LEHI CROSSING

AIR MONITORING PROJECT REPORT

Air Quality Division
June 11, 2019

Arizona Department of Environmental Quality

FIGURES

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EXECUTIVE SUMMARY

Goal

To evaluate potential health impacts of mining operations of the Vulcan Materials Company facility on the Lehi Crossing community in Mesa, Arizona.

What We Did

The Arizona Department of Environmental Quality (ADEQ):

- Performed an analysis to determine areas of potentially elevated hazardous air pollutants (HAPs) concentrations to find the most appropriate location for the monitors
- Contracted with Kary Environmental Services (KES) to monitor for the presence of HAPs as well as particulate matter near the Vulcan facility

What We Learned

There were no significant HAPs or PM concentrations found in the ambient air in the Lehi Crossing air monitoring project area. Findings include:

- HAPs concentrations measured during a 5-day sampling episode were less than the screening values of AAAQG. Even with the most conservative approach, the maximum 1-hour average concentrations are well below the 1-hour AAAQG for the majority of the HAPs.
- The maximum daily average concentration for PM_{10} was roughly 1/3 of the NAAQS.
- The maximum daily average concentration for $PM_{2.5}$ was 1/5 of the NAAQS.

Hotspot Analysis

ADEQ performed a dispersion modeling analysis to determine areas of potentially elevated HAPs due to the emissions from the hot mix asphalt plant in the Vulcan facility, comparing stack release parameters from Maricopa County Air Quality Department (MCAQD) Air Quality Permit 120027. ADEQ used three years (2015, 2016, and 2017) of meteorological data collected from MCAQD Falcon Field Air Monitoring Station, located about 2.2 miles from Vulcan.

HAP Monitoring

ADEQ compared HAP findings with the Arizona Ambient Air Quality Guidelines (AAAQG) for 25 major HAPs associated with hot mix asphalt production, which is conducted at the Vulcan facility. AAAQGs are residential screening values that are protective of public health, including children. Chemical concentrations in air that exceed AAAQGs may not necessarily represent a health risk, but indicate further evaluation may be necessary to determine whether there is a true threat to public health.

PM Monitoring

KES conducted particulate matter (PM) monitoring since PM is the primary pollutant emitted from non-metallic mineral processing (crushing and screening), which is conducted at the Vulcan facility. The findings for particles 2.5 micrometers in diameter or less ($PM_{2.5}$), commonly called soot, and for particles 10 micrometers in diameter or less (PM_{10}), commonly called dust, were compared to the EPA's National Ambient Air Quality Standard (NAAQS). The NAAQS represent ambient air quality standards that are protective of public health.

BACKGROUND

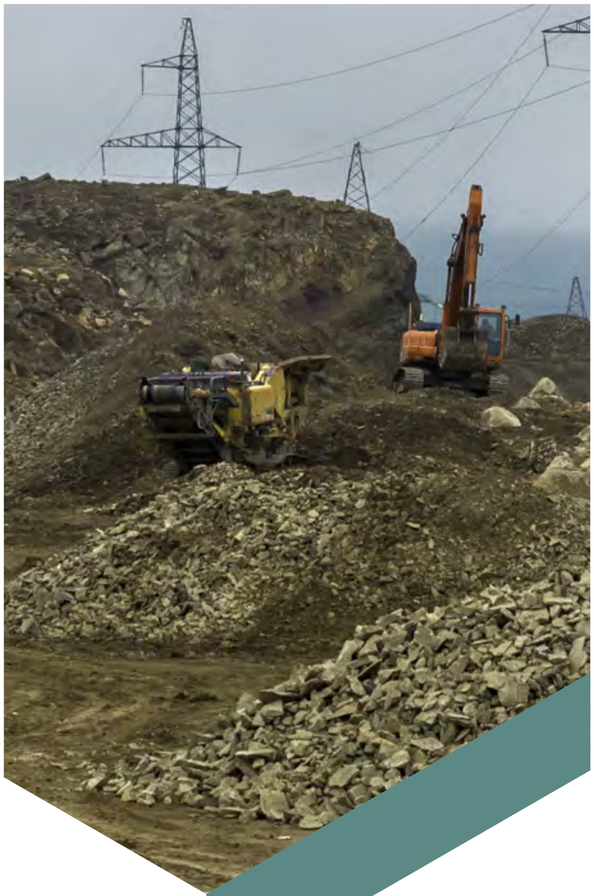
The Vulcan Materials Company operates a 57-acre line powered facility in Mesa, Arizona. The facility consists of non-metallic mineral processing (crushing and screening) and hot mix asphalt production. The Lehi Crossing community near the Vulcan facility has expressed concerns about the potential for the presence of the hazardous air pollutants (HAPs) in ambient air leaving the Vulcan facility and transporting into general community areas. The community members are concerned that air quality issues were impacting their quality of life and potentially harming their health. Figure 1 shows the locations of the Vulcan facility and the nearby Lehi Crossing Community.

