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# TRANSPORTATION CONFORMITY PARTICULATE MATTER HOT-SPOT AIR QUALITY MODELING

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A report of the findings of
**ICT-R27-93**
**Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling**

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## ACRONYMS

| | |
|---|---|
| ADT | Average daily traffic |
| AADT | Annual average daily traffic |
| BDE | Bureau of Design and Environment |
| CAAA | Clean Air Act Amendment |
| CBL | Convective boundary layer |
| CMAP | Chicago Metropolitan Agency for Planning |
| CTM | Chemical transport model |
| DOT | Department of Transportation |
| EF | Emission factor |
| EPA | Environmental Protection Agency |
| ETS | Emissions, traffic and signalization |
| FHWA | Federal Highway Administration |
| GHG | Greenhouse gas |
| GUI | Graphical user interface |
| ICT | Illinois Center for Transportation |
| IDOT | Illinois Department of Transportation |
| MET | Abbreviation for meteorological |
| MOVES | Motor Vehicle Emissions Simulator |
| MPO | Metropolitan planning organization |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | National Environmental Policy Act |
| NWS | National weather station |
| PBL | Planetary boundary layer |
| PM | Particulate matter |
| PDM | Project data manager |
| SBL | Stable boundary layer |
| SIP | State implementation plan |
| TAZ | Traffic analysis zone |
| TRP | Technical Review Panel |
| VSP | Vehicle specific power |

# EXECUTIVE SUMMARY

## INTRODUCTION

On March 10, 2006, the U.S. Environmental Protection Agency (U.S. EPA) published a final rule requiring project-level, hot-spot particulate matter (PM) transportation conformity analysis in nonattainment and maintenance areas for “projects of air quality concern” (40 CFR Part 93, *FR*, March 10, 2006). The 2006 U.S. EPA’s $PM_{2.5}$ and $PM_{10}$ hot-spot regulations also state that “quantitative PM hot-spot analyses will not be required until U.S. EPA releases an appropriate motor vehicle emissions model for these project-level analyses.” On December 23, 2009, U.S. EPA released the final draft version of its next-generation Motor Vehicle Emission Simulator (MOVES2010), which is capable of estimating project-level total emissions and emission rates. Following that, in December 2010, U.S. EPA released a public guidance document, *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in* $PM_{2.5}$ *and* $PM_{10}$ *Nonattainment and Maintenance Areas* (EPA-420-B-10-040, December 2010), in which MOVES2010 is designated the official mobile emission model, and AERMOD and CAL3QHCR are designated air-dispersion models for the PM hot-spot conformity analyses.

In Illinois, there are two annual $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) nonattainment areas: Chicago and St. Louis (Metro-East). PM hot-spot analyses are required and reported in Illinois Department of Transportation (IDOT) National Environmental Policy Act (NEPA) documents prepared for IDOT projects. Currently, the Federal Highway Administration (FHWA) and the IDOT Bureau of Design and Environment (BDE) require project existing and projected average daily traffic (ADT) and the percentage of diesel trucks be provided to determine whether a project is of air quality concern. IDOT districts are required to provide and present this information, usually at a district coordination meeting. Based on the traffic volumes and the percentage of diesel trucks, FHWA/BDE determines whether a project is of air quality concern.

In light of the new development in PM hot-spot regulations and IDOT’s NEPA documentation requirements, the Illinois Center for Transportation (ICT) issued a request for proposal (RFP) on June 30, 2010, to perform quantitative modeling of motor vehicle–generated PM in Illinois’s $PM_{2.5}$ nonattainment and maintenance areas [in IDOT Districts 1, 3, and 8 (Chicago and Metro East)], following the U.S. EPA’s PM hot-spot guidance. A research team led by Dr. Jane Lin of University of Illinois at Chicago was selected to perform the research.

## STUDY OBJECTIVE AND SCOPE

Over the course of the project, there has been a tremendous learning process for the research group, as well as the Technical Review Panel (TRP), with respect to understanding the technical requirements in every single step of the guidance. As a result, the study objective and scope have evolved during the project.

The project initially set out to find Illinois-specific threshold values for defining “projects of potential air quality concern” and to develop a graphical user interface (GUI) that IDOT could use to determine easily whether a project is of air quality concern.

As the research team and the TRP gained a better understanding of the PM hot-spot guidance and insight into the technical details, it was found that $PM_{2.5}$ hot-spot analyses differ from project to project, with the results being difficult to generalize across projects for several reasons: (1) $PM_{2.5}$ has a complicated chemical composition and may vary from site to site, (2) each project has specific source and receptor placements, (3) many factors [e.g., site geometry, traffic composition, meteorological conditions, project location (urban vs. rural), and air-dispersion model parameters] are at work, and (4) the recent modification of the $PM_{2.5}$ annual ambient standard from 15 μg/m$^3$ to 12 μg/m$^3$ has also elevated the importance of the background concentration levels to the decision of $PM_{2.5}$ hot-spot conformity. In particular, both Chicago and Metro East have very high background annual $PM_{2.5}$ average concentration levels, which already put the two areas at the risk of violating the NAAQS, even in the no-build scenario. In that sense, the goal of finding threshold values is in question.

Thus, the project scope was modified to (1) perform and demonstrate quantitative $PM_{2.5}$ hot-spot analyses in the Chicago and Metro East areas, (2) identify data needs and gaps in $PM_{2.5}$ hot-spot modeling, (3) gain technical insights into PM hot-spot modeling, and (4) understand uncertainties and limitations of PM hot-spot modeling.

## STUDY APPROACH

The modeling exercise started with attempting to gain an understanding of MOVES, the new U.S. EPA mobile source emission model, with respect to model input, parameters, model capability, and output. A number of sensitivity analyses were also performed to understand the effects of various parameters on the MOVES emission estimation. The parameters investigated include temperature, calendar year, season, and time-of-day variation. Chapter 4 details the MOVES project scale-model setup and Chapter 6 discusses the sensitivity-analysis results.

The air dispersion models, AERMOD and CAL3QHCR, were investigated, with respect to the model input requirements, technical details, and modeling effort, as well as to make comparisons between the two. AERMOD is the focus because it is a newly introduced model to the transportation agencies. Chapter 5 describes the specifications for both models.

After getting a good handle on MOVES and the air-dispersion models for PM hot-spot analyses, the research team then set out to assess the amount of modeling effort and technical requirements through a pilot study at the interchange of I-80 and I-55, south of Chicago. It is a typical cloverleaf-shaped highway interchange with a modest amount of traffic - hourly volumes from as low as 30 vehicles per hour (vph) on a ramp to about 3000 vph on the main line. However, truck traffic can go as high as 70% at some locations. Chapter 7 details the pilot study and the model implementation step-by-step.

Three case studies were then performed, one highway project in Metro East and two arterial street-signal intersection projects, with one each from Chicago and Metro East. Furthermore, the effect of a project's geographic location (in this context, Chicago or Metro East) on the $PM_{2.5}$ concentration levels was tested, after controlling for geometry and traffic conditions of the case study site. Owing to such factors as different meteorological conditions, fuel supply, vehicle fleet age distribution, and Inspection and Maintenance (I/M) program, geographic location would have an effect on the $PM_{2.5}$ concentration levels, even if the traffic conditions, site geometry, and other site configurations are exactly the same. Chapter 8 describes in detail the model input and the results for each case study.

## MAJOR FINDINGS

The most important finding was that so many factors are at work in various degrees in the case of $PM_{2.5}$ hot-spot modeling. It is generally difficult, if not nearly impossible, to generalize the findings of one case study to another. To complicate the modeling process further, the research team found that AERMOD and CAL3QHCR models use very different methodologies to model pollutant atmospheric dispersion and show considerable discrepancies in model results for the same project setting. Thus, more in-depth investigation is needed.

The geographic location of a roadway project plays an obviously important role in $PM_{2.5}$ hot-spot modeling because such factors as meteorological conditions, fuel supply, and fleet age distribution vary by location. In particular, temperature is a major factor. Because $PM_{2.5}$ emissions from diesel vehicles are highly insensitive to temperature, the difference is attributed to gasoline vehicles.

The urban/rural classification of a project site matters considerably because it directly determines which local meteorological inputs (from a nearby urban or rural representative weather station) to use in emission and air-dispersion modeling. The pilot study showed that using the rural meteorological representation can result in 1.4 times the urban concentration levels (without the background concentration levels).

Some findings specific to the pilot and case studies in this project are as follows:

- For the highway projects, the contribution from traffic ranges roughly from 0 to 4 micrograms per cubic meter ($\mu g/m^3$) in Chicago and from 0 to 3 $\mu g/m^3$ in Metro East. These results are found to be comparable with those of other studies in other parts of the country.
- For the arterial projects, the contribution from traffic ranges roughly from 0 to 3 $\mu g/m^3$ in Chicago and from 0 to 1.5 $\mu g/m^3$ in Metro East. These results are found to be comparable with those of other studies in other parts of the country.
- The background concentrations in both Chicago and Metro East are already very high, typically above 10 $\mu g/m^3$ in Chicago and above 11 $\mu g/m^3$ in St. Louis. Even a small contribution from a roadway project in either region may push the project to exceed the annual $PM_{2.5}$ NAAQS standard. In that case, the build versus no-build analysis is critical in determining a project of "potential air quality concern."

## MODEL EXPERIENCE AND INSIGHT

Tremendous experience was gained by the research team in $PM_{2.5}$ hot-spot conformity analyses from the project. Foremost, the PM hot-spot modeling procedure defined in the U.S. EPA guidance would require state DOTs, Metropolitan Planning Organizations (MPOs), and transportation-consulting companies a considerable amount of time and expertise to understand, as well as a workforce to implement. Not only because MOVES and AERMOD are new to most of them but also because of the great deal of technical details specific to the PM hot-spot conformity procedure defined in the guidance.

Based on the study, it is clear that the careful selection of input parameters for all models (MOVES, AERMOD, and CAL3QHCR) is required to avoid possible variations in the concentration results. In that sense, TRP input and interagency consultation were critical to the success of the $PM_{2.5}$ hot-spot conformity analyses.

There is a considerable data gap between what the models (MOVES and air-dispersion models) need and what is currently being collected by the transportation agencies (or what is being modeled, in the case of regional transportation modeling).

## RECOMMENDATION FOR FUTURE WORK

More case studies are needed to examine the effects of various project configurations and settings.

Further investigations in model performance are necessary with respect to key model input parameters (e.g., site geometry, traffic composition, fleet age distribution, and meteorology).

Further comparison between AERMOD and CAL3QHCR is warranted to better understand the consistency between the two models.

Finally, there is an urgent need to document the traffic and vehicle activity data requirements (e.g., traffic volume, fleet composition, signal data, traffic speed, etc.) in detail, to identify the potential sources, and to update the protocols and methods for collecting or generating the data.

# CONTENTS

# CHAPTER 1 INTRODUCTION

On March 10, 2006, the U.S. Environmental Protection Agency (U.S. EPA) published a final rule requiring project-level, hot-spot particulate matter (PM) transportation conformity analysis in nonattainment and maintenance areas on “projects of air quality concern” (40 CFR Part 93, FR March 10, 2006). In Illinois, PM hot-spot analyses are reported in Illinois Department of Transportation (IDOT) National Environmental Policy Act (NEPA) documents prepared for IDOT projects, when a hot-spot analysis is required. The 2006 U.S. EPA’s $PM_{2.5}$ and $PM_{10}$ hot-spot regulations also state that “quantitative PM hot-spot analyses will not be required until U.S. EPA releases an appropriate motor vehicle emissions model for these project-level analyses.” On December 23, 2009, U.S. EPA released the final draft version of its Motor Vehicle Emission Simulator (MOVES2010), which is capable of estimating project-level total emissions and emission rates and is the newly designated mobile source emission model replacing MOBILE. Following that in December 2010, U.S. EPA released a public guidance document *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and $PM_{10}$ Nonattainment and Maintenance Areas* (EPA-420-B-10-040, December 2010), in which MOVES2010 is designated the official mobile source emission model for the analyses.

This chapter will first briefly introduce the 2010 U.S. EPA’s PM hot-spot guidance, followed by the project scope/objectives, and lastly will provide a highlight of the importance of interagency consultation throughout the PM hot-spot modeling process.

## 1.1 PARTICULATE MATTER

Particulate matter (PM) is fine particles of solid matter suspended in liquid or gas. These particles come in different dimensions and shapes, which determine how they are transported in the air and removed from it. These properties also determine how these particles are inhaled into the respiratory system, which directly relates to potential health problems. Based on the size, PM can be broadly classified into two groups: coarser particles, with sizes ranging from 2.5 to 10 micrometers (μm); and finer particles, with sizes less than 2.5 μm. $PM_{2.5}$ refers to particulate matter of size 2.5 μm, and $PM_{10}$ refers to size 10 μm. Coarser particles are predominantly produced from industrial sources, crushing and grinding rocks and soil, windblown soil and dust, and wear of vehicular brakes and tires. Finer particles are predominantly produced from fuel combustion, agricultural burning, and smelting and processing metals (Almeida et al. 2005; Chow et al. 1994). According to the *Transportation Energy Data Book* (U.S. Department of Energy 2010), the transportation sector accounted for 3.2% of the nation’s total $PM_{10}$ emissions and 8% of the total $PM_{2.5}$ emissions in 2008. In the transportation sector, gasoline-powered vehicles accounted for 48.6% of $PM_{10}$, and diesel-powered vehicles accounted for the remaining 51.4%. However for $PM_{2.5}$, diesel-powered vehicles accounted for nearly two-thirds (63.3%), and gasoline-powered vehicles accounted for the remaining 36.7%. To protect public health, in 2006, U.S. EPA revised the 24-hour $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) from the level of 65 micrograms per cubic meter (μg/m$^3$) to 35 μg/m$^3$ and retained the annual fine particle standard at 15 μg/m$^3$. In December 2012, U.S. EPA revised the annual $PM_{2.5}$ standard from 15 μg/m$^3$ to 12 μg/m$^3$ (U.S. EPA *Particulate Matter Standards*; U.S. EPA *Regulatory Actions*).

