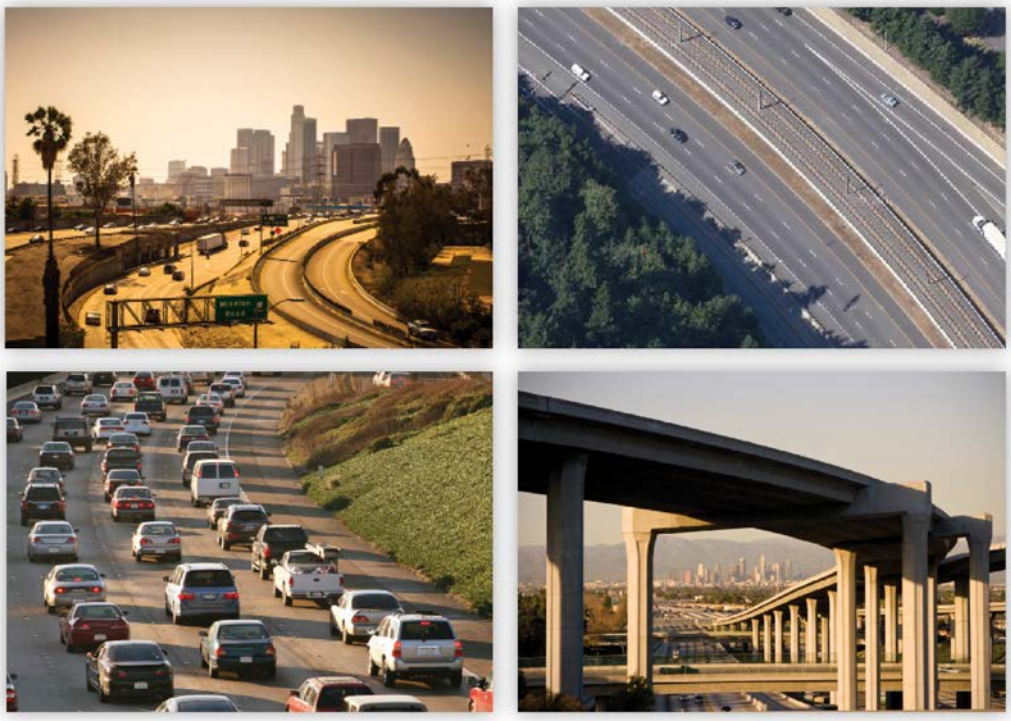
Recommended Near-Road Monitoring Sites for Model-to-Monitor Case Study Comparisons



Draft Report Prepared for

Washington State Department of Transportation
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Innovative Environmental Solutions

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Draft Report

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Abstract

Background: The project-level modeling chain includes traffic activity data collection, emissions estimation, and air dispersion modeling to predict near-road pollutant concentrations. The objective of this work was to support case studies to evaluate uncertainties in this modeling chain. The project goal is to assemble data to support case study analyses to improve understanding of how modeled near-road concentrations compare to monitored near-road data.

Methods: The project team developed a database that contained the highest pollutant measurements from the near-road monitoring network, pollutant measurements from other regional monitoring sites, traffic activity data, and meteorological data. This database was designed to support the overall objective of model evaluation. In addition, we analyzed data for selected sites. Based on these findings, we identified priority sites for case study use.

Results: The final database includes 2015 data that represent the highest 25 values for daily (24-hr) average $PM_{2.5}$, daily maximum 1-hour NO_2, and daily maximum 8-hour CO concentrations occurring at each site (61 near-road sites total). The database also provides the daily and hourly air quality and meteorological data for all sites monitoring CO, NO_2 (and/or NO_x), or $PM_{2.5}$ within a 100-km radius of the near-road sites. For selected sites in California, Arizona, Colorado, Indiana, Massachusetts, Missouri, Ohio, Oregon, Rhode Island, Texas, and Virginia, we assembled hourly traffic data (counts/volume, speed, and/or vehicle characterization). Based on a number of evaluation factors, we assessed that the sites in Ontario, CA, Providence, RI, and St. Louis, MO, would be useful for model-to-monitor case study evaluations; the site in Portland, OR, can serve as a alternative site if needed. The resulting database and selected sites for analysis can be used to explore the relationship between near-road pollution increments and factors such as traffic speed, traffic volume, fleet mix, time of day, day of week, meteorology, and distance to road.

1. Introduction

This report includes recommended sites for model-to-monitor case studies. The recommendations are based on prior work completed for the Near-Road Air Quality Transportation Pooled Fund (TPF) to examine national near-road air quality data, examine the characteristics and data availability associated with the near-road sites, and to build a database to support near-road air quality analysis that is linked to high-concentration near-road events.

As of September 2016, the U.S. Environmental Protection Agency (EPA) listed 79 official national near-road (NR) monitoring sites,[1] 61 of which were operating in 2015. Sonoma Technology, Inc. (STI) developed a database of selected daily and hourly air quality and meteorological data for these 61 NR sites. These data include the highest 25 values for daily (24-hour) average $PM_{2.5}$, daily maximum 1-hour NO_2, and daily maximum 8-hour CO concentrations for each site. The database also provides the daily and hourly air quality and meteorological data for all sites monitoring CO, NO_2 (and/or NO_x), or $PM_{2.5}$ within a 100-km radius of the NR sites; we refer to these additional monitoring stations as "nearby" sites.

To support case study analyses and comparisons between modeled and monitored NR pollutant concentrations, we performed additional analysis of the 61 official national NR monitoring sites to identify those where (1) there was either a daily maximum $PM_{2.5}$ concentration exceeding 35 $\mu g/m^3$ during 2015 or the site was located in a Transportation Pooled Fund (TPF) partner state; and (2) the site had corresponding available hourly traffic data (volume, speeds, and/or vehicle characterization). Using these screening criteria, we identified 18 candidate sites.

During a webinar to TPF partners on February 27, 2017, we presented our findings concerning the 18 candidate study sites. Based on data completeness, roadway configuration characteristics, and discussions with TPF partners during the webinar, seven of the 18 candidate sites were identified for further assessment (Table 1). Subsequent to the February 2017 webinar, STI completed a more comprehensive review of the seven candidate sites, and developed a short list of four recommended sites for model-to-monitor case study analysis. The remainder of this report is organized as follows: the four recommended sites are identified in Section 2; data review highlights from our assessment of the seven candidate sites are provided in Section 3; and the basis for our recommendations are summarized in Section 4. Appendix A provides more data details on the seven candidate sites; Appendix B documents the database prepared to support case study assessments (the database covers all 61 sites included in the national NR monitoring network as of 2015).[2]

[1] https://www3.epa.gov/ttnamti1/nearroad.html.

[2] This material was previously delivered as: Brown S.G., Seagram A.F., and Eisinger D.S. (2017) Near-Road Pooled Fund Task Order 2, Phase 2 – Air quality, meteorological, and traffic data for the 25 highest daily PM, NO_2, and CO concentrations at selected near-road monitoring sites in 2015. Technical memorandum prepared for Karin Landsberg, Washington Department of Transportation, STI-914202-6665-TM, February 15.

Table 1. Seven candidate NR monitoring case study sites, as presented to TPF partners on February 27, 2017. The Site Name is the City, State (Target Road) [AQS[a] Site Number] for each site and are listed alphabetically by city. For $PM_{2.5}$ Data, "H" indicates hourly and "D" indicates daily measurements, where the number indicates "1-in-*n*" day measurement frequency. For Road Type, "S" indicates freeway segment, and "I" indicates proximity to freeway interchange.[b]

AQS ID	Site Name	Road Type	TPF Partner Site	Hourly Traffic Volume	Hourly Traffic Speed	Hourly Vehicle Characterization	$PM_{2.5}$ Data	CO Data	Collocated Meteorological Data
25-025-0044	Boston, MA (I-93) [0044]	S		x	x	x	H/D3	x	
08-031-0027	Denver, CO (I-25) [0027]	S	x	x	x		H/D3	x	x
06-071-0027	Ontario, CA (SR-60) [0027]	S	x	x	x	x	D1		
41-067-0005	Portland, OR (I-5) [0005]	S		x	x	x	D3	x	x
44-007-0030	Providence, RI (I-95) [0030]	I		x	x	x	H	x	
51-760-0025	Richmond, VA (I-95) [0025]	I	x	x	x	x	H	x	
29-510-0094	St. Louis, MO (I-64) [0094]	S		x	x	x	H	x	x

[a] AQS is the EPA's Air Quality System.

[b] "Interchange" sites are those that are near a freeway/freeway interchange, where modeling emissions from interchange traffic will likely be required to fully capture the impact of vehicle emissions on the NR site.

2. Site Recommendations

Following development of the database (61 NR sites), further identification of high-$PM_{2.5}$ sites or TPF partner state sites with hourly traffic data (18 sites), and TPF input to help narrow the list of potential candidates (7 sites), STI evaluated these remaining seven sites to assess site characteristics, data availability, and meteorological and air quality conditions to identify the most suitable sites for use during the next round of work involving model-to-monitor case studies. Based on the data review highlighted in Section 3, three sites (listed in alphabetical order by city) and one alternative site are recommended as the best candidates for case study work, as described below:

Recommended for Analysis

- **Ontario, CA (SR-60) [0027].** Hourly air quality data (NO_2 and NO_x, but no CO) and 24-hour $PM_{2.5}$ data (sampled daily, i.e., 1-in-1 day frequency) were collected at this site in 2015. Hourly traffic-related data were collected at a nearby sensor. There is no on-site meteorological data, though two international airport meteorological stations are nearby.

- **Providence, RI (I-95) [0030].** Hourly air quality data (CO, NO_2, NO_x, and $PM_{2.5}$) were monitored at this site in 2015. Meteorological data is available from another monitoring site located approximately 2.5 km away. Hourly traffic-related data are available from at least two nearby sensors. This is the only site near a freeway interchange with good data completeness for 2015.

- **St. Louis, MO (I-64) [0094].** Hourly meteorological and air quality data (CO, NO_2, NO_x, $PM_{2.5}$) were collected at this site in 2015. Hourly traffic-related data were collected at two nearby sensors. In 2015, the site had the largest estimated negative near-road $PM_{2.5}$ increment among all NR sites included in the analysis.

Recommended as a Backup

- **Portland, OR (I-5) [0005].** Hourly meteorological and air quality data (CO, NO_2, and NO_x) were monitored at this site in 2015. Only 24-hour $PM_{2.5}$ data are available, at 1-in-3 day frequency. Hourly traffic-related data were collected at a nearby sensor. The lack of daily $PM_{2.5}$ data renders this site least desirable among these four for case study analysis.

With TPF concurrence, the model-to-monitor case study work will proceed using the first three locations identified (Ontario, Providence, and St. Louis); if an unforeseen analysis problem emerges, we will use the Portland site for analysis. The top three sites cover a diversity of locations, include a California case to enable EMFAC-based assessment (since emission at other sites will be modeled with MOVES), include different roadway configurations (freeway segments and freeway interchange), and air quality conditions.

3. Data Review Highlights of Seven Near-Road Sites

In the sections that follow, each of the seven NR monitoring sites are described in terms of their location, site characteristics, data availability, and meteorological and air quality conditions. This information can be used to support the selection of NR monitoring sites for case study analyses and model-to-monitoring comparisons.

3.1 Boston, MA (I-93) [0044]

The NR monitoring site in Boston, MA (locally named "Von Hillern St") is adjacent to I-93 (**Figure 1**, **Table 2**). It is located 10 m east of the roadway, and approximately 30 m west of a commuter rail and rapid transit line (Massachusetts Bay Transportation Authority).

Figure 1. View of the Boston, MA (I-93) [0044] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 2. Site information for the Boston, MA (I-93) [0044] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).

Parameter	Value
AADT	198,239
FE-AADT	251,761
Number of adjacent lanes	7
Distance to target road	10 m
$PM_{2.5}$ increment	0.3 µg/m^3
24-hour maximum $PM_{2.5}$	20.8 µg/m^3
Annual mean $PM_{2.5}$	6.7 µg/m^3
CO max. 1-hour	1.8 ppm
NO_2 max. 1-hour	61.0 ppb

3.1.1 Data Completeness

Hourly CO, NO_2, NO_x, and 24-hour $PM_{2.5}$ were monitored at this site in 2015, with generally good data completeness (Figure 2). Hourly $PM_{2.5}$ was also measured starting September 1, 2015. Traffic-related data were available from one traffic monitor located approximately 700 m northbound from the NR monitoring site (Figure 1).

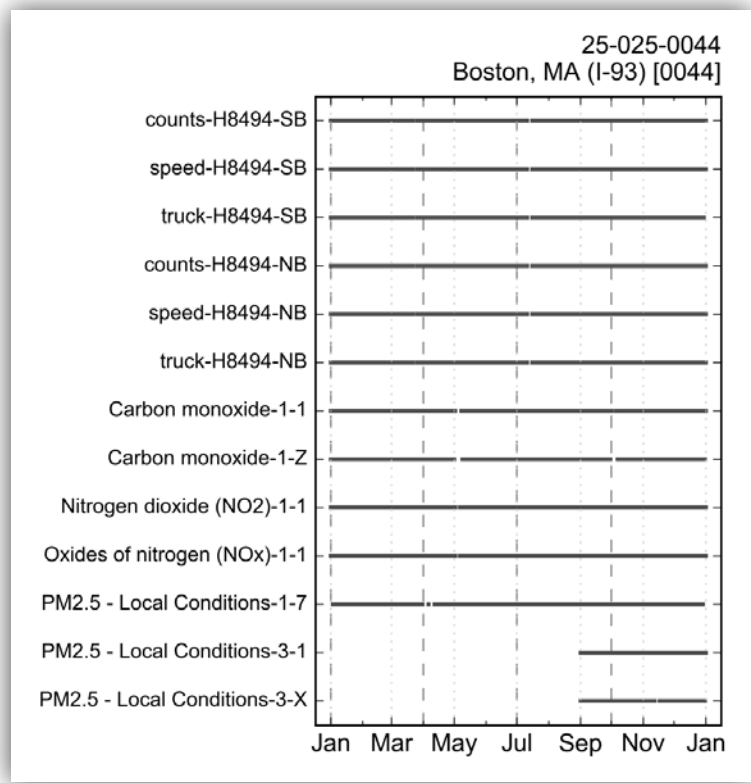

Figure 2. Graphical summary of data availability of air quality and traffic-related data at the Boston, MA (I-93) [0044] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

3.1.2 Meteorological Data

Wind speed and direction are not measured at the Boston, MA (I-93) [0044] NR monitoring site. The closest monitoring site that measured wind speed and wind direction in 2015 was the Dudley Square Roxbury site (AQS ID 25-025-0042), located approximately 2.3 km west (inland; see Appendix A, Figure A-1). The wind is predominantly from the southwest. Wind speeds are generally slow (<4 m/s); the mean annual wind speed is 1.82 m/s (Figure 3).

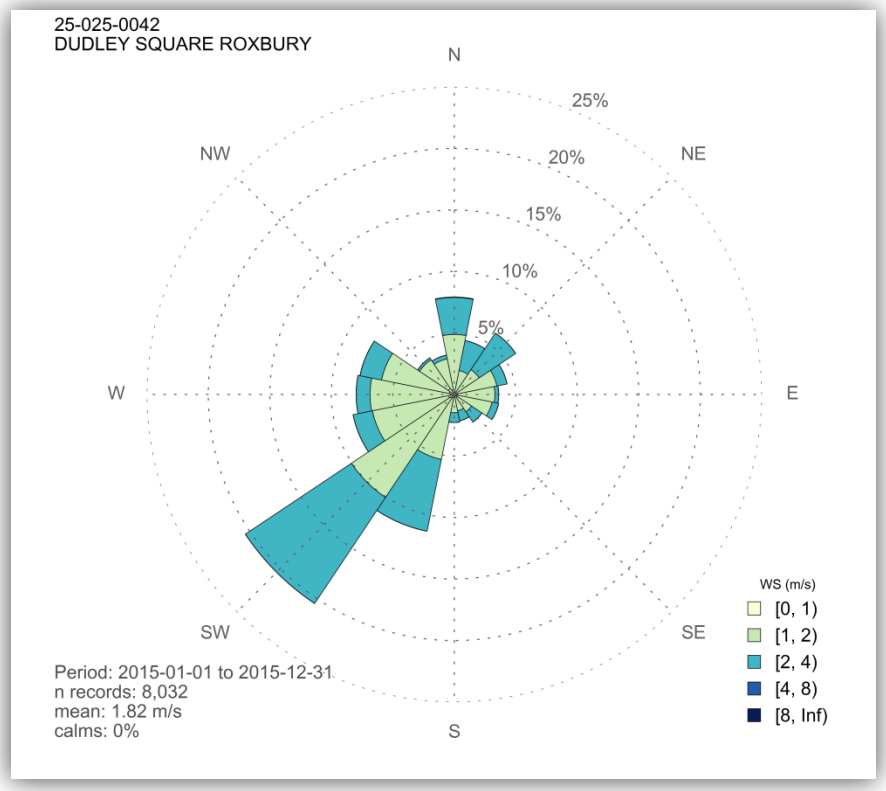

Figure 3. Pollution rose of hourly wind speed and direction for the Dudley Square Roxbury (AQS ID 25-025-0042) monitoring site.

3.1.3 Air Quality and Other Considerations

There is one large point-source of $PM_{2.5}$ emissions (≥20 tons per year) that could impact air quality near the Boston, MA (I-93) [0044] NR monitoring site: a cogeneration facility located approximately 4.8 km north (see Appendix A, Figure A-1). The proximity of the commuter and light rail lines to the NR monitoring site may also complicate analyses that aim to isolate the effects of motor vehicle emissions on NR air quality. A pollution rose of all available hourly $PM_{2.5}$ concentrations at the NR monitoring site and using the wind directions taken from the Dudley Square Roxbury site (from September 1, 2015, through December 31, 2015, only) indicates that higher $PM_{2.5}$ concentrations (≥4 µg/m^3) are common from all wind directions (Figure 4).

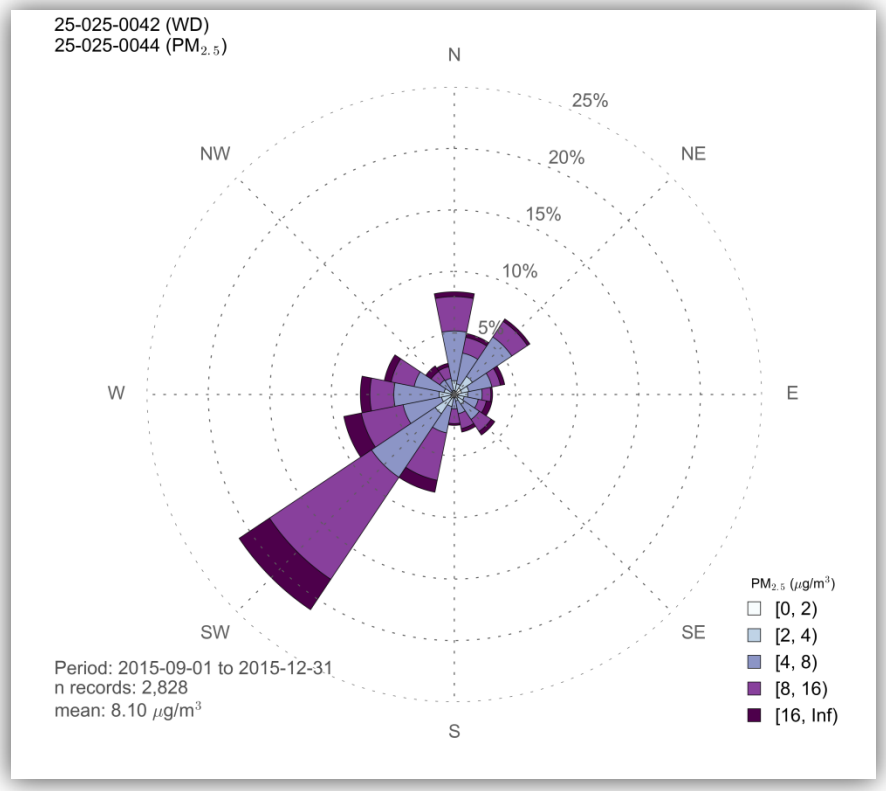

Figure 4. Pollution rose of hourly $PM_{2.5}$ measurements from the Boston, MA (I-93) [0044] NR monitoring site and wind directions taken from the nearest monitoring station (Dudley Square Roxbury site, AQS ID 25-025-0042; approximately 2.3 km west).

3.2 Denver, CO (I-25) [0027]

The NR monitoring site in Denver, CO (locally named "I-25") is adjacent to I-25 (9 m to the east; Figure 5, Table 3).

