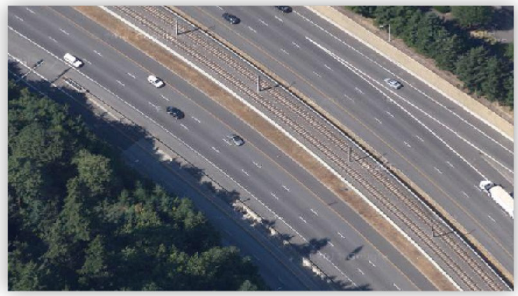
Factors Affecting Estimates of Background Concentration

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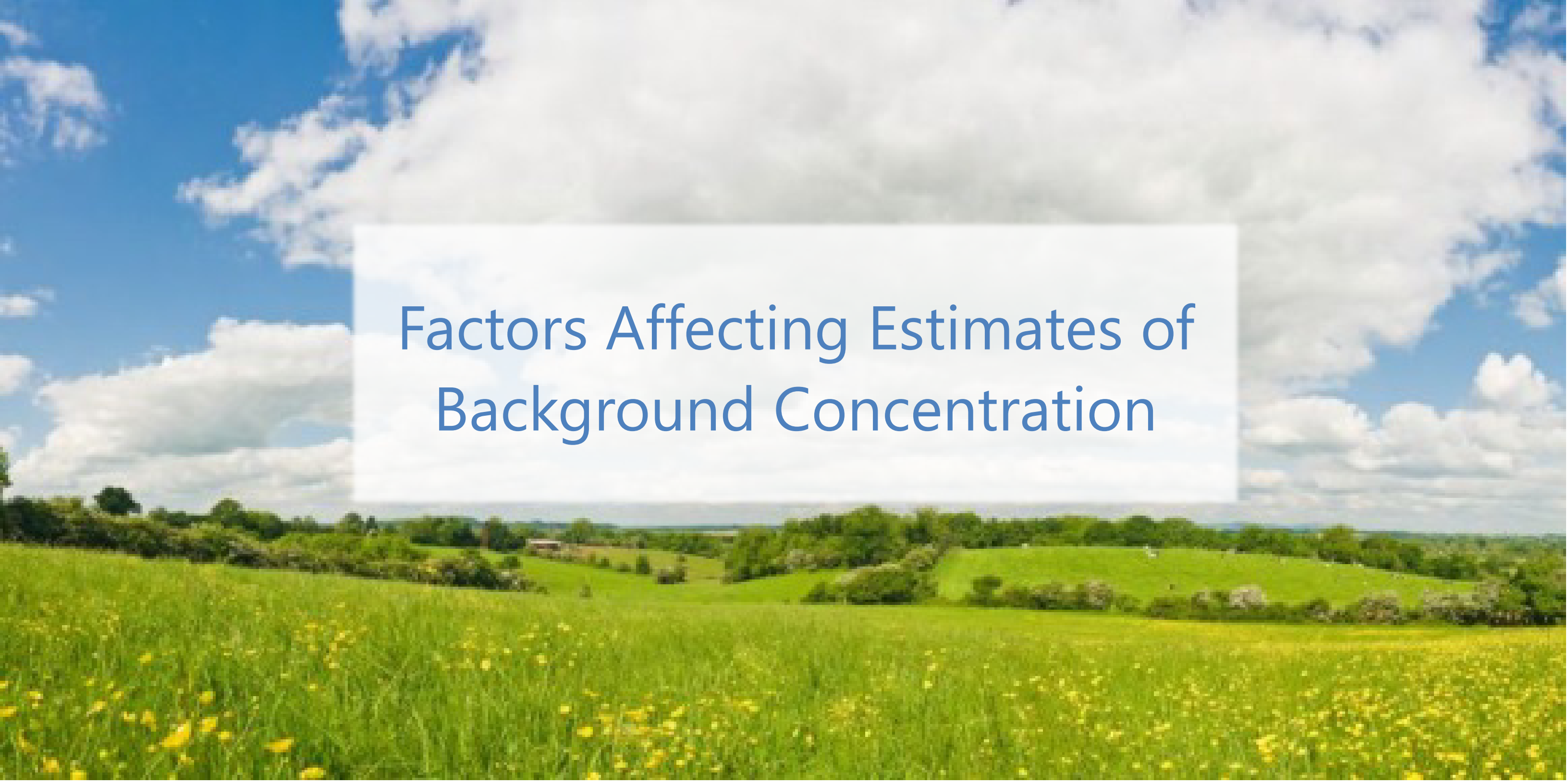

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Abstract

This work was completed as part of the Near-Road Air Quality Research Pooled Fund TPF-5(284), under the U.S. Federal Highway Administration (FHWA) Transportation Pooled Fund Program. The lead agency for TPF-5(284) is the Washington State Department of Transportation (DOT). Other participants that funded this work include FHWA and the Arizona, California, Colorado, Texas, and Virginia Departments of Transportation. Sonoma Technology, Inc., provides TPF-5(284) participants with technical, planning, facilitation, and website support.

Factors Affecting Estimates of Background Concentration

Background. Transportation conformity is required under the U.S. Clean Air Act to ensure that federally funded transportation projects are consistent with (i.e., conform to) the purpose of air quality planning requirements included in state implementation plans (SIPs); conformity requirements apply in air quality nonattainment and maintenance areas. Transportation conformity requires "hot-spot" (i.e., near-road) analyses for carbon monoxide (CO) and particulate matter (PM), including $PM_{2.5}$ and PM_{10}. The pooled fund partnership sponsored this work on background $PM_{2.5}$ concentrations since background $PM_{2.5}$ is a key input to completing quantitative $PM_{2.5}$ hot-spot analyses. A quantitative $PM_{2.5}$ hot-spot analysis involves estimating the contribution of the project to localized $PM_{2.5}$ concentrations in the project area. Contributions of $PM_{2.5}$ that are modeled to result from the project are summed with the estimated background concentration, and compared to the National Ambient Air Quality Standards (NAAQS). The purpose of the work presented in this report is to give transportation project analysts additional information to help them estimate background concentrations when completing a quantitative $PM_{2.5}$ hot-spot analysis.

Methods. A survey of TPF partners and hot-spot modeling practitioners was conducted to better identify and understand the current challenges that are faced when estimating background concentrations for hot-spot analyses. 2015-2017 data from the near-road monitoring network and nearby monitoring sites were analyzed to illustrate how the factors identified in the survey can affect estimates of background concentrations. In addition, case examples of scenarios highlighting key factors were developed to help project analysts understand how those factors can quantitatively contribute to uncertainty in background concentration estimation.

Results. In half of the 45 core-based statistical areas (CBSAs) evaluated in these analyses, the maximum estimated background $PM_{2.5}$ concentration ranged from 25% higher to 200% higher than the minimum estimated background $PM_{2.5}$ concentration, depending on monitor choice; in the other half of CBSAs, background values were more similar (i.e., less than a 25% difference in design value). In general, a larger range is observed across monitors in a CBSA when the 24-hour NAAQS, versus the annual NAAQS, is used. Monitor location classification (rural, suburban, city center) is an important factor influencing background concentration. Many CBSAs cover a large geographic area that can be highly varied in terms of population density, land use, and number and type of emissions sources. Several key factors that can bias background concentration estimates were identified: proximity, prevailing wind patterns, land use characteristics, lack of a single representative monitor, different instrument methods, nonattainment designation status and year, and exceptional-type events. Each of these factors should be evaluated and discussed during interagency consultation.

1. Introduction

1.1 Overview

Clean Air Act (CAA) section 176(c) (42 U.S.C. 7506(c)) mandates that transportation projects that are federally funded will not cause or worsen air quality violations or delay attainment of the National Ambient Air Quality Standards (NAAQS) and therefore must conform to the purpose of the State Implementation Plan (SIP) for air quality (e.g., "transportation conformity"). Conformity requirements are included in the U.S. Environmental Protection Agency (EPA) transportation conformity rule (40 CFR 51.390 and 40 CFR Part 93). The rule requires "hot-spot" (i.e., near-road) analyses for carbon monoxide (CO) and particulate matter (PM), including $PM_{2.5}$ and PM_{10}, for selected transportation projects. PM hot-spot analyses are required for "projects of local air quality concern" (POAQC); EPA has identified projects of concern as certain highway projects that involve significant levels of diesel vehicle traffic and any other project identified in a PM SIP as a POAQC. The pooled fund partnership sponsored this work on background $PM_{2.5}$ concentrations since background $PM_{2.5}$ is a key input to completing quantitative $PM_{2.5}$ hot-spot analyses for POAQC. A quantitative $PM_{2.5}$ hot-spot analysis estimates the contribution of a transportation project to localized $PM_{2.5}$ concentrations in the project area. Contributions of $PM_{2.5}$ that are modeled to result from the project are summed with the estimated background concentration, and compared to the NAAQS.

The purpose of the work presented in this report is to give transportation project analysts additional information to help them estimate background concentrations when completing a quantitative $PM_{2.5}$ hot-spot analysis. The results of the analyses presented in this report can be used during the transportation conformity interagency consultation process to help conformity stakeholders improve $PM_{2.5}$ hot-spot assessments and POAQC determinations.

For the purpose of this study, "background concentration" means the ambient concentration in the vicinity of a transportation project minus the transportation project's contribution. The work presented in this report uses ambient monitoring data to examine important factors for estimating background concentrations. A key focus of this work is to help transportation project analysts select a representative background monitor. The material included here is meant to complement other publicly available resources such as EPA national guidance, *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas*;[1] and a report by the National Cooperative Highway Research Program (NCHRP), Project 25-25 Task 89, *Establishing Representative Background Concentrations for Quantitative Hot-spot Analyses for Particulate Matter*, published in August 2014.[2]

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[1] See Section 8 in https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#pmguidance. As of the completion of this work, the latest version of EPA's guidance was dated November 2015.
[2] See http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3514.

This project consisted of three major tasks. As part of Task 1, TPF partners and other practitioners were surveyed to better identify and understand the current challenges that are faced when estimating background concentrations and conducting hot-spot analyses. As part of Task 2, $PM_{2.5}$ data from the near-road monitoring network and nearby monitoring sites were analyzed to illustrate how the factors identified in the survey can affect background concentration estimation. In addition, case examples were developed to highlight key factors and illustrate how those factors can quantitatively contribute to uncertainty in background concentration estimation. Finally, in Task 3, recommendations and future research needs to reduce uncertainty in background concentration estimation were identified.

Section 1.2 provides a summary of the survey findings; Appendix A provides a comprehensive summary of the survey results. An overview of the technical approach used to perform Task 2 is provided in Section 2. Sections 3 and 4 report the results and examples from Task 2. Finally, recommendations to reduce uncertainty are provided in Section 5.

1.2 Survey Findings

During August-October 2018, TPF partners and hot-spot modeling practitioners were asked the following four questions about the challenges faced when estimating background concentrations as part of $PM_{2.5}$ hot-spot analyses.

1. How well is the current analysis process working?
2. What key challenges are you encountering?
3. What uncertainties result from existing processes?
4. What improvements do you recommend?

Responses were provided by the EPA, the U.S. Federal Highway Administration (FHWA), as well as the Arizona, California, Colorado, and Virginia State Departments of Transportation. STI and the Texas Transportation Institute (TTI) also contributed responses to the survey. **Table 1** provides a digest of the most important factors identified as contributing to uncertainty in background estimation. Factors are listed in approximate order of importance, based on survey results. Two of the top concerns identified in the survey—the representativeness of available monitors for project sites and the representation of future background concentrations—are further explored in Tasks 2 and 3 of this project.

A third important concern related to the inclusion of "Exceptional-type" events was addressed by STI during prior NCHRP work (Pasch et al., 2014). In addition, in September 2018, EPA released updated guidance to address frequently asked questions regarding the handling of exceptional events.[3] The Recommendations section of this report includes brief considerations on exceptional and exceptional-type events. Appendix A provides a detailed summary of all the survey responses.

[3] EPA guidance is available at https://www.epa.gov/sites/production/files/2018-10/documents/updated_faqs_for_exceptional_events_final_september_2018.pdf.

Table 1. Key background concentration uncertainty factors named by survey respondents.

