



Sonoma Technology, Inc.
Environmental Science and Innovative Solutions

Thirty-Third Quarterly Report of Ambient Air Quality Monitoring at Sunshine Canyon Landfill and Van Gogh Elementary School

December 1, 2015 – February 29, 2016

Quarterly Report
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Executive Summary

ES-1. Background

Continuous monitoring of meteorological and air quality parameters began at the Sunshine Canyon Landfill (the Landfill) and at Van Gogh Elementary School in the nearby community of Granada Hills in fall 2007. The Sunshine Canyon Landfill Upwind Site was installed in December 2015. PM₁₀ (particulate matter less than 10 microns in aerodynamic diameter) is measured hourly, wind speed (WS) and wind direction (WD) are measured as 1-minute averages, and black carbon (BC, a surrogate for diesel particulate matter [DPM]) is averaged over 5-minute intervals. The collected data undergo quarterly validation and are evaluated for completeness. BC data are compensated for filter tape saturation effects, which cause BC values to be underestimated. In the data collected since 2007, this compensation increases values by about 16% compared to uncompensated values.

Following data validation, all data are reported as hourly averages. PM₁₀ concentrations are then compared with federal and state PM₁₀ standards. When PM₁₀ exceedances occur, additional comparisons are made with the historical, regional, and annual ambient PM₁₀ concentrations. At least annually, the PM₁₀ and BC data are analyzed to characterize the impact of landfill operations on ambient air quality on a neighborhood scale. The validated hourly data and a summary of the analytical results and field operations are reported to the Planning Department of the City of Los Angeles and to the Los Angeles County Department of Regional Planning. This Thirty-Third Quarterly Report summarizes the December-February (winter) quarter monitoring results from the ninth year of continuous monitoring.

ES-2. Statistics

The percent data capture for PM₁₀ was approximately 100.0% at the Landfill and Van Gogh School sites, and 84.0% at the Landfill Upwind site. Approximately 10.5%, 5.4%, and 10.9% of the captured PM₁₀ data at the Landfill, Landfill Upwind, and Van Gogh School sites, respectively, were invalidated. Zero hourly values were deemed suspect at the Landfill and Landfill Upwind sites, whereas 1.2% hourly values were deemed suspect at the Van Gogh School site. BC data capture was 96.3% at the Landfill site, with 0.3% of the data invalidated. A relatively large portion (33.2%) of this data set was deemed suspect due to problems with the Aethalometer filter tape. BC data capture was approximately 100% at the Van Gogh School site, with 0.87% of the data invalidated and none deemed suspect. At the new Landfill Upwind site, BC data capture was 88%, with 0.2% data invalidated and 0.6% deemed suspect. There were no exceedances of the federal 24-hr PM₁₀ standard of 150 µg/m³ during this quarter at any of the three sites. The percentage of days on which the state PM₁₀ standard of 50 µg/m³ was exceeded during this winter quarter was 4% (four days) at the Landfill site, and 0% (zero days) at Landfill Upwind and Van Gogh School sites.

From 2008 to 2016, winter quarter average 24-hr BC concentrations ranged from 0.38 µg/m³ to 1.47 µg/m³ at the Landfill site, and from 0.50 µg/m³ to 0.85 µg/m³ at the Van Gogh site. This winter quarter, the Landfill site had a lower BC average (0.38 µg/m³) than it has had in all prior

winter quarters. This is the first winter quarter where the Landfill Upwind site has been operational; the average 24-hr BC concentration at this site was 0.33 $\mu\text{g}/\text{m}^3$.

ES-3. Monitoring Site Infrastructure Upgrades

Republic Services (Republic) has purchased new PM_{10} monitors (Met One Instruments Model 1020) for the Landfill and Van Gogh School monitoring sites. Additionally, Republic has funded and managed the installation of the infrastructure (concrete pad, fencing, and electrical power) to support the new Landfill Upwind monitoring site on the north rim of the landfill. Sonoma Technology, Inc. (STI) began monitoring at the upwind site on December 11, 2015, measuring PM_{10} , BC, and wind speed and direction, analogous to the downwind site. The site is planned to run for a minimum of one year, at which time its utility will be assessed and a decision will be made whether to keep the site for the duration of the existing monitoring contract.