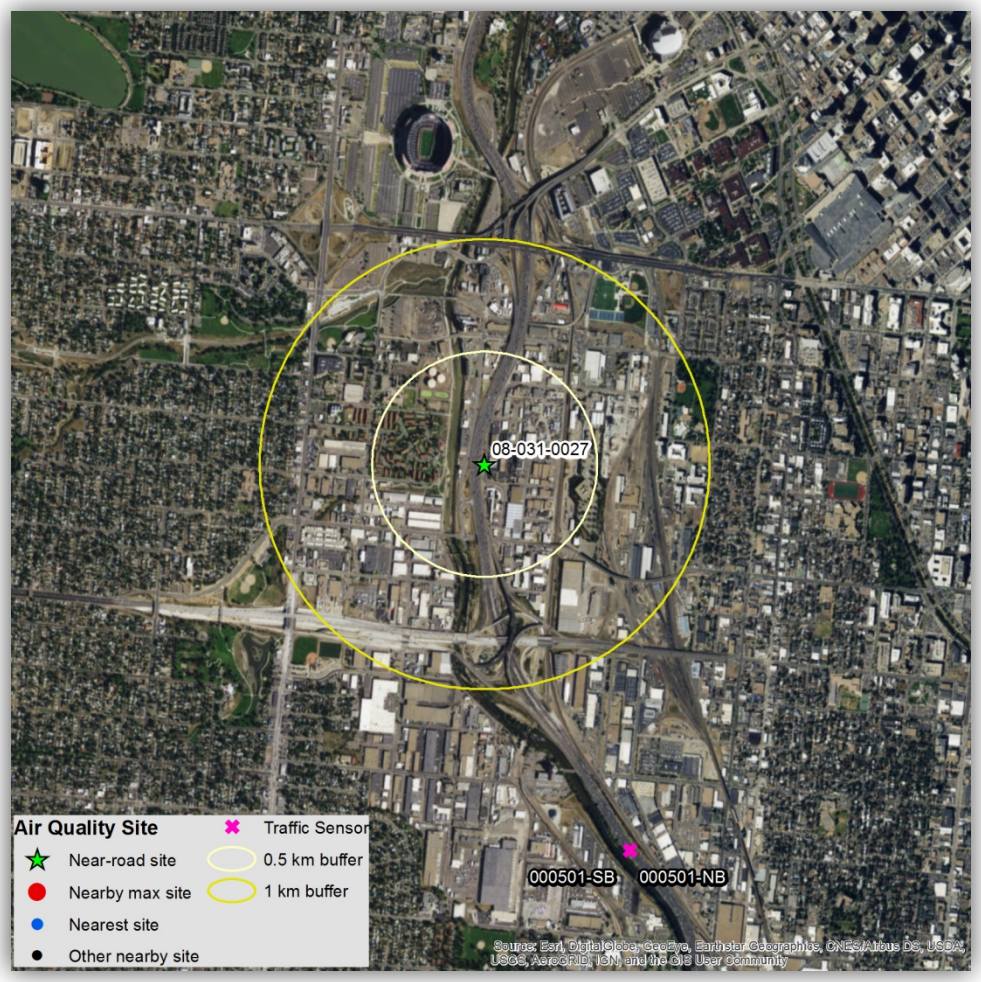

Figure 5. View of the Denver, CO (I-25) [0027] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 3. Site information for the Denver, CO (I-25) [0027] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).

Parameter	Value
AADT	249,000
FE-AADT	263,118
Number of adjacent lanes	10
Distance to target road	9 m
$PM_{2.5}$ increment	2.6 µg/m^3
24-hour maximum $PM_{2.5}$	29.1 µg/m^3
Annual mean $PM_{2.5}$	9.0 µg/m^3
CO max. 1-hour	2.9 ppm
NO_2 max. 1-hour	81.1 ppb

3.2.1 Data Completeness

Hourly CO, NO_x, NO_2, and $PM_{2.5}$ were monitored at this site in 2015, with generally good data completeness (Figure 6). Daily (24-hour) $PM_{2.5}$ measurements were taken every 1-in-3 days (Table 1). Hourly wind speed and wind direction were also measured in 2015. There is a substantial portion of both traffic volume (counts) and speed data missing in both the NB and SB directions from the nearest traffic monitoring site. No vehicle characterization ("truck") data are available.

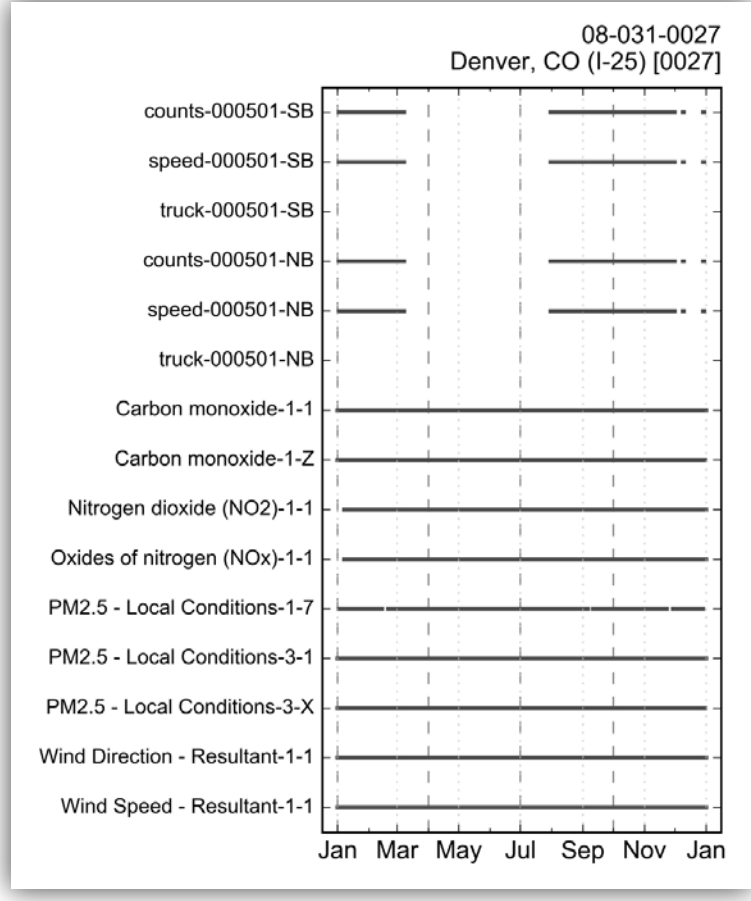

Figure 6. Graphical summary of data availability of air quality and traffic-related data at the Denver, CO (I-25) [0027] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

3.2.2 Meteorological Data

Wind speeds are frequently low (<2 m/s) at the Denver, CO (I-55) [0027] NR monitoring site (Figure 7). The wind is predominantly from the north and south, i.e., parallel to the adjacent freeway segment.

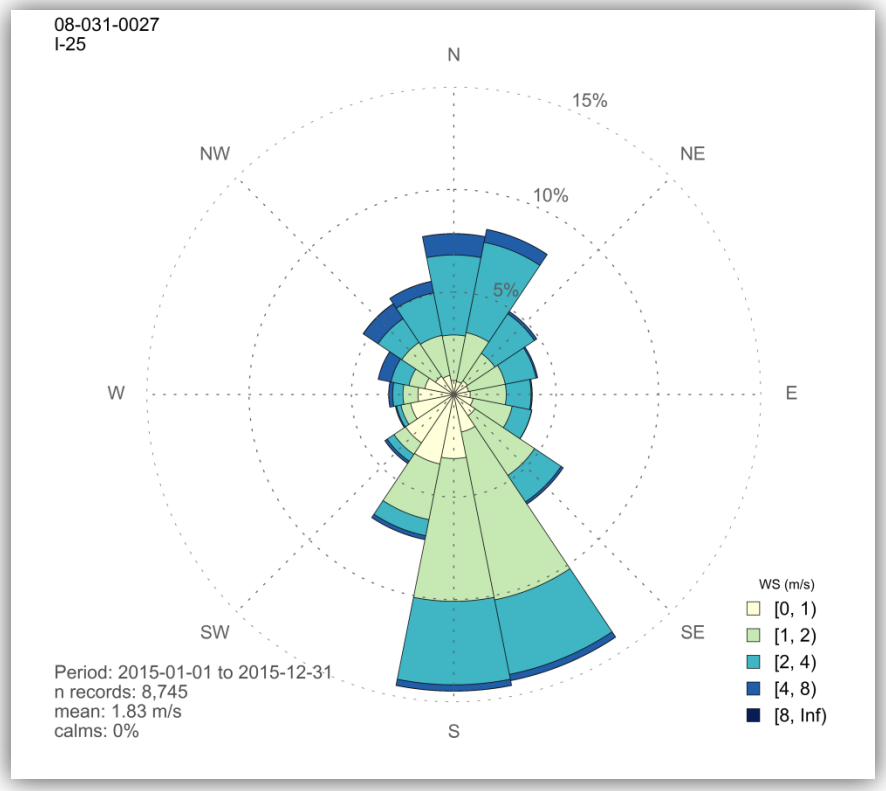

Figure 7. Pollution rose of hourly wind speed and direction for the Denver, CO (I-25) [0027] NR monitoring site.

3.2.3 Air Quality and Other Considerations

There are several point sources of $PM_{2.5}$ emissions in the Denver area, though large sources are located more than 5 km from the Denver, CO (I-25) [0027] NR monitoring site (see Appendix A, Figure A-2). From a pollution rose of hourly $PM_{2.5}$ measurements in 2015, it appears as though higher concentrations of $PM_{2.5}$ (≥8 µg/m^3) are relatively common over all wind directions (**Figure 8**).

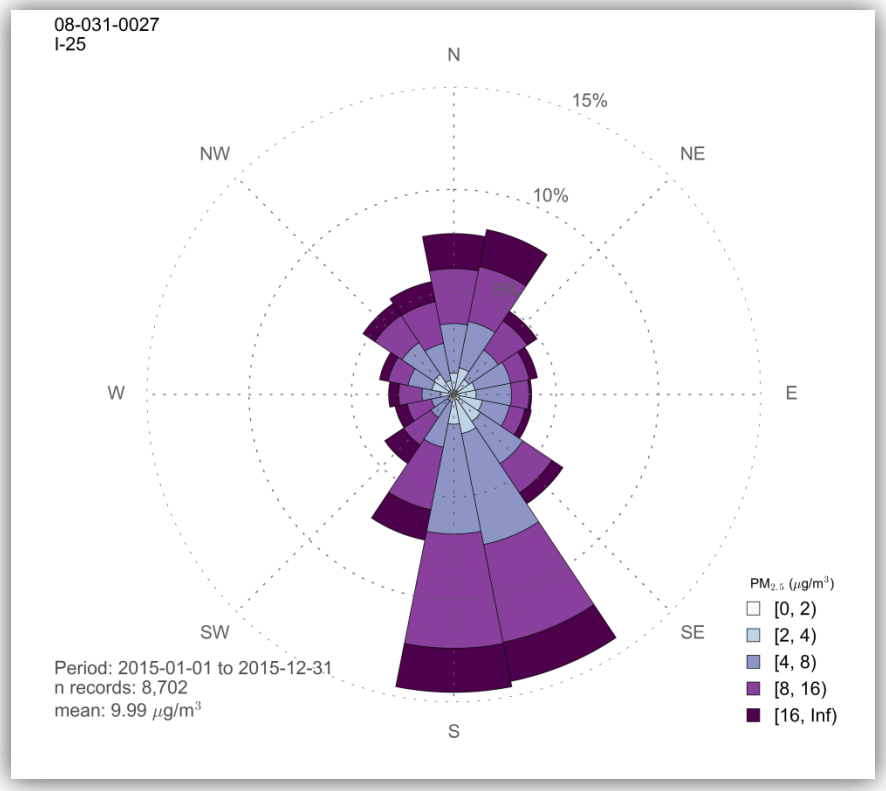

Figure 8. Pollution rose of hourly wind direction and $PM_{2.5}$ measurements from the Denver, CO (I-25) [0027] NR monitoring site.

3.3 Ontario, CA (SR-60) [0027]

The NR monitoring site in Ontario, CA (locally named "Ontario-Route 60 Near Road") is located 9 m north of SR-60 (Figure 9, Table 4). The road adjacent to this site is characterized as a freeway segment. The closest traffic monitor is located approximately 400 m to the east.

Figure 9. View of the Ontario, CA (SR-60) [0027] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 4. Site information for the Ontario, CA (SR-60) [0027] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).

Parameter	Value
AADT	215,000
FE-AADT	625,736
Number of adjacent lanes	10
Distance to target road	9 m
$PM_{2.5}$ increment	2.3 µg/m^3
24-hour maximum $PM_{2.5}$	52.8 µg/m^3
Annual mean $PM_{2.5}$	14.3 µg/m^3
CO max. 1-hour	N/A
NO_2 max. 1-hour	79.3 ppb

3.3.1 Data Completeness

Hourly NO_2 and NO_x, and 24-hour average $PM_{2.5}$ were monitored at this site in 2015, though less than half a year of data are available for NO_x and NO_2 (Figure 10). Traffic-related data are also complete.

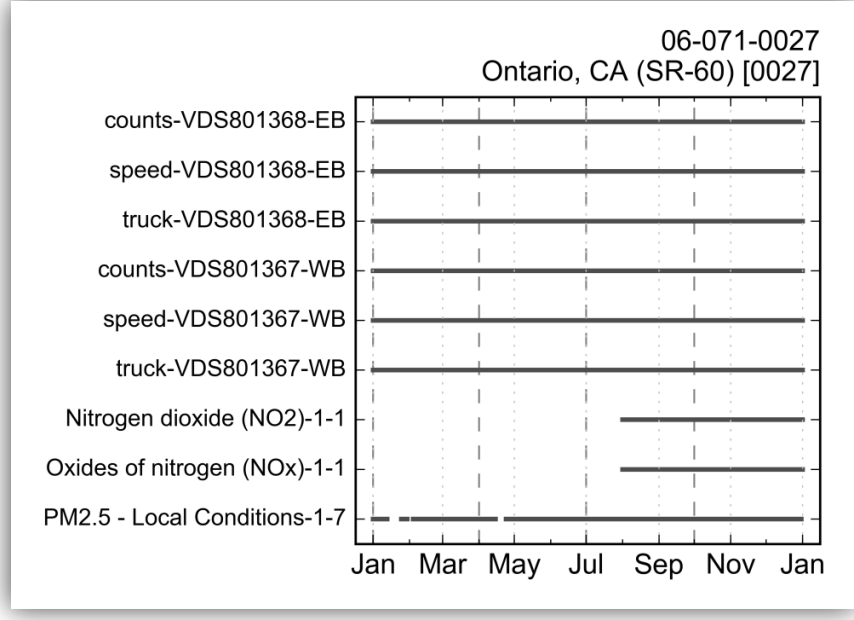

Figure 10. Graphical summary of data availability of air quality and traffic-related data at the Ontario, CA (SR-60) [0027] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

3.3.2 Meteorological Data

Meteorological parameters are not measured at the Ontario, CA (SR-60) [0027] NR monitoring site. The closest monitoring sites that measured wind speed and wind direction in 2015 are the Ontario International Airport and Chino Airport monitoring stations,[3] located 2.6 km north and 6.8 km south of the NR site, respectively. The predominant wind direction at both of these sites is from the west (Figures 11 and 12), i.e., parallel to the roadway segment adjacent to the NR monitoring site.

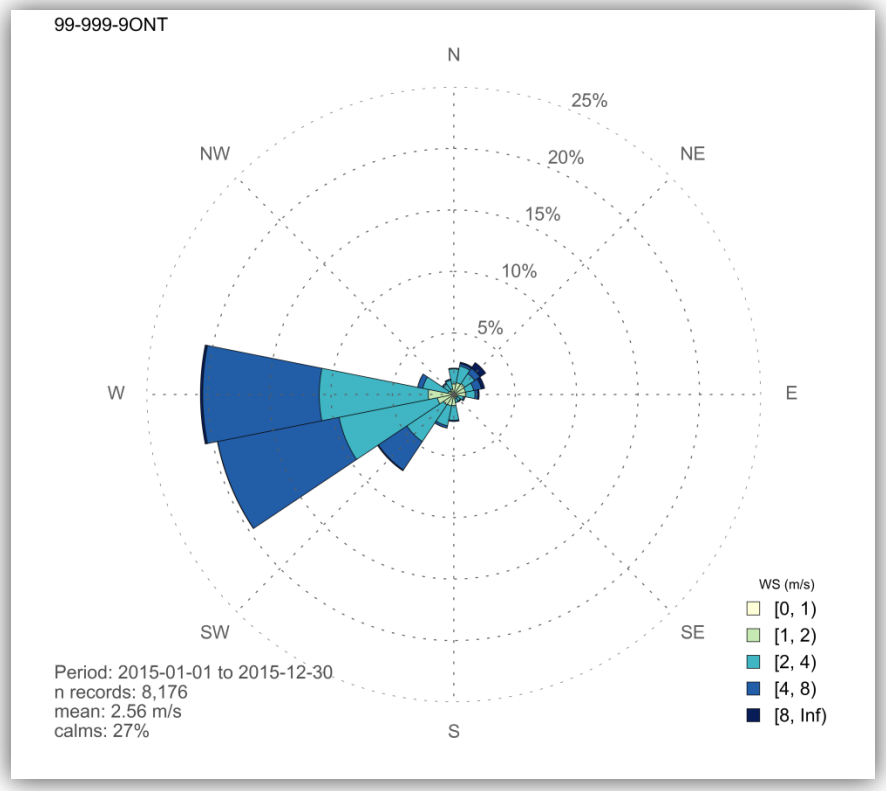

Figure 11. Pollution rose of hourly wind speed and direction from the Ontario International Airport monitoring site (ONT), located 2.6 km north of the Ontario, CA (SR-60) [0027] NR site.

[3] These sites are not part of the AQS reporting network; data from these sites are available from other data sources.

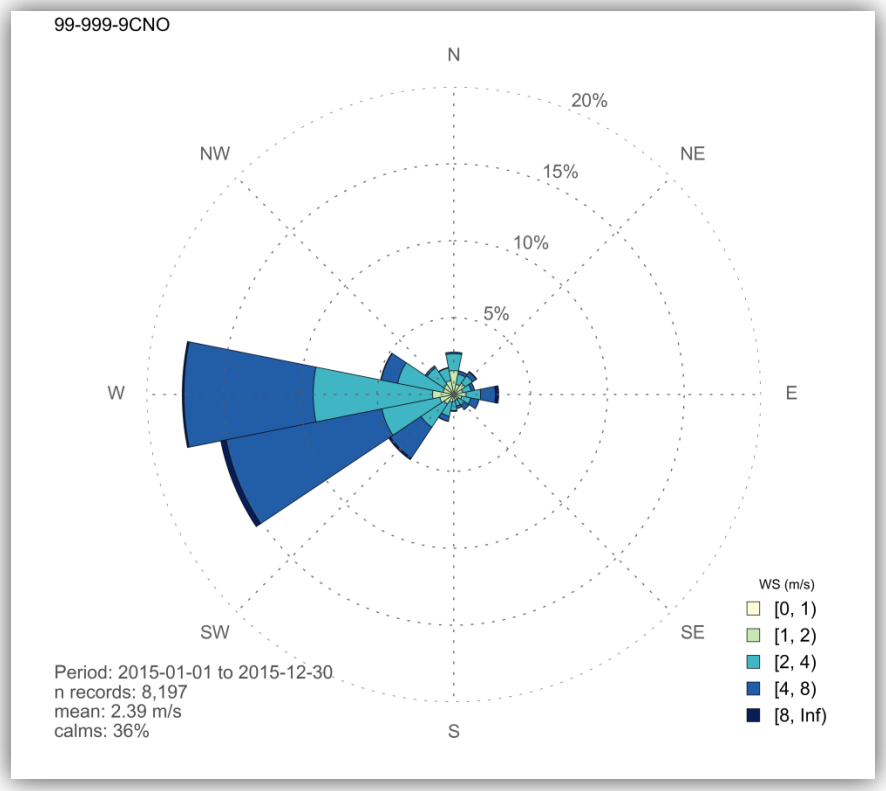

Figure 12. Pollution rose of hourly wind speed and direction from the Chino Airport monitoring site (CNO), located 6.8 km south of the Ontario, CA (SR-60) [0027] NR site.

3.3.3 Air Quality and Other Considerations

There are no large point sources of $PM_{2.5}$ emissions near the Ontario, CA (SR-60) [0027] site (see Appendix A, Figure A-3).

3.4 Portland, OR (I-5) [0005]

The NR monitoring site near Portland, OR, is adjacent to I-5 (Figure 13). It is located 27 m east of the roadway (Table 5). The closest traffic monitoring site is approximately 250 m south.

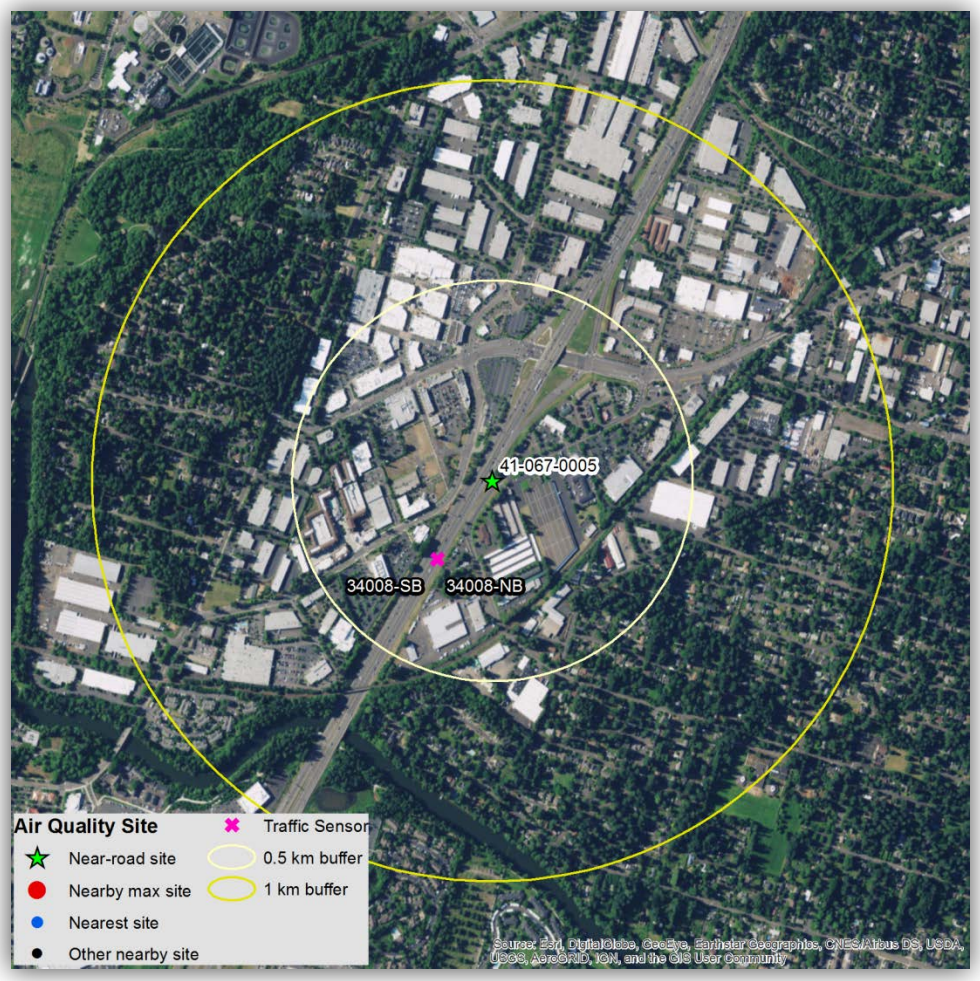

Figure 13. View of the Portland, OR (I-5) [0005] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 5. Site information for the Portland, OR (I-5) [0005] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).

