Lead Gradient Study at McClellan-Palomar Airport

Final Report

AIR POLLUTION CONTROL DISTRICT
COUNTY OF SAN DIEGO

Prepared by:

San Diego Air Pollution Control District
Monitoring and Technical Services Division

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10124 Old Grove Rd. – San Diego - California 92131-1649 – (858) 586-2600
FAX (858) 586-2601– Smoking Vehicle Hotline – 1-800-28-SMOKE
www.sdapcd.org

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1. BACKGROUND

The U.S. Environmental Protection Agency (EPA) revised the monitoring requirements for measuring ambient levels of airborne lead (Pb) in December 2010, and mandated a 1.0 ton per year (tpy) lead emission threshold for permanent testing at airports. Following this revision the EPA required a 1-year monitoring study of 15 airports that had emissions greater than 0.5 tpy, but less than 1.0 tpy. The study goal was to help the EPA determine whether airports that emit less than 1.0 tpy have the potential to cause the surrounding areas to exceed the National Ambient Air Quality Standards (NAAQS) for lead of 0.15 micrograms per cubic meter ($\mu g/m^3$) for a rolling 3-month average.

Based on 2008 lead emission estimates from the National Emission Inventory database, two San Diego County airports, Gillespie Field (SEE) in El Cajon, and McClellan-Palomar Airport (CRQ) in Carlsbad, were chosen for the 1-year study. The measurement project was funded by an EPA grant which required a single-location lead sampler at each facility. In March 2012, the EPA worked in partnership with the San Diego Air Pollution Control District (District) to install Total Suspended Particulate (TSP) samplers to collect for airborne lead at Gillespie Field and McClellan-Palomar Airport. These samplers were placed in areas determined by the EPA to be in maximum impact zones.

The data gathered from these studies were intended to help the EPA better understand the potential impacts of leaded aviation fuel usage on airborne air quality and public health. The sampler locations at each airport were determined by the EPA based on their criteria of identifying the location of maximum impact. The 1-year monitoring study at the two San Diego County airports concluded in March 2013.

The McClellan-Palomar Airport sampler was placed at a location representative of the highest expected airborne lead concentrations, immediately downwind of the run-up area. Lead levels measured at the McClellan-Palomar Airport monitoring location exceeded the National Ambient Air Quality Standards (NAAQS) while levels of lead measured at the Gillespie Field monitoring site were well below the national standard (test results were less than half of the standard).

Although there are more piston-engine aircraft operating out of Gillespie Field than at McClellan-Palomar Airport, the lead monitoring data showed an exceedance of the NAAQS for lead at the McClellan-Palomar Airport, but not at Gillespie Field. The District determined that this was due solely to the distances of the samplers from their respective aircraft run-up and operations areas.

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2. PURPOSE OF THE STUDY

The District expressed concerns to the EPA that the single-test locations at each airport were inadequate to accurately map lead levels on and around the airports. The District's position is that the airborne lead levels measured are inconclusive as a result of the EPA's project design that searched for maximum impacts, regardless of whether or not the location was an area with public access.

At McClellan-Palomar Airport, the single lead sampler was set immediately adjacent to the primary "run-up" area, where aircraft engines are run at relatively high power settings to check engine components and propellers prior to take-off. This sampler location was in very close proximity to piston-driven aircraft engines running at relatively high power settings and sampled localized exhaust emissions, rather than ambient air to which the public could be exposed.

The District has emphasized to the EPA that this run-up area is not representative of air quality in areas readily accessible to the public. The monitoring location at Gillespie Field was farther away from the aircraft run-up area, and as expected, the tests produced lower ambient lead levels.

Due to concerns over the EPA's single-location testing protocol, the District used internal funds to conduct a more rigorous lead testing program at McClellan-Palomar Airport. This study was designed to show how lead concentrations vary depending upon the location on the airport and the distance from the run-up area. Due to siting and electrical power constraints the District secured portable samplers to accomplish this lead testing at McClellan-Palomar Airport.

In an effort to better understand levels of lead present in ambient air on the McClellan-Palomar Airport property, the District conducted a 'Lead Gradient Study' to assess the concentrations of lead as a function of distance from the run-up area. Working closely with the San Diego County Airports Division (Department of Public Works), the District installed samplers at multiple locations throughout the airport property to more realistically assess airborne lead levels in areas where the public could be impacted (e.g., near the airport passenger terminal and near the airport fence lines).

This special monitoring study was conducted in April and May 2013. As expected, this study showed that lead levels were lower as the distance from the aircraft run-up area increased. The District's testing procedures provide a more realistic and scientifically defensible indication of airborne lead levels for the general public on and around the airport.

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3. STUDY PLAN

Airborne lead is measured by analyzing particulate filters in the laboratory that were collected in the field. Any Total Suspended Particulate (TSP) sampler design that meets the requirements of Chapter 40 of the Code of Federal Regulations, Part 50 (40 CFR 50), Appendix B (Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)) is acceptable for use as a Federal Reference Method (FRM) sampler for the collection of airborne lead samples.

Due to the non-availability of electrical power at various airport locations, the District selected the Airmetrics MiniVol™ Tactical Air Samplers (TAS) for use in this study. These portable, battery-operated ambient air samplers were used for the collection of particulate matter during this study. The low-flow technology used in the MiniVol™ TAS was developed jointly with the EPA to address the need for portable air pollution sampling technology. While not a reference method sampler, the mass concentrations from the MiniVol™ TAS give results very similar to the reference method samplers. [Monitoring was conducted using a non-reference method and cannot be compared to the National Ambient Air Quality Standard (NAAQS) for lead. However, the data provides an accurate estimate of airborne lead levels for this gradient study.]

Both accurate and precise, the battery operated, lightweight MiniVol™ TAS is ideal for sampling at remote sites or areas without power. Particulates with aerodynamic diameters of approximately 100 µm or less were collected on 47 mm quartz fiber filters by these portable, low-volume air samplers.

The MiniVol™ TAS features a 7-day programmable timer, a constant flow control system, an elapsed time totalizer, rechargeable battery packs, and an all-weather enclosure. For the MiniVol™ TAS, the actual volumetric flow rate was maintained at 5 liters per minute.

The particulates collected on filters were analyzed at the District laboratory to determine lead concentrations by using the Standard Operating Procedure (SOP) for the Determination of Lead in TSP by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) as described in EQL-0710-192, "*Heated Nitric Acid Hot Block Digestion and ICP/MS Analysis for Lead (Pb) on TSP High-Volume Filters*."

3.1 Project Task Description

Eleven portable samplers were installed at ten locations inside the airport property (the additional portable sampler was collocated at two different locations to provide a measure of precision for these samplers). A Federal Reference Method High-Volume TSP sampler was collocated with one of the portable samplers to provide a measure of accuracy for the MiniVol™ samplers.

The primary objective of this study was to fulfill an urgent need to investigate the expected airborne lead concentrations inside the airport environment where pilots, passengers, airport personnel, and other members of the public have access. Secondly, the 'Lead Gradient Study' was needed to assess the concentrations of lead as a function of distance from the run-up area where maximum lead concentrations were detected in the year-long monitoring program. The third objective of this study was to measure the airborne lead levels at the airport perimeter (fence line), where there is the greatest potential of lead exposure to the public immediately outside the airport property.

3.2 Site Locations

A total of 10 sites were selected for lead sampling. The locations included areas typically upwind, crosswind, and downwind of airport activity areas, as well as areas of public access. A map showing the monitoring site locations is included in Appendix A (Figure A-1). Details of each monitoring site are included below (all sites are at roughly the same elevation):

Site # 1 – Background: A portable MiniVol™ sampler was placed near the southwest end of the runway (typically upwind during peak airport operating hours – i.e., daytime).

Site # 2 – Passenger Terminal Tarmac: A portable MiniVol™ sampler was placed on the tarmac outside of the Passenger Terminal Building to assess the airborne levels of lead that have the potential to expose airline passengers and ground crews. [Note: Jet engines, including those used on the turboprop aircraft used by the airlines that service McClellan-Palomar Airport, do not burn fuel containing lead. Therefore, airline passengers are not exposed to airborne lead from these aircraft.] An FRM High-Volume TSP sampler was collocated at this site (Site #2A) in order to provide a comparison of lead levels collected by these two methodologies.

Site # 3 – Helipad: A portable MiniVol™ sampler was placed on the site south-southwest of the run-up area blast fence and west of the "Helipad" near the airport fuel tank storage area.

Site # 4 – Run-up Area: A portable MiniVol™ sampler was placed at the same location where the FRM High-Volume TSP sampler was placed for the original year-long study. A duplicate, collocated MiniVol™ sampler was placed at this location during the second half of the study to estimate the precision of the sampling method using the MiniVol™ samplers.

The following three "gradient" sites are located along the same downwind trajectory.

Site # 5 – First Gradient site: A portable MiniVol™ sampler was placed about 310 feet east of Site #4.

Site # 6 – Second Gradient site: A portable MiniVol™ sampler was placed about 620 feet east of Site #4.

Site # 7 – Third Gradient site: A portable MiniVol™ sampler was placed about 930 feet east of Site #4. This site is at the eastern edge of the airport property before the terrain drops down to the street below (i.e., El Camino Real – the first non-airport public area directly downwind of the airport.). A duplicate, collocated MiniVol™ sampler was placed at this location during the first half of the study to estimate the precision of the sampling method using the MiniVol™ samplers.

Note: A wind rose was generated using three years (2008-2010) of wind data from 7:00 a.m to 7:00 p.m. for the months of April and May. The wind rose for these data (Appendix B) indicated fairly strong and frequent southerly flow during these months. Therefore, three portable sampling sites were chosen near the northeast corner of the airport property to assess the levels of airborne lead at the fence line that have the potential to migrate off the airport property.

The following three sites are located along the northeast fence line of the airport, near the access road to the northern aircraft parking area.

Site # 8 – First northeast fence site: A portable MiniVol™ sampler was placed near the fence along the northeast corner of the airport property.

Site # 9 – Second northeast fence site: A portable MiniVol™ sampler was placed near the fence along the northern border of the airport property, approximately the same distance east as the Run-up area site (Site #4).

Site # 10 – Third northeast fence site: A portable MiniVol™ sampler was placed near the fence along the northern border of the airport property, west of Site #9.

3.3 Sampling Time and Frequency

A total of ten sample days were conducted for this study. Each lead sample was collected for a 24-hour period. The EPA 2013 Monitoring Schedule Calendar (Figure C-1 in Appendix C) for a 3-day monitoring schedule was followed. However, instead of collecting samples from the usual midnight to midnight, samples were collected from 10 am to 10 am in order to make it possible to conduct battery change-outs, sampler leak checks, flow checks before and after each sample run, and to minimize demands on personnel (due to the site locations on the airport property, District personnel needed to be escorted by County Airport officials during site visits).

3.4 Project Organization

This study was performed by the District's Monitoring and Technical Services Division. The organization chart below (Figure 1) shows the key personnel involved in this project, their titles, and functional roles in this Lead Gradient Study.