## 1.2 QUANTITATIVE PM HOT-SPOT CONFORMITY-ANALYSIS GUIDANCE

The 1990 Clean Air Act Amendments (CAAA) requires states to attain and maintain the NAAQS. The requirements of the CAAA establish significant restrictions on transportation investments in areas already exceeding the standards, so that the regional and local air quality does not get any worse. Specific to reducing PM emissions, U.S. EPA published a final rule in 2010 requiring project-level, hot-spot PM transportation conformity analysis in nonattainment and maintenance areas for “projects of air quality concern” (U.S. EPA 2010a).

Transportation conformity is required under Clean Air Act section 176(c) [42 U.S.C. 7506(c)] to ensure that federally supported highway and transit project activities are consistent with the purpose of the state air quality implementation plan (SIP). Conformity to the purpose of the SIP means that transportation activities will not cause new air quality violations, worsen existing violations, or delay the timely attainment of the relevant NAAQS. Hot-spot analysis, as defined in 40 CFR Part 93.101, is an estimation and comparison of likely future, localized PM pollutant concentration with NAAQS. This analysis is done to ensure that current and future transportation projects meet the Clean Air Act conformity requirements. “Projects of air quality concern” are certain highway and transit projects that involve significant levels of diesel traffic, or any other project that is identified by the PM SIP as a localized air quality concern. $PM_{2.5}$ nonattainment and maintenance areas are required to attain and maintain two standards—a 24-hour standard of 35 $\mu g/m^3$ and an annual standard of 12.0 $\mu g/m^3$ [on December 14, 2012, the U.S. EPA revised the $PM_{2.5}$ standard to 12 $\mu g/m^3$ (U.S. EPA *Regulatory Actions*)]. $PM_{10}$ nonattainment and maintenance areas are required to attain and maintain a 24-hour standard of 150 $\mu g/m^3$.

In December 2010, U.S. EPA released the final version of *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in $PM_{2.5}$ and $PM_{10}$ Nonattainment and Maintenance Areas* (U.S. EPA 2010b), in which MOVES2010 is designated the official mobile emission model for the analyses (except in California) and AERMOD or CAL3QHCR for air dispersion modeling for the analyses.

## 1.3 EVOLUTION OF THE PROJECT SCOPE

In Illinois, there are two annual $PM_{2.5}$ NAAQS nonattainment areas: Chicago and Metro East. PM hot-spot analyses are required and reported in IDOT NEPA documents prepared for IDOT projects. Currently, the Federal Highway Administration (FHWA) and the IDOT Bureau of Design and Environment (BDE) require project existing and projected average daily traffic (ADT) and the percentage of diesel trucks be provided, to determine whether a project is of air quality concern. IDOT districts are required to provide and present this information, usually at a district coordination meeting. Based on the traffic volumes and the percentage of diesel trucks, FHWA/BDE determines whether a project is of air quality concern.

In light of the new development in PM hot-spot regulations and IDOT’s NEPA documentation requirements, initially the goal of the project was to determine thresholds (based on ADT and percent diesel trucks) that would provide IDOT with specific level(s) that could be defended, if challenged, and would reduce the work required by district staff to obtain and present project-specific traffic data. Projects that exceeded the approved thresholds (projects of air quality concern) would require additional PM modeling to be undertaken. Therefore, this project initially set out to find Illinois-specific threshold values for defining “projects of potential air quality concern” and to develop a graphical user interface (GUI) that IDOT could use to determine easily whether a project is a project of air quality concern.

Specifically, the original project consisted of the following five tasks:

Task 1: Generate Illinois-specific $PM_{2.5}$ emission rates using MOVES2010a.

Task 2: Perform quantitative $PM_{2.5}$ hot-spot analyses in nonattainment and maintenance areas.

Task 3: Assist in developing, defending, and securing the approval of Illinois-specific thresholds.

Task 4: Develop a graphical user interface computer program for PM hot-spot modeling and analyses.

Task 5: Produce a final ICT project report.

Over the course of the project, the original scope was modified as a result of better understanding of the PM hot-spot guidance and insight into the technical details; experience gained from a series of modeling exercises, including MOVES sensitivity analyses, AERMOD and CAL3QHCR comparison and sensitivity analyses, and case studies of step-by-step $PM_{2.5}$ hot-spot analyses in the Chicago and East St. Louis metropolitan areas. It was found that the $PM_{2.5}$ hot-spot analyses differ from project to project for several reasons: (1) $PM_{2.5}$ has a complicated chemical composition and may vary from site to site, (2) each project has specific source and receptor placements, and (3) many factors [e.g., site geometry, traffic composition, meteorological conditions, background concentrations, project location (urban versus rural), and air-dispersion model parameters are at work. These reasons have made the results of $PM_{2.5}$ hot-spot modeling difficult to generalize across projects, and therefore make it difficult to determine statewide threshold values for $PM_{2.5}$.

The recent modification of the $PM_{2.5}$ annual ambient standard from 15 μg/m$^3$ to 12 μg/m$^3$ has also elevated the importance of the background concentration levels to the decision of $PM_{2.5}$ hot-spot conformity. In particular, both Chicago and Metro East have very high background annual $PM_{2.5}$ average concentration levels, which already put the two areas at the risk of violating the NAAQS. New alignment projects would be more at risk for hot spot conformity problems. The no-build/build analysis becomes more important in determining a project of "potential air quality concern".

Based on the above, the project scope was modified to (1) perform and demonstrate quantitative $PM_{2.5}$ hot-spot analyses in the Chicago and Metro East areas, (2) identify data needs and gaps in $PM_{2.5}$ hot-spot modeling, (3) gain technical insights to PM hot-spot modeling, and (4) understand PM hot-spot modeling uncertainties and limitations.

## 1.4 INTERAGENCY CONSULTATION

The interagency consultation process is an important tool for performing any project-level conformity determination and discussing hot-spot analyses requirements. According to the U.S. EPA guidance (U.S. EPA 2010b), an interagency consultation process is required to determine the models and reach a consensus on assumptions such as the following:

1. The geographic area covered by the analysis.
2. The emission (MOVES/EMFAC) and air-dispersion (AERMOD/CAL3QHCR) models used in the analysis.
3. Whether/how to estimate road and construction dust emissions.
4. How the background concentration from nearby sources is calculated.
5. The appropriateness of receptors to be compared with the annual $PM_{2.5}$ NAAQS.
6. Whether to classify the case study site as urban or rural and to use the corresponding meteorological data.

The Technical Review Panel (TRP) for this study consists of representatives from the U.S. EPA, FHWA, IDOT, Illinois Environmental Protection Agency (Illinois EPA), and Chicago Metropolitan Agency for Planning (CMAP). The various agencies were helpful in solving technical issues and evaluating the appropriate methods and assumptions to be used in the hot-spot analyses. Conference calls were held throughout the duration of the project with the TRP, and various technical and regulatory issues were discussed at the meetings. Minutes of the meetings are provided in Appendix A.

# CHAPTER 2 PM HOT-SPOT CONFORMITY MODELING BACKGROUND

## 2.1 INTRODUCTION

This chapter gives an overview of MOVES (section 2.2), U.S. EPA's approved mobile source emission model; and AERMOD and CAL3QHCR (section 2.3), the designated air-dispersion models, in PM hot-spot conformity analyses. Model comparisons between emission models (MOVES and MOBILE) and air-dispersion models (AERMOD and CAL3QHCR) are also presented in the chapter.

## 2.2 EMISSION MODELING

### 2.2.1 MOVES

MOVES is U.S. EPA's next-generation emission model to replace MOBILE for emission rate estimation. Furthermore, MOVES also provides an estimate of total emission, which MOBILE does not. Other key distinctive features of MOVES that make it superior to MOBILE are (1) its modal-based approach, as opposed to average speed–based approach, for emission factor (EF) estimation; (2) the availability of MySQL database management, compared with an external spreadsheet data management scheme; (3) geographical scale at macro-, meso-, and microscale, compared with a single, large, regional scale; and (4) more sophisticated greenhouse gas (GHG) estimation mechanisms and total energy consumption estimation.

MOVES follows a modal approach for EF estimation, compared with the driving cycle–based approach followed by MOBILE, and calculates emission inventories or emission rates using a set of modal functions. A modal approach refers to estimating emissions based on vehicle operating modes, as defined by a number of factors, including speed, acceleration, and road grade. A driving cycle–based approach is essentially based on the average speed of the speed trace (representing a trip) to derive emission rates. In MOVES, operating modes are "binned" according to second-by-second speed and vehicle specific power (VSP). VSP represents the power demand placed on a vehicle under various driving modes and speeds. Vehicles are also binned into the so-called source bins. After distributing total activities into different bins, MOVES assigns an emission rate for according to vehicle characteristics that significantly influence fuel (or energy) consumption and emissions. Each unique combination of source and operating mode bins; and the emission rates are aggregated for each vehicle type. A few correction factors are applied to the emission rates—adjusting for the influence of temperature, air conditioning, and fuel effects—to obtain the total emissions as shown in Eq. (2.1) (Beardsley 2004).

$$Total\ Emissions_{emission\ process,vehicle\ type} = \left(\sum Emission\ Rate_{emission\ process,bin} \times Activity_{bin}\right) \times Adjustments_{process} \quad (2.1)$$

where the emission rate for each emission process is estimated for each source type and operating mode bin; adjustments are applied to emission rates to reflect the conditions for the location and time specified by the user. Adjustments are also made for temperature, humidity, air conditioning, I/M program, and fuel properties.

MOVES is a data-driven model with all inputs, outputs, default activities, base modal emission rates, and intermediate calculation data stored and managed in the MySQL database. This design provides users with flexibility in constructing and storing their own database under the unified framework in MySQL. MOVES is designed to estimate emissions at scales ranging from the individual link level to county, regional, and national levels. The macroscopic, or national, scale is the default selection in MOVES. Data collected on a nationwide level is apportioned, or allocated, to states or counties. With the mesoscopic, or county, scale, the model replaces the national default allocations with user-supplied data. The microscopic, or project, scale is the finest level of modeling in MOVES. It allows the user to model the emission effects from a group of specific roadway links and/or a single off-network common area (U.S. EPA 2002). An off-network (non-road) area is one where start and extended idle emissions are produced, such as a parking lot or a construction zone located along a highway.

The latest version of MOVES is MOVES2010b released by US EPA in April 2012 (and subsequently updated in January 2013). All the MOVES model runs in this project were updated to using MOVES2010b.

### 2.2.2 MOVES Versus MOBILE

Because MOVES is a new model, few studies in the literature have assessed its performance. Studies (Sonntag and Gao 2007; Beardsley et al. 2010) compared the macroscopic scale of MOVES and MOBILE and showed the difference in emission estimates was caused by the inclusion of alternative fuel types and newer-technology vehicles by MOVES. Bai et al. (2009) compared the macroscopic scale of MOVES with EMFAC and found the $CO_2$, $CH_4$ emission difference to depend on vehicle activity and base emission rate, respectively. Vallamsundar and Lin (2011) compared the mesoscopic scale of MOVES with MOBILE and found lower estimates of $CO_2$ and $NO_x$ from MOBILE, compared with MOVES, because of the underlying base emission rates.

## 2.3 AIR-DISPERSION MODELING

Once the emission estimates are obtained from MOVES2010b, the next step is to estimate pollutant concentrations in the atmosphere caused by vehicular emissions. Air-dispersion models are widely used to measure how the airborne pollutants disperse in the atmosphere and how the concentration disperses over time and space. These models are mainly used for regulatory purposes, such as determining whether the pollutant concentration in the atmosphere of an existing or proposed project meet the NAAQS. Regulatory models currently recommended by U.S. EPA are AERMOD and, CALPUFF; however, other models (such as CAL3QHC/CAL3QHCR, BLP, CALINE3, CTDMPLUS, and OCD) are also accepted by U.S. EPA (U.S. EPA *Preferred/Recommended Models*). A number of studies in the literature give an overview and comparison between different air-dispersion models and use of these models in different situations (Caputo et al. 2003). AERMOD and CAL3QHCR are the designated models for performing the PM hot-spot transportation conformity analysis. Because the focus of this project is on U.S. EPA's recommended models for transportation-related hot-spot analyses, detailed description has been provided for only CAL3QHCR and AERMOD.