Factors Contributing to Background Uncertainty	Importance: Low, Medium, High	Discussion
Factors Ranked Highest in Importance		
Representativeness of available monitors for project sites	High, based on number of respondents raising issue and rankings provided	The number of monitors available in a given area varies. For example, the SCAQMD operates 25 $PM_{2.5}$ and 24 PM_{10} monitors in the greater Los Angeles region;[4] the Maricopa County Air Quality Department operates 10 $PM_{2.5}$ and 17 PM_{10} monitors in the greater Phoenix region;[5] and the Colorado Department of Public Health operates 17 $PM_{2.5}$ and 14 PM_{10} monitors throughout the entire state.[6] Respondents noted several challenges representing $PM_{2.5}$ concentrations at a project site: data from monitors distant from the project site, deciding whether to interpolate among several monitors, selecting multiple monitors to represent a project spanning a large geographic area, and achieving interagency consensus over monitor selection and data interpretation. The overall impact from this factor is High.
Representation of future background concentrations	High, based on number of respondents raising issue and rankings provided	Background concentration estimates based on historic measured concentration data represent conditions that have already occurred. In contrast, project hot-spot analyses must forecast future conditions by modeling incremental project impacts and adding those impacts to predicted future-year background concentrations. Unadjusted use of historic concentrations to represent future years does not account for emissions and concentration changes over time. In areas making steady progress toward meeting and maintaining achievement of the NAAQS, unadjusted use of historic concentrations may over-estimate background.
"Exceptional-type" events (ETEs) (concentrations lower than the NAAQS)	High, based on number of respondents raising issue and rankings provided	EPA allows for removal of "exceptional event" data (e.g., fire-related $PM_{2.5}$ impacts) from concentrations used to assess attainment, for events that exceed the NAAQS. However, the EPA process is not set up to remove event data when concentrations are below the NAAQS ("exceptional-type events"), even though those data can affect background calculations. The overall impact varies from Low to High, depending on the presence and severity of exceptional events.

[4] See Table 1 in the 2018 SCAQMD Annual Air Quality Monitoring Network Plan, available at http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-monitoring-network-plan/annual-air-quality-monitoring-network-plan-v2.pdf.

[5] See Figure 6 in the 2016 Air Monitoring Network Plan available at https://www.epa.gov/sites/production/files/2017-10/documents/azplan2017-maricopacounty.pdf.

[6] See https://www.colorado.gov/airquality/report.aspx.

Factors Contributing to Background Uncertainty	Importance: Low, Medium, High	Discussion
Other Factors Rated Highly by Respondents		
Estimation of fugitive dust impacts on background may need revised analysis approaches	High for one respondent, but mentioned as an issue by others	There is concern that some new analysis approaches or considerations may be needed when considering fugitive dust and its relationship to PM_{10} background. Issues raised include the different dust impacts that might be experienced at background monitoring sites vs. project sites, as well as the importance of properly accounting for the more rapid deposition of PM_{10} particles compared to $PM_{2.5}$ particles.
Areas affected by pollutant transport	High for one respondent	There is concern that in areas experiencing overwhelming transport of pollution from outside the region, more flexibility should be available to address project analyses since background concentrations will be calculated as being high at the project site.
Lack of proactive efforts to anticipate data needs	High for one respondent	It may be possible, for some upcoming projects, to anticipate that there will be a lack of available background data, or that the process needed to assess background will be difficult given the complexity of interpreting data from the available monitors. For cases such as those, there is interest in encouraging project sponsors to proactively anticipate data gaps and data analysis issues, and taking preemptive action to either collect data or build consensus over how to interpret the data that are available.[7]
Not correctly following interagency consultation procedures	High for one respondent	EPA feedback emphasized the importance of EPA and state and local air agency involvement in the interagency consultation process as a method of resolving issues.

[7] Emerging sensor technologies may also offer a cost-effective option for evaluating concentrations at the project site. Recent work suggests that high-time-resolution measurements from small sensors can be used to distinguish the background $PM_{2.5}$ relative to the $PM_{2.5}$ from traffic in environments dominated by mobile sources (Kecorius et al., 2017). Low-cost $PM_{2.5}$ sensors are rapidly evolving and could be considered in place of expensive instrumentation for performing monitoring; data and information from sensors could provide information for interagency consultation.

2. Methods

As described in the EPA National Guidance,[8] $PM_{2.5}$ background concentrations can be estimated in one of four ways:

1. Using ambient monitoring data from a single monitor
2. Interpolating ambient monitoring data from multiple monitors
3. Using Chemical Transport Models (CTM) to estimate future-year background concentrations
4. Adjusting air quality monitoring data to account for future changes in air quality: using an on-road mobile source adjustment factor

Other options can also be considered and discussed with EPA during interagency consultation.[9] As part of Task 2, data from the near-road monitoring network and nearby monitoring sites were analyzed in order to illustrate how the factors identified in the survey can affect background concentration estimation based on ambient data from a single monitor. The survey participants identified the uncertainty introduced by the choice of the background monitor (or monitors) as the highest-priority concern, since an incorrectly selected monitor can bias estimated background concentrations at the project site to be higher or lower than actual background concentrations. In order to illustrate this challenge, STI assessed the range of $PM_{2.5}$ concentrations measured at monitors within each of the metropolitan areas for which a $PM_{2.5}$ near-road monitor was operational in 2017. The results provide quantitative bounds for how much uncertainty can be introduced by the incorrect selection of a background monitor.

$PM_{2.5}$ hot-spot analyses are performed by estimating both the 24-hour and annual forms of the $PM_{2.5}$ NAAQS (also referred to as "design values").[10] Both forms are calculated by using three years of measurements. Therefore, we obtained annual summary data for the years 2015-2017 from the EPA Air Data web portal. The annual summary data set includes annual means calculated using both forms of the standard. From this dataset, the three-year average was calculated; only complete annual and three-year aggregates were included in subsequent analyses. Data that were categorized by EPA as resulting from exceptional events were excluded from the annual and three-year aggregates. Using these results, STI performed the following analyses.

- **Three-year average annual mean.** We evaluated the range of three-year average annual mean data across $PM_{2.5}$ monitors in each metropolitan area with a near-road monitor in 2017. For example, assume Metropolitan Area A has four $PM_{2.5}$ monitors. For Area A, we calculated the three-year average of the annual means for each monitor using data from 2015-2017. We then developed graphics to display the range across all monitors in Area A, in order to help

[8] See Section 8 in https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#pmguidance.
[9] See Section 8.3, p. 121, in the EPA guidance: "Additional options for background concentrations can be considered by the EPA Regional Office, OTAQ, and OAQPS."
[10] See https://www.epa.gov/criteria-air-pollutants/naaqs-table.

project analysts quantitatively understand the potential impact of incorrectly selecting the monitor(s) to represent background concentrations at their project site.

- **Three-year average of 98th percentile of 24-hr mean.** To complement the annual average data from the first analysis, we also calculated the three-year average of the 98th percentile of daily mean data for each monitor in the metropolitan areas that had an operational near-road $PM_{2.5}$ monitor in 2017. We then developed graphics to display the range across all monitors in each metropolitan area.
- **Nearest monitor comparison.** Finally, for each metropolitan area in which a $PM_{2.5}$ near-road monitor was operational in 2017, we evaluated the differences in three-year average annual means between monitor pairs by subtracting the value at the nearby monitor from the value at the near-road monitor. The point of this analysis is to illustrate the potential uncertainty or bias that could be introduced into a background concentration calculation by selecting a monitor *near* the "correct" representative monitor, rather than the correct representative monitor itself. We note that the increments calculated as part of this analysis may differ from previously reported results because they are calculated using three-year mean data, rather than daily data.

The failure to incorporate potential future-year concentrations when implementation of the SIP is expected to reduce $PM_{2.5}$ was identified as the second priority concern in the survey, since this failure could lead to biases in the $PM_{2.5}$ hot-spot analysis. STI's background $PM_{2.5}$ concentration work under NCHRP indicates that EPA-approved, forecasted $PM_{2.5}$ concentrations are not widely available. However, the presumption under the Clean Air Act is that areas will attain the NAAQS by the required deadline. For metropolitan areas where $PM_{2.5}$ near-road monitors were operating in 2017, we developed a table that shows attainment year, and nonattainment or maintenance status. We used that information to quantitatively establish the uncertainty that can be introduced into the future-year background concentration estimation effort if changes in concentration over time are not weighed. For example, if Metropolitan Area B is a "moderate" $PM_{2.5}$ nonattainment area under the 2012 $PM_{2.5}$ NAAQS, it has an attainment date requirement of December 2021, and is presumed to be on track to achieve annualized background concentrations less than or equal to 12 µg/m^3 by the attainment date. Assume, as an illustration, that in 2016 the three-year average of annual average $PM_{2.5}$ concentrations was 13 µg/m^3 at a monitor selected to represent background for a proposed project in Metropolitan Area B. By documenting the attainment milestone date (≤12 µg/m^3 by December 2021) and comparing that information to the 2016 data (13 µg/m^3), we will help project analysts quantitatively understand potential uncertainty with future-year background calculations.

3. Results

3.1 Range in Design Values by Metropolitan Area

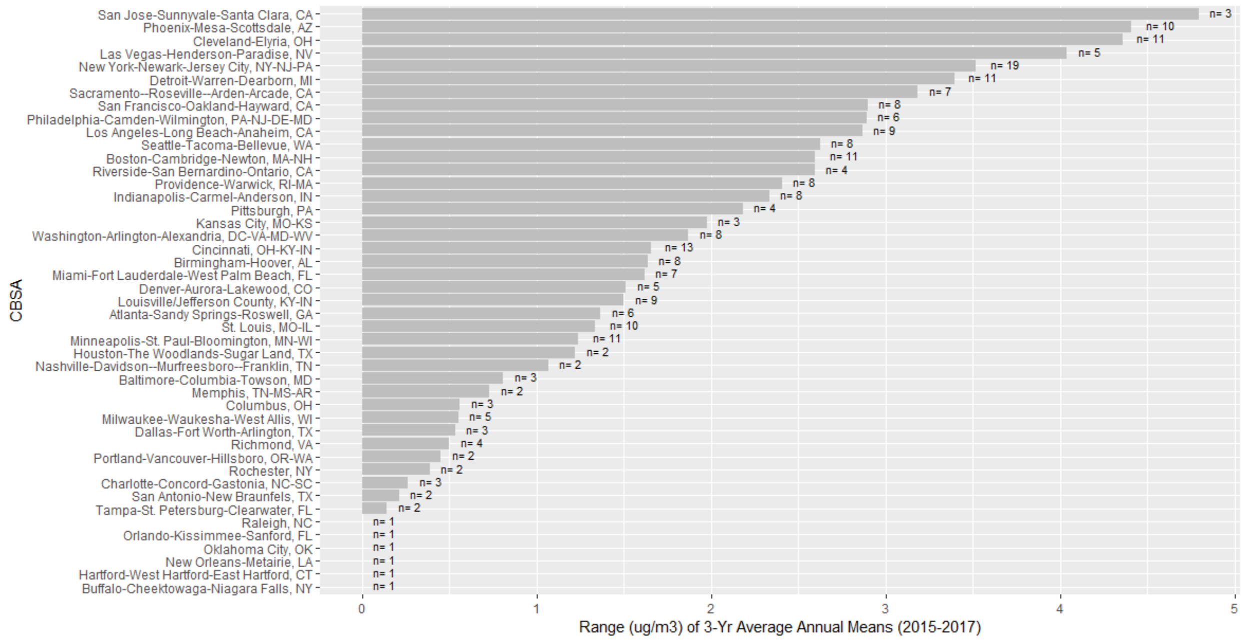
Overall, 45 core-based statistical areas (CBSAs) were evaluated in these analyses. As shown in **Figure 1**, in half of the CBSAs, the maximum estimated background concentration, using either the three-year average of annual means or three-year average of 98th percentiles of daily means, could be from 25% higher to 200% higher than the minimum estimated background concentration, depending on monitor choice. In the other half of CBSAs, monitor choice results in a more similar background value (i.e., less than a 25% difference in design value).

The number of monitors in a CBSA is not on its own an indicator of the potential range of background concentration values that might be available for use. However, as shown in **Figure 2**, monitor location classification (rural, suburban, city center) is an important factor. Design values at rural monitors are typically lower than the CBSA-wide mean; suburban or city center monitors are typically equal to or greater than the CBSA-wide mean. Many CBSAs cover a large geographic area that can be highly varied in terms of population density, land use, and number and type of emissions sources. For example, the CBSA with the largest range of background values (4.8 $\mu g/m^3$) based on the annual metric is San Jose-Sunnyvale-Santa Clara. This CBSA includes Santa Clara and San Benito counties and stretches from the densely populated Silicon Valley cities of Sunnyvale, Santa Clara, and San Jose to the smaller towns of Gilroy and Hollister. Monitors are sited in San Jose (3-yr mean is 9.3 $\mu g/m^3$), Gilroy (3-yr mean is 6.1 $\mu g/m^3$), and Hollister (3-yr mean is 4.5 $\mu g/m^3$), with a distance of approximately 46 miles (74 km) between the San Jose monitor and the Hollister monitor.