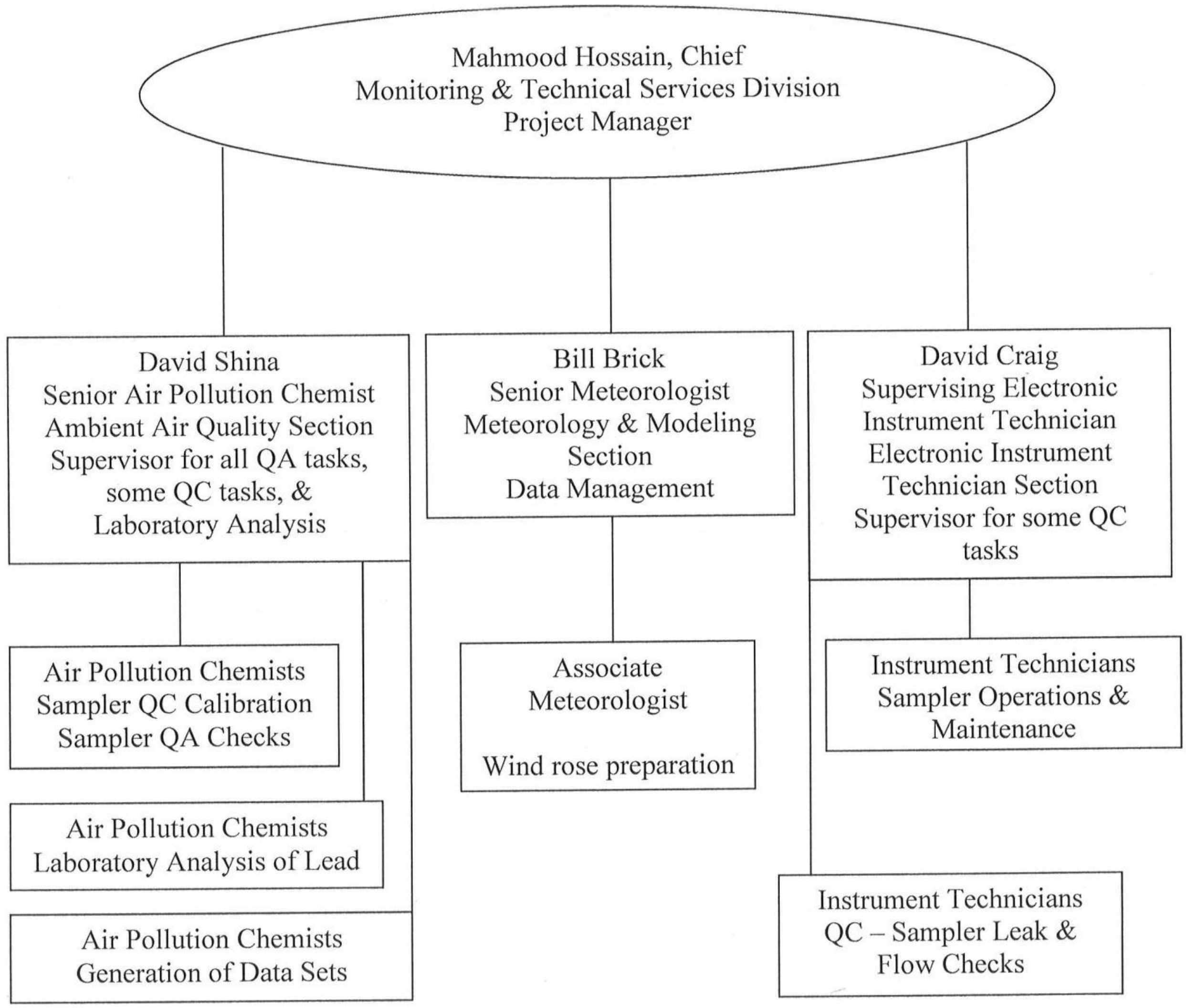

Figure 1. Organization chart for the Lead Gradient Study – Monitoring and Technical Services Division of the San Diego Air Pollution Control District.

4. QUALITY CONTROL AND QUALITY ASSURANCE ACTIVITIES

The collection of valid data requires extensive Quality Assurance (QA) and Quality Control (QC) tasks (collectively known as QA/QC) to provide confidence in the data sampling and subsequent laboratory analysis. Performance of these tasks enables the District to meet the Data Quality Objective (DQO) for this study (i.e., data that are scientifically representative and defensible). The QA/QC activities performed by District personnel on this project are detailed below.

4.1 QC Checks of Field Equipment

The MiniVol™ samplers were set to run at 5.0 liters/minute (lpm). All field samplers were initially checked out in the District laboratory, including testing the batteries to ensure 24-hours of uninterrupted operation. After installation, all MiniVol™ sampler flows were calibrated in the field using a volumetric flow meter manufactured by Alicat Scientific, Inc.

Three-point calibrations of the MiniVol™ samplers were conducted using a portable calibration volumetric flow meter. The three points were 4.0, 5.0, and 6.0 lpm with the design flow set to 5.0 lpm. The averages of triplicate readings at each set point were used to determine a slope and intercept for each MiniVol™ unit.

Before the beginning of each sample run, all MiniVol™ samplers were checked for leaks and a flow verification check by using a BGI TetraCal volumetric flow meter. Additionally, a flow verification check was performed after the end of each sample run. All data were entered onto the Sampler Check Sheet/Chain-of-Custody Form (this form and other QA/AC forms are provided in Appendix D).

The Reference Method Hi-Vol TSP sampler was initially calibrated at the site after installation and before initiating a sample run by using a variable orifice device. A five point calibration of the Hi-Vol was conducted using a Tisch TE 502 variable orifice with a Merriam DN0025 digital manometer. The five points were 42.0, 42.9, 43.7, 44.5, 45.3 cubic feet per minute (cfm) with a design flow of 44.5 cfm. The average of triplicate readings at each set point was used to determine a slope and intercept for the Hi-Vol unit. The Hi-Vol temperature sensor was calibrated using a Fisher Scientific Model 15-077-940 digital thermometer. The Hi-Vol ambient pressure transducer was calibrated using the ambient pressure transducer of a BGI TetraCal volumetric flow meter.

4.1.1 Details of Quality Control Steps Performed

The Hi-Vol TSP sampler was calibrated in accordance with the California Air Resources Board's (ARB) Standard Operating Procedures (SOP) titled "Standard Operating Procedures for Air Quality Monitoring, Appendix E.2 Calibration Procedure High Volume Samplers" with the following modifications: i) flow calibration was corrected for the site temperature and pressure, regardless of the site elevation; ii) the sampler was not turned off between flow readings after the instrument pump was warmed up.

The MiniVol™ samplers were calibrated according to APCD SOP titled "MiniVol Calibration Procedure." The MiniVol™ samplers were initially leak checked without the filter assembly in place with an acceptable flow rate variation of 0.0 liter per minute (lpm). Next, a single point flow check was conducted on the MiniVol™ samplers with the filter assembly in place. The MiniVol™ sampler Model 4.2 and Model 5.0 used in this study had the same flow rate acceptance criterion of ±10% from the reference with a ±5% trigger warning. When a trigger warning was observed, field staff investigated the cause of the difference and subsequently either repaired or replaced the sampler before setting up the sampler to run. Finally, if the flow rate was within 0.1 lpm of the ± 5% threshold and the sampler did not deviate significantly from previous flow rate checks, then the sampler was programmed to run.

4.2 QA Checks of Field Equipment

QA checks of the MiniVol™ samplers and the TSP sampler were performed throughout the study. The QA checks were performed using instruments dedicated for audits by staff who were not involved in the QC checks.

4.2.1 Details of Quality Assurance Steps Performed

Midway through the study, the MiniVol™ samplers and the Hi-Vol TSP sampler were audited using equipment dedicated for audits by personnel who did not participate in performing any QC checks.

The Hi-Vol TSP sampler was audited according to the ARB SOP and with the following acceptance criteria:

1. Flow: ± 10% difference of reference value and design value of 44.5 cubic feet per minute (cfm)
2. Clock: absolute difference of ± 5 min.
3. Date: absolute difference of 0 day.
4. Ambient Temperature: absolute difference of ± 2 ^{o}C.
5. Ambient Pressure: absolute difference of 10 mm Hg.

The MiniVol™ samplers were audited by initially leak checking the system with the filter assembly connected and with an acceptable flow rate variation of 0.0 lpm. If a leak was detected, the filter assembly was removed and re-checked. If the sampler still failed the leak check, it was either repaired or replaced. Once the MiniVol™ sampler passed the leak test, a flow rate check was performed with an acceptance criterion of ±10% from the reference and with a ±5% trigger. When a trigger warning was observed, QA field staff investigated the cause of the difference and alerted the field technician so they could either repair or replace the sampler before setting up the sampler to run.

4.3 Sampler Operational Acceptance Criteria

Before and after each sampling event, the field samplers were tested to ensure proper operation within the accepted tolerance levels.

Sampler tolerances used for the McClellan-Palomar Lead Gradient Study were as follows:

MiniVol™ samplers:

1. Flow: ± 10% difference of reference value.
2. Clock: absolute difference of ± 5 min.
3. Date: absolute difference of 0 day.
4. Leak Test: 0 lpm.

Hi-Vol TSP sampler:

1. Flow: ± 10% difference of design value of 44.5 cfm (after sampling event only).
2. Clock: absolute difference of ± 5 min.
3. Date: absolute difference of 0 day.

4.4 QA/QC Activities for the Laboratory Analysis of Lead

EPA method EQL-0710-192 for the analysis of Lead in TSP High-Volume filters by ICP/MS was used to analyze the TSP High-Volume filter collected at Site # 2. This method was slightly modified to analyze the 47 mm quartz filters used to collect particulates by the MiniVol™ samplers for the presence of lead.

The District uses an Agilent Technologies Model 7500cx ICP/MS for laboratory analysis of lead.

A method detection limit (MDL) study was conducted before any filters were analyzed. This was done for each type of filter analyzed. Calibrations were performed daily after successfully verifying the instrument was correctly aligned. Internal standards were used for every analysis to verify that the instrument was working properly.

Method EQL-0710-192 includes the following QA/QC requirements: a blank filter strip (laboratory reagent blank) and matching filter spike (laboratory fortified blank); a sample duplicate (laboratory duplicate) and matching sample spike (laboratory fortified matrix spike); initial calibration verification, initial calibration blank, quality control standard and quantitation limit standard; and, ongoing calibration verification and blanks every ten laboratory samples. The spikes must be made using a different source standard than the one used for the initial calibration. In addition, three high-level and three low-level independent source audit strips must be analyzed every calendar quarter that filters are analyzed.

Since the entire filter collected by MiniVol™ samplers are digested, these samples do not provide a means to run duplicates or duplicate spikes, so sample spikes were not run with those filters. Blanks and blank spikes on 47mm quartz filters were analyzed.

Field sampler blanks (installed in sampler but not run) and trip blanks (transported to and from the airport) were also deployed and analyzed during the study.

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5. DATA MANAGEMENT

5.1 Sample Volume Calculations

This section of the report documents the various sampler volume calculations for the MiniVol™ Sampler and the Hi-Vol TSP Sampler.

5.1.1 MiniVol™ Sampler

The average of the starting and ending rotameter flow rates were determined from the Chain-of-Custody forms. Using the calibrated slope and intercept, the corrected average flow rate was calculated. The sample volume was calculated using the corrected average flow rate and the sample duration (taken from the difference between the ending and starting readings of the elapsed timer). These calculations are presented below in one equation.

$$V = \frac{\left[\frac{(f_1 + f_2)}{2} * S + I\right] * (t_2 - t_1) * 60}{1000}$$

where	V	= Sampled volume in cubic meters
	f_1	= Beginning flow rate in liters per minute
	f_2	= Ending flow rate in liters per minute
	S	= Calibrated slope
	I	= Calibrated intercept
	t_2	= Ending elapsed timer value in hours
	t_1	= Beginning elapsed timer value in hours
	60	= Conversion between hours and minutes
	1000	= Conversion from liters to cubic meters

5.1.2 Hi-Vol TSP Sampler

The Hi-Vol samplers record the average flow rate for the programmed run duration. Using the calibrated slope and intercept, the corrected average flow rate was calculated. The sample volume was calculated using the corrected average flow rate and the sample duration (recorded by the Hi-Vol unit). These calculations are presented below in one equation.

$$V = ((F * S) + I) * T * 0.0283168$$

where	V	= Sampled volume in cubic meters
	F	= Average flow rate from the Hi-Vol unit in cubic feet per minute
	S	= Calibrated slope
	I	= Calibrated Intercept
	T	= Total run time in minutes
	0.0283168	= Conversion from cubic feet to cubic meters

5.2 Quantification of Lead Concentrations

The lead concentration measured by the ICP/MS is expressed in micrograms per liter (µg/L). This number was subsequently multiplied by the solvent volume to obtain total lead mass.

To obtain the final amount of lead per cubic meter ($\mu g/m^3$), the lead mass was divided by the sample volume obtained in section 5.1 above.

5.2.1 MiniVol™ Sampler

The entire sample filter is digested in a vial that is brought to 50 ml volume when complete. The measured concentration was multiplied by the solvent volume and converted to liters. This calculation is shown as follows:

$$M = (C * V) / 1000$$

where	M	= Mass of lead in µg
	C	= Concentration of lead measured by the ICP-MS in µg/L
	V	= Volume of solvent in milliliters
	1000	= Conversion from milliliters to liters

5.2.2 Hi-Vol TSP Sampler

A one inch wide filter strip was digested in a vial that is brought to 50 ml volume when complete. The sample was then diluted 1:10 prior to analyses. Since a one-inch strip represents one-ninth of the exposed filter, the result was multiplied by nine. The formula for this is:

$$M = (C*V*9)/1000$$

where	M	= Mass of lead in µg
	C	= Concentration of lead measured by the ICP-MS in µg/L
	V	= Volume of solvent, which includes a factor of ten for the dilution
	9	= Filter strip multiplier to convert one strip to entire filter
	1000	= Conversion from milliliters to liters

6. RESULTS AND STUDY SUMMARY

This airport Lead Gradient Study was designed to provide a more complete and accurate representation of airborne lead concentrations at the McClellan-Palomar Airport in Carlsbad, California. The study measured airborne lead concentrations in multiple areas around the airport grounds (e.g., background, downwind of the run-up area, etc.), areas that have true public access, and areas at the perimeter of the airport where the non-aviation public could be exposed to airborne lead from piston-engine aircraft.