The two new PM_{10} monitors, and the STI PM_{10} monitor destined for the upwind site, were collocated in Fresno, California, to demonstrate the comparability of the monitors' performance. Similarly, the STI-supplied Aethalometer at the upwind site was collocated with the Aethalometer at the existing Landfill monitoring station for several months. Data from these tests were presented in the previous report and demonstrated a high degree of correlation and low bias between similar instruments.

1. Introduction

This report provides a summary of data completeness, ambient PM₁₀ (particulate matter less than 10 microns in aerodynamic diameter) concentrations, average and maximum black carbon (BC, a surrogate for diesel particulate matter [DPM]) concentrations, instrument flow rate verification (quality control) data, and field operations for the winter quarterly period of December 1, 2015, through February 29, 2016. This is the ninth consecutive year that winter-season data have been collected from continuous monitoring at the Sunshine Canyon Landfill and Van Gogh School monitoring sites, and the first year that winter-season data have been collected from continuous monitoring at the Sunshine Canyon Landfill Upwind monitoring site. PM₁₀ was measured with a beta-attenuation monitor (BAM), and BC was measured with an Aethalometer. **Figure 1** shows a map of the monitoring site locations.



Figure 1. Angled view of Sunshine Canyon Landfill and surrounding monitoring stations: Sunshine Canyon Landfill, Sunshine Canyon Landfill Upwind, and Van Gogh School. All monitoring stations are marked with a green cross.

2. Data Completeness

Table 1 gives completeness statistics for all measured variables during the winter quarter. The percent data capture for PM₁₀ was 100.0% at the Landfill site and Van Gogh School sites, and 84.0% at the Landfill Upwind site. Approximately 10.5%, 5.4%, and 10.9% of the captured PM₁₀ at the Landfill, Landfill Upwind, and Van Gogh School sites, respectively, were invalidated. Zero hourly values were deemed suspect at the Landfill and Landfill Upwind sites, whereas 1.2% hourly values were deemed suspect at the Van Gogh School site. Suspect data are included in subsequent analyses (e.g., regional comparisons), while invalid data are not.

Table 1. Data completeness statistics for the winter monitoring quarter.

Monitoring Location	Dates	Percent Data Capture ^a			Percent Data Valid or Suspect ^b			Percent Data Suspect ^c		
		PM ₁₀	BC	WS/WD	PM ₁₀	BC	WS/WD	PM ₁₀	BC	WS/WD
Sunshine Canyon Landfill	12/01/15-02/29/16	100.0	96.3	99.4	89.5	99.7	98.3	0.0	33.2	0.4
Sunshine Canyon Landfill Upwind	12/01/15-02/29/16	84.0	88.0	100.0	94.6	99.8	98.6	0.0	0.6	0.0
Van Gogh School	12/01/15-02/29/16	100.0	94.6	76.8	89.1	99.1	97.8	1.2	0.6	0.0

^a Percent Data Capture is the number of collected data values divided by the total number of expected data intervals in the date range (e.g., for the raw BC 1-hr data, 24 data values per day are expected), assuming a start date of December 1, 2015.

^b Percent Data Valid or Suspect is the number of data values that are either valid or suspect, divided by the number of captured data values.

^c Percent Data Suspect is the number of data values labeled as suspect divided by the number of captured data values.

BC data capture was 96.3% at the Landfill site, with 0.3% of the data invalidated. A relatively large portion (33.2%) of this data set was deemed suspect due to problems found with the Aethalometer filter tape (see site visit log information in Table 4). BC data capture was approximately 100% at the Van Gogh School site, with 0.87% of the data invalidated and none deemed suspect. At the new Landfill Upwind site, BC data capture was 88.0%, with 0.2% data invalidated and 0.6% deemed suspect.

