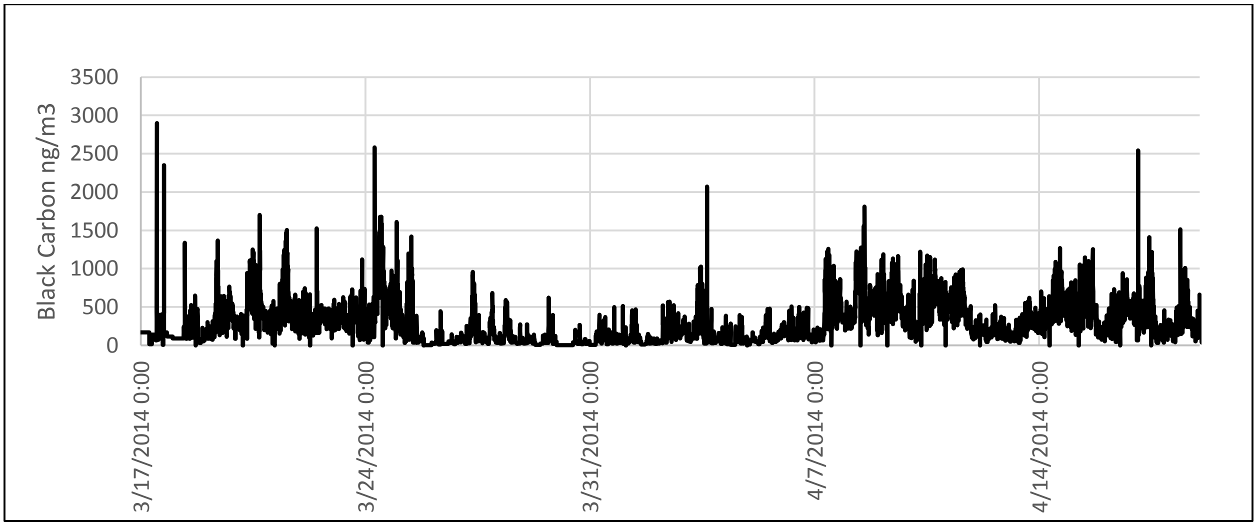

Figure 79. Black Carbon at BLN

For this location, the major influence would be from the clean oceanic air from the southwest and northwest, as suggested by the wind rose. However, a minor effect can be seen from the diurnal pattern shown in Figure 80, with a small peak at around 8 AM.

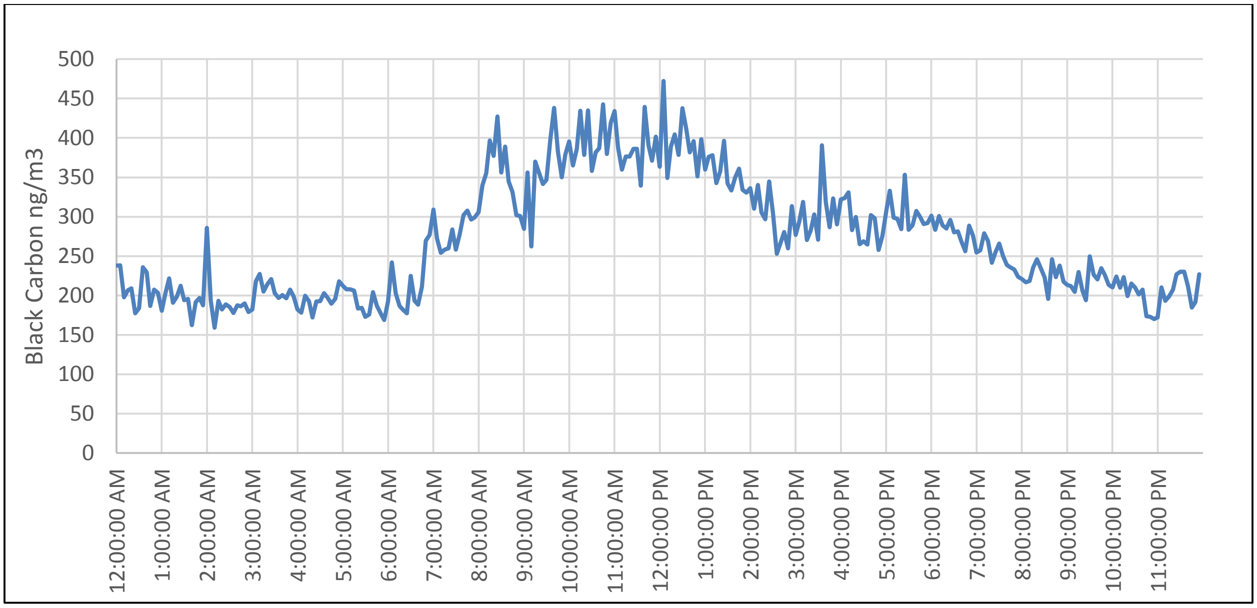

Figure 80. BLN Diurnal Pattern

10.0 TOXICS—ALL SITES

Because of the limited analytes and smaller data sets, a combination presentation will be more efficient and comprehensive, particularly in comparing sites.

10.1.1. Volatile Organic Compounds

Table 9 shows the results of the 24-hr canister sampling. There were several VOCs detected, most of which are generally found in the atmosphere (e.g., acetone). A key target (and risk driver) however was found in all samples—benzene. However, its detection was affected by an overall laboratory contamination.

The concentrations measured in the field samples were affected by the presence—in all sample batches—of benzene at a concentration of greater than three times the detection limit, indicating a high confidence detection. When this amount is subtracted from the average, an amount of approximately 0.9 µg/m^3 remains.

In addition, one sample at BLN was invalidated due to contamination from a lawn mower during one of the sampling events. This data was removed.

It is noteworthy that all the field samples—Annex and PGE, for example, for RSA onsite samples—all contained approximately the same concentration. It is concluded from reviewing all the field and laboratory data that the detected benzene is a combination of contamination and actual presence in the atmosphere. However, it is believed that the concentration is regional, as PGE is affected at approximately the same magnitude as Annex and BLN. The fact that PGE contains that same amount is of interest, as there are no local sources (within at least one-half mile, to the Lehigh quarry) to cause these values. The OSD benzene was lower than the RSA sites, which is unexpected since the higher traffic effects are expected.

Regardless of the actual source, the risk evaluation will show that the estimated overall concentration of 1.5 µg/m^3 is half of the 3 µg/m^3 REL risk value.

Table 9. All VOC Detections and Averages

(Percent = Percent Detected)

Annex		
Compound	Percent	Average (ug/m3)
1,1,2-Trichloroethane	7.7%	0.49
1,2,4-Trimethylbenzene	92.3%	0.78
1,3,5-Trimethylbenzene	42%	0.76
1,3-Dichloropropane	7.7%	0.34
2,2,4-Trimethylpentane	46.2%	0.71
2-Butanone	7.7%	1.19
4-Ethyltoluene	23.1%	0.86
Acetone	69.2%	8.83
Benzene	92.3%	2.29
Dichloromethane	15.4%	0.78
Ethylbenzene	38.5%	0.82
Hexane	23.1%	4.35
Isopropylbenzene	15.4%	0.67
m,p-Xylenes	76.9%	2.89
Naphthalene	7.7%	3.05
n-Propylbenzene	7.7%	0.84
o-Xylene	69.2%	1.38
Toluene	84.6%	6.94
Trichlorofluoromethane	38.5%	0.71
PGE		
Compound	Percent	Average (ug/m3)
1,2,4-Trimethylbenzene	50%	0.91
1,3,5-Trimethylbenzene	33%	0.76
2,2,4-Trimethylpentane	83%	1.86
4-Ethyltoluene	17%	0.93
Benzene	100%	2.73
Dichloromethane	67%	1.40
Ethylbenzene	67%	1.63
Hexane	33%	2.89
Isopropylbenzene	50%	1.99
m,p-Xylenes	100%	4.56
o-Xylene	83%	1.91
Toluene	100%	16.25

OSD		
Compound	Percent	Average (ug/m3)
Acetone	75%	9.39
Benzene	100%	1.58
Carbon disulfide	25%	2.98
Dichloromethane	25%	0.49
Hexane	25%	5.74
m,p-Xylenes	50%	0.83
o-Xylene	25%	0.96
Styrene	25%	0.36
Tetrachloroethene	25%	0.29
Toluene	100%	3.23
Trichlorofluoromethane	25%	0.61
BLN		
Compound	Percent	Average (ug/m3)
2,2,4-Trimethylpentane	50%	0.59
Acetone	50%	6.50
Benzene	100%	2.47
m,p-Xylenes	100%	1.41
o-Xylene	100%	1.42
Toluene	50%	3.92
Trichlorofluoromethane	50%	0.93
Blanks		
Compound	Count	Average (ug/m3)
Benzene	6	0.85
Dichloromethane	1	0.60
m,p-Xylenes	1	0.62
o-Xylene	1	0.44
Tetrachloroethene	1	0.79
Toluene	4	1.44

10.1.2. Mercury

Table 10 shows the summary from sample collection at all four sites. The summary data show that there is a gradient between PGE and Annex, suggesting influence from Lehigh. BLN and OSD showed virtually identical values, suggesting that less than 1 ng/m^3 is the regional background level. Other informal sources suggest that 1-2 ng/m^3 is a typical global background concentration.[23] The RSL for mercury is 31 ng/m^3, so the measured values at RSA are from 10 to 30 times lower than the risk level.

Table 10. Mercury Sampling Results

Site	Sample Date	Total Hg (ng/m³)	Average (ng/m3)
Annex	7/31/2013	0.753	1.0
	8/28/2013	0.575	
	10/28/2013	1.047	
	11/16/2013	0.678	
	12/15/2013	0.286	
	2/21/2014	1.078	
	2/22/2014	1.517	
	2/23/2014	1.011	
	3/8/2014	1.003	
	4/19/2014	1.578	
	5/3/2014	1.367	
	5/24/2014	1.561	
PGE	7/31/2013	8.299	2.9
	8/28/2013	4.340	
	10/28/2013	3.618	
	11/16/2013	2.819	
	12/15/2013	1.208	
	2/23/2014	0.347	
	3/7/2014	0.347	
	4/19/2014	2.444	
	5/3/2014	2.146	
	5/24/2014	3.708	
OSD	9/23/2013	0.139	0.25
	10/28/2013	0.358	

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[23] Personal communication, Robert Brunette, Eurofins FrontierGS, Technical Director of Mercury Analysis laboratory.

BLN	2/21/2014	0.333	0.35
	2/22/2014	0.297	
	2/23/2014	0.450	
	3/8/2014	0.303	

Table 11. Summary of Mercury Measurements (ng/m^3)

Annex	1.0
PGE	2.9
OSD	0.25
BLN	0.35

10.1.3. Hexavalent Chromium

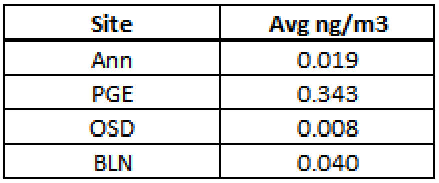
Similar to mercury, the data show a gradient between the PGE and other sites. Table 12 shows all the hexavalent chromium results. Table 13 shows the summary, which indicates much higher concentration at PGE vs. any of the other sites, particularly Annex. The two background locations are quite variable.

The RSL health standard is 100 ng/m3, so the detected concentrations are much lower than any point of concern.

Table 12. Hexavalent chromium Data

Site	SAMPDATE	RESULT	DL (ng/m3)	UNITS	Conc.	Average
Annex	2/24/2014	0.0193	0.0054	ng/m_Air	0.0193	0.019
Annex	7/25/2013	<0.0069	0.0069	ng/m_Air	0.00345	
Annex	8/7/2013	0.0868	0.0138	ng/m_Air	0.0868	
Annex	10/29/2013	<0.0057	0.0057	ng/m_Air	0.00285	
Annex	11/17/2013	0.009	0.0057	ng/m_Air	0.009	
Annex	12/16/2013	<0.0055	0.0055	ng/m_Air	0.00275	
Annex	2/22/2014	0.0038	0.0054	ng/m_Air	0.0038	
Annex	2/23/2014	0.0785	0.0054	ng/m_Air	0.0785	
Annex	4/20/2014	<0.004	0.0036	ng/m_Air	0.0018	
Annex	5/4/2014	<0.004	0.0036	ng/m_Air	0.0018	
Annex	5/25/2014	<0.004	0.0036	ng/m_Air	0.0018	
Blank	4/1/2014	<0.0054	0.0054	ng/m_Air	0.0027	
BLN	2/22/2014	0.074	0.0054	ng/m_Air	0.074	0.040
BLN	2/23/2014	0.011	0.0054	ng/m_Air	0.011	
BLN	3/8/2014	0.0335	0.0054	ng/m_Air	0.0335	
OSD	9/24/2013	<0.0057	0.0057	ng/m_Air	0.00285	0.008
OSD	10/29/2013	0.0131	0.0057	ng/m_Air	0.0131	
PGE	8/1/2013	<0.0057	0.0057	ng/m_Air	0.00285	0.343
PGE	10/22/2013	0.0352	0.0056	ng/m_Air	0.0352	
PGE	12/15/2013	0.0235	0.0057	ng/m_Air	0.0235	
PGE	2/23/2014	1.23	0.0054	ng/m_Air	1.23	
PGE	3/8/2014	0.822	0.0054	ng/m_Air	0.822	
PGE	4/20/2014	0.218	0.0036	ng/m_Air	0.218	
PGE	5/25/2014	0.0727	0.0036	ng/m_Air	0.0727	

Table 13. Site Averages Hexavalent Chromium



Site	Avg ng/m3
Ann	0.019
PGE	0.343
OSD	0.008
BLN	0.040

11.0 OBSERVATIONS

11.1.1. AAQS Violations

11.1.1.1. Annex—PM2.5

As noted in Section 5.4, the annual standard for PM2.5 was exceeded, at least on a numerical basis. However, that discussion also presented an alternative method for assessing that value as well as indicating the basis for a formal exceedance, which was not met for this test program.

11.1.1.2. PGE PM10

While the majority of the data was below ambient air quality standards, there was a period during which PGE site measured very high emissions, presumably from the nearby quarry. See Figure 81 which contains both PGE and Annex. This shows that on a few occasions, the elevated PGE levels were transported to Annex and impacted that site as well.

The 24-hour data shows that there were 14 exceedances of the 24-hr California ambient air quality standards, ranging from 0.120 mg/m^3 to 0.050 $^{\text{mg/m3}}$, shown in Table 14. All except one of these were during the springtime of 2013 period of high detected concentrations.

Table 14. California AAQS Violations

Date	Avg-24 hr.
6/4/2013 0:00	0.120
5/13/2013 0:00	0.084
5/2/2013 0:00	0.082
6/3/2013 0:00	0.072
6/8/2013 0:00	0.067
7/13/2013 0:00	0.061
6/6/2013 0:00	0.059
6/2/2013 0:00	0.059
4/29/2013 0:00	0.057
5/31/2013 0:00	0.056
7/5/2013 0:00	0.055
6/14/2013 0:00	0.055
6/5/2013 0:00	0.054

1/24/2014 0:00	0.050

Figure 81 shows a plot of hourly data collected at the PGE site, as well as concurrent data at the Annex site. The PGE data shows an extended period in which very concentrations were measured, though it is interesting that they occurred during the evening hours. Figures 82 and 83 are smaller time frames that allow the timing to be visualized.

