

# **ATTACHMENT 1**

# **CRITIQUE OF INTERCOUNTY CONNECTOR HOT SPOT STUDY**

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# CONTENTS

|   | <b>Page</b> |
|---|-------------|
| SUMMARY OF MAJOR CONCERNS .....   | 1           |
| TOOLS FOR ASSESSING THE AMBIENT AIR QUALITY IMPACTS OF PM <sub>2.5</sub><br>EMISSIONS ..... | 1           |
| NEAR ROADWAY MEASURED FINE PARTICLE CONCENTRATIONS.....                                     | 7           |
| SOURCE APPORTIONMENT .....  | 9           |
| DISPERSION MODELING .....   | 10          |
| Models.....   | 10          |
| Road Network .....  | 11          |
| Receptor Network .....  | 11          |
| Traffic Volumes .....   | 11          |
| Emission Factors.....   | 12          |
| Meteorological Data.....  | 12          |
| REFERENCES .....  | 13          |

# TABLES

|  | <b>Page</b> |
|--|-------------|
| Table 1 Washington, DC-Maryland-Virginia Nonattainment Area Annual Average<br>PM <sub>2.5</sub> Concentrations (1999-2005) (µg/m <sup>3</sup> ).....   | 6           |
| Table 2 Comparison of Average Source Contributions (%) to PM <sub>2.5</sub> Mass<br>Concentrations Among PMF Studies with Eight Carbon Fractions ..... | 10          |

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## ACRONYMS AND ABBREVIATIONS

|                   |  |
|-------------------|--|
| BC                | black carbon   |
| CO                | carbon monoxide  |
| EPA               | U.S. Environmental Protection Agency                                   |
| HDDV              | heavy-duty diesel vehicles   |
| ICC               | Intercounty Connector  |
| MDOT              | Maryland Department of Transportation                                  |
| MWCOG             | Metropolitan Washington Council of Governments                         |
| NAAQS             | National Ambient Air Quality Standards                                 |
| NO <sub>x</sub>   | oxides of nitrogen   |
| PM <sub>2.5</sub> | particulate matter with an aerodynamic diameter of 2.5 microns or less |
| PMF               | positive matrix factorization  |
| SHA               | State Highway Administration   |
| VMT               | vehicle miles traveled   |

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This analysis evaluates the Project-level Conformity Determination for the Intercounty Connector (ICC) Project in Maryland. The ICC project area (Montgomery and Prince George's counties in Maryland) is within the Washington, DC-Maryland-Virginia nonattainment area for particulate matter with an aerodynamic diameter of 2.5 microns or less ( $PM_{2.5}$ ); and therefore the project is required to meet transportation conformity requirements found in 40 CFR Part 43 as amended (EPA, 2006). Project-level conformity requires a determination that emissions from the Project will not cause or contribute to new violations, more severe or more frequent violations of the National Ambient Air Quality Standards (NAAQS) during the year of highest expected emission 40 CFR § 93.116. The Maryland Department of Transportation (MDOT) March 2006 document that is evaluated here addresses the project level transportation conformity requirements for the ICC, including a hot spot analysis. The design year for the ICC is 2030 and it is expected to be open to traffic in 2010.

The ICC is a proposed six-lane, 18-mile highway that would link I-95 and US 1 at its eastern terminus with I-270 at its western terminus. The Project is expected to add an additional 12,325 daily vehicle trips to current annual average daily travel of 175,575 on the segment of I-95 that connects with the Project, and 13,200 additional vehicle trips on the segment connecting with I-370.

## SUMMARY OF MAJOR CONCERNS

The Maryland SHA hot spot conformity analysis is seriously flawed on three major grounds:

1. It selectively excludes from its analysis of air quality data in the region all the monitors located in close proximity to similarly sized highways that are the monitors that violate the NAAQS for  $PM_{2.5}$ ;
2. It fails to evaluate the evidence in the peer-reviewed scientific literature showing that emissions of  $PM_{2.5}$  (measured as black carbon [BC]) from highways carrying as many motor vehicles as are expected to travel the ICC Project in the vicinity of the termini at I-95 and I-370 are likely to add 2.0 to 2.5  $\mu\text{g}/\text{m}^3$  to baseline concentrations in the near-roadway atmosphere; and
3. It fails to use U.S. Environmental Protection Agency (EPA)-approved modeling tools that are readily available for estimating future emissions from the highway.

Consideration of relevant, credible scientific evidence omitted from the SHA analysis supports the conclusion that adding 120,000 vehicle trips per day in the vicinity of I-95 and I-370 will contribute to new or more frequent and more severe violations of the NAAQS.