### 2.3.1 CAL3QHC and CAL3QHCR

CALINE is a near-roadway Gaussian air-dispersion model developed by the California Department of Transportation and designed to predict air pollutant concentrations near roadways, for emissions from vehicles operating under free-flow conditions. CALINE uses a series of finite line elements (sources) to represent highway links and sums up the incremental concentration from each element. However, it does not permit the direct estimation of the contribution of emissions from idling vehicles. CAL3QHC enhances CALINE-3 by incorporating methods for estimating queue lengths and the contribution of emissions from idling vehicles. The model permits the estimation of total air pollution concentrations from both moving and idling vehicles. Surface roughness and meteorological variables (such as atmospheric stability, wind speed, and wind direction) are assumed to be spatially constant over the entire study area (U.S. EPA 1995a).

CAL3QHCR, a refined version of CAL3QHC, uses the same basic algorithm as the CAL3QHC model. Enhancements include incorporation of up to a year of detailed meteorological data, along with vehicular emissions, traffic volume, and signalization data, in one run, whereas CAL3QHC was designed to process 1 hour of meteorological and emissions traffic and signalization (ETS) data. CAL3QHCR incorporate various concentration-averaging algorithms (1-hour, 8-hour, 24-hour, and annual concentrations), compared with only the maximum hourly average by CAL3QHC. CAL3QHCR has some built-in assumptions, mostly related to the model application. Wind speed should be at least 1 meter per second (m/s), and speeds below this have not been validated for the model. The model is also highly sensitive to very low mixing heights (U.S. EPA 1995a).

### 2.3.2 AERMOD

AERMOD was developed as a replacement for U.S. EPA's Industrial Source Complex (ISC) Model ISC3 by incorporating parameterization of the planetary boundary layer (PBL) and a few other minor modifications. PBL is the turbulent air layer next to the earth's surface that is affected by the surface heating and drag; turbulence; and friction from its contact with the planetary surface. Vertical mixing and turbulence are strong in this layer and above the PBL is the free atmosphere, which is nonturbulent or only intermittently turbulent. Height of the PBL typically ranges from a few hundred meters at night to 1 to 2 km during the day. Other minor modifications to ISC3 include the modeling of plume interaction with terrain, surface releases, building downwash, and urban dispersion (Cimorelli et al. 2005).

AERMOD is a steady-state plume model. There are two types of PBL: the convective boundary layer (CBL) and the stable boundary layer (SBL). CBL driven by surface heating during the daytime has moderate to strong vertical mixing, whereas SBL driven by surface cooling during nighttime has little or no vertical mixing. AERMOD uses Gaussian distribution in both the horizontal and the vertical directions in the SBL, similar to CAL3QHC. But in the CBL, it uses Gaussian distribution in the horizontal but bi-Gaussian in the vertical direction; and the concentration is calculated as a weighted average of two distributions (Cimorelli et al. 2005). There are two regulatory components for AERMOD: the meteorological preprocessor (AERMET) and the terrain data preprocessor (AERMAP). AERMET processes the meteorological data from the National Weather Station (NWS) and onsite data. The two files produced by AERMET are the surface scalar parameters and the vertical profile of meteorological data. AERMAP preprocesses complex terrain data and generates receptor grids, using USGS Digital Elevation Data. Other nonregulatory components of AERMOD include AERSCREEN, which is the screening version of AERMOD; AERSURFACE, a surface-characteristics preprocessor; and BPIPRIME, a multi-building dimensions program for PRIME applications (U.S. EPA 2004a).

### 2.3.3 AERMOD Versus CAL3QHCR

With respect to model comparison, although a good number of studies compared AERMOD with its predecessor model ISC and found AERMOD to produce lower concentration estimates (Long 2004; Silverman et al. 2007), the literature also suggests there are conditions when AERMOD predicts concentrations that are much higher than those predicted by ISC (Faulkner et al. 2008). Chen et al. (2009) compared CALINE4, CAL3QHCR, and AERMOD for near-road $PM_{2.5}$ and found a moderate match between CALINE and CAL3QHCR with the observed concentration, as AERMOD underestimated $PM_{2.5}$ concentrations. On the contrary, a number of studies found AERMOD generally to produce higher estimates of $PM_{2.5}$ than CALINE4 or CAL3QHCR. For example, Singh et al. (2006) compared AERMOD and CALINE4 models using a heavily traveled road in Windsor, Ontario, and found AERMOD to give higher concentrations of $PM_{2.5}$, compared with CALINE for 2 out of 3 days. Radonjic et al. (2003) performed a comparison of CAL3QHCR, ISCST3, AERMOD, and CALPUFF for a hypothetical roadway segment. They found the PM concentrations from AERMOD to be higher than those from CAL3QHCR by factors ranging from 1.3 to 4.8, depending on the averaging period. Claggett and Bai (2012) performed a comparison between AERMOD area and volume sources with CAL3QHCR for $PM_{2.5}$ and found the highest concentration estimates from AERMOD area sources, followed by CAL3QHCR and AERMOD volume sources.

With respect to the sensitivity testing of AERMOD, Zou et al. (2010) evaluated the sensitivity of AERMOD and found the effect of urban/rural dispersion coefficients, that terrain conditions to have limited influence on the model's performance. Several studies (Long et al. 2004; Grosch and Lee (1999) compared the effect of different surface characteristics on AERMOD concentrations and found the Bowen ratio to have the least effect and the surface roughness to have the greatest effect on the model concentrations. Schroeder and Schewe (2009) showed how different study radii and different locations of the meteorological towers affected the surface roughness length, which in turn affected the concentration estimates.

It is worth noting that most of these studies focused on industrial sources; and hence, there is a void in the current literature on studying AERMOD's behavior with respect to roadway mobile sources. In addition, a limited number of studies compare AERMOD and CAL3QHCR. This comparison is important because U.S. EPA recommends using either AERMOD or CAL3QHCR for performing PM hot-spot transportation conformity analyses for highway and intersection projects but using only AERMOD for transit, freight, terminal projects, and projects that involve highway/intersection and terminals (U.S. EPA 2010b). In the case of highway projects, model selection is not straightforward; and there lacks useful information in the literature with respect to the comparative model performance for roadway sources.

Each model has its own advantages and disadvantages. Both AERMOD and CAL3QHCR are Gaussian-based models; but AERMOD incorporates the concept of planetary boundary layer based on more recent atmospheric science, compared with CAL3QHCR. This translates into the way atmospheric stability is represented in the two models. Atmospheric stability is a measure of the amount of vertical turbulence in the atmosphere, which translates into its ability to mix pollutants. In CAL3QHCR, stability is represented by discrete stability classes—from A (unstable) to F (stable)—developed by Pasquill (Turner 1994). AERMOD uses a more advanced method to characterize stability; it uses a continuous function called Monin-Obukhov length, to characterize the atmospheric stability (U.S EPA 2004b). Golder (1972) developed a mapping between Pasquill stability class, Monin-Obukhov length and surface roughness. With respect to model capabilities, AERMOD is flexible in how different sources are represented (sources can be represented as area, area polygon, area circle, volume, or point sources), while CAL3QHCR must represent all sources as lines. CAL3QHCR was developed specifically for modeling roadway applications and has been validated against observations adjacent to roadways (U.S EPA 1995a). It is possible to incorporate a large number of receptors and sources to be modeled simultaneously in AERMOD, compared with CAL3QHCR. AERMOD enables multiple years of meteorological data to be processed simultaneously, compared with modeling a single year of data for CAL3QHCR. Overall, AERMOD requires detailed input data preparation involving a considerable amount of time and effort - roughly double or triple that of CAL3QHCR - and, generally speaking, offers a much steeper learning curve than CAL3QHCR.

# CHAPTER 3 PM HOT-SPOT CONFORMITY MODELING DATA REQUIREMENTS

## 3.1 INPUT DATA REQUIREMENTS FOR PERFORMING THE PM HOT-SPOT ANALYSIS

The following input data are required for performing PM air quality modeling on any highway/intersection project site:

1. Drawing of the project site in form shape file, CADD drawing, or aerial photo (in bmp, jpeg, or gif format)
2. Location of the project site in terms of the geographical coordinates (latitude and longitude)
3. All dimensions of the project area (length, width, orientation of roadways, and radii for circular ramps)
4. The extent of the project area to be considered for the modeling process (e.g., what extent beyond the interchange or what extent beyond the exit/entrance ramp to be modeled)
5. Right-of-way distance from the edge of the roadways, where the first set of receptors can be placed
6. Traffic volume for each time period of the day (annual average daily traffic or AADT)—morning peak: 6 to 9 A.M.; afternoon: 9 A.M. to 4 P.M.; evening peak: 4 to 7 P.M.; overnight: 7 P.M. to 6 A.M.
7. Fleet composition by the four time periods of the day
8. Traffic activity data for all roadway links by the four time periods of the day, in the form of either average speed or link drive schedule (vehicle trajectory)
9. Age distribution of the vehicle fleet by vehicle type
10. Fuel supply and formulation parameters
11. One year of onsite meteorological data or 5 years of off-site meteorological data in a format compatible with AERMOD/CAL3QHCR, depending on which model is to be employed
12. Details on the land-use type of the project site
13. Background concentration from all sources other than the project

## 3.2 EXISTING DATA INVENTORY

Table 3.1 lists the data obtained from various agencies (i.e., Illinois EPA, CMAP, East-West Gateway, and IDOT) for emission modeling and air quality modeling for the Chicago and Metro East regions. (These data are in the format of MOBILE6 and were converted to the MOVES format.)

Table 3.1 Available Input Data

| | File Name | Description | Data Source |
|---|---|---|---|
| **Traffic Data—Chicago Area** | | | |
| 1 | VBYHR07.def | "Activity file" corresponding to the default HVMT.def that gives VMT by the hour of the day for the Chicago area for the year 2007. | Illinois EPA |
| 2 | VBYSPD07.def | "Activity file" corresponding to the default SVMT.def that gives VMT by speed bin for freeways and arterials by the hour for the Chicago area for the year 2007. | |
| 3 | FVMTCH07.def | "Activity file" corresponding to VMT fractions by the facility type for the Chicago area. | |
| 4 | Linkvols_10_40.shp, c11q3_spd2010.shp, c11q3_spd2040.shp | Traffic and speed data for Chicago for the calendar years 2010 (observations) and 2040 (model projections) in the form of GIS files. | CMAP |
| 5 | I55 and I80 traffic counts | Traffic count data for calendar year 2010 for the Joliet pilot study site. | IDOT |
| 6 | Synchro analysis and HCM analysis report | Traffic signal plan data for the Algonquin and IL53 case study site. | IDOT |
| **Traffic Data—Metro East Area** | | | |
| 7 | HVMTME04.def | "Activity file" corresponding to VMT fractions by the hour of the day for the Metro East area for the year 2004. | Illinois EPA |
| 8 | SVMTME04.def | "Activity file" corresponding to VMT fractions by speed bin and the hour of the day for the Metro East area for the year 2004. | |
| 9 | Finalloads_year2010_all fields.shp, finalloads_year2040_allfie lds.shp | Traffic and speed data for Metro East for the calendar years 2010 and 2040 in the form of GIS files | East-West Gateway |
| 10 | IL3_Hawthorne timing | Traffic signal phasing and timing plan for the State Route 3 and Piasa Lane intersection case study site. | IDOT |
| **Registration Data** | | | |
| 11 | CHRD08AA.d | Registration distribution for the Chicago area for the year 2008. | Illinois EPA |
| 12 | MERD08AA.d | Registration distribution for Metro East for the year 2008. | |
| 13 | DNSTRD03.d | Registration distribution data for downstate counties. | |
| **CADD Drawings** | | | |
| 14 | .DXF format | CADD drawings in .DXF format were obtained for the Poplar Street bridge and the Algonquin and Il53 intersection case study sites. | IDOT |
| **Illinois Weather Data** | | | |
| 15 | Background concentration (see air-monitoring sites in Figure 3.1 for Chicago and in Fig 3.2 for Metro East) | $PM_{2.5}$ annual design values for the calendar years 2008, 2009, and 2010 for Chicago; $PM_{2.5}$ annual design values for the calendar years 2009, 2010, and 2011 for Missouri. | Illinois EPA |
| 16 | Urban surface and upper-air meteorological data | These files were constructed using data from National Weather Service surface stations and from NWS upper-air soundings originating from a separate location. Meteorological data in a format compatible to AERMOD and CAL3QHCR for Chicago and St. Louis were obtained. For St. Louis, 5 years (calendar years 2006 through 2010) of meteorological data was obtained from the Lambert–St. Louis International Airport surface station and the Lincoln upper-air station. For Chicago, 5 years (calendar years 2005 through 2009) of meteorological data was obtained from the O'Hare surface station and the Davenport, Iowa, upper-air station. | |

*(table continues next page)*

| Emission Factor Inputs | | | |
|---|---|---|---|
| 17 | 2008Inputs.docx | 2008 inventory of temperature, humidity, and fuel data used for summer weekday and annual emission factor calculation. | Illinois EPA |
| 18 | RKINFO.xlsx | MOBILE inputs for the years 2002 through 2020 for summer weekday and annual emission factor calculation. | U.S. EPA |
| 19 | FOWLERINFO.xlsx | MOBILE inputs for the years 2010 through 2020 for summer weekday and annual emission factor calculation. | |

## 3.3 DATA GAPS IN CURRENT DATA COLLECTION PRACTICE

Based on the experience gained from a series of modeling exercises with the pilot study and the case studies, the following data gaps in the current data collection practice have been identified:

1. An electronic version of CADD drawing of the project site, which would greatly help the coding of the sources and receptors, especially for complicated project sites.
2. Current and future traffic activity data (total traffic volume and speed) by the time of day and the vehicle type.
3. Data on the fleet composition of the traffic volume are required to be improved because, for some case study sites, data on the split of the trucks into single-unit and multiple-unit trucks were not available; and default data from HPMS had to be employed.
4. If possible, data on the fleet composition with respect to the 13 MOVES vehicle types would improve the accuracy of the results. Currently, default MOVES data were used to map the four-tire, single-unit, and multiple-unit truck composition into the 13 MOVES vehicle types.
5. Meteorological data in a format compatible to AERMOD and CAL3QHCR or a converter that could convert the data from one format into the other.
6. More recent traffic signal timing plan for the project sites.
7. Detailed traffic activity data in terms of drive schedule compared with average speed would improve the accuracy of the analyses, especially for arterial projects.