The data presented in this section document the airborne lead concentrations measured on 10 sampling days during this Lead Gradient Study (Table 1). This section also includes a discussion on the representativeness of the data compared to the 1-year study, the results of each individual sampling day, and a summary of the Lead Gradient Study.

McClellan-Palomar Lead Gradient Study Results

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP[4] Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
04/25/13	0.006	0.008	0.007	0.029	0.093	--	0.019	0.030	0.014	--	0.005	0.007	0.005
04/28/13	0.000[1]	0.002[1]	0.000[1]	0.000[1]	0.000[1]		0.000[1]	0.001[1]	0.001[1]	0.000[1]	0.000[1]	0.000[1]	0.001[1]
05/01/13	n/a	0.011	0.010	0.029	0.085	--	0.017	0.011	0.008	0.009	n/a	0.003	0.004
05/04/13	0.001[2]	0.005	0.005	0.004	0.215	--	0.008	0.003[2, 3]	0.002[2, 3]	0.003[2, 3]	0.013	0.049	0.041
05/07/13	0.001[2]	0.007	0.008	0.005	0.124	--	0.015	0.006	0.004	0.005	n/a	n/a	0.010
05/10/13	0.003	0.008	0.007	0.019	0.096	--	0.013	0.008	0.007	0.007	0.005	0.008	0.009
05/13/13	n/a	0.006	0.007	0.017	0.043	0.044	0.020	0.014	0.011	--	0.004	0.003	0.004
05/16/13	n/a	0.003	0.005	0.001[2]	0.142	0.143	0.010	0.004	0.003[2]	--	0.008	0.013	0.008
05/19/13	0.000[2]	0.001[2]	0.003	0.014	0.158	0.141	0.019	0.011	0.008	--	0.013	0.032	0.013
05/22/13	0.006	0.010	0.004	0.005	0.131	0.129	0.016	0.007	0.006	--	0.009	0.017	0.011
05/25/13	0.002[2]	0.004	0.004	0.011	0.122	0.115	0.017	0.009	0.005	--	0.004	0.006	n/a
Average	0.003	0.006	0.006	0.013	0.121	0.114	0.015	0.010	0.007	0.006	0.008	0.015	0.012

National Ambient Air Quality Standards for Lead, 0.15 $\mu g/m^3$ (Rolling 3-Month Average)

n/a: no valid sampler run
[1]Sampler Blanks (Sampler Blanks use default average volume of $7.30 m^3$)
[2]Below level of quantitation (Quant Limit = $0.004 \mu g/m^3$ for $7.5 m^3$ volume)
[3]Outside continuing calibration interval limit
[4] TSP Hi-Vol quant limit = $0.001 \mu g/m^3$

Table 1. McClellan-Palomar Airport Lead Gradient Study results.

6.1 Representativeness of Data from the Lead Gradient Study

Before discussing the results from this study it is important to determine the representativeness of the data collected during the Lead Gradient Study compared to the data collected during the EPA-funded 1-year lead monitoring study. A total of ten lead samples were collected at the run-up site (Site #4) during the Lead Gradient Study conducted in April and May 2013. In comparison, 55 samples were collected at the same site during the 1-year study from March 2012 to March 2013.

A histogram of the airborne lead levels expressed as a percentage of the total number of samples collected in 0.025 $\mu g/m^3$ range increments for each sampling method (i.e., Hi-Vol TSP for the 1-year study and MiniVol™ Sampler for the Lead Gradient Study) is displayed in Figure 2.

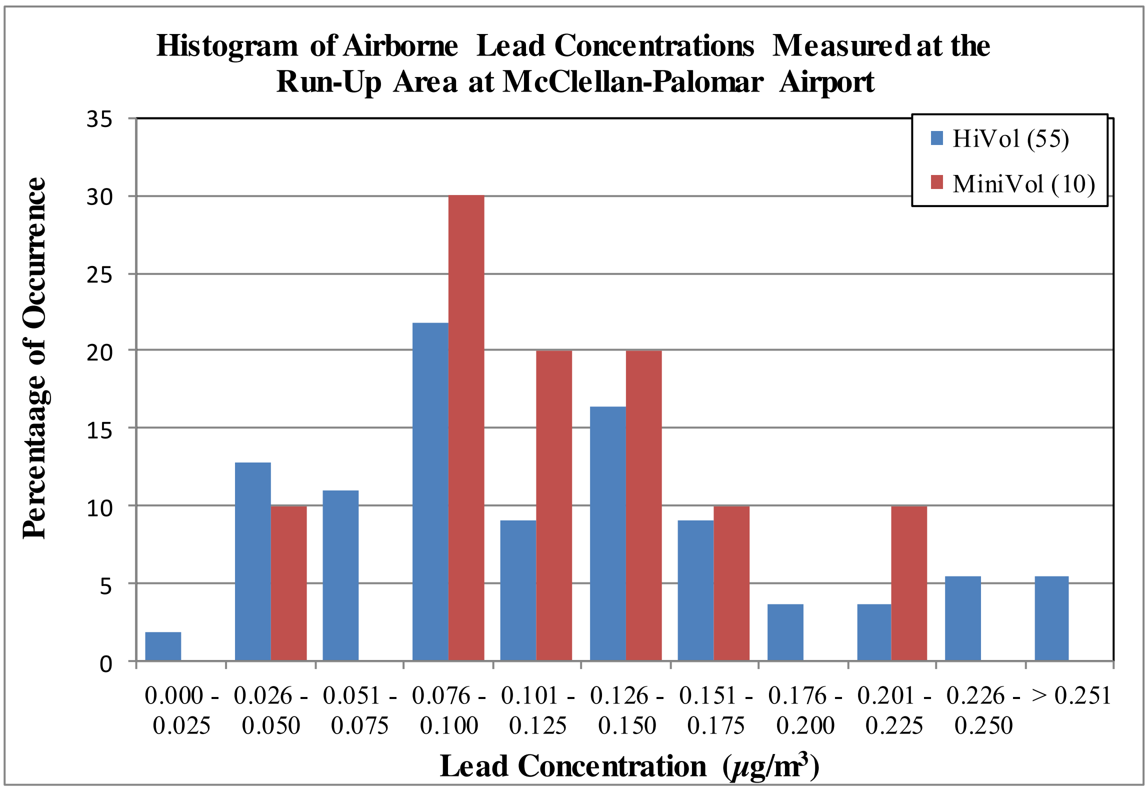

Figure 2. Histogram of lead concentrations measured at the run-up area location during the 1-year study (Hi-Vol) and the Lead Gradient Study (MiniVol™ – Site#4).

Figure 2 shows a good agreement between the Hi-Vol TSP sampler and MiniVol™ Sampler distributions. The histogram also shows that the lead concentrations measured during the Lead Gradient Study are not biased towards higher or lower lead concentrations when compared to the Hi-Vol TSP sampler from the 1-year study. In other words, the Lead Gradient Study found the same relative ranges of lead concentrations as the longer-term, 1-year study, and the Lead Gradient Study values provide an accurate representation of typical conditions at McClellan-Palomar Airport.

The number of piston-engine flight operations at the airport on a lead sampling day is a critical factor in lead concentrations measured in the run-up area. Under typical meteorological conditions (i.e., westerly winds during the daytime hours; when most flights are conducted), the 24-hour lead concentrations should be directly correlated with the number of flight operations (i.e., higher lead concentrations on days with a greater number of flights).

With the approval of the Federal Aviation Administration (FAA), the San Diego County Airports Division (Department of Public Works) provided the District with daily aircraft operations data for McClellan-Palomar Airport (flight operation counts are available only when the airport control tower is in operation: 7 a.m. to 10 p.m. (the vast majority of flight operations occur during these hours)). These data were analyzed by the day of the week for the time period that covered both the 1-year study and the Lead Gradient Study to determine if there was any bias towards weekends versus weekdays during the studies.

The average flight operations data by day of week are provided in Table 2 and a graph of these data is shown in Figure 3. Although the flight operations data do not differentiate between types of aircraft (i.e., piston-engine versus jet-engine), it is assumed that the ratio of engine types is similar on all days of the week. However, it is reasonable to also assume that a greater number of recreational flights (mostly piston-engine driven) occur on weekends versus weekdays.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Average	Average	Average	Average	Average	Average	Average
March 2012 to May 2013	447 / 126	396 / 105	394 / 115	411 / 98	438 / 131	396 / 114	388 / 111
1-Year Study	516 / 86	421 / 92	404 / 146	379 / 68	405 / 88	379 /111	300 / 141
Lead Gradient Study [1]	603	455	383	482 & 491	458 & 129	535	521 & 378

Table 2. Average flight counts for each day of the week. [1] Indicates actual daily flight counts for the Lead Gradient Study (the days with two values indicate that there were two sample days on this day of the week during the study).

Over the entire study period, there were a greater number of flight operations on Sundays versus the other days of the week (this is consistent with a greater number of recreational flights by General Aviation aircraft on weekends). This was also true for lead sample days during the 1-year study and the Lead Gradient Study.

In general there were a greater number of flight operations on each day of the week during the Lead Gradient Study than the average number of operations during the entire study period and the 1-year study period. The exceptions are on Tuesday values (Lead Gradient Study slightly less than longer-term averages) and the second of two Thursday values (significantly fewer flight operations). [For all days during April and May 2013, there were several days where the

Thursday flight operations were significantly lower than other days. The reason for this significant decrease on one day of the week is unknown at this time.]

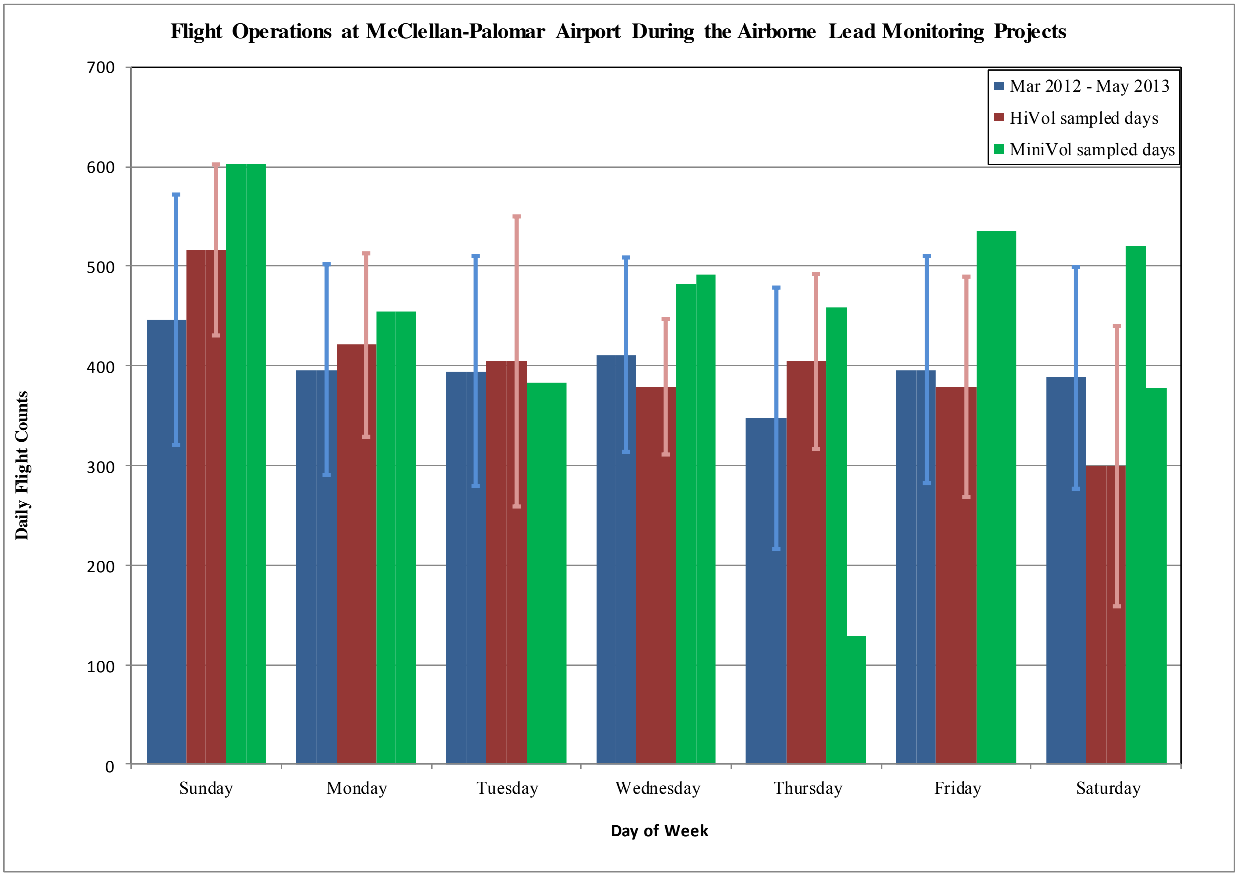

Figure 3. Average flight operations for each day of the week during the entire time period of both lead studies (March 2012 through May 2013), sample days for the 1-year study (Hi-Vol), and sample days for the Lead Gradient Study (MiniVol™). Vertical lines indicate the one standard deviation range of values from the mean for the entire time period and the 1-year study. Days of the week with more than one sampling date during the Lead Gradient Study are shown with a split bar.

