

Air Quality Sampling in The Dalles

Naphthalene and Total PAH Sampling - Summer 2017

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.



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Executive Summary

AmeriTies West, LLC. (“AmeriTies”) is located in The Dalles and treats wood products for preservation before use in the railroad industry. In an effort to reduce impacts on air quality from the processing and storage of treated wood products, AmeriTies altered the chemical formula used to preserve the wood following the completion of air quality monitoring in 2016. In 2017, Oregon DEQ collected air samples at three locations in The Dalles from July 17 – September 19 as a follow-up to samples, which were collected in 2016 during the same period. Samples were analyzed for levels of polycyclic aromatic hydrocarbons (PAHs), including naphthalene.

Sampling results show that the average 24-hr concentration of naphthalene at the Wasco County Bldg. was less in 2017 compared to 2016 during the same time period. The average 24-hr concentrations of naphthalene at all locations were above the Oregon Annual Ambient Benchmark Concentration (ABC) of $0.03 \mu\text{g}/\text{m}^3$ for cancer risk, but below both the currently proposed short-term guideline concentration (SGC) of $200 \mu\text{g}/\text{m}^3$ and the minimal risk level (MRL) for chronic non-cancer health effects set by the Agency for Toxic Substances and Disease Registry (ATSDR) of $3.7 \mu\text{g}/\text{m}^3$. No significant difference was seen in the average 24-hr toxicity equivalency values (TEVs) for total PAHs between 2016 and 2017 at any of the monitoring locations. Levels of PAHs were highest at the Wasco County Bldg. site and decreased toward the Cherry Heights location. This decreasing trend was also seen in 2016. A strong positive correlation between the 24-hr TEVs for total PAHs and maximum daily temperature was seen at the Wasco County Bldg. site using temperature data and sampling results from both 2016 and 2017. The strength of this correlation decreased as distance from the AmeriTies facility increased.

An extensive wildfire season led to unhealthy air quality conditions in The Dalles during the summer of 2017. An increase in particulate matter and PAH levels was recorded at the Cherry Heights monitoring location on two separate days during the sampling period due to wildfire smoke impacts.

Production records from AmeriTies show that production was less in 2017 compared to 2016, while the volume of treated products being stored on the property was greater in 2017. No correlation was seen between naphthalene and AmeriTies’ production rates. Meteorological conditions play an important role in the levels and dispersion of PAHs in the area.

Key Findings:

- The average 24-hr concentration of naphthalene at the Wasco County Bldg. site was less in 2017 compared to 2016 during the same period, however no significant difference was seen between 2016 and 2017 at the Cherry Heights location.
- The average 24-hr concentration of naphthalene at all sites was above the Oregon Annual Ambient Benchmark Concentration ($0.03 \mu\text{g}/\text{m}^3$), but below both the currently proposed short-term guideline concentration ($200 \mu\text{g}/\text{m}^3$) and the MRL for chronic non-cancer health effects set by ATSDR ($3.7 \mu\text{g}/\text{m}^3$).
- No significant difference was seen in the average 24-hr TEVs for total PAHs between 2016 and 2017 during the sampling period at any site.
- The AmeriTies production levels during 2017 were less than 2016 while the volume of treated wood products being stored on the property was greater in 2017 compared to 2016 during the same time period.

1. Introduction and Background

In July of 2017, Oregon DEQ started collecting air samples at three locations in The Dalles to determine the level of total polycyclic aromatic hydrocarbons (PAHs) and naphthalene present in ambient air. This report and sampling effort represents a follow-up effort to air sampling which took place during the summer of 2016 in response to complaints about odors coming from AmeriTies West, LLC (“AmeriTies”). The AmeriTies facility treats raw lumber to preserve final products before they are used in railroad construction. Through a cooperative agreement with DEQ, AmeriTies altered the chemical formula of the preservative in an effort to reduce odors coming from the processing and storage of treated wood products. The formula of the preservative was adjusted following the completion of air quality sampling in 2016.

2. Air Quality Sampling

2.1 Sampling Locations

Air quality samples were taken at three separate locations. A meteorological station was set up by DEQ to measure wind speed and wind direction near the City Park monitoring location. Temperature data from a National Weather Service located at The Dalles Municipal Airport (ASOS Station ID: KDLS) was used to evaluate the relationship between maximum daily temperature and levels of total PAHs and naphthalene (Figure 1).

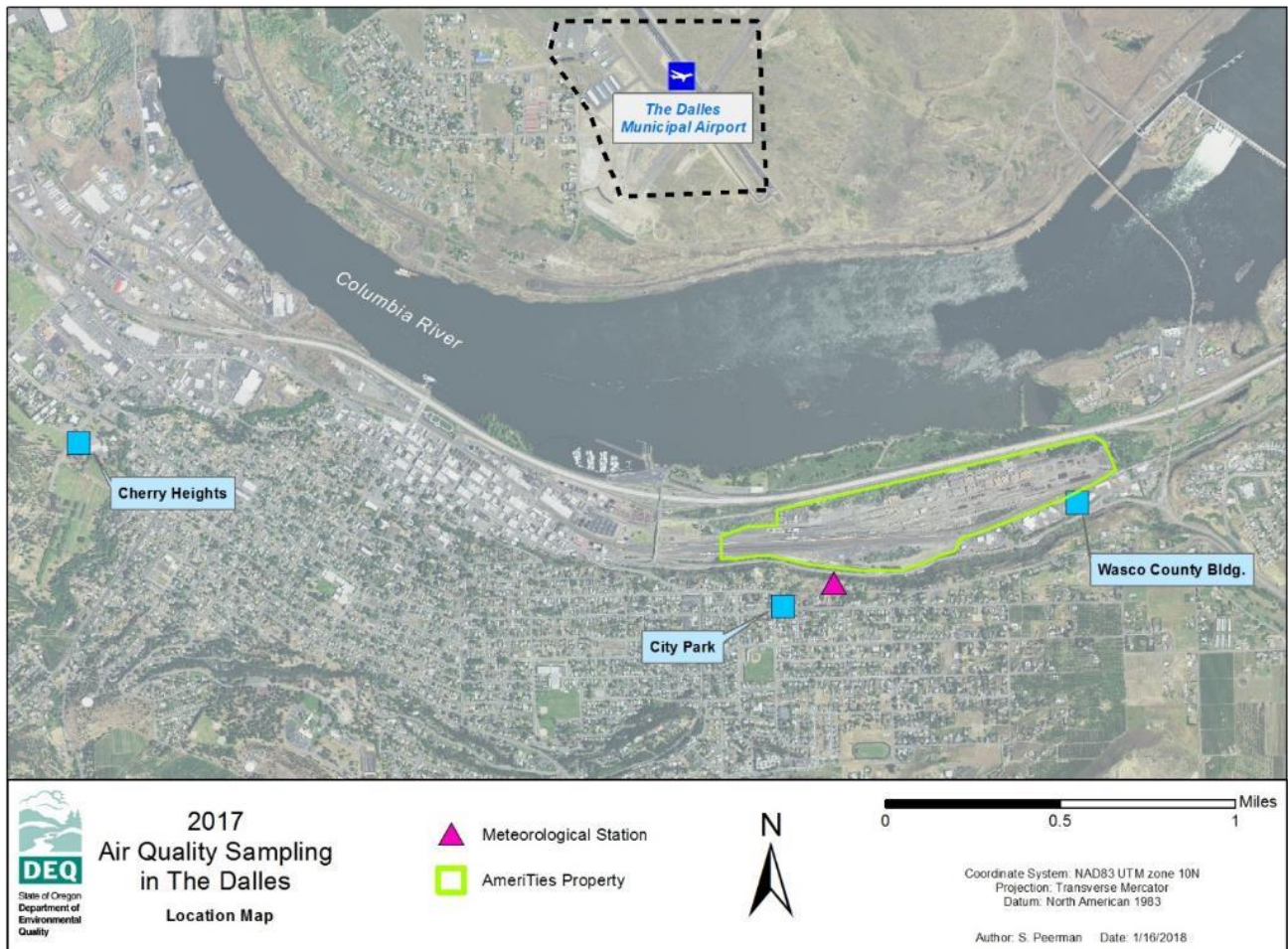


Figure 1. Monitoring locations in The Dalles from July 17 – September 19, 2017.

2.2 Sampling Method

Individual air samples were collected by drawing ambient air through a filter at a constant flow rate for a duration of 24 hours to obtain the daily concentrations for naphthalene and total PAHs. One sample was taken at each site approximately every three days. The first samples occurred on July 17th and the last samples occurred on September 19th. Each sample started and ended at midnight, Pacific Standard Time (PST).

3. Results

3.1 Naphthalene

Data from 2017 show that the average 24-hr concentration of naphthalene over the sampling period decreased as distance of the monitoring locations from the AmeriTies facility increased. This trend is consistent with data from 2016 where the highest concentrations were seen at the Wasco County Building site and the lowest concentrations were seen at the Cherry Heights site. Naphthalene concentrations from each site were summarized and compared to naphthalene concentrations from 2016 in Table 1. Naphthalene results were also compared to the Oregon Ambient Benchmark Concentration (ABC) of 0.03 $\mu\text{g}/\text{m}^3$ which is based on a concentration level that would result in a cancer risk of one in one million additional cancers based on a lifetime of exposure.

Table 1. Concentrations of naphthalene in The Dalles, Oregon based on 24-hr samples taken between July 17th – September 19th in 2016 and 2017.