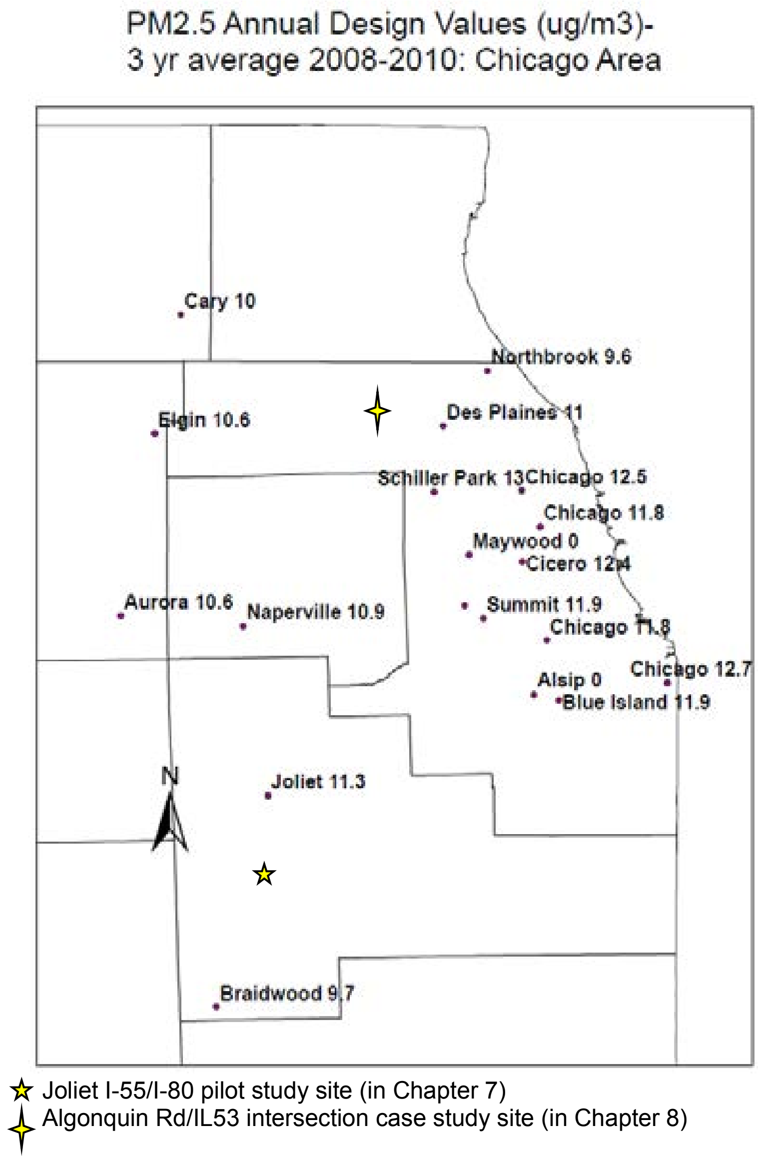



Figure 3.1 Air-monitoring stations in Chicago.

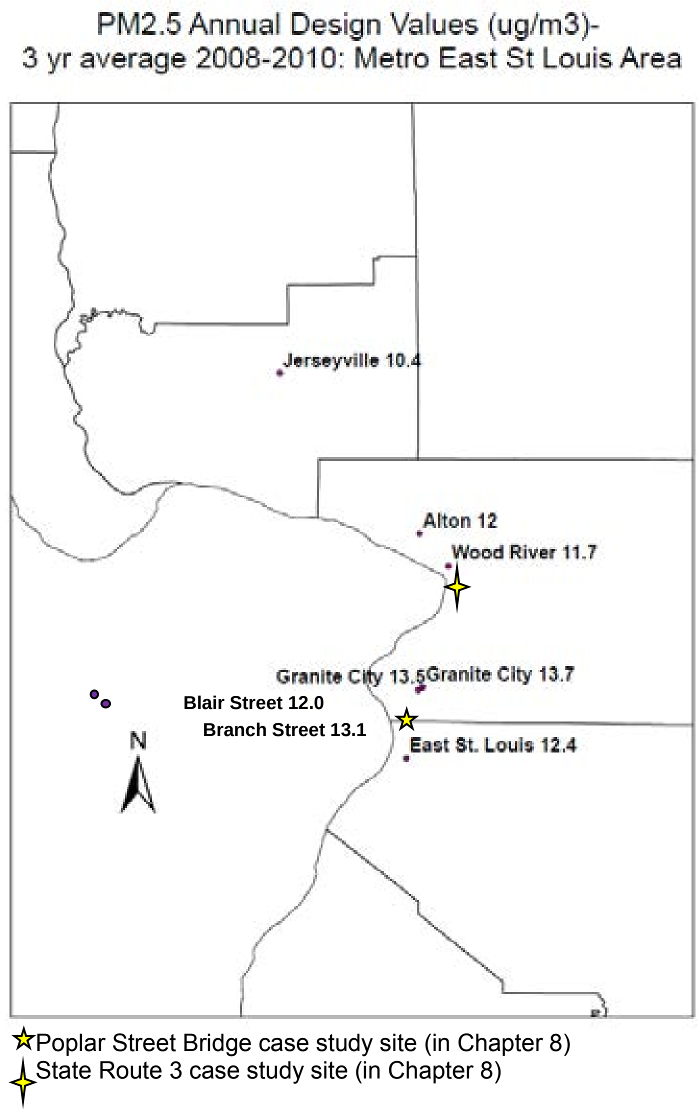



Figure 3.2 Air-monitoring stations in Metro East.

# CHAPTER 4 MOVES MODEL SETUP

## 4.1 MOVES INSTALLATION

MOVES2010b is the latest version of the MOVES emissions-modeling tool and builds on the functionality of the previous versions. The MOVES model can be downloaded free of cost from http://www.epa.gov/otaq/models/moves/index.htm. Once MOVES is downloaded, U.S. EPA provides step-by-step instructions on installing it. A snapshot of the MOVES installation suite is shown in Figure 4.1.

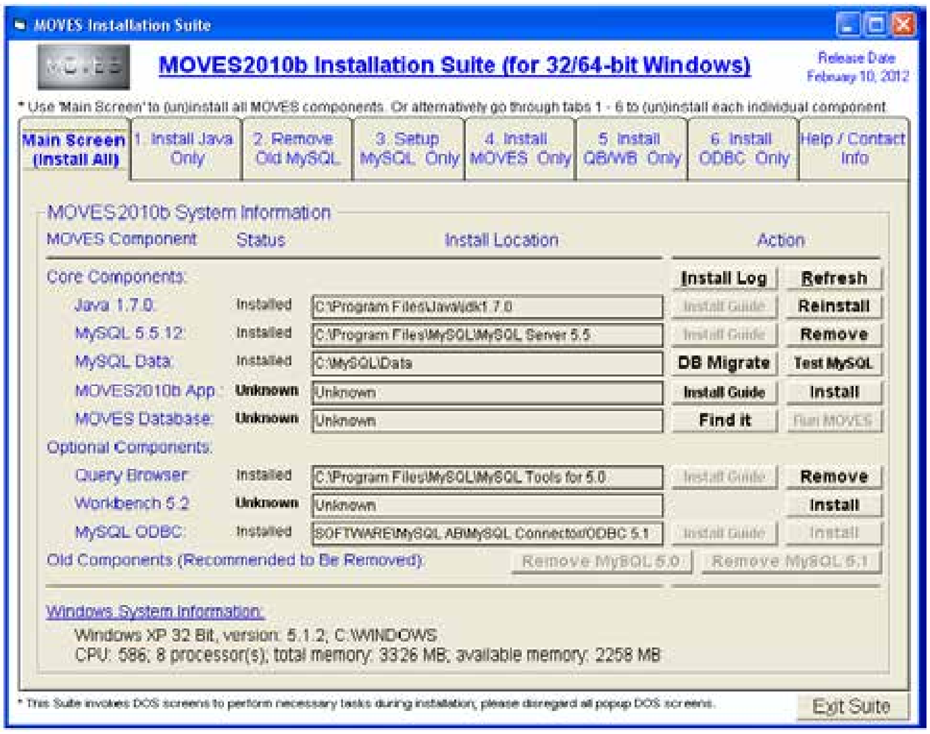



Figure 4.1 MOVES installation suite (U.S. EPA 2012).

## 4.2 MOVES PROJECT-LEVEL ANALYSIS

MOVES provides three scales of analysis: national, county or regional, and project. For SIP or regional conformity analysis, the county scale should be employed; whereas for more localized emission estimation, such as transportation conformity for PM, the project scale should be employed. The project scale is the finest scale available in MOVES and requires the user to provide all the information because no defaults are available. For this purpose, the details of the input data required and the possible sources from where they can be obtained are identified (Table 4.1). MOVES requires more data and in different formats, compared with MOBILE's requirements. U.S. EPA has developed converters that allow users to convert MOBILE inputs into a MOVES-compatible format. These converters are spreadsheet tools that take MOBILE-formatted input files and convert them to MOVES format. These converters are not needed if the users enter the data directly (U.S. EPA *Tools to Convert MOBILE6*).

Once the input data is obtained from the sources listed above, there are two stages in setting the model run. The first stage consists of creating a MOVES RunSpec, which refers to a run specification of a range of parameters in MOVES and is loaded or generated through the

MOVES GUI, shown in Figure 4.2 (a). The second stage consists of preparing a database of local-specific information through the project data manager (PDM), as shown in Figure 4.2 (b). The upper window in Figure 4.2 (b) is the GUI of the PDM. Each tab in the PDM window defines the data item required, which is described in Table 4.1. An input file template is created by PDM in an Excel Workbook environment, which contains multiple worksheets that correspond to the data tab in PDM [lower window in Figure 4.2 (b)]. All the RunSpec entries in the first stage should be completed before accessing the PDM. The project-level application of MOVES allows for modeling only 1 calendar year, 1 month, and 1 hour in a given run. To generate emissions estimates for multiple hours, batch mode features in MOVES can be employed.

Table 4.1 Input Data Requirements for MOVES Project Scale

| Data item | Description | Source |
|---|---|---|
| Link | Roadway link characteristics. | User-defined. |
| Link Drive Schedule | Speed/time trace second-by-second and percentage grade for roadway links. | Traffic microsimulation models. |
| Operating Mode Distribution | The vehicle operating mode distribution specifies the amount of time spent by vehicle fleet in different operating modes. | For roadway links, this information is optional if the speed-time trace data table is provided. For off-network links, this information is required. This off-network data should be derived for each traffic analysis zone (TAZ), quantifying how many trip starts (or number of trips from the Origin-Destination table) are associated with each TAZ. |
| Link Source Type Fraction | Vehicle fleet composition for each roadway link. | Local specific percentage of link traffic volume driven by each vehicle type. |
| Off-Network Link | Off-network links can be defined to represent traffic-analysis zones for estimating vehicle start emissions. | Local specific number of starts for each TAZ, the fraction of time spent in idling, and the fraction of the vehicle population parked. |
| Source Type Age Distribution[2] | Vehicle age distribution. | Local-specific input data. |
| Meteorology[1, 2] | Temperature and humidity. | Local-specific or MOVES default data. |
| Fuel Supply[1] | Fuel-supply parameters and associated market share for each fuel. | Local-specific or MOVES default data. |
| I/M Program[1] | Inspection–maintenance program parameters for nonattainment areas. | Local-specific or MOVES default data. To note that there is no PM benefit from I/M. |

NOTE: Parameters with superscript[1] can be obtained from the MOVES default database. Parameters with superscript[2] can be incorporated from existing MOBILE input data using converters.