The wind data capture percentage was 99.4%, 100.0%, and 76.8% at the Landfill, Landfill Upwind, and Van Gogh School sites, respectively. At the Landfill site, 1.7% of the wind data were invalidated, with 0.4% of wind data deemed suspect. At the Landfill Upwind site, 1.4% of the wind data were invalidated, with no wind data deemed suspect. The percentage of wind data invalidated at Van Gogh School was 2.2%, with none of the wind data deemed suspect.

3. PM₁₀ Exceedances

The federal and state PM₁₀ exceedances for the winter 2016 quarter, the winter quarters of the previous eight years (2008–2015), and the winter quarter of the baseline year (November 22, 2001–November 21, 2002) are summarized in **Table 2**. There were no exceedances of the federal 24-hr PM₁₀ standard of 150 µg/m³ during this quarter at any of the three sites. In the December 2015–February 2016 quarter, the state standard of 50 µg/m³ was exceeded 4% of the time (four days) at the Landfill site and 0% of the time (zero days) at the Landfill Upwind and Van Gogh School sites.

Table 2. Number of exceedances of federal and state 24-hr PM₁₀ standards during the winter quarters of the baseline year (2002) and 2008–2016. In the “Federal 24-Hr” column, the values are *number of exceedances* and the *date(s)* on which those exceedances occurred. In the “State 24-Hr” column, the values are *number of exceedances/total days on which valid 24-hr averages were measured* and the *percentage of exceedances* out of the total number of days on which valid 24-hr average PM₁₀ concentrations were measured. The most recent winter quarter is shown in bold.

Site	Quarterly Period	Exceedances of PM ₁₀ Standard	
		Federal 24-Hr 150 µg/m ³	State 24-Hr 50 µg/m ³
Sunshine Canyon Landfill	12/01/01–02/28/02	0	8/55 (15%)
	12/01/07–02/29/08	1 (02/14/08)	10/83 (12%)
	12/01/08–02/28/09	1 (01/09/09)	3/51 (6%)
	12/01/09–02/28/10	0	0/87 (0%)
	12/01/10–02/28/11	1 (01/20/11)	7/90 (8%)
	12/01/11–02/29/12	0	13/91 (14%)
	12/01/12–02/28/13	0	2/88 (2%)
	12/01/13–02/28/14	2 (12/04/13, 12/09/13)	14/90 (16%)
	12/01/14–02/28/15	0	10/89 (11%)
12/01/15–02/29/16	0	4/91 (4%)	
Sunshine Canyon Landfill Upwind	12/01/15–02/29/16	0	0/91 (0%)
Van Gogh School	12/01/01–02/28/02	0	7/70 (10%)
	12/01/07–02/29/08	0	2/73 (3%)
	12/01/08–02/28/09	0	6/85 (7%)
	12/01/09–02/28/10	0	0/81 (0%)
	12/01/10–02/28/11	0	1/88 (1%)
	12/01/11–02/29/12	0	2/86 (2%)
	12/01/12–02/28/13	0	3/87 (3%)
	12/01/13–02/28/14	0	1/90 (1%)
	12/01/14–02/28/15	0	4/88 (5%)
12/01/15–02/29/16	0	0/91 (0%)	

4. Average and Maximum Black Carbon Concentrations and PM₁₀ Concentrations

Although no federal or state standards exist for BC concentrations in ambient air, BC is a measurable component of ambient air that correlates well with DPM. Because of growing evidence that DPM is associated with several negative health effects, BC is often measured in an attempt to quantify the relative amounts of DPM in ambient air. Findings from the Multiple Air Toxics Exposure Study IV (MATES IV), conducted by the South Coast Air Quality Management District (SCAQMD), found DPM to be the most important toxic air pollutant contributing to risk in the Los Angeles basin.¹