## TOOLS FOR ASSESSING THE AMBIENT AIR QUALITY IMPACTS OF $PM_{2.5}$ EMISSIONS

Methods for evaluating the potential impact of the ICC on  $PM_{2.5}$  concentrations include analysis of existing monitoring data in the region, using data for roadways with similar traffic volumes and mixes, and appropriate dispersion or receptor modeling techniques. In this evaluation, Pechan has reviewed all appropriate analytical techniques to evaluate the potential effect of the ICC. For example, EPA's Guideline for Air Quality Models (40CFR Part 51, Appendix W)

suggests modeling techniques that are appropriate for evaluating the effects of line sources, such as roadways. CAL3QHCR is one example of a guideline model that is available for evaluating line sources. While MDOT-SHA relies solely on PM<sub>2.5</sub> monitoring data to perform a qualitative project analysis, it is more appropriate to perform a more advanced analysis that includes a combination of modeling techniques and ambient monitoring data evaluations. This report summarizes how a quantitative dispersion modeling analysis could be performed by MDOT-SHA. In addition, critical comments on the analysis performed by MDOT-SHA are also provided.

The PM<sub>2.5</sub> hot spot analysis prepared by the Maryland SHA relies upon EPA's recent announcement in the March 10, 2006 Hot Spot rule that the MOBILE6.2 emissions model for PM<sub>2.5</sub> is not currently appropriate for project level conformity determinations. Neither EPA nor SHA dispute that modeling tools are available to replicate the dispersion of emissions from highways in the atmosphere for the purpose of estimating ambient concentrations. See Part 51 Appendix W, 4.2.2.(d), 5.2.3.(b), 5.2.4.(f). SHA does not use modeling to assess the impact of incremental emissions added by the proposed ICC project. Instead, SHA undertakes a qualitative hot spot analysis based upon data selected from 2 of 13 PM<sub>2.5</sub> monitors in the Washington metropolitan nonattainment area. None of these monitors have been sited in accordance with the criteria described in Appendix W, section 10.2.2.(b) for measuring near roadway concentrations. Neither of these two monitoring stations have been located in proximity to a highway for the purpose of detecting highway emissions as required by 40 CFR, Part 58, Appendix E, 8.3.

The PM<sub>2.5</sub> ambient air quality monitoring data presented in the MDOT-SHA analysis is largely based on the Muirkirk (Beltsville) site in Prince George's County (EPA site id 240330030). There are several concerns about using data from this single site to characterize ambient air quality characteristics in the vicinity of the proposed project.

1. This monitoring site was inactive prior to July 2004, so only PM<sub>2.5</sub> measurements from 2004 and 2005 are available for analysis (49 readings of 24-hour average PM<sub>2.5</sub> concentrations in 2004 and 107 readings of 24-hour average PM<sub>2.5</sub> concentrations in 2005). This amount of data is insufficient for EPA's established criteria for computing a PM<sub>2.5</sub> design value at this site (which requires 3 complete data years), so using data from this site alone is not sufficient for characterizing PM<sub>2.5</sub> levels in the vicinity of the project. For example, the current 24-hour standard is based on a 3-year average of the 98<sup>th</sup> percentile of 24-hour PM<sub>2.5</sub> concentrations; the current annual standard is based on a 3-year average of annual mean PM<sub>2.5</sub> concentrations.
2. As noted above, the MDOT analysis does not report the 3-year average 24-hour or annual average PM<sub>2.5</sub> concentrations, which is what is needed for comparison with the relevant ambient air quality standards. Because the Muirkirk site lacks the necessary data to perform a 3 year analysis per 40 CFR 50 – Appendix N, it is suggested that data from other sites in the region be presented in the analysis so that this report presents data in a form where it can be compared directly with the relevant ambient air quality standards. We reviewed the monitoring site characteristics in the Washington, DC-Maryland-Virginia area with respect to the likelihood that they represent a well developed and heavily traveled nearby roadway network similar to what exists and is planned for the

area where the ICC will be built. The two monitoring sites with surroundings most like the area of the planned project are the near roadway monitors at River Terrace/RFK (site ID 110010041) and Park Services/Ohio Drive (site ID 110010042), which are both in the District of Columbia. Both of these sites are near heavily traveled roadways/freeways that are similar in design and volume to the ICC at I-270 and the ICC at I-295. The River Terrace/RFK site is about 150 meters from both I-295 and Benning Road. The Park Services/Ohio Drive site is 115 meters from I-395 near where it crosses the Potomac River. Therefore, the analyses performed in this study use the monitoring data from these two near roadway sites as the appropriate point of comparison for the ICC evaluation.