In summary, the number of flight operations conducted during the Lead Gradient Study sampling days were consistent with the number of flight operations throughout the year and for sample days during the 1-year study previously conducted at the run-up area site (Site #4 in the Lead Gradient Study). Therefore, the data collected during the Lead Gradient Study are representative for the purposes of this study.

6.2 Results from the Lead Gradient Study

The purpose of this Lead Gradient Study at McClellan-Palomar Airport was to show that the lead concentrations measured in the maximum impact area immediately adjacent to the primary run-up area during the EPA-funded 1-year study were not representative of the airport in general, nor representative of what could be expected in areas accessible to the public at this airport. The District's concern over the EPA's single-point monitoring protocol stemmed from the principles of atmospheric dispersion, where airborne concentrations decrease as the distance from a source increases. District staff believed that EPA's single-point location, chosen for maximum impact rather than true public exposure did not provide a realistic measurement of airborne lead concentrations at this airport.

The EPA's single-point monitoring location (Site #4 in the Lead Gradient Study) is in close proximity and immediately downwind (under most daytime conditions) of the airport's primary run-up area. It is not unusual for three or more piston-engine aircraft to be in the run-up area at the same time doing run-up tests, performing other pre-takeoff checks, or simply idling while awaiting takeoff clearance from the airport control tower. This maximum impact location is effectively measuring aircraft engine exhaust at the source and is not representative of airborne lead concentrations at other locations on the airport property.

6.2.1 Average Airborne Lead Concentrations

The maximum impact location (Site #4) is clearly evident in the airborne lead concentration data collected during the Lead Gradient Study (Table 1), and more strikingly in Figures 4 and 5. Figure 4 shows a bar graph of average airborne lead concentrations collected during the Lead Gradient Study. This graph clearly shows that the maximum impact site near the primary run-up area is the only location that measures airborne lead concentrations approaching or exceeding half the standard for airborne lead.

The data reported in Table 1 for April 28, 2013, are known as Sampler Blanks. These are particulate filters that were taken from the District facilities to the airport, loaded into the samplers, and left for a 24-hour period (standard sample time). The samples were then collected from the samplers and returned to the District lab for analysis. This provides a reference to what level of lead can be deposited on the filters by routine handling and sample loading/unloading in the field. All Sample Blank measurements were below the level of quantification for the sample analysis method. This shows that there was no artificial contamination due to sample handling by field/laboratory personnel.

The majority of the data for Figure 4 are plotted with the site locations oriented from "west to east" orientation, with the Background site (Site #1) shown on the far left (west). The average concentration for Site #1 was 0.003 $\mu g/m^3$ (2% of the standard). Average airborne lead concentrations can be seen to increase as the sites move eastward (towards more cumulative aircraft operations activities) and peaking at the primary run-up area. The Background site has no real public access and is limited to airport personnel and pilots/passengers inside of aircraft. The average airborne lead concentrations at the Commuter Airline Terminal (Sites #2 and #2A) were 0.006 $\mu g/m^3$ (4% of the standard) for the non-FRM MiniVol™ sampler (Site #2) and the

FRM Hi-Vol sampler (Site #2A). These averages were double the average from the Background sampler (Site #1), and show that piston-engine aircraft operating on the airport grounds do contribute to airborne lead concentrations, but not at levels approaching half of the standard for airborne lead. This site is in an area specifically designed for public access (air and ground crews also work in this area), although the commuter aircraft do not contribute to airborne lead concentrations (all are powered by jet-engines that do not burn leaded fuel).

> NOTE: The fact that the two sampling methods used at the Commuter Airline Terminal site had the same average over the course of the study provides an indication of the accuracy of the MiniVol™ sampler, even though this sampler is not a Federal Reference (or Equivalent) Method (and the data cannot be used for regulatory purposes).

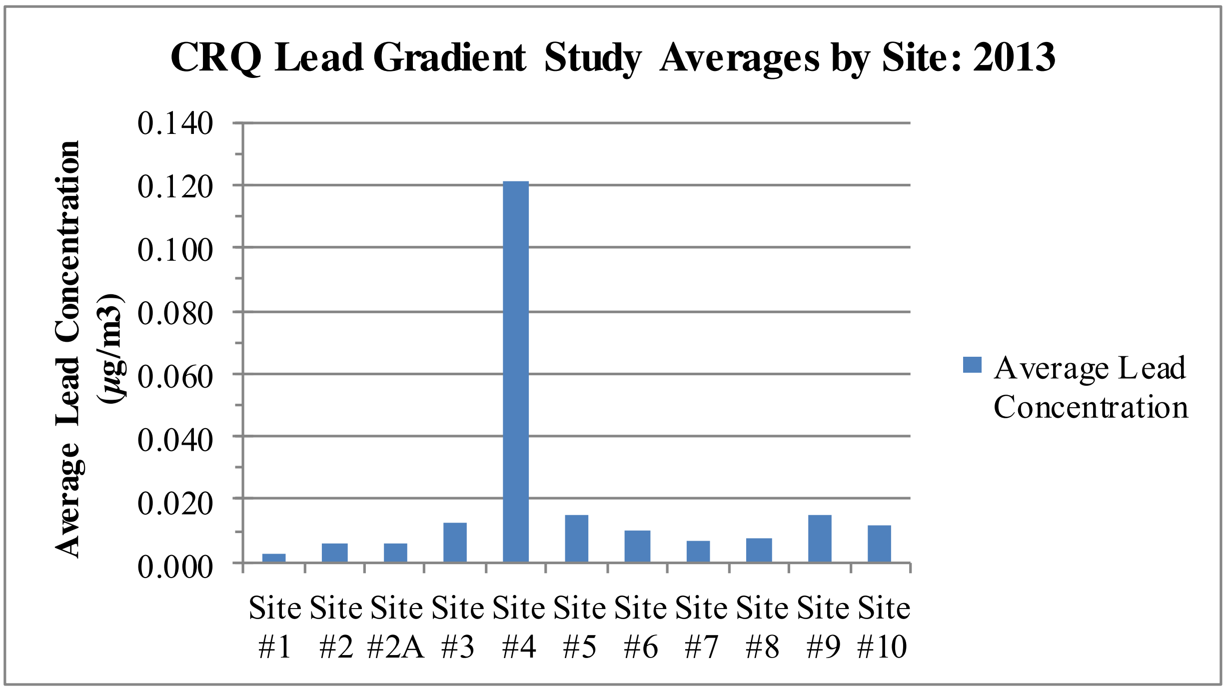

Figure 4. Bar graph of average airborne lead concentrations measured during the Lead Gradient Study at McClellan-Palomar Airport, April and May, 2013.

The next site in the eastward progression is the Helipad site (Site #3). Public access to this area is limited to pilots and passengers of general aviation aircraft (including helicopters), airport personnel, and airport support staff (e.g., operators of fuel trucks, mechanics, etc.). Downwind and near aircraft operations, this site measured an average airborne lead concentration of 0.013 $\mu g/m^3$ (9% of the standard), which represents the highest reading in the public access areas on the south side of the airport.

The primary run-up area site (Site #4) measured the highest average concentration during this study, and was the only site that measured airborne lead measurements during the 1-year EPA-funded study (and precipitated this Lead Gradient Study). The average airborne lead concentration for this site was 0.121 $\mu g/m^3$ (81% of the standard). At over 50% of the standard, measurements in this range require continuous airborne lead monitoring at the airport. Immediately adjacent to the airport's primary run-up area, the blast fence has a very real potential to funnel run-up area and other upwind emissions directly towards this location. The averages for the five collocated samples at this location during the second half of the study were within 0.005 $\mu g/m^3$ (3% of the standard), showing the validity of this sampling method.

This location, chosen by the EPA as a maximum impact site for the 1-year study is not in a public access area. Only airport personnel using the nearby access road to transit across the airport property or other airport workers (e.g., lighting maintenance) have any access to this area. Any worker in this area would be on location for short periods of time. With the information obtained from the longer-term 1-year study and this Lead Gradient Study, airport personnel should further limit their time spent in this area of the airport to avoid unnecessary exposure to airborne lead.

The next three sites on the bar graph (Figure 4) are the Gradient sites (Sites #5, #6, and #7), sited to document how airborne lead concentrations vary with distance from the primary run-up area. The bar graph shows that the average airborne lead concentrations decreased as the downwind distance increased. This result is consistent with the principles of atmospheric dispersion.

The average concentrations for these three sites were: 0.015, 0.010, and 0.007 $\mu g/m^3$ (10%, 7%, and 5% of the standard), respectively. Site # 7 included a collocated sampler during the first half of the study. The averages for the four collocated samples at this location were within 0.001 $\mu g/m^3$ (1% of the standard), showing the validity of this sampling method.

Sites #8, #9, and #10 are known as the Northeast Fence sites. These sites were designed to measure airborne lead concentrations that have the potential to move beyond the airport property, and thereby affecting the non-aviation public. The numbering of these sites in the bar graph is opposite the west to east orientation of the previously described sites, and this should be considered when referencing Figure 4.

Of the three Northeast Fence sites, the middle site (Site #9) had the highest average airborne lead concentration (Figure 4). All three Northeast Fence sites are downwind of the northern aircraft parking area (outdoor parking only – i.e., no hangers), but the middle site measured the highest airborne lead concentrations. This is primarily due to its proximity to the northern (secondary) run-up area that serves the general aviation (primarily piston-engine) aircraft based on the north end of the airport.

These sites also get emissions from the runway, main taxiway (south of the runway), primary run-up area, and Fixed-Base Operator (FBO) operations on the southern side of the airport when there are southerly winds. The average airborne lead concentrations at Sites #8, #9, and #10 were: 0.008, 0.015, and 0. 0.012 $\mu g/m^3$ (5%, 10%, and 8% of the standard), respectively.

Of all the sites monitored during the Lead Gradient Study, Site #9 had the highest average airborne lead concentration of any of the sites that have public access. As expected, airborne lead concentrations were higher at the primary run-up area site (Site #4 – not in a public access area), and the average airborne lead concentration at the first gradient site (Site #5 – not in a public access area) was equal to the average at Site #9 (a public access site, just to the north of the pilot access road to the northern aircraft parking area, and immediately adjacent to the northern airport fence line).

Based on the average airborne lead concentrations measured during this study, any long-term lead monitoring at McClellan-Palomar Airport should be performed at this location using FRM equipment (i.e., TSP Hi-Vol).

6.2.2 Maximum Airborne Lead Concentrations

A visual representation of the maximum airborne lead concentrations measured during this study is shown in Figure 5. The maximum airborne lead concentrations show a similar pattern to the average concentrations, and Site #9 had the highest measured concentration other than the primary run-up area site (Site #4). Maximum value specifics are included below.