Aethalometers are subject to a saturation effect, where the buildup of BC on the air sampling tape causes an artifact that affects the accuracy of the measured concentration.^{2,3} Instrument response is dampened with heavier loading (i.e., heavier concentrations) of BC aerosol. This artifact can cause BC concentration readings to be lower. However, mathematical methods to correct the BC concentration values are available and are widely used. All the reported BC values to date from the Landfill, Landfill Upwind, and Van Gogh School sites have been adjusted to compensate for this tape saturation effect; this compensation had not been performed in quarterly reports prior to the 29th Quarterly Report (winter 2015). Because the compensation process changes the reported concentration, and because uncompensated values were used in previous reports, prior-year BC concentrations shown in this report do not match concentrations reported in reports prior to the 29th Quarterly Report. All BC data shown in this report have been compensated, with the exception of data from the baseline year; raw data for the baseline year are unavailable for compensation.

Table 3 provides the 24-hr average and maximum compensated BC concentrations collected during the winter 2016 quarter and compares them to compensated BC data from the winter quarters of the eight previous years. The winter 2016 quarter data at the Van Gogh School site are similar to those of previous winter quarters, though the winter 2016 BC average at the Landfill site is the lowest winter average recorded since the beginning of the study. The average 24-hr BC concentration at the Landfill Upwind site is similarly low.

¹ South Coast Air Quality Management District (2015) MATES-IV: Multiple Air Toxics Exposure Study in the South Coast Air Basin. Final report, May. Available at <http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/mates-iv-final-draft-report-4-1-15.pdf?sfvrsn=7>.

² Drinovec L. et al. (2014) The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation. *Atmos. Meas. Tech. Discuss.*, 7(9), 10179-10220, doi: 10.5194/amtd-7-10179-2014. Available at <http://www.atmos-meas-tech-discuss.net/7/10179/2014/>.

³ Allen G. (2014) Analysis of spatial and temporal trends of black carbon in Boston. Report prepared by Northeast States for Coordinated Air Use Management (NESCAUM), Boston, MA, January. Available at nescaum.org/documents/analysis-of-spatial-and-temporal-trends-of-black-carbon-in-boston/nescaum-boston-bc-final-rept-2014.pdf/.

Table 3. Twenty-four-hour BC concentrations for the winter quarter of the baseline year (2002) and each year from 2008 through 2016. Asterisks (*) denote uncompensated BC values. The most recent winter quarter is shown in bold.

Site	Quarterly Period	BC Concentrations ($\mu\text{g}/\text{m}^3$)	
		Average 24-Hr	Maximum 24-Hr
Sunshine Canyon Landfill	12/01/01–02/28/02	0.88*	3.49*
	12/01/07–02/28/08	0.78	2.87
	12/01/08–02/28/09	0.73	2.63
	12/01/09–02/28/10	0.89	3.06
	12/01/10–02/28/11	0.63	2.82
	12/01/11–02/28/12	0.70	2.17
	12/01/12–02/28/13	0.70	2.38
	12/01/13–02/28/14	0.79	2.90
	12/01/14–02/28/15	0.75	3.17
	12/01/15–02/29/16	0.38	1.47
Sunshine Canyon Landfill Upwind	12/01/15–02/29/16	0.33	2.62
Van Gogh School	12/01/01–02/28/02	0.76*	3.72*
	12/01/07–02/28/08	0.58	2.07
	12/01/08–02/28/09	0.68	3.73
	12/01/09–02/28/10	0.76	2.29
	12/01/10–02/28/11	0.60	2.82
	12/01/11–02/28/12	0.57	2.18
	12/01/12–02/28/13	0.50	1.95
	12/01/13–02/28/14	0.51	1.84
	12/01/14–02/28/15	0.85	2.99
	12/01/15–02/29/16	0.51	2.62

Figure 2 shows a notched box-whisker plot⁴ of winter quarter PM_{10} and BC data for all nine monitoring years (2008-2016). Each box indicates the interquartile range (IQR), where 50% of the data lie, with the notch at the median. If notches do not overlap, this indicates that the median concentrations are statistically different at the 95% confidence level. The whiskers go to 1.5 times the IQR; points beyond this (outliers) are shown individually.