3. EPA's December 2005 *Draft National Ambient Air Monitoring Strategy* (EPA, 2005) recognizes that its current monitoring network design does not capture near roadway impacts, and that there is an urgent need to do so. It acknowledges that "research monitoring efforts to characterize the impacts of mobile sources near roadways are emerging as a key area for ambient monitoring development." It goes on to say the following:

"An estimated 35 million Americans live near four-lane roads, and EPA and others will need to investigate how to incorporate near roadway conditions and exposures into NAAQS attainment monitoring. To date, ambient monitoring in these areas consists of targeted research efforts.

Over 1,000 compounds have been identified in exhaust and evaporative emissions from motor vehicles. These compounds include criteria pollutants and air toxics. Motor vehicle emissions significantly impact air quality and contribute to national emission inventories for criteria and air toxic pollutants. Mobile sources account for over 75 percent of national carbon monoxide (CO) emissions, over 50 percent of national oxides of nitrogen (NO<sub>x</sub>) emissions, and over 25 percent of national PM<sub>2.5</sub> emissions. For air toxics, mobile sources significantly contribute to air pollutant concentrations of gaseous and particulate phase compounds. For example, mobile sources emit over 50 percent of the nation's benzene, toluene, and acetaldehyde. PM air toxic emissions include metals, ions, and semi-volatile organic compounds.

Given that an estimated 35 million people live within 100 meters of a four-lane roadway, near roadway exposure from these mobile source emissions is an important concern. It cannot properly be thought of as either a *hotspot* issue affecting relatively few areas in a city or a broader component of PM NAAQS attainment issues. Near roadway exposure may, in fact, emerge as one of the dominant urban air quality issues. Air quality measurements collected near roads often identify elevated pollutant concentrations at these locations, as well as pollutant composition

and characteristics that differ from those measured at a distance from roadways.

Elevated pollutant concentrations near roadways may lead to elevated exposures for populations working or residing near these roads. In addition, these populations may experience exposures to differing physical and chemical compositions of certain pollutants. The location of schools near major roads may also result in elevated exposures for children due to potentially increased concentrations indoors, increased exposures during outdoor activities, or increased exposures while commuting to school (e.g., walking along roads or riding in a school bus or passenger vehicle). Mobile sources influence temporal and spatial patterns of regulated gases, air toxics, and PM concentrations within urban areas. Since motor vehicle emissions generally occur near the breathing zone, near roadway populations may be exposed to *fresh* combustion emissions as well as combustion pollutants *aged* in the atmosphere.

Results from emissions and exposure studies suggest that simple methods of estimating the contribution of motor vehicle exhaust to exposure likely do not capture the substantial variability in the chemical and physical characteristics of motor vehicle exhaust that may be leading to adverse health effects. Comprehensive assessments of exposure will be a critical factor in identifying which compounds are leading to adverse health effects in the near roadway environment.

With this background, EPA's strategy currently involves (1) recognition of the importance of near roadway exposures and (2) the need for further exploration of what these exposures mean for both urban NAAQS-oriented monitoring networks and air toxics networks. EPA anticipates discussing these issues both internally and with partners and other stakeholders over the coming months, and then continuing to develop specific elements of a near roadway monitoring strategy that can be adopted into this overall strategy document."

5. The MDOT-SHA report references a Metropolitan Washington Council of Governments (MWCOG) report from 2005 that "showed a downward trend in annual average PM<sub>2.5</sub> design values between 1999 and 2004" for the region. (Regarding terminology, note that Table A-11 in the MWCOG report presents annual average PM<sub>2.5</sub> concentrations, which is not the same thing as design values.) Table A-11 in the MWCOG report is included in this analysis as Table 1. It is recommended that the MDOT-SHA analysis include the information in Table 1 in order to present a more complete picture of ambient PM<sub>2.5</sub> concentrations in the area by monitor. We have augmented this table to include the 2005

annual average PM<sub>2.5</sub> concentrations for the Washington, DC-Maryland-Virginia area monitors. Inspection of the annual means for the 1999-2005 time period shown in the table does not indicate that there is a downward trend in these values. In fact, the median PM<sub>2.5</sub> annual mean for the area monitors is as high in 2005 as it was in 1999, 2001 and 2002.