Parameter	Value
AADT	156,000
FE-AADT	289,052
Number of adjacent lanes	6
Distance to target road	27 m
$PM_{2.5}$ increment	0.6 µg/m^3
24-hour maximum $PM_{2.5}$	61.5 µg/m^3
Annual mean $PM_{2.5}$	7.9 µg/m^3
CO max. 1-hour	1.8 ppm
NO_2 max. 1-hour	40.9 ppb

3.4.1 Data Completeness

Hourly CO, NO_2 and NO_x, and 24-hour average $PM_{2.5}$ were monitored at this site in 2015 (Figure 14). There is nearly one month of CO data missing during this period. The 24-hour $PM_{2.5}$ data were only sampled every 1-in-3 days (Table 1).

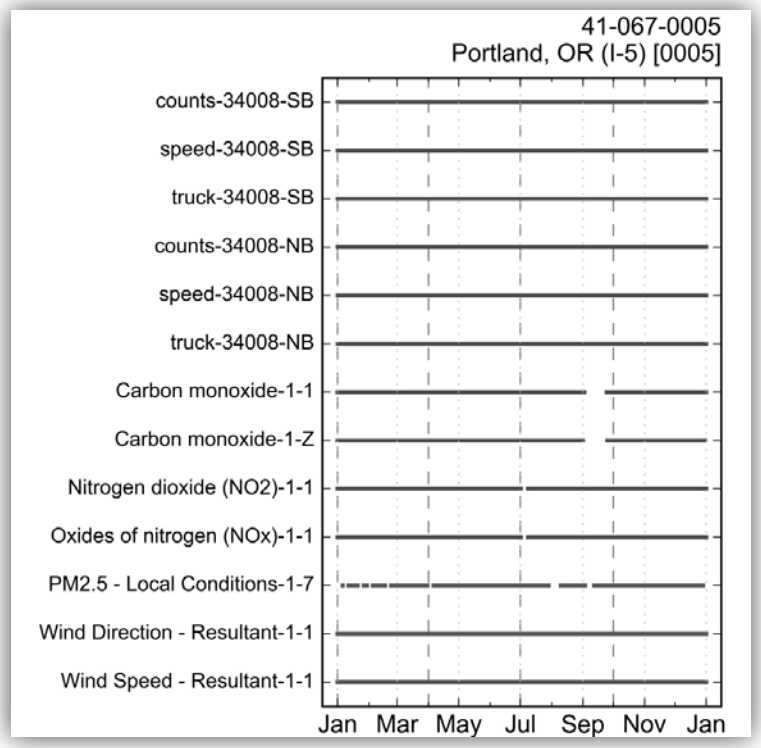

Figure 14. Graphical summary of data availability of air quality and traffic-related data at the Portland, OR (I-5) [0005] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

3.4.2 Meteorological Data

Wind speeds are frequently low (<2 m/s) at the Portland, OR (I-5) [0005] NR monitoring site, which results in an annual average wind speed of only 1.31 m/s (Figure 15). The predominant wind direction is from the south; the highest frequency of high wind speeds is also from this direction. Wind speeds are always low when blowing from the east.

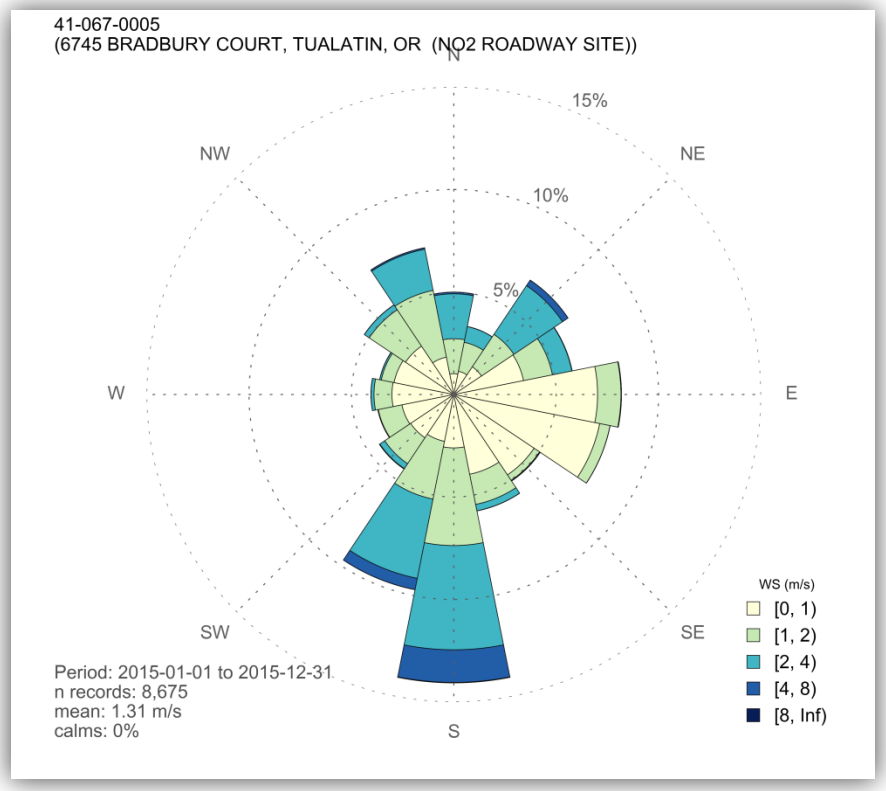

Figure 15. Pollution rose of hourly wind speed and direction from the Portland, OR (I-5) [0005] NR monitoring site.

3.4.3 Air Quality and Other Considerations

There are no large point sources of $PM_{2.5}$ emissions near the Portland, OR (I-5) [0005] NR monitoring site (see Appendix A, Figure A-4).

3.5 Providence, RI (I-95) [0030]

The NR monitoring site in Providence, RI (locally named "Near Rd") is adjacent to I-95 (5 m to the east), and approximately 400 m north of the I-95/US 6 interchange (Figure 16). Though this NR monitor is not located within an interchange, it is approximately 50 m away from the start of the ramps to the interchange, and 380 m away from the center of the interchange. Given the preponderance of southwesterly winds, it is likely that emissions from the interchange affect the air quality at this NR site (see the "Air Quality and Other Considerations" section). The 24-hr average $PM_{2.5}$ increment at this site is also relatively high compared to that of other NR sites (Table 6).

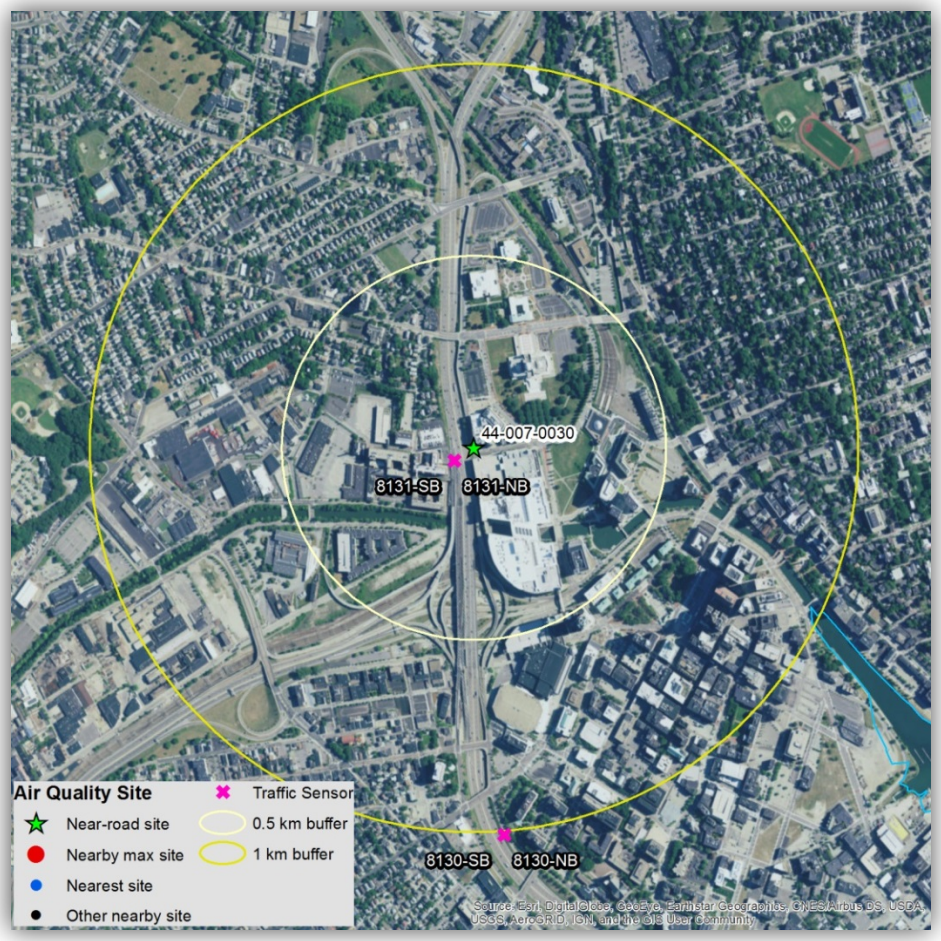

Figure 16. View of the Providence, RI (I-95) [0030] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 6. Site information for the Providence, RI (I-95) [0030] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).[3]

Parameter	Value
AADT	186,300
FE-AADT	416,790
Number of adjacent lanes	8
Distance to target road	5 m
$PM_{2.5}$ increment	3.0 µg/m^3
24-hour maximum $PM_{2.5}$	92.5 µg/m^3
Annual mean $PM_{2.5}$	9.9 µg/m^3
CO max. 1-hour	3.7 ppm
NO_2 max. 1-hour	86.2 ppb

3.5.1 Data Completeness

Hourly CO, NO_2, NO_x, and $PM_{2.5}$ were monitored at this site in 2015, with generally good data completeness (Figure 17).[4] For the database developed in this work, data for both northbound (NB) and southbound (SB) traffic along I-95 from two traffic monitors were included. The monitors are located just north and south of the interchange (Figure 16). Traffic data for eastbound (EB) and westbound (WB) traffic along US 6 are also available and may be used in subsequent analyses.

3.5.2 Meteorological Data

Meteorological parameters, namely wind speed and wind direction, were not measured at the Providence, RI (I-95) [0030] site in 2015. Meteorological data for 2015 are available from a nearby site (AQS ID 44-007-0022), which is located approximately 2.5 km south of the NR monitoring site (see Appendix A, Figure A-5). Winds in this area are predominantly from the west, with peaks in frequency in the southwest and northwest directions (Figure 18). Thus, the wind most frequently blows across the freeway segment to the NR monitoring site.

[4] DeWinter J.L., Brown S.G., Seagram A.F., Graham A.R., and Eisinger D.S. (2016) National near-road data assessment: Report No. 2 with 2015 data. Final report prepared for the Washington State Department of Transportation, lead agency for the Near-Road Air Quality Research Transportation Pooled Fund, TPF-5(284), by Sonoma Technology, Inc., Petaluma, CA, STI-914203-6482, October 7.

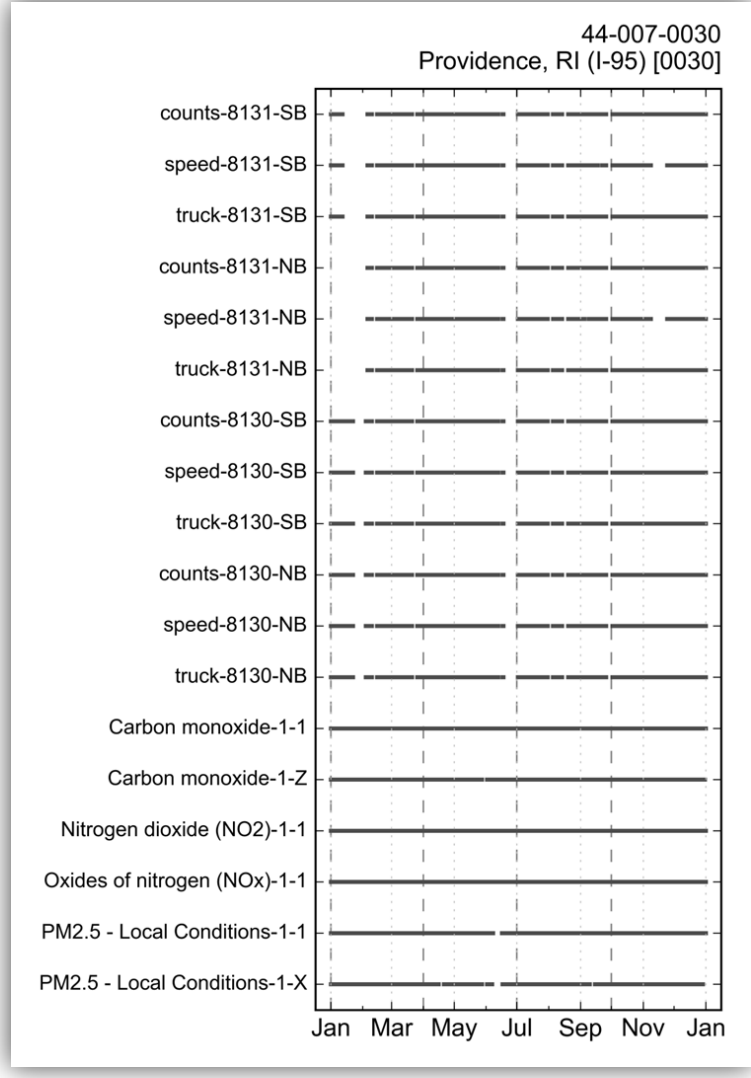

Figure 17. Graphical summary of data availability of air quality and traffic-related data at the Providence, RI (I-95) [0030] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

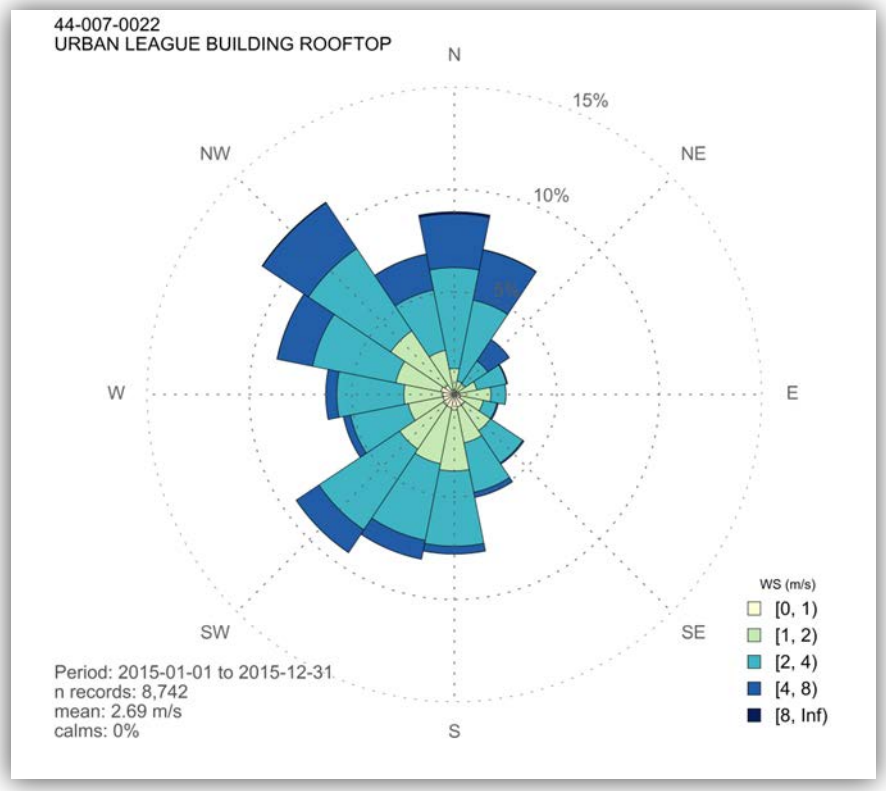

Figure 18. Wind rose at the Urban League Building Rooftop site (AQS ID 44-007-0022) for 2015.

3.5.3 Air Quality and Other Considerations

There are no large[5] point sources of $PM_{2.5}$ emissions near the Providence, RI (I-95) [0030] site (see Appendix A, Figure A-6). High $PM_{2.5}$ concentrations most frequently occur when the wind is from the west (i.e., from the direction of the adjacent freeway segment), the south (i.e., from the direction of the I-95/US 6 interchange), or from any direction in between (**Figure 19**).

[5] "Large" point sources are defined as those with $PM_{2.5}$ emissions exceeding 20 tons per year. This value is chosen for illustrative purposes only, and should not be confused with guidance levels from the Clean Air Act or from EPA regarding significant or major point sources of $PM_{2.5}$ emissions.

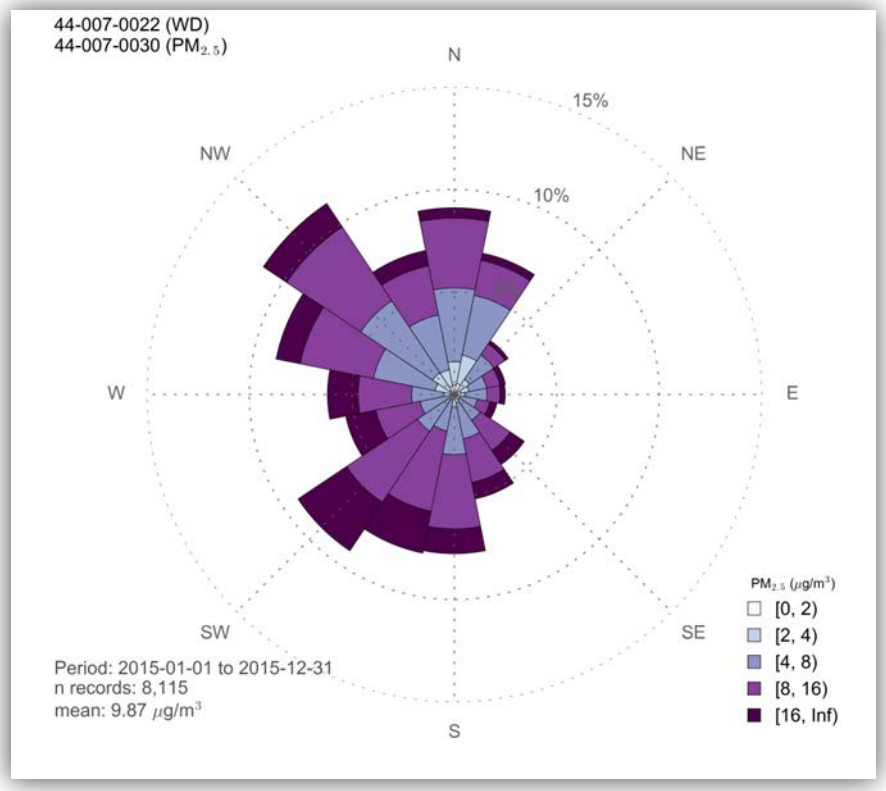

Figure 19. Pollution rose of hourly $PM_{2.5}$ measurements from the Providence, RI (I-95) [0030] NR monitoring site and wind direction taken from the nearest monitoring station (Urban League Building Rooftop site, AQS ID 44-007-0022, approximately 2.5 km south).

3.6 Richmond, VA (I-95) [0025]

The NR monitoring site in Richmond, VA (locally named "Bryan Park") is adjacent to I-95. It is located 21 m west of the roadway and adjacent to a large public park (Joseph Bryan Park; Figure 20; Table 7). The Bryan Park Interchange (between I-95, I-64, and I-195) is 500 m southwest of the NR monitoring site. There is also a railyard (the Acca Yard, which includes CSX Transportation's Bryan Park terminal facility) approximately 1 km to the southwest.