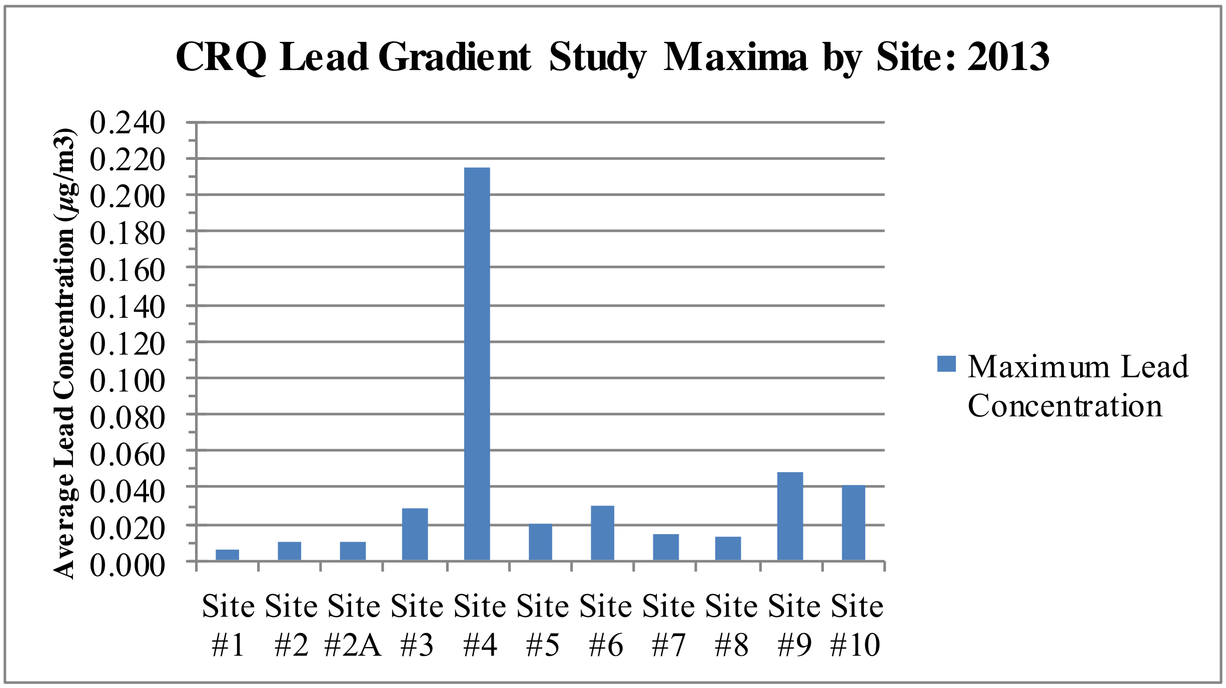

Figure 5. Bar graph of maximum airborne lead concentrations measured during the Lead Gradient Study at McClellan-Palomar Airport, April and May, 2013.

The maximum airborne lead concentration measured during the Lead Gradient Study at the Background site (Site #1) was 0.006 µg/m^3 (4% of the standard). Site #1 is essentially a non-public access site (see 6.2.1 for a discussion on average concentrations).

The maximum airborne lead concentrations measured at the Commuter Airline Terminal (Sites #2 and #2A) were 0.011 µg/m^3 (7% of the standard) for the non-FRM MiniVol™ sampler (Site

#2), and 0.010 µg/m^3 (7% of the standard) for the FRM Hi-Vol sampler (Site #2A). These averages were nearly double the maximum concentration from the Background sampler (Site #1), and show that piston-engine aircraft operating on the airport grounds do contribute to airborne lead concentrations, but not at levels approaching half of the standard for airborne lead. This site is in an area specifically designed for public access (air and ground crews also work in this area), although the commuter aircraft do not contribute to airborne lead concentrations (all are powered by jet-engines that do not burn leaded fuel).

> NOTE: The fact that the two sampling methods used at the Commuter Airline Terminal site had nearly the same maximum concentration over the course of the study provides an indication of the accuracy of the MiniVol™ sampler, even though this sampler is not a Federal Reference (or Equivalent) Method (and the data cannot be used for regulatory purposes).

The next site in the eastward progression is the Helipad site (Site #3). Public access to this area is limited to pilots and passengers of general aviation aircraft (including helicopters). Additionally, airport personnel and airport support staff (e.g., operators of fuel trucks, mechanics, etc.) occasionally work in this area. Downwind and near aircraft operations, this site measured a maximum airborne lead concentration of 0.029 µg/m^3 (19% of the standard), which represents the highest reading in the public access areas on the south side of the airport.

The highest airborne lead concentration measured during the entire study was at the primary run-up area site (Site #4), and was the only site that measured airborne lead during the 1-year EPA-funded study (and precipitated this Lead Gradient Study). The maximum airborne lead concentration for this site was 0.215 µg/m^3 (143% of the standard). Immediately adjacent to the airport's primary run-up area, the blast fence has a very real potential to funnel run-up area and other upwind emissions directly towards this location. The maximum values for the five collocated samples at this location during the second half of the study were within 0.005 µg/m^3 (3% of the standard), showing the validity of this sampling method.

This location, chosen by the EPA as a maximum impact site for the 1-year study is not in a public access area. Only airport personnel using the nearby access road to transit across the airport property or other airport workers (e.g., lighting maintenance) have any access to this area. Anyone in this area would be on location for very limited periods of time. With the information obtained from the longer-term 1-year study and this Lead Gradient Study, airport personnel should further limit their time spent in this area of the airport to avoid unnecessary exposure to airborne lead.

The next three sites on the bar graph (Figure 5) are the Gradient sites (Sites #5, #6, and #7), sited to document how airborne lead concentrations vary with distance from the primary run-up area. The bar graph shows that although the maximum airborne lead concentrations decreased as the downwind distance increased (i.e., between Sites #5 and Site #7), the maximum value was measured at the middle location (Site #6). This is most likely due to the wind trajectories on that sampling date (see detailed daily discussions below in 6.2.3).

The maximum concentrations for these three sites were: 0.020, 0.030, and 0.014 $\mu g/m^3$ (13%, 20%, and 9% of the standard), respectively. Site # 7 included a collocated sampler for four sample runs in the first half of this study. The maximum values for the four collocated samples at this location were within 0.001 $\mu g/m^3$ (1% of the standard), showing the validity of this sampling method.

Sites #8, #9, and #10 are known as the Northeast Fence sites. These sites were designed to measure airborne lead concentrations that have the potential to move beyond the airport property, and thereby affecting the non-aviation public. The numbering of these sites in the bar graph is opposite the west to east orientation of the previously described sites, and this should be considered when referencing Figure 5.

Of the three Northeast Fence sites, the middle site (Site #9) had the highest maximum airborne lead concentration (Figure 5). All three Northeast Fence sites are downwind of the northern aircraft parking area (outdoor parking only – i.e., no hangers), but the middle site measured the highest airborne lead concentrations. This is primarily due to its proximity to the northern (secondary) run-up area that serves the general aviation (primarily piston-engine) aircraft based on the north end of the airport.

These sites also get emissions from the runway, main taxiway (south of the runway), primary run-up area, and Fixed-Base Operator (FBO) operations on the southern side of the airport when there are southerly winds. The maximum airborne lead concentrations at Sites #8, #9, and #10 were: 0.013, 0.049, and 0. 041 $\mu g/m^3$ (9%, 33%, and 27% of the standard), respectively.

Of all the sites monitored during the Lead Gradient Study, Site #9 had the highest maximum airborne lead concentration of any of the sites that have public access, and the second highest of all sites (as expected, airborne lead concentrations were higher at the primary run-up area site (Site #4 – not in a public access area)).

Site #9 is in a public access area, just to the north of the pilot access road to the northern aircraft parking area, and immediately adjacent to the northern airport fence line. Based on the maximum airborne lead concentrations measured during this study, any long-term lead monitoring at McClellan-Palomar Airport should be performed at this location using FRM equipment (i.e., TSP Hi-Vol).

6.2.3 Sampling Day Specific Discussions on Airborne Lead Concentrations

Airborne concentrations of pollutants are dependent upon a number of factors. For emissions from a source, the downwind concentrations are dependent upon the emission rate, the height of the emission above the ground, the temperature and velocity of the exhaust, terrain characteristics, and a wide-variety of atmospheric variables. For example, dispersion near the surface is greater on windy days than on days with low wind speeds due to surface-induced (or frictional) turbulence. The vertical stability of the atmosphere also plays a large role in atmospheric dispersion.

For this study we have very limited data on the emission factors from aircraft engines because we know so little about the actual aircraft operating on one day versus another. To do proper dispersion modeling for an airport we would need detailed information about each piston-engine type operated (i.e., emission factors for various power settings), how long they operated on the airport, where they were at each moment and how high their power settings were, etc. This information is not available. Modeling would also require more detailed atmospheric data than in currently available for this location.

We must therefore rely on the monitoring data collected during the study. The following discussions focus on the available meteorology (hourly winds – plotted in wind roses) and the resultant airborne lead concentrations measured on each sampling day.

<u>Thursday, April 25, 2013 [458 Flight Operations]</u>

The highest measured airborne lead concentrations of the Lead Gradient Study for the Background site (Site #1 – tied with May 22 for this site) and Helipad site (Site #3 – tied with May 1 for this site) and the 2nd and 3rd Gradient sites (Site #6 and Site #7, respectively) were measured on this sampling date. The airport site map with a wind rose overlay is provided in Figure 6. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Over half (54%) of the wind observations during the lead sampling period were classified as calm (i.e., < 1 knot), while daytime winds were relatively strong on this date (blue is stronger than red, which is stronger than yellow – see Appendix B). The airborne lead concentrations tabulated for each site are also included in Figure 6.

The relatively high concentration for the Background site (Site #1) implies some aircraft operations at the westerly end of the runway or emissions on the taxiway during the easterly winds. The relatively high concentration for the Helipad site (Site #3) measured on this sample date implies that there was higher than normal helicopter training activity (helicopters used for training tend to be piston-engine driven) or other, localized aircraft operations in this area of the airport. The relatively strong westerly winds on this date would have created eddies downwind of the large hanger buildings to the west of the Helipad site. This can trap emissions in the building wake, leading to higher airborne lead concentrations.

The nearby run-up area site (Site #4) is relatively low compared to the other Lead Gradient Study sample days. The combination of aircraft operations locations and strong winds appear to have had lesser impacts on Site #4, and the 1st Gradient site (Site #5) as well. The relatively higher impacts at the 2nd and 3rd Gradient sites (i.e., Site #6 and Site #7, respectively) could be explained by emissions from the helipad area being blown eastward before turning slightly north-northeastward, thereby missing sites #4 and #5, and having greater impacts on sites #6 and #7. The impacts on sites #6 and #7 could also result from emissions from the runway area that are advected eastward (reported winds that were used to create the wind rose are hourly averages, while instantaneous winds can be much more variable, and therefore lead to plume meander).

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
4/25/2013	0.006	0.008	0.007	0.029	0.093	--	0.019	0.030	0.014	--	0.005	0.007	0.005

Figure 6. Airport site map with wind rose overlay for Thursday, April 25, 2013 (54.2% calm). Airborne lead concentration data are included for this sample day.

Wednesday, May 1, 2013 [482 Flight Operations]

The highest measured airborne lead concentrations of the Lead Gradient Study for the Passenger Terminal Tarmac sites (Site #2 and Site #2A) and the Helipad site (Site #3 – tied with April 25 for this site) were measured on this sampling date. The airport site map with a wind rose overlay is provided in Figure 7. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Roughly 38% of the wind observations during the lead sampling period were classified as calm (i.e., < 1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3
5/1/2013	n/a	0.011	0.010	0.029	0.085	--	0.017	0.011	0.008	0.009	n/a	0.003	0.004

Figure 7. Airport site map with wind rose overlay for Wednesday, May 1, 2013 (37.5% calm). Airborne lead concentration data are included for this sample day.

The relatively high values of airborne lead for these sites indicate that the southerly and northerly components of the winds blew emissions from the taxiway and runway environments towards these monitors, and away from the run-up area (Site #4 – relatively low on this date).

<u>Saturday, May 4, 2013 [521 Flight Operations]</u>

The highest measured airborne lead concentrations of the Lead Gradient Study for the Run-Up Area site (Site #4) and the Northeast Fence sites (Sites #10, #9, and #8) were measured on this sampling date. The airport site map with a wind rose overlay is provided in Figure 8. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Only 8% of the wind observations during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

The southerly winds on this date blew aircraft emissions from the primary run-up area to the Run-Up area site (Site #4) and towards the Northeast Fence sites (Sites #8, #9, and #10). The Gradient sites (Sites #5, #6, and #7) were all lower than average on this date, indicating that the southerly winds blew emissions away from these sites. The Upwind site (Site #1), Passenger Terminal Tarmac sites (Site #2 and Site #2A) and the Helipad site (Site #3) were all lower than average, indicating that the southerly winds advected relatively clean air across the airport on this date.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3
5/4/2013	0.001	0.005	0.005	0.004	0.215	--	0.008	0.003	0.002	0.003	0.013	0.049	0.041

Figure 8. Airport site map with wind rose overlay for Saturday, May 4, 2013 (8.3% calm). Airborne lead concentration data are included for this sample day.