Jul. 17th - Sep. 19th 2016 vs. 2017	Naphthalene ($\mu\text{g}/\text{m}^3$ STP)					
	2016 Wasco County Bldg. <i>n</i> = 25	2017 Wasco County Bldg. <i>n</i> = 22	2016 City Park ² <i>n</i> = 6	2017 City Park <i>n</i> = 20	2016 Cherry Heights <i>n</i> = 25	2017 Cherry Heights <i>n</i> = 23
	Min. Concentration	0.991	0.166	0.037	0.0192	0.00609
Max. Concentration	5.49	2.48	1.52	0.712	0.211	0.156
Avg. Concentration	2.603	1.164	0.583	0.302	0.0645	0.0432
Number of Times Over the Oregon Annual ABC ¹	86.8	38.8	19.4	10.1	2.2	1.4

¹ The Oregon Annual Ambient Benchmark Concentration (ABC) for Naphthalene is 0.03 $\mu\text{g}/\text{m}^3$ STP.

² Monitoring stopped at this location on August 2, 2016 due to complaints received about noise from air monitoring equipment.

Monitoring results showed that the average 24-hr concentration of naphthalene during the sampling period were lower in 2017 at the Wasco County Building site compared to 2016. All naphthalene results at the Wasco County Building site were above the ABC of 0.03 $\mu\text{g}/\text{m}^3$, but below both the currently proposed short-term guideline concentration (SGC) of 200 $\mu\text{g}/\text{m}^3$ and the minimal risk level (MRL) of 3.7 $\mu\text{g}/\text{m}^3$ set by the Agency for Toxic Substances and Disease Registry (ATSDR) for chronic non-cancer health effects.

The distribution of naphthalene concentrations were similar in 2016 and 2017 at the Cherry Heights monitoring location with no significant difference in the average concentrations during the sampling period. No comparison of average naphthalene concentrations was made for the City Park monitoring location because sampling was stopped prematurely in 2016 (August 2nd) due to complaints about noise coming from the air monitoring equipment.

3.2 Total PAHs

The ABC for total PAHs is based on the cancer risk associated with combined exposure to a specific list of PAH compounds, which does not include naphthalene. There are currently 26 PAHs recommended by the DEQ Air Toxics Science Advisory Committee to calculate total PAH cancer risk, however the DEQ laboratory does not currently analyze for 10 of those PAH compounds due to various technical reasons including limited capability of laboratory instruments and the need to develop new analytical methods capable of distinguishing between individual PAH compounds. Therefore, the total PAH values reported here are likely less than would be reported if all 26 PAH compounds were analyzed.

3.2.1 Cancer Toxicity Equivalency Values and Total PAHs

Total PAH levels were reported as toxicity equivalency values (TEV). TEVs are often used to quantify the combined cancer risk of several individual PAH compounds. TEVs for total PAHs are calculated by multiplying individual PAH compounds by a chemical-specific toxicity equivalency factor (TEF) to obtain an adjusted concentration that is based on the cancer potency of the individual PAH relative to benzo(a)pyrene. Then the adjusted concentrations of individual PAHs are added together to obtain a single 24-hr TEV for total PAHs. Individual PAHs and their currently proposed cancer TEFs are presented in Table 2.

Table 2. Currently proposed list of polycyclic aromatic hydrocarbons (PAHs) and their cancer toxicity equivalency factors. This list was proposed to the Oregon Environmental Quality Commission by the Air Toxics Science Advisory Committee on July 14, 2017.

PAH	Toxicity Equivalency Factor (TEF)	Currently Analyzed by DEQ
Acenaphthene	--	Yes
Acenaphthylene	--	Yes
Anthracene	0	Yes
Benzo(a)anthracene	0.2	Yes
Benzo(a)pyrene	1	Yes
Benzo(b)fluoranthene	0.8	Yes
Benzo(e)pyrene	--	Yes
Benzo(g,h,i)perylene	0.009	Yes
Benzo(k)fluoranthene	0.03	Yes
Chrysene	0.1	Yes
Dibenzo(a,h)anthracene	10	Yes
Fluoranthene	0.08	Yes
Fluorene	--	Yes
Indeno(1,2,3-cd)pyrene	0.07	Yes
Phenanthrene	0	Yes
Pyrene	0	Yes
5-Methylchrysene	1	No
6-Nitrochrysene	10	No
Anthanthrene	0.4	No
Benzo(c)fluorene	20	No
Benzo(j)fluoranthene	0.3	No
Cyclopenta[c,d]pyrene	0.4	No
Dibenzo(a,e)pyrene	0.4	No
Dibenzo(a,h)pyrene	0.9	No
Dibenzo(a,i)pyrene	0.6	No
Dibenzo(a,l)pyrene	30	No

NOTE: (-) indicates that a TEF is unavailable from EPA/635/R-08/012A (2010).

TEVs for total PAHs from July 17th – September 19th are compared for 2016 and 2017 and are summarized in Table 3. The average TEV for 24-hr concentration of total PAHs at the Wasco County Bldg. site was less in 2017 however this difference was not statistically significant.

Table 3. Total PAHs from 2016 and 2017 during summer sampling period (July 17th – September 19th). The TEV for 24-hr concentration of total PAHs is based on the use of toxicity equivalency factors (TEFs) for individual PAH compounds where TEFs exist. Summary statistics for both 2016 and 2017 results are based on currently proposed TEFs shown above in Table 2.

Jul. 17th - Sep. 19th 2016 vs. 2017	TEVs for 24-hr total PAHs ¹ (µg/m ³ STP)					
	2016 Wasco County Bldg.	2017 Wasco County Bldg.	2016 City Park ³	2017 City Park	2016 Cherry Heights	2017 Cherry Heights
	<i>n</i> = 25	<i>n</i> = 22	<i>n</i> = 6	<i>n</i> = 20	<i>n</i> = 25	<i>n</i> = 23
Min. Concentration	0.0016	0.0007	0.0015	0.0002	0.0000	0.0000
Max. Concentration	0.0224	0.0135	0.0052	0.0056	0.0002	0.0016
Avg. Concentration	0.0061	0.0057	0.0029	0.0022	0.0001	0.0002
Number of Times the Oregon Annual ABC ²	3.1	2.8	1.4	1.1	0.0	0.1

¹ Results which were below the analytical detection limit were set to a concentration of zero.

² The Oregon Annual Ambient Benchmark Concentration (ABC) for Total PAHs is 0.002 µg/m³ STP.

³ Monitoring stopped at this location on August 2, 2016 due to complaints about noise from air monitoring equipment.

3.2.2 Total PAHs vs. Temperature

The relationship between evaporation and temperature is well explained by the laws of thermodynamics. The rate at which an organic compound evaporates will increase as the temperature of the atmosphere increases due to the increased kinetic energy in the molecules. This relationship was seen in the TEVs for 24-hr total PAH results from 2016 and 2017 at the Wasco County Bldg. site (Figure 2). The TEVs for 24-hr total PAHs at this location were strongly correlated with the maximum daily temperature as recorded at The Dalles Municipal Airport, located approximately 1.7 miles northwest of the Wasco County Bldg. site (see Figure 1). Figure 2 suggests that temperature explains 70% of the variation in total PAH levels for this location.

The correlation between maximum daily temperature and 24-hr total PAHs at the City Park monitoring site is not as strong as the Wasco County Bldg. site, however the positive correlation is still evident in the data (Figure 3). The curved regression line for these data explains 51% of the variation in the data at the City Park location.

Results from the Cherry Heights monitoring location show no correlation between TEVs for 24-hr total PAHs and maximum daily temperature (Figure 4). This monitoring location is farthest from the AmeriTies facility and recorded the lowest concentrations of naphthalene as well as TEVs for 24-hr total PAHs.

These data show that concentrations of PAHs are higher near AmeriTies and the daily concentrations will generally increase as ambient temperature increases in the area. A comparison shows that the average maximum daily temperature in 2017 (90°F, *n* = 22) was higher than the average maximum daily temperature in 2016 (86°F, *n* = 22). Though this comparison does not prove that the change in the formula of the preservative is responsible for the lower concentrations of PAHs at the Wasco County Bldg site, the results suggest that the change in formula may have had some positive effect on PAH levels near the AmeriTies facility.

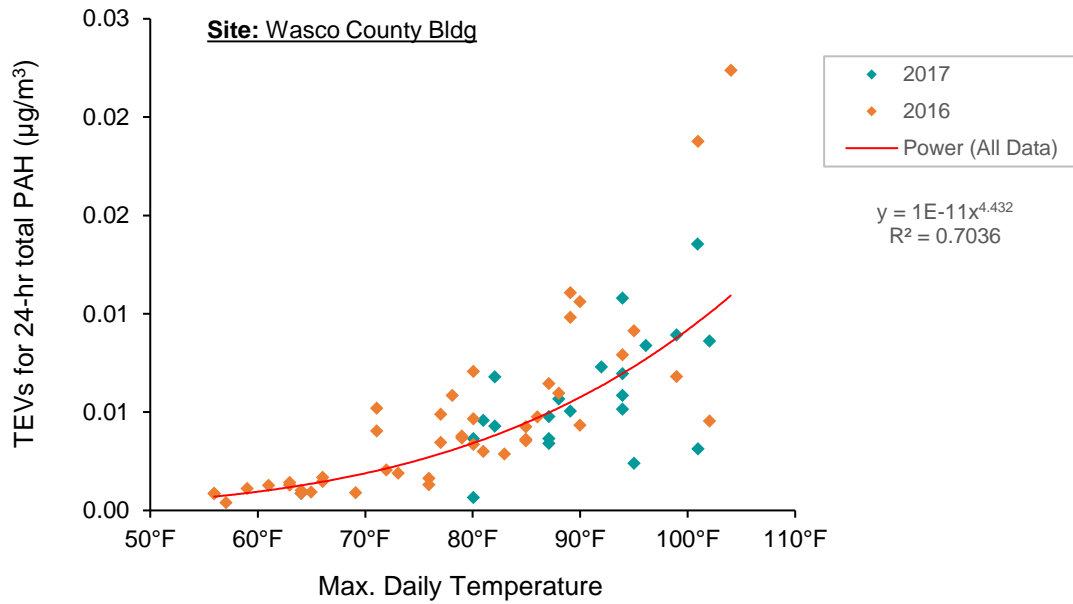


Figure 2. Correlation between the 24-hr total PAH concentration at the Wasco County Bldg. and maximum daily temperature. Maximum daily temperature was recorded at The Dalles Municipal Airport (located approximately 1.7 miles northwest of the Wasco County Bldg. site). The TEVs for 24-hr total PAH values were calculated based on toxicity equivalency factors proposed by the Air Toxics Science Advisory Committee on July 14th, 2017.