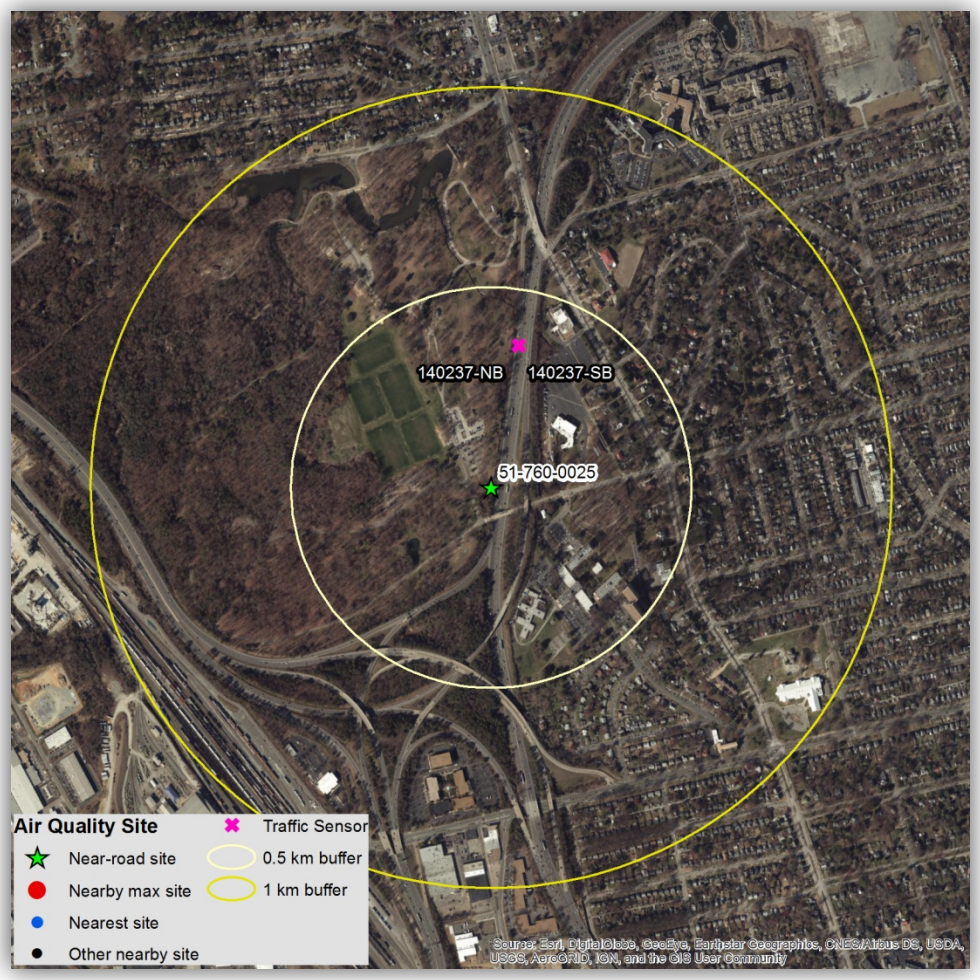

Figure 20. View of the Richmond, VA (I-95) [0025] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 7. Site information for the Richmond, VA (I-95) [0025] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).

Parameter	Value
AADT	151,000
FE-AADT	259,720
Number of adjacent lanes	6
Distance to target road	21 m
$PM_{2.5}$ increment	2.3 µg/m^3
24-hour maximum $PM_{2.5}$	27.8 µg/m^3
Annual mean $PM_{2.5}$	10.1 µg/m^3
CO max. 1-hour	1.2 ppm
NO_2 max. 1-hour	56.5 ppb

3.6.1 Data Completeness

Hourly CO, NO_2, NO_x, and $PM_{2.5}$ were monitored at this site in 2015, with generally good data completeness (Figure 21). For the database developed in this work, traffic data for both NB and SB traffic along I-95 from two traffic monitors were included; both monitors are located north of the NR monitoring site (0.3 km and 4.8 km northward along I-95). However, there is no vehicle characterization ("truck") data available from the traffic sensor that is closest to the NR monitoring site (140237); the data from the traffic sensor that is further from the NR monitoring site (140009) may be less representative, and there is only one quarter of the vehicle characterization data available in the NB direction.

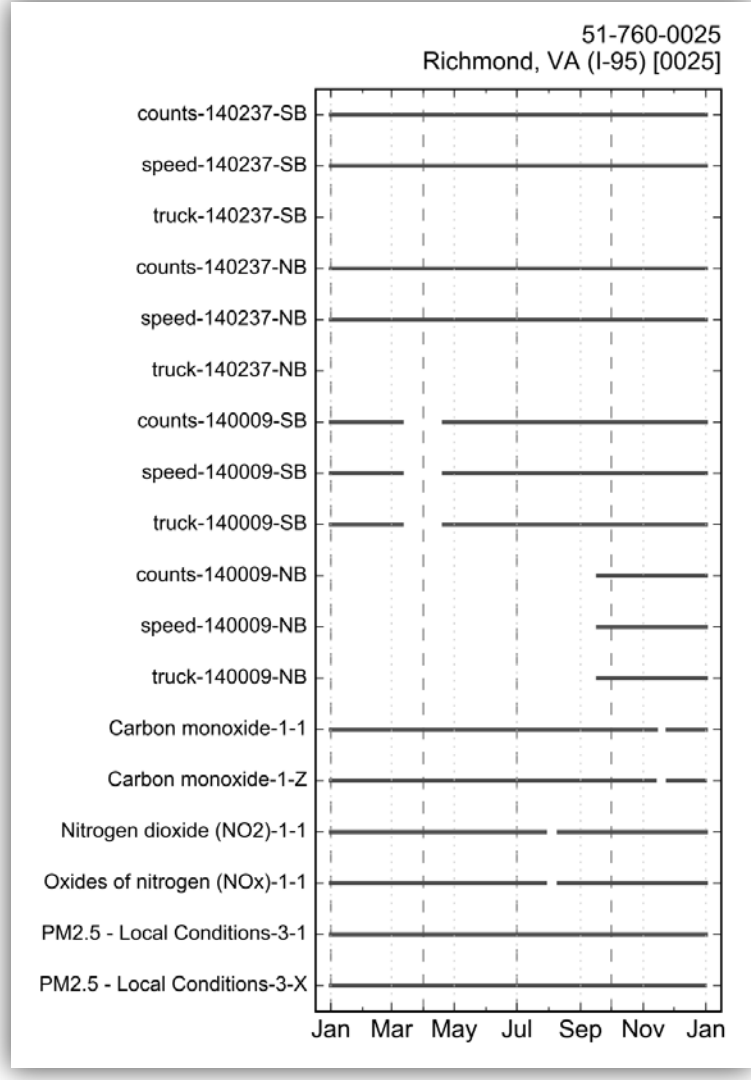

Figure 21. Graphical summary of data availability of air quality and traffic-related data at the Richmond, VA (I-95) [0025] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

3.6.2 Meteorological Data

Wind speed and direction are not measured at the Richmond, VA (I-95) [0025] NR monitoring site. The closest monitoring site that measured wind speed and wind direction in 2015 was the MathScience Innovation Center site (AQS ID 51-087-0014), located >5 km southeast (see Appendix A, Figure A-7). The wind is predominantly from the south through the southwest and from the north-northeast) (Figure 22). Wind speeds are generally slow (<4 m/s). However, because of the distance between the two monitoring sites, this wind speed and direction data may not be representative of the meteorological conditions at the Richmond, VA (I-95) [0025] NR monitoring site.

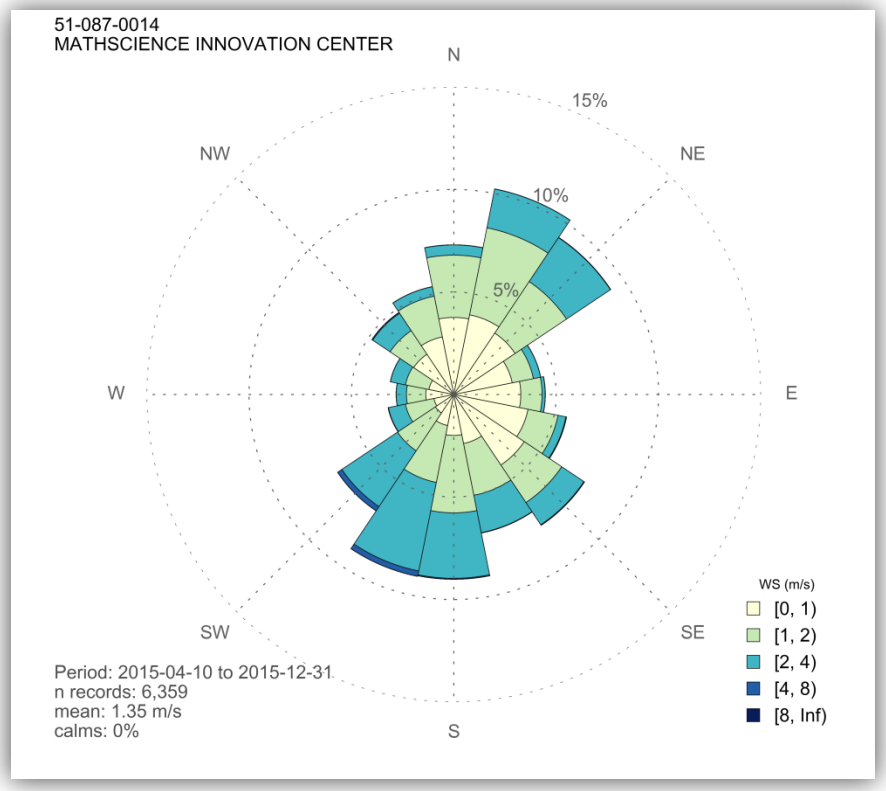

Figure 22. Pollution rose of hourly wind speed and direction for the MathScience Innovation Center (AQS ID 51-087-0014) monitoring site.

3.6.3 Air Quality and Other Considerations

Though there are no large point-sources of $PM_{2.5}$ near the Richmond, VA (I-95) [0025] NR monitoring site (see Appendix A, Figure A-7), there is a railyard to the southwest.

3.7 St. Louis, MO (I-64) [0094]

The NR monitoring site in St. Louis, MO (locally named "Forest Park") is adjacent to I-64, 25 m north of the roadway (Figure 23, Table 8). There is a large public park (Forest Park) north of the site.

Figure 23. View of the St. Louis, MO (I-64) [0094] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

Table 8. Site information for the St. Louis, MO (I-64) [0094] NR monitoring site based on data from 2015. The $PM_{2.5}$ increment (difference between mean annual average daily $PM_{2.5}$ concentration at the NR site and that from the closest monitoring site) is taken from the report "National Near-Road Data Assessment: Report No. 2 With 2015 Data" (October 2016).

Parameter	Value
AADT	159,326
FE-AADT	360,077
Number of adjacent lanes	8
Distance to target road	25 m
$PM_{2.5}$ increment	-1.2 µg/m^3
24-hour maximum $PM_{2.5}$	39.4 µg/m^3
Annual mean $PM_{2.5}$	9.2 µg/m^3
CO max. 1-hour	1.9 ppm
NO_2 max. 1-hour	55.5 ppb

3.7.1 Data Completeness

Hourly CO, NO_2 (with three POCs), NO_x (with two POCs), and $PM_{2.5}$ were monitored at this site in 2015 (Figure 24). Data completeness varies by parameter and POC, but is good overall. Traffic-related data were available from two traffic sensors along I-64, located east and west of the NR monitoring site (Figure 23).

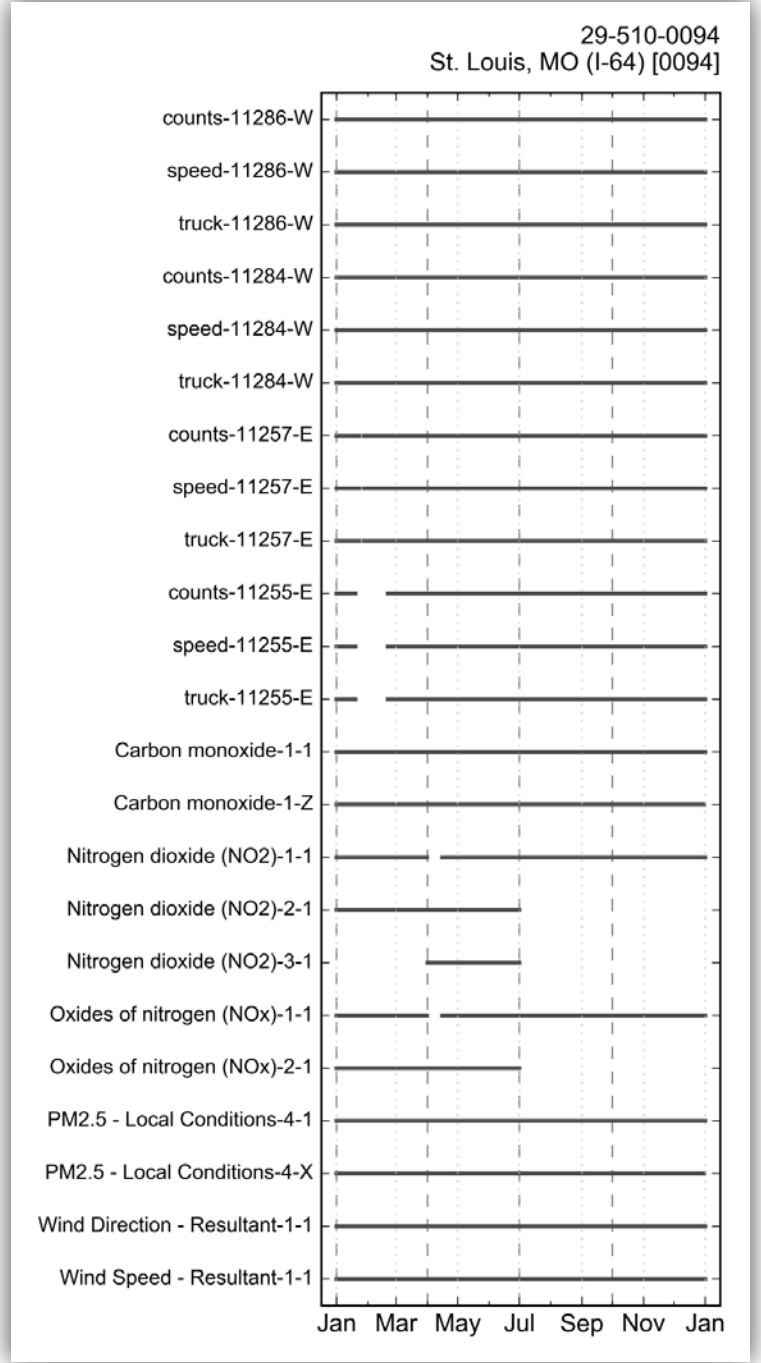

Figure 24. Graphical summary of data availability of air quality and traffic-related data at the St. Louis, MO (I-64) [0094] site in 2015. Valid data are plotted as individual points by parameter over the entire period of their sample duration (e.g., hourly data are represented by a single point, 24-hour average data are represented by 24 points). For air quality and/or meteorological data obtained from AQS, parameters are denoted as "Parameter Name-Parameter Occurrence Code (POC)-Sample Duration code" (see Appendix A, Table A-1 for definitions). For traffic-related data (counts, speed, truck), parameters are denoted as "Parameter-Sensor ID-Direction of traffic flow" (see Appendix A, Table A-2 for definitions) and are aggregated across all lanes. Dashed vertical lines indicate the start of each quarter (January 1, April 1, July 1, October 1).

3.7.2 Meteorological Data

The predominant wind direction at the St. Louis, MO (I-64) [0094] NR monitoring site is from the south to southeast, which is oriented across the adjacent roadway segment (Figure 25). Wind speeds are generally faster (≥4 m/s) when winds are from the NW (i.e., from the direction of the park area).

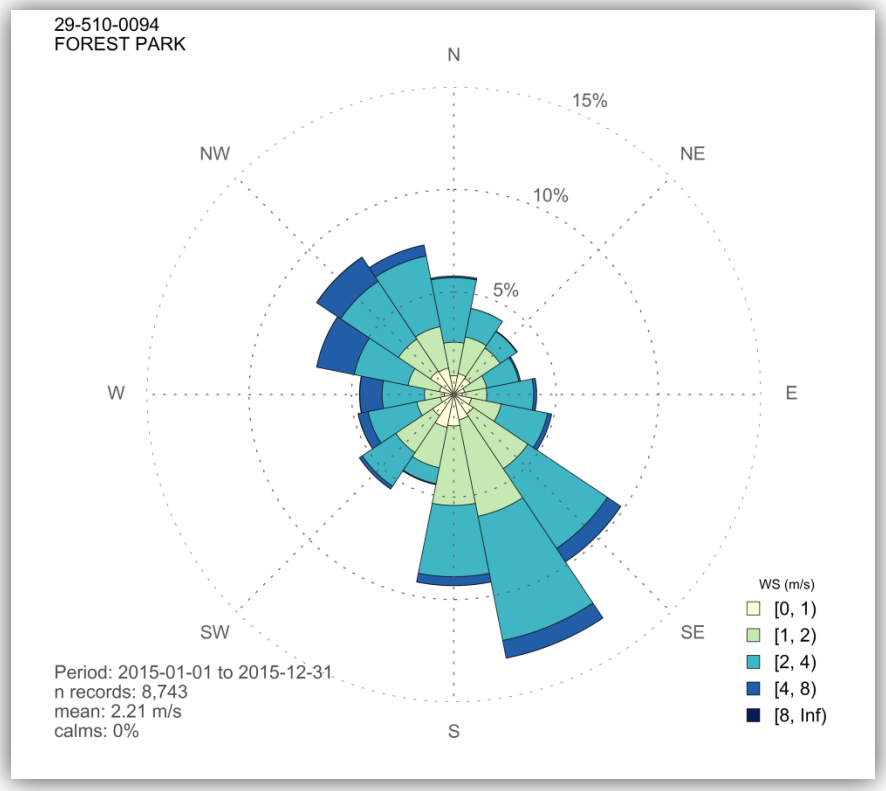

Figure 25. Pollution rose of hourly wind speed and direction from the St. Louis, MO (I-64) [0094] NR monitoring site.

3.7.3 Air Quality and Other Considerations

High $PM_{2.5}$ concentrations most frequently occur when the wind directions are from the south to southeast (i.e., from the direction of the adjacent freeway segment; Figure 26).

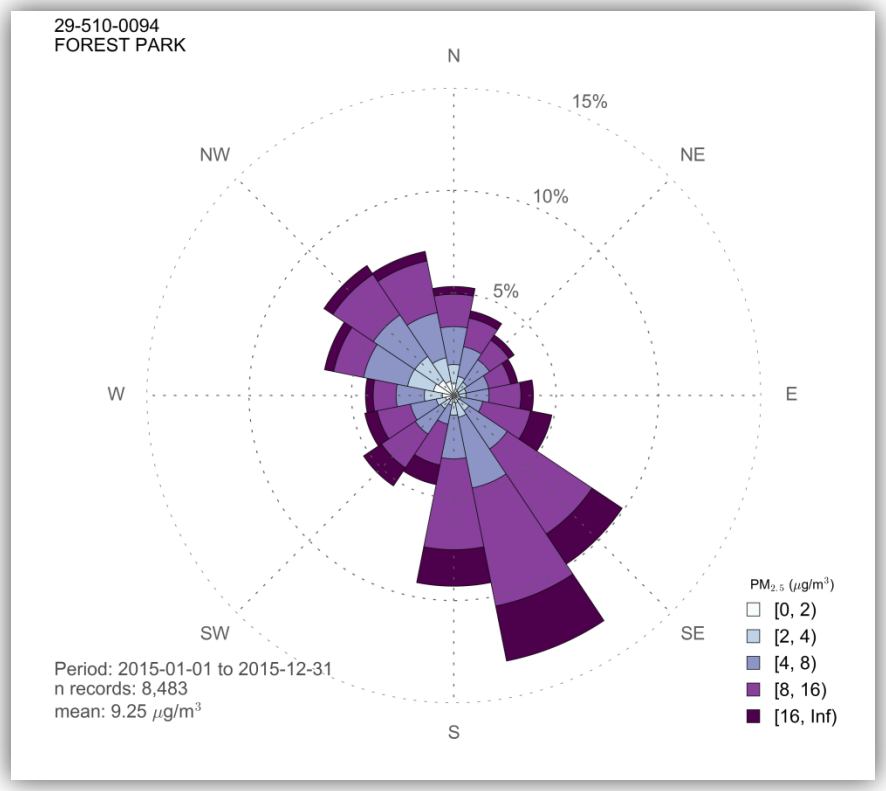

Figure 26. Pollution rose of hourly wind direction and $PM_{2.5}$ measurements from the St. Louis, MO (I-64) [0094] NR monitoring site.

There are no large point sources of $PM_{2.5}$ emissions near the St. Louis, MO (I-64) [0094] NR monitoring site (see Appendix A, Figure A-8). This site is also removed from many urban sources of emissions, as it is flanked by a large park area to the north. The mean annual average daily $PM_{2.5}$ increment in 2015 at this site was the largest negative value calculated across all NR monitoring sites in 2015,[6] meaning that daily average $PM_{2.5}$ concentrations at this NR monitoring site are typically lower than those measured at other monitoring sites nearby (non-NR sites).

[6] DeWinter J.L., Brown S.G., Seagram A.F., Graham A.R., and Eisinger D.S. (2016) National near-road data assessment: Report No. 2 with 2015 data. Final report prepared for the Washington State Department of Transportation, lead agency for the Near-Road Air Quality Research Transportation Pooled Fund, TPF-5(284), by Sonoma Technology, Inc., Petaluma, CA, STI-914203-6482, October 7.

4. Summary of Basis for Recommendations

We recommend evaluating the following three sites for case studies and model-to-monitor comparisons (listed in alphabetical order by city):

- **Ontario, CA (SR-60) [0027].** This site is located 9 m from SR-60 in a TPF partner state and would allow analysis of a freeway segment with one of the highest FE-AADT ratings among all other NR monitoring sites (e.g., roughly 50% higher than the Providence or St. Louis sites). Hourly NO_2 and NO_x, and daily 24-hour average $PM_{2.5}$ were monitored at this site in 2015, though less than half a year of data are available for NO_x and NO_2. Complete EB and WB traffic data for 2015 are available from a traffic monitor located about 400 m to the east of the air quality monitoring site. In addition, as this site is in California, it affords the opportunity to complete EMFAC-based model-to-monitor comparison work, since emissions at other sites will be modeled with MOVES. A potential difficulty in performing an ambient case-study and model-to-monitor comparison for this site is that there was no on-site meteorological data in 2015. However, there is meteorological data available from two airport stations a few miles away. CO, which is often used to assess model performance, is also not measured at this site.