On December 20, 2005, EPA proposed revisions to the NAAQS for particle pollution to protect the public health, citing evidence from nearly 2,000 new health research studies showing adverse health effects associated with exposure to daily concentrations of PM<sub>2.5</sub> well below the NAAQS set in 1997. The proposal would strengthen the short-term (24 hour) NAAQS for PM<sub>2.5</sub> and would replace the current annual and 24-hour PM<sub>10</sub> standards with a new, qualified indicator for thoracic coarse particles (PM<sub>10-PM<sub>2.5</sub></sub>). As proposed, the annual mean standard for PM<sub>2.5</sub> would be maintained at a level of 15 µg/m<sup>3</sup>, while the 24-hour primary standard (98<sup>th</sup> percentile form) would be lowered from 65 µg/m<sup>3</sup> to 35 µg/m<sup>3</sup>. EPA is under a court-ordered deadline to revise the NAAQS no later than September 2006. The importance of these proposed revisions to the Washington, DC-Maryland-Virginia PM<sub>2.5</sub> nonattainment area is that measured 24-hour average PM<sub>2.5</sub> concentrations at near roadway monitors will now exceed the 24-hour NAAQS rather than reaching levels that are only 55 percent of the NAAQS, and more rigorous analyses of the potential 24-hour average PM<sub>2.5</sub> concentration increases associated with proposed projects like the ICC are needed.

The MDOT-SHA analysis should present information about the onroad vehicle emissions for the nonattainment area as a percentage of total manmade PM<sub>2.5</sub> emissions to put the two direct PM<sub>2.5</sub> emission components in perspective. The Exhibit 1 PM<sub>2.5</sub> Trends Analysis for Washington, DC-Maryland-Virginia Nonattainment Area presents estimates of NO<sub>x</sub> and direct PM<sub>2.5</sub> emissions for 2002, 2010, 2020, and 2030 from the air quality conformity analysis. This exhibit is limited to onroad vehicle emissions, which are a subset of total NO<sub>x</sub> and direct PM<sub>2.5</sub> emissions for the region. The area's future attainment status for PM<sub>2.5</sub> will be influenced more by total nonattainment area emissions of these pollutants than by onroad vehicle emissions alone, so it is recommended that the analysis present the total emissions burden for the area.

EPA's March 2006 Transportation Conformity Guidance for Qualitative Hot-spot Analysis in PM<sub>2.5</sub> and PM<sub>10</sub> Nonattainment and Maintenance Areas (in section 4.2) says that the hot spot analysis should include a discussion of any mitigation measures that will be implemented and their expected effects. The MDOT-SHA analysis provides no information about possible mitigation measures and their expected effects. Example mitigation approaches might include retrofit of diesel truck engines operating in the area, implementing a diesel truck emissions inspection program, or a smoking vehicle identification and repair program.

**Table 1. Washington, DC-Maryland-Virginia Nonattainment Area Annual Average PM<sub>2.5</sub> Concentrations (1999-2005) (µg/m<sup>3</sup>)**

| Site ID   | Monitor              | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|-----------|----------------------|------|------|------|------|------|------|------|
| 110010041 | River Terrace        | 15.9 | 18.9 | 16.9 | 16.3 | 14.9 | 14.9 | 14.8 |
| 110010042 | Park Services        | 15.3 | 15.3 | 15.0 | 15.6 | 13.4 | 14.5 | 15.8 |
| 110010043 | McMillan Reservoir   | 18.1 | 15.7 | 16.1 | 15.6 | 14.3 | 14.4 | 14.5 |
| 240313001 | Rockville            | 13.5 | 14.3 | 12.8 | 13.0 | 11.9 | 12.6 | 13.6 |
|           | Bladensburg          | 19.3 | 18.3 | 17.1 | 18.4 |      |      |      |
|           | Greenbelt            |      |      |      | 12.1 | 11.5 | 9.8  |      |
| 240330030 | Beltsville           |      |      |      |      |      | 12.6 | 13.4 |
|           | Suitland             | 15.2 | 14.4 | 13.5 |      |      |      |      |
| 240338003 | PG Equestrian Center |      |      |      | 15.4 | 12.6 | 13.3 | 13.8 |
|           | Arlington            | 13.8 | 14.9 | 14.7 | 14.9 | 14.1 | 14.5 | 15.2 |
| 510590030 | Franconia            | 13.4 | 14.1 | 14.3 | 13.1 | 13.2 | 13.9 | 13.4 |
|           | Seven Corners        | 14.5 | 15.3 | 13.9 |      |      |      |      |
| 510591005 | Annandale            |      |      |      | 13.7 | 13.2 | 13.7 | 14.3 |
| 510595001 | Lewinsville          | 14.3 | 15.1 | 14.5 | 14.1 | 13.6 | 14.0 | 14.7 |
| 511071005 | Ashburn              | 12.8 | 13.8 | 14.1 | 13.5 | 13.1 | 14.1 | 14.5 |
|           | <i>Highest</i>       | 19.3 | 18.9 | 17.1 | 18.4 | 14.9 | 14.9 | 15.8 |
|           | <i>Lowest</i>        | 12.8 | 13.8 | 12.8 | 12.1 | 11.5 | 9.8  | 13.4 |
|           | <i>Median</i>        | 14.5 | 15.1 | 14.5 | 14.5 | 13.2 | 14.0 | 14.5 |

NOTE: Blank data indicates the monitor has not been installed or has been removed.