Figure 1

Figure 1 Location of the Vulcan Facility and Nearby Lehi Crossing Community

PROJECT OBJECTIVES

To address concerns from the Lehi Crossing community, the Arizona Department of Environmental Quality (ADEQ) contracted with Kary Environmental Services (KES) to conduct a community-based ambient air monitoring and measurements program between April 29 and May 4, 2019, to assess public exposure to HAPs in ambient air near the Vulcan facility. The monitoring data collected were used to determine the threat to public health and if further evaluation is necessary. Specifically, ADEQ determined representative ambient HAPs concentrations and compared them against Arizona Ambient Air Quality Guidelines (AAAQG) for listed HAPs. The monitoring project covered 25 major HAPs associated with hot mix asphalt plants. Additionally, KES conducted PM_{10} and $PM_{2.5}$ monitoring because particulate matter (PM) is the primary pollutant emitted from non-metallic mineral processing.



AAAQGs were developed by the Arizona Department of Health Services (ADHS). ADEQ has been using the list of AAAQGs as health-based reference values for making risk management decisions in its environmental programs. AAAQGs are residential screening values that are protective of public health, including children. Chemical concentrations in air that exceed AAAQGs may not necessarily represent a health risk. Rather, when contaminant concentrations exceed these guidelines, further evaluation may be necessary to determine whether there is a true threat to public health.

SELECTION OF MONITORING SITE

ADEQ performed a dispersion modeling analysis with the EPA's AERMOD model to determine the areas of potentially elevated HAPs concentrations ("hotspots") due to the emissions from the hot mix asphalt plant (HMAP) in the Vulcan facility. Since the drum dryer is the most significant emission source for HAPs in a HMAP, ADEQ modeled the drum dryer stack only. ADEQ obtained the stack release parameters from the Maricopa County Air Quality Department (MCAQD) Air Quality Permit 120027. ADEQ used three years (2015, 2016, and 2017) of meteorological data collected from MCAQD Falcon Field Air Monitoring Station, located about 2.2 miles from Vulcan.

Based on the results of the modeled runs, ADEQ determined that the preferred site location was located right outside of the perimeter fence at the northwestern corner of the Vulcan property (Figure 2). The actual sampling locations are shown in Figure 3.