- **Providence, RI (I-95) [0030].** This site is located 5 m from I-95 and has hourly data for multiple pollutants (CO, NO_2, NO_x, and $PM_{2.5}$). In addition, monitored concentrations are likely influenced by a nearby interchange, and NB and SB traffic data are available from monitors located just north and south of the interchange. The estimated near-road $PM_{2.5}$ increment at this site is also the second highest among all evaluated NR sites.

- **St. Louis, MO (I-64) [0094].** This site is located 25 m from I-64 and has hourly data for CO, NO_2, NO_x and $PM_{2.5}$, as well as meteorological data. Traffic data are available from two traffic sensors near the monitoring site, with total volume (count), speed, and vehicle characterization data. The St. Louis site also provides an opportunity to examine a site with a large negative $PM_{2.5}$ increment among evaluated NR monitoring sites operating in 2015. There are no large point sources close to the near-road site; however, industrial sources are located near at least one of the nearby sites used for comparison when calculating the near-road increment.

In addition to the top three sites recommended for analysis, we also identified a fourth site, located in Portland, Oregon, to serve as a backup if unforeseen analysis problems arise with any of the first three sites:

- **Portland, OR (I-5) [0005].** This site is located 27 m from I-5 and is adjacent to a freeway segment. Complete NB and SB traffic data are available from a traffic monitor located about 250 m south of the air quality monitoring site. There are no other large $PM_{2.5}$ sources in the area. On-site meteorological data are available. Hourly CO, NO_2 and NO_x, and 24-hour average $PM_{2.5}$ were monitored at this site in 2015. However, the 24-hour $PM_{2.5}$ data were only sampled every 1-in-3 days; for this reason, this site is recommended as an alternative analysis candidate, rather than as one of the sites for initial focus.

Based on data from 2015, these four sites cover a range of $PM_{2.5}$ increments: the St. Louis, MO (I-64) [0094] had the largest negative increment (-1.2 µg/m^3), the $PM_{2.5}$ increment at the Portland, OR (I-5) [0005] site is near zero (0.6 µg/m^3), and the Providence, RI (I-95) [0030] had second-largest positive increment (3.0 µg/m^3) of the 34 sites examined.

The remaining three sites of the seven candidate sites detailed in this document were deemed low-priority for further assessment for the following reasons:

- **Boston, MA (I-93) [0044].** There is no on-site meteorological data available at this site. The sampling frequency of 24-hour $PM_{2.5}$ concentrations is only 1-in-3 days.
- **Denver, CO (I-25) [0027].** There is no vehicle characterization data available at this site, making it difficult to assess truck emission-related impacts.
- **Richmond, VA (I-95) [0025].** There is no on-site meteorological data available at this site. The proximity of a large railyard could influence ambient concentrations at the NR monitor. There is also no vehicle characterization data available from the traffic sensor that is closest to the NR monitoring site and the overall traffic data completeness is relatively low.

Appendix A. Additional Information for the Seven Candidate Sites

Sample duration codes and traffic flow direction abbreviations are defined in Table A-1 and Table A-2, respectively. Supplemental maps of the location of NR monitoring sites discussed in this technical memorandum are also included, presented in alphabetical order by city name (Figures A-1 through A-8).

Table A-1. Sample duration definitions from AQS. The Sample Duration is a code corresponding to the amount of time used to collect the sample, i.e., averaging time. "Observed or Calculated Value" indicates whether the sample value is observed or calculated over the sample duration period.

Sample Duration	Sample Duration Description	Observed or Calculated Value
1	1 HOUR	Observed
7	24 HOUR	Observed
X	24-HR BLK AVG	Calculated
Z	8-HR RUN AVG END HOUR	Calculated

Table A-2. Abbreviations for traffic flow directions.

Direction Abbreviation	Description
NB	Northbound
EB	Eastbound
SB	Southbound
WB	Westbound

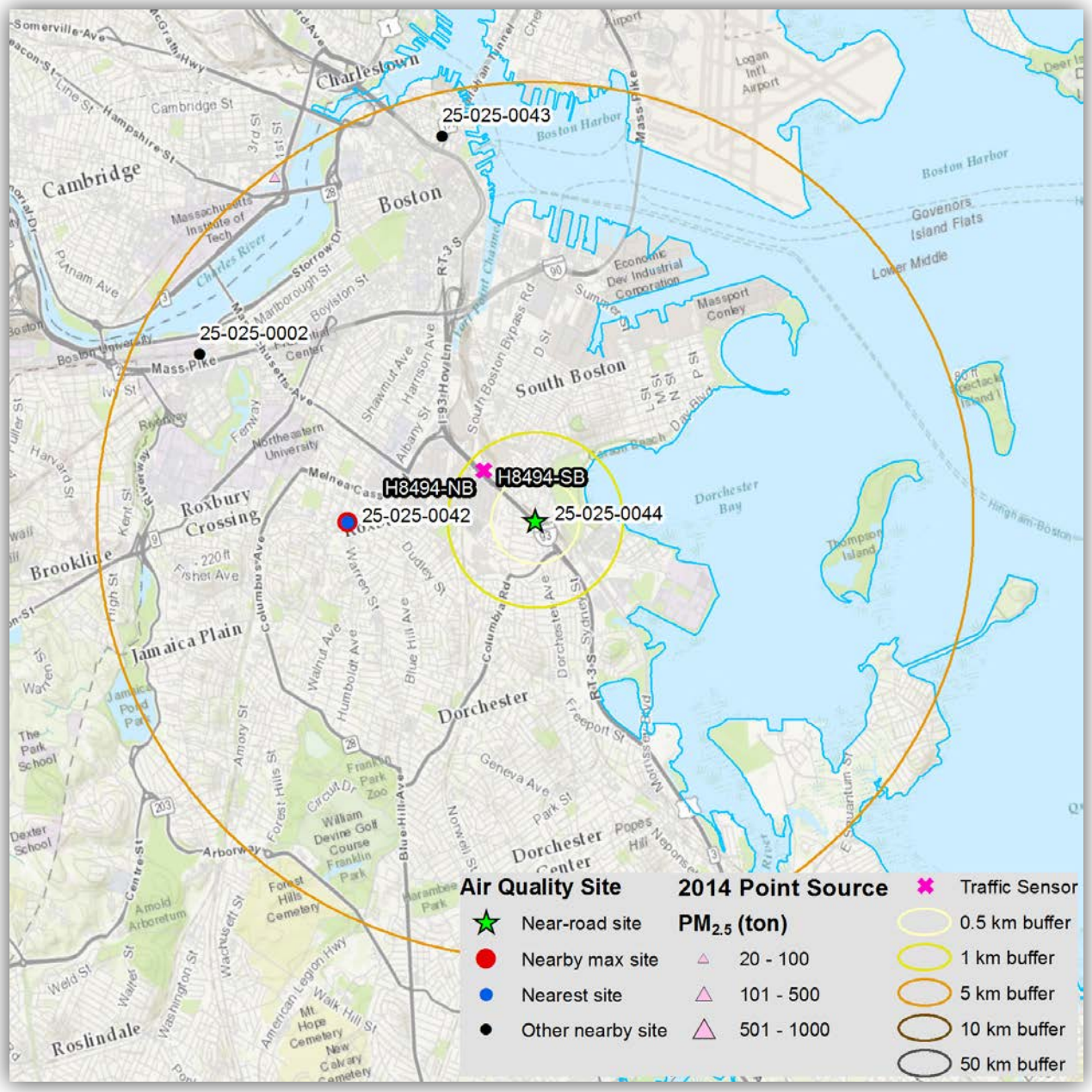

Figure A-1. Location of the Boston, MA (I-93) [0044] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site.

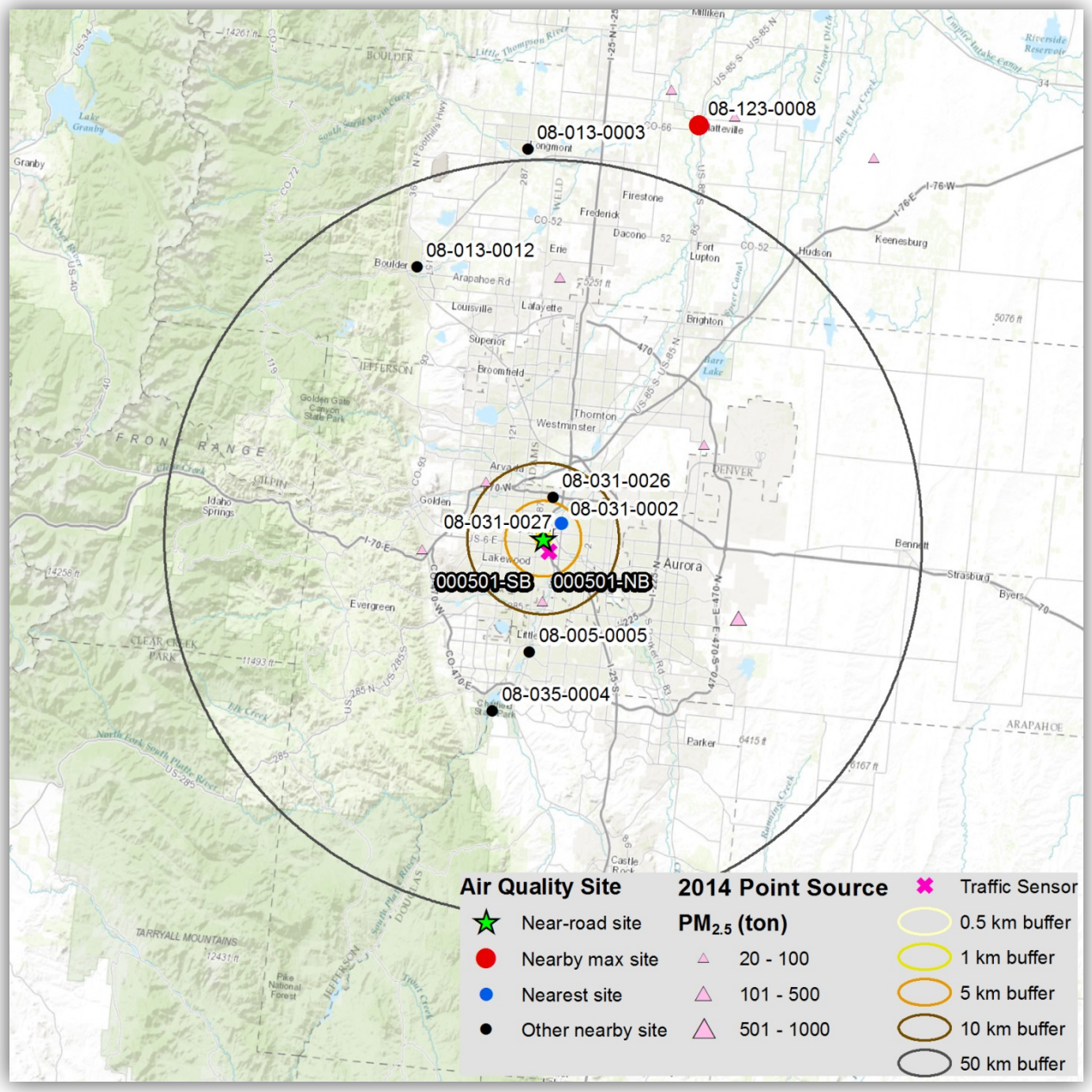

Figure A-2. Location of the Denver, CO (I-25) [0027] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site.

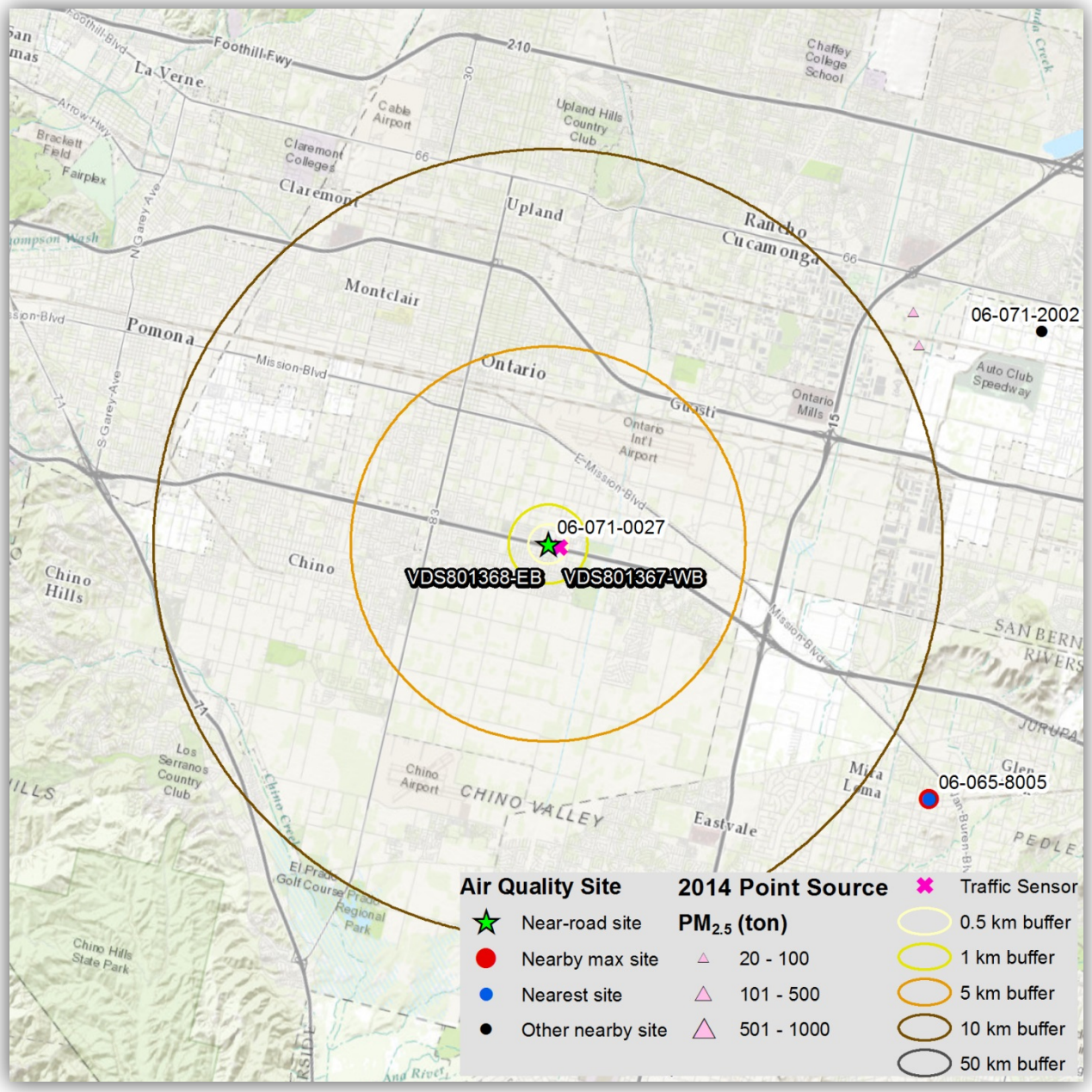

Figure A-3. Location of the Ontario, CA (SR-60) [0027] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site. The locations of non-AQS meteorological monitoring stations are denoted by black squares.

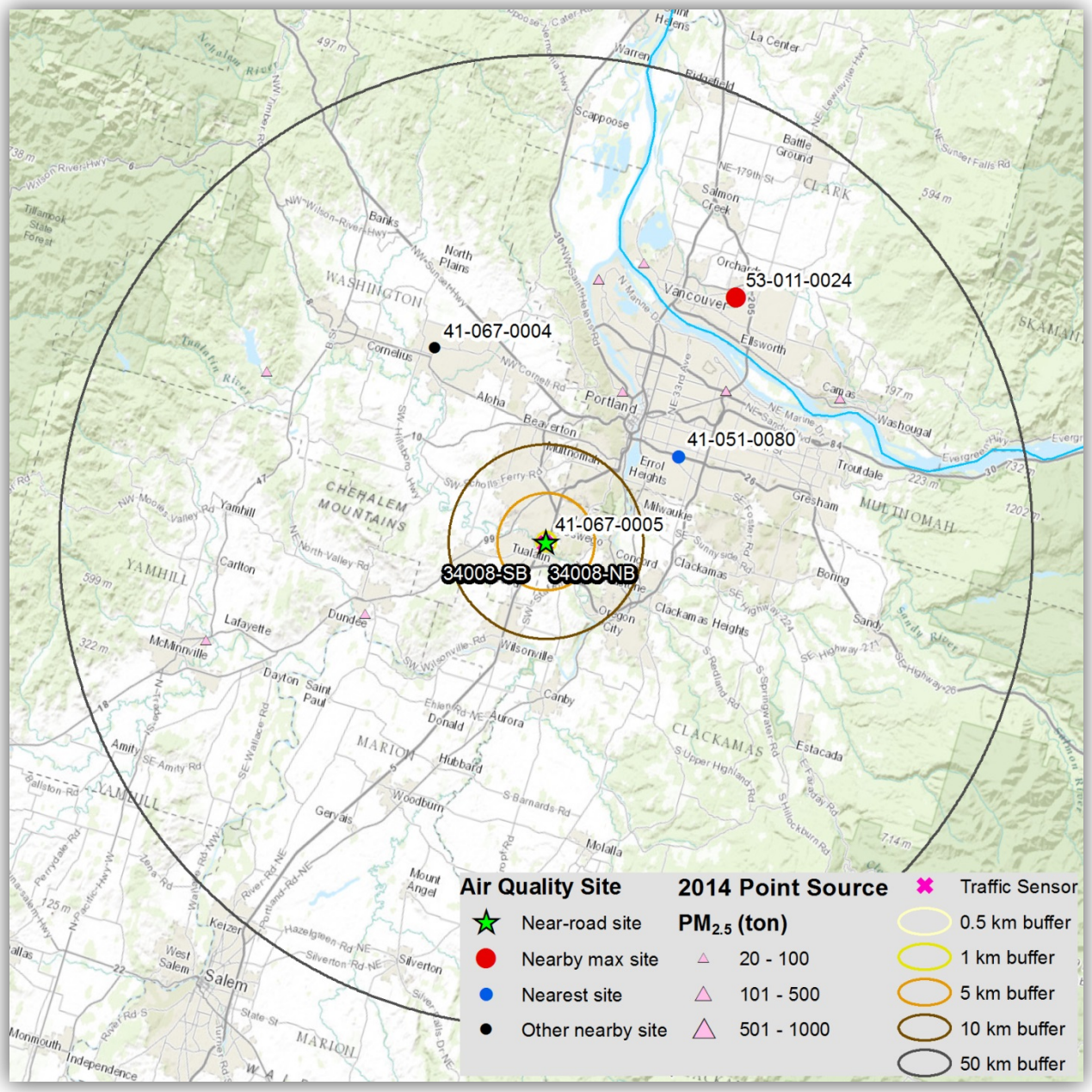

Figure A-4. Location of the Portland, OR (I-5) [0005] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site.

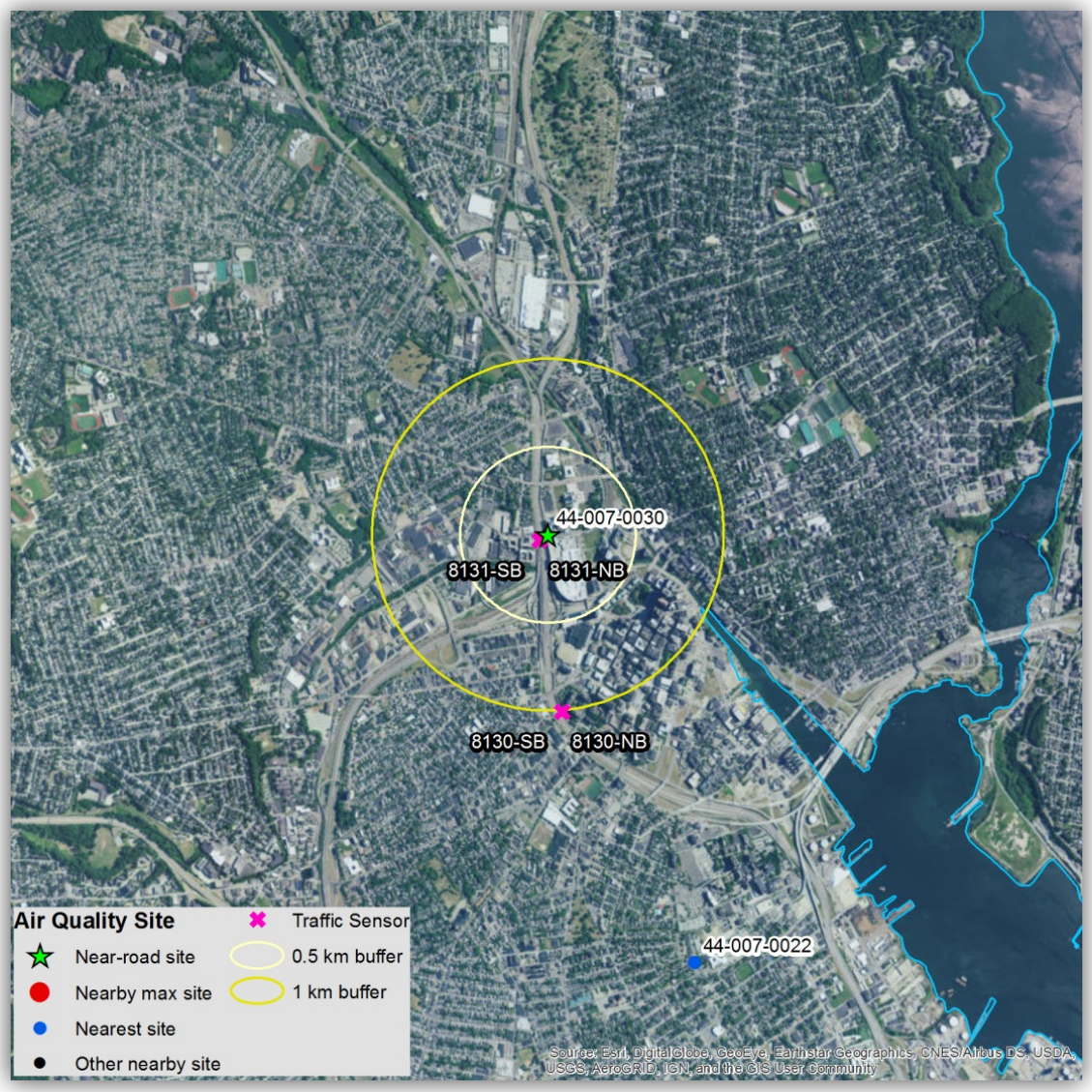

Figure A-5. View of the Providence, RI (I-95) [0030] NR monitoring site and surrounding monitoring locations. The AQS ID of air quality monitoring sites and sensor ID of traffic monitors are labeled.