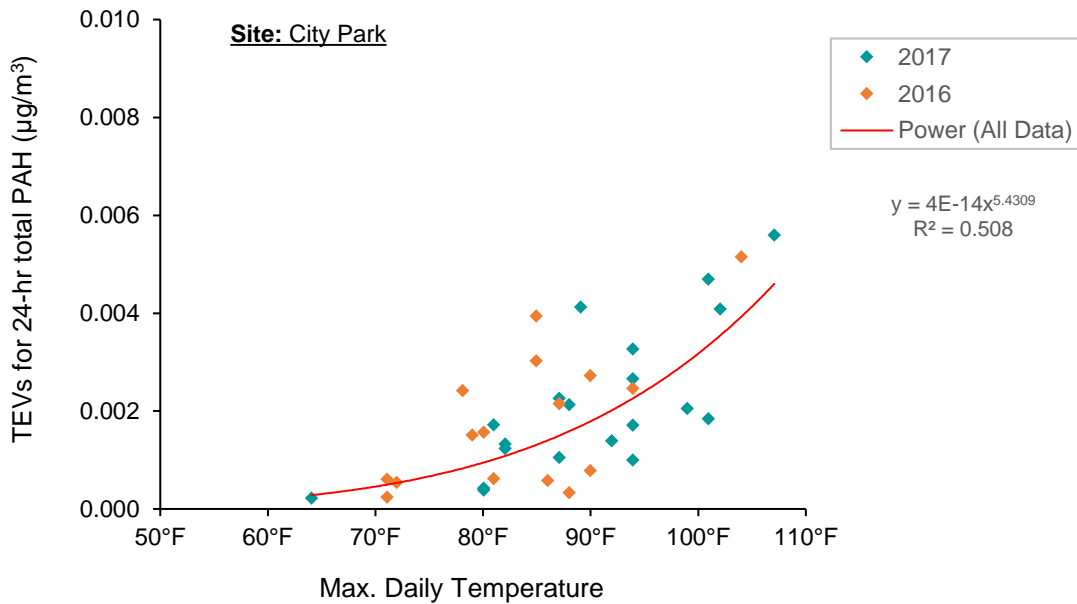


Figure 3. Correlation between the 24-hr total PAH concentration at the City Park and maximum daily temperature. Maximum daily temperature was recorded at The Dalles Municipal Airport (located approximately 1.7 miles northwest of the Wasco County Bldg. site). The TEVs for 24-hr total PAH values were calculated based on toxicity equivalency factors proposed by the Air Toxics Science Advisory Committee on July 14th, 2017.

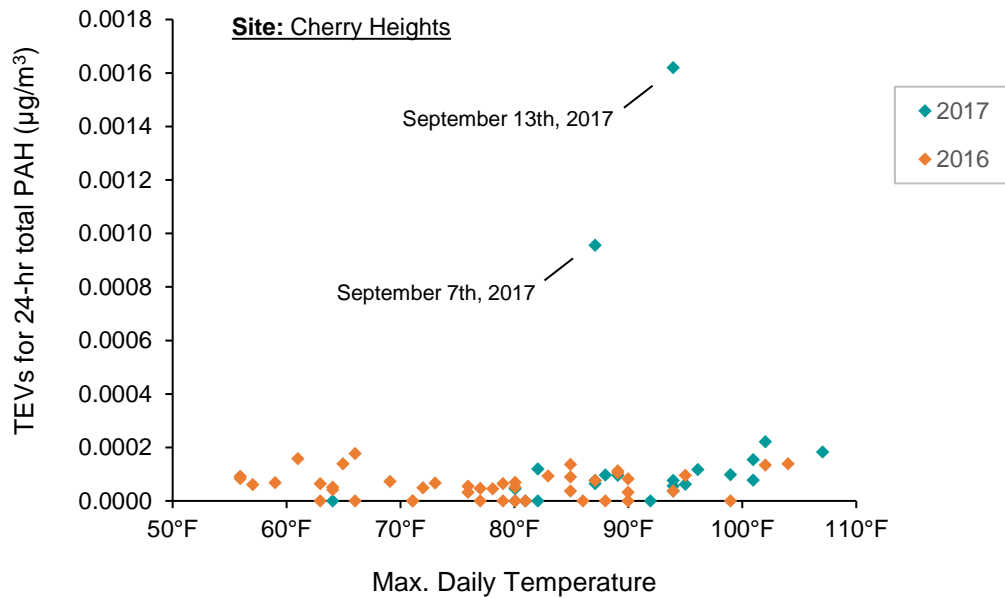


Figure 4. Correlation between the 24-hr total PAH concentration at Cherry Heights and maximum daily temperature. Maximum daily temperature was recorded at The Dalles Municipal Airport (located approximately 1.7 miles northwest of the Wasco County Bldg. site). The TEVs for 24-hr total PAH values were calculated based on toxicity equivalency factors proposed by the Air Toxics Science Advisory Committee on July 14th, 2017. Results from September 7th and September 13th were affected by heavy wildfire smoke in the area.

3.3 Individual PAH Levels

Summary statistics for individual PAHs during the 2016 and 2017 sampling periods are provided in Appendix A.

3.4 Dispersion of Air Pollutants

3.4.1 Meteorological Data

Meteorological conditions play an important role in the transport of air pollutants. Wind speed and direction were recorded throughout the 2017 monitoring period near the City Park monitoring location (Figure 5). A clear diurnal wind pattern was seen at this station with strong winds generally occurring from the northwest during the daytime and with light winds generally occurring from the southeast during the nighttime (Figures 6-7). The strong westerly winds that often prevailed during the daytime support the decreasing trend seen in 24-hr total PAH and naphthalene levels from the Wasco County Bldg. site to the Cherry Heights site.

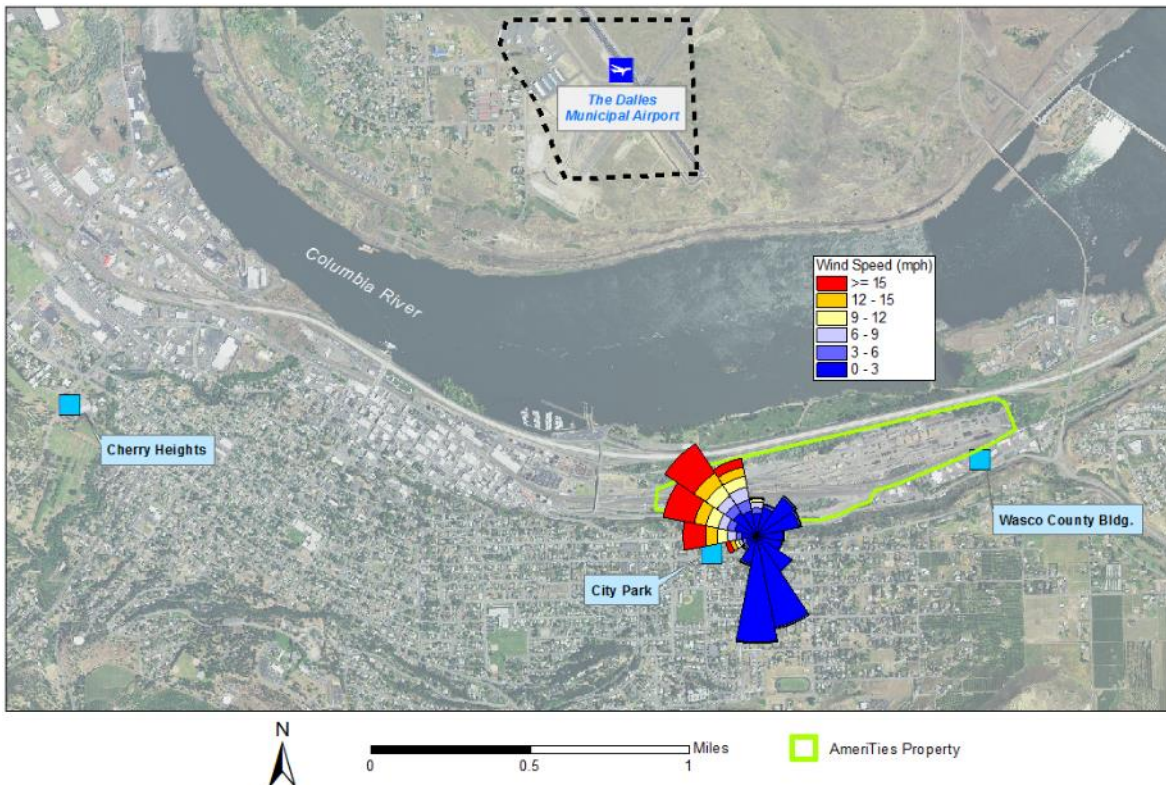


Figure 5. Wind speed and direction frequencies recorded in The Dalles from July 17 – September 19, 2017.