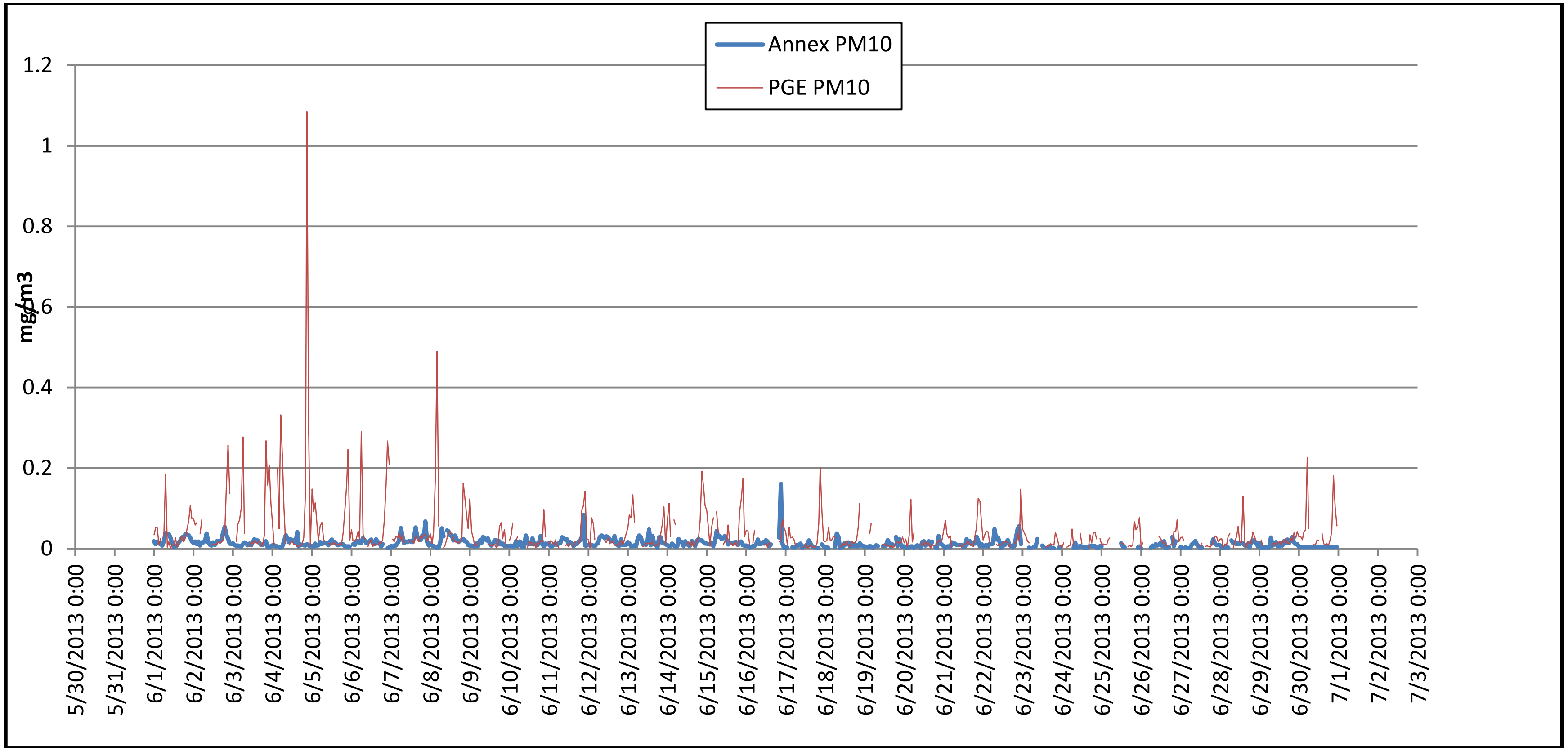


Figure 81. PGE and Annex PM10 Data, June 2013

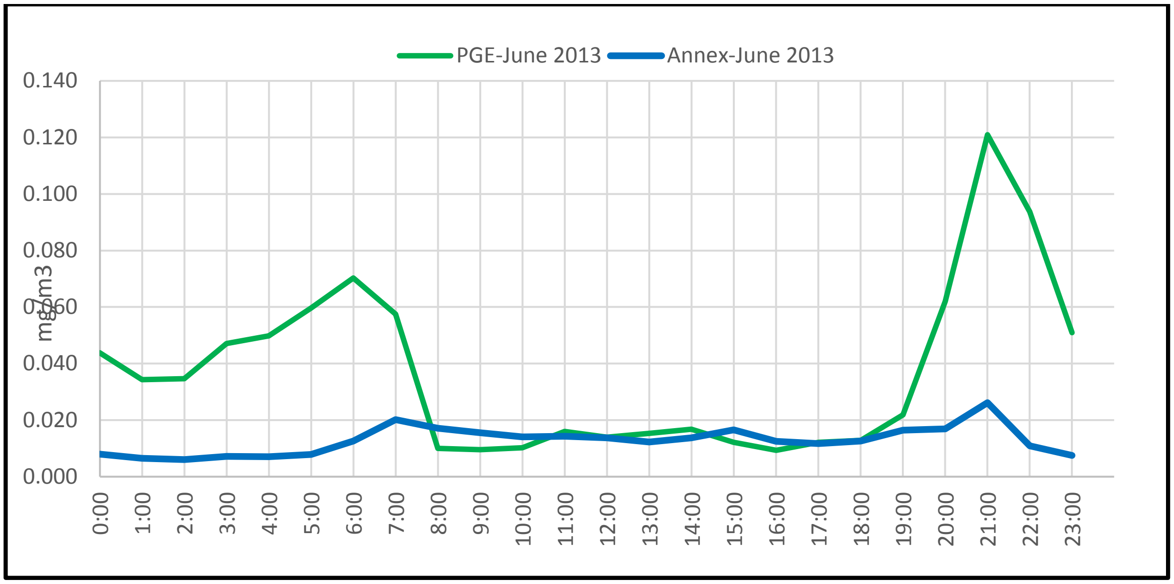


Figure 82. PGE and Annex Diurnal PM10

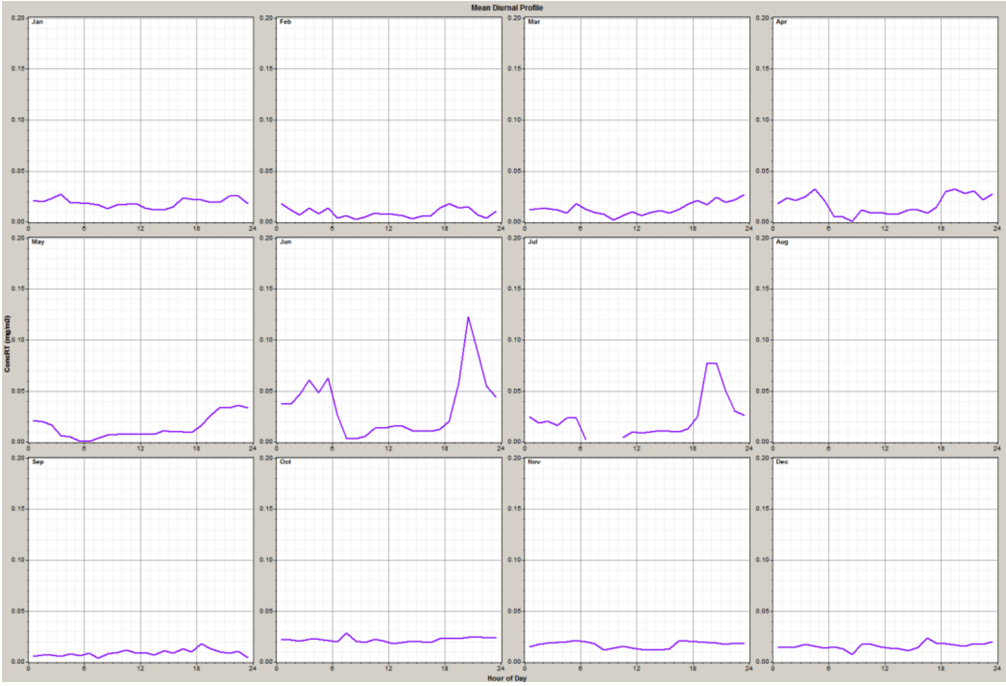


Figure 83.   PGE PM10 Diurnal Pattern

Shows the effect of the nighttime emissions phenomenon that was detected by observing enhanced concentrations at PGE during the spring of 2013. From these data, it appears that this started at the end of May and went through July.

11.1.2. Calcium Carbonate Enhancement

The question of calcium deposition was clearly demonstrated by multiple avenues. The presence of calcium carbonate as a deposition has been recognized for years, as there is no other source for this type of dust in the area. However, several lines of evidence were collected to confirm this observation. Some specific instances of detection are shown below, while the elemental data, both DRUM and Partisol, show clearly this same conclusion.

11.1.2.1. Elemental Data Ratio

Elemental ratios in collected samples, both DRUM and Partisol samples, showed significant enhancement relative to standard crustal concentrations in California.[24] Table 15 shows the enhancement from two soil element ratios—Titanium and Iron—at all the test sites. Using both ratios, the enhancement from Calcium is seen to be approximately a factor of two compared to the standard crustal values.

In addition, a gradient is seen between the locations: PGE is higher than Annex, as would be expected, though not by a large amount, and Annex is higher than OSD. BLN is the same as Annex, which is not surprising since it is located approximately the same distance from the quarry as the BLN site and would be subjected to similar fugitive dust plumes.

Table 15. Elemental Enhancement

Location	Ca/Ti	Ca/Fe
Crust	7.28	0.74
Annex	14.7	1.49
PGE	16.0	1.51
BLN	14.7	1.49
OSD	7.8	0.92

11.1.2.2. Elemental Abundance Ratio

An alternative method is the enrichment factor ratio, which takes the ratio between a comparison pair to the potential enhanced pair. In this approach, it is site-specific and not dependent on literature values that may not be representative of the site:

$$EFs = \frac{\frac{Es}{Tis}}{\frac{Er}{Tir}}$$

Es = element (Ca) in sample
Ti = Titanium in sample

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[24] Background Concentrations of Trace and Major Elements in California Soils, http://envisci.ucr.edu/downloads/chang/kearney_special_report_1996.pdf

Er = element (Ca) in earth abundance reference
Tir = Titanium in earth abundance reference

The result of this calculation for both Iron and Titanium was:

Ca/Fe	1.2
Ca/Ti	10.8

If there was no enhancement, the ratio would be 1.0. Therefore, these two ratios show that the Calcium is enriched by factors between 0.2 and ~11. While this range is wide, this calculation confirms the excess Calcium in the atmosphere that is deposited on surfaces. As is discussed in relation to the PGE results from June, 2013, it is thought that the low wind speeds in the evening allow high concentrations to be transported in the stable nocturnal conditions.

11.1.2.3. Directional Dependence of Calcium Detection

Using DRUM data at Annex for both coarse and fine modes, for both Calcium and Silicon, a comparison was made of detections with the wind direction. Figure 84 shows how the detections are clustered around 245 degrees, which leads from Annex to the upper section of the quarry and which coincides with the Annex wind rose.

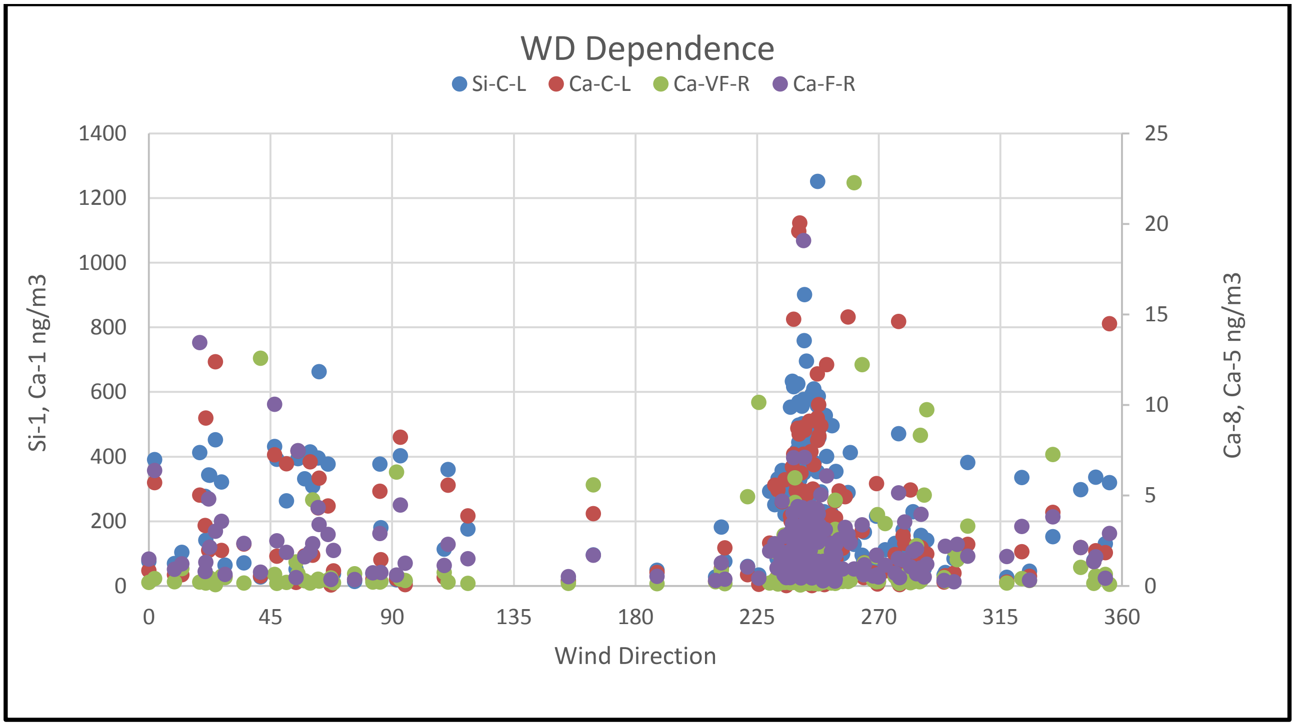


Figure 84. Wind Direction Dependence of silicon and calcium.
L = left axis, C = coarse fraction (chan 1),
R = right axis, F = fine fraction (chan 5), VS = very fine fraction (chan 8).

The cluster shows both coarse (from quarry fugitives) and fine/very fine (from process emissions).

The dominant frequency is around 245 degrees, but there is a second cluster for the north-east sectors. Two options are suggested for this observation: non-plant sources, or emissions that have been transported around the edge of the mountain, perhaps even through the valley to reach the Annex site. The low levels of fine Calcium in comparison to the other direction, plus the relatively consistence between coarse Silicon and Calcium suggest a soil source. Therefore, it is concluded that these detections are from background urban sources.

Another example of the directional dependence of Calcium detection is shown in Figure 85. This plot shows a consistent wind direction of around 245 degrees. The detection of coarse Silicon is tracked well by Calcium. There is a period with sporadic rains—from January 5-14, where everything is cut down. Then, starting at January 23, the plant enters its shutdown phase, so all concentrations decrease.

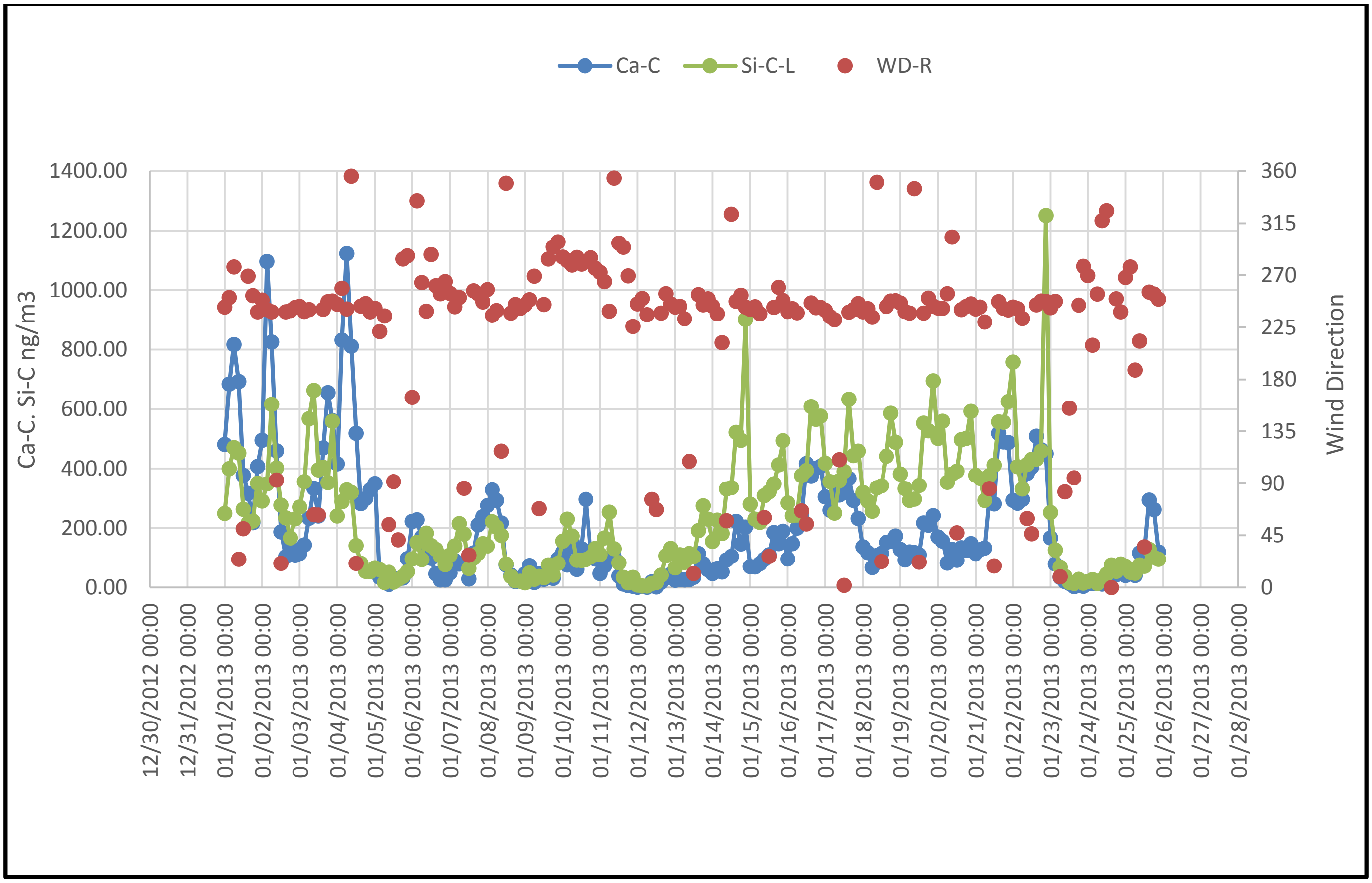


Figure 85. Wind Direction Dependence on Calcium enrichment

11.1.2.4. Passive Sampler

Passive samplers were deployed at three sites and subsequently analyzed by electron microscope with x-ray microprobe analysis. This analysis provides both a mass concentration for the coarse and fine fractions, but also shows enhancements for the target elements.

These results were not as dramatic some of the other results, these results do indicate a difference between PGE and the other locations.

Table 16. Passive Sampler Results

	Annex	PGE	OSD
Description	Number%	Number%	Number%
Ca-rich soil	6	8	4
Ca-rich	8.5	15.5	13
	Wt%	Wt%	Wt%
Ca-rich soil	5.5	13	8
Ca-rich	5	18.5	7

Table 1

11.1.2.5. Soil Samples

Soil samples were collected at three sites to assess the possible enhancement of Calcium and other industrial metals from deposition. The sites were PGE, on the Hill trail, and at Annex. Two types of samples were collected: surface scrape, and subsurface (6” depth) (surface scrape only at Hill trail). The samples were analyzed by ICP-MS for Calcium and the CAM-17 metals.

Table 17 shows the results. The data show higher levels of Calcium in the surface samples than in the subsurface samples, with a range of a factor of 1.2 at the Annex to 2.3 at the Hill Trail surface. Both the Hill Trail and PGE samples showed a higher enhancement than the Annex, which is what would be expected considering the distance from the quarry source. While not a rigorous test, this confirms the many other results that show the presence of calcium carbonate, indicative of surface deposition.

Table 17. Soil Samples—Calcium Enrichment

	Annex Surface	Annex Subsurface	Hill Surface	PGE Subsurface	PGE Surface			
ANALYTE	Result	Result	Result	Result	Result	DL	RL	UNITS
Calcium	23000	19000	43000	18000	31000	13	50	mg/kg
Enhancement	1.2		2.3		1.7			
Antimony	4.4	4.6	2.7	4.7	2.9	2.0	2.5	mg/kg
Nickel	130	79	61	83	79	0.21	1.0	mg/kg
Silver	ND	ND	ND	ND	ND	0.18	0.50	mg/kg
Vanadium	130	160	99	170	110	0.090	1.0	mg/kg

Zinc	94	93	64	81	87	0.27	1.0	mg/kg
Barium	170	130	210	98	160	0.57	1.0	mg/kg
Beryllium	ND	ND	ND	ND	ND	0.050	0.50	mg/kg
Cadmium	0.81	2.0	ND	0.74	0.98	0.15	0.50	mg/kg
Cobalt	34	38	23	43	30	0.080	1.0	mg/kg
Chromium	160	150	81	150	64	0.31	1.0	mg/kg
Copper	60	72	40	79	64	0.30	1.0	mg/kg
Lead	8.1	6.2	ND	ND	ND	0.87	2.5	mg/kg
Molybdenum	ND	ND	ND	ND	1.6	0.24	1.0	mg/kg
Arsenic	1.2	ND	1.1	ND	2.5	0.39	1.0	mg/kg
Selenium	ND	ND	ND	ND	ND	0.11	2.5	mg/kg
Thallium	ND	ND	ND	ND	ND	0.022	1.0	mg/kg
Mercury	0.14	ND	0.12	ND	ND	0.0072	0.10	mg/kg

11.1.3. Plume Visuals

11.1.3.1. Plume from Plant

An example of the effect of dominant meteorology from the obvious potentially major source adjacent to RSA occurred on November 15, 2013, around 15:00. The afternoon light facilitated the visual impact of the emission plume from the Lehigh plant. It shows what appears to be emissions from numerous points of the short to tall buildings, possibly both point and fugitive emissions.

The wind and PM10 data was examined for this period to determine what the conditions were at RSA.

Figure 86. Point and Fugitive Emissions from Lehigh Plant—Nov 15, 2013 15:00

The wind data are shown in Figure 87, indicating the wind direction was constant for the night time hours, and shifted quickly in the early morning hours to a northerly to north-easterly direction throughout the day. Then again at night, it resumed the usual southwest pattern. Both at night and during the day, the winds were low, indeed low and constant during the day hours.

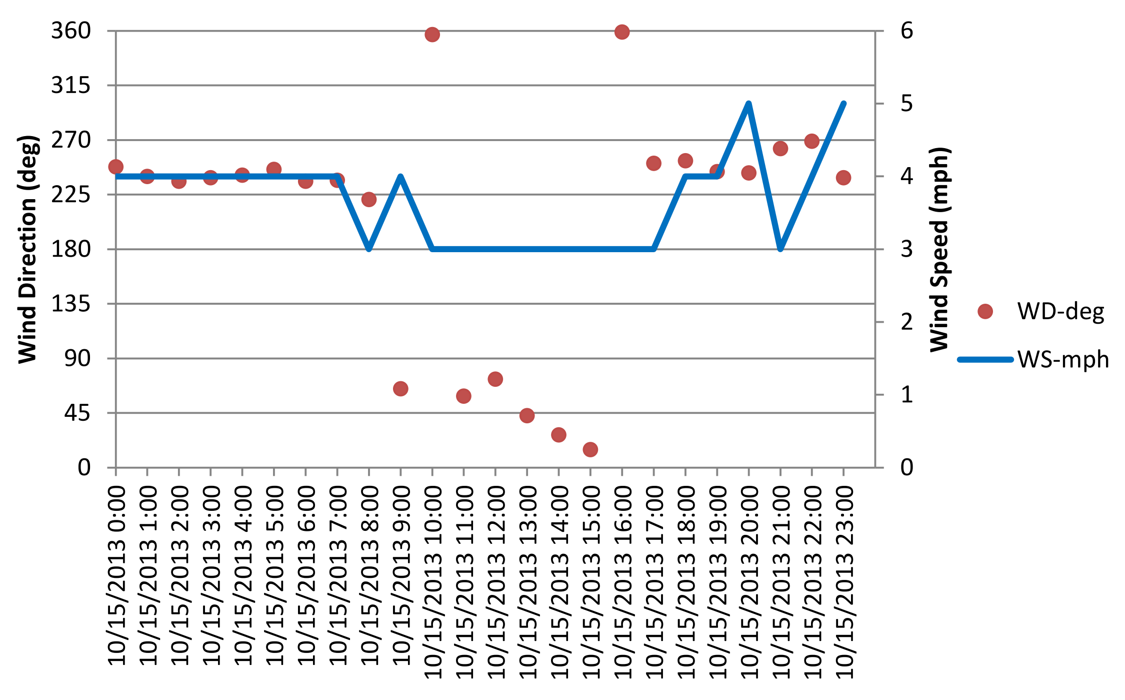


Figure 87. Wind data for November 15, 2013

The Hysplit model, which tracks air masses in time, was used to examine the pattern for this day. Figure 88. shows the results, indicating the air for that day originated along the north coast, hugging the coast, presumably transporting clean air.