Similarly, the Phoenix-Mesa-Scottsdale CBSA includes both Maricopa and Pinal counties, a geographic extent of more than 14,500 square miles. For the annual form of the $PM_{2.5}$ NAAQS, we report a range of 4.4 $\mu g/m^3$ across the ten monitors in the area. Most of the monitors are located within the more populated areas of Phoenix, Mesa, Scottsdale, and Glendale, where a smaller range of 2.8 $\mu g/m^3$ is observed in the annual design values (6.8-9.6 $\mu g/m^3$). However, one monitor (04-021-3002) at the base of the Tonto National Forest is approximately 30 miles east of the more populated areas, with a 3-year average annual mean of only 5.2 $\mu g/m^3$. Also of note, one of the monitors in this CBSA (04-013-9997) has two collocated instruments that report 3-year average annual means of 8.1 and 7.0, which is a difference of over 1 $\mu g/m^3$ for two instruments located at the same location. This difference can likely be attributed to differences in the measurement methodology.

In general, a larger range is observed across monitors in a CBSA when the 24-hour metric is used. This result is expected given the greater variability in 98th percentile values compared to annual mean values. The largest range is observed in the Seattle-Tacoma-Bellevue, Washington, CBSA (range of 28.1 $\mu g/m^3$ across eight monitors). The range is smaller (14 $\mu g/m^3$) across most monitors in this

CBSA. However, data for one of the monitors (53-053-0029), with a 3-year 24-hour design value of 48 μg/m^3, indicate that an exceptional event contributed to the elevated concentrations on three days in 2015. The exceptional event was not concurred by EPA, however.



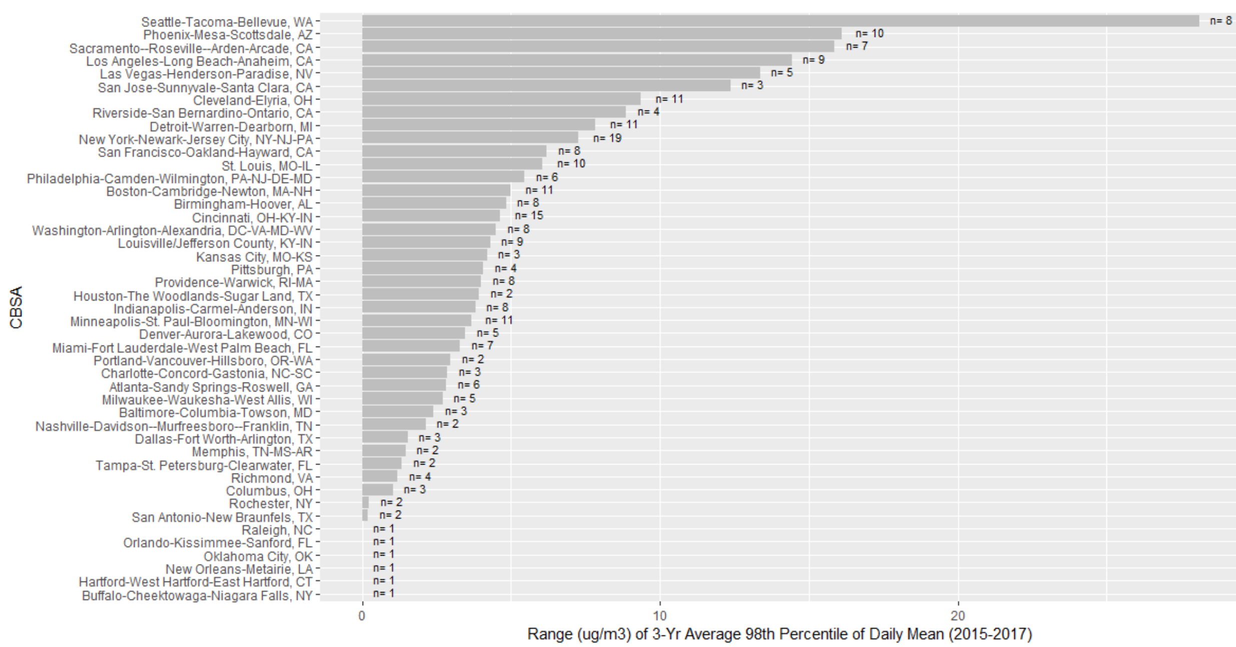


Figure 1. Range of 3-year average annual mean (top) and range of 3-year average of the 98th percentile of daily mean (bottom) across monitors, by CBSA area; "n" indicates the number of monitors in each CBSA (excluding the near-road monitor).

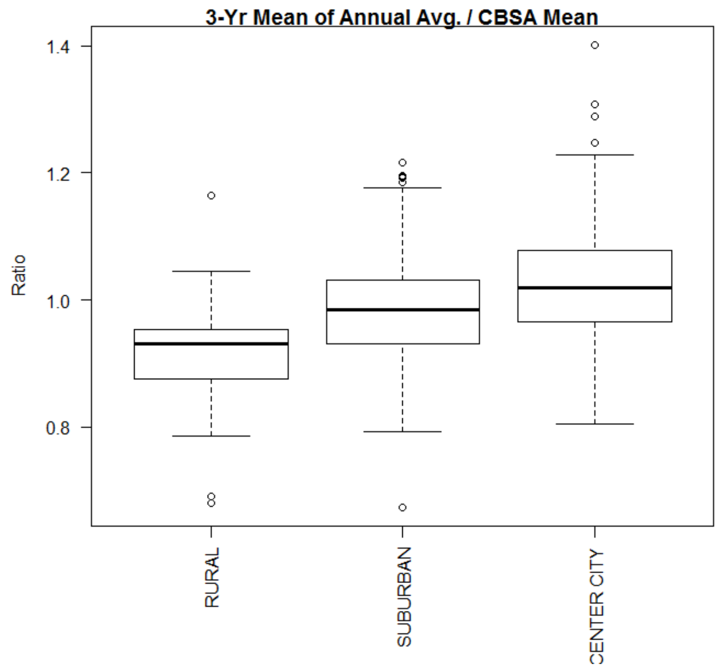


Figure 2. Ratio of three-year average annual means, by location type, to overall CBSA mean in the CBSA area.

3.2 Nearby-Monitor-Pairs Analysis

As discussed in Section 1.2, the survey participants identified the uncertainty introduced by the choice of the background monitor (or monitors) as their highest-priority concern, since an incorrectly selected monitor can bias estimated background concentrations at the project site to be higher or lower than actual background concentrations. STI conducted a nearby-monitor-pairs analysis in order to assess the range of potential increments that would be calculated using the $PM_{2.5}$ concentrations measured at monitors within each of the metropolitan areas where a $PM_{2.5}$ near-road monitor was operational in 2017. The results provide quantitative bounds for how much uncertainty can be introduced by the incorrect selection of a background monitor.

Figure 3 provides the results of the nearby-monitor-pairs analysis that was conducted for 20 near-road monitors that had three years of complete $PM_{2.5}$ data, using three-year average annual mean data for complete pairs. The increment across pairs ranged from -2.5 µg/m^3 to 5 µg/m^3. A negative increment implies that if the background were estimated using that nearby monitor, it would overestimate true background concentrations at the specific near-road location. In general, increments increased (positively or negatively) with greater distance between monitor pairs. The largest range in increments was observed for the San Jose-Sunnyvale-Santa Clara metropolitan area (06-085-0006), where the largest increment (4.9 µg/m^3) was observed between the near-road monitor in San Jose and the rural residential monitor in Hollister, more than 50 km away. A large range in increments was also observed in the Detroit-Warren-Dearborn, Michigan, metropolitan area

(26-163-0095), where many of the nearby monitors were 20-50 km away from the near-road monitoring site.

Also shown in Figure 3 are the increments between the near-road monitor and the nearest upwind monitor. EPA recommends that background concentrations be estimated using the data from the nearest upwind monitor, if such a monitor is available nearby and not in an environment with other emissions sources that are different from those in the project area. Seven near-road monitors with a nearby upwind monitor were available for evaluation; upwind monitors were not available for the other near-road locations due to either the absence of an upwind monitor or incomplete data. Of these pairs, most increments were smaller than if the increment had been calculated using another monitor in the CBSA. For the two near-road monitors collocated in Denver (08-031-0027, POC 1 and POC 3), using the nearest upwind monitor would result in the lowest estimate of background, and thus the largest calculated increment. However, in these two locations, the “nearest” upwind monitor was 10-20 km away.

In addition to confirming the significance of monitor selection, this analysis supports several key considerations practitioners can weigh during interagency consultation regarding monitor selection. First, the distance between the monitor and the project area is an important indicator of potential differences in environments between the two locations. Monitors farther from the project area might have different land use characteristics than the project area, especially if the monitor(s) are located outside the urban core where the project will occur. Second, a predominant wind direction may not be identified because of a lack of available meteorological monitors relative to the project area, a lack of data completeness, or the environment of the project area itself. Additional factors for consideration and discussion during interagency consultation are further discussed in the remainder of this report.

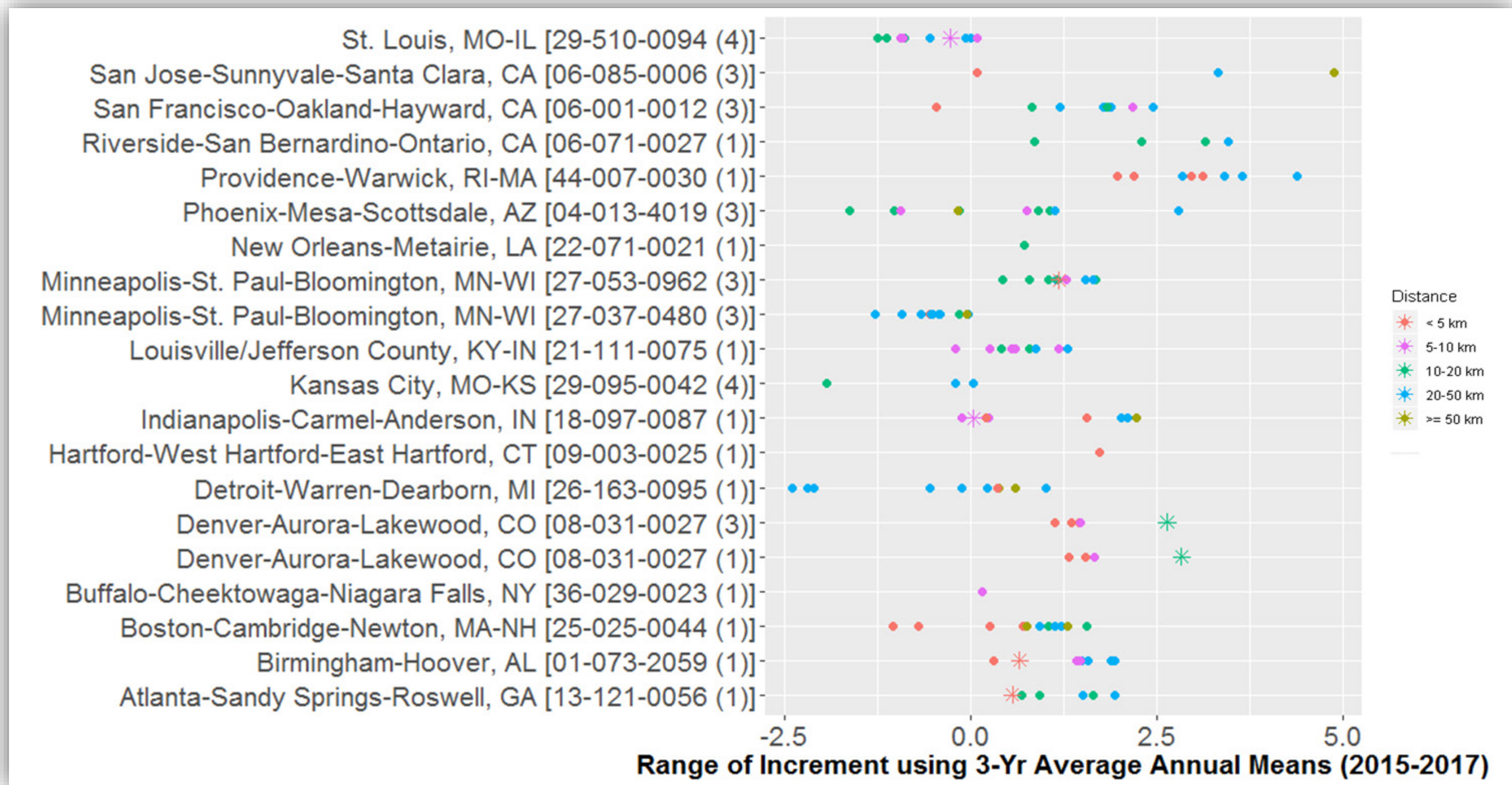


Figure 3. Increment between the 3-year average annual mean at the near-road monitor (y-axis) and each nearby monitor within the CBSA. The colors indicate the distance between each nearby monitor and the near-road monitor. The asterisk indicates the nearest upwind monitor to the near-road monitor, for the seven locations where prevailing winds could be used to establish an upwind site.