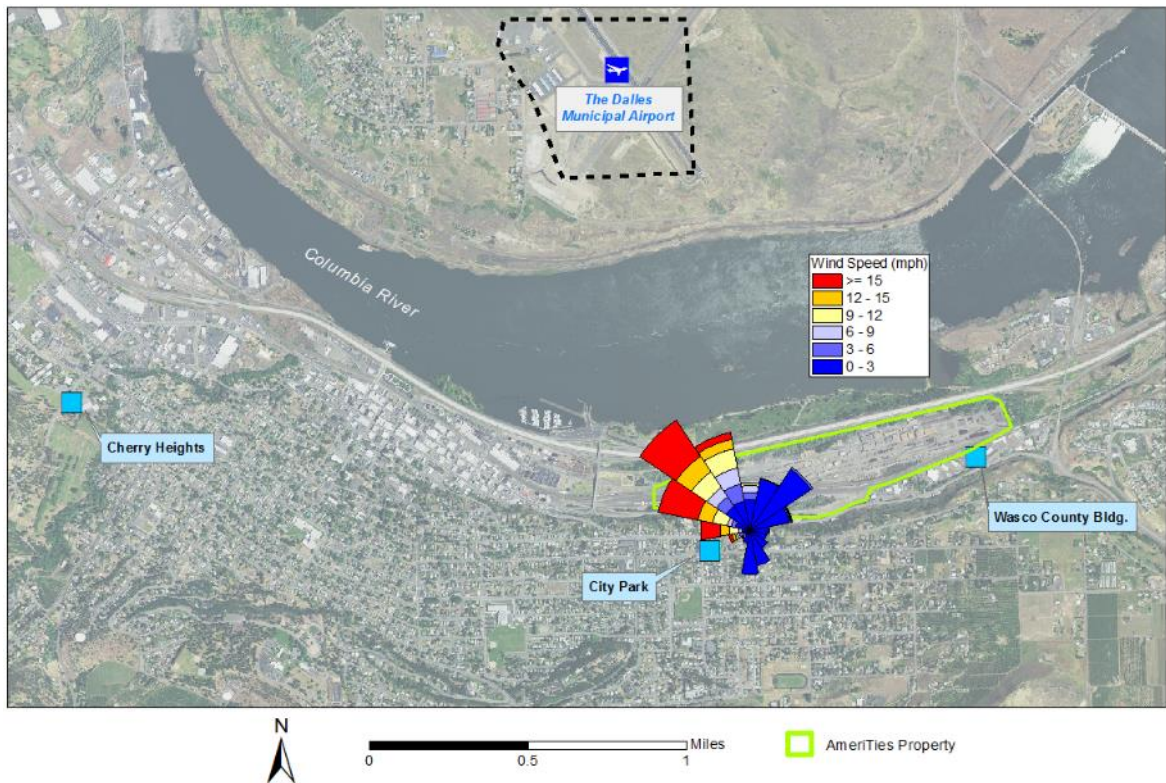


Figure 6. Daytime (5 a.m. – 9 p.m. PST) wind speed and direction frequencies for July 17 – September 19, 2017.

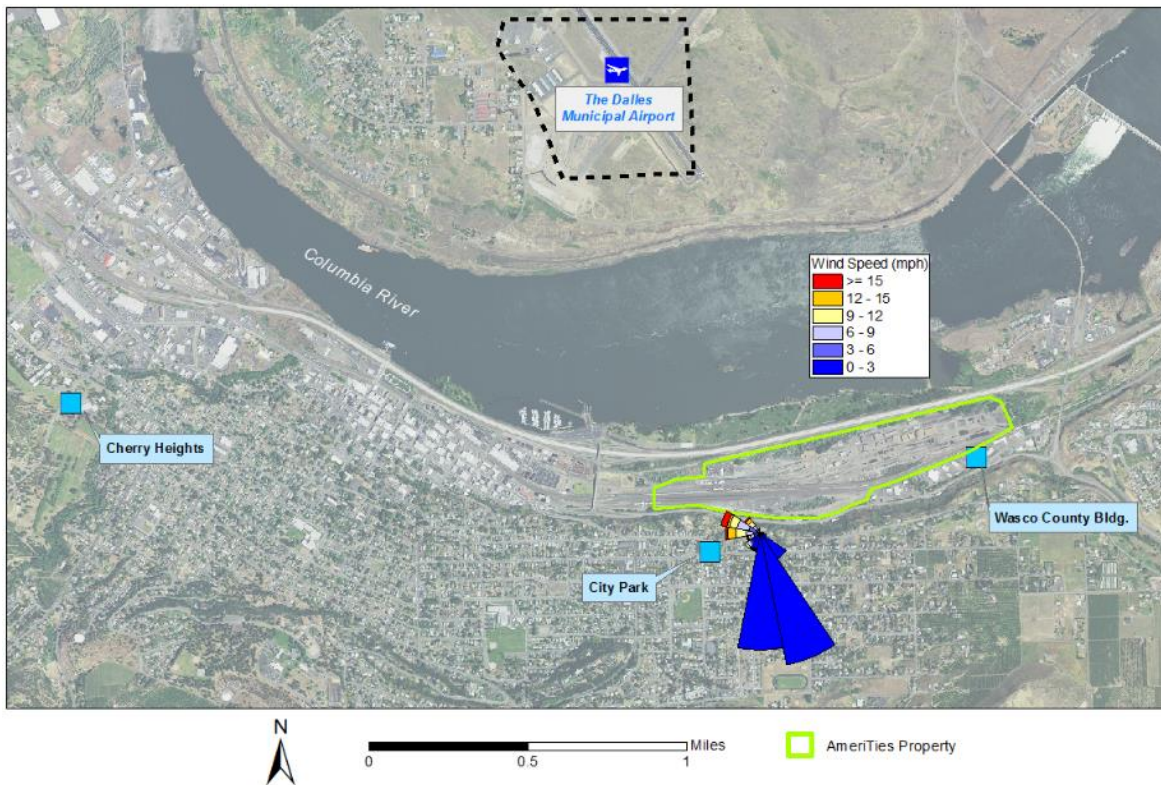


Figure 7. Nighttime (9 p.m. – 5 a.m. PST) wind speed and direction frequencies for July 17 – September 19, 2017.

3.4.2 Wildfire Smoke Impact

Results from air quality samples combined with meteorological data and satellite imagery show a clear impact on air quality from both near and distant wildfires in 2017. The daily concentrations of naphthalene and the TEVs for total PAHs from two days stand out in the 2017 results at the Cherry Heights location: September 7th and September 13th (Figure 8-9).

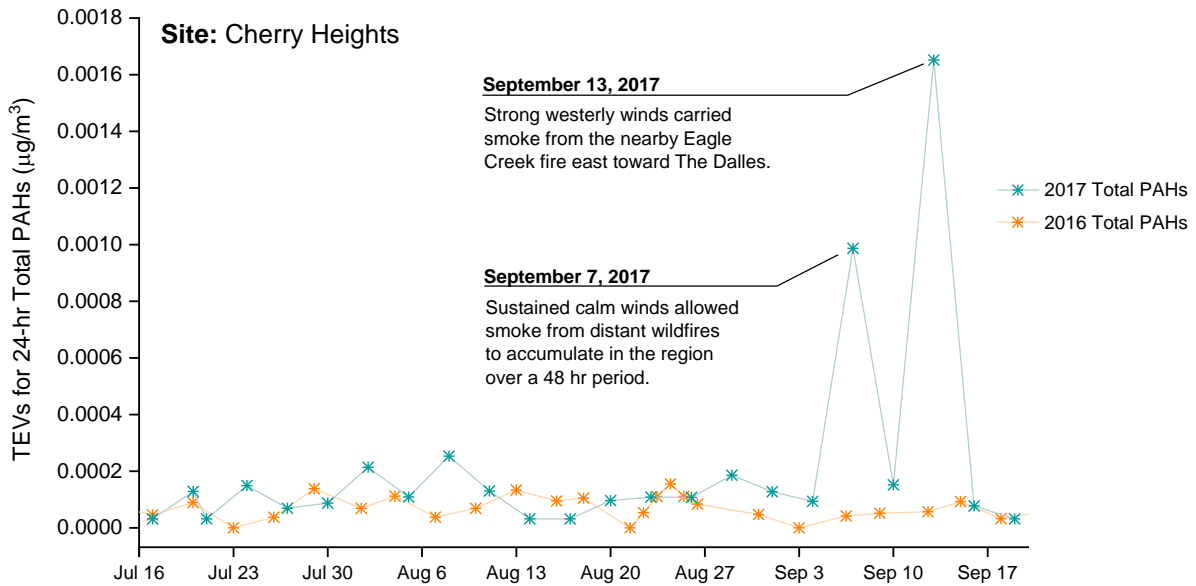


Figure 8. TEVs for 24-hr total PAHs from 2016 and 2017. The two highest values in 2017 were seen on September 7th and September 13th due to wildfire smoke intrusion.

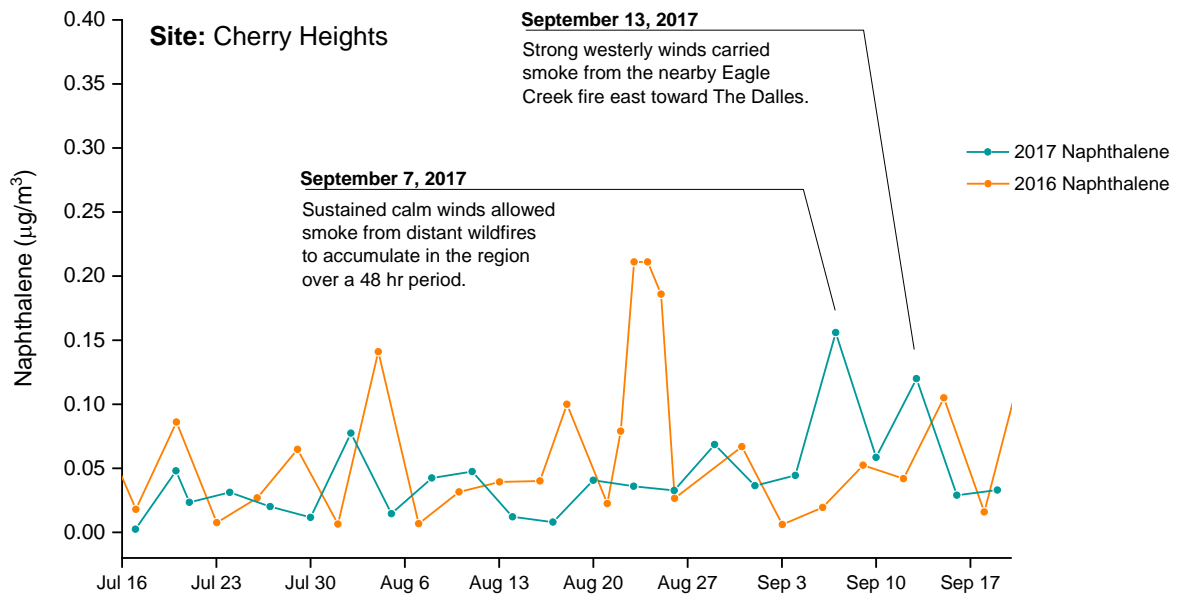


Figure 9. Daily naphthalene concentrations from 2016 and 2017. The two highest concentrations in 2017 were seen on September 7th and September 13th due to wildfire smoke intrusion.