SOURCE: MWCOG. The 2005 data have been added to the original MWCOG table. The 2005 annual average PM<sub>2.5</sub> concentrations are taken from Appendix A of the MDOT-SHA analysis.

Note also that the MDOT-SHA analysis only examined one master plan alignment for the ICC (the preferred approach). This analysis should include other scenarios, such as transit oriented land use and development, toll lane-express bus, High Occupancy Toll lane-express bus, and a combination of the above.

## NEAR ROADWAY MEASURED FINE PARTICLE CONCENTRATIONS

There is limited information in the literature about roadway traffic generated fine particle contributions to ambient  $PM_{2.5}$  levels. This information is limited in part because of the recent emphasis in EPA's  $PM_{2.5}$  monitoring programs to establish monitors at locations that satisfy the primary objectives of determining each area's compliance with established ambient air quality standards, and to provide data that was compatible with health effects research needs. However, it is important to consider the research that has been conducted and to use that information to assist in evaluating the potential  $PM_{2.5}$  hot spots that might occur near new roadway construction, considering the contributions from other nearby roadways as well. This research also provides another indicator of what  $PM_{2.5}$  concentrations might be near the ICC roadway.

For example, Zhu et al, present results of measured PM concentrations near the Interstate 405 freeway and the Interstate 710 freeway in the South Coast Air Basin. The Interstate 405 study shows that particle number concentration near the freeway was about 25 times greater than that at background locations, and that the concentration of ultrafine particles drops to background levels within 300 meters downwind of the freeway. For the conditions of these measurements, relative concentrations of CO and BC near the freeway tracked each other well as distance from the freeway increased. (BC originates as ultrafine or fine particles from primary sources during incomplete combustion of carbon-based fuels, for example, diesel engines, wood burning, and poorly maintained industrial and residential heating.) Particle number concentration (6-220 nm) decreased exponentially with downwind distance from the freeway. Data showed that both atmospheric dispersion and coagulation contributed to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. Average traffic flow during the sampling periods was 13,900 vehicles per hour. Ninety three percent of vehicles were gasoline powered cars or light trucks.

The Interstate 405 study included measurements of concentrations of CO, BC, PM and particle number at increasing distances from the freeway. CO and BC were intentionally selected because their ambient concentrations are related closely to vehicle emissions. Averaged concentrations at five distances from the freeway are summarized below along with measured upper and lower limits:

### Measured Average (and Upper and Lower Limit) BC Concentrations at Increasing Distances from the 405 Freeway

| Downwind Distance (m) | BC ( $\mu\text{g}/\text{m}^3$ ) | BC ( $\mu\text{g}/\text{m}^3$ ) Downwind-Upwind Average Concentration |
|-----------------------|---------------------------------|---|
| 30                    | 5.4 (3.4-10.0)                  | 4.75  |
| 60                    | 3.2 (3.0-3.5)                   | 2.55  |
| 90                    | 2.5 (2.4-2.6)                   | 1.85  |
| 150                   | 1.6 (1.1-2.0)                   | 0.95  |
| 300                   | 1.3 (1.1-1.5)                   | 0.65  |

The Interstate 710 study was conducted in part because the freeway has a much higher percentage of heavy-duty diesel truck travel than the Interstate 405 freeway. On the 710 freeway, more than 25 percent of the vehicles are heavy-duty diesel trucks. Measurements were taken at 17, 20, 30, 90, 150 and 300 meters downwind and 200 meters upwind from the center of the freeway. As with the 405 freeway study, relative concentrations of CO, BC and particle number downwind from the freeway were found to be many micrograms per cubic meter greater than upwind concentrations and tracked each other well as one moves away from the freeway. These measured average BC concentrations at increasing distances from the 710 Freeway are shown in the table below. Both atmospheric dispersion and coagulation appear to contribute to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. Average traffic flow during sampling periods was 12,180 vehicles per hour with more than 25 percent of vehicles being heavy-duty diesel trucks. The data resulting from this study may be used to estimate exposure to ultrafine particles in the vicinity of major highways.