<u>Tuesday, May 7, 2013 [383 Flight Operations]</u>

The measured airborne lead concentration for the Run-Up Area site (Site #4) was only slightly above the average for the Lead Gradient Study on this sampling date. The airport site map with a wind rose overlay is provided in Figure 9. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Roughly 21% of the wind observations during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

Southwesterly winds should have advected run-up area emissions towards the more eastern of the Northeast Fence sites (i.e., Sites #9 and #8). However, these sites did not collect valid data on this date and no data are available. Airborne lead concentrations at all other sites were near average (for the Lead Gradient Study) levels.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
5/7/2013	0.001	0.007	0.008	0.005	0.124	--	0.015	0.006	0.004	0.005	n/a	n/a	0.010

Figure 9. Airport site map with wind rose overlay for Tuesday, May 7, 2013 (20.8% calm). Airborne lead concentration data are included for this sample day.

Friday, May 10, 2013 [535 Flight Operations]

The wind rose for this date shows predominately onshore (westerly) winds for the entire sampling period. The airport site map with a wind rose overlay is provided in Figure 10. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Exactly half of the wind observations during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

Airborne lead concentrations were at or below average (for the Lead Gradient Study) at most of the sites on this sampling date. The Passenger Terminal Tarmac sites (Site #2 and Site #2A) and the Helipad site (Site #3) were slightly higher than average, indicating that aircraft operations on the southern side of the airport were advected eastward.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
5/10/2013	0.003	0.008	0.007	0.019	0.096	--	0.013	0.008	0.007	0.007	0.005	0.008	0.009

Figure 10. Airport site map with wind rose overlay for Friday, May 10, 2013 (50.0% calm). Airborne lead concentration data are included for this sample day.

Monday, May 13, 2013 [455 Flight Operations]

The wind rose for this date shows predominately onshore (westerly component) winds, with periods of west-southwest and west-northwesterly winds during the sampling period. The airport site map with a wind rose overlay is provided in Figure 11. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Approximately 46% of the wind observations collected during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

Airborne lead concentrations were at or below average (for the Lead Gradient Study) at most of the sites on this sampling date. The Passenger Terminal Tarmac sites (Site #2 and Site #2A) and the Helipad site (Site #3) were slightly higher than average, indicating that aircraft operations on the southern side of the airport were advected eastward.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
5/13/2013	n/a	0.006	0.007	0.017	0.043	0.044	0.020	0.014	0.011	--	0.004	0.003	0.004

Figure 11. Airport site map with wind rose overlay for Monday, May 13, 2013 (45.8% calm). Airborne lead concentration data are included for this sample day.

Thursday, May 16, 2013 [129 Flight Operations – the lowest number that occurred on a sampling day during this study]

The wind rose for this date shows relatively strong (red) southwesterly winds, with a large percentage (based on the length of the wind indicator) of light southerly to south-southeasterly winds (yellow) during the sampling period. The airport site map with a wind rose overlay is provided in Figure 12. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). None of the wind observations collected during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

Only the run-up area site was above average (for the Lead Gradient Study) for airborne lead concentrations on this sampling day. The localized emissions from the run-up area were responsible for this, and the stronger winds effectively dispersed the emissions before they reached the sites further downwind. The small number of flight operations contributed to the lower concentrations as well. It appears that weather, including a weak frontal system approaching from the northwest, stratus clouds, and sustained, relatively strong winds resulted in fewer recreational flights on this day.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
5/16/2013	n/a	0.003	0.005	0.001	0.142	0.143	0.010	0.004	0.003	--	0.008	0.013	0.008

Figure 12. Airport site map with wind rose overlay for Thursday, May 16, 2013 (0.0% calm). Airborne lead concentration data are included for this sample day.

Sunday, May 19, 2013 [603 Flight Operations – the highest number that occurred on a sampling day during this study]

The wind rose for this date shows that stronger winds (red) were from the west to west-southwest, while a large percentage (based on the length of the wind indicator) of winds (yellow) were south-southwesterly during the sampling period. The airport site map with a wind rose overlay is provided in Figure 13. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). 25% of the wind observations collected during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

The Northeast Fence sites (Site #8, #9, and #10) measured higher than average concentrations on this sampling day. Site #9 had the second highest airborne lead concentration for that site during the Lead Gradient Study, which is consistent with the winds for the day and the close proximity to the secondary run-up area on the north side of the airport. All sites east of the Helipad site (Site #3) had airborne lead concentrations above average (for the Lead Gradient Study) on this sampling day. These airborne lead measurements are consistent with the wind patterns for the sampling day.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3
5/19/2013	0.000	0.001	0.003	0.014	0.158	0.141	0.019	0.011	0.008	--	0.013	0.032	0.013

Figure 13. Airport site map with wind rose overlay for Sunday, May 19, 2013 (25.0% calm). Airborne lead concentration data are included for this sample day.

<u>Wednesday, May 22, 2013 [491 Flight Operations]</u>

The wind rose for this date shows strong southwesterly winds, with a large percentage of southerly to south-southeasterly winds (mostly light) during the sampling period. The airport site map with a wind rose overlay is provided in Figure 14. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). None of the wind observations collected during the lead sampling period were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

The Background site (Site #1) measured its highest airborne lead concentration (tied with April 25) for that site during the Lead Gradient Study. Most other sites were near their averages for the Lead Gradient Study on this sampling day. These airborne lead measurements are consistent with the wind patterns for the sampling day.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
5/22/2013	0.006	0.010	0.004	0.005	0.131	0.129	0.016	0.007	0.006	--	0.009	0.017	0.011

Figure 14. Airport site map with wind rose overlay for Wednesday, May 22, 2013 (0.0% calm). Airborne lead concentration data are included for this sample day.

Saturday, May 25, 2013 [378 Flight Operations]

The wind rose for this last sample day of the Lead Gradient Study shows that relatively strong southwesterly winds were prevalent during the sampling period. The airport site map with a wind rose overlay is provided in Figure 15. The wind rose represents the data from the lead sample collection period (i.e., 10 a.m. to 10 a.m. the following day). Roughly 29% of the wind observations collected during the lead sampling periods were classified as calm (i.e., <1 knot). The airborne lead concentrations tabulated for each site are also included in this figure.

The sites measured airborne lead concentrations that were near their averages for the Lead Gradient Study. These airborne lead measurements are consistent with the wind patterns for the sampling day.

	Site#1	Site#2	Site#2A	Site#3	Site#4	Site#4	Site#5	Site#6	Site#7	Site#7	Site#8	Site#9	Site#10
Sample collection date	Background	Tarmac of Passenger Terminal	TSP Hi Vol FRM	Helipad	Run up Area	Collocated	1st Gradient site (310')	2nd Gradient site distance 620'	3rd Gradient site distance 920'	Collocated	1st Northeast fence site	2nd Northeast fence site	3rd Northeast fence site
	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
5/25/2013	0.002	0.004	0.004	0.011	0.122	0.115	0.017	0.009	0.005	--	0.004	0.006	n/a

Figure 15. Airport site map with wind rose overlay for Saturday, May 25, 2013 (29.2% calm). Airborne lead concentration data are included for this sample day.

7. CONCLUSIONS

The previous 1-year EPA-funded study detected elevated levels of airborne lead near the primary run-up area at McClellan-Palomar Airport in Carlsbad, California. In that study the lead sampler was in very close proximity to where piston-driven aircraft engines operate at relatively high power settings and sampled localized exhaust emissions, rather than ambient air to which the public could be exposed. Furthermore, members of the general public do not have access in this area.

The District expressed concerns to the EPA that this single-test location was inadequate to accurately document airborne lead levels on and around the airport. The District's position is that the airborne lead levels measured are inconclusive as a result of the EPA's project design that searched for maximum impacts, regardless of whether or not the sampling location was in an area with public access.

Due to concerns over the EPA's single-location testing protocol in a maximum impact area, the District used internal funds to conduct a more rigorous lead testing program at the McClellan-Palomar Airport (Lead Gradient Study). The District conducted this study to document airborne lead concentrations in numerous locations on the airport property.

The primary objective of the Lead Gradient Study was to investigate airborne lead concentrations inside the McClellan-Palomar Airport property where pilots, passengers, airport personnel, and other members of the public have access. Additional objectives were to document how these concentrations varied as a function of the distance from the primary run-up area, and to measure airborne lead levels at the airport perimeter, where there is the greatest potential for exposure to the general public.

The study showed that lead levels measured during the 1-year EPA-funded study are not representative of airborne lead concentrations in areas readily accessible to the public. The airborne lead measurements collected during the 1-year EPA-funded study exceeded the minimum threshold and will require continuous airborne lead monitoring at McClellan-Palomar Airport. Results from the Lead Gradient Study show that additional or continued measurements in the primary run-up area will not be representative of areas that are accessible to the public, and would not contribute to protecting public health.

The most representative location for future airborne lead monitoring and protecting public health is Site #9 from the Lead Gradient Study (along the perimeter fence in the northeast corner of the airport property). This site measured the highest airborne lead concentrations outside of the primary run-up area and represents the area with the greatest potential for exposure to the general public.

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APPENDIX

A

McClellan – Palomar Airport Lead Monitoring Sites

Figure A-1. Map image of McClellan-Palomar Airport showing sampling locations for the Lead Gradient Study.

APPENDIX

B

McClellan – Palomar Airport Wind Rose
for 7 a.m. to 7 p.m., April and May, 2008 through 2010

Figure B-1. Map image of McClellan-Palomar Airport showing daytime (7 a.m. through 7 p.m.) wind rose for April and May, 2008, 2009, and 2010.

46% of the wind observations from this time period were classified as calm (i.e., <1 knot).

The color codes for this and other wind roses in this report are as follows:

Light Green: 0 to 4 knots.
Yellow: 4 to 7 knots.
Red: 7 to 11 knots.
Dark Blue: 11 to 17 knots.

APPENDIX

C

EPA 2013 Monitoring Schedule

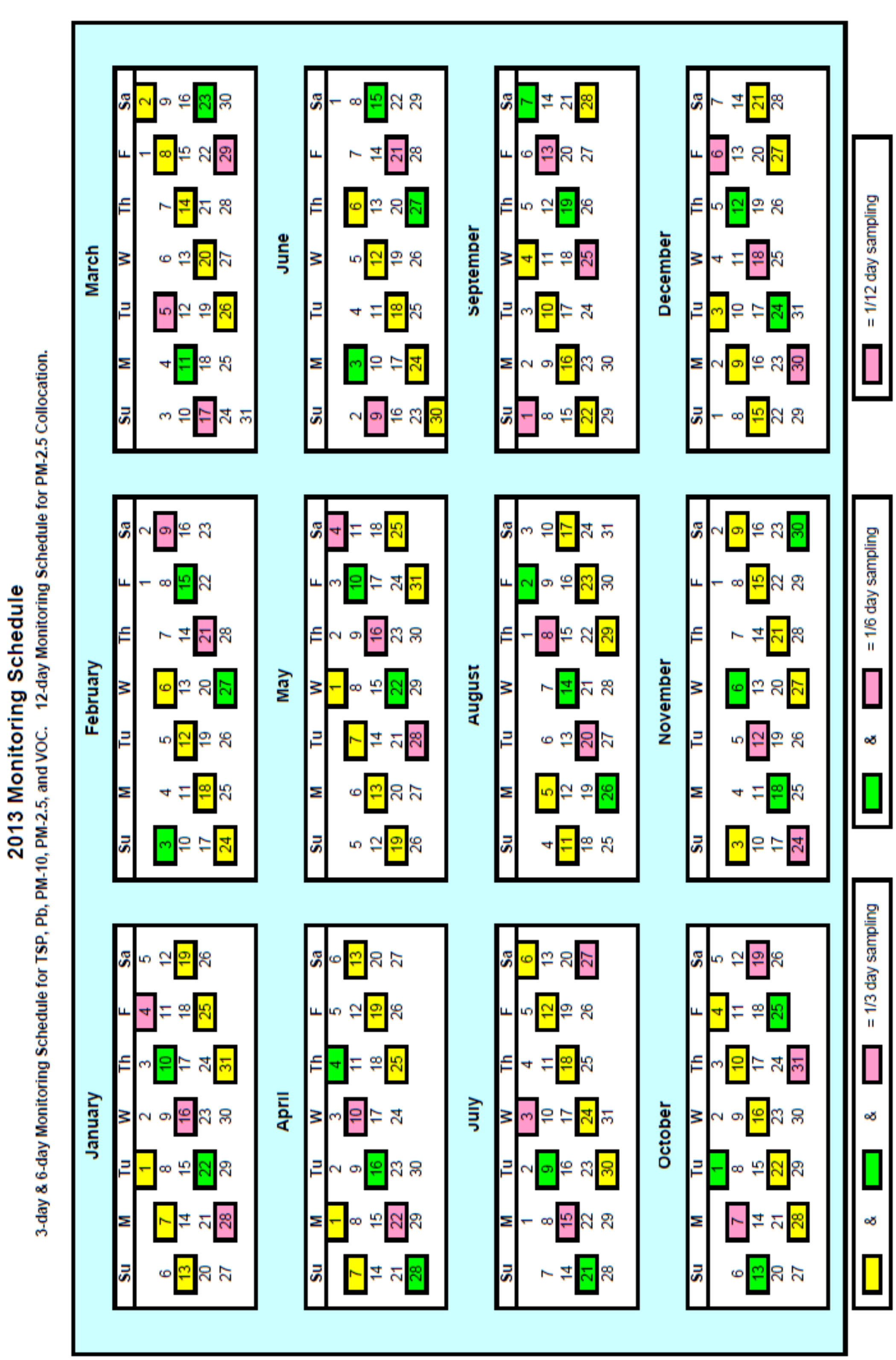


Figure C-1. EPA 2013 Monitoring Schedule.