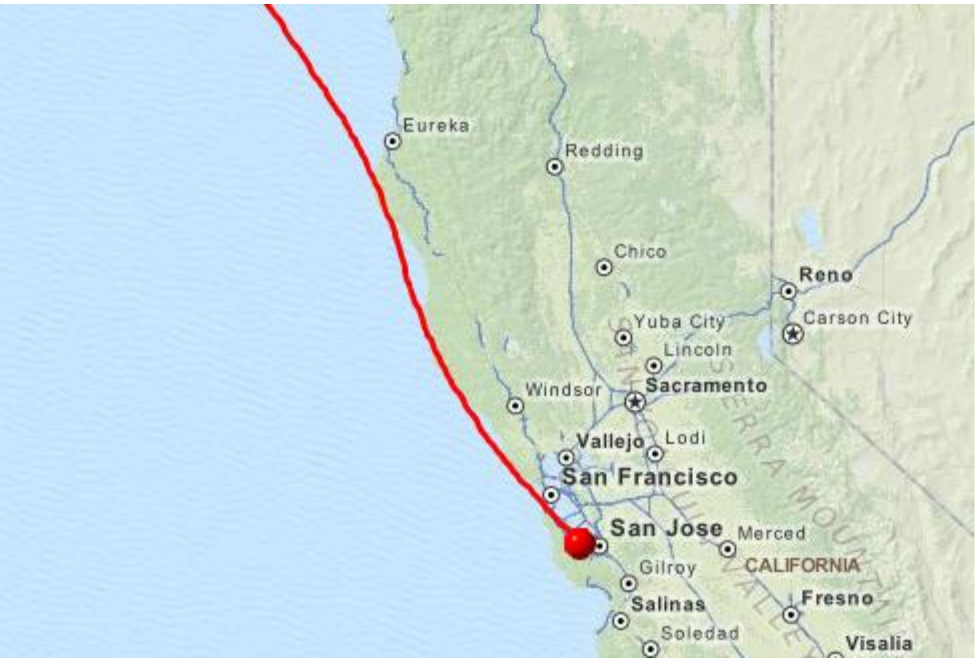


Figure 88. Hysplit Trajectory Model—shows origin of air masses

The PM10 data for that day show low concentrations throughout the day until the evening when concentrations increased somewhat, as shown in Figure 87.

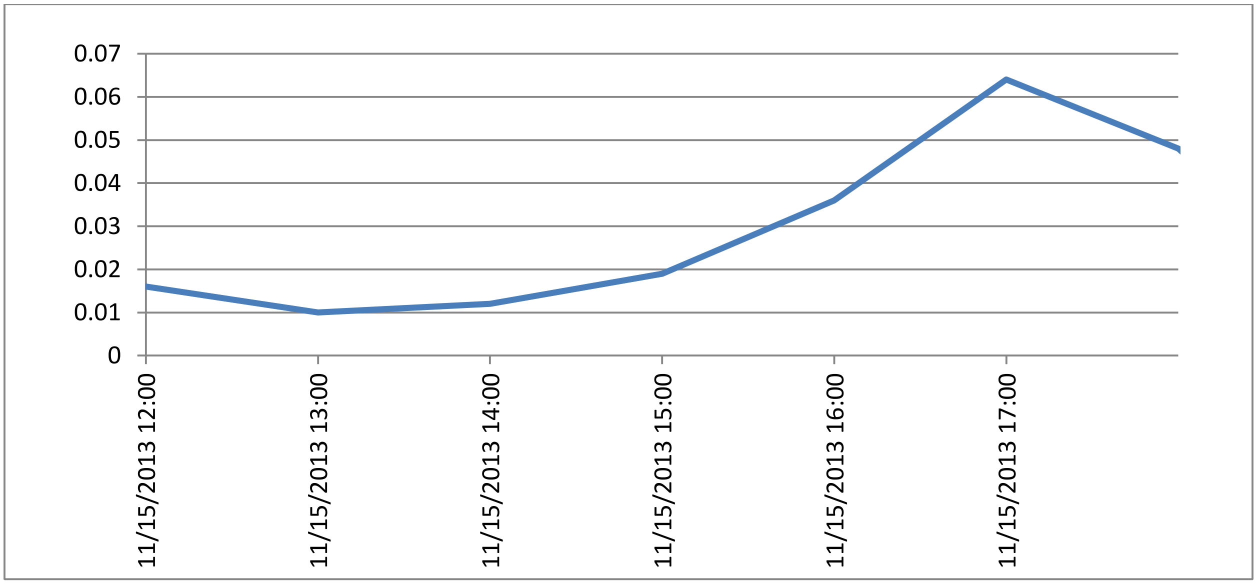


Figure 89. Annex PM10

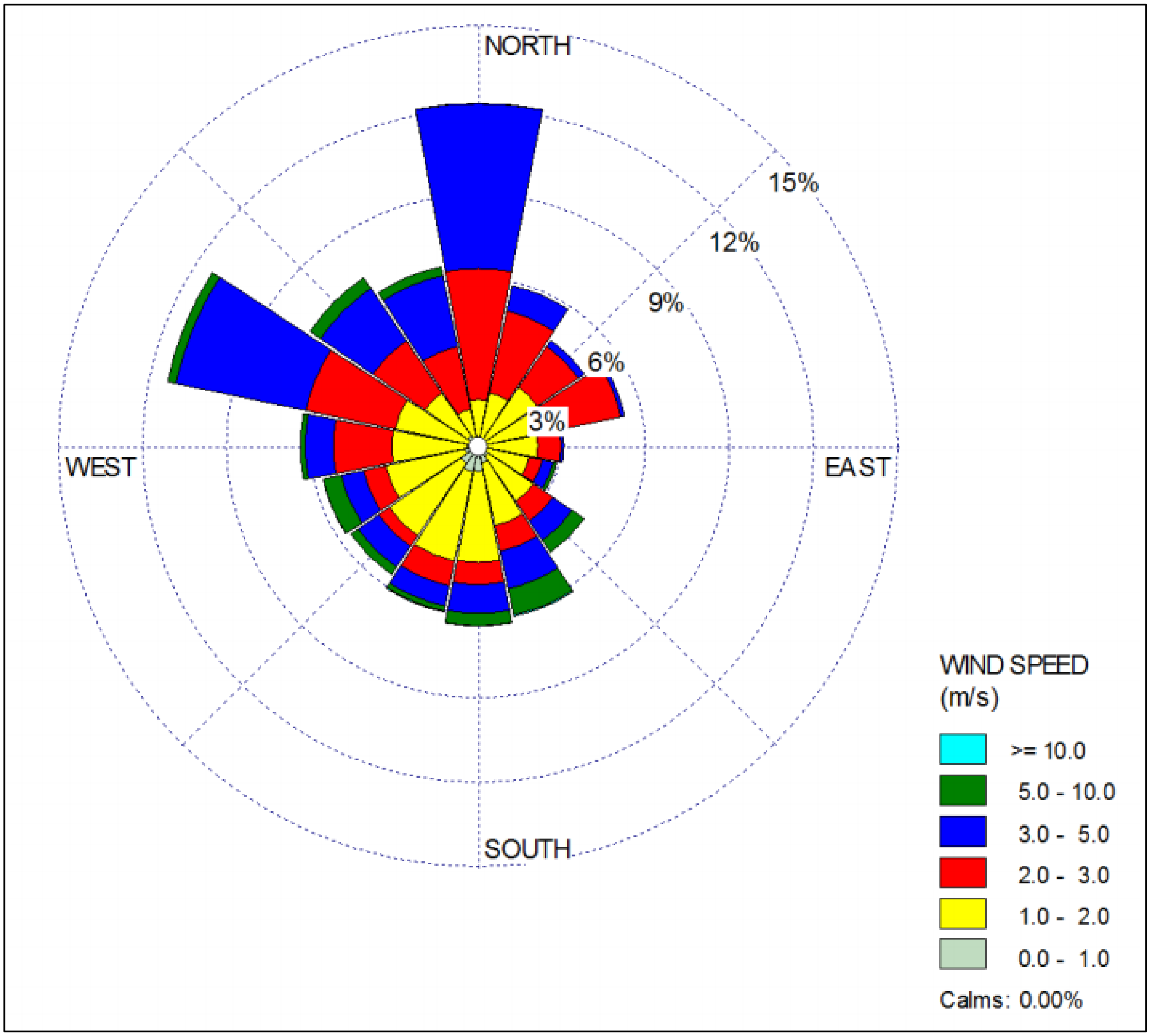


Figure 90. Annual Wind Rose for Lehigh

The annual wind effects at Lehigh are illustrated in their wind rose, indicating major wind direction petals originating from the north and northwest, consistent with this model.

11.1.3.2. Blast Plume

June 5, 2013 2 PM—Blast Observed.

Plume observed by public, but was not detected to impact the Annex. The wind was from the north as is mostly the case during the day time hours.

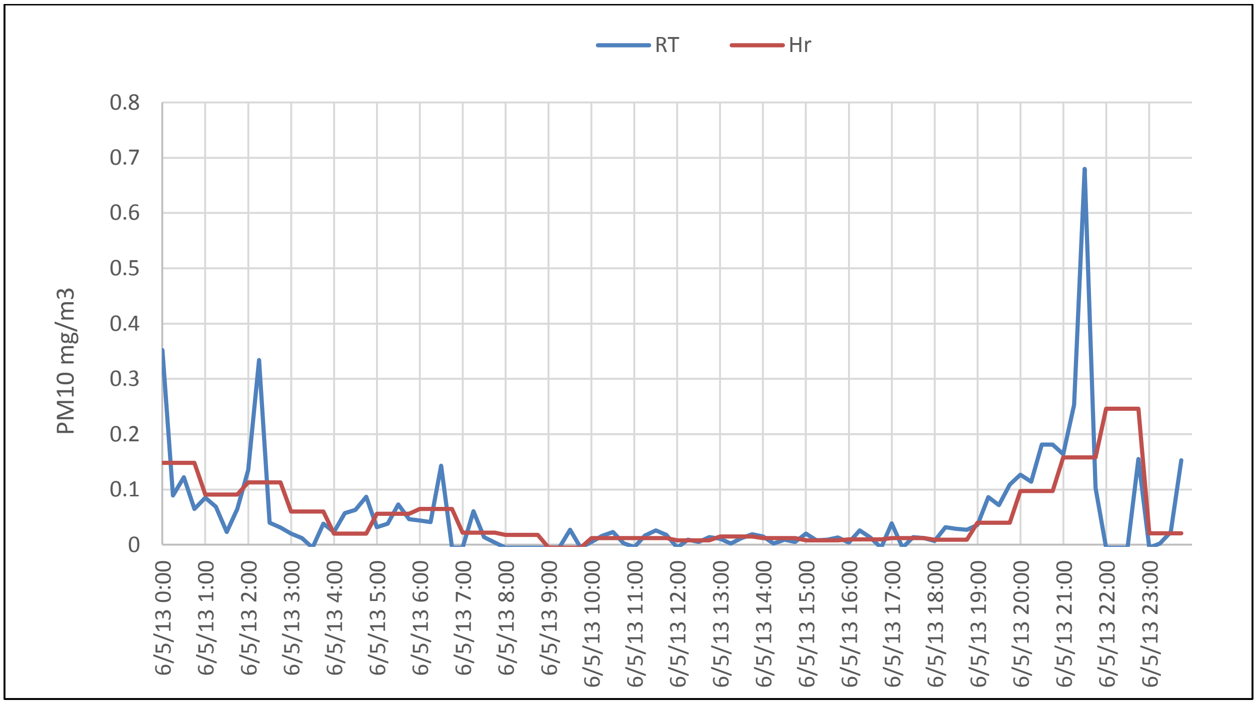


Figure 91. PGE Data during blast

11.1.3.3. Blast Event

Figure 92 contains a series of photos of the plume from a blast event, showing how the momentum of the blast combines with the normal daytime turbulence to provide lift to transport the plume up and away to the east, away from RSA. The elapsed time was approximately four minutes.

There was no change in the monitors’ data, as this plume was not carried up and over any of the monitoring sites.

Figure 92. Plume from blast, May 25, 2013 2 PM

11.1.3.4. Haze Observation: June 21, 2013 7 AM

Daytime wind directions from the north precluded impact to the RSA area from plant emissions. Evening concentrations increase, as is a common pattern due to low wind speeds and changing directions. Figure 93.

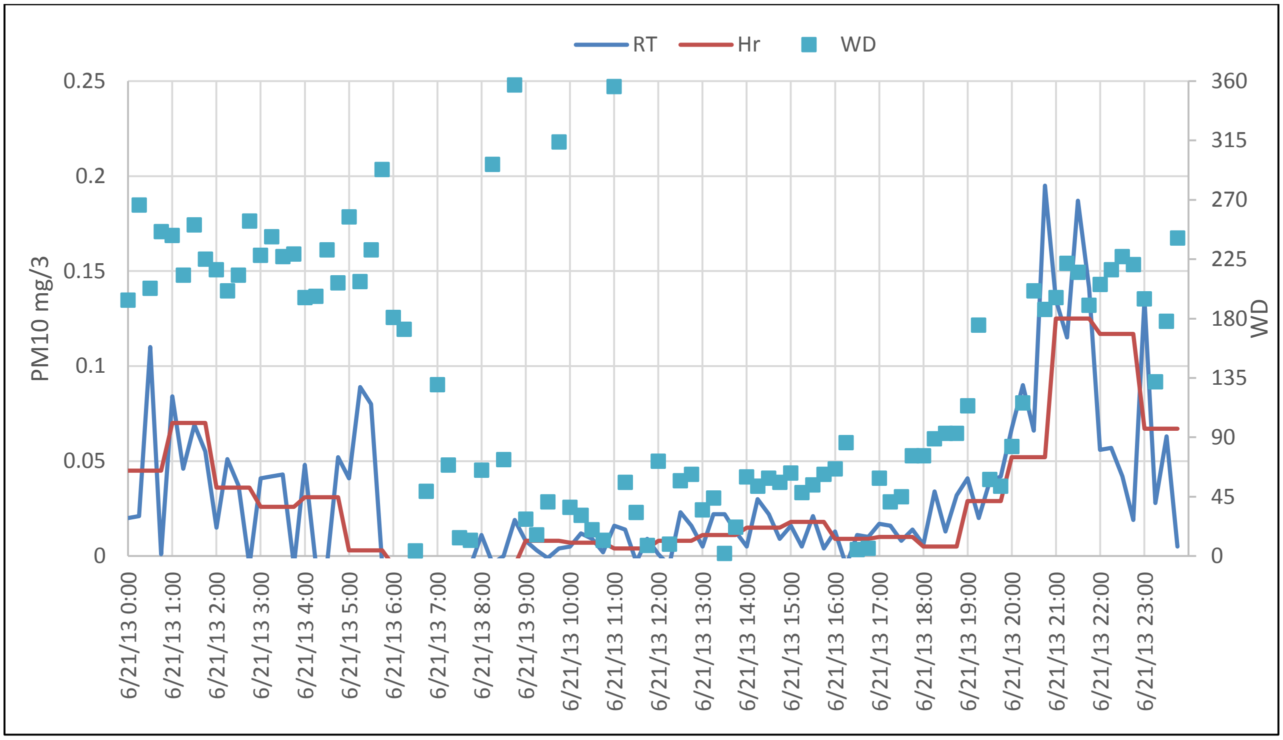


Figure 93. PGE data during observation of Lehigh haze event.

11.1.3.5. Regional meteorological Conditions during sampling

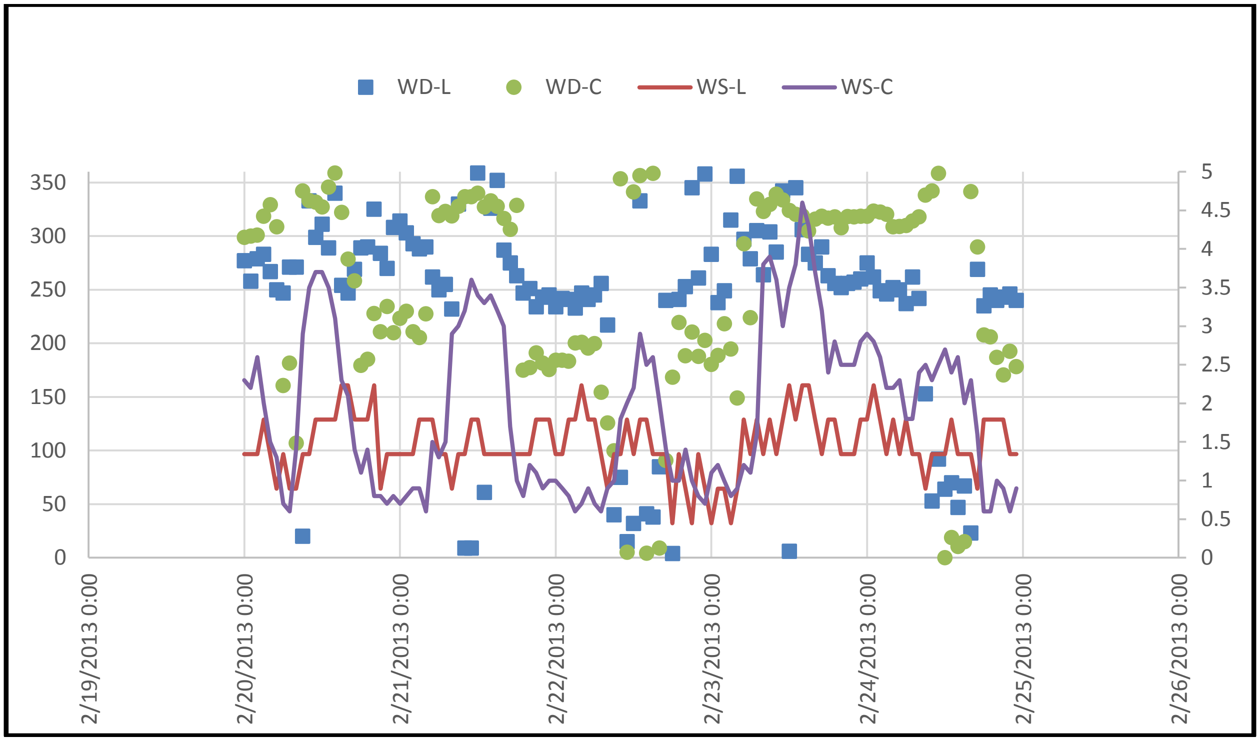


Figure 94. Meteorological Conditions—Mercury Sampling
(C = Cupertino, L = Los Altos)

Figure 94. During a mercury sampling event on Feb 23-24, 2013, the wind patterns changed over time. The combination of the two monitoring stations at Cupertino (BAAQMD) and Los Altos RAWS shows the effect of the local topology.

11.1.3.6. Deer Hollow—Influence of close sources

Monitoring was initiated at Deer Hollow, but was discontinued after several months due to the noted effect of nearby, very localized sources. It was noted that both the early morning (staff arrival and activities) and afternoon busy periods (visitors) were detected.

Figure 95 shows the diurnal pattern of the Deer Hollow data in comparison to the Annex pattern. This suggests that an enhancement on the order of 2-5 ug/m^3 easily occurs if close to the source. No evidence of the same influence was seen at Annex, which is higher and away from the trails, so somewhere between 50 and 100 feet appears to be the factor.