For PM_{10} , these plots show no statistically significant temporal trend in the concentrations over the last nine years for the winter quarter, although average PM_{10}

⁴ A notched box-whisker plot shows the entire distribution of concentrations for each year. Each box shows the 25th, 50th (median), and 75th percentiles. The whiskers indicate values that are up to 1.5 times the inter-quartile range from the 25th or 75th percentile. The boxes are notched (narrowed) at the median and return to full width at the 95% lower- and upper-confidence interval values. These plots indicate that we are 95% confident that the median falls within the notch. If the 95% confidence interval is beyond the 25th or 75th percentile, then the notches extend beyond the box (hence a “folded” appearance).

concentrations measured at the Van Gogh School site are consistently lower than those measured at the Landfill site at this time of the year.

Table 3 and Figure 2 suggest that, while there is some year-to-year variability, there is no statistically significant trend in winter-quarter 24-hr average BC over the past nine years at either the Landfill site or the Van Gogh School site. The average and maximum 24-hr winter-quarter BC concentrations at the Landfill site in 2016 are the lowest on record, and are also lower than those for the Van Gogh School site during the same period. This is similar to the concentrations in the 2015 fall quarter (September–November 2015, 32nd Quarterly Report), the 2015 summer quarter (June–August 2015, 31st Quarterly Report), and the 2015 spring quarter (March–May 2015, 30th Quarterly Report).

The Landfill Upwind site was installed on December 10 and 11, 2015; data from this site are available from December 11, 2015, at 09:00 onward. The site is generally upwind of the Landfill. The 24-hr average PM₁₀ and BC data from the three sites for the current winter quarter are shown in notched box-whisker plots in **Figures 3 and 4**, respectively. For PM₁₀, the Landfill site concentrations are higher than concentrations at the Landfill Upwind site or Van Gogh School site. Twenty-four-hour average BC is not statistically significantly different between the Landfill Upwind and Landfill sites, though more outliers (high concentrations) were measured at the Van Gogh School site.