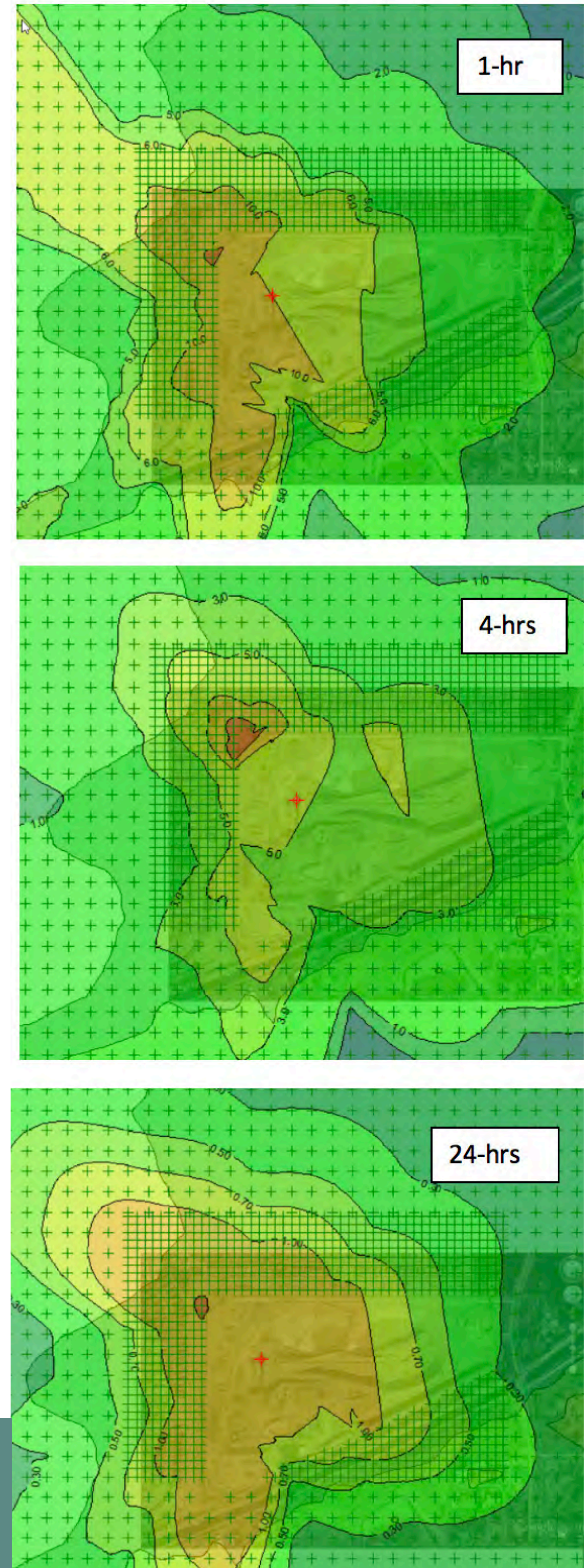


Figure 2

Figure 2 Dispersion Modeling Results for Identifying "Hot-Spots"

Figure 3

Figure 3 Air Monitoring Locations

SAMPLING INSTRUMENTATION AND METHODS

Table 1 provides a summary of sampling instrumentation and methods for HAPs. A brief description follows:
The EPA Method TO-15 was used for sampling and the analysis of 12 volatile organic compounds (VOCs) in ambient air. Samples were collected in a certified passivated steel canister and then analyzed with gas chromatography–mass spectrometry (GC-MS). The NIOSH Method 1501 was also used for sampling and the analysis for Naphthalene.

- The NIOSH Method 7300/7303 was used for sampling and the analysis of 9 heavy metals in ambient air. Samples were collected by using sampling pumps with cellulose ester mem brane filter in cassette filter holder and then analyzed with inductively coupled plasma mass spectrometry (ICP-MS).
- The OSHA 1007 Method was used for sampling and the analysis of 3 aliphatic aldehydes (Formaldehyde, Acetaldehyde and Propionaldehyde) in ambient air. Samples were collected in passive diffusive samplers and then analyzed with high performance liquid chromatography (HPLC) - ultraviolet (UV) detector.
- The NIOSH 6009 Method were used for sampling and the analysis for Mercury.

KES used two solar powered trailers in addition to mounted Met One E-BAMs for $PM_{2.5}$ and PM_{10} sampling. The Met One E-BAM is a portable, real-time beta gauge, which is comparable to EPA methods for $PM_{2.5}$ and PM_{10} particulate measurements. The E-BAM utilizes beta ray attenuation to measure PM concentrations in ambient air. A beta particle sources emits electrons measured by a detector. A pump pulls ambient air through particle selective inlets and onto a filter tape. The difference in beta counts between a clean filter tape and one laden with particulates determines volumetric concentration. Each E-BAM also has meteorological data collection units allowing the continuous collection of meteorological parameters such as wind speed, wind direction, ambient temperature, and relative humidity.

Table 1 Sampling Instrumentation and Methods for HAPs

HAPs	Method(s)	Lab Analysis	Monitoring Device
Formaldehyde	OSHA 1007	HPLC-UV	Diffusive Sampler
Acetaldehyde	OSHA 1007	HPLC-UV	Diffusive Sampler
Propionaldehyde	OSHA 1007	HPLC-UV	Diffusive Sampler
Hexane	TO-15	GC-MS	Summa Canister
Benzene	TO-15	GC-MS	Summa Canister
Naphthalene	TO-15	GC-MS	Summa Canister
Ethylbenzene	TO-15	GC-MS	Summa Canister
Toluene	TO-15	GC-MS	Summa Canister
Xylene	TO-15	GC-MS	Summa Canister
Methyl ethylketone	TO-15	GC-MS	Summa Canister
Acrolein	TO-15	GC-MS	Summa Canister
Methyl chloroform	TO-15	GC-MS	Summa Canister
Styrene	TO-15	GC-MS	Summa Canister
Tetrachloroethane	TO-15	GC-MS	Summa Canister
1,3-Butadiene	TO-15	GC-MS	Summa Canister
Nickel	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Manganese	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Chromium	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Selenium	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Cadmium	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Antimony	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Cobalt	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Arsenic	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Beryllium	NIOSH 7300/7303	ICP-MS	Pump + 0.8 um Cellulose Ester Filter Media
Naphthalene	NIOSH 1501	GC-FID	Diffusive Solid Sorbent Badge Media
Mercury	NIOSH 6009	CVAA	Pump + Solid Sorbent Tube Media