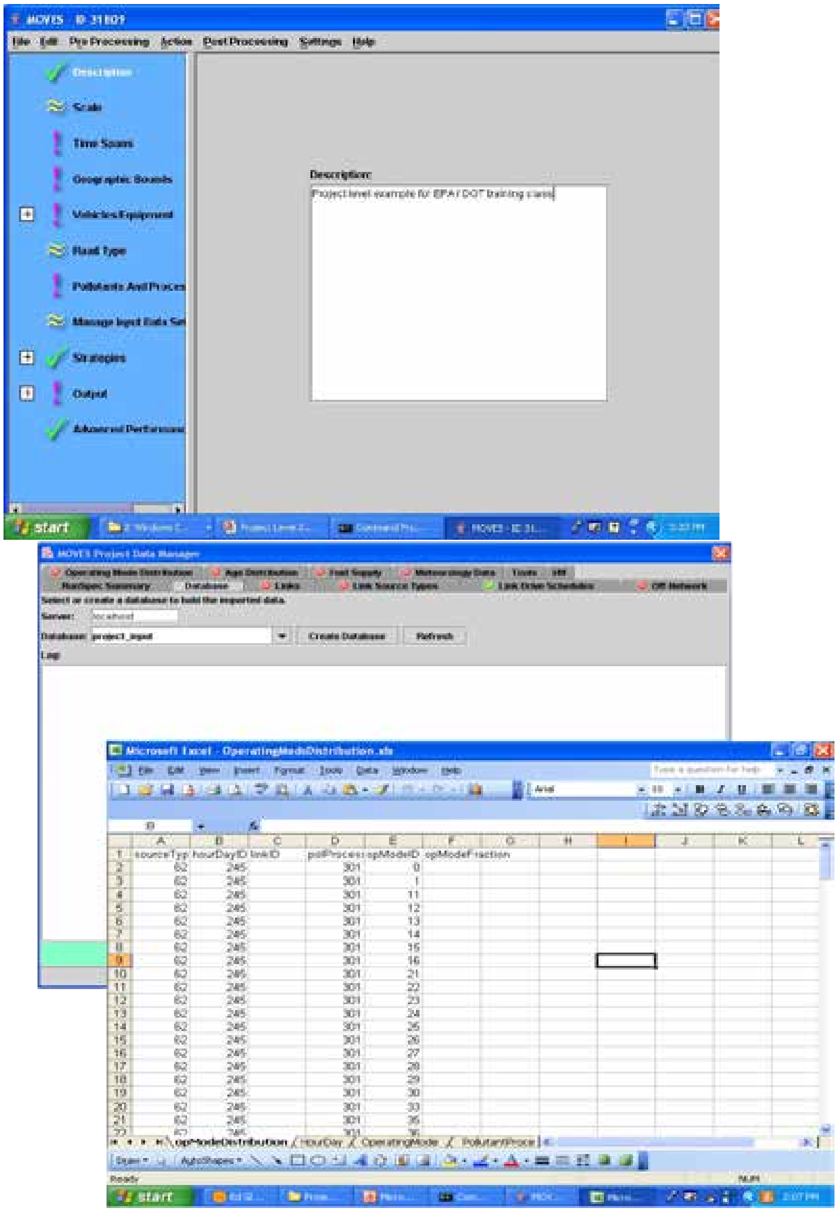



Figure 4.2 (a) MOVES RunSpec; (b) MOVES project data manager and input file template.

### 4.2.1 Stage 1: RunSpec

A RunSpec file contains the following MOVES run information of the project (see Appendix B for an example):

- Description: short description and purpose of the project being modeled
- Scale: defines the level of analysis
- Time spans and aggregation level: years, months, days, and hours; and aggregation by the specified time unit
- Geographic bound: location to be modeled

- Vehicle types: The combination of vehicle types by engine type, fuel type, and other vehicle technologies is specified.
- Road types: On-road or off-network link in urban/rural environment is specified.
- Pollutants and processes: each pollutant that would be generated by one or more emission processes
- Additional user databases: other user-specified information

### 4.2.2 Stage 2: Project Data Manager (PDM)

Descriptions of all input parameters, as shown in Table 4.1, imported into the Project Data Manager (PDM) are provided in this section. A sample MOVES project level input template (in Excel worksheet format) is available from this research team upon request.

#### *4.2.2.1 link*

Table 4.2 is used to define the individual roadway links and a single off-network link.

Table 4.2 MOVES I/P Data Fields in the link Table

| Data field name | Description |
|---|---|
| linkID | Specifies the ID of the particular link. Each link requires a linkID. |
| countyID | Specifies the ID of the county where the project is modeled. |
| zoneID | Specifies the ID of the zone where the project is modeled. |
| roadTypeID | Specifies the MOVES roadway type that best describes the link being modeled. |
| linkLength | Specifies the link length in miles for each roadway link. |
| linkVolume | Represents the total average traffic flow from all vehicle types on the link during the hour being modeled. |
| linkAvgSpeed | Specifies the average speed of all the vehicles on the roadway link in the given hour. |
| linkDescription | Description of the link (e.g., inbound/outbound/off-network) for reference. |
| linkAvgGrade | Specifies the overall average road grade (in percent grade units) for each link. |

#### *4.2.2.2. driveschedulesecondlink*

Table 4.3 is used to define the precise speed and grade as a function of time (seconds) on a particular roadway link being modeled. The time domain is entered in units of seconds, the speed variable in miles per hour, and the grade variable in percent grade.

Table 4.3 MOVES I/P Data Field in the *driveschedulesecondlink* Table

| Data field name | Description |
|---|---|
| linkID | Specifies the ID of the particular link. Each link requires a linkID. |
| secondID | Specifies the second for the vehicle operation. |
| speed | Specifies the speed of the vehicle for each second specified. |
| grade | Specifies the overall average road grade (in percent grade units) for each link. |

Second-by-second driving schedules to model vehicle operation can be specified. However, if the drive schedule is not specified, MOVES uses the average speed incorporated in the Links tab and default MOVES driving cycles to model vehicle operation.

#### *4.2.2.3 opmodedistribution*

Table 4.4 is used for specifying the operating mode fraction data for source types, hour/day combinations, roadway links, and pollutant/process combinations. These data are entered as a distribution across operating modes. Operating modes are "modes" of vehicle activity that have distinct emission rates. For a given source type, hour/day combination, roadway link, and pollutant/process combination, the operating mode distribution must sum to one.

Table 4.4 MOVES I/P Data Fields in the *opmodedistribution*Table

| Data field name | Description |
|---|---|
| sourceTypeID | Specifies the ID of the source considered. |
| hourDayID | Specifies the ID of the hour for which the project is modeled. |
| linkID | Specifies the ID of the particular link. Each link requires a linkID. |
| polProcessID | Specifies the ID of the pollutant associated with the emission process. |
| opModeID | Specifies the ID of the operating mode associated with the vehicle operation (e.g., OFF-ROAD 101 stands for soak time < 6 minutes, and ON-ROAD 22 stands for VSP 0–3 kW/tonne and instantaneous speed 25–50 mph. |
| opModeFraction | Specifies the fraction of the time spent by the vehicle in the corresponding operating mode. For example: OFF-ROAD for opMode108, opmodefraction = 0.05, which means 5% of the vehicles have not been started for more than 720 minutes. |

The operating mode distribution and drive schedule need not exist together for all road type links. Drive schedule has speed/time trace for on-road links, which is used by MOVES internally to create the operating-mode distribution. Operating-mode distribution data will override link drive schedule data if both are present, and link drive schedule will override average speed information if both are present (U.S. EPA 2012). Hence, at least one of the three must be entered for each of the user's defined roadway links. However, the operating mode distribution has to be provided for modeling off-network.

#### *4.2.2.4 linksourcetypehour*

Table 4.5 is used to specify the fraction of the link traffic volume that is driven by each source type.

Table 4.5 MOVES I/P Data Fields in the linksourcetypehour Table

| Data field name | Description |
|---|---|
| linkID | Specifies the ID of the particular link. Each link requires a linkID. |
| sourceTypeID | Specifies the ID of source considered. |
| sourceTypeHourFraction | Specifies the fraction of a particular source type. The fractions of all source types should sum to 1 for each link. |

#### *4.2.2.5 sourcetypeagedistribution*

The sourcetypeagedistribution for each type of source is specified in Table 4.6. The source age ranges from 0 to 30 years, and all ages greater than 30 years are included in the age 30 group. The distribution must sum to unity within a source type.

Table 4.6 MOVES I/P Data Fields in the sourcetypeagedistribution Table

| Data field name | Description |
|---|---|
| sourceTypeID | Specifies the ID of the source considered. |
| yearID | Specifies the ID of the analysis year of the project. |
| ageID | Specifies the source age of the analysis year. |
| ageFraction | Is a number between 0 and 1 that specifies the fraction of the source type in the corresponding age category. |

#### *4.2.2.6 offnetworklink*

An off-network consists of project boundaries where the vehicle start and extended idling operations are produced. It provides information about vehicles that are not driven on the project links but still contribute to the project emissions (see Table 4.7).

Table 4.7 MOVES I/P Data Fields in the offnetworklink Table

| Data field name | Description |
|---|---|
| sourceTypeID | Specifies the ID of the source considered. |
| vehiclePopulation | Specifies the average number of off-network vehicles during the hour being modeled. |
| startFraction | Is a number from 0 to 1.0 that specifies the fraction of this population that has a start operation in the given hour. |
| extendedIdleFraction | Is a number from 0 to 1.0 that specifies the fraction of the population that has had an extended idle operation in the given hour. |
| parkedVehicleFraction | Is a number from 0 to 1.0 that specifies the fraction of the vehicle population that has been parked in the given hour. |

#### *4.2.2.7 zonemonthhour*

Table 4.8 is used to import temperature and humidity data for the months, zones, counties, and hours that are specified in the project.

Table 4.8 MOVES I/P Data Fields in the zonemonthhour Table

| Data field name | Description |
|---|---|
| monthID | Specifies the ID of the month considered. |
| zoneID | Specifies the ID of the zone where the project is modeled. |
| hourID | Specifies the ID of the hour for which the project is modeled. |
| temperature | Specifies the temperature for the zone, hour, and month being modeled. |
| relHumidity | Specifies the relative humidity for the zone, hour, and month being modeled. |

### *4.2.2.8 fuelsupply*

Table 4.9 is used to assign existing fuels to the counties, months, and years, and to assign the associated market share for each fuel.

Table 4.9 MOVES I/P Data Fields in the fuelsupply Table

| Data field name | Description |
|---|---|
| countyID | Specifies the ID of the county where the project is being modeled. |
| fuelYearID | Specifies the fuel year of the fuel supply. |
| monthGroupID | Specifies the month of the fuel supply. |
| fuelFormulationID | Fuel formulation identification number. |
| marketShare | The market share for a given fuel type (gasoline, diesel, etc.) must sum to one for each county, fuel year, and month. |
| marketShareCV | This is the coefficient of variation for the market share. It would be used if uncertainty calculations were enabled. |

## 4.3 MOVES OUTPUT

There are two types of outputs produced by MOVES:

- **Emission inventory**: The quantity of emissions and/or energy used within a region and a time span. This output is stored in MOVES Output.
- **Emission rates:** The rate at which emission occurs (the mass and/or energy per unit of activity) is calculated. This output is stored in the RatePerDistance, RatePerProfile, and RatePerVehicle tables. Descriptions of other output tables produced by MOVES can be found be found in the MOVES user guide (U.S. EPA 2012).

# CHAPTER 5 AERMOD AND CAL3QHCR MODEL SETUP

## 5.1 AERMOD MODELING

### 5.1.1 AERMOD Setup

AERMOD can be downloaded free of cost from http://www.epa.gov/scram001/dispersion_prefrec.htm. Each component of the AERMOD modeling system (AERMAP, AERSURFACE, and AERMET) should be stored in its own subdirectory. The outputs from these subcomponents are required to be copied to the subdirectory where AERMOD will be executed. The input and output file to each subcomponent model has to be renamed or copied to the basic file name of the executable. For example, when executing an AERMOD run, “myinputfile.inp” has to be renamed to “AERMOD.INP” and “myoutputfile.out” has to be renamed to “AERMOD.OUT.” Once the “AERMOD.OUT” file has been produced, it has to be renamed back to “myoutputfile.out”; otherwise “AERMOD.OUT” will be over written the next time AERMOD is run. AERMOD is executed by double-clicking the AERMOD.exe.

### 5.1.2 Model Description

One of the basic inputs to AERMOD is the runstream setup file, which contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options (see Appendix C for an example). Another basic type of input data needed to run the model is the meteorological data, which is provided by the AERMET preprocessor. For applications involving elevated terrain effects, the receptor and terrain data are obtained from the AERMAP preprocessor. AERMOD can model a roadway line source as a series of volume or area sources (U.S. EPA 2004a). Volume source is more appropriate for line sources, which have some initial plume depth (rail lines, conveyor belts), and area sources are more appropriate for near ground–level sources with no plume rise (viaduct, storage piles).

Because the roadway sources in this project were modeled using the AERMOD area source approach, a detailed description has been provided for only this source type. The AERMOD model includes three options for specifying the shape of an area source: the AREA source type is used to specify rectangular areas; the AREAPOLY source type may be used to specify a source as an irregularly shaped polygon of up to 20 sides; and the AREACIRC source keyword may be used to specify a circular-shaped area source. For the area source approach of modeling roadway links, the following parameters are required:

1. Source characterization: Sources are defined based on (1) the travel activity that corresponds to volume and speed, (2) the physical dimensions, and (3) the orientation. For example, a single source can be used for a roadway link if the entire link has the same travel activity and no change in geometry. However, for a curved link with the same travel activity, more than one AERMOD source is required to be used to preserve the geometry.
2. Area source emission factor in grams/sec/m$^2$.
3. Initial vertical dispersion height is assumed to be about 1.7 times the average vehicle height, to account for the effects of vehicle-induced turbulence. For light-duty vehicles, this height is about 2.6 m, using an average vehicle height of 1.53 m, or 5 ft. For heavy-duty vehicles, this height is about 6.8 m, using an average vehicle height of 4.0 m (Appendix J, U.S. EPA 2010b). *The User’s Guide for the AMS/EPA Regulatory Model—AERMOD* (U.S. EPA 2004a) recommends that the initial vertical

dispersion coefficient (σzo) be estimated for a surface-based volume source by dividing the initial vertical dimension by 2.15. For typical light-duty vehicles, this figure corresponds to a σzo of 1.2 m. For typical heavy-duty vehicles, this figure corresponds to a σzo of 3.2 m. For a combination of light-duty and heavy-duty traffic, the initial vertical dimension should be a combination of their respective values by using a traffic volume/emissions weighted average.