APPENDIX

D

McClellan – Palomar Airport Lead Monitoring Study

Chain-of-Custody Forms
Calibration Forms
Audit Forms

Total Suspended Particulate
MiniVol Portable Air Sampler
S/N: 1217

Location: McClellan - Palomar Airport
Datum WGS84
Lat 33.126370 N Long 117.288510 W

Revision 1b
May 06, 2013
Site ID 01

Filter assembled by	Date	Time	Filter S/N (Site ID, Sampler S/N, & Run date)
David Sodeman	5/16/13	16:28	St01_1217_051913

1) TB=Trip blank; 2) FB=Field blank

filter lot # 13059-7DC-341

Released by	Received by	Date	Time	Inspection (pass or fail & reason)
David Sodeman	Lab	5/16/13	16:52	Pass
LAB	Noel Seefeldt	5/17/13	09:10	PASS
Noel Seefeldt	Lab	5/20/13	18:45	PASS
Lab	David Sodeman	5/21/13	838	Pass unloaded
Lab	Mark Burke	5/28/13	0905	Pass, Ingested

Site ID: 01 **Sampler S/N:** 1217 **Installed by:** Noel Seefeldt **Installation date/time:** 5/17/13 1330

New battery Y/N	Leak test without filter assembly (lpm)	Assigned filter intact Y/N	Starting flow check with filter assembly and run filter (lpm)		Standard (STD) Name, S/N, Cal due date	Timer ± 1 Min of DST (local time)		Timer **Auto Mode** start (run for 24 hrs starting at 1000)			Elapsed time indicator at start (hr.tenths)
			Flowmeter	STD (Qa)		Timer	Ref	Date	Time	Auto	
Y	0.0	Y	5.0	4.88	TRICAL 139 4/30/13	1339	1339	5/19/13	1000	Y	6795.07

1) Inlet height above ground 2 meters (6' 7"); 2) Reset the indicator lights if lit; 3) Design flow 5.0 lpm; 4) Verify the site ID & sampler S/N; 5) Wear nitrile gloves

Site ID: 01 **Sampler S/N:** 1217 **Collection by:** Noel Seefeldt **Collection date/time:** 5/20/13 1001

Run finish date mm/dd/yy	Elapsed time indicator at finish (hh.tenths)	Total run time Finish-Start (hh.tenths)	Indicator lights **on/off**		Ending flow check with filter assembly and run filter (lpm)		Standard (STD) Name, S/N, Cal due date	Assigned filter intact Y/N
			Low flow	Low batt	Flowmeter	STD (Qa)		
05/20/13	6819.09	24.0	OFF	OFF	5.0	4.88	TRICAL 139 4/30/14	Y

Comments (Filter inspection at installation and collection, weather, abnormal conditions etc.) please include the date: 5/17/13 Some clouds, light breeze
5/19 10:00 AM. UNIT DID START ON ITS OWN, BUT STILL SWITCHED UNIT TO ON. Sunny with
Some clouds - Unit was turned off at 10:01:29. Cloud + Sun, light breeze.

Figure D-1. MiniVol™ Sampler Chain-of-Custody form.

Equipment:	Airmetrics MiniVols	CALIBRATION:

STATION: Palomar Airport Site 01 OPERATOR: D. Sodeman CHECKER: ______ DATE: 5/28/2013

TARGET ANALYZER INFORMATION

Make & MN: Airmetrics MiniVol
Property #: 1217
Version #: 4.2

TRANSFER STANDARD: CALIBRATION

Make& MN: Alicat 25 slpm MFM
Property#: 13986
Cert CAL Date: 9/27/2012
Cert DUE Date: 9/27/2013
Cert Equation: y = x

CALIBRATION

	Reference	MiniVol		CALCULATIONS		
	Actual (Lpm)	Set Pt.	Obs Flow (Lpm)	%Diff	Status Lim ±10%	Comment
Pt 1 Run 1	5.94	6.0	6.0			
Pt 1 Run 2	5.96	6.0	6.0			
Pt 1 Run 3	5.96	6.0	6.0			
Point 1 Avg	5.95	6.0	6.0	0.8	PASS	NO calib needed
Pt 2 Run 1	4.93	5.0	5.0			
Pt 2 Run 2	4.95	5.0	5.0			
Pt 2 Run 3	4.98	5.0	5.0			
Point 2 Avg	4.95	5.0	5.0	1.0	PASS	NO calib needed
Pt 3 Run 1	3.90	4.0	4.0			
Pt 3 Run 2	3.91	4.0	4.0			
Pt 3 Run 3	3.90	4.0	4.0			
Point 3 Avg	3.90	4.0	4.0	2.6	PASS	NO calib needed

LEAK TEST: filter assembly in place

	Display	At Rest	Actual	Limit (lpm)	Status
Reference	0.00	0.00	0.00	0	PASS
MiniVol	0.5	0.0	0.5	0	FAIL

LEAK TEST: NO filter assembly in place

MiniVol	0.0	0.0	0.0	0	PASS

only needs to be run in above leak check fails

Average %Diff 1.5
Slope 1.025
Intercept -0.192
Correlation Coefficient 1.000

OVERALL STATUS

MInIVOl	LIMIT	STATUS
ALL OK	All Okay	NO CALIB NEEDED

COMMENTS

CALCULATIONS

%Diff= { (Observed- Reference) / Stnd } *100

Version 2 SDAPCD 12/2012

Figure D-2. MiniVol™ Sampler Calibration form.

Equipment:	Airmetrics MiniVols	AUDIT

STATION: Palomar Airport Site 3 OPERATOR: D. Roque CHECKER: ______ DATE: 5/8/2013

TARGET ANALYZER INFORMATION

Make & MN: Airmetrics MiniVol
Serial Number: 5080
Version #: 5.0
Slope: 1.198
Intercept: -0.602
Cal Date: 4/24/2013

TRANSFER STANDARD: AUDIT

Make& MN: Trical
S/N#: 257
Cert CAL Date: 2/26/2013
Cert DUE Date: Feb. 2014

AUDIT

	Reference Actual (Lpm)	MiniVol Set Pt.	Obs Flow (Lpm)	Corr. Flow (Lpm)	CALCULATIONS %Diff	Status Lim ±10%	Comment
Set point	5.35	5.0	5.0	5.4	0.7	PASS	

	Reference	SYS	abs(DIFF)	Limit	Status
Clock	11:44	11:44	0.00	≤ 5 min	pass
Day	wed	wed	0	0 day	pass

LEAK TEST: filter assembly in place

	Display	At Rest	Actual	Limit (lpm)	Status
Reference	0.00	0.00	0.00	0	PASS
MiniVol	0	0.0	0.0	0	PASS

LEAK TEST: NO filter assembly in place

MiniVol	n/a	n/a	n/a	n/a	n/a

only needs to be run in above leak check fails

OVERALL STATUS

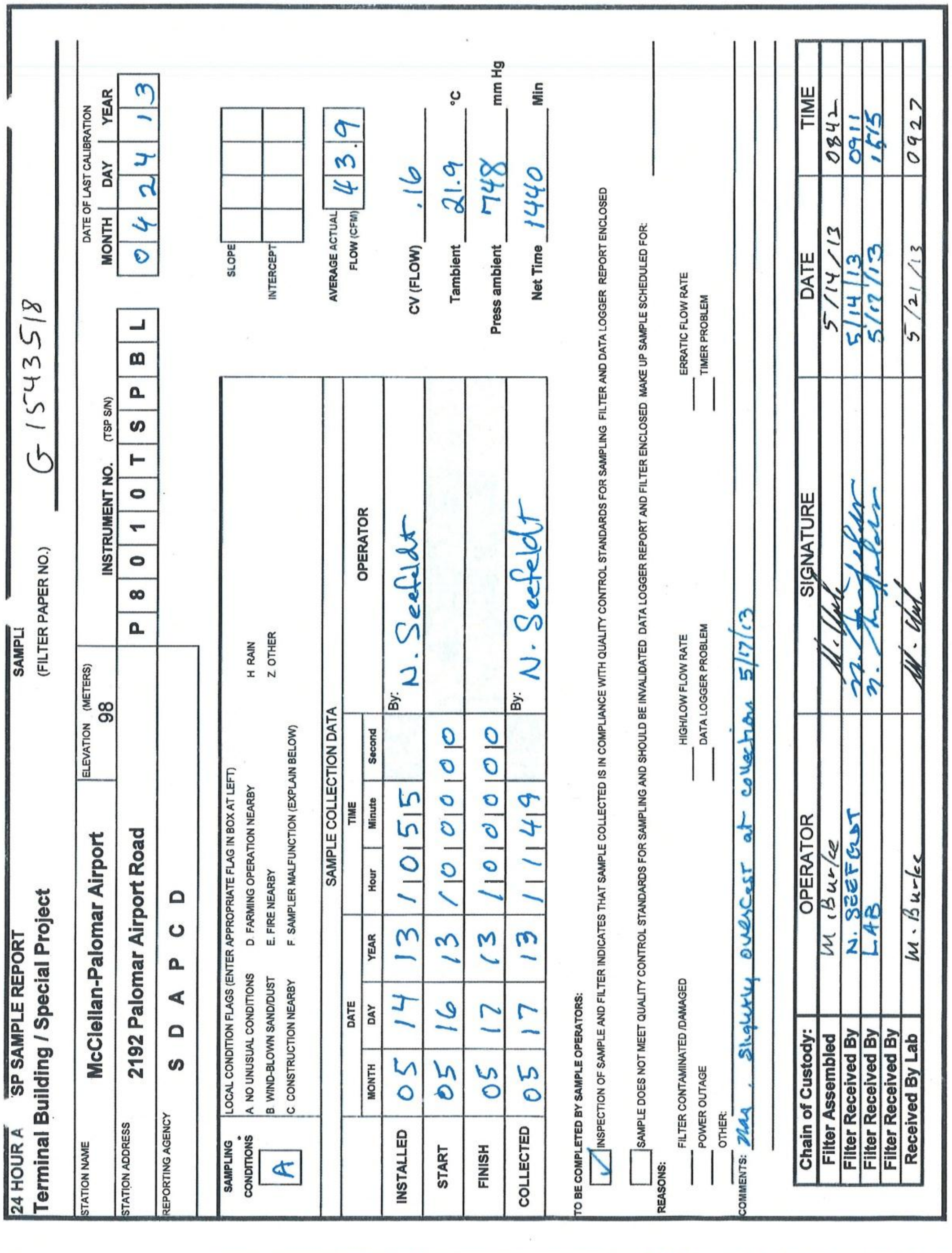
MiniVOl	STATUS
ALL OK	NO CALIB NEEDED

COMMENTS:

CALCULATIONS

%Diff= { (Observed- Reference) / Stnd } *100

Figure D-3. MiniVol™ Sampler Audit form.