Sampling Duration and Frequency

The duration of the monitoring project was 5 days from April 29, 2019, 5 a.m. to May 4, 2019, 5 a.m. Table 2 provides a summary of sampling frequency and the total number of samples collected for HAPs during the 5-day sampling episode.

Table 2 Sampling Frequency and Total No. of Samples Collected

HAPs	Data Collection Frequency (8-hr period)	Data Collection Frequency (24-hour period)	Total No. of 4-hr Samples	Total No. of 8-hr Samples	Total No. of 12-hr Samples	Total No. of 24-hr Samples
Formaldehyde	2 x 4 hours/day	2 x 12 hours/day	10		10	
Acetaldehyde	2 x 4 hours/day	2 x 12 hours/day	10		10	
Propionaldehyde	2 x 4 hours/day	2 x 12 hours/day	10		10	
Hexane	2 x 4 hours/day	1 x 24 hours/day	10			5
Benzene	2 x 4 hours/day	1 x 24 hours/day	10			5
Naphthalene	2 x 4 hours/day	1 x 24 hours/day	10			5
Ethylbenzene	2 x 4 hours/day	1 x 24 hours/day	10			5
Toluene	2 x 4 hours/day	1 x 24 hours/day	10			5
Xylene	2 x 4 hours/day	1 x 24 hours/day	10			5
Methyl ethylketone	2 x 4 hours/day	1 x 24 hours/day	10			5
Acrolein	2 x 4 hours/day	1 x 24 hours/day	10			5
Methyl chloroform	2 x 4 hours/day	1 x 24 hours/day	10			5
Styrene	2 x 4 hours/day	1 x 24 hours/day	10			5
Tetrachloroethane	2 x 4 hours/day	1 x 24 hours/day	10			5
1,3-Butadiene	2 x 4 hours/day	1 x 24 hours/day	10			5
Nickel	2 x 4 hours/day	2 x 12 hours/day	10		10	
Manganese	2 x 4 hours/day	2 x 12 hours/day	10		10	
Chromium	2 x 4 hours/day	2 x 12 hours/day	10		10	
Selenium	2 x 4 hours/day	2 x 12 hours/day	10		10	
Cadmium	2 x 4 hours/day	2 x 12 hours/day	10		10	
Antimony	2 x 4 hours/day	2 x 12 hours/day	10		10	
Cobalt	2 x 4 hours/day	2 x 12 hours/day	10		10	
Arsenic	2 x 4 hours/day	2 x 12 hours/day	10		10	
Beryllium	2 x 4 hours/day	2 x 12 hours/day	10		10	
Naphthalene	2 x 4 hours/day	3 x 8 hours/day	10	15		
Mercury	2 x 4 hours/day	3 x 8 hours/day	10	15		

The E-BAM recorded PM_{10} and $PM_{2.5}$ measurements by continuously sampling and reporting concentration data at a 15-minute interval from April 29, 2019, 6 a.m. to May 4, 2019, 5 a.m. While E-BAM has both hourly measurement cycle and real time measurement cycle, only hourly average concentrations were used for the data analysis since the hourly value is the most accurate concentration measurement made by the E-BAM.

QUALITY CONTROL ACTIVITIES

Samples were collected according to methodologies outlined in the Air Monitoring Plan (i.e. calibrated pumps, method specific flow rates, volumes, etc.). All sampling pumps, media, and summa canisters were handled, transported, and utilized per methodological requirements and in accordance with standard industry practice. Sampling pumps were calibrated by the laboratory prior to use. Flow rate checks were conducted and documented prior to, and following each sampling period using a laboratory provided calibrated rotameter. At least one project manager or technician from the contractor was onsite throughout the duration of sampling to conduct quality control checks. Project management and technicians were responsible for the security of the equipment and sampling media, and reported or documented any attempt to influence the analytical results.