4. The source release height is the height at which wind effectively begins to affect the plume and is estimated from the midpoint of the initial vertical dimension. For moving light-duty vehicles, this is about 1.3 m. For moving heavy-duty vehicles, it is 3.4 m (Appendix J, U.S. EPA 2010b). For a combination of vehicles with different heights, these dimensions are computed using a traffic volume/emissions weighted average.

5. Receptor characterization: Receptors are placed at a height of 1.8m above the ground. Around the sources, receptors are placed with closer spacing (e.g., 10 to 25 m) and with wider spacing (e.g., 50 to 100 m) farther from a source (U.S. EPA, 2010b). Receptor placement for annual $PM_{2.5}$ should be in accordance with the requirement (U.S. EPA 2010b) of being population-oriented and representing communitywide air quality effect. Receptor locations are specified in terms of X, Y, and Z coordinates.

6. The background concentration includes emissions from all sources other than the project affecting the concentrations in the entire area. The concentration obtained from AERMOD and CAL3QHCR is added to the background concentration to obtain the total representative concentration, called the design value, which describes the future air quality concentration in a case study area that can be compared with a NAAQS. Ambient monitoring data from surrounding monitoring stations located upwind of the case study area were found to provide information about background concentrations from sources around the case study. For predicting future background concentration, chemical transport models (CTM) can be used (U.S. EPA 2010b).

## 5.2 CAL3QHCR MODELING

### 5.2.1 CAL3QHCR Setup

CAL3QHCR can be downloaded free of cost from http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#cal3qhc. A control file should be created with the path and the names of the following files:

INP: Input control file

MET: Meteorological data input file

ET1: Pre-processed ETS data file

ET2: Post-processed ETS data output file

OUT: Output summary file

LNK: Variable link data output file

Of these, the ET1, ET2, LNK, and OUT are output files generated by CAL3QHCR. Input files (INP, MET) are required to be prepared by the user. A batch file should be created for executing the CAL3QHCR run (see Appendix C for an example). The batch file contains two

DOS commands to copy the control file created to the default control file, CAL3R.CTL, and to execute CAL3QHCR. CAL3QHCR is executed by double-clicking on the batch file name.

### 5.2.2 CAL3QHCR Description

CAL3QHCR is a separate, enhanced version of CAL3QHC that uses the same basic algorithms as CAL3QHC. CAL3QHCR has been enhanced to process up to a year of hourly meteorological (MET) and emission, traffic volume, and signalization (ETS) data, compared with CAL3QHC's ability to, process 1 hour of ETS and MET data. CAL3QHCR allows two-tier approaches for processing the MET and ETS data. In the Tier 1 approach, a full year of hourly MET data is entered into CAL3QHCR in place of the 1 hour of MET data that is commonly entered into CAL3QHC. One hour of ETS data is entered similar to CAL3QHC. For a Tier I approach, the program uses the same hour of ETS data for every hour in the week. Tier 2 allows a full year of hourly MET data, along with detailed ETS data for each hour of a week (1 to 7 sets of 24-hour patterns). These seven sets of ETS data are assumed to be the same for each week throughout the modeled period (U.S EPA 1995b). The PM hot-spot guidance requires use of the Tier 2 approach for hot-spot modeling (U.S. EPA 2010b).

Three major types of data sets have to be prepared before using CAL3QHCR. These data sets contain the MET, the ETS, and the input control data, respectively. Meteorological data is required to be processed through meteorological preprocessors, such as PCRAMMET or MPRM, to produce data in a compatible format for CAL3QHCR. Refer to U.S. EPA's *Meteorological Processors* for more details on the meteorological preprocessor's description and setup. The ETS data contains the emission rates, traffic volume, and signalization data for roadway segments. CAL3QHCR can model sources only as line segments. For modeling the roadway links as line segments, the following parameters are required:

1. Source characterization: All the roadways are specified in the form of line sources. The starting and ending coordinates of the link centerline is required for source dimensions. For a succession of links, the start coordinates of the next link usually equals the end coordinates of the prior link, with no gaps or overlaps. The location of the source is specified in terms of end-point coordinates. Link width is defined as the width of the traveled roadway plus 3 m (10 ft) on each side to account for the dispersion of the plume generated by the wake of moving vehicles. Source height should be within ± 10 m (± 32 ft). In most applications (at grade), a source height of 0 m is used.
2. Emission factor in grams/vehicle mile.
3. Receptors: Receptors are placed at a height of 1.8 m above the ground. Around the sources, receptors are placed more closely together (e.g., 10 to 25 m); and farther from a source, they are spaced more widely (e.g., 50 to 100 m) (U.S. EPA 2010b). Receptor locations are specified in terms of X, Y, and Z coordinates.
4. Background concentration: Although CAL3QHCR allows the user to specify the background concentration in the input control file, the PM hot-spot guidance (U.S. EPA 2010b) recommends entering a value of 0 for this parameter and adding the background concentration to the final average concentration obtained from CAL3QHCR to obtain the total representative concentration.

5. Queuing algorithm: While modeling arterial/intersection projects, the PM hot-spot guidance (U.S. EPA 2010b) recommends not using the queuing algorithm in CAL3QHCR. The idling, accelerating/decelerating vehicle emissions should instead be captured by the emission analysis in MOVES by specifying their corresponding activity patterns.

The input control file contains the ETS and MET data, along with a number of parameters related to the run, and is read in by the program. These parameters relate to the execution start and stop dates, the meteorological data identification values, Tier I or II approach, and the pollutant to be modeled. Four types of output files are generated by CAL3QHCR. The first two files contain ETS data, with the file extensions ET1 and ET2, and are regarded as temporary storage files. The third file contains the processed link variable data, with the extension LNK. The file with the extension .OUT contains a summary of the input data, concentration results, link contribution results, and a table of calm-wind duration and frequency of duration data (U.S. EPA 1995a).

# CHAPTER 6 MOVES SENSITIVITY ANALYSES

## 6.1 MOVES INPUT DATA

Table 6.1 lists the input data used for the MOVES project scale for this project.

Table 6.1 Input Data for MOVES Project Scale

| Input Item | Description | Source |
|---|---|---|
| Link | Roadway link characteristics. | Link length, traffic volume, and average traffic speed for each time period were obtained from local data. |
| Link Drive Schedule/Opmode Distribution | Vehicle activity. Either average speed, link drive schedule or operating mode distribution should be incorporated. | Average speed is used for describing the vehicle activity. |
| Link Source Type Fraction | Vehicle fleet composition. | All 13 source types are used, and fractions were obtained by combining the local data with default MOVES 13 vehicle type fractions. |
| Source Type Age Distribution | Vehicle age distribution. | Separate age-distribution data for Chicago and Metro East were obtained in MOBILE format from Illinois EPA and converted into MOVES format using U.S. EPA converters (U.S. EPA *Tools to Convert MOBILE6*). |
| Meteorology | Temperature and humidity values. | Hourly temperature and relative humidity values were obtained from Illinois EPA. The temperature for the four time periods was the average across each time period (e.g., average temperature between 6 and 9 a.m. for the morning peak). |
| Fuel supply | Fuel-supply parameters and associated market share for each fuel. | MOVES default fuel data was used with changes made to Reid vapor pressure, sulfur content based on local data. |
| I/M program | Inspection-maintenance program parameters for nonattainment areas. | Default MOVES database. To note, there is no PM benefit from I/M. |

## 6.2 SENSITIVITY TESTS

Sensitivity tests were performed to understand the behavior of the MOVES model under various settings. This approach is crucial for interpreting the model results and also because the task of preparing the input data is time- and resource-intensive for performing the PM hot-spot analysis. Sensitivity analysis of the MOVES model to changes in speed, temperature, seasons, and time of day and year are investigated in this chapter. MOVES sensitivity tests were performed at the project scale for a range of scenarios for Chicago. The sensitivity analyses were performed for diesel combination, short-haul trucks, and gasoline passenger cars.

### 6.2.1 Temperature

Although MOVES contains a default database of temperature values for all counties in the county based on 30-year average data from the National Climatic Data Center, U.S. EPA recommends using the local data for regulatory purposes. According to Choi (2011), temperature affects emissions through temperature adjustment on EFs and air-conditioning adjustment, which is calculated based on temperature and humidity. This sensitivity test was done to show how the EFs vary with respect to temperature. MOVES was run by keeping all parameters constant except for temperature, which varied from 0°F to 100°F for the morning peak in spring 2011. Sensitivity results are shown for three speed values of 15 mph, 35 mph, and 55 mph. EFs for gasoline vehicles were found to decrease with an increase in temperature until 70°F, after which there was no temperature effect, as shown in Figure 6.1. The same trend was observed for all speed values. EFs for diesel vehicles were found to be insensitive to temperature changes, mainly because the temperature adjustments are not applied to diesel PM EFs (Choi 2011).

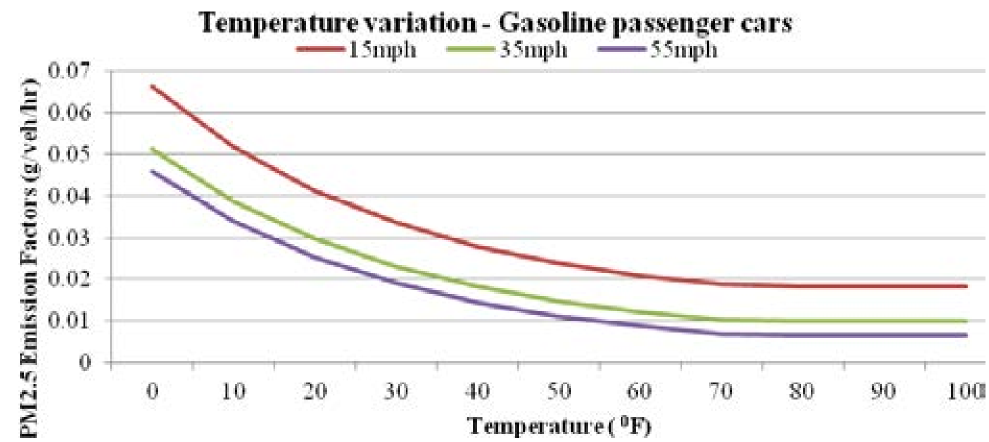
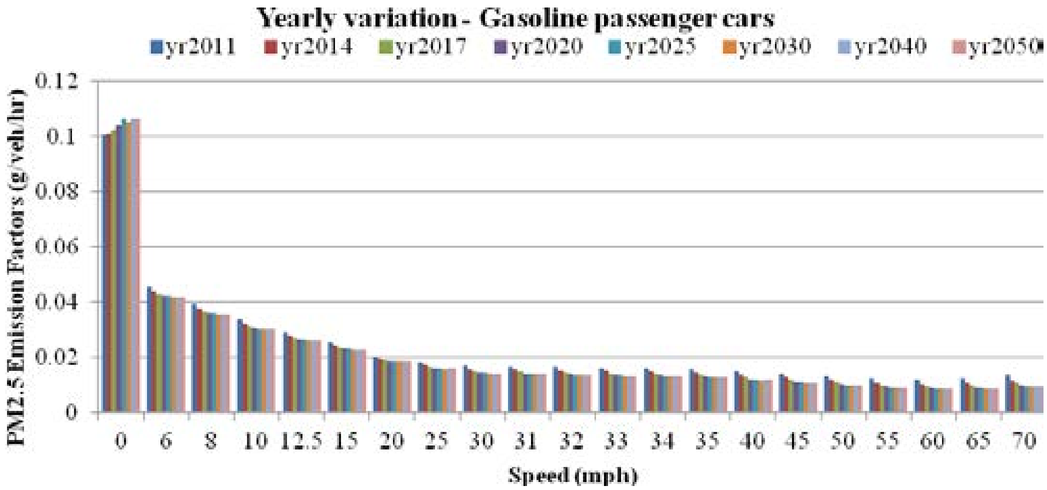



Figure 6.1 Sensitivity to temperature for the calendar year 2011 for gasoline passenger cars.