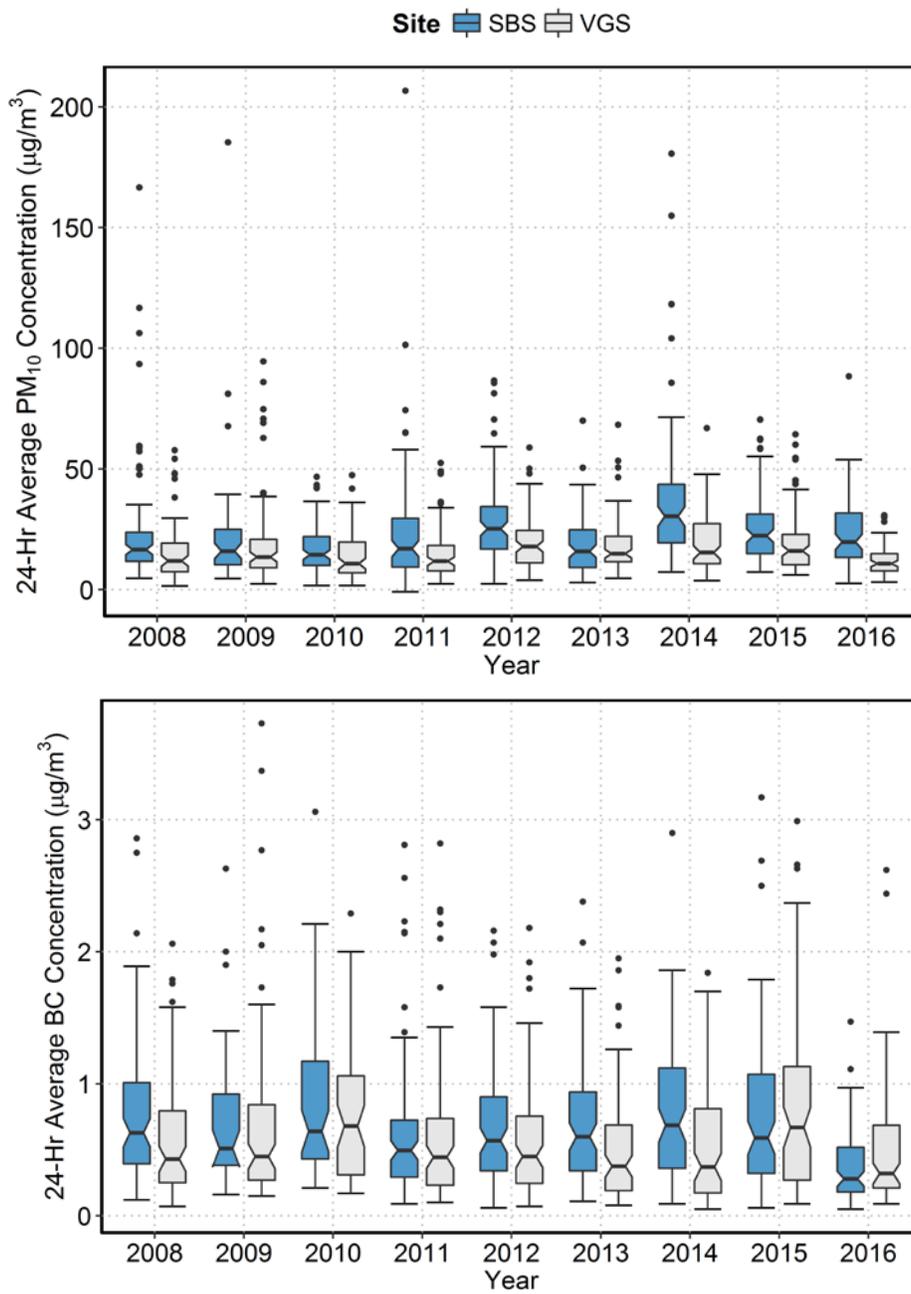


Figure 2. Notched box-whisker plot of daily 24-hr average concentrations of PM₁₀ (top) and BC (bottom) at the Landfill site (SBS) and the Van Gogh School site (VGS) during winter (December-February) quarters from 2008 to 2016.