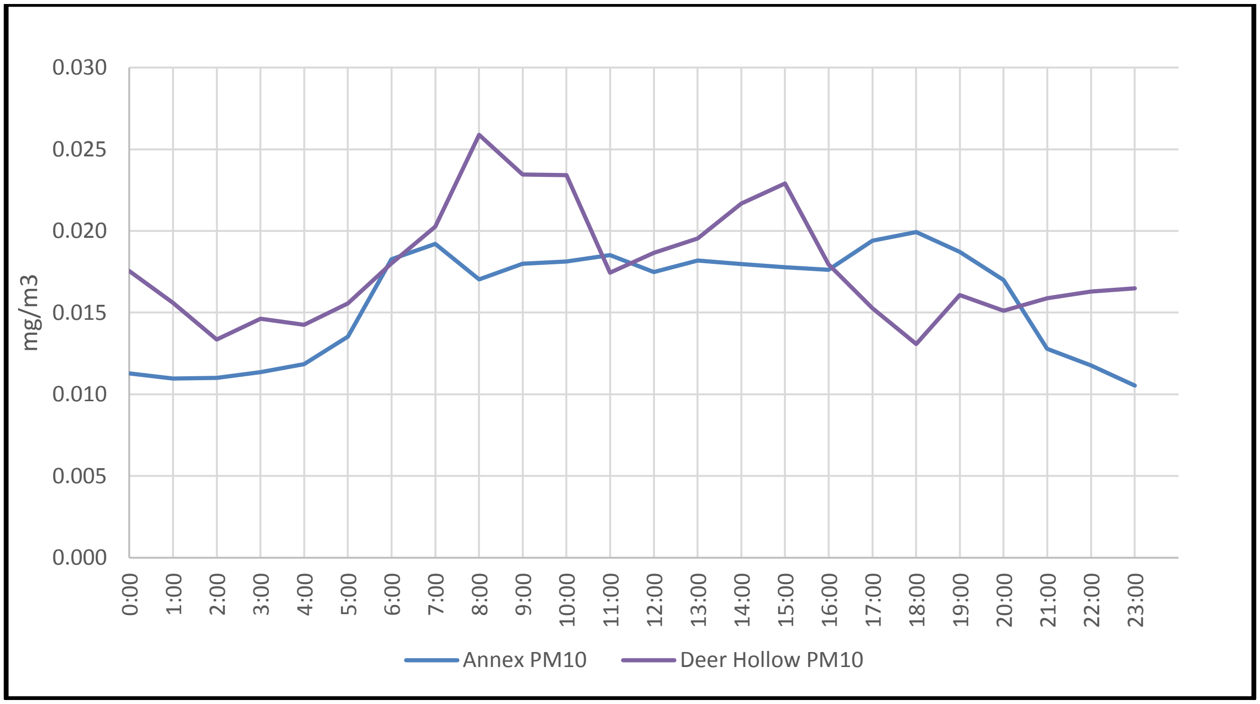


Figure 95. Deer Hollow diurnal pattern

11.2. Site Comparisons

11.2.1. Annex-PGE-BLN

Besides the DRUM sampler, elemental concentrations were collected via a Partisol sampler, which provides a 24-hr average concentration. While this sort of sample is less powerful in assessing source characteristics, its main value is a direct input into risk comparisons, which are based on 24-hr averages. In addition, the Partisol is a Federal Equivalent Method, which carries with it the inherent validation of EPA methodology. While the DRUM sampler has substantial quality assurance and comparative validation data available, it does not carry the same FEM designation.

Table 18 contains the results from the Partisol sampling at the Annex, PGE and BLN sites. Figure 96 shows the summary of these values. Note that the PGE results are for day time period only—the 10 hour period from 7 AM to 5 PM. This was done due to the limited availability of power from the solar panels.

Even with the shorter time period for the PGE site, the concentrations for all elements are substantially larger. This is not surprising based on all the other site data.

The shorter time period for these samples are not as useful for trends compared to the DRUM samples, so the results are integrated only into the risk calculations.

Table 18. 24-hr Integrated Sampling/XRF Analysis

ug/m3	Ann-1	Ann-2	Ann-3	Ann-Avg	PGE-1	BLN-1
PM10 Mass	11.7	11.8	12.0	12.6	24.0	12.6
Elements	**Ann-1**	**Ann-2**	**Ann-3**	**Ann-Avg**	**PGE-1**	**BLN-1**
Ag-silver	0.0001	0.0007	0.0006	0.0005	0.00084	0.00044
Al-aluminum	0.0700	0.2581	0.2596	0.1959	0.23249	0.18261
As-arsenic	0.0000	0.0002	0.0003	0.0002	0.00014	0.00018
Ba-barium	0.0056	0.0029	0.0048	0.0044	0.00801	0.00369
Br-bromine	0.0036	0.0048	0.0044	0.0043	0.00463	0.00387
Ca-calciium	0.3016	0.4949	0.4311	0.4092	0.59126	0.38440
Cd-cadmium	0.0005	0.0004	0.0000	0.0003	0.00070	0.00039
Cl-chlorine	0.4299	1.2262	1.4027	1.0196	1.53136	0.97633
Co-cobalt	0.0000	0.0000	0.0000	0.0000	0.00000	0.00001
Cr-chromium	0.0006	0.0013	0.0034	0.0017	0.00562	0.00150
Cu-copper	0.0038	0.0052	0.0040	0.0043	0.00539	0.00400
Fe-iron	0.1762	0.3501	0.2964	0.2742	0.39083	0.25777
Ga-gallium	0.0002	0.0003	0.0001	0.0002	0.00043	0.00016
Ge-germanium	0.0004	0.0001	0.0001	0.0002	0.00114	0.00014
Hg-mercury	0.0002	0.0002	0.0002	0.0002	0.00031	0.00027
In-indium	0.0003	0.0007	0.0016	0.0009	0.00018	0.00086
K-potassium	0.0876	0.1542	0.1410	0.1276	0.16889	0.11986
La-lanthanum	0.0003	0.0005	0.0000	0.0003	0.00363	0.00039
Mg-magnesium	0.0264	0.2394	0.2566	0.1741	0.10376	0.16125
Mn-manganese	0.0033	0.0066	0.0060	0.0053	0.00869	0.00497
Mo-molybdenum	0.0003	0.0007	0.0001	0.0004	0.00040	0.00039
Na-sodium	0.3446	1.0819	0.9003	0.7756	1.51444	0.76488
Ni-nickel	0.0004	0.0008	0.0005	0.0006	0.00049	0.00057
P-phosphorus	0.0041	0.0129	0.0105	0.0092	0.00080	0.00840
Pb-lead	0.0006	0.0016	0.0010	0.0011	0.00057	0.00101
Pd-Palladium	0.0005	0.0004	0.0004	0.0004	0.00064	0.00033
Rb-rubidium	0.0001	0.0003	0.0001	0.0002	0.00022	0.00020
S-sulfur	0.3499	0.5445	0.6031	0.4992	0.70788	0.45939
Sb-antimony	0.0001	0.0019	0.0024	0.0015	0.00000	0.00132
Se-selenium	0.0008	0.0009	0.0006	0.0008	0.00113	0.00077
Si-silicon	0.2716	0.7653	0.7330	0.5900	0.81701	0.55424
Sn-tin	0.0022	0.0031	0.0040	0.0031	0.00271	0.00299
Sr-strontium	0.0009	0.0027	0.0027	0.0021	0.00195	0.00197
Ti-titanium	0.0161	0.0359	0.0316	0.0279	0.03696	0.02613
V-vanadium	0.0006	0.0009	0.0008	0.0007	0.00138	0.00068
Y-yttrium	0.0002	0.0004	0.0004	0.0003	0.00066	0.00031
Zn-zinc	0.0045	0.0058	0.0054	0.0052	0.00648	0.00471
Zr-zirconium	0.0011	0.0013	0.0013	0.0012	0.00097	0.00112

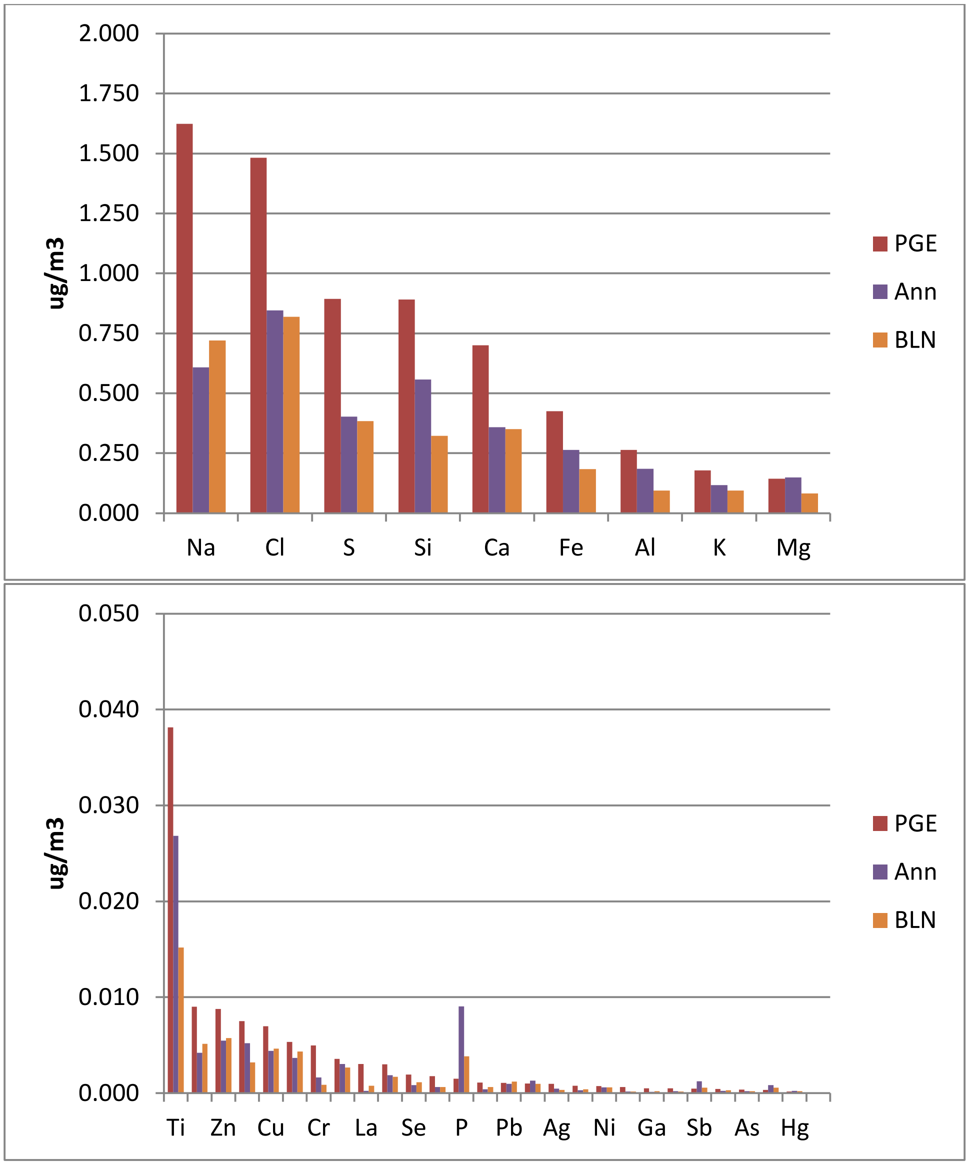


Figure 96. Plot of Average Elemental Concentration
(µg/m^3, ranked by concentration at PGE site)

Table 19. shows the ratio between various concentrations obtained from the elemental data. When compared to the standard earth element crustal ratios, it is seen that Calcium has a varying indication of enhancement from different elements. The gradient between sites is not as pronounced for Calcium as for other parameters.

Table 19. Elemental Ratios

Location	Ann-1	Ann-2	Ann-3	Ann-Avg	PGE-1	BLN-1	Crust
Ca/Si	1.11	0.65	0.59	0.69	0.72	0.69	0.15
Ca/Ti	18.7	13.8	13.6	14.7	16.0	14.7	7.28
Ca/Fe	1.71	1.41	1.45	1.49	1.51	1.49	0.74

11.2.2. Diurnal Patterns

The combined diurnal pattern of PM10, PM2.5, and Black Carbon is illustrative of the daily trends. It is a compilation of all data collected during monitoring period. Figure 97 shows how PM10 is relatively constant throughout the day time hours, with small increases during commute times. This was mirrored by PM2.5, though at a slightly lower level as expected.

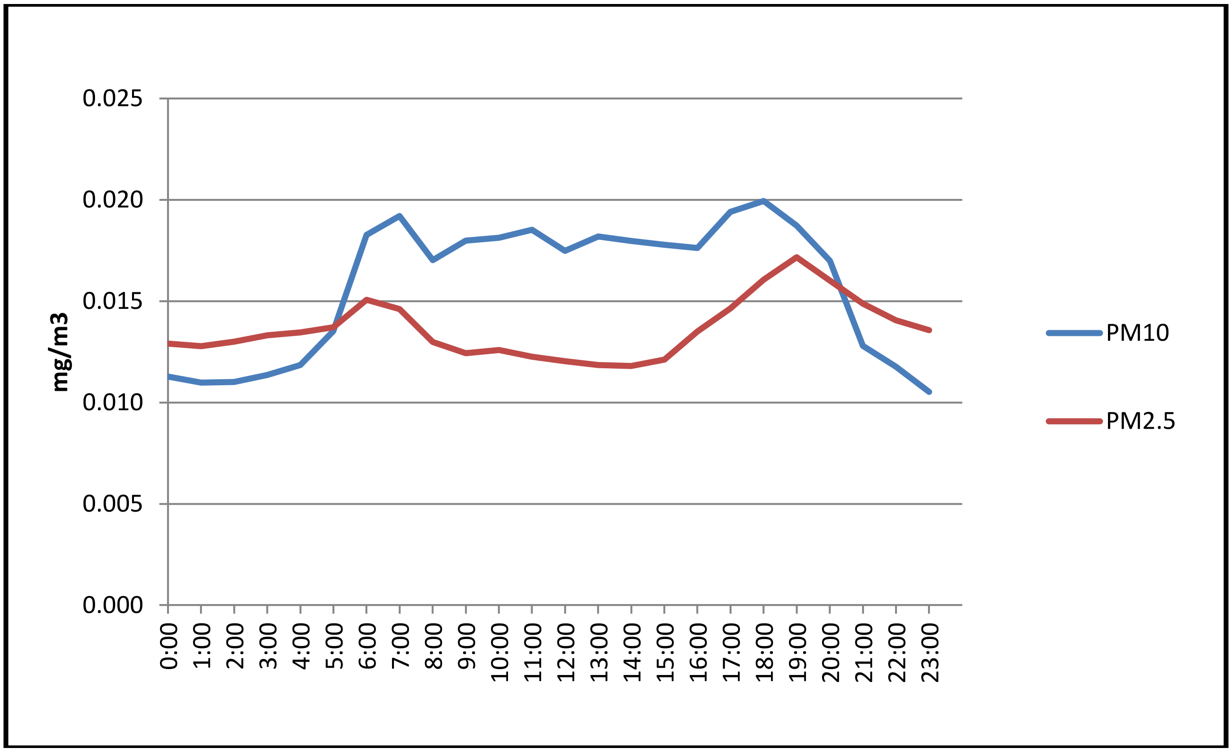


Figure 97. Annex PM Diurnal Patterns
Annex only, to emphasize scale

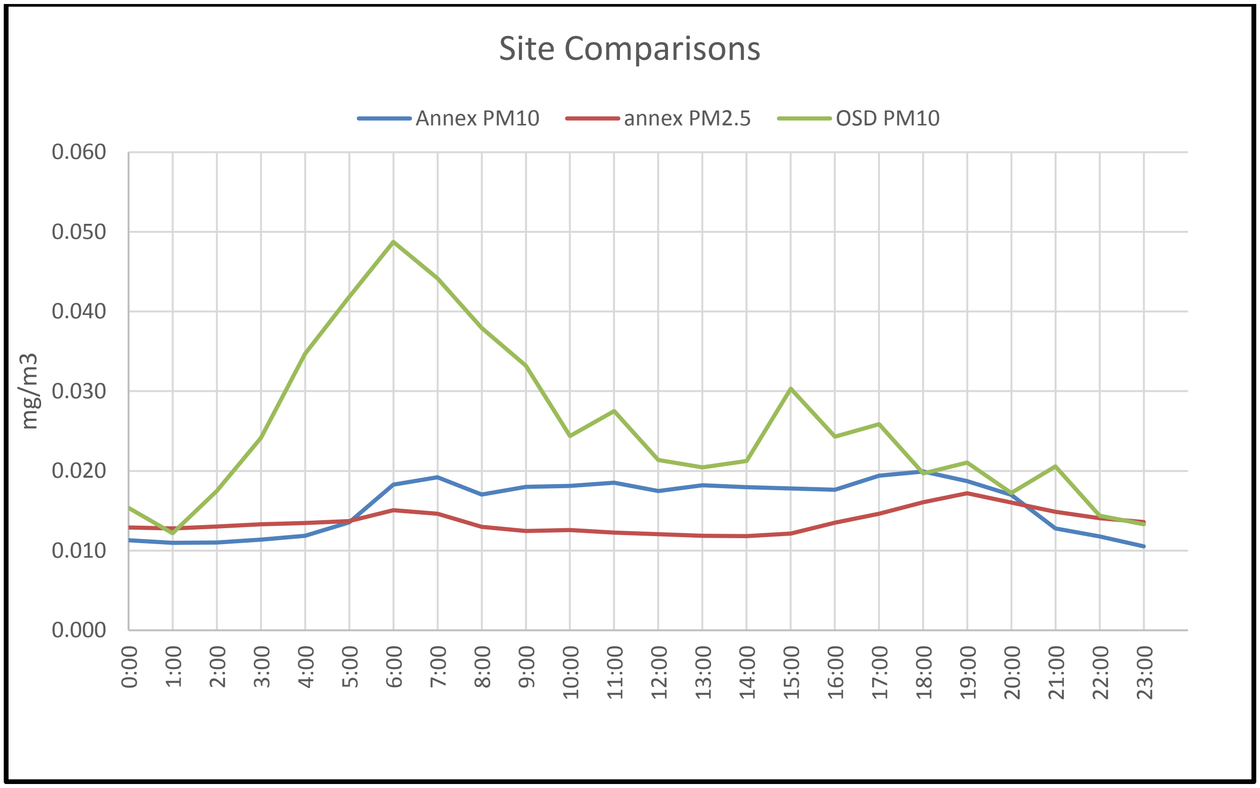


Figure 98. Annex PM10, Annex PM2.5, OSD PM10

Figure 98 shows both the Annex and PGE sites to illustrate the difference between urban and ‘rural’ locations. The Annex location does see some influence from the traffic periods, but not as dramatically as OSD. The overall concentration at OSD is approximately two times the Annex.