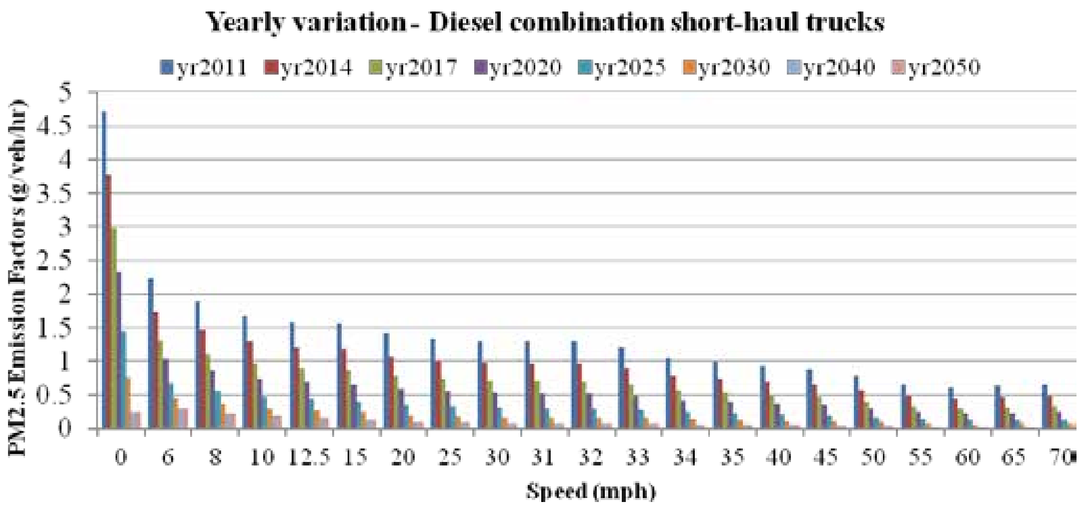
Meteorological data were obtained from Illinois EPA for the latest available five calendar years, and the average of the 5 years of data was used in MOVES as per the PM Guidance. The historic trend for temperature difference over the past 30 years, from 1980 through 2010, in Chicago was found to vary between 0.2 and 3 (National Oceanic and Atmospheric Administration website). A sensitivity test was performed to analyze the effect of temperature variation from the 5-year average. By decreasing the temperature by 0.5°F and 3°F, EFs were found to increase by 2% and 9%, respectively, for all vehicle types and speed values. However, the temperature increase had no effect on the following MOVES vehicle types: single-unit and combination short-haul and long-haul trucks and intercity bus. Based on these results, the interagency consultation members decided that it was acceptable to use the average of the latest 5-year meteorological data for future years.

### 6.2.2 Yearly, Seasonal, and Daily Variation

MOVES EFs for different years, seasons, and times of day were obtained to see the variation in $PM_{2.5}$ EFs. For yearly variation, EFs for the morning peak in spring were generated for the calendar years 2011, 2014, 2017, 2020, 2025, 2030, 2040, and 2050. The yearly variation (Figure 6.2) shows that the diesel vehicle EFs decreased sharply until 2030 and decreased gradually after that. This finding was attributed to the adoption of more stringent policies on fuel and vehicle technology, technological advancement, and a cleaner and younger vehicle fleet in future years.



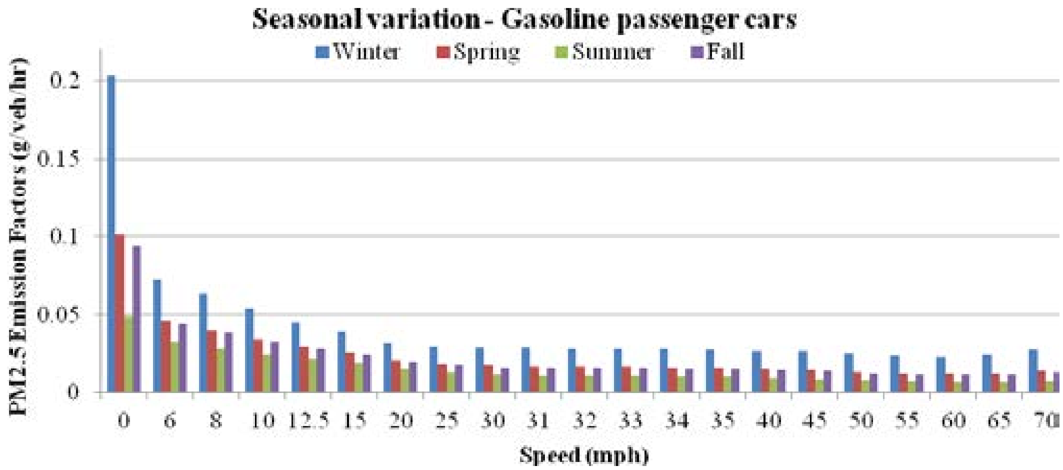

**(a)**



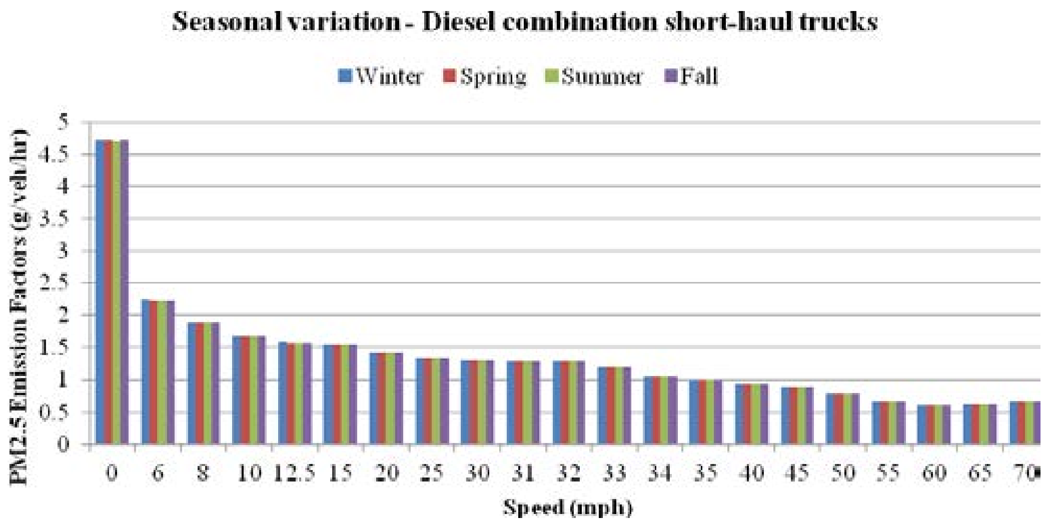

**(b)**

Figure 6.2 Yearly variations: (a) gasoline passenger cars,
(b) diesel combination short-haul trucks.

The seasonal variation (Figure 6.3) was performed for the morning peak in the calendar year 2011 for all four seasons (spring, summer, fall, and winter). The seasonal variation shows that the $PM_{2.5}$ EFs were highest in winter and lowest in summer and that finding combined with the low atmospheric transport and dispersion characteristics would lead to higher $PM_{2.5}$ concentration in winter (Turner 1994).



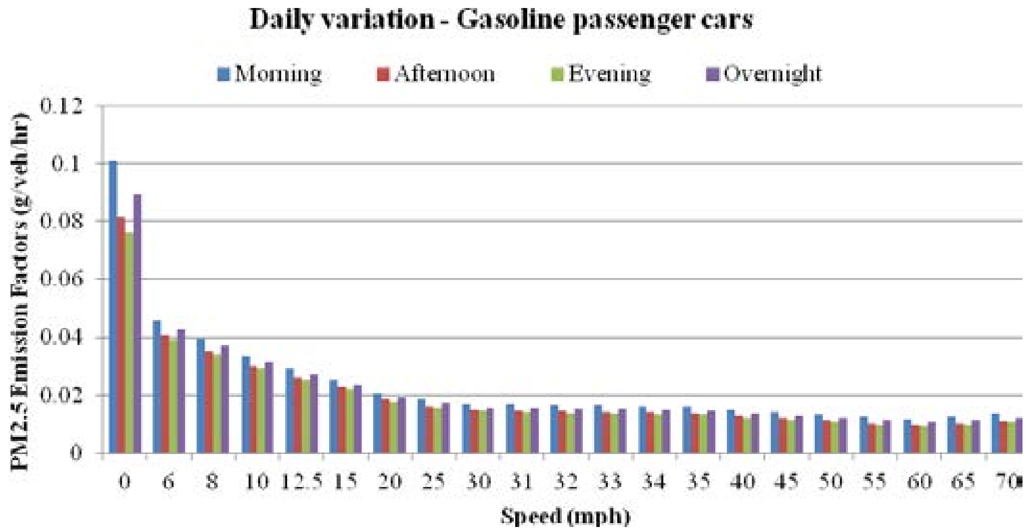

**(a)**



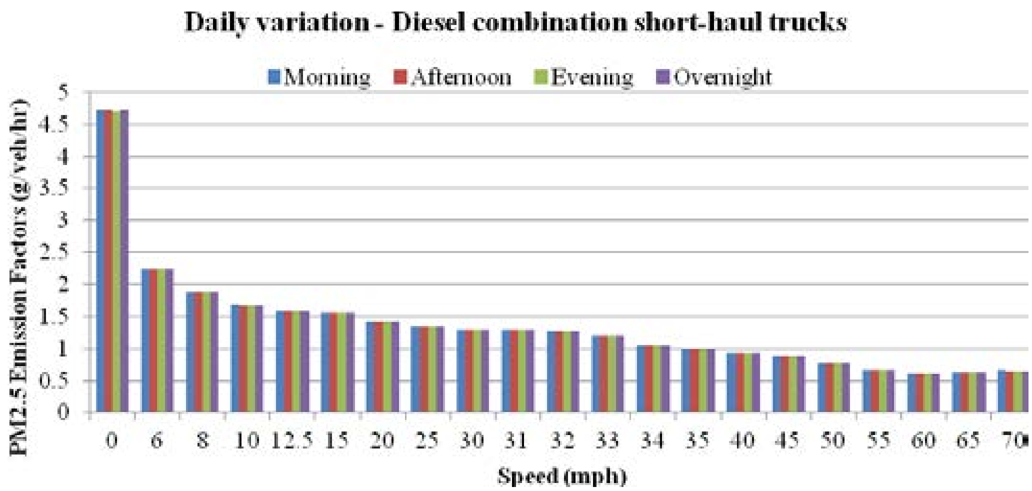

**(b)**

Figure 6.3 Seasonal variations: (a) gasoline passenger cars, (b) diesel combination short-haul trucks.

The time-of-day variation (Figure 6.4) was performed for the spring season in the calendar year 2011 for four time periods (morning peak, midday, evening peak, and overnight). The time-of-day variation shows that the $PM_{2.5}$ EFs were highest during overnight and morning and lowest during midday periods. On the other hand, the EFs for diesel vehicle remained constant and did not exhibit any variation between seasons and different time-of-day periods. A possible reason could be insufficient data points in the MOVES database with respect to diesel trucks to exhibit the seasonal and time-of-day variation. In all the charts, it can be seen that the EFs decreased with increase in speed, with the highest EFs produced at 0 mph, or when vehicles are idling. The MOVES sensitivity test analysis in this study exhibited a trend consistent with previous studies (Choi 2011; Glaze and Wayson 2012).




**(a)**




**(b)**

Figure 6.4 Daily variations: (a) gasoline passenger cars, (b) diesel combination short-haul trucks.

### 6.3 MOVES RESULTS VALIDATION

MOVES EFs obtained for Chicago were validated by comparing them with the national average EFs. The scenario consisted of the calendar year 2011, January, morning peak, all speed and vehicle types, urban restricted-access road type. National average input data was based on a link of 1 mile, 10,000 vehicles, and different vehicle-type fractions. Figure 6.5 shows the difference in percentage between the two results.

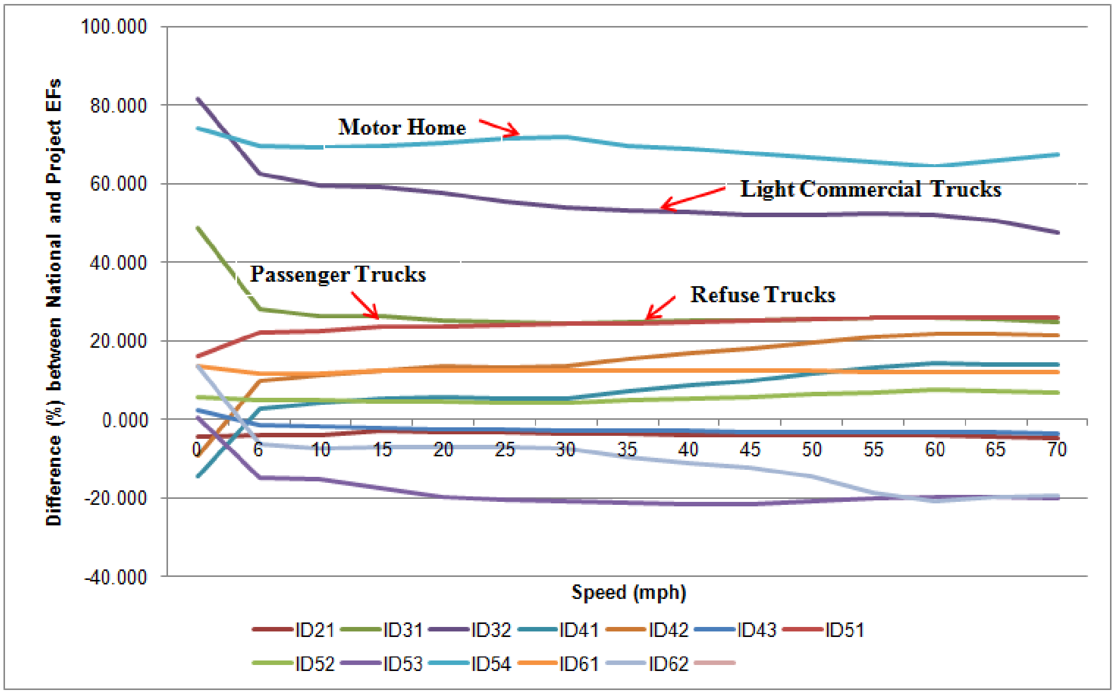



Figure 6.5 Validation of MOVES EFs with national average EFs.