3.3 Future-Year Concentrations

At the time this work was completed (2019), nine U.S. areas were classified as nonattainment or maintenance for $PM_{2.5}$ based on the 2012 annual standard (12 μg/m^3). Six of the nine areas contained a near-road monitor in 2017 (**Table 2**), and all of those areas were classified as moderate nonattainment. For some areas, the 2015-2017 Annual Design Value was below the NAAQS, although the area's official designation had not yet been updated to maintenance or attainment.

Depending on the timeline for the project, the attainment status for the project area, and the relationship of the years to be modeled for the conformity analysis to the attainment deadlines, it may be appropriate to account for future changes in the estimate of the background. As specified by EPA guidance, estimates of future-year background concentrations can be developed using Chemical Transport Models (CTM) combined with ambient concentrations, if model outputs are available for areas with monitoring sites considered for estimating background.[11] However, CTM-based projections of future-year $PM_{2.5}$ concentrations are not available for all areas, and project analysts would benefit by having other analysis approaches available to estimate how background $PM_{2.5}$ concentrations will change over time. In this discussion, we introduce quantitative information regarding future-year attainment requirements to give conformity stakeholders material that may help with interagency consultation regarding future-year $PM_{2.5}$ background concentrations. In addition to the material presented here, the pooled fund research team also separately completed analyses to quantify the impact of fleet turnover on $PM_{2.5}$ exhaust emissions, and that material is available to assist with interagency consultation on future-year conditions.[12]

In this discussion, we assume that if an area is required under the Clean Air Act to attain the $PM_{2.5}$ NAAQS by a certain date, and that area is making reasonable progress toward meeting its $PM_{2.5}$ attainment deadline, then interagency consultation participants may determine it is appropriate to assume that the background $PM_{2.5}$ concentration will be no greater than the NAAQS by the area's attainment date. Alternatively, if an area has already passed its attainment date, but interagency consultation partners can establish a date by which attainment is anticipated, that information could inform discussion of background $PM_{2.5}$ concentrations. For example, assume "current" $PM_{2.5}$ concentrations are above the NAAQS, and the area is making progress towards attainment; interagency consultation could deem it appropriate to assume a linear reduction in background concentrations between "current" conditions and the attainment date. Alternatively, depending on when control programs are implemented to meet attainment, a step-wise scaling approach may be used that more appropriately connects expected background $PM_{2.5}$ concentration changes to control program implementation milestones. Regardless, the concept behind the material in this discussion is that interagency consultation partners can develop an appropriate scaling method to systematically

[11] See Section 8.3.2 of EPA's *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas*.

[12] Work documenting fleet turnover impacts was previously published under pooled fund sponsorship; see Reid (2016).

adjust future-year $PM_{2.5}$ concentrations based on the difference between current-year data and the milestone year when NAAQS attainment is expected.

Table 2 summarizes the current (as of 2018) nonattainment areas for the 2012 $PM_{2.5}$ annual standard (12 μg/m^3) as well as the near-road monitors in those areas, attainment deadlines, and percent reduction needed from current concentrations to reach the NAAQS level. The required attainment deadline for all nonattainment areas violating the 2012 annual standard is 2021 (six years after the promulgation of the standard and area designations in 2015).[13] By 2021, areas in nonattainment as of 2015-2017 are required to reduce background $PM_{2.5}$ concentrations to no more than the NAAQS. Needed concentration reductions to achieve the 2021 attainment deadline vary by region; for example, Allegheny County, Pennsylvania, requires an 8% reduction in concentrations, while the San Joaquin Valley in California requires an 85% reduction in concentrations.

Table 3 summarizes the current (as of 2018) nonattainment or maintenance areas for the 2006 $PM_{2.5}$ 24-hour standard (35 μg/m^3) as well as the near-road monitors in those areas, attainment deadlines, and percent reduction from current concentrations to the NAAQS level. The attainment deadline for moderate nonattainment areas was December 2015, while the attainment deadline for serious nonattainment areas is December 2019;[14] the attainment deadlines in Table 3 for moderate nonattainment areas may no longer be accurate for areas that did not reach attainment by the deadline. For some areas, the 2015-2017 24-hour Design Value is below the NAAQS, but the official designation has not yet been updated to maintenance or attainment.

Interagency consultation participants could use the data in Tables 2 and 3 to discuss rates of reasonable further progress toward attainment, and estimation of background $PM_{2.5}$. For example, Allegheny County had a 2015-2017 annual $PM_{2.5}$ design value of 13 μg/m^3, with a requirement to attain 12 μg/m^3 by 2021. If interagency consultation determined that Allegheny County was on track to meet attainment, transportation project analyses could use 12 μg/m^3 as the assumed background concentration for project-level analysis years of 2021 or later, even in the absence of CTM-based data.

The material presented here does not assess the rate of progress or the ability of individual areas to reach attainment. Those factors are best addressed during interagency consultation; however, the material included here can inform interagency discussion about how to employ the NAAQS deadline, paired with a local understanding of rate of progress toward attainment, as a potential method of refining future-year background concentration estimates.

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[13] See https://www.epa.gov/sites/production/files/2016-08/documents/pm25-sip-requirements-rule-webinar-august-16-2016.pdf.
[14] See https://www.epa.gov/pm-pollution/fine-particulate-naaqs-implementation-milestones.

Table 2. Nonattainment areas based on the 2012 annual $PM_{2.5}$ NAAQS; six of these areas had a near-road monitor in 2017.

Near-Road Monitor				Nonattainment Area			
CBSA	City	AQS Code	Target Road	Nonattainment Area	Attainment Deadline	2015-2017 Annual Design Value (µg/m^3)[15]	% Above Annual Standard
Pittsburgh, PA	Wilkinsburg	42-003-1376	I-376	Allegheny County, PA	2021	13.0	8.3
Los Angeles-Long Beach-Anaheim, CA	Anaheim	06-059-0008	I-5	Los Angeles-South Coast Air Basin, CA	2021	14.7	22.5
Riverside-San Bernardino-Ontario, CA	Ontario	06-071-0026	I-10	Los Angeles-South Coast Air Basin, CA	2021	14.7	22.5
Fresno, CA	Fresno	06-019-2016	CA 99	San Joaquin Valley Air Basin, CA	2021	22.2	85.0
Bakersfield, CA	Bakersfield	Unknown*	CA 99	San Joaquin Valley Air Basin, CA	2021	22.2	85.0
Cleveland-Elyria, OH	Cleveland	39-035-0073	I-271	Cleveland, OH	2021	11.7	-2.5
Nonattainment Areas where a near-road monitor was not located in 2017							
				Delaware County, PA	2021	10.3	-14.2
				Imperial County, CA	2021	12.0	0.0
				Lebanon County, PA	2021	10.1	-15.8
				Plumas County, CA	2021	15.1	25.8
				West Silver Valley, ID	2021	12.4	3.3

*The Bakersfield near-road monitor is planned but not yet operational.

15 https://www.epa.gov/air-trends/air-quality-design-values#report.

Table 3. Nonattainment areas based on the 2006 24-hour $PM_{2.5}$ NAAQS; 18 areas had a near-road monitor in 2017.

Near-Road Monitor				Nonattainment Area				
CBSA	City	AQS Code	Target Road	Nonattainment Area	Attainment Deadline	Designation Status	2015-2017 24-Hour Design Value (μg/m3)[16]	% Above 24-Hour Standard
Birmingham-Hoover, AL	Birmingham	01-073-2059	I-20	Birmingham, AL	2015	Maintenance	22	-37.1
Cleveland-Elyria, OH	Cleveland	39-035-0073	I-271	Cleveland-Akron-Lorain, OH	2015	Maintenance	25	-28.6
Detroit-Warren-Dearborn, MI	Detroit	26-163-0093	I-96	Detroit-Ann Arbor, MI	2015	Maintenance	28	-20.0
Detroit-Warren-Dearborn, MI	Livonia	26-163-0095	I-275	Detroit-Ann Arbor, MI	2015	Maintenance	28	-20.0
Fresno, CA	Fresno	06-019-2016	CA 99	San Joaquin Valley, CA	2019	Nonattainment	72	105.7
Bakersfield, CA	Bakersfield	Unknown*	CA 99	San Joaquin Valley, CA	2019	Nonattainment	72	105.7
Los Angeles-Long Beach-Anaheim, CA	Anaheim	06-059-0008	I-5	Los Angeles-South Coast Air Basin, CA	2019	Nonattainment	39	11.4
Riverside-San Bernardino-Ontario, CA	Ontario	06-071-0026	I-10	Los Angeles-South Coast Air Basin, CA	2019	Nonattainment	39	11.4
Milwaukee-Waukesha-West Allis, WI	Milwaukee	55-079-0056	I-94	Milwaukee-Racine, WI	2015	Maintenance	22	-37.1
New York-Newark-Jersey City, NY-NJ-PA	Fort Lee	34-003-0010	I-95/ US 1	New York-N. New Jersey-Long Island, NY-NJ-CT	2015	Maintenance	23	-34.3

*The Bakersfield near-road monitor is planned but not yet operational

[16] https://www.epa.gov/air-trends/air-quality-design-values#report

Near-Road Monitor				Nonattainment Area				
CBSA	City	AQS Code	Target Road	Nonattainment Area	Attainment Deadline	Designation Status	2015-2017 24-Hour Design Value (µg/m3)[16]	% Above 24-Hour Standard
New York-Newark-Jersey City, NY-NJ-PA	Queens	36-081-0125	I-495 (L.I.E.)	New York-N. New Jersey-Long Island, NY-NJ-CT	2015	Maintenance	23	-34.3
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Philadelphia	42-101-0075	I-95	Philadelphia-Wilmington, PA-NJ-DE	2015	Maintenance	25	-28.6
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Philadelphia	42-101-0076	I-76	Philadelphia-Wilmington, PA-NJ-DE	2015	Maintenance	25	-28.6
Pittsburgh, PA	Wilkinsburg	42-003-1376	I-376	Pittsburgh-Beaver Valley, PA	2015	Maintenance	24	-31.4
Sacramento--Roseville--Arden-Arcade, CA	Sacramento	06-067-0015	I-5	Sacramento, CA	2015	Nonattainment	34	-2.9
San Francisco-Oakland-Hayward, CA	Oakland	06-001-0012	I-880	San Francisco Bay Area, CA	2015	Nonattainment	35	0.0
San Francisco-Oakland-Hayward, CA	Berkeley	06-001-0013	I-80	San Francisco Bay Area, CA	2015	Nonattainment	35	0.0
San Jose-Sunnyvale-Santa Clara, CA	San Jose	06-085-0006	US 101	San Francisco Bay Area, CA	2015	Nonattainment	35	0.0
Nonattainment Areas where a near-road monitor was not located in 2017								
				Allentown, PA	2015	Maintenance	24	-31.4
				Canton-Massillon, OH	2015	Maintenance	22	-37.1

Near-Road Monitor				Nonattainment Area				
CBSA	City	AQS Code	Target Road	Nonattainment Area	Attainment Deadline	Designation Status	2015-2017 24-Hour Design Value (µg/m3)[16]	% Above 24-Hour Standard
				Charleston, WV	2015	Maintenance	17	-51.4
				Chico, CA	2015	Nonattainment	28	-20.0
				Fairbanks, AK	2019	Nonattainment	85	142.9
				Harrisburg-Lebanon-Carlisle-York, PA	2015	Maintenance	30	-14.3
				Imperial County, CA	2015	Nonattainment	31	-11.4
				Johnstown, PA	2015	Maintenance	25	-28.6
				Klamath Falls, OR	2015	Nonattainment	36	2.9
				Knoxville-Sevierville-La Follette, TN	2015	Maintenance	34	-2.9
				Lancaster, PA	2015	Maintenance	28	-20.0
				Liberty-Clairton, PA	2015	Nonattainment	37	5.7
				Logan, UT-ID	2015	Nonattainment	33	-5.7
				Nogales, AZ	2015	Nonattainment	28	-20.0
				Oakridge, OR	2015	Nonattainment	46	31.4
				Provo, UT	2019	Nonattainment	31	-11.4
				Salt Lake City, UT	2019	Nonattainment	37	5.7
				Steubenville-Weirton, OH-WV	2015	Maintenance	25	-28.6
				Tacoma, WA	2015	Maintenance	31	-11.4
				West Central Pinal, AZ	2015	Nonattainment	32	-8.6
				Yuba City-Marysville, CA	2015	Maintenance	28	-20.0

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4. Case Examples

The following three examples draw upon the real cases identified in Section 3. The ambient monitoring data and nonattainment designations from these cases were used to show how uncertainty can be introduced into estimates of background concentrations. Each example provides a generalized model for scenarios that could occur during actual projects.