### Measured Average (and Upper and Lower Limit) BC Concentrations at Increasing Distances from the 710 Freeway

| Downwind Distance (m) | BC ( $\mu\text{g}/\text{m}^3$ ) | BC ( $\mu\text{g}/\text{m}^3$ ) Downwind-Upwind Average Concentration |
|-----------------------|---------------------------------|---|
| 200 m (upwind)        | 4.6 (3.1-5.9)                   |   |
| 17 m                  | 21.7 (20.3-24.8)                | 17.1  |
| 20                    | 19.4 (16.5-21.6)                | 14.8  |
| 30                    | 17.1 (12.6-19.3)                | 12.5  |
| 90                    | 7.8 (4.5-9.3)                   | 3.2   |
| 150                   | 6.5 (3.9-9.2)                   | 1.9   |
| 300                   | 5.5 (3.5-7.7)                   | 0.9   |

A recent study in Seattle, WA (Curtis, Gilroy, and Harper, 2004) studied the relationship between BC levels at an urban near roadway monitoring site, and a heavily traveled freeway. This study showed that there were frequently peak evening rush hour BC levels of  $5 \mu\text{g}/\text{m}^3$  or above near I-5. The I-5 traffic corridor is a microscale monitoring site represented by the Olive Street BC data. The traffic volumes and BC readings correlate well, supporting the hypothesis that traffic is a major contributor to  $\text{PM}_{2.5}$  at the site, given that BC originates as ultrafine or fine particles. The Olive Street air monitoring site is about 20 meters west of the southbound lane of I-5. This area of I-5 contains express lanes along several high use overpasses which all contribute to the area traffic. Daily volumes along this section of I-5 average 284,700 vehicles per day (in 2003). Light-duty traffic has peak weekday flows above 10,000 vehicles per hour, with diesel traffic of about 1,000 vehicles per hour. BC tends to peak during weekdays with high traffic volumes, and is sharply lower on weekends. This reduction parallels the significantly lower weekend diesel traffic volumes.

Peak BC measurements occur during the afternoon rush hour (4-6 pm). Correlations between light-duty vehicle volumes and BC peaks (readings above  $5 \mu\text{g}/\text{m}^3$ ) are better than those between diesel truck volumes and BC peaks. This may occur because light-duty volumes overwhelm diesel truck volumes during this period (93 percent of the traffic volume is from light-duty vehicles).

The Seattle study also provides BC measurements for a Beacon Hill site, which is used as the urban background for Seattle. Hourly BC readings during the week of July 21-27, 2003 stayed within the range of 0 to 2  $\mu\text{g}/\text{m}^3$ , with readings mostly below 1.0  $\mu\text{g}/\text{m}^3$ .

An East Bay (California) children's respiratory health study (Kim et al., 2004) provides measurements of BC concentrations taken at schoolyards in the area around Oakland, CA. This study evaluated nearby traffic sources and average pollutant concentrations at ten schools. BC concentrations were found to be between 0.7 and 0.8  $\mu\text{g}/\text{m}^3$  at schools without nearby major traffic sources. Schools within 60 to 360 meters of major traffic sources (90,000 to 210,000 annual average daily traffic) were found to have BC concentrations between 0.8 and 1.1  $\mu\text{g}/\text{m}^3$ . Notably, BC concentrations are above the study average (0.8  $\mu\text{g}/\text{m}^3$ ) only for those schools that are near and downwind of heavily traveled freeways. The highest BC concentration of 1.1  $\mu\text{g}/\text{m}^3$  was measured at the school 60 meters from a freeway. This East Bay study helps to define the lower bound of the range of BC contributions from highways.

The above research studies provide evidence through measurements of BC downwind of heavily traveled freeways of the likely contribution of a highway to ambient  $\text{PM}_{2.5}$  levels (BC is a component of  $\text{PM}_{2.5}$  and the BC measured in these studies is emitted as fine or ultrafine particles—less than 2.5 microns). Thus, these data show based on similar vehicle mixes and traffic volumes what the range of  $\text{PM}_{2.5}$  contributions is likely to be at different downwind distances from the ICC. In addition, given the levels of observed BC concentrations measured downwind of roadways, baseline  $\text{PM}_{2.5}$  ambient concentrations measured at non-urban sites not near heavily traveled roadways are not likely to represent ambient levels near the proposed project. Therefore, based on these data, in the residential neighborhoods along the ICC alignment, current BC levels should be near 0.7  $\mu\text{g}/\text{m}^3$ . After the ICC is built, BC concentrations are likely to be in the range of 5  $\mu\text{g}/\text{m}^3$  at a 30-meter distance, and declining with distance from the roadway to values around 1.0  $\mu\text{g}/\text{m}^3$  at 300 meters.