Satellite imagery from September 7th shows a widespread infiltration of wildfire smoke throughout the Pacific Northwest which can be attributed to the more than 50 active fires that were burning at that time (Figure 10). Meteorological data show that predominantly calm winds were experienced in The Dalles on September 6th and 7th which allowed high concentrations of smoke to persist throughout the area (Figure 11).

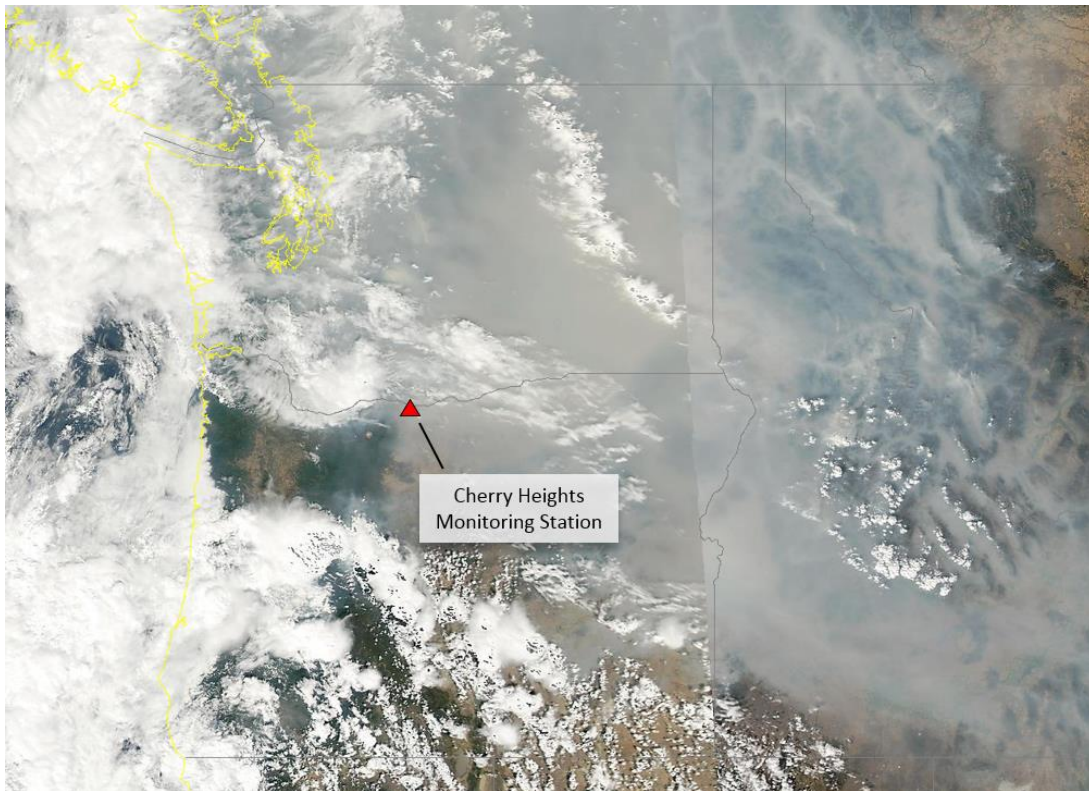


Figure 10. Satellite image of the Pacific Northwest on September 7th, 2017 showing the widespread infiltration of wildfire smoke. Image source: NASA Aqua MODIS satellite, 250m resolution.

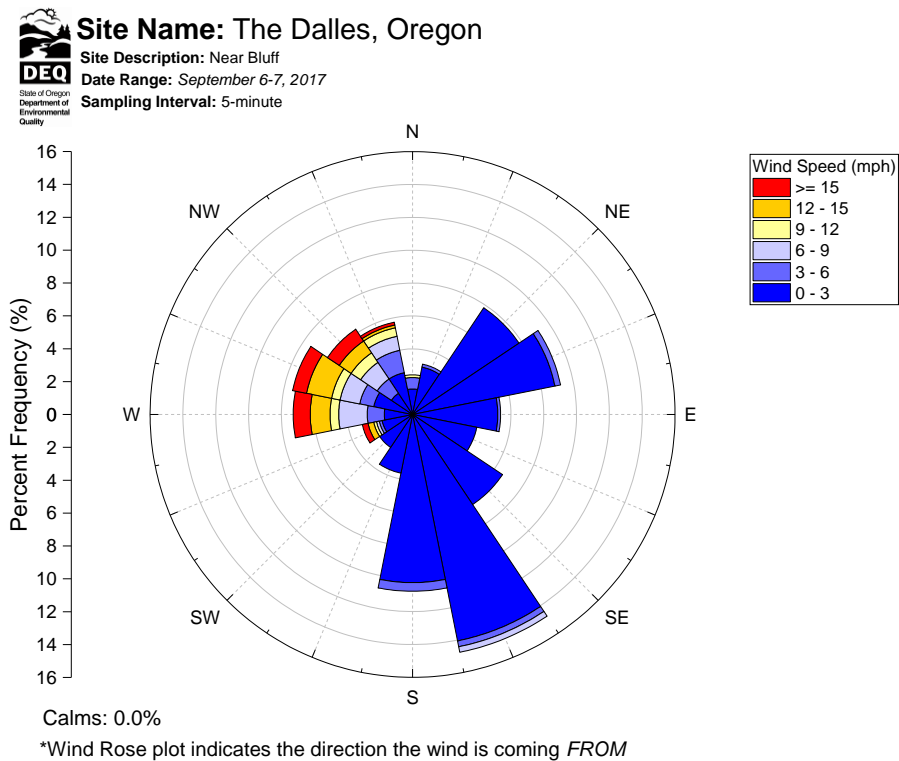


Figure 11. Calm winds were experienced September 6-7, 2017 allowing wildfire smoke to persist throughout the Pacific Northwest.

Air Quality Sampling in The Dalles

In comparison, the higher TEVs for 24-hr total PAHs on September 13th at Cherry Heights was caused by smoke coming directly from the nearby Eagle Creek fire (Figure 12). Meteorological data show that strong westerly winds contributed to the growth of the fire and were responsible for carrying high concentrations of smoke toward The Dalles (Figure 13). This day resulted in the only detections of benzo(a)pyrene in either the 2016 or 2017 monitoring periods. Levels of benzo(a)pyrene were highest at the Cherry Heights location (0.00078 $\mu\text{g}/\text{m}^3$) and lowest at the Wasco County Bldg. (0.00059 $\mu\text{g}/\text{m}^3$). This decreasing trend shows that the fire was responsible for the impact as westerly winds carried smoke eastward across The Dalles throughout the day.

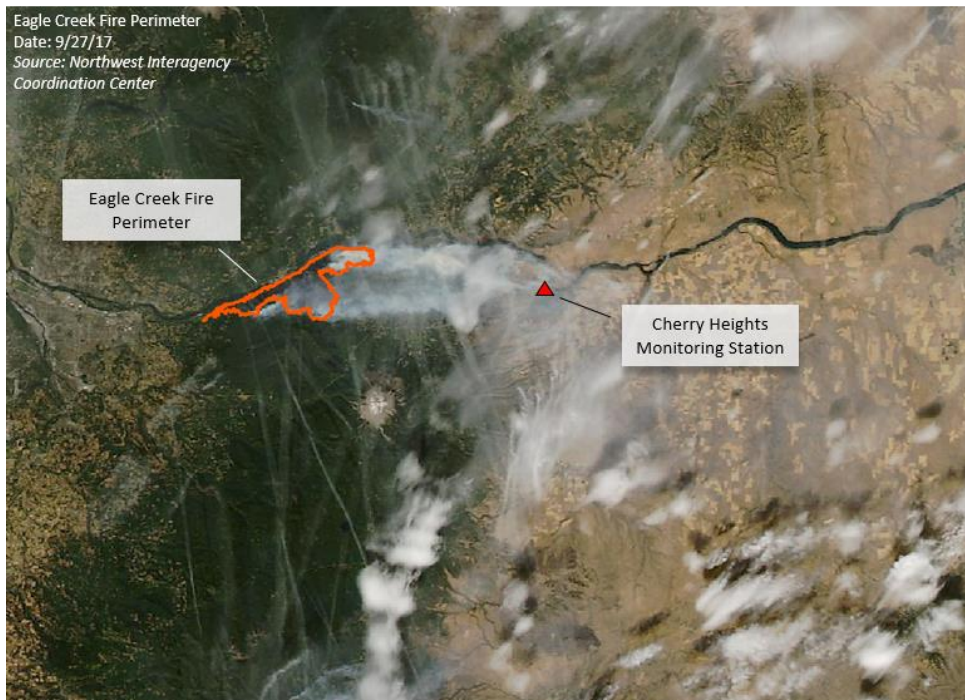


Figure 12. Satellite image from September 13th, 2017 of dense smoke from the Eagle Creek fire impacting The Dalles. Image Source: NASA Aqua MODIS satellite, 250m resolution.