Example #1: Project area is not located in the urban core or is located between two candidate monitoring locations

This example is based on the metropolitan area encompassing San Jose-Santa Clara-Sunnyvale, California (described in Section 3.1). **Figure 4** shows three monitors (green dots) and a near-road monitor (yellow dot) located in this CBSA. One monitor in San Jose is classified as a commercial location in the urban/city center. A monitor in Gilroy is classified as a residential/suburban location, and a monitor by California State Route 25 in Hollister (south of Gilroy) is classified as a residential/rural location. Based on the three-year average of annual mean data for each monitor, there is a difference of 4.8 $\mu g/m^3$ between the monitor in the urban core and the monitor in Hollister.

Also shown are two potential transportation project locations (red stars). The monitor nearest to Project 1 is in Gilroy. Hypothetically, if the monitor in Gilroy were not available, then the monitor in either San Jose or Hollister could be used. However, because of differences in emissions and land use classifications, this change could result in a 52% overestimate (San Jose) or 26% underestimate (Hollister) of the true background concentration in Gilroy. Project 2 is located between the monitor in San Jose and the monitor in Gilroy. In this case, an interpolation using a distance-weighted methodology may be most appropriate to estimate the background in the project area by weighting the concentrations from both the San Jose and Gilroy monitors; the result of a distance-weighted interpolation method for this project location is 8.1 $\mu g/m^3$.

Note that for simplification purposes, this illustration ignores prevailing wind direction in order to demonstrate, quantitatively, how monitor choice can affect background concentration estimation. Example #2 addresses prevailing wind patterns in monitor selection.

Figure 4. Illustration of ambient monitors (green dots) and potential project areas (red stars) in the San Jose-Santa Clara-Sunnyvale metropolitan area in California; three-year average annual mean values are reported for each monitor.

Example #2: Project area is near multiple monitors, but only one is representative of upwind concentrations

This example is based on the Indianapolis-Carmel-Anderson metropolitan area in Indiana. As shown in Figure 5, five nearby monitors are located within 5 miles of the near-road monitoring location. If a hypothetical project were to be conducted at the near-road monitoring location, each nearby monitor could be evaluated and considered for estimating the background concentrations at the project site. Two monitors are closest to the potential project site: one monitor to the northeast is approximately 1.8 miles away, with a three-year average annual mean concentration of 8.9 µg/m^3, while the other is approximately one mile to the southeast, with a three-year average annual mean concentration of 10.2 µg/m^3. Both monitors are located in residential areas similar to the project site. If the first monitor were used to estimate the background concentration at the near-road location, the resulting increment would be 1.5 µg/m^3, a 16% increase over the background. If the second monitor were used to estimate the background concentration at the near-road location, the resulting increment would be 0.2 μg/m^3, a 2% increase over the background. However, as shown in the figure inset, the predominant wind direction for this area is from the west-southwest. Therefore, the other two monitors in the area should also be considered. The monitor southwest of the site is in an industrial area and therefore may not be representative. However, the monitor located due west may be considered representative of background, as it is located in the direction that is frequently upwind of the project site and, like the project site, it is in a residential area. Using this monitor to estimate the background concentration at the near-road location, the resulting "increment" would be 0.0 μg/m^3, a 0% increase over the background. Note, however, that the monitor west of the project site is over four miles away, considerably farther than the two closest monitors.

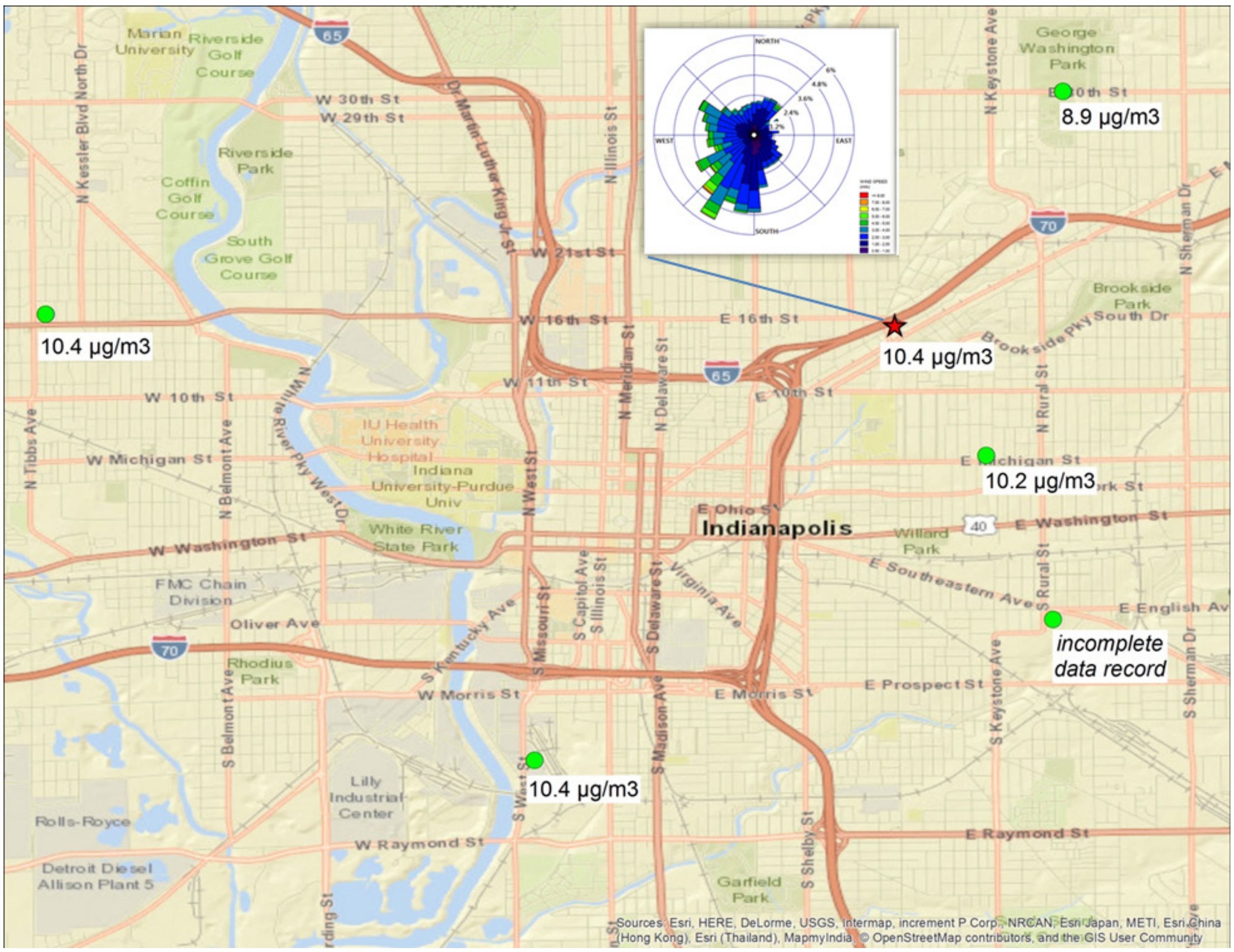

Figure 5. Illustration of ambient monitors (green dots) located in the Indianapolis-Carmel-Anderson, Indiana, metropolitan area, as well as the potential project area (red star, a near-road monitoring location); three-year average annual mean values for each monitor are reported. Also displayed is the wind rose showing the frequency of winds originating from each direction, using data from 2016.

Example #3: Project area is located in a nonattainment area that is expected to reduce background concentrations by the time period of the project

This example is based on the Pittsburgh metropolitan area, which is part of Allegheny County, Pennsylvania, an area designated as nonattainment based on the 2012 annual standard (Table 2). The 2015-2017 annual design value for Allegheny County is 13.0 μg/m^3, 8% above the NAAQS (12 μg/m^3). As shown in **Figure 6**, there are three nearby monitors within 5 miles of the near-road monitoring site where the project would be located. The area near the project is predominantly residential, as is the monitoring site to the northwest and the monitoring site farthest to the south. The site nearest to the project location is also residential but is in close proximity to a large steel facility; therefore, this monitor may be excluded from consideration. There is no single predominant wind direction for the project area, but winds are frequently from the southwest; therefore, the monitor located farthest south may be selected to estimate background concentrations. The three-year average of annual means is 13.0 μg/m^3 at this location. However, the area is expected to achieve the NAAQS threshold of no more than 12.0 μg/m^3 by 2021. Therefore, if the project is expected to be completed in or have peak emissions in 2021 or later, the background concentration would be overestimated unless estimates of future-year concentrations are considered.

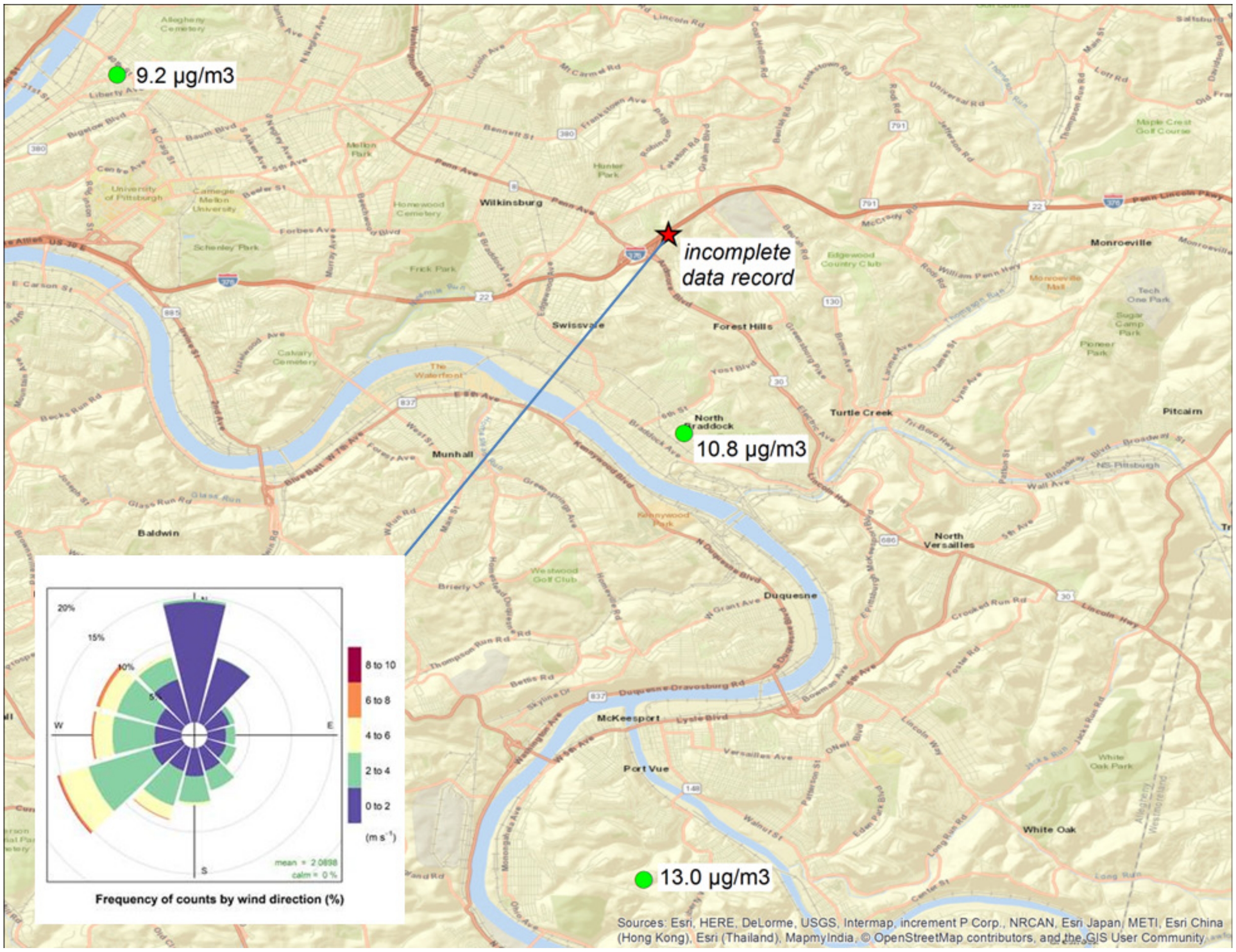

Figure 6. Illustration of ambient monitors (green dots) located in the Pittsburgh, Pennsylvania, metropolitan area as well as a potential project area (red star, a near-road monitoring location); three-year average annual mean values for each monitor are reported. We note that these three-year mean values do not meet completeness criteria but are shown for hypothetical demonstration. Also displayed is the wind rose showing the frequency of winds originating from each direction, using data from 2017.