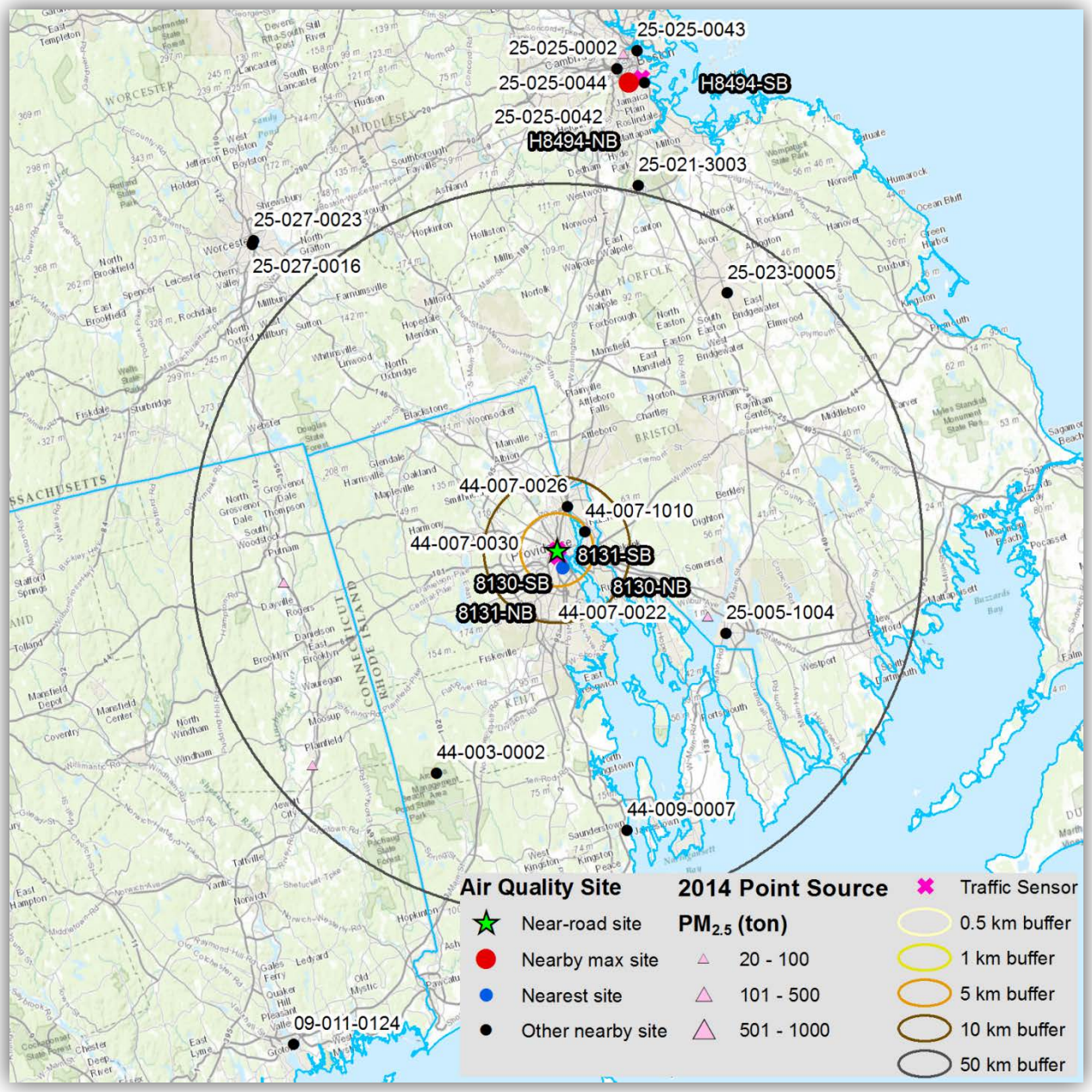

Figure A-6. Location of the Providence, RI (I-95) [0030] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site.

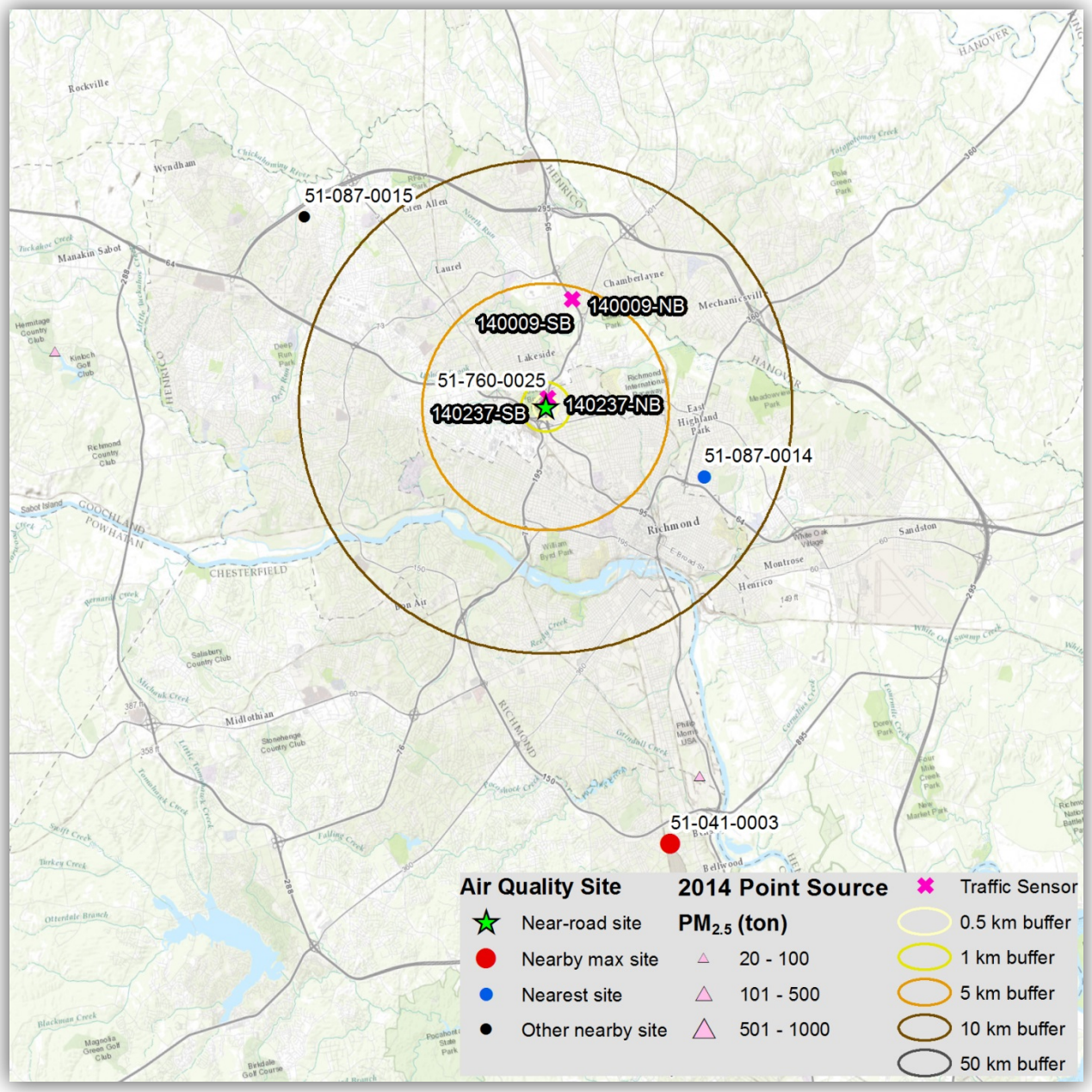

Figure A-7. Location of the Richmond, VA (I-95) [0025] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site.

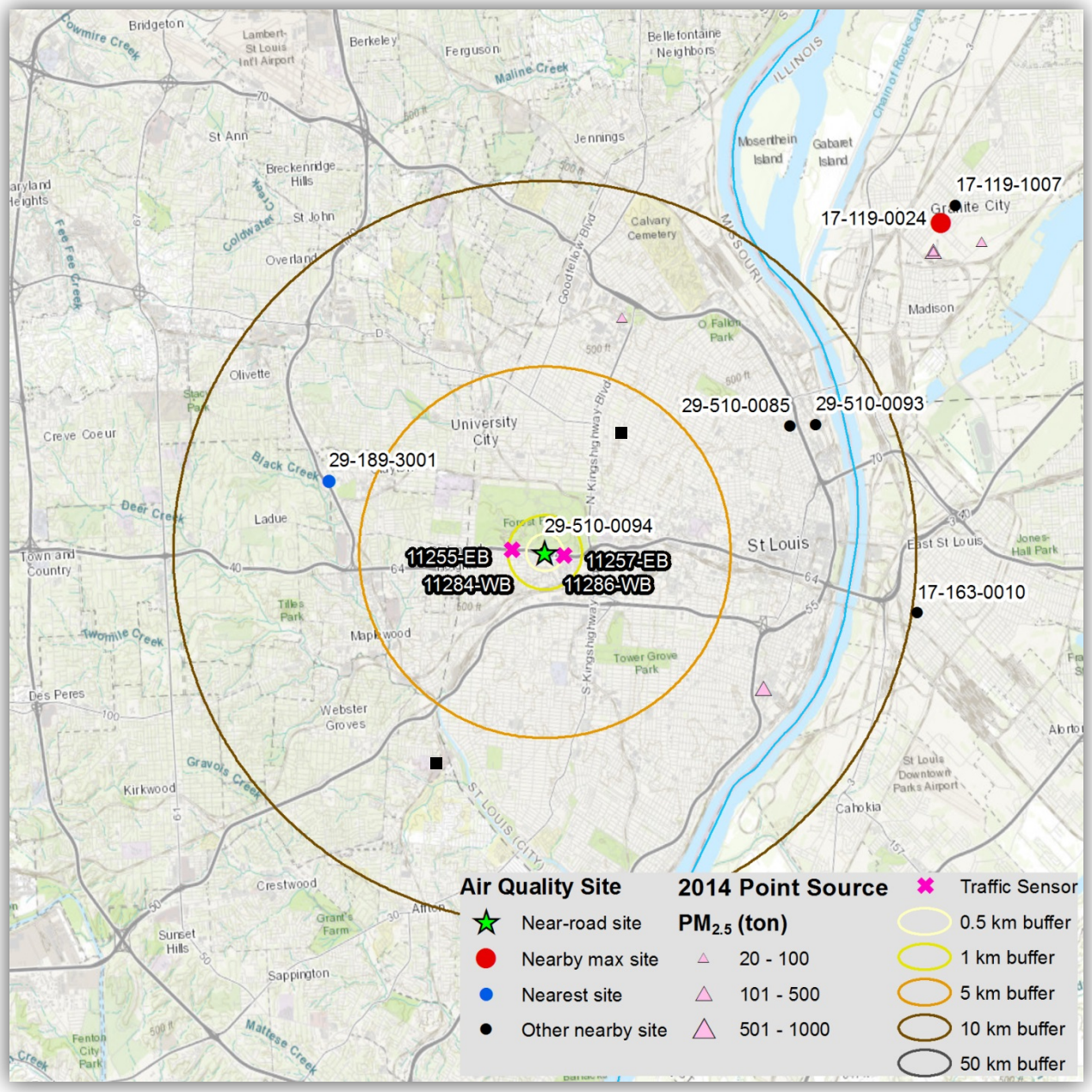

Figure A-8. Location of the St. Louis, MO (I-64) [0094] NR monitoring site, as indicated by a green star. Other monitoring sites are denoted with circles, where the nearest monitoring site and the nearest monitoring site with the highest annual mean $PM_{2.5}$ concentration are denoted with a small blue circle and large red circle, respectively. Traffic monitoring sites (for which data were available and used in this work) are indicated by a magenta "x." Point sources of $PM_{2.5}$ emissions (based on the 2014 National Emissions Inventory) are represented by triangles. Circular buffers indicate distance from the NR monitoring site.

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Appendix B. Air Quality, Meteorological, and Traffic Data for the 25 Highest Daily PM, NO_2, and CO Concentrations at Selected Near-Road Monitoring Sites in 2015

Previously delivered as a technical memorandum on February 15, 2017.

Sonoma Technology, Inc.
Innovative Environmental Solutions

Technical Memorandum

February 15, 2017 STI-914202-6665-TM

To: Karin Landsberg, Washington DOT

From: Steven Brown, Annie Seagram, Doug Eisinger

Re: Near-Road Pooled Fund Task Order 2, Phase 2 – Air quality, meteorological, and traffic data for the 25 highest daily PM, NO_2, and CO concentrations at selected near-road monitoring sites in 2015

Overview

The goal of this work was to develop a database of meteorological, air quality, and traffic-related data from 2015 that can support comparisons between modeled and monitored near-road concentrations. Database development focused on 2015 data, since 2016 data are not certified by the monitoring agencies until May 2017.

As of September 2016, the U.S. Environmental Protection Agency (EPA) listed 79 official national near-road (NR) monitoring sites,[1] 61 of which were operating in 2015. Sonoma Technology, Inc., developed a database of selected daily and hourly air quality and meteorological data for these 61 NR sites. These data represent the highest 25 values for daily (24-hr) average $PM_{2.5}$,[2] daily maximum 1-hour NO_2, and daily maximum 8-hour CO concentrations occurring at each site. The database also provides the daily and hourly air quality and meteorological data for all sites monitoring CO, NO_2 (and/or NO_x), or $PM_{2.5}$ within a 100-km radius of the near-road sites; we refer to these additional monitoring stations as "nearby" (NB) sites.

For near-road monitoring sites where a daily maximum $PM_{2.5}$ concentration exceeded 35 µg/m^3, and for any near-road sites in a Transportation Pooled Fund (TPF) partner state, we investigated whether hourly traffic data (counts/volume, speed, and/or vehicle characterization) were available from state Department of Transportation (DOT) websites or through contacts with staff from individual DOTs. Hourly traffic data were available at 18 of these sites (Table 1).[3] Traffic data from the nearest traffic count stations within the same traffic corridor were obtained from state DOTs for California (Caltrans), Arizona, Colorado, Indiana, Massachusetts, Missouri, Ohio, Oregon, Rhode Island, Texas,

[1] https://www3.epa.gov/ttnamti1/nearroad.html.
[2] Of the 61 sites that were operational in 2015, $PM_{2.5}$ was monitored at 36 sites: 18 of these sites monitored hourly $PM_{2.5}$, 15 sites monitored daily (24-hour) $PM_{2.5}$ (at various sampling frequencies), and 3 sites measured both hourly and daily $PM_{2.5}$.
[3] See also the Appendix for site summary information.

and Virginia. The target roads near the near-road monitoring sites vary by number of lanes and configuration, including freeways that are near (a) another freeway interchange, (b) arterial roads, (c) on/off ramps, or (d) interchanges having a diamond or "T" shape (Table 2). Accordingly, traffic data from multiple traffic count stations were obtained, where available, with the aim of better capturing activity along the traffic corridor.

Table 1. Near-road monitoring sites with 2015 traffic data. Associated data and data characteristics are marked with an "x" if available or applicable. The AQS ID refers to the EPA Air Quality System (AQS) identifying number for an air quality monitoring station.

AQS ID	Site Name: City, State (Target Road) [AQS Site Number]	TPF Partner Site	Hourly Traffic Volume	Hourly Traffic Speed	Hourly Vehicle Characterization	$PM_{2.5}$ Data	2015 $PM_{2.5}$ 24-hour Exceeds 35 µg/m^3	2015 NO_2 1-hour Exceeds 100 ppb	CO Data	Collocated Meteorological Data
04-013-4019	Tempe, AZ (I-10) [4019]	x	x			x			x	x
04-013-4020	Phoenix, AZ (I-10) [4020]	x	x			x	x		x	x
06-001-0012	Oakland, CA (I-880) [0012]	x	x	x	x	x	x	x	x	
06-037-4008	Long Beach, CA (I-710) [4008]	x	x	x	x	x				
06-071-0027	Ontario, CA (SR-60) [0027]	x	x	x	x	x	x			
06-085-0006	San Jose, CA (US 101) [0006]	x	x	x	x	x	x		x	
08-031-0027	Denver, CO (I-25) [0027]	x	x	x		x			x	x
18-097-0087	Indianapolis, IN (I-70) [0087]		x	x	x	x	x		x	x
25-025-0044	Boston, MA (I-93) [0044]		x	x	x	x			x	
29-510-0094	St. Louis, MO (I-64) [0094]		x	x	x	x	x		x	x
39-035-0073	Cleveland, OH (I-271) [0073]	x	x	x	x				x	x
39-061-0048	Cincinnati, OH (I-75) [0048]	x	x	x	x				x	
41-067-0005	Portland, OR (I-5) [0005]		x	x	x	x	x		x	x
44-007-0030	Providence, RI (I-95) [0030]		x	x	x	x	x		x	
48-201-1052	Houston, TX (I-610) [1052]	x	x			x			x	x
48-439-1053	Fort Worth, TX (I-20) [1053]	x	x	x		x			x	x
48-453-1068	Austin, TX (I-35) [1068]	x	x							x
51-760-0025	Richmond, VA (I-95) [0025]	x	x	x	x	x			x	

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Table 2. Roadway characteristics of near-road monitoring sites with 2015 traffic data. The site name is the City, State (Target Road) [AQS Site Number]. The Annual Average Daily Traffic (AADT) counts and Fleet Equivalent (FE)-AADT are as reported by EPA.[a]

AQS ID	Site Name	AADT	FE-AADT	Target Road Description	No. of Lanes
04-013-4019	Tempe, AZ (I-10) [4019]	320,138	624,315	Freeway/freeway interchange (T shape)	13
04-013-4020	Phoenix, AZ (I-10) [4020]	260,136	490,838	Freeway segment with nearby freeway/freeway interchange	12
06-001-0012	Oakland, CA (I-880) [0012]	424,008	424,008	Urban freeway segment with nearby arterial roads	8
06-037-4008	Long Beach, CA (I-710) [4008]	619,008	619,008	Freeway segment adjacent to on/off ramps	9
06-071-0027	Ontario, CA (SR-60) [0027]	625,736	625,736	Freeway segment	10
06-085-0006	San Jose, CA (US 101) [0006]	294,140	294,140	Freeway/freeway interchange (Diamond shape)	8
08-031-0027	Denver, CO (I-25) [0027]	249,000	263,118	Urban freeway segment with nearby freeway/freeway interchange	10
18-097-0087	Indianapolis, IN (I-70) [0087]	189,760	362,110	Freeway segment	10
25-025-0044	Boston, MA (I-93) [0044]	198,239	251,761	Urban freeway segment with nearby arterial roads	7
29-510-0094	St. Louis, MO (I-64) [0094]	159,326	360,077	Freeway segment with nearby freeway/arterial interchange	8
39-035-0073	Cleveland, OH (I-271) [0073]	153,660	287,580	Freeway segment with nearby freeway/freeway interchange	12
39-061-0048	Cincinnati, OH (I-75) [0048]	163,000	386,380	Freeway segment near diverging highways	6
41-067-0005	Portland, OR (I-5) [0005]	156,000	289,052	Freeway segment with nearby freeway/arterial interchange	6
44-007-0030	Providence, RI (I-95) [0030]	186,300	416,790	Freeway/arterial interchange (turbine)	8
48-201-1052	Houston, TX (I-610) [1052]	202,120	334,915	Freeway segment with nearby stacked interchange	8
48-439-1053	Fort Worth, TX (I-20) [1053]	184,680	242,856	Freeway segment with nearby freeway/freeway interchange	8
48-453-1068	Austin, TX (I-35) [1068]	188,150	350,712	Freeway segment	6
51-760-0025	Richmond, VA (I-95) [0025]	151,000	259,720	Freeway segment	6

[a] As of September 2016. See: https://www3.epa.gov/ttnamti1/nearroad.html.

Air Quality Data

Data Sources

Pre-generated data files for 2015 for the NR and NB sites were downloaded from EPA's Air Data website[4] on January 17, 2017. Files downloaded include:

- Air Quality System (AQS) site listing table,
- Daily summary data files for CO, NO_2, NO_x, and $PM_{2.5}$ Federal Reference Method/Federal Equivalent Method (FRM/FEM) mass, and
- Hourly data files for CO, NO_2, NO_x, $PM_{2.5}$ FRM/FEM mass, and resultant wind speed and direction.