Field blanks were prepared and collected in the same type of sampling media utilized throughout the project and were collected along with the investigative samples throughout the sampling event. Analysis of the field blanks was used to determine if decontamination procedures by the lab and in the field were done correctly on the certified sample collection media.

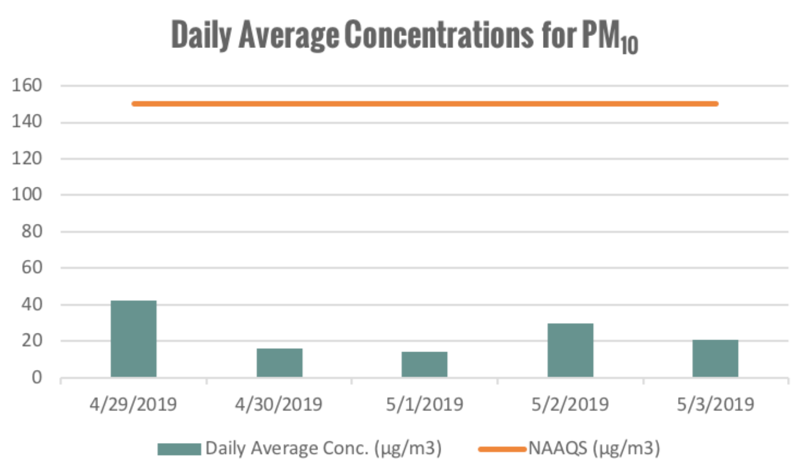
Analytical precision was estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples and/or field samples. Accuracy is the closeness of a measured result to an accepted reference value. The laboratory determined how their internal laboratory blanks were run based on each method being sampled for and the number of samples being run.

RESULTS

7.1 PM_{10}

Figure 4 presents daily average concentrations for PM_{10} during the 5-day sampling episode. The maximum daily average concentration of 41.7 µg/m³ is well below the National Ambient Air Quality Standard (NAAQS) of 150 µg/m³ for PM_{10}.

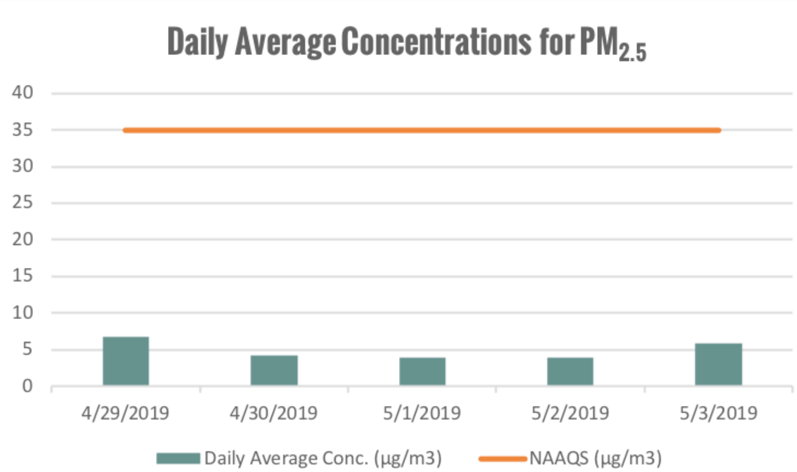
Figure 4 Daily Average Concentrations for PM10



7.2 $PM_{2.5}$

Figure 5 presents daily average concentrations for $PM_{2.5}$ during the 5-day sampling episode. The maximum daily average concentration of 6.8 µg/m³ is well below the NAAQS of 35 µg/m³ for $PM_{2.5}$.

Figure 5 Daily Average Concentrations for PM2.5



7.3 HAPs

Table 3 presents the HAPs monitoring results during the 5-day sampling episode. As shown in Table 3, ADEQ detected a total of 14 HAPs. Among 11 organic compounds detected, aliphatic aldehydes (acetaldehyde, propionaldehyde) and BTEX (toluene, xylene) seemed to be prevalent in the full set of samples collected. Of the 10 metals measured for, there were only three metals that showed any detectable concentrations during the study period. These were nickel, manganese, and chromium. Overall, during the Vulcan operation days (April 29, 2019, and April 30, 2019), ADEQ detected more types of HAPs with relatively higher concentrations.