5. Recommendations

The results from the analyses presented in this report, as well as prior work supported by the Pooled Fund and NCHRP (DeWinter et al., 2018; Seagram et al., 2019), suggest several important factors that can introduce biases into estimated background concentrations. For a number of the factors examined here, we use recent data to illustrate concepts or share insights complementary to those provided in EPA national guidance, including:

1. **Proximity.** Greater distances between the monitor and project area may result in an over- or under-estimate of background concentrations due to different land use, wind patterns, and nearby emissions sources.
2. **Prevailing wind patterns.** Monitors located downwind or parallel to the project area may not be representative. For example, if a project is strongly influenced by winds in a prevailing West-East flow, then monitors located north or south of the road may not accurately represent the background concentration in the project area. Conversely, some projects may not be located in an area with a predominant wind direction, but may be influenced by winds from multiple directions depending on factors such as the time of day or season.
3. **Land use characteristics.** Land use and location designations for a monitor can indicate the representativeness of that monitor for estimating background concentrations in the project area. Commercial locations in the urban core will be best represented by a monitor also in the urban core. Likewise, projects in residential rural or suburban areas will be better represented by monitors in areas with similar land use and location designations.
4. **Lack of a single representative monitor.** Some project areas are located in between multiple candidate monitors and may be best represented by an interpolation of concentrations using multiple monitors, rather than a single monitor.
5. **Nonattainment designation status and year.** By each area's attainment date, nonattainment and maintenance areas are required to reduce to and then maintain concentrations at levels not greater than the NAAQS. Actual rates of progress toward attainment deadlines can vary by region. Interagency consultation partners can potentially consider rates of progress towards attainment as a way of estimating future-year background $PM_{2.5}$ concentrations when CTM-based concentration estimates are not available.

Our findings also indicate several additional factors that are not discussed in the EPA national guidance. These factors include:

1. **Instrument method.** While not discussed in this report, the pooled fund research team separately completed analyses to quantify the impact of instrument method on the increment above the background concentration. That work demonstrated that measurement methodology can introduce a positive or negative bias, depending on the specific instrument, operating procedures, and environmental conditions. In a case study of the near-

road site, Milwaukee-0056, different instrument methods contributed to a +/- bias of 0.6 μg/m^3, whereas using identical instrument methods removed this bias.[17] EPA found that the precision for 24-hour $PM_{2.5}$ ranges from 7% for instruments using Federal Reference Method (FRM) to approximately 20% for instruments using Federal Equivalent Methods (FEM).[18]

2. **Exceptional-type events.** In some areas, exceptional-type events, such as fires, may cause background concentrations to temporarily increase. If these events are not officially identified and excluded by EPA, their inclusion will bias background estimation. A more complete discussion of this issue is provided in Pasch et al. (2014); in addition, EPA released updated guidance in 2018 to assist with handling exceptional events, and that material can support interagency consultation.[19] During interagency consultation regarding exceptional situations, the following considerations can be used to weigh how to protect against bias in background concentration estimation:
   - Determine whether exceptional or exceptional-type events occurred that were not formally submitted to EPA or were submitted and not concurred by EPA.
   - Evaluate background concentrations with and without the concentration data points affected by the exceptional conditions, and determine their relative importance to the estimate of background concentrations.
   - If the exceptional conditions substantially affect background concentration estimates, and will potentially affect conformity determination outcomes, discuss among the interagency consultation partners a process by which the exceptional data could be removed from the project assessment.

Our findings support key considerations to include in discussions regarding monitor selection and background estimation during interagency consultation and related analyses. For example, in situations where multiple monitors are used to estimate background, using only monitors with the same instrument methodology may lower the uncertainty of the background estimate by removing the confounding factor of different instrument methodology. The relative importance of instrument methodology could be evaluated for projects in which multiple monitors will be weighted to estimate the background (e.g., using the inverse distance weighted or IDW approach) by calculating the weighted background using only monitors with the same instrument methodology versus a combination of methodologies. Table 4 summarizes the factors that can introduce bias and uncertainty into background estimates. Methods to reduce uncertainty are dependent on the availability of monitors, opportunities to perform additional monitoring or modeling, and the interagency consultation process; these factors included in these steps should be discussed during interagency consultation.

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[17] Mukherjee A., Brown S., McCarthy M., and Eisinger D. (2019) Refined POAQC screening Part 2: data fusion task results. Presented to Transportation Pooled Fund participants by Sonoma Technology, Inc., Petaluma, CA, STI-914201-7093, March 27.

[18] See EPA, 2015; Figure ES-1, national estimates for PM instruments for 2011-13: https://www3.epa.gov/ttnamti1/files/ambient/pm25/qa/20112013pm25qareport.pdf.

[19] See https://www.epa.gov/sites/production/files/2018-10/documents/updated_faqs_for_exceptional_events_final_september_2018.pdf.

Table 4. Factors influencing background concentration estimation and ways to reduce potential uncertainty.

No.	Factor	Potential Uncertainty	Ways to Reduce Uncertainty	Priority
1	Project located in suburban/rural area far from urban core; nearby monitors are in the urban core	Using nearby monitors located in the urban core may overestimate the background for the project area	• Explore other nearby/ bordering CBSA to find a more appropriate monitor • Consider siting a monitor at the project site	1
2	Project located in urban area; nearby monitors are in suburban/rural area far from urban core	Using nearby monitors not located in the urban area may underestimate the background for the project area	• Explore other nearby/ bordering CBSA to find a more appropriate monitor • Consider siting a monitor at the project site	1
3	Nearest monitor is not located upwind or there is not one prevailing wind direction	Using nearby monitor(s) not located upwind may over- or under-estimate the background for the project area	• Use a wind rose to understand wind patterns for the area	1
4	Nearest upwind monitor is near emissions sources not expected in the project area	Using a nearby monitor that is near other emissions sources may overestimate the background in the project area	• Evaluate the next nearest monitor, even if it is not located upwind, if it meets other key criteria such as similar land use	1
5	Several nearby monitors located at varying distances from the project area, each of which may be influenced by a combination of sources	Background may be over- or under-estimated by using one monitor or a combination of the available nearby monitors	• Interpolate data from nearby monitors to weight the concentrations based on proximity and appropriate similar land uses	2
6	Project will occur in a nonattainment or maintenance area, and background concentrations are currently over the NAAQS	Using monitoring data to estimate background concentrations may overestimate future background concentrations unless reductions to meet attainment are considered	• Use future-year model data to scale current concentrations to estimate background, or, if determined appropriate during interagency consultation, use future-year background concentrations that appropriately reflect the area's progress toward attaining the NAAQS	2

No.	Factor	Potential Uncertainty	Ways to Reduce Uncertainty	Priority
7	Several monitors with different instrument methodologies are located near the project area, and an interpolation must be performed to estimate background	Measurement methodology can introduce a positive or negative bias, depending on the specific instrument, operating procedures, and environmental conditions	• Interpolate data from nearby monitors using only monitors with the same instrument methodology to lower the uncertainty of the background estimate	2

In summary, selection of appropriate data to represent background concentrations is as much an art as it is a science. In many situations, the "ideal" background monitor does not exist, due to a range of factors. Project sites may be in places where winds are not uniformly from one direction, where there are few available monitors to represent background, where land uses are not similar at the background and project sites, or where estimates of future-year concentrations are not available. Therefore, a few key principles are important to remember:

1. "Background" for a project site is best represented by data from a similar area, if monitors are available.
2. Generally, monitors located farther from the urban core, in more rural or suburban areas, have lower concentrations (see Figure 2).
3. Often, wind direction is variable, and there may not be an upwind monitor in the prevailing wind direction; in our analysis of 20 CBSAs, a prevailing upwind monitor was available in only seven locations (see Figure 3). Therefore, in many cases an analyst needs to interpolate from among several monitors to arrive at a representative background value.
4. Many sites have unique characteristics such as topography or nearby emissions sources. Nearby monitors may not be the most representative if their adjacent land uses are dissimilar to the project site's land use. Analysts should carefully review the characteristics of each background monitor option before settling on one or more to represent their project area.

6. References

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Seagram A.F., Brown S.G., Huang S., Landsberg K., and Eisinger D.S. (2019) National assessment of near-road air quality in 2016: multi-year pollutant trends and estimation of near-road $PM_{2.5}$ increment. *Transportation Research Record*, doi: 10.1177/0361198119825538 (STI-6963), January 30. Available at https://journals.sagepub.com/doi/10.1177/0361198119825538.

Appendix A. Survey Findings

A.1 Introduction, Survey Methods, Response

The first task of this work effort was to survey practitioners to learn more about the challenges they experience when estimating background $PM_{2.5}$ concentrations. This work involved preparation of interview questions, dissemination of surveys by WSDOT, follow-up phone interviews with selected individuals, and preparation of summary findings (this appendix). The survey questions were shared with a combination of state DOT air quality staff, air quality consultants supporting state DOT project-level analysis, EPA conformity staff, and FHWA air quality staff. Those surveyed were asked to identify key factors contributing to practical challenges and uncertainty in background concentration estimation.

The survey included four questions:

1. How well is the current process working for determining background $PM_{2.5}$ concentrations?
2. What key technical, procedural, or policy challenges are you encountering determining background $PM_{2.5}$ concentrations? Note if challenge is of "low, medium, or high" importance.
3. What key uncertainties are involved with using existing processes? Can you quantify the uncertainties or rank them as "low, medium, or high" in importance?
4. What best-practice or process improvements do you recommend? Feel free to identify steps state DOTs can take now, or those that may need supporting changes in federal guidance.

Karin Landsberg (WSDOT) emailed the survey to 28 individuals on August 22, 2018. Those invited to participate included representatives from AASHTO; EPA; FHWA; the Arizona, California, Colorado, Maryland, Ohio, Texas, Virginia, and Washington State DOTs; North Central Texas Council of Governments; Ramboll Group; Sonoma Technology, Inc. (STI); and the Texas Transportation Institute (TTI). After the initial email, STI placed follow-up phone calls to solicit further input from national-level organizations such as AASHTO and EPA, and assisted Caltrans in providing a survey response.

Survey responses were provided by EPA; FHWA; the Arizona, California, Colorado, and Virginia State DOTs; STI; and TTI. Some responses, e.g., from FHWA and STI, represented input from several of the individuals on the original survey email list.

A.2 Most Important Factors Contributing to Uncertainty

Table A-1 provides a digest of the most important factors identified as contributing to uncertainty in background estimation. The table identifies key factors and qualitatively ranks each factor's importance. Factors are listed in approximate order of importance, based on survey results.

Table A-1. Key background concentration uncertainty factors named by survey respondents.

Factors Contributing to Background Uncertainty	Importance: Low, Medium, High	Discussion
Factors Ranked Highest in Importance		
Representativeness of available monitors for project sites	High, based on number of respondents raising issue and rankings provided	There is variability in the number of monitors available in a given area. For example, the SCAQMD operates 25 $PM_{2.5}$ and 24 PM_{10} monitors in the greater Los Angeles region;[20] the Maricopa County Air Quality Department operates 10 $PM_{2.5}$ and 17 PM_{10} monitors in the greater Phoenix region;[21] and the Colorado Department of Public Health operates 17 $PM_{2.5}$ and 14 PM_{10} monitors throughout the entire state.[22] Respondents noted several challenges representing $PM_{2.5}$ concentrations at a project site due to having data from monitors distant from the project site, having to decide whether to interpolate among several monitors, having to select multiple monitors to represent a project spanning a large geographic area, and having to achieve interagency consensus over monitor selection and data interpretation. The overall impact from this factor is High.

[20] See Table 1 in the 2018 SCAQMD Annual Air Quality Monitoring Network Plan, available at http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-monitoring-network-plan/annual-air-quality-monitoring-network-plan-v2.pdf.
[21] See Figure 6 in the 2016 Air Monitoring Network Plan available at https://www.epa.gov/sites/production/files/2017-10/documents/azplan2017-maricopacounty.pdf.
[22] See https://www.colorado.gov/airquality/report.aspx.