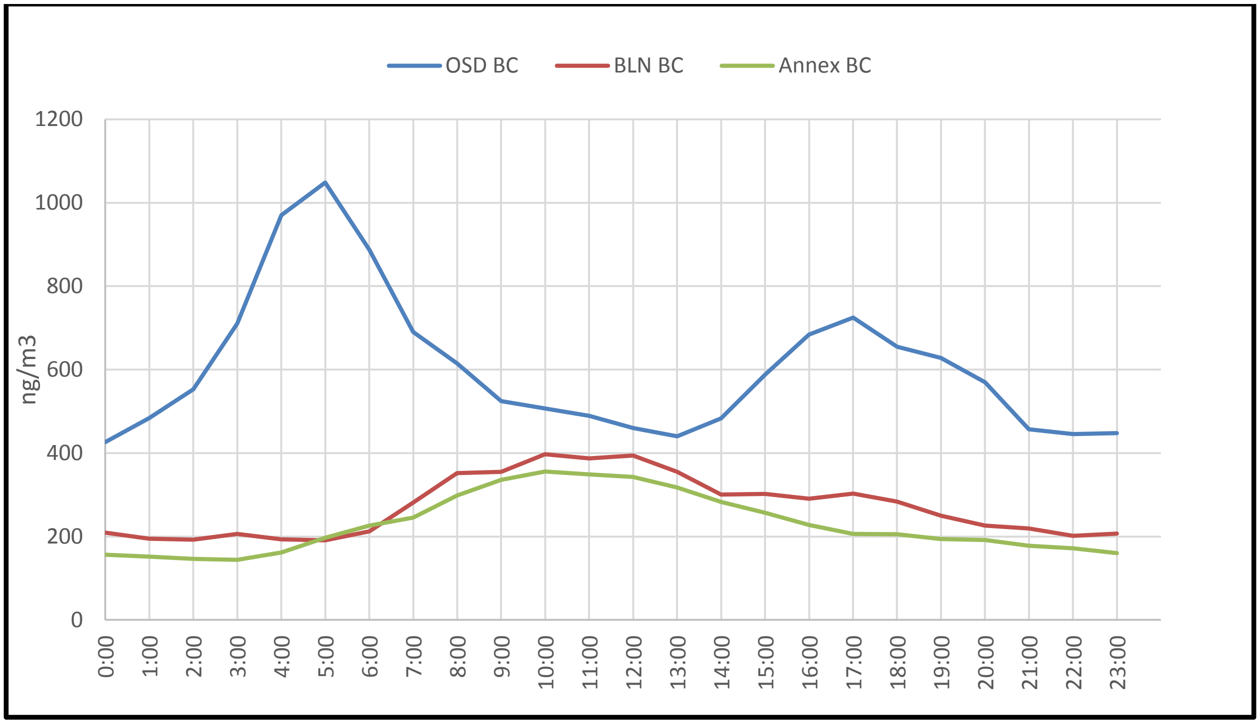


Figure 99. Black Carbon Diurnal Pattern

Black carbon displays a different pattern in Figure 99 than PM10 which reflects the common behavior of the ultrafine particulate, which decays in particle count in approximately 100 yards from the origin on the roadway due to coagulation and recombination with other aerosols. However, the combined particulate does not disappear, becoming mixed with other particles and showing up as part of PM2.5. In addition, local meteorology affects the transport, as suggested by Figure 100, showing some times of the year in which a small morning peak appears.

This plot contains significant information about the impact of various sources to the site. First, the small peaks in the morning and afternoon commute times suggest a minor effect from those sources. A visual estimate from the plot suggests that the effect is approximately 2 $\mu g/m^3$ for P10 in the morning and 3 $\mu g/m^3$ in the evening. This is mirrored in the PM2.5 effect, with approximately 3 $\mu g/m^3$ in the morning, and 5 $\mu g/m^3$ in the evening. This is likely due to meteorology as it is likely that an equal number of commute vehicles are in transit both in the morning and afternoon. The relative amounts of the two parameters suggests a vehicular source since the PM2.5 increase is a larger fraction of its baseline amount compared to PM10. Furthermore, PM2.5 is a higher fraction of total emissions from vehicles because of their nature as a combustion source.

This all points to the effect of the highway at approximately 15% of the total pollutant load during commute periods, though on average, these factors are of minor significance. The black carbon pattern on average does not show any effect from the highway, although shorter time periods did show some influence during different months of the year, as shown in Figure 100.

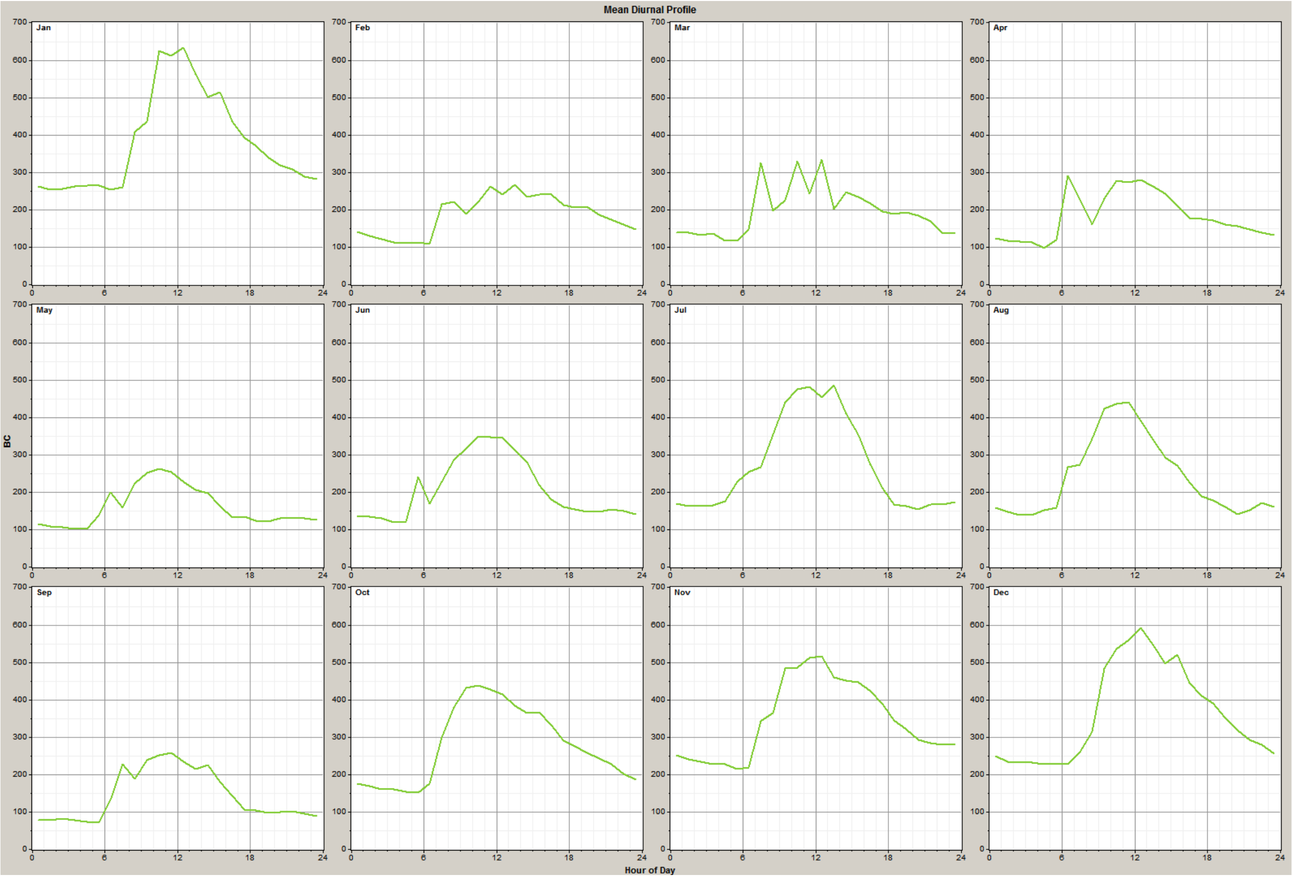


Figure 100. Monthly Annex Black Carbon Diurnal

Small peak on the left shoulder during the morning commute hours is a signature of vehicular emissions It appears to be detectable only part of the year, which suggests it is based on seasonal meteorological conditions.

11.2.3. Residence-Annex Comparison—PM10

A short test was conducted to evaluate the residence on Mora Drive with the Annex for equivalence as a monitoring location. Two PM10 EBAMs were set up next to each other at the residence and run for several weeks. Then, one of the two instruments was moved down to the Annex, which is approximately 400 feet horizontally and 100 feet vertically from the residence.

The results of the first comparison showed that the average concentrations were in good agreement, with the subsequent tests at the Annex with the Residence equally good.

- Residence1: 15.69 µg/m^3
- Residence2: 15.01 µg/m^3
- Annex: 15.49 µg/m^3
- Residence: 15.75 µg/m^3

11.2.4. Gradient--Mercury

The mercury data show a clear gradient between PGE and Annex. Table 20 shows a subset of the mercury results, showing that in early all cases, PGE is higher than Annex. BLN is much lower, indicating a background level at 0.35 ng/m^3.. The average of PGE at 2.9 ng/m^3 is approximately three times the average at Annex, at 1.0 ng/m^3. There were no simultaneous measurements done at OSD, however, the values seen there were in the background range, 0.25 ng/m^3.

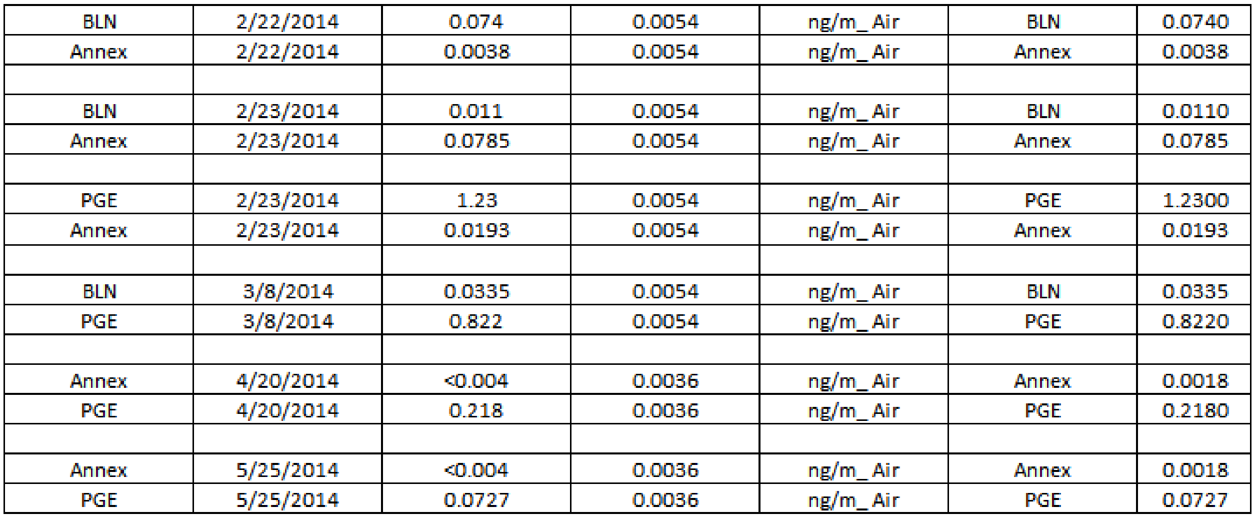
Table 20. Mercury Gradient

Sample Date	Ann (ng/m^3)	PGE (ng.m3)	BLN (ng/m^3)
7/31/2013	0.753	8.299	
8/28/2013	0.575	4.340	
10/28/2013	1.047	3.618	
11/16/2013	0.678	2.819	
12/15/2013	0.286	1.208	
2/21/2014	1.078		0.333
2/22/2014	1.517		0.297
2/23/2014	1.011	0.347	0.450
3/8/2014	1.003	0.347	0.303
4/19/2014	1.578	2.444	
5/3/2014	1.367	2.146	
5/24/2014	1.561	3.708	
Avg.	1.0	2.9	0.35

11.2.5. Hexavalent Chromium

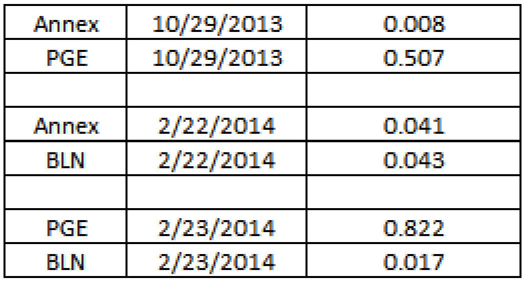
Table 21 shows the set of gradient sample pairs, and Table 22 shows the comparison. In one case—Annex and BLN—are identical. The wind data shows that the average for that day is consistent with normal patterns, with an average direction of ~245 degrees. This suggests that the clean ocean air affected both sites equally, with no other air mass influence. All the other days were sampled under similar typical wind patterns. At a minimum, it suggests the complex air movement around the Lehigh site allows some of the emissions to influence not only PGE, which is close, but also the Annex site. Other test data is suggestive of this as well.

Table 21. Mercury Gradient Sample Pairings
(Units are ng/m^3)



BLN	2/22/2014	0.074	0.0054	ng/m_ Air	BLN	0.0740
Annex	2/22/2014	0.0038	0.0054	ng/m_ Air	Annex	0.0038
BLN	2/23/2014	0.011	0.0054	ng/m_ Air	BLN	0.0110
Annex	2/23/2014	0.0785	0.0054	ng/m_ Air	Annex	0.0785
PGE	2/23/2014	1.23	0.0054	ng/m_ Air	PGE	1.2300
Annex	2/23/2014	0.0193	0.0054	ng/m_ Air	Annex	0.0193
BLN	3/8/2014	0.0335	0.0054	ng/m_ Air	BLN	0.0335
PGE	3/8/2014	0.822	0.0054	ng/m_ Air	PGE	0.8220
Annex	4/20/2014	<0.004	0.0036	ng/m_ Air	Annex	0.0018
PGE	4/20/2014	0.218	0.0036	ng/m_ Air	PGE	0.2180
Annex	5/25/2014	<0.004	0.0036	ng/m_ Air	Annex	0.0018
PGE	5/25/2014	0.0727	0.0036	ng/m_ Air	PGE	0.0727

Table 22. Mercury Gradients by Site
(Units are ng/m^3)



Annex	10/29/2013	0.008
PGE	10/29/2013	0.507
Annex	2/22/2014	0.041
BLN	2/22/2014	0.043
PGE	2/23/2014	0.822
BLN	2/23/2014	0.017

11.2.6. Wind Direction Trends

Figure 101 shows how the PM10 and BC concentrations stay relatively constant throughout the year, even as wind directions change over time. This suggests that the environment at RSA is somewhat insulated from much of what occurs outside of the area by the presence of the dominant oceanic air masses, and that relatively little of that outside influence penetrates into the preserve, thus providing a clean, isolated environment for workers and visitors.

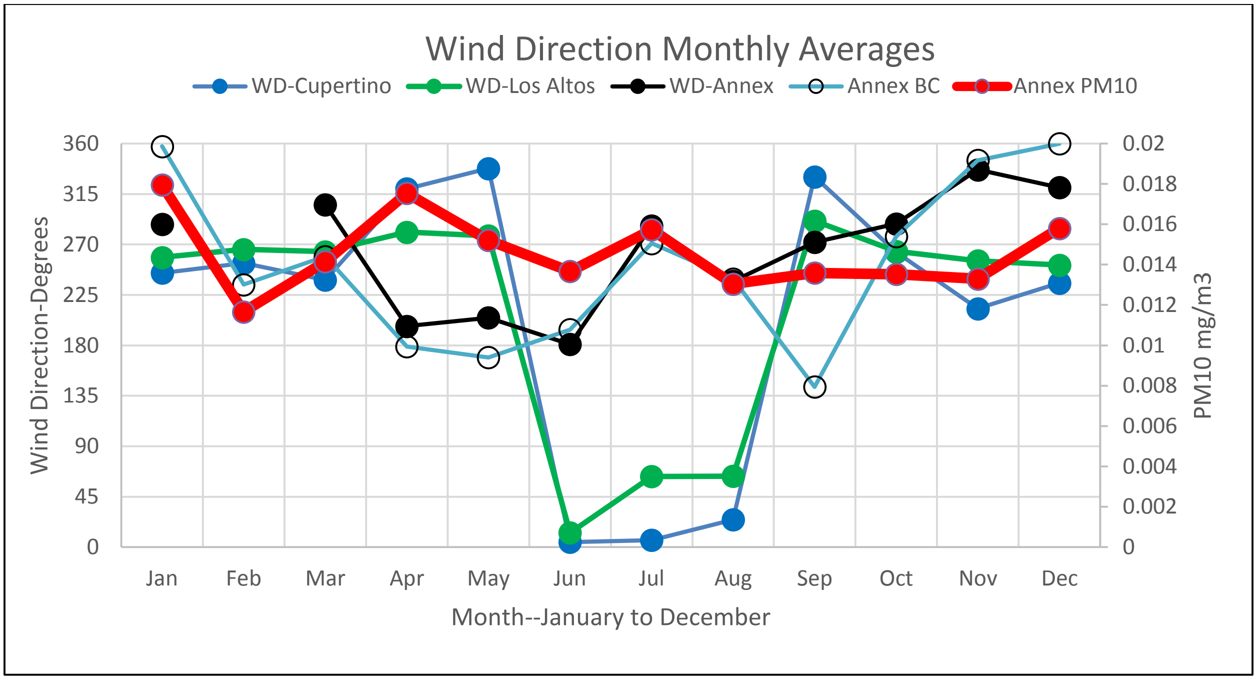


Figure 101. Wind Direction Dependence of PM10

Figure 102 shows how there is a slight directional dependence for black carbon, with higher concentrations trending towards northerly directions. This makes sense in terms of transport from I-280 and other urban areas to the north. However, PM10 does not vary much—a range of only 4 µg/m^3—over directions from the south to the north. This suggests general background as the major influence. However, as the diurnal patterns presented elsewhere show, there are slight effects from the morning and afternoon commute times, confirming a minor effect from the highway.

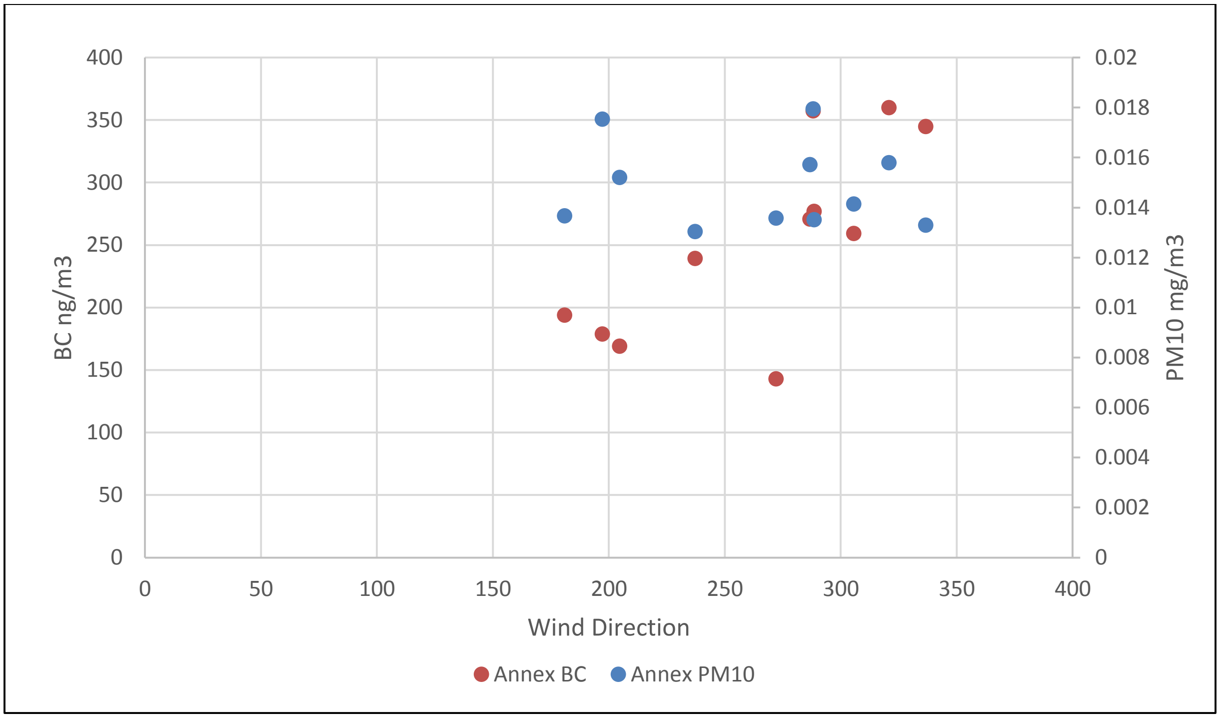


Figure 102. Wind Direction Dependence of BC and PM10

11.2.7. BAAQMD Data

Table 23 shows the comparison between the Monta Vista and RSA data sets.