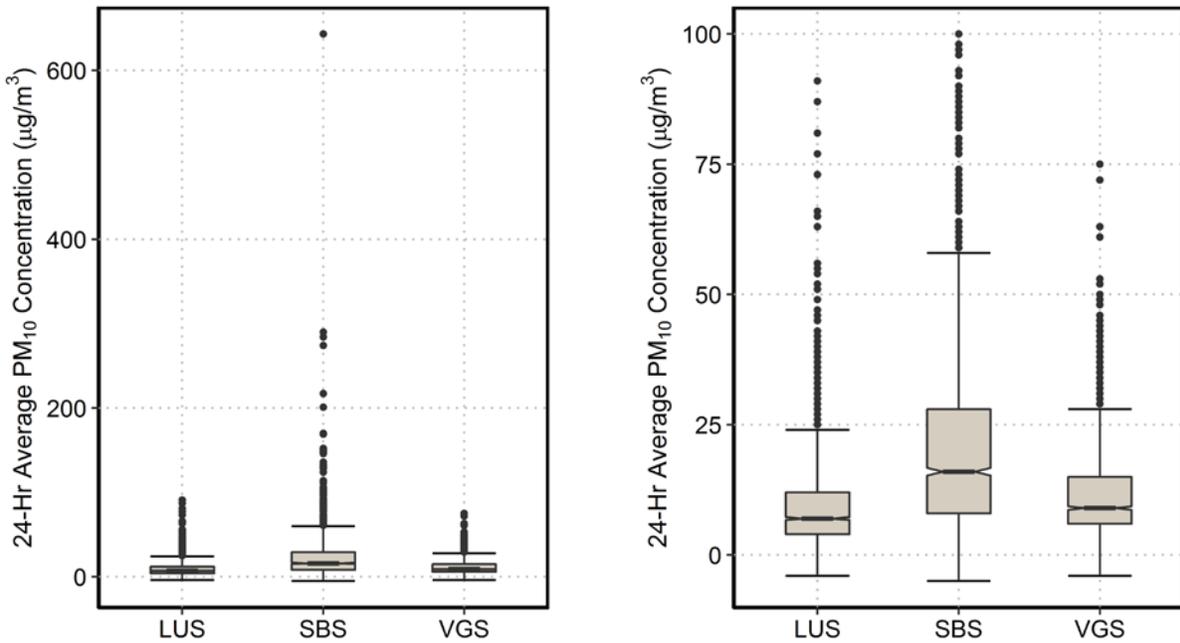


Figure 3. Notched box-whisker plots of daily 24-hr average PM₁₀ concentrations measured during the winter 2016 quarter (December 1, 2015–February 29, 2016) at the Landfill Upwind site (LUS), the Landfill site (SBS), and the Van Gogh School site (VGS). All data points (left); zoomed-in view of the data (right).

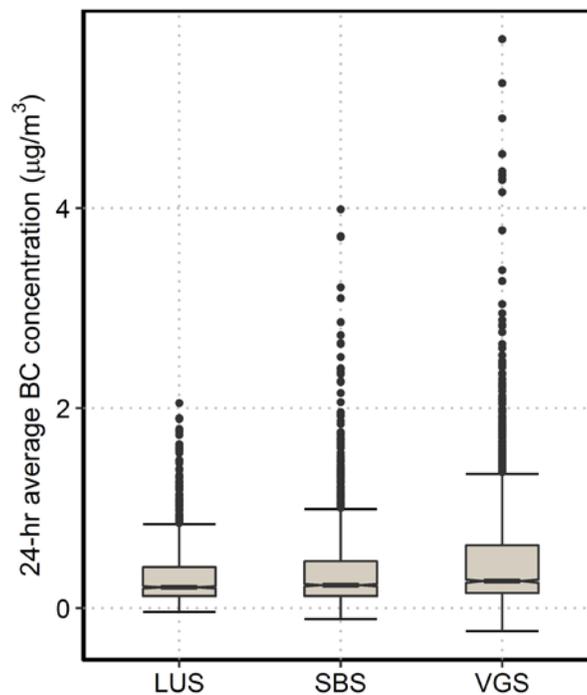


Figure 4. Notched box-whisker plot of daily 24-hr average BC concentrations measured during the winter 2016 quarter (December 1, 2015–February 29, 2016) at the Landfill Upwind site (LUS), Landfill site (SBS), and the Van Gogh School site (VGS).

5. Field Operations

Table 4, **Table 5**, and **Table 6** list dates and major tasks associated with visits to the Landfill, Landfill Upwind, and Van Gogh School sites, respectively, during the winter 2016 quarter.

Table 4. Landfill monitoring site visits, field maintenance, and operations.

Date of Site Visit	Description of Work
December 1, 2015	Collected PM ₁₀ and BC data. Incomplete site check due to high winds.
December 9, 2015	Replaced BAM s/n A3306 with BAM 1020 s/n T19280. Performed flow check on BAM sampler.
January 12, 2016	Performed flow check on BC and BAM samplers. Cleaned BAM roller, vane, and nozzle. Found BAM out of tape; installed new tape spool and restarted. Collected PM ₁₀ and BC data.
February 11, 2016	Performed flow check on BC and BAM samplers. Noticed puncture holes in Aethalometer tape and unevenly spaced sample marks; restarted Aethalometer. Found new signs of water leaks in trailer and on BAM; leak is in the roof at sample inlet penetrations and tripod base mounts. Seams repaired with Henry's roofing adhesive. Collected PM ₁₀ and BC data.