Factors Contributing to Background Uncertainty	Importance: Low, Medium, High	Discussion
Representation of future background concentrations	High, based on number of respondents raising issue and rankings provided	Background concentration estimates that are based on historic measured concentration data are representations of conditions that have already occurred. In contrast, project hot-spot analyses must forecast future conditions by modeling incremental project impacts and adding those impacts to predicted future-year background concentrations. Unadjusted use of historic concentrations to represent future years does not account for emissions and concentration changes over time. In areas making steady progress toward meeting and maintaining achievement of the NAAQS, unadjusted use of historic concentrations may over-estimate background.
"Exceptional-type" events (ETEs) (concentrations below the NAAQS)	High, based on number of respondents raising issue and rankings provided	EPA allows for removal of "exceptional event" data (e.g., fire-related $PM_{2.5}$ impacts) from concentrations used to assess attainment, for events that exceed the NAAQS. However, the EPA process is not set up to remove event data when concentrations are below the NAAQS ("exceptional-type events"), even though those data can affect background calculations. The overall impact varies from Low to High, depending on the presence and severity of exceptional events.
Other Factors Rated Highly by Respondents		
Estimation of fugitive dust impacts on background may need revised analysis approaches	High for one respondent, and mentioned as an issue by others	There is concern that some new analysis approaches or considerations may be needed when considering fugitive dust and its relationship to PM_{10} background. Issues raised include the different dust impacts that might be experienced at background monitoring sites vs. project sites, as well as the importance of properly accounting for the more rapid deposition of PM_{10} compared to $PM_{2.5}$ particles.
Areas affected by pollutant transport	High for one respondent	There is concern that in areas experiencing overwhelming transport of pollution from outside the region, more flexibility should be available to address project analyses, since background concentrations will be calculated as being high at the project site.

Factors Contributing to Background Uncertainty	Importance: Low, Medium, High	Discussion
Lack of proactive efforts to anticipate data needs	High for one respondent	It may be possible, for some upcoming projects, to anticipate that there will be a lack of available background data, or that the process needed to assess background will be difficult given the complexity of interpreting data from the available monitors. For such cases, there is interest in encouraging project sponsors to proactively anticipate data gaps and data analysis issues, and taking preemptive action to either collect data or build consensus over how to interpret the data that are available.
Not correctly following interagency consultation procedures	High for one respondent	EPA feedback emphasized the importance of EPA and state and local air agency involvement in the interagency consultation process as a method of resolving issues.

A.3 Summary of All Survey Responses Received

1) *How well is the current process working for determining background $PM_{2.5}$ concentrations?*

   a) One view (from EPA staff) is that when state and local air agency staff are included from the beginning in interagency consultation, the process works well.

   b) An alternate view expressed is that there is no standard process for selecting background concentration monitors; therefore, interagency disagreements can result over monitor use and background values. Another respondent noted that a detailed study would be needed to assess the current process.

      – Example provided among survey responses: On one large project, both FHWA and the EPA Region recommended a background monitor that was less than ¼ mile from the project corridor. However, the state air agency did not accept the FHWA/EPA recommendation and chose a monitor that was over 3 miles northeast of the project, was heavily impacted by industrial activity, and coincidentally had the highest concentrations of any monitor in the metropolitan area (on an average basis, even higher than the existing near-road monitor next to an interstate).

   c) Monitor location and availability (relevant to project sites) is a concern; in some cases, there are few monitors available, and those that are available can be distant from the project site.

   d) Background data are readily available from some agencies, but not from others.

   e) There are several practical problems that make it difficult to forecast background PM.

2) *What key technical, procedural, or policy challenges are you encountering determining background $PM_{2.5}$ concentrations? Note if challenge is of "low, medium, or high" importance.*

   a) A consistent *high* importance comment: Analysts encounter difficulties assessing monitoring site representativeness. Need to develop adjustment methodologies listed in the EPA guide for more accurate background information, especially with lack of representative monitors and monitors heavily influenced by exceptional (or exceptional-type) events and transport (i.e., across international borders). EPA should issue guidance on how to handle monitored values affected by exceptional-type events in project-level analysis.

   b) High: Need to consider rural areas without updated SIPs or Emissions Inventory in place. Additionally, fugitive emissions need to be better accounted for in the process.

   c) High (in some cases): Need to be able to remove exceptional-type events (ETEs) from background data.

   d) High: Need to be able to practically use the flexibility in EPA guidance to forecast $PM_{2.5}$ background.

   e) Medium: More clarity is needed on the use of interpolation to derive a background concentration from multiple monitors.

   f) Additional comment from FHWA: State DOTs aren't being proactive in pursuing alternative sources of background concentrations when existing monitoring data are either not appropriate or representative. Sometimes DOTs are stuck with monitors that are over the NAAQS (forcing projects into Build/No-Build analysis). In areas like that, where a future project is likely to be a project of air quality concern, state DOTs should be working with air agency partners now to begin development of photochemical modeling or other alternative sources of background data such as on-site monitoring.

   g) Additional comment from EPA: Some calculation errors have resulted when analysts failed to use the correct monitoring values or the right years of data; interagency consultation can resolve these issues (high importance).

   h) Additional comment from VDOT: Over time, changes in emissions sources may occur near a background monitor; if project analysts are not aware of the changes, use of that monitor may bias the monitoring data (high or low). A process is needed to communicate and assess such source changes.

3) *What key uncertainties are involved with using existing processes? Can you quantify the uncertainties or rank them as "low, medium, or high" in importance?*

   a) High: Using existing ambient monitoring data to represent future background concentrations in the project corridor, particularly when ambient monitoring data demonstrate decreasing concentration trends with time.

b) High: choice of monitor, years to use, and monitoring values to use. These uncertainties can be overcome through interagency consultation, but there may be cases where representative existing sites are not available.

c) Low to High: Identifying a representative monitor introduces substantial uncertainty. The uncertainty becomes greater the further away the monitor is from the project site.

– Due to funding resources decreasing, monitors are being removed, thereby making the data unusable for project analysis. This, in turn, makes monitor selection more uncertain.

4) *What best-practice or process improvements do you recommend? Feel free to identify steps state DOTs can take now, or those that may need supporting changes in federal guidance.*

a) General implementation of monitor interpolation, not just in particular circumstances.

b) State DOTs can be proactive in pursuing alternative sources of background data, even collecting their own data or working with air agency partners to collect data for the specific purpose of representing background concentrations.

c) State DOTs can track monitoring data, and work with air agency partners and with EPA to increase the scope of exceptional events submissions to include near-NAAQS values that are associated with exceptional event episodes.

d) Suggestion to better account for dispersion properties of fugitive dust; look at what EPA did for haul roads (regarding fugitive dust) as a potential guide.

e) Have agencies pre-package background data to support analyses, and also pre-package any CTM data that can help forecast $PM_{2.5}$ at monitors.

f) Develop alternative forecasting approaches if CTM data are not available.

g) Provide more case study materials to illustrate how to develop representative background when available monitors are distant from the project site.

h) Work with EPA to address uncertainty in the conformity process. Modify guidance (if not regulations) to recognize that background concentration and dispersion modeling evaluations produce "expected" values; given the analysis uncertainties, expected values, rather than minimum or maximum values, should be used for conformity assessment.

i) Ensure EPA and the state air agency are consulted early in the process.

A.4 Individual Responses, Organized by Question

1) How well is the current process working for determining background $PM_{2.5}$ concentrations?

a) ADOT

– I think our issue is locating proper monitors for background in case the candidate monitors are too far away from the project sites. Some nonattainment areas only have one monitor to choose from. The current process works fine for metro areas with more monitors; it becomes an exercise in describing the shortcomings of the monitors in the hot-spot analysis.

b) Caltrans

– The process works better with some air districts compared to others. For example, the South Coast Air Quality Management District (SCAQMD) has ready-to-use background concentration data, spanning five years. Other air districts have not similarly assembled the data, and Caltrans must spend more time and effort to obtain the data from EPA datasets.

c) CDOT

– I am not aware of any issues regarding obtaining concentrations and APCD did not bring any up in response to this question. Colorado has only needed to do one PM_{10} analysis.

d) EPA (Laura Berry thoughts, not comprehensively representing the agency or EPA's Office of Transportation and Air Quality [OTAQ])

– The current process works well when project sponsors follow the recommendation in the $PM_{2.5}$ hot-spot guidance to follow interagency consultation procedures. The guidance indicates that state and local air quality agencies have "the primary expertise on what emission sources are expected to affect background concentrations, including any nearby sources." When they are consulted from the beginning, things go well. There are $PM_{2.5}$ monitors in the vicinity of the projects that need hot-spot analyses, and interagency consultation has been used to select the most appropriate monitor(s) in the cases I have seen. Keep in mind that less than a handful of projects are doing a $PM_{2.5}$ hot-spot analysis in the United States every year.

e) FHWA

– There is no standard process for selecting background concentration monitors. On one large project, both FHWA and the EPA Region recommended a background monitor that was less than ¼ mile from the project corridor. However, the state air agency did not accept the FHWA/EPA recommendation and chose a monitor that was over 3 miles northeast of the project, heavily impacted by industrial activity, and which coincidentally had the highest concentrations of any monitor in the metro area (on an average basis, even higher than the existing near-road monitor next to an interstate).

f) STI

– There is substantial guidance from EPA and National Cooperative Highway Research Program (NCHRP) on this topic that offers various approaches and best practices for determining background $PM_{2.5}$ concentrations. Despite that guidance, the decision for determining the background $PM_{2.5}$ concentration tends to be largely driven by the Interagency Consultation process. When there is only one reasonable potential monitor, we understand the options are limited. The representativeness of historical $PM_{2.5}$ data is uncertain, given that our project horizon years tend to be quite far into the future. There is no practical pathway to account for projections of future background $PM_{2.5}$ concentrations. In concept, EPA guidance allows for this possibility, but in practice it's difficult to demonstrate EPA's requirements for those who don't have expertise working with chemical transport model data. Access to model data could be problematic, and substantial cooperation would be needed from all interagency partners.

g) TTI

– Background Concentration (BC) accounts for a significant portion of the $PM_{2.5}$ concentration with studies showing BC to account for 90-95% of design value concentration. Uncertainties associated with the background concentration may dominate uncertainties and sensitivities involved in the design value calculation. The current process of determining the BC has to be communicated along with the uncertainties involved in the process to help interpret the results in the proper context. This consideration is important for understanding the potential outcome of a design value that hinges predominantly on the background compared to the project contribution. Also, a number of studies have been focused on improving the accuracy of modeled vehicle emissions and concentration estimates and understanding the sensitivity of the models to key input parameters (traffic, emissions, meteorological, topographic, etc.). However, literature is limited in terms of quantifying the range or degree of uncertainty involved in the background concentration estimation.

h) VDOT

– Suspect not as well as possible, but a detailed study would be needed to assess the current process and make that determination.

2) What key technical, procedural, or policy challenges are you encountering determining background $PM_{2.5}$ concentrations? Note if challenge is of "low, medium, or high" importance.

a) ADOT

– We may need to develop adjustment methodologies listed in the EPA guide for more accurate background information, especially with lack of representative monitors and monitors heavily influenced by exceptional events. High.

– The other policy challenges are rural areas w/out updated SIPs or emissions inventories in place so the use of "background" from a SIP isn't a viable option either. High.

– Also the fugitive dust (reentrained road dust) portion calculated with AP-42 becomes challenging; a straight addition of the fugitive dust concentration may not be the best approach given the old information used in calculating road dust. Road dust will be the dominate source of emissions, yet the dispersion properties are different between tailpipe exhaust $PM_{2.5}$ and re-entrained dust. Yet, most of the effort in the approach is focused on MOVES/tailpipe which is not the largest contributor to PM_{10} (the hot-spot guidance clearly was focused on $PM_{2.5}$ emissions with PM_{10} an afterthought). Fugitive emissions need to be better accounted for in the process. High.

- Additionally, we have the Nogales, Arizona area where the monitor violates the standard due to Mexico but there is no option for flexibility for transport areas at the project level. High.

b) Caltrans

- High: There have been situations where exceptional events occurred, but resulting concentrations were below the NAAQS, and the events were not officially identified as exceptional by EPA. These events resulted in higher-than-normal $PM_{2.5}$ concentrations, which then skewed the background concentration calculation.
- Low-Med: In some areas, such as the Mojave Desert Air Basin, monitors are located very far apart. Therefore, to find a representative site is hard unless the transportation project is located near the monitor.

c) CDOT

- APCD did not identify any challenges associated with determining background $PM_{2.5}$ concentrations.

d) EPA (Laura Berry thoughts, not comprehensively representing the agency or OTAQ)

- In one case, the agency making the conformity determination was not using the correct monitor value for the background, because they did not account for the number of days of monitor readings. (The monitor value that represents the NAAQS depends on whether the monitor samples every day, every other day, etc.) This was corrected during the interagency consultation process, and the correct value was ultimately used. The selection of the appropriate monitor value is described in the $PM_{2.5}$ hot-spot guidance in Section 9, and guidance is based on how background monitors are used in design value calculations for other purposes.
- In another case, the project sponsor was not using the right years of data from a monitor.
- I would consider these issues of high importance, because using the correct background monitor value is important to ensure the design value of the project is calculated correctly. It demonstrates the importance of interagency consultation on both choosing the monitor, and in determining the correct years and correct monitor values to use.

e) FHWA

- High: lack of state air agency/EPA incentive to submit exceptional events documentation (when appropriate) for monitored values that are below but very near the NAAQS. While these values don't have any consequences for demonstrating attainment of the NAAQS at a regional scale, they do impact our ability to demonstrate attainment of the NAAQS through modeling, when they are included in the calculation of background concentrations. EPA should issue guidance on how to handle monitored values affected by exceptional events in project level analysis.