Table 23. BAAQMD and RSA Data

Table 2. Comparison of Cupertino and San Jose Maximum 24-hour Average and Annual Average Toxic Air Contaminant Ambient Air Monitoring Data 2011-2013			**Rancho San Antonio Ambient Air--2013-2014**	
Compound	Annual Average Concentration, µg/m^3		µg/m3	µg/m3
	Cupertino	San Jose	RSA-Annex	RSA-PGE
Acetaldehyde	1.1	1.7	NA	NA
Acrolein	0.79	0.96	NA	NA
Acrylonitrile	0.017	0.056	NA	NA
Arsenic	0.00012	<MDL	0.0002	0.00039
Benzene	0.46	1	0.93	1.22
1,3 Butadiene	0.05	0.13	<MDL	<MDL
Carbon Tetrachloride	0.62	0.64	<MDL	<MDL
Chloroform	0.14	0.17	<MDL	<MDL
Chromium (Total)	0.0022	0.0038	0.0016	0.0050
Copper	0.0083	0.012	0.0044	0.0070
Elemental Carbon	0.52	0.64	0.335*	0.336*
Diesel PM	0.54	0.66	0.352**	0.349**
Ethylbenzene	0.16	0.53	<MDL	0.15
Ethylene Dibromide	<MDL	<MDL	NA	NA
Ethylene Dichloride	0.11	0.11	<MDL	<MDL
Formaldehyde	1.8	2.3	NA	NA
Lead	0.0023	0.0031	0.001	0.001
Manganese	0.0086	0.0094	0.00523	0.0075
Mercury	0.0022	N/A	0.001	0.00029
Methyl Chloroform	0.053	0.062	<MDL	<MDL
Methylene Chloride	0.49	1.1	1.30	1.98
Methyl Ethyl Ketone	0.68	0.8	<MDL	<MDL
Nickel	0.0014	<MDL	0.0006	0.00073
Perchloroethylene	0.056	0.25	<MDL	<MDL
Selenium	0.0008	0.0011	0.00084	0.00193
Toluene	0.85	2.9	2.04	10.46
Trichloroethylene	0.035	0.04	<MDL	<MDL
Vanadium	0.0023	<MDL	0.00063	0.00176
Vinyl chloride	<MDL	<MDL	<MDL	<MDL
m&p- Xylene	0.49	1.9	<MDL	<MDL
o-Xylene	0.22	0.72	<MDL	<MDL
Hexavalent chromium	NA	NA	0.011 ng/m3	0.400 ng/m3

*Black carbon. **SCAQMD factor of 1.04

12.0 HEALTH-BASED RISK LEVEL COMPARISONS

12.1. External Review

The culmination of the study is to address the original driver: Concern about exposure and health impacts from potential nearby emission sources. Below is the memo from Mr. Kurt Fehling, a consulting health scientist, who reviewed the data in relation to accepted risk management practices.

The Fehling Group, LLC

Table 2

Memo

To: Eric Winegar, Ph.D./Winegar Air Sciences
From: Kurt Fehling and Elizabeth Liebig/The Fehling Group
Date: July 31, 2014
Re: Screening Level Assessment for Ambient Air Concentrations, Rancho San Antonio, Cupertino, California

Based upon our understanding of the air data collected, air samples were collected in two areas of the site with two off-site--one area upwind, and another further away in town. The data for the sites were averaged by area and arranged by type of constituent, shown in the below tables.

The areas that were evaluated include:
Annex – main site in the park located near the bottom of the valley and close to the office;
PGE – major trail at the top of the ridge which is the closest location to the cement plant and near the point of maximum impact from the HRA;
OSD – administration offices in Mountain View which is in the middle of an urban area and near a major road (El Camino Real); and
BLN – residential area in Los Altos, which is upwind of the site and will be used for background comparisons. Some of these samples may have been impacted by lawn mowing activities so we understand that the data provided to us were "corrected" to account for a key invalidated sample.

Average air concentrations from the four areas listed above were compared to residential and industrial USEPA Region 9 Ambient Air Regional Screening Levels (RSLs) and California Office of Health Hazard Assessment Relative Screening Levels (REL) to identify constituents that exceed these screening criteria and may warrant additional evaluation. The RSL table for 0.1 target hazard index was used to account for possible chemical additivity. This screening is shown in Tables 1 (21) and 2 (22) and is summarized below.

Findings:

- Few of the detected VOC species had REL values available.
- Four target chemicals had REL values: benzene, bromomethane, dichloromethane, and toluene. None of the concentrations detected exceeded the REL value. With the exception of benzene, the detected levels were significantly lower than the REL values: The largest ratio was approximately 200, and the smallest was approximately 5.

- A comparison of the criteria pollutants and other aerosol or inorganic species showed that none of the elements exceeded the REL or RSL levels.
- Several state of federal standards were exceeded: PM2.5 at Annex ,and PM10 (multiple times) at PGE.

Background Comparison

When the data are visually compared to the upwind background data from BLN, it is apparent that the upwind sources may be a contributor to site levels. In fact for those chemicals that exceed the RSL (residential or industrial) the average background concentrations are similar to site levels with the exception of Bromomethane.

Conclusions

Based upon a comparison of average concentrations, it would appear that most concentrations of site-related airborne chemicals are consistent with regional background concentrations.

From this ensemble of comparisons, it is concluded that the large majority of the target parameters do not exceed REL.

12.3. Risk Comparison Tables

Tables 24 and 25 contain the final average concentrations compared to current risk evaluation levels, as discussed in the review memo. These tables also contain comparison to California and Federal Air Quality Standards.

Table 24. Table 1: Comparison of Results with Health-based Risk Levels

Target VOC	OEHHA REL ug/m3	Annex		PGE		OSD		BLN	
	*--- = No Standard	(µg/m3)	Exceeds REL?	(µg/m3)	Exceeds REL?	(µg/m3)	Exceeds REL?	(µg/m3)	Exceeds REL?
1,1,1-Trichloroethane	1000	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---	---
1,1-Dichloroethane	70	---	---	---	---	---	---	---	---
1,1-Dichloroethene	---	---	---	---	---	---	---	---	---
1,1-Dichloropropene	---	---	---	---	---	---	---	---	---
1,1-Difluoroethane	---	---	---	---	---	---	---	---	---
1,2,3-Trichloropropane	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---
1,2-Dibromoethane	0.8	---	---	---	---	---	---	---	---
1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---
1,2-Dichloroethane	400	---	---	---	---	---	---	---	---
1,2-Dichloropropane	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---
1,3-Butadiene	2	---	---	---	---	---	---	---	---
1,3-Dichlorobenzene	---	---	---	---	---	---	---	---	---
1,3-Dichloropropane	---	---	---	---	---		---	---	---
1,4 Dioxane	3000	---	---	---	---	---	---	---	---
1,4-Dichlorobenzene	800	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	1.22	NA	2.19	NA	---	---	0.92	NA
2,2-Dichloropropane	---	---	---	---	---	---	---	---	---
2-Butanone	---	3.21	NA	7.16	NA	---	---	---	---
2-Hexanone	---	---	---	---	---	---	---	---	---
2-propanol	---	---	---	---	---	---	---	---	---
4-Ethyltoluene	---	0.76	NA	1.18	NA	---	---	---	---
4-Methyl-2-pentanone	---	---	---	---	---	---	---	---	---
Acetone	---	11.19	NA	8.99	NA	11.99	NA	10.87	NA
Acrylonitrile	5	---	---	---	---	---	---	---	---
Benzene	3	0.93	No	1.22	No	0.06	No	0.96	No
Benzyl chloride	---	---	---	---	---	---	---	---	---
Bromochloromethane	---	---	---	---	---	---	---	---	---
Bromodichloromethane	---	---	---	---	---	---	---	---	---
Bromoform	---	---	---	---	---	---	---	---	---
Bromomethane	5	0.62	No	1.05	No		---	---	---
Carbon disulfide	800	---	---	---	---	---	---	---	---
Carbon tetrachloride	40		---		---	---	---		---

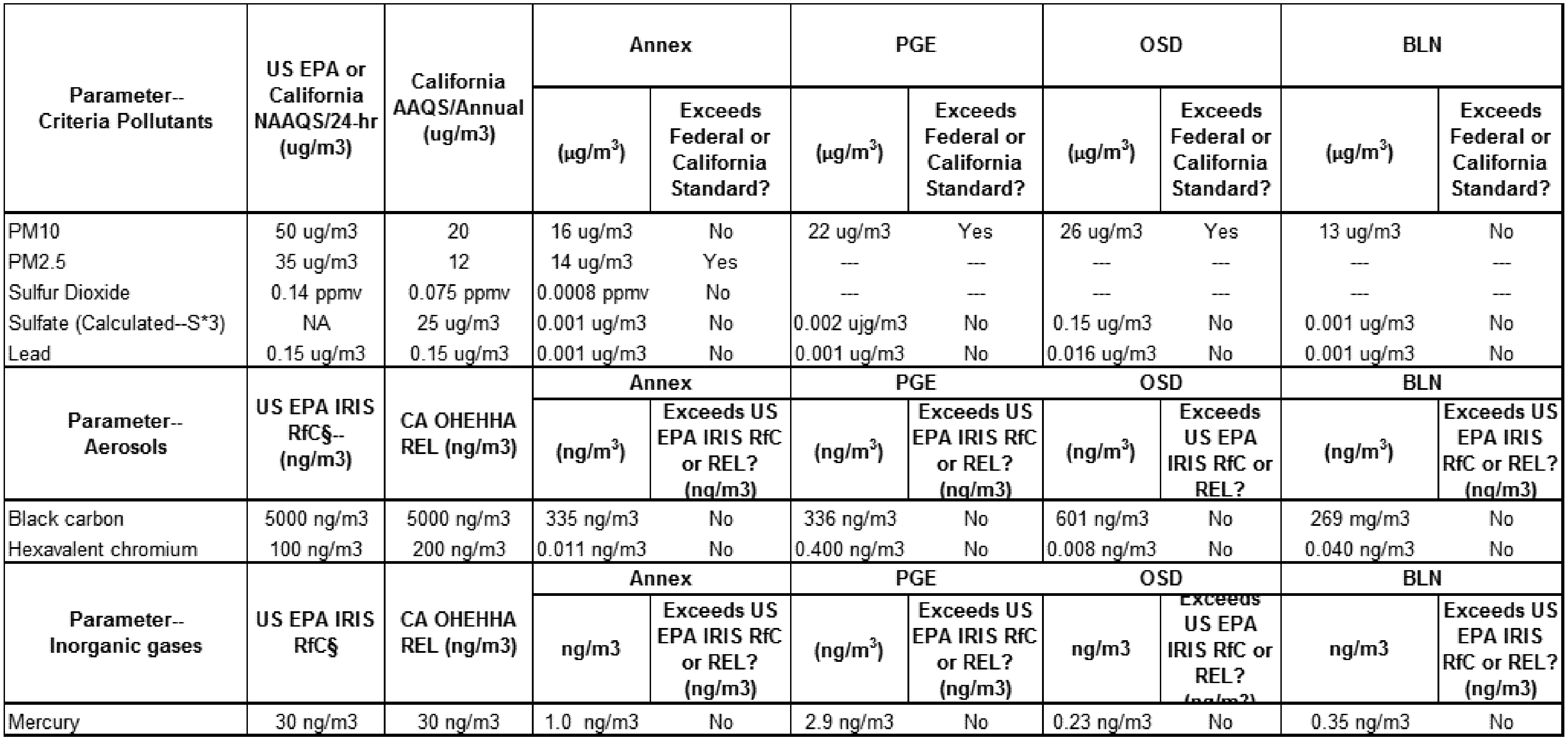
Target VOC	OEHHA REL ug/m3	Annex		PGE		OSD		BLN	
	*--- = No Standard	(µg/m3)	Exceeds REL?	(µg/m3)	Exceeds REL?	(µg/m3)	Exceeds REL?	(µg/m3)	Exceeds REL?
Chlorobenzene	1000	---	---	---	---	---	---	---	---
Chloroethane	30000	---	---	---	---	---	---	---	---
Chloroform	300	---	---	---	---	---	---	---	---
Chloromethane	---	---	---	---	---	---	---	---	---
cis-1,2-Dichloroethene	---	---	---	---	---	---	---	---	---
cis-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---
Cyclohexane	---	---	---	---	---	---	---	---	---
Dibromochloromethane	---	---	---	---	---	---	---	---	---
Dichlorodifluoromethane	---	---	---	---	---	---	---	---	---
Dichloromethane	400	1.30	No	1.98	No	1.24	No	---	---
Ethylbenzene	---	---	---	0.15	NA	---	---	---	---
Freon 113	---	---	---	---	---	---	---	---	---
Freon 114	---	---	---	---	---	---	---	---	---
Hexane	---	---	---	---	---	---	---	---	---
Isopropylbenzene	---	---	---	---	---	---	---	---	---
m,p-Xylenes	---	---	---	---	---	---	---	---	---
Methyl tert butyl ether	8000	---	---	---	---	---	---	---	---
Naphthalene	9	---	---	---	---	---	---	---	---
n-Heptane	---	---	---	---	---	---	---	---	---
n-Propylbenzene	---	---	---	---	---	---	---	---	---
o-Xylene	700	---	---	---	---	---	---	---	---
Styrene	900	---	---	---	---	---	---	---	---
Tetrachloroethene	35	---	---	---	---	---	---	---	---
Tetrahydrofuran	---	---	---	---	---	---	---	---	---
Toluene	300	2.04	No	10.46	No	---	---	0.76	No
trans-1,2-Dichloroethene	---	---	---	---	---	---	---	---	---
trans-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---
Trichloroethene	600	---	---	---	---	---	---	---	---
Trichlorofluoromethane	---	1.38	NA	1.36	NA	1.29	NA	1.35	NA
Vinyl acetate	200	---	---	---	---	---	---	---	---
Vinyl chloride¶ (10 ppbv)	---	---	---	---	---	---	---	---	---

Vinyl chloride¶ California Criteria Pollutant: Std = 10 ppbv

*--- = No Standard

**--- = Non-detect

Table 25. Table 2:. Comparison of RSA Data for Risk Levels for Aerosols and Criteria Pollutants



Parameter--Criteria Pollutants	US EPA or California NAAQS/24-hr (ug/m3)	California AAQS/Annual (ug/m3)	Annex		PGE		OSD		BLN	
			(µg/m^3)	Exceeds Federal or California Standard?	(µg/m^3)	Exceeds Federal or California Standard?	(µg/m^3)	Exceeds Federal or California Standard?	(µg/m^3)	Exceeds Federal or California Standard?
PM10	50 ug/m3	20	16 ug/m3	No	22 ug/m3	Yes	26 ug/m3	Yes	13 ug/m3	No
PM2.5	35 ug/m3	12	14 ug/m3	Yes	---	---	---	---	---	---
Sulfur Dioxide	0.14 ppmv	0.075 ppmv	0.0008 ppmv	No	---	---	---	---	---	---
Sulfate (Calculated--S*3)	NA	25 ug/m3	0.001 ug/m3	No	0.002 ujg/m3	No	0.15 ug/m3	No	0.001 ug/m3	No
Lead	0.15 ug/m3	0.15 ug/m3	0.001 ug/m3	No	0.001 ug/m3	No	0.016 ug/m3	No	0.001 ug/m3	No
			Annex		PGE		OSD		BLN	
Parameter--Aerosols	US EPA IRIS RfC§--(ng/m3)	CA OHEHHA REL (ng/m3)	(ng/m^3)	Exceeds US EPA IRIS RfC or REL? (ng/m3)	(ng/m^3)	Exceeds US EPA IRIS RfC or REL? (ng/m3)	(ng/m^3)	Exceeds US EPA IRIS RfC or REL?	(ng/m^3)	Exceeds US EPA IRIS RfC or REL? (ng/m3)
Black carbon	5000 ng/m3	5000 ng/m3	335 ng/m3	No	336 ng/m3	No	601 ng/m3	No	269 mg/m3	No
Hexavalent chromium	100 ng/m3	200 ng/m3	0.011 ng/m3	No	0.400 ng/m3	No	0.008 ng/m3	No	0.040 ng/m3	No
			Annex		PGE		OSD		BLN	
Parameter--Inorganic gases	US EPA IRIS RfC§	CA OHEHHA REL (ng/m3)	ng/m3	Exceeds US EPA IRIS RfC or REL? (ng/m3)	(ng/m^3)	Exceeds US EPA IRIS RfC or REL? (ng/m3)	ng/m3	Exceeds US EPA IRIS RfC or REL?	ng/m3	Exceeds US EPA IRIS RfC or REL? (ng/m3)
Mercury	30 ng/m3	30 ng/m3	1.0 ng/m3	No	2.9 ng/m3	No	0.23 ng/m3	No	0.35 ng/m3	No

Table 2 (25) continued.

Parameter--elements	**OEHHA REL (ug/m3)**	**Annex**		**PGE**		**OSD**		**BLN**	
		Avg. Conc. (µg/m^3)	**Exceeds REL?**	**Avg. Conc. (µg/m^3)**	**Exceeds REL?**	**Avg. Conc. (µg/m^3)**	**Exceeds REL?**	**Avg. Conc. (µg/m^3)**	**Exceeds REL?**
Aluminum	NA	0.18469	---	0.26393	---	0.1047	---	0.09466	---
Antimony	NA	0.00124	---	0.00047	---	0.0155	---	0.00059	---
Arsenic	**0.015**	0.00020	No	0.00039	No	0.0000	No	0.00022	No
Barium	NA	0.00420	---	0.00903	---	0.0059	---	0.00514	---
Bromine	NA	0.00369	---	0.00534	---	0.0005	---	0.00435	---
Cadmium	**0.02**	0.00042	No	0.00112	No	0.0058	No	0.00065	No
Calcium	NA	0.35905	---	0.70082	---	0.1154	---	0.35048	---
Chlorine (sea salt)	**0.2**	0.84555	Yes	1.48260	Yes	0.3588	Yes	0.81919	Yes
Chromium	NA	0.00164	---	0.00498	---	---	---	0.00088	---
Cobalt	NA	0.00001	---	0.00000	---	0.0000	---	0.00001	---
Copper	NA	0.00441	---	0.00699	---	0.0033	---	0.00465	---
Gallium	NA	0.00015	---	0.00050	---	0.00	---	0.00020	---
Germanium	NA	0.00018	---	0.00064	---	0.0000	---	0.00017	---
Indium	NA	0.00084	---	0.00033	---	---	---	0.00056	---
Iron	NA	0.26392	---	0.42480	---	0.0535	---	0.18374	---
Lanthanum	NA	0.00023	---	0.00304	---	0.0088	---	0.00078	---
Lead* (Federal Criteria)	NA	0.00099	No*	0.00107	No*	0.0164	No*	0.00122	No*

Table 2 (25). Continued.

Parameter--elements	OEHHA REL (ug/m3)	Annex		PGE		OSD		BLN	
		Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?	Avg. Conc. (µg/m^3)	Exceeds REL?
Magnesium	NA	0.14887	---	0.14418	---	0.0134	---	0.08249	---
Manganese	**0.09**	0.00523	No	0.00750	No	0.0078	No	0.00319	No
Mercury	**0.03**	0.00023	No	0.00018	No	0.0004	No	0.00022	No
Molybdenum	NA	0.00031	---	0.00076	---	0.0001	---	0.00041	---
Nickel	**0.014**	0.00060	No	0.00073	No	---	---	0.00060	No
Phosphorus	NA	0.00907	---	0.00150	---	---	---	0.00385	---
Potassium	NA	0.11645	---	0.17789	---	0.0647	---	0.09486	---
Rubidium	NA	0.00021	---	0.00050	---	---	---	0.00018	---
Selenium	**20**	0.00084	---	0.00193	---	0.0007	---	0.00113	---
Silicon (Silica)	**3**	0.55755	No	0.89045	No	0.0931	No	0.32236	No
Silver	NA	0.00048	---	0.00098	---	0.0372	---	0.00036	---
Sodium	NA	0.60876	---	1.62434	---	0.4280	---	0.71999	---
Strontium	NA	0.00188	---	0.00301	---	0.0007	---	0.00171	---
Sulfur	NA	0.40284	---	0.89371	---	0.1461	---	0.38395	---
Tin	NA	0.00306	---	0.00359	---	---	---	0.00267	---
Titanium	NA	0.02682	---	0.03813	---	---	---	0.01519	---
Vanadium	NA	0.00063	---	0.00176	---	0.0049	---	0.00065	---
Yttrium	NA	0.00025	---	0.00045	---	---	---	0.00030	---
Zinc	NA	0.00547	---	0.00879	---	0.0016	---	0.00575	---
Zirconium	NA	0.00132	---	0.00100	---	---	---	0.00096	---

*Federa; Criteria Pollutant--Rolling 3 month average of 0.15 ug/m3

§Reference Concentration

Ca;lifornai OHEHHA Re

--- Indicates no constituent detected.