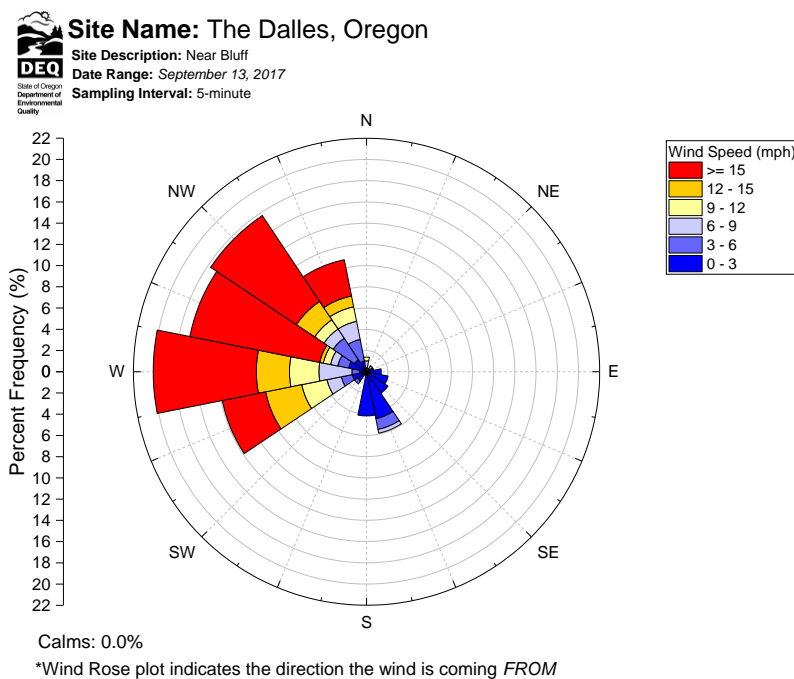


Figure 13. Strong winds from the west prevailed on September 13, 2017 which carried dense smoke from the nearby Eagle Creek fire to The Dalles.

Air Quality Sampling in The Dalles

DEQ continuously monitors air quality at various locations around the state through continuous measurements of particulate matter and other criteria pollutants. Air quality ratings, mainly driven by levels of particulate matter, are then calculated and used to communicate potential health risks to the public (Figure 14). A nephelometer at the Cherry Heights location continuously monitors particulate matter levels in the atmosphere that are a size of 2.5 microns and smaller (PM_{2.5}). The 24-hr average PM_{2.5} data confirm the impact of wildfire smoke on September 7th and September 13th which resulted in an air quality rating of “Unhealthy” for both days (Figure 15).

24-hr Average PM _{2.5} (µg/m ³)	Air Quality Rating	Meaning
0.0 - 12.0	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.
12.1 - 35.4	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
35.5 - 55.4	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
55.5 - 150.4	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
150.5 - 250.4	Very Unhealthy	Health alert: everyone may experience more serious health effects.
>250.5	Hazardous	Health warnings of emergency conditions. The entire population is more likely to be affected.

Figure 14. Air quality ratings and corresponding PM_{2.5} concentration.

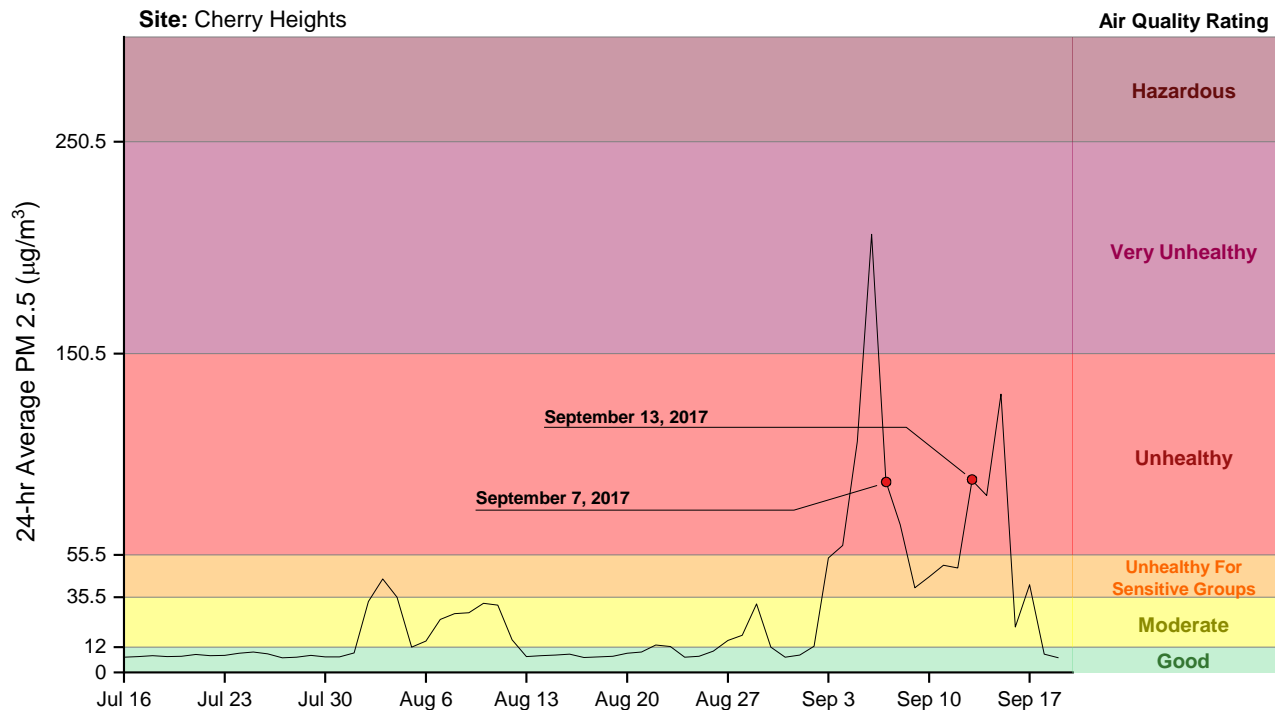


Figure 15. A nephelometer at the Cherry Heights monitoring location recorded elevated levels of PM_{2.5} caused by wildfire smoke intrusion.

3.5 AmeriTies Production & Storage

AmeriTies treats and stores four types of wood products for railroad use: cross ties, switch ties, bridge timbers, and poles. When raw wood is being treated and processed, the production of the facility is measured in non-standard units called “Charges”. One Charge is equal to a full load of product that is treated and processed by the equipment at the facility. Each wood product comes in various sizes, therefore the number of products that equals a full load will vary. Records show that production was slightly lower in 2017 when compared to the same period in 2016. In 2017, AmeriTies was closed for 12 consecutive days during the sampling period, however naphthalene levels were shown to increase during this time indicating that naphthalene concentrations are not well correlated with AmeriTies production activities (Figure 16). Once the treated products are stored on the property, the volume is reported in “Tie Equivalent” (TE) units to account for the variation in size of the products. The TE is calculated by dividing the total volume (cubic feet) of all products by a conversion factor of 3.83. Storage records indicate that a larger volume of treated products were being stored on the AmeriTies property in 2017 compared to the same period in 2016 (Figure 17).

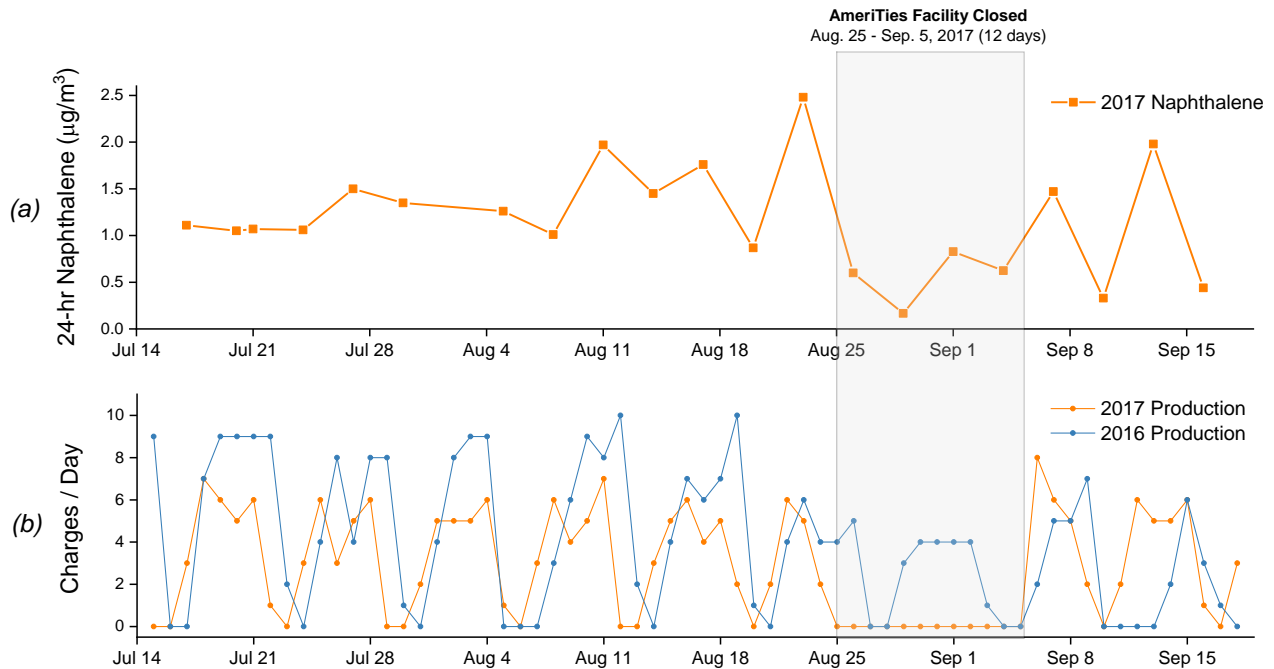


Figure 16. (a) 24-hr Naphthalene samples in 2017, and (b) AmeriTies Daily production history from 2016 and 2017. In 2017, AmeriTies was closed for a period of 12 consecutive days (August 25th – September 5th).