Table 5. Landfill Upwind monitoring site visits and field maintenance and operations.

Date of Site Visit	Description of Work
December 10-11, 2015	Cleaned trailer, secured trailer scissor jacks. Mounted Aethalometer to rack and installed BAM. Installed 10-m meteorological tower and 5305V wind sensor. Performed flow check and leak check on BAM sampler. Performed zero test. Adjusted wind data setup on 12/11/2015 (removed multiplier). Installed VAC and set to "Heat" (will need to be changed to "Cool" next summer). No data written to database until 12/11/2015 09:00.
December 23, 2015	Performed flow check on BC and BAM samplers. Found BAM load spool loose; re-spooled and re-tensioned with new roll.
January 12, 2016	Performed flow check on BC and BAM samplers. Collected PM ₁₀ and BC data.
February 11, 2016	Performed flow check on BC and BAM samplers. BAM had a filter tape break error; no break found but spool cap was loose; re-tensioned spool cap. Changed BAM tape supply. Collected PM ₁₀ and BC data.

Table 6. Van Gogh School monitoring site visits and field maintenance and operations.

Date of Site Visit	Description of Work
December 1, 2015	Performed flow check on BC and BAM samplers. Collected PM ₁₀ and BC data.
December 9, 2015	BAM 1020 s/n A4987 replaced with BAM 1020 s/n T19279. Performed flow check on new BAM sampler.
December 18, 2015	BAM zero and offset calibrations entered. BAM sample inlet installed.
January 12, 2016	Performed flow check on BC and BAM samplers. Found BAM out of tape; re-spoiled tape supply. Collected PM ₁₀ and BC data.
January 13, 2016	Performed flow check on BAM sampler. Removed debris from BAM nozzle and cleaned BAM nozzle.
February 11, 2016	Performed flow checks on BC and BAM samplers. Restarted Aethalometer. Cleaned BAM roller. Collected PM ₁₀ and BC data.

Table 7 shows the PM₁₀ and BC flow rates as reported by the monitors and measured with a NIST-traceable flow standard. BAM flow rates are volumetric (local temperature and pressure), and Aethalometer flow rates are at standard temperature and pressure. The BAM target flow rate is 16.7 liters per minute (lpm) volumetric to meet the 10-micron cut point of the inlet, with an acceptable range of 16.0 to 17.3 lpm. The Aethalometer has no size cut point.

Table 7. Flow rates for the BAM PM₁₀ and Aethalometer BC monitors at the Landfill, Landfill Upwind, and Van Gogh School sites.

Location	Date	Flow Rates (lpm)					
		BAM as Found	Reference as Found	BAM as Left	Reference as Left	Aethalometer as Found	Reference as Found
Sunshine Canyon Landfill	12/01/15	-	-	-	-	-	-
	12/09/15	-	16.67	-	16.67	-	-
	01/12/16	-	16.85	-	16.85	2.9	2.98
	02/11/16	16.7	16.90	16.7	16.90	3.0	3.22
Sunshine Canyon Landfill Upwind	12/11/15	-	-	-	-	-	-
	12/23/15	16.7	16.77	16.7	16.77	4.0	4.09
	01/12/16	16.7	16.69	16.7	16.69	4.1	4.10
	02/11/16	-	16.69	-	16.69	4.0	4.38
Van Gogh School	12/01/15	16.7	16.73	16.7	16.73	2.9	3.09
	12/09/15	-	16.73	-	16.73	-	-
	01/12/16	-	16.59	-	16.59	3.0	3.2
	01/13/16	16.7	16.72	16.7	16.72	-	-
	02/11/16	16.7	16.22	16.7	16.22	3.0	3.22