Data Processing

Air quality data for 2015 from NR and NB sites were extracted and processed from the files as follows:

- Daily $PM_{2.5}$ data were available in three different sample durations: hourly, 24-hour block average (daily average calculated by EPA using hourly data), and 24-hour (daily filter). Hourly-based daily average data were included only when 24-hour or 24-hour block average data were not available, such that only one daily value remained for each site and instrument (distinguished by Parameter Occurrence Code [POC]) for each day.
- Daily data that had a value less than 75% observed in the raw data were excluded, as prescribed by EPA procedures.
- Daily data that were categorized by the reporting agency as an "Excluded" Event Type in the raw data were excluded. If a daily value was reported for both "None" (no event occurred) and "Included" (events occurred) event types for a given site, parameter, POC, and date, the record flagged as "None" was excluded.

For daily average $PM_{2.5}$, daily maximum 1-hour NO_2, and daily maximum 8-hour CO, the days when the highest 25 concentrations were measured (the "top 25 days") were identified for each of the near-road sites. Daily and hourly data for all of the top 25 days in 2015 at each near-road site and from all the nearby air quality monitoring sites were then compiled into the data files for delivery. These data include daily $PM_{2.5}$, daily maximum 1-hour NO_2, daily maximum 1-hour NO_x, and daily maximum 8-hour CO, as well as hourly $PM_{2.5}$, hourly NO_2, hourly NO_x, hourly CO, wind speed, and wind direction. See **Table 3** for hourly air quality data availability at the NR sites. The top 25 days for each parameter are not necessarily coincident; therefore, up to 75 days of data per site may be included in this database.

[4] https://aqsdr1.epa.gov/aqsweb/aqstmp/airdata/download_files.html.

Table 3. AQS data availability at operational near-road sites in 2015. The first date of available data (in month-day format) is provided for each site by parameter: carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter of 2.5 microns or less ($PM_{2.5}$), and wind speed and direction (WSWD). For $PM_{2.5}$, the sample duration and the estimated sample frequency are also provided. An asterisk denotes that 24-hour $PM_{2.5}$ data are also available at the site, though only the hourly $PM_{2.5}$ data information is reported in this table.

AQS ID	Site Name: City, State (Target Road) [AQS Site Number]	CO Start Date	NO_2 Start Date	$PM_{2.5}$			WSWD Start Date
				Start Date	Sample Duration	Sample Frequency	
01-073-2059	Birmingham, AL (I-20) [2059]	01-01	01-01	01-12	24-hour	1-in-6	01-01
04-013-4019	Tempe, AZ (I-10) [4019]	01-01	01-01	01-01	1-hour	Hourly	01-01
04-013-4020	Phoenix, AZ (I-10) [4020]	09-02	09-02	09-02	1-hour	Hourly	09-02
06-001-0012	Oakland, CA (I-880) [0012]	01-01	01-01	01-01	1-hour	Hourly	
06-037-4008	Long Beach, CA (I-710) [4008]		04-01	01-01	24-hour	Daily	
06-059-0008	Anaheim, CA (I-5) [0008]	01-01	01-01				
06-067-0015	Sacramento, CA (I-5) [0015]	10-14	10-13				10-30
06-071-0026	Ontario, CA (I-10) [0026]	01-01	01-01				
06-071-0027	Ontario, CA (SR-60) [0027]		08-01	01-01	24-hour	Daily	
06-073-1017	San Diego, CA (I-15) [1017]	04-24	03-26				
06-085-0006	San Jose, CA (US 101) [0006]	01-01	01-01	01-01	1-hour	Hourly	
08-031-0027	Denver, CO (I-25) [0027]	01-01	01-07	01-01	1-hour*	Hourly*	01-01
08-031-0028	Denver, CO (I-25) [0028]		10-01	10-01	1-hour	Hourly	10-19
09-003-0025	Hartford, CT (I-84) [0025]	01-01	01-01	01-03	24-hour	1-in-3	01-01
11-001-0051	Washington DC, DC (DC-295) [0051]	06-01	06-01	06-01	1-hour*	Hourly*	06-01

AQS ID	Site Name: City, State (Target Road) [AQS Site Number]	CO Start Date	NO_2 Start Date	$PM_{2.5}$			WSWD Start Date
				Start Date	Sample Duration	Sample Frequency	
12-011-0035	Fort Lauderdale, FL (I-95) [0035]	08-31	08-21				
12-031-0108	Jacksonville, FL (I-95) [0108]	01-01	01-01	01-01	1-hour	Hourly	
12-057-1111	Tampa, FL (I-275) [1111]	01-01	01-01	01-01	1-hour	Hourly	
13-089-0003	Atlanta, GA (I-285) [0003]		01-01				
13-121-0056	Atlanta, GA (I-85) [0056]	01-01	01-01	01-01	24-hour	Daily	01-01
16-001-0023	Meridian, ID (I-84) [0023]	01-01	01-01				
18-097-0087	Indianapolis, IN (I-70) [0087]	01-01	01-01	01-03	24-hour	1-in-3	01-01
19-153-6011	Des Moines, IA (I-235) [6011]		01-01				
21-111-0075	Louisville, KY (I-264) [0075]	01-01	01-01	01-03	24-hour	1-in-3	
22-071-0021	New Orleans, LA (I-610) [0021]	01-01	01-01	01-03	24-hour	1-in-3	02-27
24-027-0006	Laurel, MD (I-95) [0006]	01-01	01-01	01-01	1-hour	Hourly	01-01
25-025-0044	Boston, MA (I-93) [0044]	01-01	01-01	09-01	1-hour*	Hourly*	
26-163-0093	Detroit, MI (I-96) [0093]	01-01	01-01				01-01
26-163-0095	Livonia, MI (I-275) [0095]	01-01	01-01	01-09	24-hour	1-in-3	01-01
27-037-0480	Lakeville, MN (I-35) [0480]	01-01	01-01	01-01	1-hour	Hourly	
27-053-0962	Minneapolis, MN (I-94/I-35W) [0962]	01-01	01-01	01-01	1-hour	Hourly	
29-095-0042	Kansas City, MO (I-70) [0042]	01-29	01-01	01-01	1-hour	Hourly	01-01
29-189-0016	St. Louis, MO (I-70) [0016]		01-09				01-09
29-510-0094	St. Louis, MO (I-64) [0094]	01-01	01-01	01-01	1-hour	Hourly	01-01

AQS ID	Site Name: City, State (Target Road) [AQS Site Number]	CO Start Date	NO_2 Start Date	$PM_{2.5}$			WSWD Start Date
				Start Date	Sample Duration	Sample Frequency	
32-003-1501	Las Vegas, NV (I-15) [1501]		08-01				08-01
34-003-0010	Fort Lee, NJ (I-95/US 1) [0010]	01-01	01-01	01-01	1-hour	Hourly	
36-029-0023	Cheektowaga, NY (I-90) [0023]	01-01	01-01	01-06	24-hour	1-in-3	
36-055-0015	Rochester, NY (I-490) [0015]	01-01	01-01	01-06	24-hour	1-in-3	
37-119-0045	Charlotte, NC (I-77) [0045]		01-01				01-13
37-183-0021	Raleigh, NC (I-40) [0021]		01-01				
39-035-0073	Cleveland, OH (I-271) [0073]	01-01	01-01				01-01
39-049-0038	Columbus, OH (I-270) [0038]	01-01	01-01				01-01
39-061-0048	Cincinnati, OH (I-75) [0048]	01-01	01-13				
40-109-0097	Oklahoma City, OK (I-44) [0097]	06-17	04-01	04-09	24-hour	1-in-3	05-19
41-067-0005	Portland, OR (I-5) [0005]	01-01	01-01	01-06	24-hour	1-in-3	01-01
42-003-1376	Wilkinsburg, PA (I-376) [1376]	01-01	01-01				
42-101-0075	Philadelphia, PA (I-95) [0075]	01-01	01-01	01-01	1-hour	Hourly	
42-101-0076	Philadelphia, PA (I-76) [0076]		07-20	09-02	1-hour	Hourly	
44-007-0030	Providence, RI (I-95) [0030]	01-01	01-01	01-01	1-hour	Hourly	
47-037-0040	Nashville, TN (I-40/I-24) [0040]	01-01	01-01				
47-157-0100	Memphis, TN (I-40) [0100]	01-01	01-01				
48-029-1069	San Antonio, TX (I-35) [1069]		01-01				01-01
48-113-1067	Dallas, TX (I-635) [1067]		01-01				01-01

AQS ID	Site Name: City, State (Target Road) [AQS Site Number]	CO Start Date	NO_2 Start Date	$PM_{2.5}$			WSWD Start Date
				Start Date	Sample Duration	Sample Frequency	
48-201-1052	Houston, TX (I-610) [1052]	04-15	04-15	04-15	24-hour	1-in-3	05-01
48-201-1066	Houston, TX (I-69/US 59) [1066]		01-01				01-01
48-439-1053	Fort Worth, TX (I-20) [1053]	03-12	03-12	03-22	24-hour	1-in-3	03-12
48-453-1068	Austin, TX (I-35) [1068]		01-01				01-01
51-760-0025	Richmond, VA (I-95) [0025]	01-01	01-01	01-01	1-hour	Hourly	
53-033-0030	Seattle, WA (I-5) [0030]	01-01	01-01	01-01	1-hour	Hourly	01-01
55-079-0056	Milwaukee, WI (I-94) [0056]	01-01	01-01				01-01
72-061-0006	Guaynabo, PR (De Diego Hwy) [0006]	04-01	04-21				

Traffic Data

Data Sources

Hourly traffic data were acquired from state DOTs through personal communications or from the agency's traffic data website (Table 4). The majority of DOTs use an instance of the Midwestern Software Solutions, LLC (MS2) Traffic Count Database System (TCDS) (also listed as "MS2SOFT" in this document and delivered files). Traffic count stations were selected according to their proximity to the near-road monitoring site; at a minimum, selected stations were within the same traffic corridor as the near-road site's target road. Hourly counts (volume), speed, and vehicle characterization (used to determine the volume of trucks within the fleet) were obtained by traffic flow direction and by lane, if possible. Data from multiple traffic count stations near the near-road monitoring site were also acquired, where possible.

Table 4. Traffic data sources by agency. Agency names are abbreviated as in the database.

Agency Abbreviation	Agency	Website or Primary Contact
AZ DOT	Arizona Department of Transportation	http://adot.ms2soft.com
Caltrans	Caltrans – California Department of Transportation	http://pems.dot.ca.gov
CO DOT	Colorado Department of Transportation	http://cdot.ms2soft.com
IN DOT	Indiana Department of Transportation	http://indot.ms2soft.com
MA DOT	Massachusetts Department of Transportation	http://mhd.ms2soft.com/
MO DOT	Missouri Department of Transportation	Jeffery Baird jeffery.baird@modot.mo.gov
OH DOT	Ohio Department of Transportation	http://odot.ms2soft.com
OR DOT	Oregon Department of Transportation	Don Crownover don.r.crownover@odot.state.or.us
RI DOT	Rhode Island Department of Transportation	Philip d'Ercole philip.dercole@dot.ri.gov
TX DOT	Texas Department of Transportation	http://txdot.ms2soft.com
VA DOT	Virginia Department of Transportation	Ralph Jones ralph.jones@vdot.virginia.gov

Data Processing

The file format, aggregation level, reporting units and/or vehicle classes, and level of quality assurance of the traffic data varied by individual traffic count sensor, data source, and/or agency. Traffic data acquired from Caltrans, Rhode Island DOT, and Virginia DOT included hourly data capture; the data were discarded for hours with less than 75% data capture within the hour, as prescribed by EPA procedures. Through all instances of MS2 TCDSs, traffic data are reported as raw data directly from the traffic counter but are only available if an entire day of data has an "Accepted" count status.

Hourly traffic data in the deliverable database is reported by traffic flow direction (Northbound/Southbound, or Eastbound/Westbound), i.e., all data by lane are aggregated. For speed data reported as volume counts by speed range, the midpoint of the speed range was used to calculate a volume-weighted mean traffic speed. If the maximum speed range was unbounded (e.g., "80+ mph"), the "midpoint" speed for this range was taken as the minimum bound plus half the difference between the bounds of the preceding speed range.[5]

Depending on the individual traffic count sensor and/or agency, vehicle characterization data were reported in one of the following ways:

1. **As an estimated volume.** A truck count may be calculated from aggregated volume and occupancy data (i.e., as data obtained from Caltrans).[6]
2. **As vehicle counts by vehicle length range.** When vehicles were counted by length range, the ranges where the minimum bound equaled or exceeded 48 feet were counted as "truck," as prescribed by FHWA guidance.[7] If the highest length range was unbounded, but the minimum bound was less than 48 feet, the vehicle counts within this length range were designated as "truck."[8]
3. **As vehicle counts by vehicle class, as defined by the Federal Highway Administration (FHWA) Scheme F.**[9] This classification scheme includes 13 defined vehicle classes (Class 1-13), as well as Unused (Class 14) and Unclassified (Class 15) categories. All vehicle counts from Classes 5-13 were designated as "truck."

The hourly truck count divided by the total vehicle count was multiplied by 100 to obtain the truck percentage, rounded to one decimal place.

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[5] For example, if the highest two speed ranges were "70-80 mph" and "80+ mph", the midpoints used to calculate the mean speed would be 75 mph and 85 mph.

[6] See http://pems.dot.ca.gov/?dnode=Help&content=help_calc#truck.

[7] See http://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/index.htm#length.

[8] For example, if length ranges are defined as "0-30 feet," "31-49 feet," and "49-80 feet," then only the counts within the "49-80 feet" range are assigned as "truck." If the length ranges are defined as "0-30 feet," "31-40 feet," and "41+ feet," then the counts within the "41+ feet" range are assigned as "truck," even though the minimum bound does not exceed 48 feet.

[9] See https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/13091/13091.pdf.

Description of Delivered Files and Database

STI is delivering both a database and the underlying comma-separated values [CSV] files. The compiled meteorology, air quality, and traffic-related data, with ancillary metadata and cross-reference information comprise 13 tables in the database (which directly correspond to 13 files in CSV format). A description of the data in each column by table is provided in **Tables 5 through 18**. The name of the table in the database and corresponding CSV format file are noted in each caption.

Some values in the hourly air quality and traffic data records in these tables are blank. For the hourly air quality data, a blank record indicates that the data were not present in the original files downloaded from EPA's Air Data website. For the traffic data, a blank record indicates that either the data did not meet the 75% data capture criterion (for data from Caltrans, Rhode Island DOT, and Virginia DOT), or the record was not present in the original files obtained from the state DOT.

Table 5. Air Quality System (AQS) site information for near-road (NR) and nearby (NB) sites (table: aqs_sites, file: *aqs_sites.csv*).

Field Name	Description
AQS_ID	AQS site identification number, as "SS-CCC-NNNN", where SS is the State FIPS (Federal Information Processing Standards) Code, CCC is the County FIPS Code, and NNNN is the Site Number within the county.
latitude	Latitude of monitoring site, in decimal degrees (positive North).
longitude	Longitude of monitoring site, in decimal degrees (positive East).
elevation	Elevation of monitoring site (meters above sea level).
land_use	Category of land use where the site is located.
location_setting	Setting of site location.
met_site_state_code	Meteorological site State Code.
met_site_county_code	Meteorological site County Code.
met_site_site_number	Meteorological site Site Number.
met_site_type	Type of meteorological site.
met_site_distance	Distance from meteorological site to AQS monitoring site, in meters.
met_site_direction	Direction of meteorological site relative to the AQS monitoring site, as a cardinal direction.
local_site_name	Local site name.
address	Address of monitoring site.
zip_code	Zip code of monitoring site.
state_name	Full state name.
county_name	County name.
city_name	City name.
CBSA_name	Core Based Statistical Area (CBSA) in which the site is located.
tribe_name	Tribe name.
location_type	Designation of site as either a near-road (NR) monitoring site or a "nearby" (NB) site.

Table 6. Daily air quality metrics (table: daily_aq, file: *daily_aq.csv*).

Field Name	Description
AQS_ID	AQS site identification number, as "SS-CCC-NNNN", where SS is the State FIPS (Federal Information Processing Standards) Code, CCC is the County FIPS Code, and NNNN is the Site Number within the county.
parameter	Parameter (chemical species or other data) code measured by the monitor.
POC	Parameter Occurrence Code, used to uniquely identify the monitor on site if there is more than one monitor concurrently measuring the same parameter.
sample_duration	Duration code corresponding to the amount of time used to collect the sample, i.e., averaging time. This can correspond to either the averaging time of one sample, or the averaging time of several individual samples.
unit	Unit code corresponding to the unit of the measured parameter.
method	Sampling methodology code corresponding to the collection and analysis methods used to measure the sample.
datetime	Start date and time information, in "YYYY-mm-dd HH:MM:SS" format, reported in Local Standard Time (LST).
sample_value	The measured sample value of the parameter.
pollutant_standard_ID	Pollutant Standard code of sample value.
event_type	Indication of whether an exceptional event occurred and is included in the sample value statistic. "None" indicates that no event occurred; "Included" indicates that an event occurred and that the data during the event are included in the sample value.
observed_pct	Percentage (%) of observations recorded during the averaging time (sample duration) of the maximum number expected.

Table 7. Date and time information (table: dt_info, file: *dt_info.csv*). This table can be used to easily access individual date and time attributes (e.g., to perform a "group by hour" operation).

Field Name	Description
datetime	Start date and time information, in "YYYY-mm-dd HH:MM:SS" format, reported in Local Standard Time (LST).
year	Year of the date and time information
month	Month of the date and time information
day	Day of the date and time information
hour	Hour of the date and time information (as 24-hour clock)
quarter	Quarter of the date and time information [defined as Quarter 1 (JFM), 2 (AMJ), 3 (JAS), or 4 (OND)].

Table 8. Sample duration codes and descriptions (table: durations, file: *durations.csv*).

Field Name	Description
sample_duration	Duration code corresponding to the amount of time used to collect the sample, i.e., averaging time. This can correspond to either the averaging time of one sample, or the averaging time of several individual samples.
duration_description	Full name of sample duration.
observed_or_calculated	Whether the sample value is observed or calculated over the sample duration period.

Table 9. Hourly air quality and meteorological data from AQS for the top 25 days (table: hourly_aq, file: *hourly_aq.csv*). Refer to the AQS file format documentation for more information[a,b].

Field Name	Description
AQS_ID	AQS site identification number, as "SS-CCC-NNNN", where SS is the State FIPS (Federal Information Processing Standards) Code, CCC is the County FIPS Code, and NNNN is the Site Number within the county.
parameter	Parameter (chemical species or other data) code measured by the monitor.
POC	Parameter Occurrence Code, used to uniquely identify the monitor on site if there is more than one monitor concurrently measuring the same parameter.
sample_duration	Duration code corresponding to the amount of time used to collect the sample, i.e. averaging time. This can correspond to either the averaging time of one sample, or the averaging time of several individual samples.
unit	Unit code corresponding to the unit of the measured parameter.
method	Sampling methodology code corresponding to the collection and analysis methods used to measure the sample.
datetime	Start date and time information, in "YYYY-mm-dd HH:MM:SS" format reported in Local Standard Time (LST).
sample_value	The measured sample value of the parameter.

[a] https://aqs.epa.gov/aqsweb/documents/AQS_Format.html.
[b] https://www.epa.gov/sites/production/files/2016-08/documents/aqs_user_guide_2016.pdf.

Table 10. Method codes and descriptions (table: methods, file: *methods.csv*).

Field Name	Description
method	Sampling methodology code corresponding to the collection and analysis methods used to measure the sample.
parameter	Parameter (chemical species or other data) code measured by the monitor.
sample_duration	Duration code corresponding to the amount of time used to collect the sample, i.e., averaging time. This can correspond to either the averaging time of one sample, or the averaging time of several individual samples.
unit	Unit code corresponding to the unit of the measured parameter.
recording_mode	Mode of how the samples were recorded (continuously or intermittently).
collection_description	Description of sample collection method.
analysis_description	Description of sample analysis method.
method_type	Indicator for type of method used to collect the sample: Federal Reference Method (FRM), Federal Equivalent Method (FEM), or neither (left blank).
reference_method_ID	Federal Reference Method (FRM) identification code.
equivalent_method	Description of Federal Equivalent Method (FEM).
federal_MDL	Federal Method Detection Limit (MLD).

Table 11. Metadata for NR sites (table: nr_sites, file: *nr_sites.csv*).

Field Name	Description
AQS_ID	AQS site identification number, as "SS-CCC-NNNN", where SS is the State FIPS (Federal Information Processing Standards) Code, CCC is the County FIPS Code, and NNNN is the Site Number within the county.
site_name	Name of the NR site as "City, State (Target Road) [AQS Site Number]".
phase	Installation phase of the near-road monitoring site.
target_road	Name of target road.
distance_to_target_m	Distance between the near-road monitoring site and the target road, in meters.
AADT	Annual Average Daily Traffic (AADT) counts on the target road
AADT_rank_in_CBSA	Rank of AADT within the CBSA.
FEAADT	Fleet Equivalent (FE) AADT.
FEAADT_rank_in_CBSA	Rank of FE-AADT within the CBSA.
population_2014	Population within the CBSA in 2014.
population_2015	Population within the CBSA in 2015.

Table 12. Cross-reference of NR sites to NB sites, i.e., all sites within 100 km of the NR site (table: nr_sites_nb_sites_association, file: *nr_sites_nb_sites_association.csv*).

Field Name	Description
NR_AQS_ID	AQS site identification number of the near-road (NR) site.
NB_AQS_ID	AQS site identification number of the associated nearby (NB) site.
distance_m	Distance from the NB site to the associated NR site, in meters.
distance_rank	Rank of distance between NB sites and NR site, by NR site.

Table 13. Cross-reference of NR sites to associated traffic counting stations (table: nr_sites_tr_sites, file: *nr_sites_tr_sites.csv*).