- Medium: more clarity on the use of interpolation to derive a background concentration from multiple monitors. One state DOT tried this for a major freeway project, where the candidate background monitors were all some distance from the project corridor, but EPA disallowed it without any good reasons.
- High: state DOTs aren't being proactive in pursuing alternative sources of background concentrations when existing monitoring data are either not appropriate or representative. Sometimes DOTs are stuck with monitors that are over the NAAQS (forcing projects into Build/No-Build analysis). In areas like that where future projects are likely to be a project of air quality concern, state DOTs should be working with air agency partners now to begin development of photochemical modeling or other alternative sources of background data such as on-site monitoring.

f) STI

- Limited understanding of how to utilize flexibility implied by EPA guidance in practice on using chemical transport model data to inform future background concentration estimates (high importance).
- Exceptional-type events: we haven't encountered a practical circumstance yet where this has affected background concentrations in a way that would substantially alter the analysis approach or the conformity determination. Therefore low importance, recognizing that it could be of higher importance for specific areas that are affected with frequent upsets from dust or smoke.

g) TTI

- Methods to estimate BC (high): EPA recommends four methods, based on either a single or multiple background ambient $PM_{2.5}$ monitoring sites for developing the background concentrations. However, no specific guidance is provided regarding which method is preferred for an area. Depending on which method is adopted, the background concentration estimates could be different thereby causing uncertainties in the design value calculation.
- Representative ambient monitoring stations (medium): Selecting the representative ambient monitoring stations requires consideration of factors such distance to the project area, similar land use in terms of density and mix of emission sources, meteorology, and terrain, prevailing wind direction (monitors located upwind from the area), etc. In addition to these factors, guidance is required on the number of stations to be considered within a certain distance from the project area.
- Data criteria (low): EPA requires 75% completeness in the ambient monitoring data utilized for BC estimation. Also, days influenced by an "exceptional event" have to be flagged and removed from the BC estimation based on interagency consultation

h) VDOT

- Monitoring site representativeness (High importance).
- Exceptional-type events (ETEs) - No effective means to address ETEs as defined in the NCHRP 25-25 Task 89 report. While EPA at the time appeared open to the concept, a new or updated regulation or guidance to suit has not been issued by EPA. (Med-High, depending on local conditions).
- Future BCs – Need a better understanding of future uncertainty. Are the forecast BCs biased (high or low)? Can this be tested using forecast BCs for the project opening year in project-level analyses completed to date, where the opening year may have already passed or is in the relatively near future? (Med-High).
- Changes in sources near the monitor: Even if the “right” monitoring site is selected for BCs, changes in sources nearby may occur that bias the monitoring data (high or low) to be used in the conformity analysis. If the change is a result of a regulation (emission controls on stationary sources), air agency staff may know of it but transportation modelers are typically not likely to know. Need a process to communicate and assess such changes, else may use historical data for BCs not knowing a significant change may be in store.

3) ***What key uncertainties are involved with using existing processes? Can you quantify the uncertainties or rank them as “low, medium, or high” in importance?***

a) ADOT

- The biggest uncertainty is that the monitor represents the project area, other than qualitatively how can you demonstrate environmental conditions in near field are capturing the project’s emissions? Meteorologically, often the wind shifts direction from morning to night and there isn’t a predominant “upwind” representation.
- The other uncertainty that came up on a recent project is that the air agency can remove a monitor in a location thereby making the data unusable; EPA is funding less and less monitors so air agencies are reducing their monitoring network. Also, legal challenges are uncertain.

b) Caltrans

- Low-Med: It is generally not feasible to monitor at the project location; therefore we need to rely on the available background concentration monitors. However, there is uncertainty about the difference between the “real world” concentrations at the project site (where we don’t have data), compared to the concentrations at the background monitor location.
- Low-Med: Caltrans has noticed that in some situations, there are two monitors co-located at a background site. In some of those cases, the monitors have measured different concentration values, leading one to question the accuracy of the monitored values.

- Low-Med: Also, in terms of PM_{10} and fugitive dust, it may be possible that there are higher concentrations measured at the background monitor, than at the project site. Freeways typically have a relatively clean surface, with limited fugitive dust originating from them, compared to the locations where background monitors are sometimes situated.

c) CDOT

- APCD did not identify any uncertainties associated with determining background $PM_{2.5}$ concentrations.

d) EPA (Laura Berry thoughts, not comprehensively representing the agency or OTAQ)

- I see the key "uncertainties" being related to the choices described above: the choice of the background monitor(s), what years to use, what values to use. These choices are of high importance, because again, using the correct background monitor value is important to ensure the design value of the project is calculated correctly. Using the appropriate background concentration(s) is just one aspect of the hot-spot process that demonstrates the importance of early, frequent interagency consultation in $PM_{2.5}$ hot-spot analyses, because these "uncertainties" can be overcome with interagency consultation.

e) FHWA

- High: using existing ambient monitoring data to represent future background concentrations in the project corridor when ambient monitoring data demonstrate decreasing concentration trends with time.

f) STI

- Historical year vs. horizon year differences in the background $PM_{2.5}$ concentration. High potential uncertainty.
- No representative or reasonable nearby monitors: high potential uncertainty.
- Exceptional-type events: Low potential uncertainty.
- Instrument uncertainty: low potential uncertainty.

g) TTI

- Uncertainties in the $PM_{2.5}$ hot-spot modeling process originates from the different steps and modeling components involved in the process. Further, these propagate through the entire modeling chain. Specifically, the modeling components or steps involved in a $PM_{2.5}$ hot-spot process consists of (1) traffic data characterization, (2) emission modeling, (3) meteorological data processing, (4) air dispersion modeling, and (5) background concentration estimation. The different sets of input parameters, data sources and data resolution at each step of the modeling process contribute to model uncertainty in hot-spot analyses. Uncertainties involved in each of these modeling components, in terms of the parameters evaluated and the level of uncertainty in the results is shown in the following table:

Modeling Component	Parameters Evaluated	Rank of Uncertainty
Traffic Data Characterization	• TDM[23] (peak or average values) against hourly values or observed	• High
Emission Modeling	• Regulatory $PM_{2.5}$ hot-spot vs site-specific data used in MOVES emission rates	• Low
Air Dispersion Modeling	• Model selection (AERMOD vs CAL3QHCR) • Source type selection (area vs volume sources) • Land use type (incorrect selection of urban vs rural)	• High • Medium • Medium
Meteorological Data	• Onsite vs offsite data • Offsite meteorological data classified by surface roughness values[24]	• High • Medium
Background Concentration	• Different methods using single, multiple or same near-road monitor	• High

h) VDOT

– Not being able to address uncertainty in conformity analyses, particularly in the conformity tests (NAAQS and B/NB). Model estimates for near road concentrations and BCs are both treated as if they were perfectly accurate with no uncertainty (High).

– Handling of ETEs as noted above (High).

– Forecasting future BCs as noted above (High).

– Notwithstanding guidance for selecting monitoring sites, good sites may not be available.

4) *What best-practice or process improvements do you recommend? Feel free to identify steps state DOTs can take now, or those that may need supporting changes in federal guidance.*

a) ADOT

– Instead of trying to capture meteorological impacts by representative monitors, the focus should be on concentrations in the project area; it is not clear how adding the

[23] Travel Demand Model.

[24] Texas Commission of Environmental Quality produces pre-processed meteorological data for all counties in the state of Texas. TCEQ produces three sets of meteorological data corresponding to three categories of surface roughness (low, medium and high). Based on the surface roughness obtained through processing of specific land use data for the case study site, appropriate meteorological data is recommended. Uncertainty associated with incorrect selection of surface roughness is ranked as medium.

concentration to a monitor background that may not accurately predict conditions of the roadway adds value. Often, elevated monitors have nothing to do with transportation sources, yet transportation sources appear to be the only source subject to this background representative monitor approach; adding emission factors to background seems a bit fragmented. Suggestion to look at roads' fugitive nature similar to what EPA did for haul roads; also, there's a need to better account for the dispersion properties of fugitives (understanding AP-42 limitations – site specific silt loading and the requirement to be consistent with regional emissions analysis). As noted, AZ has many very old SIPs with very old silt loading values. Expand on section "6.3.5 Using alternative local approaches for road dust" of the PM-Guidance. Also re-think the additive approach "6.5 ADDING DUST EMISSIONS TO MOVES".

b) Caltrans

- It would be helpful for all local air agencies to organize and make available background data, similar to how the SCAQMD has prepared and made such data available for use.
- Similarly, it would be beneficial if local air agencies had CTM data available to forecast concentrations at their monitors. SCAQMD has such data, and that has helped Caltrans forecast future PM.

c) CDOT

i) APCD did not identify any improvements associated with determining background $PM_{2.5}$ concentrations.

d) EPA (Laura Berry thoughts, not comprehensively representing the agency or OTAQ)

- Ensuring that EPA and the state air quality agency are consulted on determining background concentrations early in the process, as they are the experts in determining whether monitors are representative of the project area, and how to use the data.

e) FHWA

- 1) General implementation of monitor interpolation, not just in particular circumstances. 2) state DOTs can be proactive in pursuing alternatives sources of background data, even collecting their own data or working with air agency partners to collect data for the specific purpose of representing of background concentrations. 3) State DOTs can track monitoring data, and work with air agency partners to increase the scope of exceptional events submissions to include near-NAAQS values that are associated with exceptional event episodes.

f) STI

- A key need is to improve the ability of project analysts to forecast $PM_{2.5}$ concentrations for future years covered by project analyses. These improvements could take the form of improved availability of CTM modeling results, or development of other forecasting approaches such as interpolations based on expected attainment dates.

- An additional need is to provide further analysis support or case examples to illustrate background concentration estimation in locations where available monitors are located far from the project site.

g) TTI

- Based on the experience gained from a series of modeling exercises for $PM_{2.5}$ hot-spot analysis, the following data gaps in the current data collection practice are identified:
  - The modeling scenarios and results highlight the importance of careful selection and processing of input parameters for traffic, emissions, and air dispersion components. Quality assurance at every step of the modeling process is required to avoid possible variations in the concentration results.
  - Fleet composition of the traffic data needs to be improved to be consistent with MOVES vehicle type requirement. The traffic counters classify the vehicles into 4-tire, single unit and multiple unit truck categories, and post-processing has to be done to match approximately these categories with MOVES vehicle types.
  - Resolution of travel activity data: Current and future traffic activity data by time of day needs to be consistent with time periods as required by the $PM_{2.5}$ hot-spot process. The regional transportation models utilized by state agencies produce traffic data for time periods different from the $PM_{2.5}$ hot-spot time periods. And post-processing has to be done to approximate the traffic temporal distribution.
  - Detailed traffic activity data in terms of drive schedule or operating mode distribution compared to average speed would improve the accuracy of the analyses especially for arterial sites.
  - Another insight gained is the importance of road dust emission characterization in the $PM_{2.5}$ emission inventory estimation. Currently, road dust ERs is calculated using AP-42, which are based on aggregate estimates and were developed many years ago. With the advances in measurement technology and modeling methods in the past decade, additional research can vastly improve the associated modeling techniques for this process.
  - The process of preparing the meteorological data for AERMOD/ CAL3QHCR using meteorological preprocessors involves a lot of time and effort. Availability of a converter tool that could convert the data from one format into the other (or convert raw data into any format) would greatly help to streamline the process, as these data are mostly available in a compatible format for only one of the models.
  - Availability of electronic CADD drawings of the case study sites would help in the coding of the sources and receptors especially for complicated sites. Google map image would suffice for simplified sites.

h) VDOT

- Work with EPA to address uncertainty in conformity analyses, particularly in the conformity tests (NAAQS and B/NB). In the absence of otherwise formally addressing uncertainty, and as a means to limit potential litigation, provide in guidance (if not regulation) that:

  - Determinations of compliance with the NAAQS or B/NB tests are to be based on expected values (not the min or max considering uncertainty).
  - Dispersion model estimates are to be considered the expected value for roadway contributions for regulatory applications.
  - BCs determined following EPA regulations and guidance are to be considered the expected values for BCs.

- Work with EPA to have ETEs excluded.