24 HOUR A SP SAMPLE REPORT SAMPLE

Terminal Building / Special Project

(FILTER PAPER NO.) G 1543518

STATION NAME	McClellan-Palomar Airport	ELEVATION (METERS)	98
STATION ADDRESS	2192 Palomar Airport Road	INSTRUMENT NO. (TSP S/N)	P 8 0 1 0 T S P B L
REPORTING AGENCY	S D A P C D	DATE OF LAST CALIBRATION (MONTH / DAY / YEAR)	04 / 24 / 13

SAMPLING CONDITIONS: A

LOCAL CONDITION FLAGS (ENTER APPROPRIATE FLAG IN BOX AT LEFT)
A NO UNUSUAL CONDITIONS D FARMING OPERATION NEARBY H RAIN
B WIND-BLOWN SAND/DUST E FIRE NEARBY Z OTHER
C CONSTRUCTION NEARBY F SAMPLER MALFUNCTION (EXPLAIN BELOW)

SLOPE
INTERCEPT

AVERAGE ACTUAL FLOW (CFM) 43.9
CV (FLOW) .16
Tambient 21.9 °C
Press ambient 748 mm Hg
Net Time 1440 Min

SAMPLE COLLECTION DATA

	DATE MONTH	DAY	YEAR	TIME Hour	Minute	Second	OPERATOR
INSTALLED	05	14	13	10	55		By: N. Seefeldt
START	05	16	13	10	00	00	
FINISH	05	17	13	10	00	00	
COLLECTED	05	17	13	11	49		By: N. Seefeldt

TO BE COMPLETED BY SAMPLE OPERATORS:
☑ INSPECTION OF SAMPLE AND FILTER INDICATES THAT SAMPLE COLLECTED IS IN COMPLIANCE WITH QUALITY CONTROL STANDARDS FOR SAMPLING FILTER AND DATA LOGGER REPORT ENCLOSED
☐ SAMPLE DOES NOT MEET QUALITY CONTROL STANDARDS FOR SAMPLING AND SHOULD BE INVALIDATED DATA LOGGER REPORT AND FILTER ENCLOSED MAKE UP SAMPLE SCHEDULED FOR:

REASONS:
___ FILTER CONTAMINATED /DAMAGED ___ HIGH/LOW FLOW RATE ___ ERRATIC FLOW RATE
___ POWER OUTAGE ___ DATA LOGGER PROBLEM ___ TIMER PROBLEM
___ OTHER:

COMMENTS: Slightly overcast at collection 5/17/13

Chain of Custody:	OPERATOR	SIGNATURE	DATE	TIME
Filter Assembled	M. Burke	[signature]	5/14/13	0842
Filter Received By	N. SEEFELDT	[signature]	5/14/13	0911
Filter Received By	LAB	[signature]	5/17/13	1515
Filter Received By				
Received By Lab	M. Burke	[signature]	5/21/13	0927

Figure D-4. TSP chain-of-custody form.

equipment: Tisch TE-5170VLVFC+ Primary | **TSP-Pb** | **FINAL CALIBRATION**

STATION: Palomar St 02 DONE BY: David Sodeman CHECKER: ______ CAL TYPE: FINAL DATE: 04/24/13

TARGET INFORMATION (station analyzer)

ANALYZER

Make& MN: Tisch TE-5170VLVFC+ Primary Property#: 13958 S/N: 600-1004

CALIBRATION DATA (previous)

Q_{prev} = { (1.17 (slope) x [Q_a from the Target Sampler]) + -7.58 (intercept) } Date of Last Cal: 11/16/12

TRANSFER STANDARD INFORMATION

ANALYZER

Make& MN: Tisch TE 5028 Property#: 10611 S/N: 2011 Cert Date: 10/24/2012 Month Due: Oct, 2013

CERTIFICATION EQUATION

Qa= { (33.8 (slope) x (SQRT [Δp_{actual} * (T_a / P_a)])) + 0.678 (intercept) }

PRESSURE SENSOR

Make& MN: Meriam DN0028 Property#: 14005 S/N: 1243000081 Cert Date: 10/23/2013 Month Due: Apr, 2014

BAROMETRIC PRESSURE SENSOR

Make& MN: TriCal Property#: ______ S/N: 139 Cert Date: 4/15/2013 Month Due: Apr, 2014

TEMPERATURE SENSOR

Make& MN: Fisher Sci 15-077-940 Property#: N/A S/N: 122257832 Cert Date: 5/8/2012 Month Due: May, 2014

TSP-Pb CALIBRATION

	TRIAL (#)	*Sampler* Q_a *(cfm)*	METER PRESSURE $\Delta P_{uncorrected}$ (in H_2O)	offset (in H_2O)	ΔP (in H_2O)	Temp (°C)	Press Pa (mmHg)	REF Q_a (cfm)	Sampler Q_{prev} (scfm)	%DIFF $Q_{prev}/Q_{a(REF)}$ (%)	Status $Q_{prev}/Q_{a(REF)}$ (pass/fail)	%DIFF $Q_{a(Sam)}/Q_{a(REF)}$ (%)	Status $Q_{a(Sam)}/Q_{a(REF)}$ (pass/fail)
Point 1	1	45.3	4.44	0.00	4.44	19.3	749						
	2	45.3	4.53	0.00	4.53	19.0	749						
	3	45.2	4.47	0.00	4.47	18.7	749						
	AVERAGE	45.3	4.48	0.00	4.48	19.0	749	45.36	45.42	0.13	pass	-0.13	pass
Point 2	1	44.5	4.35	0.00	4.35	19.5	749						
	2	44.5	4.31	0.00	4.31	19.6	749						
	3	44.5	4.29	0.00	4.29	19.5	749						
	AVERAGE	44.5	4.32	0.00	4.32	19.5	749	44.59	44.49	-0.22	pass	-0.20	pass
Point 3	1	43.7	4.15	0.00	4.15	18.8	749						
	2	43.7	4.12	0.00	4.12	18.6	749						
	3	43.7	4.13	0.00	4.13	19.1	749						
	AVERAGE	43.7	4.13	0.00	4.13	18.8	749	43.56	43.55	-0.02	pass	0.32	pass
Point 4	1	42.9	3.96	0.00	3.96	19.9	749						
	2	42.9	3.98	0.00	3.98	20.2	749						
	3	42.9	3.94	0.00	3.94	20.6	749						
	AVERAGE	42.9	3.96	0.00	3.96	20.2	749	42.77	42.61	-0.37	pass	0.30	pass
Point 5	1	42.0	3.79	0.00	3.79	20.5	749						
	2	42.0	3.78	0.00	3.78	20.0	749						
	3	41.9	3.77	0.00	3.77	19.7	749						
	AVERAGE	42.0	3.78	0.00	3.78	20.1	749	41.80	41.56	-0.57	pass	0.48	pass

SENSOR CALIBRATIONS

Pre-Calibration Check (As Is)	REF	SYS	abs(DIFF)	Limit	Status
Amb Temp	18.9	16.9	2	± 2°C	pass
Amb Press	749	750	1	≤ 10 mmHg	pass
Clock	16:02	15:06	0.04	≤ 5 min	pass

Calibration	REF	SYS	abs(DIFF)	Limit	Status
Amb Temp	19.0	17	2	± 2°C	pass
Amb Press	749	750	1	≤ 10 mmHg	pass
Clock	16:03	15:07	0:56	≤ 5 min	pass

Post-Calibration Check	REF	SYS	abs(DIFF)	Limit	Status
Amb Temp	19.1	19.3	0.2	± 2°C	pass
Amb Press	749	749	0	≤ 10 mmHg	pass
Clock	16:04	16:04	0:00	≤ 5 min	pass

CLEAN FILTER POINT

$Qa_{(Sam)}$: 44 cfm

$Qa_{(REF)}$: 44.0 scfm

%Diff: 0.00 %

Q_{design}: 44.5 cfm

%Diff: -1.12 %

NEW CALIBRATION INFORMATION

Slope: **1.09**

Intercept: **-4.00**

r: **0.9992**

%Diff: **0.15** %

CRITICAL PERFORMANCE CRITERIA	STATUS
Passing: $Qa_{(Sam)} \leq \pm 10\%$ Diff from Q_{design} Overall	pass
Warning: $Qa_{(Sam)}$ ±5% ≤ %Diff < ±10% Q_{design} rate Overall	pass
Passing: $Qa_{(Sam)}$ ≤ 7% of $Qa_{(REF)}$ per Level and Overall	pass
Warning: $Qa_{(Sam)}$ ±5% ≤ %Diff < ±7% of $Qa_{(REF)}$ per Level and Overall	pass
$r \geq 0.97$	pass

CALCULATIONS

Q_{prev} = (slope x $Q_{a(Sam)}$)+intercept Ta= 273.15 + Temp(°C)

$\Delta P = \Delta P_{uncorrected}$ - offset Q_{design} = 44.5 cfm

COMMENTS Start Time: 15:50 End Time: 17:03 **LAST CAL DATE:** 11/16/2012

SDAPCD TSP-Pb CALIBRATION DATA SHEET 3/31/2013

Figure D-5. TSP Calibration form.

equipment:	Tisch	Main		Pb-TSP	AUDIT

STATION: Palomar Airport DONE BY: David Roque CHECKER: ____________ DATE: 05/08/13

TARGET INFORMATION (station analyzer)

ANALYZER

Make& MN: Tisch Main Property#: 13958 S/N: 600-1004

CALIBRATION DATA

Q_{calib}= { (1.09 (K1) x Q_a from the Target Sampler) + -4.00 (K2) } Date of Last Cal: 04/24/13

TRANSFER STANDARD INFORMATION

ANALYZER

Make& MN: BGI hivolCAL Property#: 14022 S/N: 91 Cert Date: 1/24/2013 Month Due: Jan. 2014

PRESSURE SENSOR

Make& MN: BGI hivolCAL Property#: 14022 S/N: 91 Cert Date: 1/24/2013 Month Due: Jan. 2014

BAROMETRIC PRESSURE SENSOR

Make& MN: BGI hivolCAL Property#: 14022 S/N: 91 Cert Date: 1/24/2013 Month Due: Jan. 2014

TEMPERATURE SENSOR

Make& MN: Traceable Property#: n/a S/N: 122257816 Cert Date: 5/8/2012 Month Due: May. 2014

TSP AUDIT

FIVE MINUTE AVERAGES

TRIAL (#)	REF Q_a (cfm)	Sampler Qa (scfm)	Sampler Q_{calib} (scfm)	%DIFF Q_a/Q_{calib} (%)	Status Q_a/Q_{calib} (pass/fail)	%DIFF Q_a/Q_{design} (%)	Status Q_a/Q_{design} (pass/fail)
1	45.1	45.5	45.6	1.1	pass	1.3	pass
2	45.1	45.6	45.6	1.1	pass	1.3	pass
3	45.1	45.6	45.6	1.1	pass	1.3	pass
AVERAGE	45.1	45.6	45.6	1.1	pass	1.3	pass

SENSOR Audits

	REF	SYS	abs(DIFF)	Limit	Status
Clock	11:23	11:23	0:00	≤ 5 min	pass
Date	5/8/2013	5/8/2013	0	Exact	pass
Amb Temp	17	18.5	1.5	± 2°C	pass
Amb Press	756	753	3	≤ 10 mmHg	pass

COMMENTS Start Time: 1000am End Time: 1045am

CRITICAL PERFORMANCE CRITERIA	STATUS
Passing: Q_{std} ≤ 10 %Diff from Q_{design} per Trial & Overall	pass
ReCal: Q_{std} 7% ≤ %Diff < ±10% from Q_{design} per Trial & Overall	pass
Warning: Q_{std} 5% ≤ %Diff < ±7% from Q_{design} per Trial & Overall	pass
Passing: Q_{std} ≤ 10 %Diff from Q_{calib} per Trial & Overall	pass
ReCal: Q_{std} 7% ≤ %Diff < ±10% from Q_{calib} per Trial & Overall	pass
Warning: Q_{std} 5% ≤ %Diff < ±7% from Q_{calib} per Trial & Overall	pass
Passing: 39 ≤ Qstd ≤ 60 cfm	pass

CALCULATIONS

Pa= Pbar * Correction

Ta= 273.15 + Temp(°C)

ΔP= $\Delta P_{uncorrected}$ - offset

Pbar= Pbar(inHg) / 0.0394

Q_{calib}= (K1 x Q_a (sampler))+K2

Figure D-6. TSP Audit form.