Field Name	Description
AQS_ID	AQS site identification number, as "SS-CCC-NNNN", where SS is the State FIPS (Federal Information Processing Standards) Code, CCC is the County FIPS Code, and NNNN is the Site Number within the county.
agency	Owner (agency/DOT) of the traffic monitoring site.
sensor_ID	Sensor identification number.
direction	Direction of traffic flow: Northbound (NB), Eastbound (EB), Southbound (SB), Westbound (WB).
TR_latitude	Latitude of traffic monitoring sensor, in decimal degrees (positive North)
TR_longitude	Longitude of traffic monitoring sensor, in decimal degrees (positive East)
TR_location_estimated	Boolean flag of whether the traffic monitoring sensor location was estimated (1 = True) or was provided by the agency (0 = False).
data_source	Abbreviation of source (agency) of traffic monitoring data; "MS2SOFT" indicates that the data were acquired online via the agency's MS2 TCDS website.

Table 14. Parameter codes and full names (table: parameters, file: *parameters.csv*).

Field Name	Description
parameter	Parameter (chemical species or other data) code measured by the monitor.
parameter_name	Full name of parameter.

Table 15. Pollutant standard codes and descriptions (table: pollutant_standards, file: *pollutant_standards.csv*).

Field Name	Description
pollutant_standard_ID	Pollutant Standard code of sample value.
pollutant_standard_short_name	Pollutant Standard short name.
pollutant_standard_description	Pollutant Standard description of the rules used to aggregate statistics.
NAAQS_basis	National Ambient Air Quality Standard (NAAQS) basis.
round_or_truncate	Whether the sample value should be rounded (R) or truncated (T) when compared to the NAAQS.

Table 16. Hourly traffic data for the top 25 days (table: traffic, file: *traffic.csv*).

Field Name	Description
agency	Owner (agency/DOT) of the traffic monitoring site.
sensor_ID	Sensor identification number.
direction	Direction of traffic flow: Northbound (NB), Eastbound (EB), Southbound (SB), Westbound (WB).
lane	Lane number; "0" indicates that data is aggregated across all lanes in the direction indicated (counts are summed, speeds are averaged).
datetime	Start date and time information, in "YYYY-mm-dd HH:MM:SS" format, reported in Local Standard Time (LST).
counts	Count (volume) of vehicles per hour (vehicle/hour).
speed	Speed of vehicles, rounded to nearest integer (mph).
truck	Count (volume) of trucks per hour (vehicle/hour).
truck_pct	Percentage (%) of trucks per hour (i.e., count of trucks divided by the total count of vehicles per hour), rounded to one decimal place.

Table 17. Unit codes and unit names (table: units, file: *units.csv*)

Field Name	Description
unit	Unit code corresponding to the unit of the measured parameter.
unit_name	Full name of unit.

Table 18. Value and category of "truck" definition (table: truck_definitions, file: *truck_definitions.csv*)

Field Name	Description
agency	Owner (agency/DOT) of the traffic monitoring site.
sensor_ID	Sensor identification number.
truck_ge	Minimum criterion of truck classification; vehicle counts greater than or equal to (ge) this value are classified as "truck".
truck_unit	Unit of minimum truck measure or category.

Summary

The tables in the database (or individual files) consist of hourly data and daily statistics of CO, NO_2, and $PM_{2.5}$; meteorological data (wind speed and direction); traffic data (vehicle counts, speed, and/or fleet characterization); and metadata for official near-road monitoring sites and other monitoring sites within a 100 km radius. Taken together, these tables are designed to support various near-road air quality analyses and to serve as the basis for future comparisons between monitored and modeled pollutant concentrations.

Appendix. Additional Site Information

The graphics on the following pages show summaries of information for the 18 near-road sites for which hourly traffic data are available.

Tempe, Arizona
I-10 & Hwy 60

1

(33.3961, -111.968)

Traffic data availability

Counts	Hourly
Speeds	N/A
Characterization	N/A

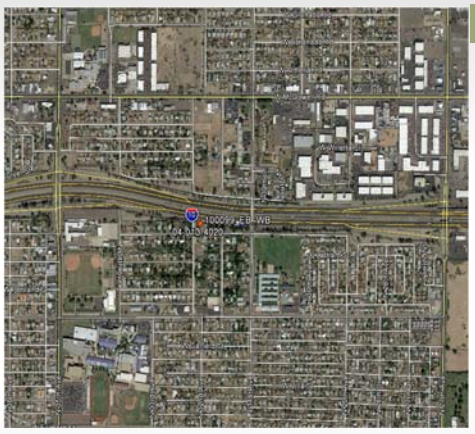
Site information

AQS ID	04-013-4019
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway/freeway interchange (T shape)
Number of lanes	13
AADT	320,138
FE-AADT	624,315
Distance to road	12 m
$PM_{2.5}$ increment*	0.1 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	22.6 µg/m^3
Annual mean $PM_{2.5}$	7.9 µg/m^3
CO max. 1-hr	1.9 ppm
NO_2 max. 1-hr	59.0 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Phoenix, Arizona
I-10

2



(33.36177, -112.128)

Traffic data availability

Counts	Hourly
Speeds	N/A
Characterization	N/A

Site information

AQS ID	04-013-4020
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment with nearby freeway/freeway interchange
Number of lanes	12
AADT	260,136
FE-AADT	490,838
Distance to road	20 m
$PM_{2.5}$ increment*	2.7 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	35.3 µg/m^3
Annual mean $PM_{2.5}$	12.6 µg/m^3
CO max. 1-hr	3.4 ppm
NO_2 max. 1-hr	69.0 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Oakland, California
I-880

3

(37.793624, -122.263376)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (truck/non-truck)

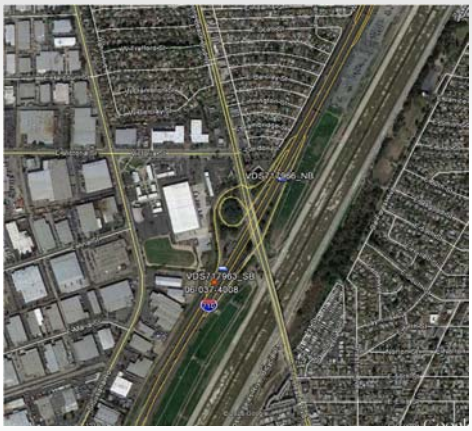
Site information

AQS ID	06-001-0012
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Urban freeway segment with nearby arterial roads
Number of lanes	8
AADT	216,000
FE-AADT	424,008
Distance to road	20 m
$PM_{2.5}$ increment*	1.3 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	37.3 µg/m^3
Annual mean $PM_{2.5}$	10 .0 µg/m^3
CO max. 1-hr	2.7 ppm
NO_2 max. 1-hr	105.9 ppb
Collocated met.	No; OAK is 5 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Long Beach, California
I-710

4



(33.860643, -118.200781)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (truck/non-truck)

Site information

AQS ID	06-037-4008
$PM_{2.5}$ nonattainment	Yes
TPF	Yes
Road type	Freeway segment adjacent to on/off ramps
Number of lanes	9
AADT	192,000
FE-AADT	619,008
Distance to road	9 m
$PM_{2.5}$ increment*	2.2 µg/m^3
$PM_{2.5}$	24-hour (daily)
$PM_{2.5}$ max. 24-hr	48.8 µg/m^3
Annual mean $PM_{2.5}$	12.7 µg/m^3
CO max. 1-hr	N/A
NO_2 max. 1-hr	94.7 ppb
Collocated met.	No; LAX is 13 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Ontario, California
SR-60

(34.030903, -117.617143)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (truck/non-truck)

Site information

AQS ID	06-071-0027
$PM_{2.5}$ nonattainment	Yes
TPF	Yes
Road type	Freeway segment
Number of lanes	10
AADT	215,000
FE-AADT	625,736
Distance to road	9 m
$PM_{2.5}$ increment*	2.3 µg/m^3
$PM_{2.5}$	24-hour (daily)
$PM_{2.5}$ max. 24-hr	52.8 µg/m^3
Annual mean $PM_{2.5}$	14.3 µg/m^3
CO max. 1-hr	N/A
NO_2 max. 1-hr	79.3 ppb
Collocated met.	No; ONT is 2 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

San Jose, California
US-101 & I-680

(37.338, -121.85)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (truck/non-truck)

Site information

AQS ID	06-085-0006
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway/freeway interchange (Diamond shape)
Number of lanes	8
AADT	191,000
FE-AADT	294,140
Distance to road	32 m
$PM_{2.5}$ increment*	-0.1 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	46.9 µg/m^3
Annual mean $PM_{2.5}$	8.4 µg/m^3
CO max. 1-hr	2.7 ppm
NO_2 max. 1-hr	61.1 ppb
Collocated met.	No; SJC is 4.5 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Denver, Colorado
I-25

7

(39.73215, -105.01526)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	N/A

Site information

AQS ID	08-031-0027
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Urban freeway segment, nearby freeway/freeway interchange
Number of lanes	10
AADT	249,000
FE-AADT	263,118
Distance to road	9 m
$PM_{2.5}$ increment*	2.6 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	29.1 µg/m^3
Annual mean $PM_{2.5}$	9.0 µg/m^3
CO max. 1-hr	2.9 ppm
NO_2 max. 1-hr	81.1 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Indianapolis, Indiana
I-70

8

(39.7878, -86.131)

Traffic data availability

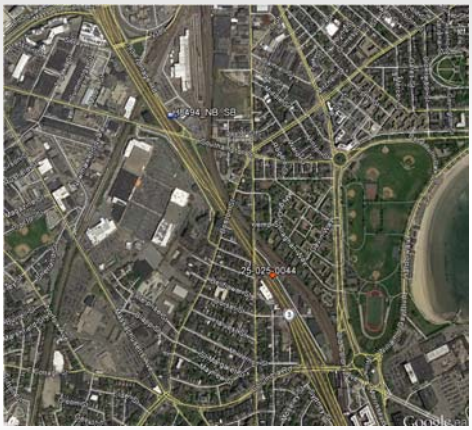
Counts	Hourly
Speeds	Hourly
Characterization	Hourly (FHWA)

Site information

AQS ID	18-097-0087
$PM_{2.5}$ nonattainment	No
TPF	No
Road type	Freeway segment
Number of lanes	10
AADT	189,760
FE-AADT	362,110
Distance to road	24.5 m
$PM_{2.5}$ increment*	1.3 µg/m^3
$PM_{2.5}$	24-hour (1-in-3)
$PM_{2.5}$ max. 24-hr	54.9 µg/m^3
Annual mean $PM_{2.5}$	11.5 µg/m^3
CO max. 1-hr	1.7 ppm
NO_2 max. 1-hr	53.7 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Boston, Massachusetts
I-93



(42.32498, -71.0559)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (length ranges)

Site information

AQS ID	25-025-0044
$PM_{2.5}$ nonattainment	No
TPF	No
Road type	Urban freeway segment with nearby arterial roads
Number of lanes	7
AADT	198,239
FE-AADT	251,761
Distance to road	10 m
$PM_{2.5}$ increment*	0.3 µg/m^3
$PM_{2.5}$	Hourly, 24-hour (1-in-3)
$PM_{2.5}$ max. 24-hr	20.8 µg/m^3
Annual mean $PM_{2.5}$	6.7 µg/m^3
CO max. 1-hr	1.8 ppm
NO_2 max. 1-hr	61.0 ppb
Collocated met.	No, BOS is 3.5 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

St. Louis, Missouri
I-64

(38.631057, -90.281144)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (length ranges)

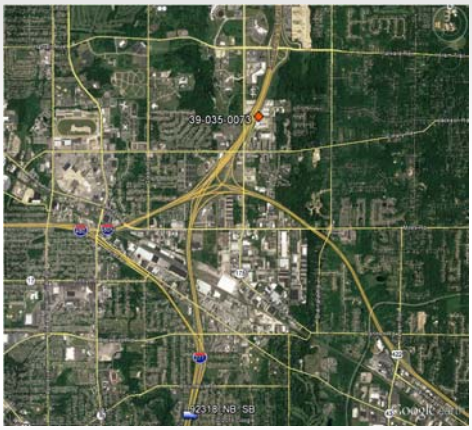
Site information

AQS ID	29-510-0094
$PM_{2.5}$ nonattainment	Yes
TPF	No
Road type	Freeway segment with nearby freeway/arterial interchange
Number of lanes	8
AADT	159,326
FE-AADT	360,077
Distance to road	25 m
$PM_{2.5}$ increment*	-1.2 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	39.4 µg/m^3
Annual mean $PM_{2.5}$	9.2 µg/m^3
CO max. 1-hr	1.9 ppm
NO_2 max. 1-hr	55.5 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Cleveland, Ohio
I-271

11



(41.440075, -81.494919)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (length ranges)

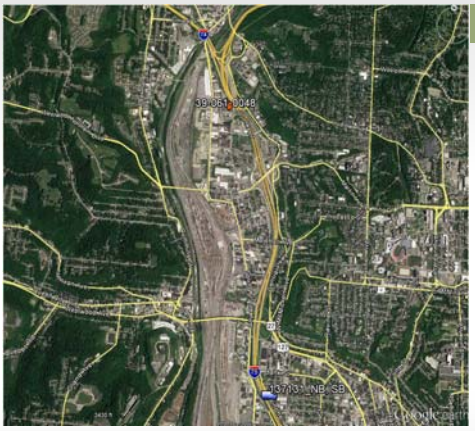
Site information

AQS ID	39-035-0073
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment with nearby freeway/freeway interchange
Number of lanes	12
AADT	153,660
FE-AADT	287,580
Distance to road	20 m
$PM_{2.5}$ increment*	N/A
$PM_{2.5}$	N/A
$PM_{2.5}$ max. 24-hr	N/A
Annual mean $PM_{2.5}$	N/A
CO max. 1-hr	1.125 ppm
NO_2 max. 1-hr	59.0 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Cincinnati, Ohio
I-75

12



(39.146055, -84.538957)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (FHWA)

Site information

AQS ID	39-061-0048
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment near diverging highways
Number of lanes	6
AADT	163,000
FE-AADT	386,380
Distance to road	8 m
$PM_{2.5}$ increment*	N/A
$PM_{2.5}$	N/A
$PM_{2.5}$ max. 24-hr	N/A
Annual mean $PM_{2.5}$	N/A
CO max. 1-hr	2.575 ppm
NO_2 max. 1-hr	85.0 ppb
Collocated met.	No

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Portland, Oregon
I-5

13

(45.393497, -122.747894)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (length ranges)

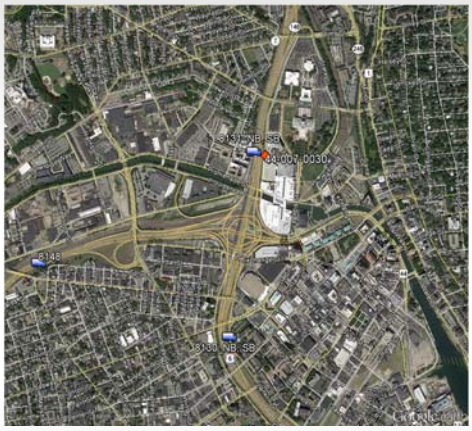
Site information

AQS ID	41-067-0005
$PM_{2.5}$ nonattainment	No
TPF	No
Road type	Freeway segment with nearby freeway/arterial interchange
Number of lanes	6
AADT	156,000
FE-AADT	289,052
Distance to road	27 m
$PM_{2.5}$ increment*	0.6 µg/m^3
$PM_{2.5}$	24-hour (1-in-3)
$PM_{2.5}$ max. 24-hr	61.5 µg/m^3
Annual mean $PM_{2.5}$	7.9 µg/m^3
CO max. 1-hr	1.8 ppm
NO_2 max. 1-hr	40.9 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Providence, Rhode Island
I-95 & Hwy 6

14



(41.829475, -71.417447)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (length ranges)

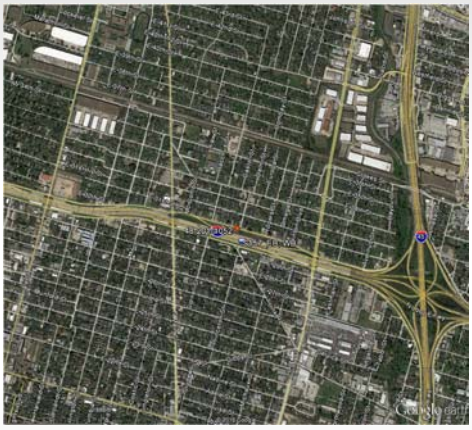
Site information

AQS ID	44-007-0030
$PM_{2.5}$ nonattainment	No
TPF	No
Road type	Freeway/arterial interchange (turbine)
Number of lanes	8
AADT	186,300
FE-AADT	416,790
Distance to road	5 m
$PM_{2.5}$ increment*	3.0 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	92.5 µg/m^3
Annual mean $PM_{2.5}$	9.9 µg/m^3
CO max. 1-hr	3.7 ppm
NO_2 max. 1-hr	86.2 ppb
Collocated met.	No; PVD is 7.5 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Houston, Texas
I-610

15



(29.81453, -95.38769)

Traffic data availability

Counts	Hourly
Speeds	N/A
Characterization	N/A

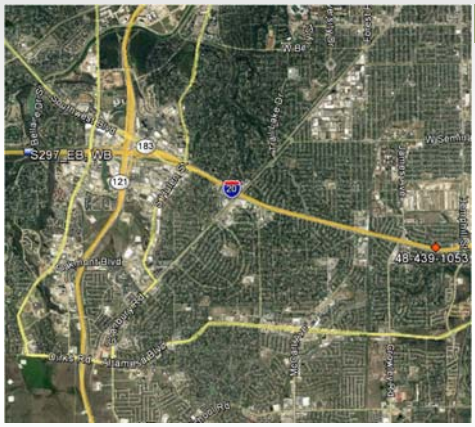
Site information

AQS ID	48-201-1052
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment with nearby stacked interchange
Number of lanes	8
AADT	202,120
FE-AADT	334,915
Distance to road	15 m
$PM_{2.5}$ increment*	N/A
$PM_{2.5}$	24-hour (1-in-3)
$PM_{2.5}$ max. 24-hr	27.0 µg/m^3
Annual mean $PM_{2.5}$	12.5 µg/m^3
CO max. 1-hr	2.636 ppm
NO_2 max. 1-hr	67.9 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Fort Worth, Texas
I-20

16



(32.66472, -97.3381)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	N/A

Site information

AQS ID	48-439-1053
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment with nearby freeway/freeway interchange
Number of lanes	8
AADT	184,680
FE-AADT	242,856
Distance to road	15 m
$PM_{2.5}$ increment*	0.3 µg/m^3
$PM_{2.5}$	24-hour (1-in-3)
$PM_{2.5}$ max. 24-hr	21.1 µg/m^3
Annual mean $PM_{2.5}$	9.3 µg/m^3
CO max. 1-hr	1.67 ppm
NO_2 max. 1-hr	58.6 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Austin, Texas
I-35

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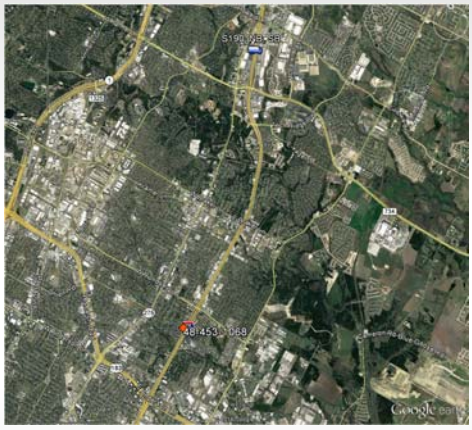

(30.35386, -97.69166)

Traffic data availability

Counts	Hourly
Speeds	N/A
Characterization	N/A

Site information

AQS ID	48-453-1068
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment
Number of lanes	6
AADT	188,150
FE-AADT	350,712
Distance to road	27 m
$PM_{2.5}$ increment*	N/A
$PM_{2.5}$	N/A
$PM_{2.5}$ max. 24-hr	N/A
Annual mean $PM_{2.5}$	N/A
CO max. 1-hr	N/A
NO_2 max. 1-hr	55.3 ppb
Collocated met.	Yes

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"

Richmond, Virginia
I-95 & I-64/I-195

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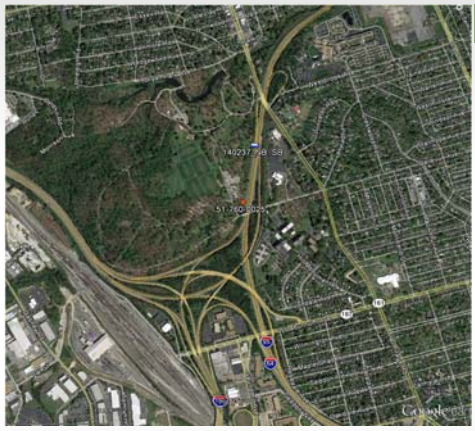

(37.590821, -77.469326)

Traffic data availability

Counts	Hourly
Speeds	Hourly
Characterization	Hourly (FHWA)

Site information

AQS ID	51-760-0025
$PM_{2.5}$ nonattainment	No
TPF	Yes
Road type	Freeway segment
Number of lanes	6
AADT	151,000
FE-AADT	259,720
Distance to road	21 m
$PM_{2.5}$ increment*	2.3 µg/m^3
$PM_{2.5}$	Hourly
$PM_{2.5}$ max. 24-hr	27.8 µg/m^3
Annual mean $PM_{2.5}$	10.1 µg/m^3
CO max. 1-hr	1.2 ppm
NO_2 max. 1-hr	56.5 ppb
Collocated met.	No; RIC is 10 mi away

* Taken from TO3 final report "National Near-Road Data Assessment: Report No. 2 With 2015 Data"