The measured concentrations were compared to both 1-hour and 24-hour health-based Arizona Ambient Air Quality Guideline (AAAQG) to see if the screening value was exceeded. In order to compare with 1-hour AAAQG, ADEQ converted the 4-hour average monitoring values obtained (C_{4h}) to the 1-hour average concentrations (C_{1h}), considering a peak concentration may occur in a shorter time period. ADEQ used the following atmospheric stability dependent formulation to do the conversion:

$$C_{1h} = C_{4h} \times (\frac{4h}{1h})^n = C_{4h} \times 4^n$$

Where n = the stability dependent exponent, which is 0.5, 0.33, 0.20 and 0.167 for Stability Class A&B, C, D, and E&F, respectively. While the value of 0.2 is mostly used (D Neutral Stability), ADEQ used the most conservative value of 0.5 to do the conversion.

Table 4 presents the calculated 1-hour concentrations and the measured 24-hour concentrations for HAPs along with their corresponding 1-hour and 24-hour AAAQG. As shown in Table 4, the maximum 24-hour average concentrations for all HAPs detected are well below than the 24-hour AAAQG. Even with the most conservative approach, the maximum 1-hour average concentrations are well below than the 1-hour AAAQG for the majority of the HAPs.

Table 3 HAPs Monitoring Results

HAPS	4-hr Sampling		8-hr Sampling		12-hr Sampling		24-hr Sampling	
	No. of Samples	Max 4-hr Ave Conc. (μg/m³)	No. of Samples	Max 8-hr Ave Conc. (μg/m³)	No. of Samples	Max 12-hr Ave Conc. (μg/m³)	No. of Samples	Max 24-hr Ave Conc. (μg/m³)
Formaldehyde	10	ND			10	6.15		3.1[a]
Acetaldehyde	10	37.9			10	17.6		8.8[a]
Propionaldehyde	10	44.4			10	21.7		11.5[a]
Hexane	10	ND					5	4.23
Benzene	10	9.26					5	1.92
Naphthalene-1	10	ND					5	ND
Naphthalene-2	10	ND	15	ND				ND
Ethylbenzene	10	6.51					5	3.39
Toluene	10	75.36					5	12.06
Xylenes	10	38.21					5	47.77
Methyl ethyl ketone	10	5.9					5	7.08
Acrolein	10	ND					5	ND
Methyl chloroform	10	ND					5	ND
Styrene	10	17.46					5	ND
Tetrachloroethene	10	2.78					5	ND
1,3-Butadiene	10	ND					5	ND
Nickel	10	0.416			10	ND		ND
Manganese	10	0.49			10	0.218		0.136[a]
Chromium	10	3.14			10	0.0863		0.043[a]
Selenium	10	ND			10	ND		ND[a]
Cadmium	10	ND			10	ND		ND[a]
Antimony	10	ND			10	ND		ND[a]
Cobalt	10	ND			10	ND		ND[a]
Arsenic	10	ND			10	ND		ND[a]
Beryllium	10	ND			10	ND		ND[a]
Mercury	10	ND	15	ND				ND[a]

ND = Not Detected;

a = The 24-hr average concentrations were derived from the concentrations for 2 continuous 12-hour sampling periods or 3 continuous 8-hour sampling periods.

Table 4 Comparison of HAPs Monitoring Concentrations and AAAQG

HAPs	Max 4-hr Ave Conc. (µg/m³)	Max 1-hr Ave Conc. (µg/m³)[a]	1-hr AAAQG (µg/m³)	Max 24-hr Ave Conc. (µg/m³)	24-hr AAAQG (µg/m³)
Formaldehyde	ND		20	3.1	12
Acetaldehyde	37.9	75.8	2300	8.8	1400
Propionaldehyde	44.4	88.8	-	11.5	-
Hexane	ND		5300	4.23	1400
Benzene	9.26	18.52	630	1.92	51
Naphthalene	ND		630	ND	400
Ethylbenzene	6.51	13.02	4500	3.39	3500
Toluene	75.36	150.7	4700	12.06	3000
Xylenes	38.21	76.4	5500	47.77	3500
Methyl ethyl ketone	5.9	11.8	7400	7.08	4700
Acrolein	ND		6.7	ND	2
Methyl chloroform	ND		20000	ND	1100
Styrene	17.46	34.92	3500	ND	1700
Tetrachloroethene	2.78	5.56	33	ND	8.8
1,3-Butadiene	ND		7.2	ND	1.9
Nickel	0.416	0.832	5.7	ND	1.5
Manganese	0.49	0.98	25	0.136	8
Chromium	3.14	6.28	11	0.043	3.8
Selenium	ND		6	ND	1.6
Cadmium	ND		1.7	ND	0.11
Antimony	ND		15	ND	4
Cobalt	ND		-	ND	-
Arsenic	ND		0.28	ND	0.073
Beryllium	ND		0.06	ND	0.016
Mercury	ND		1.5	ND	0.4

a1-hr average concentrations were estimated based on 4-hr average measurements using the equation in Section 7.3.