## SOURCE APPORTIONMENT

While the MDOT-SHA analysis focuses on direct  $\text{PM}_{2.5}$  emissions, information from source apportionment studies for the Washington, DC area show the complexity of  $\text{PM}_{2.5}$  formation and the different source contributions to observed  $\text{PM}_{2.5}$  levels in the area. Source apportionment methods for airborne PM are required to understand the relationship between human exposure and source emissions. Positive matrix factorization (PMF) has been developed to be a powerful receptor model for airborne PM and has been used to assess ambient PM source contributions. A recent research paper by Kim and Hopke (2005) examines the use of carbon fractions in source apportionment studies to identify ambient  $\text{PM}_{2.5}$  sources for three monitoring areas in the eastern United States, one of which was Washington, DC.  $\text{PM}_{2.5}$  samples were collected on Wednesdays and Saturdays at the IMPROVE monitoring site in Washington, DC. A total of 718 samples and 35 species collected between August 1988 and December 1997 were used for the Washington, DC study. This monitoring site is located near the Potomac River, 2 kilometers southeast of the Lincoln Memorial, 3 kilometers northeast of Ronald Reagan Washington National Airport, and 30 meters above sea level. Highways (I-395) are closely situated to the north and west of the site. At its closest point, the IMPROVE site is about 350 meters from I-395.

The average contribution of each source to the PM<sub>2.5</sub> area's concentrations at the Washington, DC site is shown in Table 2. The fraction of mass contributions from gasoline and diesel emissions in Washington, DC is 23 percent. High weekday-to-weekend ratios for diesel emissions demonstrate that diesel emissions are mostly from vehicles operating primarily on weekdays.

**Table 2. Comparison of Average Source Contributions (%) to PM<sub>2.5</sub> Mass Concentrations Among PMF Studies with Eight Carbon Fractions**

| Variable                                | Average Source Contribution |
|---|-----------------------------|
|   | Washington, DC              |
| Secondary Sulfate Aerosol (summer-high) | 42.8 (1.4)                  |
| Secondary Sulfate Aerosol (winter-high) | 6.0 (0.2)                   |
| Secondary Sulfate Aerosol (carbon-rich) | 10.6 (0.4)                  |
| Diesel Emissions                        | 1.8 (0.1)                   |
| Gasoline Vehicle                        | 21.0 (0.6)                  |
| Secondary Nitrate Aerosol               | 8.4 (0.3)                   |
| Airborne Soil                           | 1.9 (0.1)                   |
| Incinerator                             | 3.7 (0.1)                   |
| Aged Sea Salt                           | 2.2 (0.1)                   |
| Oil Combustion                          | 1.5 (0.1)                   |

SOURCE: Kim and Hopke, 2005

While the IMPROVE site may not be fully representative of the PM<sub>2.5</sub> concentrations near the ICC, these results should provide a reasonable representation of the source contributions to observed PM<sub>2.5</sub> levels in the area, and should be considered in any PM hot spot analyses. Given the low sulfur dioxide emissions within the Washington, DC-Maryland-Virginia area, it is likely that the sulfate contribution observed in this research will be found at consistent levels at monitors throughout the region because it results from long-range transport. Therefore, site-to-site variations in PM<sub>2.5</sub> levels in the region most likely result from variations in vehicle emissions strengths. Thus, the importance of considering nearby vehicle emissions in selecting monitors as representative of the ICC location.

## DISPERSION MODELING

The PM<sub>2.5</sub> hot spot analysis performed by SHA should have included dispersion modeling to determine whether the any of the communities located adjacent to the ICC would be exposed to increased concentrations of PM<sub>2.5</sub> that might exceed the annual or 24-hour PM<sub>2.5</sub> NAAQS. Data and methods that could be used to perform such an analysis are described below.

### Models

CALINE-3 and CAL3QHC/CAL3QHCR are listed by EPA as preferred/recommended dispersion models. CALINE-3 is a steady state Gaussian dispersion model designed to determine air pollution concentrations at receptor locations downwind of highways located in relatively uncomplicated terrain. CALINE-3 is designed to predict air pollutant concentrations near highways and arterial streets due to motor vehicles operating under free flow conditions.

The CALINE-3 algorithms are incorporated into the more refined CAL3QHC and CAL3QHCR models. CAL3QHC is a CALINE-3 based CO and PM model with queuing and hot spot calculations and with a traffic model to calculate delays and queues that occur at signalized intersections; CAL3QHCR is a more refined version based on CAL3QHC that requires local meteorological data and can determine daily or annual concentrations of PM. The resources needed to develop the input files required by CAL3QHCR and for analyzing the output results are relatively modest. The primary inputs that would be needed to run CAL3QHCR to determine PM<sub>2.5</sub> hot spots along the ICC corridor are described below.