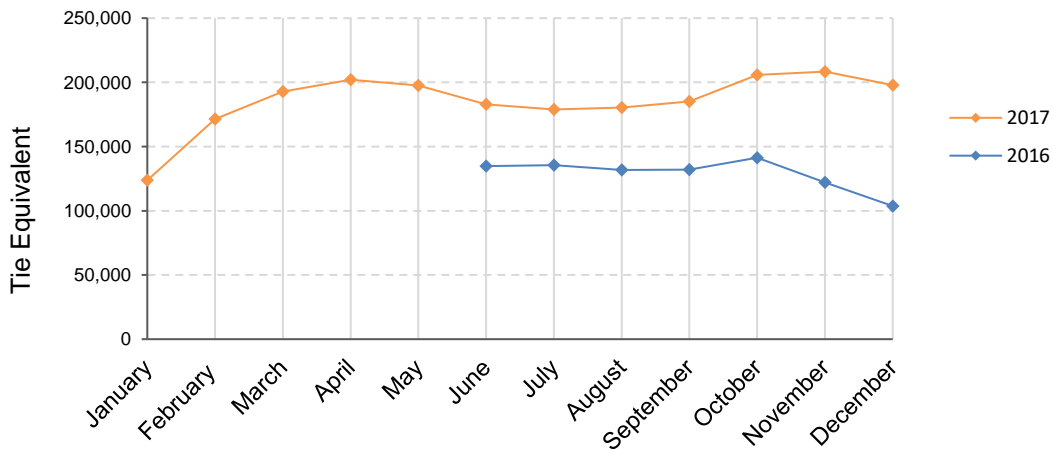


Figure 17. End-of-month treated storage volume at AmeriTies. “Tie Equivalent” units are calculated by dividing the total volume (cubic feet) of all products by a conversion factor of 3.83.

4. Summary

Air quality monitoring results from 2017 showed a decreasing trend in 24-hr concentrations of both naphthalene and TEVs for total PAHs moving west from the Wasco County Bldg. toward the Cherry Heights monitoring location. This trend is consistent with results from the same period in 2016. At the Wasco County Bldg. site, sampling results show that the average 24-hr concentration of naphthalene was less in 2017 compared to 2016 during the same period. Overall, the average 24-hr concentration of naphthalene at each site was above the Oregon ABC of $0.03 \mu\text{g}/\text{m}^3$, but below both the currently proposed SGC of $200 \mu\text{g}/\text{m}^3$ and the ATSDR MRL for non-cancer health effects of $3.7 \mu\text{g}/\text{m}^3$, which is consistent with 2016 results. A strong positive correlation between 24-hr TEVs for total PAHs and maximum daily temperature was seen at the Wasco County Bldg. This correlation dissipated as distance from the AmeriTies facility increased.

A significant number of active wildfires in 2017 led to unhealthy air quality conditions at times throughout the Pacific Northwest. Increased 24-hr total PAH concentrations were seen at the Cherry Heights monitoring location on September 7th, 2017 as a result of widespread smoke infiltration throughout the region. Unhealthy air quality conditions were seen again in The Dalles as a result of the strong westerly winds carrying dense smoke from the nearby Eagle Creek fire.

AmeriTies' production records show that the average weekly production was less in 2017 (27 charges/week in 2017 vs. 37 charges/week in 2016), while the volume of treated products being stored on the property was greater in 2017. Average levels of naphthalene and TEVs for total PAHs were down from 2016 levels at the Wasco County Bldg. site but concentrations are not well correlated with production records. The strong positive correlation between temperature and total PAHs suggests that meteorological conditions play an important role in levels and transport of naphthalene and other PAHs in the area.

Appendix A: Individual PAH Levels

Table A-1. General statistics for PAHs during 2016 air quality monitoring (Jul. 17 – Sep. 19). Statistics were generated using ProUCL software version 5.1. The Kaplan Meier Method (KM) was used to calculate statistics for datasets that include results below a laboratory analytical detection limit.

Variable	# Obs	# Missing	# Ds	# NDs	% NDs	Min ND	Max ND	KM Mean	KM Var	KM SD	KM CV
Acenaphthene (cherry heights)	25	0	25	0	0.00%	N/A	N/A	0.0125	1.04E-04	0.0102	0.817
Acenaphthene (city park)	6	0	6	0	0.00%	N/A	N/A	2.69E-01	0.0491	0.222	0.824
Acenaphthene (wasco county bldg)	25	0	23	2	8.00%	0.724	1.713	1.603	1.202	1.096	0.684
Acenaphthylene (cherry heights)	25	0	3	22	88.00%	3.90E-04	4.20E-04	4.05E-04	2.05E-09	4.53E-05	0.112
Acenaphthylene (city park)	6	0	6	0	0.00%	N/A	N/A	1.87E-03	1.68E-06	0.00129	0.692
Acenaphthylene (wasco county bldg)	25	0	23	2	8.00%	0.00704	0.0118	8.01E-03	1.09E-05	0.0033	0.412
Anthracene (cherry heights)	25	0	12	13	52.00%	4.00E-04	4.20E-04	4.79E-04	1.74E-08	1.32E-04	0.275
Anthracene (city park)	6	0	6	0	0.00%	N/A	N/A	7.31E-03	1.18E-05	0.00344	0.47
Anthracene (wasco county bldg)	25	0	23	2	8.00%	0.0159	0.0399	3.71E-02	5.91E-04	0.0243	0.656
Benzo(a)anthracene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Benzo(a)anthracene (city park)	6	0	1	5	83.33%	4.00E-04	4.10E-04	4.33E-04	5.56E-09	7.45E-05	0.172
Benzo(a)anthracene (wasco county bldg)	25	0	8	17	68.00%	3.90E-04	7.80E-04	5.03E-04	5.39E-08	2.32E-04	0.461
Benzo(a)pyrene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Benzo(a)pyrene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Benzo(a)pyrene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene (wasco county bldg)	25	0	3	22	88.00%	3.90E-04	7.80E-04	4.09E-04	3.69E-09	6.07E-05	0.149
Benzo(e)pyrene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Benzo(e)pyrene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Benzo(e)pyrene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Benzo(g,h,i)perylene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Benzo(g,h,i)perylene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Benzo(g,h,i)perylene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene (cherry heights)	25	0	1	24	96.00%	3.90E-04	4.20E-04	3.93E-04	1.88E-10	1.37E-05	0.0349
Benzo(k)fluoranthene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene (wasco county bldg)	25	0	2	23	92.00%	3.90E-04	7.80E-04	3.95E-04	2.79E-10	1.67E-05	0.0423
Chrysene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Chrysene (city park)	6	0	5	1	16.67%	4.00E-04	4.00E-04	7.83E-04	2.59E-07	5.09E-04	0.649
Chrysene (wasco county bldg)	25	0	20	5	20.00%	3.90E-04	8.50E-04	1.03E-03	4.39E-07	6.63E-04	0.646
Coronene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Coronene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Coronene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Dibenzofuran (cherry heights)	25	0	25	0	0.00%	N/A	N/A	0.0126	1.05E-04	0.0103	0.813
Dibenzofuran (city park)	6	0	6	0	0.00%	N/A	N/A	1.63E-01	0.0157	0.125	0.768
Dibenzofuran (wasco county bldg)	25	0	23	2	8.00%	0.461	0.998	0.898	0.305	0.552	0.615
Dibenzothiophene (cherry heights)	25	0	22	3	12.00%	4.00E-04	4.10E-04	8.70E-04	2.16E-07	4.64E-04	0.533
Dibenzothiophene (city park)	6	0	6	0	0.00%	N/A	N/A	8.99E-03	1.71E-05	0.0042	0.467
Dibenzothiophene (wasco county bldg)	25	0	23	2	8.00%	0.0223	0.0518	4.48E-02	7.11E-04	0.0267	0.595
Fluoranthene (cherry heights)	25	0	22	3	12.00%	4.00E-04	4.20E-04	9.26E-04	2.03E-07	4.51E-04	0.487
Fluoranthene (city park)	6	0	6	0	0.00%	N/A	N/A	3.47E-02	1.96E-04	0.014	0.403
Fluoranthene (wasco county bldg)	25	0	23	2	8.00%	0.0325	0.0874	7.18E-02	0.00271	0.0521	0.725
Fluorene (cherry heights)	25	0	25	0	0.00%	N/A	N/A	0.00933	5.29E-05	0.00728	0.779
Fluorene (city park)	6	0	6	0	0.00%	N/A	N/A	1.20E-01	0.00739	0.086	0.714
Fluorene (wasco county bldg)	25	0	23	2	8.00%	0.35	0.775	0.667	0.151	0.388	0.582
Indeno(1,2,3-cd)pyrene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Naphthalene (cherry heights)	25	0	25	0	0.00%	N/A	N/A	0.0645	0.00394	0.0628	0.974
Naphthalene (city park)	6	0	6	0	0.00%	N/A	N/A	0.583	0.279	0.528	0.906
Naphthalene (wasco county bldg)	25	0	23	2	8.00%	2.7	3.49	2.625	1.879	1.371	0.522
Perylene (cherry heights)	25	0	0	25	100.00%	3.90E-04	4.20E-04	N/A	N/A	N/A	N/A
Perylene (city park)	6	0	0	6	100.00%	4.00E-04	4.10E-04	N/A	N/A	N/A	N/A
Perylene (wasco county bldg)	25	0	0	25	100.00%	3.90E-04	7.80E-04	N/A	N/A	N/A	N/A
Phenanthrene (cherry heights)	25	0	25	0	0.00%	N/A	N/A	0.00762	2.52E-05	0.00502	0.659
Phenanthrene (city park)	6	0	6	0	0.00%	N/A	N/A	1.43E-01	0.00538	0.0734	0.513
Phenanthrene (wasco county bldg)	25	0	23	2	8.00%	0.276	0.739	0.644	0.163	0.403	0.626
Pyrene (cherry heights)	25	0	12	13	52.00%	3.90E-04	4.20E-04	5.50E-04	4.71E-08	2.17E-04	0.395
Pyrene (city park)	6	0	6	0	0.00%	N/A	N/A	1.80E-02	8.49E-05	0.00921	0.511
Pyrene (wasco county bldg)	25	0	23	2	8.00%	0.0139	0.0386	3.85E-02	8.21E-04	0.0287	0.745

Air Quality Sampling in The Dalles

Table A-2. General statistics for PAHs during 2017 air quality monitoring (Jul. 17 – Sep. 19). Statistics were generated using ProUCL software version 5.1. The Kaplan Meier Method (KM) was used to calculate statistics for datasets that include results below a laboratory analytical detection limit.