7.4 Meteorological Data

Met E-BAM Particulate Measurement Units for PM_{10} and $PM_{2.5}$ have meteorological collection units. ADEQ reviewed the meteorological data collected from the PM_{10} trailer since it was closer to the emission source and was less subject to the influence of obstructions such as trees (see Figure 3).

Figure 6 presents a wind rose plot displaying the statistical distribution of wind speeds and wind directions. As shown in Figure 6, the wind speeds were low during the sampling period. Hourly wind speeds less than 2.5 m/s accounted for nearly 97% of the wind speed observations, with an average wind speed of 1.2 m/s. The prevailing winds were from northwest and south-southeast (SSE). While the northwestern winds were more frequent, there is no "downwind" community directly exposed to the emissions from Vulcan. Considering the SSE winds and the proximity to the local community, ADEQ determined that the monitoring site selected in this study reasonably captured the potential ambient impacts from Vulcan.

Figure 6

Figure 6 Wind Rose Plot

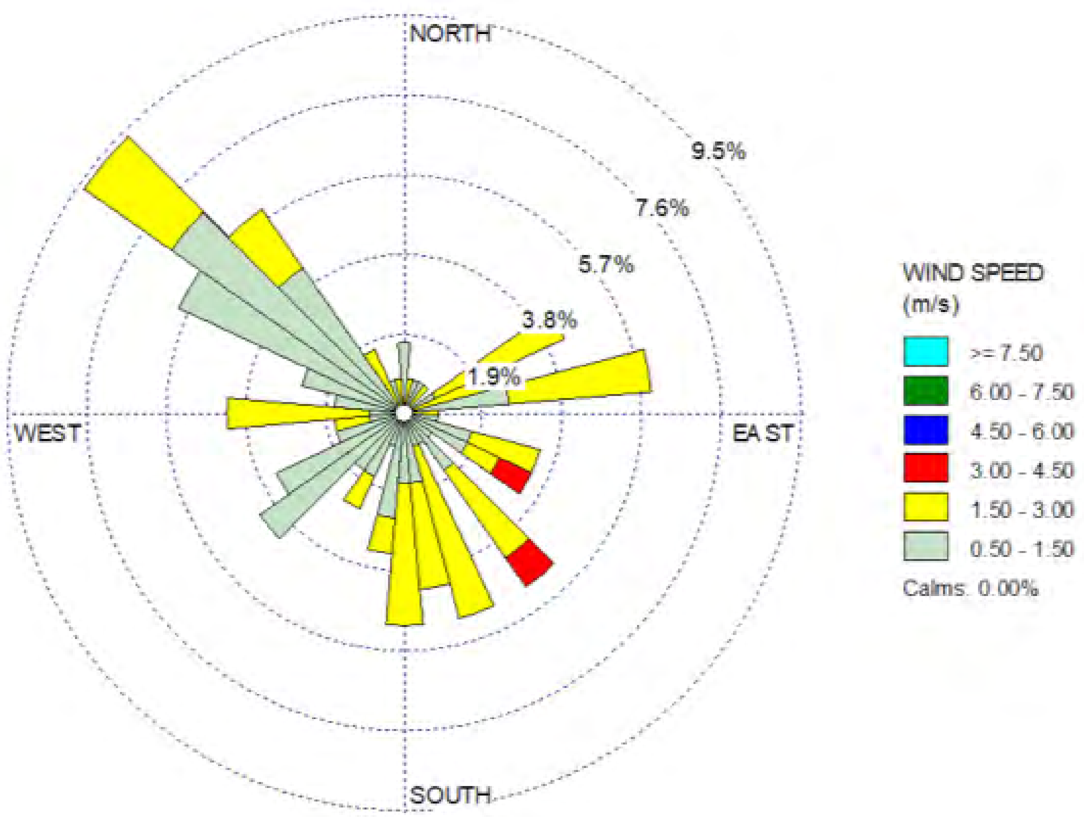


Table 5 Ambient Temperature and Relative Humidity Summary

Table 5 summarizes temperature measurements and relative humidity measurements during the sampling period.