### **Road Network**

The dispersion modeling should be focused on areas of the ICC with the heaviest expected traffic volumes (e.g., in the I-95 corridor or the area where the ICC meets I-370). Interstates, freeways, and major arterials in the selected area should be included in the road network to be modeled. For input to CAL3QHCR, roadway links need to be coded with x and y coordinates at the beginning and end of each link. This can be done fairly simply using some of the detailed maps provided in the Final Environmental Impact Statement, or from existing link coordinates used for emission and air quality modeling in the Washington area. These links should be designed to capture the approximate alignment of the ICC and the surrounding highways and major arterials.

### **Receptor Network**

The CAL3QHCR dispersion model allows up to 60 receptors to be modeled in a single input file. A receptor matrix should be designed to determine the maximum PM<sub>2.5</sub> concentrations likely to be experienced by people residing close to the ICC or by those using facilities such as schools, parks, and day care centers located near the ICC. One approach that could be used to determine the extent of the PM<sub>2.5</sub> dispersion would be to first design a receptor matrix with receptors located about 50 meters on either side of the ICC and at increments of 50 meters beyond that to about 300 to 500 meters from the road. Rows of these receptors should be spaced parallel to the ICC in increments of about 50 to 100 meters. Results of this sensitivity analysis could then be used to determine how far away from the highway the dispersion is significant. Using this as a guideline along with detailed maps of the areas surrounding the ICC, receptor locations could be selected within the range of the expected dispersion that includes residential and public facilities.

### **Traffic Volumes**

For the portions of roads to be included in the road network, daily traffic volumes are needed. These are available from the appendices to the DEIS Travel Analysis Technical Report. The data available show traffic volumes by road and direction at each key intersection in the analysis area. For input to CAL3QHCR, hourly traffic volumes are needed. The daily traffic volumes from the DEIS should be adjusted by hour using local hourly traffic allocations, such as those used by MWCOG in its emission modeling of the Washington metropolitan area for transportation conformity and SIP purposes. CAL3QHCR provides the availability to model each day of the week using different hourly traffic volumes. At a minimum, daily traffic adjustment factors to distinguish weekday traffic patterns from weekend traffic patterns should be applied.

## Emission Factors

To determine typical emission factors on the ICC and surrounding roadways, MOBILE6.2 could be modeled using local conditions to provide a conservative estimate of PM<sub>2.5</sub> emission factors from onroad vehicles. As stated in the preamble to the final rule for PM<sub>2.5</sub> hot-spot analyses in transportation conformity determinations, MOBILE6.2 is expected to provide reasonable estimates of PM<sub>2.5</sub> emission factors on a regional basis. However, on the microscale level, MOBILE6.2 does not account for variations in inputs such as temperature, speed, and driving cycle (e.g., acceleration, deceleration, cruise) in determining the PM<sub>2.5</sub> emission factors. On a roadway such as the ICC, vehicle accelerations could increase the PM<sub>2.5</sub> emission factors above those predicted by MOBILE6.2.

An important local characteristic that should be captured in performing MOBILE6.2 emission factor modeling is the fraction of vehicle miles traveled (VMT) from heavy-duty diesel vehicles (HDDVs) and the distribution of vehicles by age (particularly the heavy-duty vehicles). PM<sub>2.5</sub> emission factors from HDDVs are generally an order of magnitude greater than PM<sub>2.5</sub> emission factors from light-duty vehicles, as well as from heavy-duty gasoline vehicles. Thus, the distribution of activity by vehicle type is important to capture. If the fraction of VMT from HDDVs is expected to differ on the ICC from that on the connecting roads, such as I-95, then emission factors should be developed separately for each road with a distinct HDDV VMT fraction. In addition, as more stringent vehicle control requirements are phased in, PM<sub>2.5</sub> emission factors from projection years with PM controls fully phased in will be significantly lower than emission factors from older vehicles subject to less stringent standards. Thus, the local registration data used in performing conformity and SIP analyses for the area should also be used in these hot spot analyses.

## Meteorological Data

To perform dispersion modeling using CAL3QHCR, a meteorological data set including the wind flow vector, wind speed, and ambient temperature, by hour for each day of the year is needed for a year's worth of data. For a base year modeling run, the meteorology should correspond to the year being studied. For a projection year, an historical year with fairly typical meteorology should be selected. Unless data are available at a closer site to the ICC, meteorological data sets for the Reagan Washington National Airport could be used. These can be obtained from the National Climatic Data Center. The wind data that are input to CAL3QHCR must be reported in terms of wind flow (i.e., the direction the wind is blowing towards), while most meteorological data sites report wind direction (i.e., the direction from which the wind is blowing). Wind direction can be converted to wind flow by adjusting the wind direction by 180 degrees. The CAL3QCHR model requires a single set of inputs for each hour for the time being modeled. Thus, some manipulation of the meteorological data set will likely be needed to ensure that one and only one set of data are included for each hour of the selected year.

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