NA - Not available

13.0 CONCLUSIONS

Due to concerns about exposure to workers and the visitor community, an 18 month air quality test program was conducted at Rancho San Antonio, a preserve managed by the Mid-peninsula Regional Open Space District. For this program, several locations were selected: Two primary sites within the preserve, one in an urban area, and one in an background/residential area. The two outside sites were operated for periods of up to two months. In addition, two other short-term test sites on the property were used for quality assurance purposes.

An extensive list of pollutant substances was developed based on the type of sources in the area, including input from the Lehigh health risk assessment that included their highest risk drivers. This list consisted of a number of particulate substances, some inorganic gases and volatile organic compounds. A range of instrumentation and samplers was used to collect data from January 1, 2013 to June 22, 2014. Several key instruments provided semi-continuous output, thus allowing for clarifying the dynamics of the measured concentrations. A number of laboratories provided analytical service for time-integrated samples.

The data was collected and compiled, and reviewed and consolidated. The result are two main summary tables—Tables 24 and 25—in which the averages were compiled and compared to a number of air quality standards and risk assessment levels. In addition, several related tables were presented in the Executive Summary that contain similar information. These comparisons showed that the concentrations of the target substances largely are below recognized health standards and air quality standards. Only a few substances exceeded those levels, and then only by small margins, with the exception of PGE PM10, which exceeded the California standard ten times.

The remainder of the data assessment was to examine the potential sources in the area to determine the extent of their impact, most notably the Lehigh cement plant. The examination showed on many levels that the impact from both the urban areas and the Lehigh plant are minor, primarily due to a favorable meteorological pattern, assisted by a protective topography.

The net result was the conclusion that the air quality at Rancho San Antonio is excellent, with low levels of any substances of concern.

Appendices

Appendix A. California Ambient Air Quality Standards

Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards [1]		National Standards [2]		
		Concentration [3]	Method [4]	Primary [3,5]	Secondary [3,6]	Method [7]
Ozone (O_3)	1 Hour	0.09 ppm (180 μg/m^3)	Ultraviolet Photometry	—	Same as Primary Standard	Ultraviolet Photometry
	8 Hour	0.070 ppm (137 μg/m^3)		0.075 ppm (147 μg/m^3)		
Respirable Particulate Matter (PM10)[8]	24 Hour	50 μg/m^3	Gravimetric or Beta Attenuation	150 μg/m^3	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	20 μg/m^3		—		
Fine Particulate Matter (PM2.5)[8]	24 Hour	—	—	35 μg/m^3	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	12 μg/m^3	Gravimetric or Beta Attenuation	12.0 μg/m^3	15 μg/m^3	
Carbon Monoxide (CO)	1 Hour	20 ppm (23 mg/m^3)	Non-Dispersive Infrared Photometry (NDIR)	35 ppm (40 mg/m^3)	—	Non-Dispersive Infrared Photometry (NDIR)
	8 Hour	9.0 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)	—	
	8 Hour (Lake Tahoe)	6 ppm (7 mg/m^3)		—	—	
Nitrogen Dioxide (NO_2)[9]	1 Hour	0.18 ppm (339 μg/m^3)	Gas Phase Chemiluminescence	100 ppb (188 μg/m^3)	—	Gas Phase Chemiluminescence
	Annual Arithmetic Mean	0.030 ppm (57 μg/m^3)		0.053 ppm (100 μg/m^3)	Same as Primary Standard	
Sulfur Dioxide (SO_2)[10]	1 Hour	0.25 ppm (655 μg/m^3)	Ultraviolet Fluorescence	75 ppb (196 μg/m^3)	—	Ultraviolet Flourescence; Spectrophotometry (Pararosaniline Method)
	3 Hour	—		—	0.5 ppm (1300 μg/m^3)	
	24 Hour	0.04 ppm (105 μg/m^3)		0.14 ppm (for certain areas)[10]	—	
	Annual Arithmetic Mean	—		0.030 ppm (for certain areas)[10]	—	
Lead[11,12]	30 Day Average	1.5 μg/m^3	Atomic Absorption	—	—	High Volume Sampler and Atomic Absorption
	Calendar Quarter	—		1.5 μg/m^3 (for certain areas)[12]	Same as Primary Standard	
	Rolling 3-Month Average	—		0.15 μg/m^3		
Visibility Reducing Particles[13]	8 Hour	See footnote 13	Beta Attenuation and Transmittance through Filter Tape	**No National Standards**		
Sulfates	24 Hour	25 μg/m^3	Ion Chromatography			
Hydrogen Sulfide	1 Hour	0.03 ppm (42 μg/m^3)	Ultraviolet Fluorescence			
Vinyl Chloride[11]	24 Hour	0.01 ppm (26 μg/m^3)	Gas Chromatography			

US EPA and California Ambient Air Quality Standards
(Primary standards refer to the protection of human health; secondary standards refer to other effects, such as on visibility, buildings, crops and animals.)

Appendix B. BAAQMD Cupertino report.

It contains a useful summary and explanation of the risk assessment process and specifics relating to risk levels in the area around the Lehigh plant.

Bay Area Air Quality Management District
Summary and Analysis of Cupertino Air Monitoring Results
Updated July 14, 2014

The Air District's Cupertino Air Monitoring Station began operating on September 1, 2010. The monitoring station was located at Monta Vista Park, approximately one mile east of the Lehigh Cement Plant (see Figure 1) and was closed on December 31, 2013. After collecting three calendar years of data from 2011 through 2013, Air District staff reviewed the data and developed the following summary and analysis of the results.

CRITERIA POLLUTANTS

Criteria pollutants are air contaminants for which the U.S. Environmental Protection Agency (EPA) and/or the California Air Resources Board (CARB) have adopted health-based ambient air quality standards. Ambient air quality standards adopted by EPA are National Ambient Air Quality Standards (NAAQS), and standards adopted by CARB are State Ambient Air Quality Standards. Criteria pollutants include PM_{10}, $PM_{2.5}$, ozone, carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and lead. Ozone, CO, SO_2, and NO_2 are gases. PM_{10} is particulate matter with a diameter less than or equal to 10 microns, and $PM_{2.5}$ is particulate matter with a diameter less than or equal to 2.5 microns. Lead is a component of particulate matter.

Table 1 summarizes Cupertino monitoring results for all criteria pollutants, provides a comparison to applicable National and State ambient air quality standards, and specifies locations with similar air quality.

<u>GASES</u>: Based on three years (2011-2013) of monitoring data, Cupertino air quality easily met all applicable State and National Ambient Air Quality Standards for the gaseous criteria pollutants CO, SO_2, and NO_2. In general, Cupertino's levels of these criteria pollutants were in the middle of the distribution of Bay Area air monitoring sites, with some locations measuring levels higher and some locations measuring lower than Cupertino. NO_2 levels were similar to levels at other suburban locations, including Concord and Santa Rosa. SO_2 concentrations were somewhat higher, with measurements similar to West Oakland and Martinez, but still less than a fifth of the SO_2 NAAQS. CO measurements were among the lowest in the Bay Area, with only Bethel Island and Concord being lower. For ozone, levels at Cupertino were below the national standard and most similar to Los Gatos.

<u>PARTICULATE MATTER</u>: Ambient air quality standards have been established for $PM_{2.5}$ and PM_{10}. For both $PM_{2.5}$ and PM_{10}, there is a 24-hour standard based on daily concentrations, and an annual standard based on the average of all 24-hour concentrations over a one-year period. Cupertino PM levels have not exceeded the 24-hour $PM_{2.5}$ NAAQS nor the 24-hour PM_{10}

NAAQS. Its peak 24-hour levels were similar to those at Concord and San Rafael. Cupertino's annual average $PM_{2.5}$ levels were also below the NAAQS and the more stringent annual average State standards, with levels similar to Santa Rosa and Gilroy.

<u>LEAD</u>: Cupertino lead levels were less than 1% of the State standard, less than 10% of the recently revised national standard, and less than levels in San Francisco.

Table 1. Criteria Pollutants Measured at the Cupertino Monitoring Site Compared to State and National Ambient Air Quality Standards (2011-2013)

Pollutant	Averaging Time	State Standard	National Standard	Design Value [1]	Maximum Concentrations	Location(s) with Similar Air Quality
Ozone	1 Hour	0.09 ppm	N/A	N/A	0.09 ppm	Los Gatos
	8 Hour	0.070 ppm	0.075 ppm	0.062 ppm	0.077 ppm	
PM_{10}	24 Hour	50 Pg/m^3	150 Pg/m^3	Zero days over standard	42 Pg/m^3	Concord, San Rafael
	Annual Average	20 Pg/m^3	N/A	N/A	14.6 Pg/m^3	
$PM_{2.5}$	24 Hour	N/A	35 Pg/m^3	21 Pg/m^3	39Pg/m^3	Santa Rosa, Gilroy
	Annual Average	12 Pg/m^3	12.0 Pg/m^3	8.9 Pg/m^3	10.7 Pg/m^3	Santa Rosa, Gilroy
CO	8 Hour	9.0 ppm	9 ppm	Zero days over standard	1.3 ppm	Concord, San Pablo
	1 Hour	20 ppm	35 ppm	Zero days over standard	3.1 ppm	
NO_2	Annual Average	0.030 ppm	0.053 ppm	0.009 ppm	0.009 ppm	Concord, Santa Rosa
	1 Hour	0.18 ppm	0.100 ppm	0.038 ppm	0.045 ppm	
SO_2	Annual Average	N/A	N/A	N/A	0.001 ppm	Oakland West, Martinez
	24 Hour	0.04 ppm	N/A	N/A	0.007 ppm	
	1 Hour	0.25 ppm	0.075 ppm	0.013 ppm	0.035 ppm	
Lead	30 Day Average	1.5 Pg/m^3	N/A	N/A	0.006 Pg/m^3	San Francisco
	3 Month Rolling Average	N/A	0.15 Pg/m^3 (Recently Revised)	0.005 Pg/m^3	0.005 Pg/m^3	

Table 3

Table 1 Notes:

1. Design Values are used for comparison with the National Ambient Air Quality Standard (NAAQS).
2. For PM_{10} and CO, the Design Value is defined as the number of days in a calendar year that the location would be expected to exceed the

NAAQS.

3. For $PM_{2.5}$, NO_2, SO_2 and Lead, Design Values below the NAAQS indicate that national air quality standards are being met.

TOXIC AIR CONTAMINANTS

Table 2 summarizes toxic air contaminant monitoring results for Cupertino. Sample durations were 24-hours for either a 6-day or 12-day interval schedule. Table 2 contains the maximum concentrations for the 24-hour samples and the results for all samples averaged over a 3-year period.

The Air District estimated health risks using the ambient monitoring data and health effect values [cancer potency factors and non-cancer Reference Exposure Levels (RELs)] established by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA). Four health risk summary tables are provided as follows: cancer risk, chronic non-cancer risk, 8-hour chronic non-cancer risk, and acute non-cancer risk. Note that each health risk summary table lists only the measured toxic air contaminant compounds for which a corresponding cancer or non-cancer health effect value has been adopted by OEHHA. Health risks were based on the following exposure pathways, where applicable, under OEHHA health risk assessment guidelines: inhalation, dermal absorption, soil ingestion, mother's milk ingestion, and homegrown produce ingestion. Non-inhalation pathway exposures were estimated based on measured pollutant concentrations and conservative default exposure assumptions established in OEHHA guidelines.

Table 3 lists the estimated cancer risk associated with lifetime exposure to the measured levels of toxic air contaminants at the Cupertino and San Jose air monitoring sites (the latter is included for comparison purposes because of similar pollutant coverage). The estimated cancer risk includes an Age Sensitivity Factor to account for inherent increased susceptibility to carcinogens during infancy and childhood. The total cancer risk is based on the sum of the cancer risks determined for each individual compound. The compounds that contribute most significantly to cancer risk in Cupertino are diesel PM (70%), carbon tetrachloride (11%), benzene (5%), 1,3butadiene (4%), formaldehyde (4%), and acrylonitrile (2%). These are also the compounds that contribute most to cancer risk for the San Jose air monitoring site. These pollutants are emitted primarily from mobile sources, with the exception of carbon tetrachloride and acrylonitrile. There are no known local sources of carbon tetrachloride due to the phase-out of this compound as a stratospheric ozone-depleting compound. Measured levels of carbon tetrachloride in Cupertino are consistent with global background levels observed at other monitoring sites. Known sources of acrylonitrile include certain chemical plants and landfills. A comparison of cancer risk at the Cupertino and San Jose monitoring sites is illustrated in Figure 2.

Table 4 indicates the estimated chronic non-cancer risk represented by hazard quotient and hazard index. A hazard quotient is the ratio of the observed concentration of a particular compound to the compound's REL. RELs are concentrations at or below which no adverse noncancer health effects are anticipated to occur in the general human population,

including sensitive individuals. The hazard index is taken as the sum of the hazard quotients for each compound that affects the same target organ system (e.g., respiratory system, nervous system, etc.). A hazard index at or below one indicates that no adverse effects would be anticipated to occur. The chronic hazard index is calculated using the annual average concentration. For the Cupertino air monitoring site the chronic hazard index is 3.0, and for the San Jose monitoring site the chronic hazard index is 3.2. The compound that contributes most to chronic hazard index at both sites is acrolein (77% at Cupertino, 88% at San Jose). Acrolein is emitted mostly from mobile sources, and the chronic REL for acrolein incorporates a cumulative uncertainty ("safety") factor of 200. Other compounds with significant contributions to chronic hazard index at the Cupertino site are mercury (17%) and arsenic (10%). At the San Jose monitoring site, the arsenic level of detection was not nearly as sensitive as the Cupertino site, and mercury was not measured at all; for these reasons the San Jose monitoring site is not a good comparator to the Cupertino site for arsenic and mercury (this is also true for other Bay Area monitoring sites). However, based on a literature review, the arsenic and mercury concentrations measured at the Cupertino site appear to be within or lower than the range found for rural areas. The annual average concentration of arsenic measured at the Cupertino air monitoring site is 0.0001 $\mu g/m^3$. The range of arsenic air concentrations in remote areas is 0.001 to 0.003 $\mu g/m^3$ (ToxGuide for
Arsenic As CAS# 7440-38-2, U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry, October 2007, http://www.astsdr.cdc.gov/toxguides/toxguide-2.pdf). The annual average concentration of mercury measured at the Cupertino air monitoring site is 0.002 $\mu g/m^3$. The range of mercury concentrations in rural areas is 0.001 to 0.004 $\mu g/m^3$ (Mercury Study Report to Congress, Volume III: Fate and Transport of Mercury in the Environment, EPA-452/R-97-003 December 1997, Table 3-1 Summary of Measured Mercury Concentration in Air http://www.epa.gov/mercury/report.htm).

Table 5 lists the estimated 8-hour chronic non-cancer risk. The 8-hour hazard indices are based on concentrations for the normal 8-hour exposure period for workers, and for children at schools and daycare facilities, that are repeated over an annual period. Note that 8-hour monitoring data are not available, but these concentrations were conservatively estimated by assuming that the entire 24-hour sample was collected over a single 8-hour period (i.e., 8-hour concentrations were assumed to be three times the measured 24-hour concentration). The 8-hour chronic hazard index is 4.1 for the Cupertino monitoring site, and 4.9 for the San Jose monitoring site. Acrolein is the highest contributor to the 8-hour chronic hazard index at both sites (about 83%).

Table 6 lists the estimated acute non-cancer risk. The acute hazard indices are based on maximum concentrations for a 1-hour period. Note that 1-hour monitoring data are not available, but these concentrations were conservatively assumed to be 7.5 times the maximum 24-hour concentration (see table footnote for derivation of this adjustment factor). The acute hazard index is less than one for the Cupertino and San Jose air monitoring sites.

Table 2. Comparison of Cupertino and San Jose Maximum 24-hour Average and Annual Average Toxic Air Contaminant Ambient Air Monitoring Data 2011-2013

Compound	% of Samples above MDL[1]		Maximum 24-hour Average Concentration[1], µg/m³		Annual Average Concentration,[1] µg/m³	
	Cupertino	San Jose	Cupertino	San Jose	Cupertino	San Jose
Acetaldehyde	100%	100%	4.7	4.8	1.1	1.7
Acrolein[2]	87	100%	0.044	0.042	0.79	0.96
Acrylonitrile	17%	21%	0.088	0.34	0.017	0.056
Arsenic	28%	0%	0.0011	<MDL	0.00012	<MDL
Benzene	99%	99%	1.2	4.2	0.46	1.0
1,3 Butadiene	43%	57%	0.25	0.95	0.050	0.13
Carbon Tetrachloride	100%	100%	1.4	1.3	0.62	0.64
Chloroform	89%	96%	0.53	0.95	0.14	0.17
Chromium (Total)	95%	72%	0.011	0.0073	0.0022	0.0038
Copper	100%	100%	0.023	0.040	0.0083	0.012
Elemental Carbon[3]	100%	100%	1.6	3.2	0.52	0.64
Diesel PM[3]	100%	100%	1.7	3.4	0.54	0.66
Ethylbenzene	68%	85%	0.69	2.3	0.16	0.53
Ethylene Dibromide	0%	0%	<MDL	<MDL	<MDL	<MDL
Ethylene Dichloride	26%	25%	0.54	0.53	0.11	0.11
Formaldehyde	100%	100%	4.3	4.8	1.8	2.3
Lead	91%	74%	0.022	0.013	0.0023	0.0031
Manganese	100%	98%	0.047	0.027	0.0086	0.0094
Mercury[4]	100%	N/A	0.0052	N/A	0.0022	N/A
Methyl Chloroform	31%	41%	0.17	0.22	0.053	0.062
Methylene Chloride	74%	97%	1.1	4.9	0.49	1.1
Methyl Ethyl Ketone	90%	97%	2.3	3.5	0.68	0.80
Nickel	84%	0%	0.0067	<MDL	0.0014	<MDL
Perchloroethylene	91%	99%	0.46	1.3	0.056	0.25
Selenium	75%	17%	0.0046	0.0045	0.00080	0.0011
Toluene	100%	100%	6.0	16	0.85	2.9
Trichloroethylene	14%	21%	0.20	0.17	0.035	0.040
Vanadium	91%	7%	0.011	0.0031	0.0023	<MDL
Vinyl chloride	1%	1%	<MDL	<MDL	<MDL	<MDL
M&P Xylene	97%	100%	2.1	9.1	0.49	1.9
O Xylene	81%	96%	0.70	3.0	0.22	0.72

Table 4

Table 2 Notes:

1. MDL is the Method Detection Limit for the compound. <MDL indicates less than Method Detection Limit. When a sample is identified as <MDL, 1/2 the MDL is used to calculate the annual average concentration. When all samples except one were <MDL, the value listed for the maximum 24-hour average concentration is "<MDL." When only 10% or less of the sample values are above the MDL, the value listed for annual average concentration is "<MDL." Note that each compound MDL's are not the same for both monitoring sites. For example, the San Jose arsenic MDL was 0.0015 µg/m³ compared with 0.0001 to 0.0002 µg/m³ for Cupertino. Thus, having more arsenic values < MDL at San Jose does not necessarily mean that the concentrations are lower at the San Jose site than at the Cupertino site.