Parameter	No. of 15-Minute Measurements	Minimum	Maximum	Average
Ambient Temperature	475	56.7°F	91.0°F	72.7°F
Ambient Relative Humidity (%)	475	6.0%	74.0%	30.8%

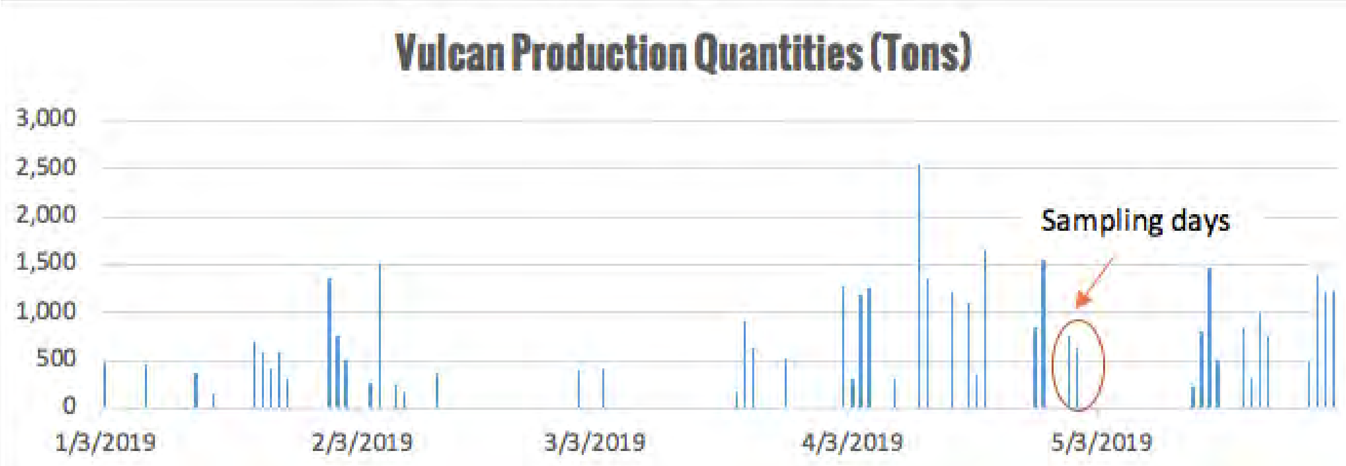
VULCAN OPERATIONAL DATA

The five-day sampling captured both operating and non-operating periods for Vulcan. According to the operating information Vulcan provided, the facility operated on April 29, 2019, and April 30, 2019. The production quantities of hot mix asphalt (HMA) for the two days were 748 tons and 625.20 tons, respectively. There were no productions during the remaining days (May 1, 2019 – May 4, 2019). As mentioned in Section 7.3, ADEQ detected more types of HAPs with relatively higher concentration on the Vulcan operation days.

Vulcan also provided ADEQ the production data for the most recent 5 months in Year 2019 (Figure 7). Overall, the production rates are market-driven and are difficult to be predicted. There were approximately 50 production days over the 5 months with an average of 3 production days per week. The daily production quantity over the 50 production days ranged from 152 tons to 2,547 tons with a median value of 631 tons. Although the production quantities on April 29, 2019, and April 30, 2019, did not mimic historic highs at the facility, they were still within a normal range and represented normal operations.

Figure 7

Figure 7 Vulcan Production Quantities in Year 2019



CONCLUSION

ADEQ contracted with KES to conduct a community-based ambient air monitoring and measurements program to assess public exposure to HAPs and particulate matter in ambient air near the Vulcan facility. There were no significant HAPs or PM concentrations found in the ambient air in the Lehi Crossing air monitoring project area. As discussed before, Vulcan operated at throughput levels on a couple of days that were nominally representative of the facility's operating cycle since January 1, 2019. The HAPs concentrations measured during a 5-day sampling episode were less than the screening values of AAAQG. Additionally, the 24-hour average PM_{10} and $PM_{2.5}$ concentrations measured were well below the NAAQS for PM_{10} and $PM_{2.5}$.

Arizona Department of Environmental Quality

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