Variable	# Obs	# Missing	# Ds	#NDs	% NDs	Min ND	Max ND	KM Mean	KM Var	KM SD	KM CV
Acenaphthene (cherry heights)	23	0	23	0	0.00%	N/A	N/A	0.0103	8.34E-05	0.00913	0.885
Acenaphthene (city park)	20	0	20	0	0.00%	N/A	N/A	0.136	0.00923	0.0961	0.707
Acenaphthene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	1.053	0.334	0.578	0.549
Acenaphthylene (cherry heights)	23	0	4	19	82.61%	4.10E-04	5.00E-04	6.27E-04	4.41E-07	6.64E-04	1.06
Acenaphthylene (city park)	20	0	19	1	5.00%	4.70E-04	4.70E-04	0.00182	1.94E-06	0.00139	0.767
Acenaphthylene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.0069	2.25E-05	0.00475	0.688
Anthracene (cherry heights)	23	0	2	21	91.30%	4.10E-04	5.10E-04	5.32E-04	1.96E-07	4.43E-04	0.833
Anthracene (city park)	20	0	20	0	0.00%	N/A	N/A	0.00436	5.53E-06	0.00235	0.54
Anthracene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.0359	3.81E-04	0.0195	0.544
Benzo(a)anthracene (cherry heights)	23	0	1	22	95.65%	4.10E-04	9.40E-04	4.39E-04	1.81E-08	1.35E-04	0.307
Benzo(a)anthracene (city park)	20	0	2	18	90.00%	4.20E-04	8.40E-04	4.66E-04	2.23E-08	1.49E-04	0.321
Benzo(a)anthracene (wasco county bldg)	22	0	7	15	68.18%	4.60E-04	5.00E-04	5.17E-04	4.52E-08	2.13E-04	0.411
Benzo(a)pyrene (cherry heights)	23	0	1	22	95.65%	4.10E-04	5.10E-04	4.26E-04	5.69E-09	7.55E-05	0.177
Benzo(a)pyrene (city park)	20	0	1	19	95.00%	4.20E-04	8.60E-04	4.31E-04	2.10E-09	4.58E-05	0.106
Benzo(a)pyrene (wasco county bldg)	22	0	1	21	95.45%	4.60E-04	5.20E-04	4.66E-04	7.66E-10	2.77E-05	0.0594
Benzo(b)fluoranthene (cherry heights)	23	0	1	22	95.65%	4.10E-04	8.70E-04	4.23E-04	2.87E-09	5.36E-05	0.127
Benzo(b)fluoranthene (city park)	20	0	2	18	90.00%	4.20E-04	9.90E-04	4.83E-04	3.59E-08	1.89E-04	0.392
Benzo(b)fluoranthene (wasco county bldg)	22	0	3	19	86.36%	4.60E-04	5.20E-04	5.30E-04	4.15E-08	2.04E-04	0.385
Benzo(e)pyrene (cherry heights)	23	0	1	22	95.65%	4.10E-04	5.10E-04	4.14E-04	4.16E-10	2.04E-05	0.0492
Benzo(e)pyrene (city park)	20	0	2	18	90.00%	4.20E-04	8.60E-04	4.55E-04	1.03E-08	1.01E-04	0.223
Benzo(e)pyrene (wasco county bldg)	22	0	2	20	90.91%	4.60E-04	5.20E-04	4.89E-04	8.46E-09	9.20E-05	0.188
Benzo(g,h,i)perylene (cherry heights)	23	0	0	23	100.00%	4.10E-04	5.10E-04	N/A	N/A	N/A	N/A
Benzo(g,h,i)perylene (city park)	20	0	0	20	100.00%	4.20E-04	9.90E-04	N/A	N/A	N/A	N/A
Benzo(g,h,i)perylene (wasco county bldg)	22	0	0	22	100.00%	4.60E-04	5.20E-04	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene (cherry heights)	23	0	1	22	95.65%	4.10E-04	9.40E-04	4.16E-04	6.03E-10	2.46E-05	0.0591
Benzo(k)fluoranthene (city park)	20	0	2	18	90.00%	4.20E-04	9.60E-04	4.52E-04	8.76E-09	9.36E-05	0.207
Benzo(k)fluoranthene (wasco county bldg)	22	0	2	20	90.91%	4.60E-04	5.20E-04	4.85E-04	6.03E-09	7.77E-05	0.16
Chrysene (cherry heights)	23	0	2	21	91.30%	4.10E-04	5.10E-04	5.05E-04	1.35E-07	3.67E-04	0.727
Chrysene (city park)	20	0	8	12	60.00%	4.70E-04	8.70E-04	7.24E-04	1.75E-07	4.18E-04	0.577
Chrysene (wasco county bldg)	22	0	18	4	18.18%	5.00E-04	5.00E-04	0.00105	2.89E-07	5.38E-04	0.513
Coronene (cherry heights)	15	8	0	15	100.00%	4.20E-04	5.10E-04	N/A	N/A	N/A	N/A
Coronene (city park)	13	7	0	13	100.00%	4.20E-04	5.20E-04	N/A	N/A	N/A	N/A
Coronene (wasco county bldg)	15	7	0	15	100.00%	4.60E-04	5.00E-04	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene (cherry heights)	23	0	0	23	100.00%	4.10E-04	8.70E-04	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene (city park)	20	0	0	20	100.00%	4.20E-04	9.90E-04	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene (wasco county bldg)	22	0	0	22	100.00%	4.60E-04	5.20E-04	N/A	N/A	N/A	N/A
Dibenzofuran (cherry heights)	23	0	23	0	0.00%	N/A	N/A	0.0196	3.46E-04	0.0186	0.949
Dibenzofuran (city park)	20	0	20	0	0.00%	N/A	N/A	0.118	0.00592	0.0769	0.651
Dibenzofuran (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.828	0.176	0.419	0.506
Dibenzothiophene (cherry heights)	23	0	15	8	34.78%	4.20E-04	0.00228	8.21E-04	1.58E-07	3.98E-04	0.484
Dibenzothiophene (city park)	20	0	20	0	0.00%	N/A	N/A	0.00602	1.46E-05	0.00382	0.634
Dibenzothiophene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.0414	4.59E-04	0.0214	0.517
Fluoranthene (cherry heights)	23	0	18	5	21.74%	4.20E-04	9.20E-04	0.00134	1.31E-06	0.00114	0.852
Fluoranthene (city park)	20	0	20	0	0.00%	N/A	N/A	0.0247	3.53E-04	0.0188	0.759
Fluoranthene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.0672	0.00151	0.0389	0.578
Fluorene (cherry heights)	23	0	23	0	0.00%	N/A	N/A	0.0118	1.20E-04	0.0109	0.924
Fluorene (city park)	20	0	20	0	0.00%	N/A	N/A	0.0819	0.00304	0.0551	0.673
Fluorene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.6	0.108	0.328	0.547
Indeno(1,2,3-cd)pyrene (cherry heights)	23	0	1	22	95.65%	4.10E-04	8.70E-04	4.17E-04	8.03E-10	2.83E-05	0.068
Indeno(1,2,3-cd)pyrene (city park)	20	0	2	18	90.00%	4.20E-04	9.90E-04	4.48E-04	6.45E-09	8.03E-05	0.179
Indeno(1,2,3-cd)pyrene (wasco county bldg)	22	0	2	20	90.91%	4.60E-04	5.20E-04	4.80E-04	4.84E-09	6.96E-05	0.145
Naphthalene (cherry heights)	23	0	23	0	0.00%	N/A	N/A	0.0432	0.00127	0.0357	0.826
Naphthalene (city park)	20	0	20	0	0.00%	N/A	N/A	0.302	0.0468	0.216	0.716
Naphthalene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	1.164	0.325	0.57	0.49
Perylene (cherry heights)	23	0	0	23	100.00%	4.10E-04	5.10E-04	N/A	N/A	N/A	N/A
Perylene (city park)	20	0	0	20	100.00%	4.20E-04	0.001	N/A	N/A	N/A	N/A
Perylene (wasco county bldg)	22	0	0	22	100.00%	4.60E-04	5.20E-04	N/A	N/A	N/A	N/A
Phenanthrene (cherry heights)	23	0	23	0	0.00%	N/A	N/A	0.00885	4.75E-05	0.00689	0.779
Phenanthrene (city park)	20	0	20	0	0.00%	N/A	N/A	0.0934	0.00395	0.0628	0.673
Phenanthrene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.539	0.0853	0.292	0.542
Pyrene (cherry heights)	23	0	12	11	47.83%	4.10E-04	5.00E-04	7.03E-04	4.16E-07	6.45E-04	0.917
Pyrene (city park)	20	0	20	0	0.00%	N/A	N/A	0.0108	6.80E-05	0.00825	0.766
Pyrene (wasco county bldg)	22	0	22	0	0.00%	N/A	N/A	0.0328	3.65E-04	0.0191	0.582