2. The concentrations presented here for Acrolein are for 2013. Although ambient air monitoring samples were collected and analyzed for Acrolein during the 2011-2012 period, the results did not meet quality assurance/quality control (QA/QC) standards. Due to the chemical properties of Acrolein, sample collection and analysis of this compound can have large associated errors and better sample collection analytical methods are currently being investigated. In 2013, more a more stable standard was utilized, allowing for better analytic accuracy that met QA/QC requirements.
3. San Jose elemental carbon (EC) is not strictly comparable to Cupertino EC: the former measurement is derived from a $PM_{2.5}$ filter, the latter from a PM_{10} filter, i.e., containing a larger size cut. Therefore, the San Jose EC and estimated diesel PM shown may be underestimated. Diesel PM is estimated from elemental carbon data using the MATES II factor of 1.04.
4. N/A is not available. Mercury was not one of the compounds tested at the San Jose monitoring site.

Table 3. Cancer Risk Based on Ambient Air Monitoring Data for Cupertino and San Jose

Compound	Unit Risk Values[1], $(\mu g/m^3)^{-1}$	Cancer Risk[2] (in a million)	
		Cupertino	San Jose
Acetaldehyde	2.9E-06	5.5	8.3
Acrylonitrile	2.9E-04	8.6	27.7
Arsenic	1.7E-02	3.5	<MDL
Benzene	2.9E-05	22.5	49.2
1,3 Butadiene	1.7E-04	14.8	38.0
Carbon Tetrachloride	4.3E-05	45.9	47.5
Chloroform	5.5E-06	1.3	1.6
Diesel PM	3.2E-04	293.0	358.0
Ethylbenzene	2.5E-06	0.7	2.3
Ethylene Dibromide	7.2E-05	<MDL	<MDL
Ethylene Dichloride	2.1E-05	3.8	3.7
Formaldehyde	6.1E-06	18.2	23.9
Lead	5.1E-05	0.2	0.3
Methylene Chloride	1.0E-06	0.9	1.9
Nickel	2.6E-04	0.6	<MDL
Perchloroethylene	6.1E-06	0.6	2.6
Trichloroethylene	2.0E-06	0.1	0.1
Vinyl chloride	7.8E-05	<MDL	<MDL
Total Cancer Risk:		**420**	**565**

Table 5

Table 3 Notes:

1. All compounds were evaluated for the inhalation pathway. For Arsenic and Lead, which have multipathway impacts, the Unit Risk Values (URVs) represent the combined inhalation and noninhalation pathways (dermal, soil ingestion, mother's milk, homegrown produce ingestion); these URVs were derived using HARP and default exposure values.
2. Cancer risk is based on a residential exposure duration of 24 hours per day, 350 days per year over a 70-year lifetime and includes a cancer risk adjustment factor of 1.7 to account for the inherent greater susceptibility to carcinogens during infancy and childhood.
3. Cancer risks are not calculated for compounds where all samples are <MDL. Note that each compound MDL is not the same for both monitoring sites. For example, the San Jose arsenic MDL was 0.0015 $\mu g/m^3$ compared with 0.0001 to 0.0002 $\mu g/m^3$ for Cupertino. Thus, the arsenic < MDL at San Jose does not necessarily mean that the cancer risk due to arsenic concentrations are lower at the San Jose site than at the Cupertino site.

Table 4. Chronic Non-cancer Risk Based on Ambient Air Monitoring Data for Cupertino and San Jose

Compound	Chronic REL, µg/m^3	Chronic Hazard Quotient		Target Organ System
		Cupertino	San Jose	
Acetaldehyde	140	0.0	0.0	Respiratory
Acrolein	0.35	2.3	2.8	Respiratory
Acrylonitrile	5	0.0	0.0	Respiratory
Arsenic	0.00037	0.3	<MDL	Cardiovascular, Reproductive/Developmental, Nervous, Respiratory, Skin
Benzene	60	0.0	0.0	Reproductive/Developmental, Hematologic, Nervous
1,3 Butadiene	2	0.0	0.1	Reproductive/Developmental
Carbon Tetrachloride	40	0.0	0.0	Alimentary, Reproductive/Developmental, Nervous
Chloroform	300	0.0	0.0	Alimentary, Reproductive/Developmental, Kidney
Diesel PM	5	0.1	0.1	Respiratory
Ethylbenzene	2000	0.0	0.0	Alimentary, Reproductive/Developmental, Endocrine, Kidney
Ethylene Dibromide	0.8	<MDL	<MDL	Reproductive/Developmental
Ethylene Dichloride	400	0.0	0.0	Alimentary
Formaldehyde	9	0.2	0.3	Respiratory
Manganese	0.09	0.1	0.1	Nervous
Mercury	0.0045	0.5	N/A	Reproductive/Developmental, Kidney, Nervous
Methyl Chloroform	1000	0.0	0.0	Nervous
Methylene Chloride	400	0.0	0.0	Cardiovascular, Nervous
Nickel	0.014	0.1	<MDL	Reproductive/Developmental, Hematologic, Respiratory
Perchloroethylene	35	0.0	0.0	Alimentary, Kidney
Selenium	20	0.0	0.0	Alimentary, Cardiovascular, Nervous
Toluene	300	0.0	0.0	Reproductive/Developmental, Nervous, Respiratory
Trichloroethylene	600	0.0	0.0	Eye, Nervous
M&P Xylene	700	0.0	0.0	Eye, Nervous, Respiratory
O Xylene	700	0.0	0.0	Eye, Nervous, Respiratory
Chronic Hazard Index:		**3.0**	**3.2**	**Respiratory**

Table 6

Table 4 Notes:

1. A chronic inhalation hazard quotient (HQ) is the ratio of the annual average concentration to the chronic inhalation REL. A noninhalation HQ is the ratio of the estimated noninhalation dose to the oral REL. The HQ for each compound is the sum of the chemical specific inhalation HQ and non-inhalation HQ. A Hazard Index (HI) is the sum of the hazard quotients (HQ) for all compounds that affect a particular target organ system. The highest target organ specific HI is the overall HI.
2. Adverse health effects are not expected to occur, even for sensitive members of the population, for hazard indices less than one. An exceedance of one does not indicate that adverse effects will occur; rather, it is an indication of the erosion of the margin of safety, and that the likelihood of adverse health effects is increased.
3. Arsenic, Mercury, and Nickel have noninhalation pathways; the chronic RELs for these compounds were derived from HARP and included the impacts of the inhalation and noninhalation pathways: inhalation, dermal adsorption, soil ingestion, mother's milk ingestion and home grown produce ingestion pathways (urban area).
4. Chronic HQs are not calculated for compounds where all samples are <MDL. Note that each compound MDL is not the same for both monitoring sites. For example, the San Jose arsenic MDL was 0.0015 µg/m^3 compared with 0.0001 to 0.0002 µg/m^3 for Cupertino. Thus, the arsenic < MDL at San Jose does not necessarily mean that the chronic HQ due to arsenic concentrations are lower at the San Jose site than at the Cupertino site.

Table 5. 8-hour Chronic Non-cancer Risk Based on Ambient Air Monitoring Data for Cupertino and San Jose

Compound	8-hour Chronic Inhalation REL, µg/m^3	8-hour Chronic Hazard Quotient		Target Organ System
		Cupertino	San Jose	
Acetaldehyde	300	0.0	0.0	Respiratory
Acrolein	0.7	3.4	4.1	Respiratory
Arsenic	0.015	0.0	<MDL	Cardiovascular, Reproductive/Developmental, Nervous, Respiratory, Skin
1,3 Butadiene	9	0.0	0.0	Reproductive/Developmental
Formaldehyde	9	0.6	0.8	Respiratory
Manganese	0.17	0.2	0.2	Nervous
Mercury	0.06	0.1	N/A	Reproductive/Developmental, Kidney, Nervous
Nickel	0.06	0.1	<MDL	Immune, Respiratory
8-hour Chronic Hazard Index:		**4.1**	**4.9**	**Respiratory**

Table 7

Table 5 Notes:

1. An 8-hr hazard quotient is calculated by dividing the 8-hour average concentration (e.g., for a worker or student or child at daycare that is repeated over an annual period) by the 8-hr REL. A hazard Index is the sum of the hazard quotients for all compounds that affect a particular target organ system. The greatest target organ HI is the overall HI.
2. Adverse health effects are not expected to occur, even for sensitive members of the population, for hazard indices less than one. An exceedance of one does not indicate that adverse effects will occur, rather, it is an indication of the erosion of the margin of safety and that the likelihood of adverse health effects is increased.
3. The maximum 8-hour chronic exposure was conservatively estimated based on the assumption that all the pollutants for a 24-hour sample were collected within an 8-hour period. Therefore, an adjustment factor of 3 (24 hr/8 hr) was applied to the annual average concentrations (averages of multiple 24-hr samples).

4. 8-hour Chronic HQs are not calculated for compounds where all samples are <MDL. Note that each compound MDL is not the same for both monitoring sites. For example, the San Jose nickel MDL was 0.009 µg/m^3 compared with 0.00003 to 0.00005 µg/m^3 for Cupertino. All of the Cupertino nickel values were less than the San Jose MDL for nickel. Thus, the nickel < MDL at San Jose does not necessarily mean that the 8-hour chronic HQ due to nickel concentrations are lower at the San Jose site than at the Cupertino site.

Table 6. Acute Non-cancer Risk Based on Ambient Air Monitoring Data for Cupertino and San Jose

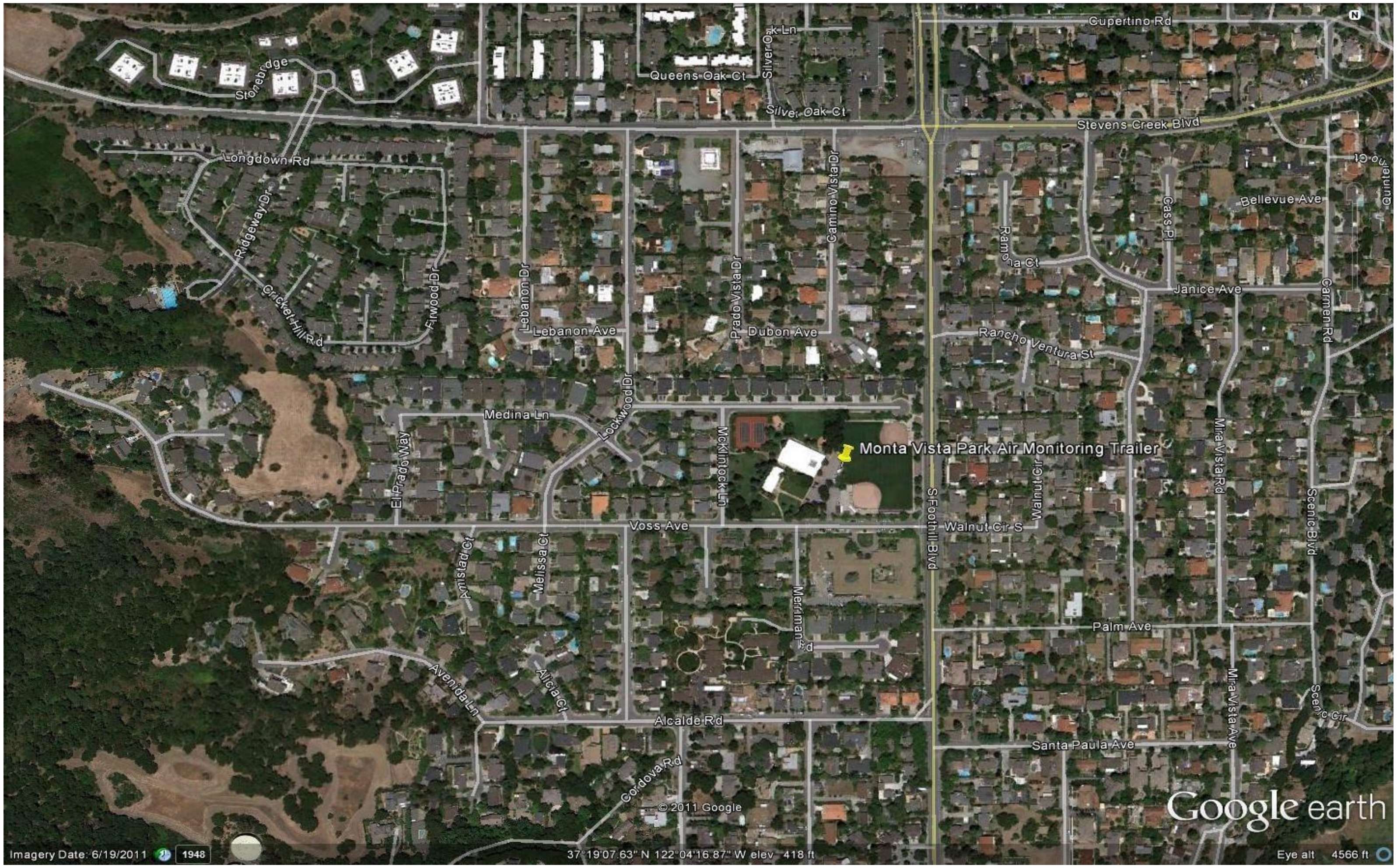
Compound	Acute Inhalation REL, µg/m^3	Acute Hazard Quotient		Target Organ System
		Cupertino	San Jose	
Acetaldehyde	470	0.1	0.1	Eye, Respiratory
Acrolein	2.5	0.1	0.1	Eye, Respiratory
Arsenic	0.2	0.0	<MDL	Cardiovascular, Reproductive/Developmental, Nervous
Benzene	1300	0.0	0.0	Reproductive/Developmental, Hematologic, Immune
1,3 Butadiene	660	0.0	0.0	Reproductive/Developmental
Carbon Tetrachloride	1900	0.0	0.0	Alimentary, Reproductive/Developmental, Nervous,
Chloroform	150	0.0	0.0	Reproductive/Developmental, Nervous, Respiratory
Copper	100	0.0	0.0	Respiratory
Formaldehyde	55	0.6	0.6	Eye
Mercury	0.6	0.1	N/A	Reproductive/Developmental, Nervous
Methyl Chloroform	68000	0.0	0.0	Nervous
Methylene Chloride	14000	0.0	0.0	Cardiovascular, Nervous
Methyl Ethyl Ketone	13000	0.0	0.0	Eye, Respiratory
Nickel	0.2	0.3	<MDL	Immune
Perchloroethylene	20000	0.0	0.0	Eye, Nervous, Respiratory
Toluene	37000	0.0	0.0	Reproductive/Developmental, Eye, Nervous, Respiratory
Vanadium	30	0.0	0.8	Eye, Respiratory
Vinyl chloride	180000	<MDL	<MDL	Eye, Nervous, Respiratory
M&P Xylene	22000	0.0	0.0	Eye, Nervous, Respiratory
O Xylene	22000	0.0	0.0	Eye, Nervous, Respiratory
Acute Hazard Index:		**0.8**	**0.9**	**sensory irritation: Eyes**

Table 8

Table 6 Notes:

1. An acute hazard quotient is the value of the maximum one-hour average concentration divided by the acute REL. A hazard Index (HI) is the sum of the hazard quotients (HQ) for all compounds that affect a particular target organ system. The greatest target organ specific HI is the overall HI.
2. Adverse health effects are not expected to occur, even for sensitive members of the population, for hazard indices less than one. An exceedance of one does not indicate that adverse effects will occur, rather, it is an indication of the erosion of the margin of safety and that the likelihood of adverse health effects is increased.
3. Max. 1-hr concentrations were assumed to be 7.5 times the max. 24-hr concentration. This adjustment factor was determined by multiplying a 1-hr to 24-hr meteorological persistence factor of 1/0.4 = 2.5 ("Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992, EPA-454/R-92-019, page 4-16), by an emission rate scalar of 3 (24 hr/8 hr), that accounts for temporal differences in emissions over the 24-hour period. This technique was used for this report to adjust concentrations based on the 24 hour monitoring data in Table 2.
4. Acute HQs are not calculated for compounds where all samples are <MDL. Note that each compound MDL is not the same for both monitoring sites. For example, the San Jose nickel MDL was 0.009 µg/m^3 compared with 0.00003 to 0.00005 µg/m^3 for Cupertino. All of the Cupertino nickel values were less than the San Jose MDL for nickel. Thus, the nickel < MDL at San Jose does not necessarily mean that the Acute HQ due to nickel concentrations are lower at the San Jose site than at the Cupertino site.

Figure 1. Location of the Air District's Cupertino Air Monitoring Station



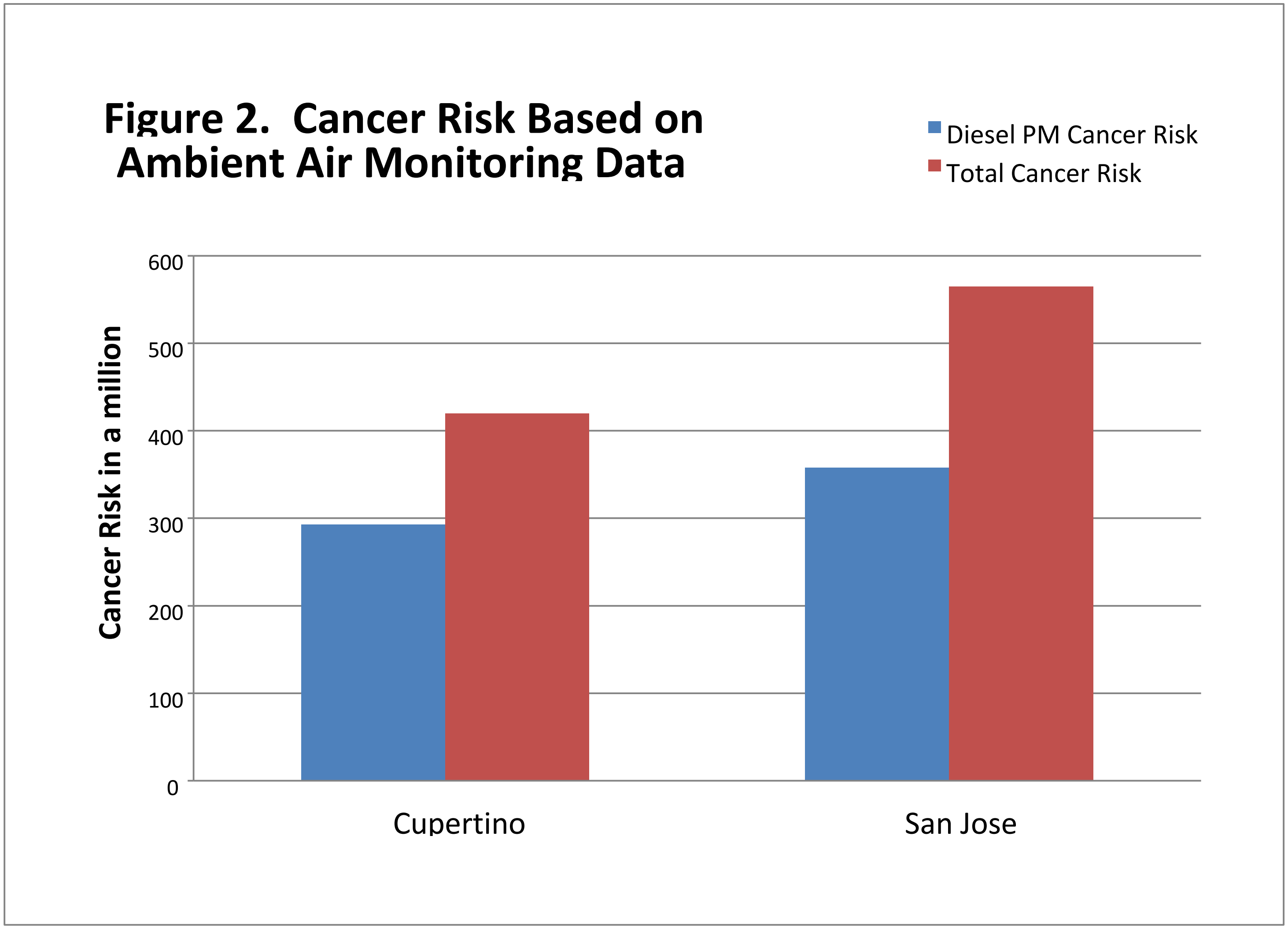


Figure 2. Cancer Risk Based on Ambient Air Monitoring Data