With the exception of the highlighted vehicle types as indicated by the red arrows, all the other vehicle types have a difference within 20% with national average. The difference can be attributed to the differences in the local-specific conditions in Illinois, such as meteorology, fuel supply, and age distribution. These local conditions are found to have a significant impact on the EFs. In spite of different local conditions, the overall trend in the EFs seemed to be consistent with the national averages.

# CHAPTER 7 PILOT STUDY

## 7.1 DESCRIPTION

The PM hot-spot process was first performed on a pilot study to evaluate the process with respect to input data, assumptions, and choice of air-dispersion model. The pilot study was useful and informative in identifying deficiencies in the input data and technical specifics in modeling before moving on to the actual case studies. Many of these issues were solved with the help of the project's Technical Review Panel and interagency consultation from both Chicago and Metro East.

The pilot study consists of the I-80 and I-55 interchange near Joliet, Illinois. Figure 7.1 shows the Google Maps image and the extent of the pilot study modeled.


Figure 7.1 Extent of the project modeled (Source: Google Maps).

## 7.2 MODEL SETUP

### 7.2.1 Traffic Data Preparation

The traffic volume data for the pilot study was obtained from traffic counters and provided by IDOT. The hourly traffic data was grouped into the time periods as required by the PM hot-spot analysis (Morning peak: 6 to 9 A.M.; midday: 9 A.M. to 4 P.M., evening peak: 4 to 7 p.m.; and overnight: 7 p.m. to 6 a.m.). To account for the worst-case scenario, the highest hourly traffic volume (in terms of both total traffic volume and truck volume) in each time period was used as a constant rate for all the hours in the corresponding period. See Appendix D for the traffic volumes used in the pilot study. The fleet-composition data from the traffic data provided by IDOT consisted of vehicles divided in three broad categories: four-tire, single-unit, and multiple-unit. Based on the association between HPMS and MOVES vehicle types (Table 7.1), these three categories were mapped into the MOVES vehicle types. The fleet-composition data was combined with MOVES default 13 vehicle-type fractions (Table 7.2) to produce vehicle-type fractions for the pilot study. The total traffic volume, fleet composition, and speed data were passed on to MOVES for producing composite emission rates.

Table 7.1 Vehicle Type Categories

| Four Tire | Single Unit | Multiple Unit |
|---|---|---|
| 11. Motorcycles | 41. Intercity buses | 61. Combination short-haul trucks |
| 21. Passenger cars | 42. Transit buses | 62. Combination long-haul trucks |
| 31. Passenger trucks | 43. School buses | |
| 32. Light commercial trucks | 51. Refuse trucks | |
| | 52. Single-unit short-haul trucks | |
| | 53. Single-unit long-haul trucks | |
| | 54. Motor homes | |

Table 7.2 MOVES vehicle type split

| Vehicle Type | Split |
|---|---:|
| 11. Motorcycles | 0.00534 |
| 21. Passenger cars | 0.322418 |
| 31. Passenger trucks | 0.409157 |
| 32. Light commercial trucks | 0.125826 |
| 41. Intercity buses | 0.000077 |
| 42. Transit buses | 0.000231 |
| 43. School buses | 0.000788 |
| 51. Refuse trucks | 0.001338 |
| 52. Single-unit short-haul trucks | 0.019524 |
| 53. Single-unit long-haul trucks | 0.002069 |
| 54. Motor homes | 0.000364 |
| 61. Combination short-haul trucks | 0.054055 |
| 62. Combination long-haul trucks | 0.058814 |

### 7.2.2 MOVES Modeling

MOVES was run both in the “Emission Inventory” and the “Emission Rate” scale to produce composite emission rates in terms of grams/hour (g/hr) and grams/mile (g/mi) for AERMOD and CAL3QHCR, respectively. MOVES RunSpec (see an example in Appendix B) and input databases were developed specifically for the project, instead of using the data from the lookup table. A total of 16 MOVES input files were developed for the four time periods and the four seasons. MOVES was run in the batch mode, and the results were extracted from the MySQL database. Refer to Table 6.1 for MOVES input parameters used.

### 7.2.3 Meteorological Data

For the pilot study, urban meteorological data were obtained from Illinois EPA for calendar years 2005 through 2009 in both AERMOD and CAL3QHCR compatible format. The total percentage of missing meteorological data for the 5 years was found to be 2.13%. If the number of hours of missing meteorological data exceeds 10% of the total number of hours for a given model run, the user should refer to *Meteorological Monitoring Guidance for Regulatory*

*Modeling Application* (U.S. EPA 2000) for ways to process the missing data. The 5 years of meteorological data were obtained from the O'Hare surface station and the Davenport, Iowa, upper-air station. The prevailing wind rose diagram for the pilot study region is shown in Figure 7.2. The dominant wind direction is from SW to NE.

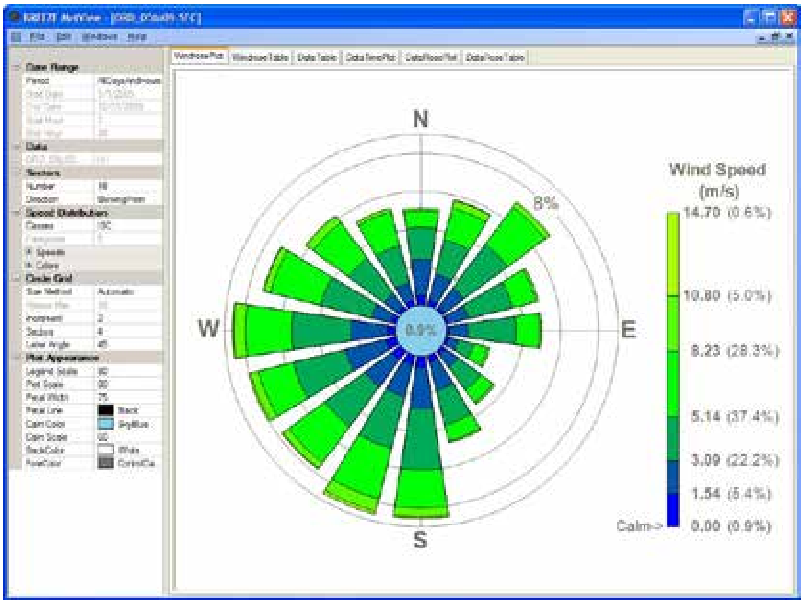



Figure 7.2 Wind rose diagram for Chicago (urban setting)
(plotted with BREEZE ROADS wind rose software).

### 7.2.4 AERMOD Modeling

The traffic volumes and composite emission rates (g/hr) from MOVES were passed on to AERMOD for producing the $PM_{2.5}$ annual average concentrations. Table 7.2 gives the input parameters used for AERMOD modeling.

Table 7.2 Input Parameters for AERMOD Area Source Modeling

| Input | Description |
|---|---|
| Averaging period | PERIOD |
| Pollutant | $PM_{2.5}$ |
| Modeling options | 1. CONC: Specifies that concentration values will be calculated<br>2. FLAT: Specifies that the terrain is flat. DFAULT may be appropriate instead of FLAT when modeling certain nearby elevated sources. |
| Urban option | URBANOPT: Sources are modeled as urban to account for the urban heat island effect. AERMOD employs nearby population as a surrogate for the magnitude of differential urban/rural heating. An urban roughness length of 1 m is used, which is the default regulatory value. Sensitivity tests (Section 7.3.2) were performed to decide the urban/rural representativeness of pilot study site. |
| Source dimensions | AREA sources were used for the highways and AREAPOLYGON sources for circular and inclined ramps. A total of 36 sources were used. |
| Emission rates | EMISFACT–SEASHR: This option is to specify a variable emission rate for the sources. The rates vary with respect to the season and the hour of the day. |
| Receptor placement | Receptors were located 50 ft from a source (measured from the edge of the roadway). The first set of receptors was placed at 25-m spacing for a distance of |

| | |
|---|---|
| | 150 m. The second set of receptors was placed at 50-m spacing for a distance of 200 m, and third set was placed at 100-m spacing for a distance of 500 m. This placement resulted in 1,168 receptors. |
| Meteorological data | The 5 years (the calendar years 2005 through 2009) of meteorological data for Chicago were obtained from Illinois EPA in AERMET format. |
| Output | The annual average concentration values averaged over 5 years of meteorological data were obtained for each receptor. |

Figure 7.3 shows the placement of the sources and receptors for the pilot study. A total of 36 area sources and 1,168 receptors were used.

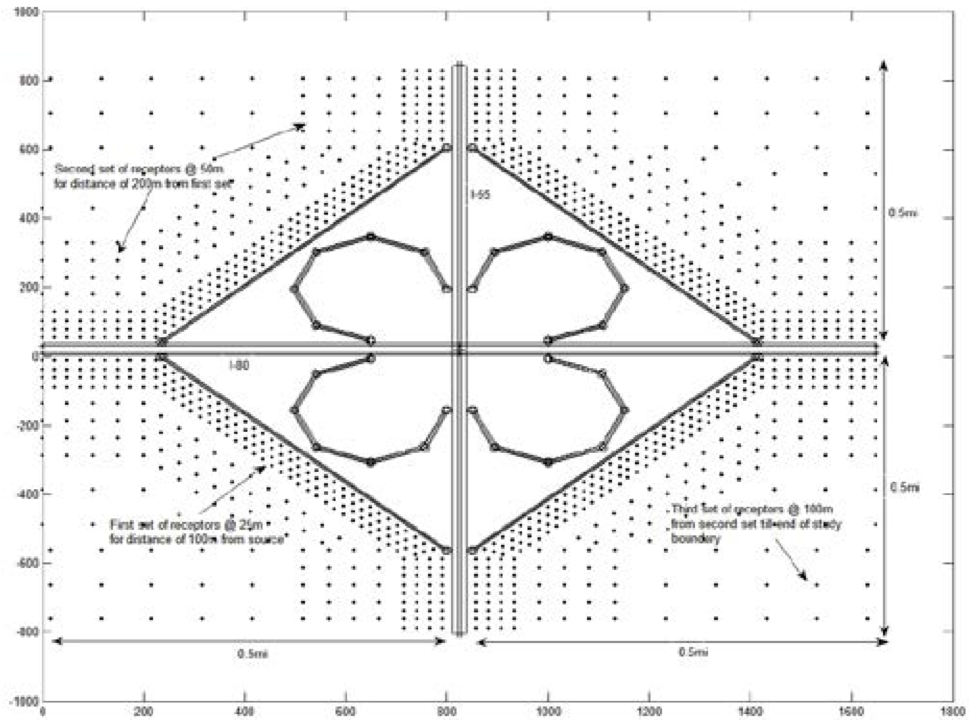



Figure 7.3 Placement of sources and receptors.

The annual $PM_{2.5}$ concentration results from AERMOD without the background concentration is shown in Figure 7.4. The location of the highest top ten concentrations in red circles is shown in Figure 7.5. The concentrations were found to be higher near the sources, and the concentration gradually decreased as the distance from the source increased. The highest top ten concentrations were obtained at locations where the traffic volumes were the highest. In addition, these concentrations were located in the NE quadrant, which matched the direction of the prevailing winds from SW to NE at the pilot study location. The highest concentration obtained without the background concentration was 5.8 $\mu g/m^3$ in the NE quadrant.

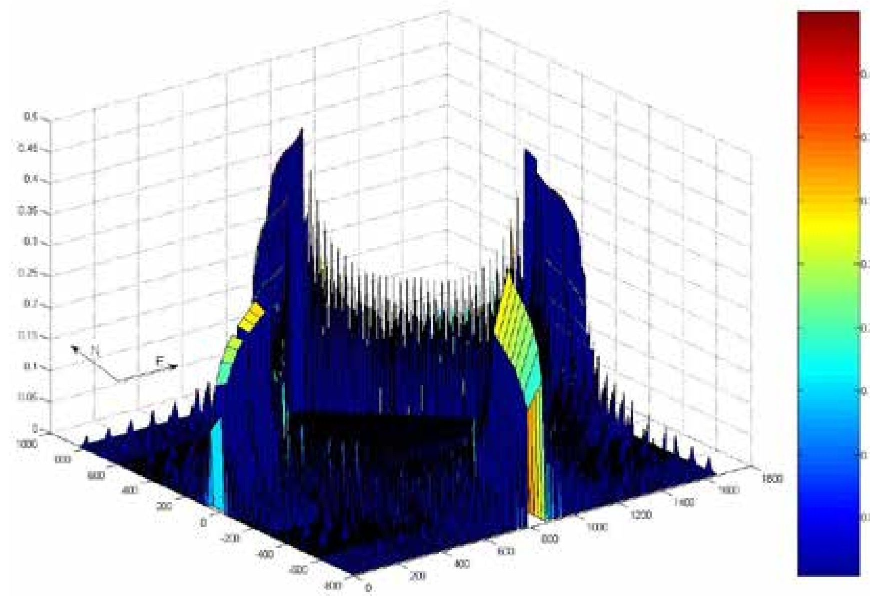



Figure 7.4 $PM_{2.5}$ concentrations without background concentration.

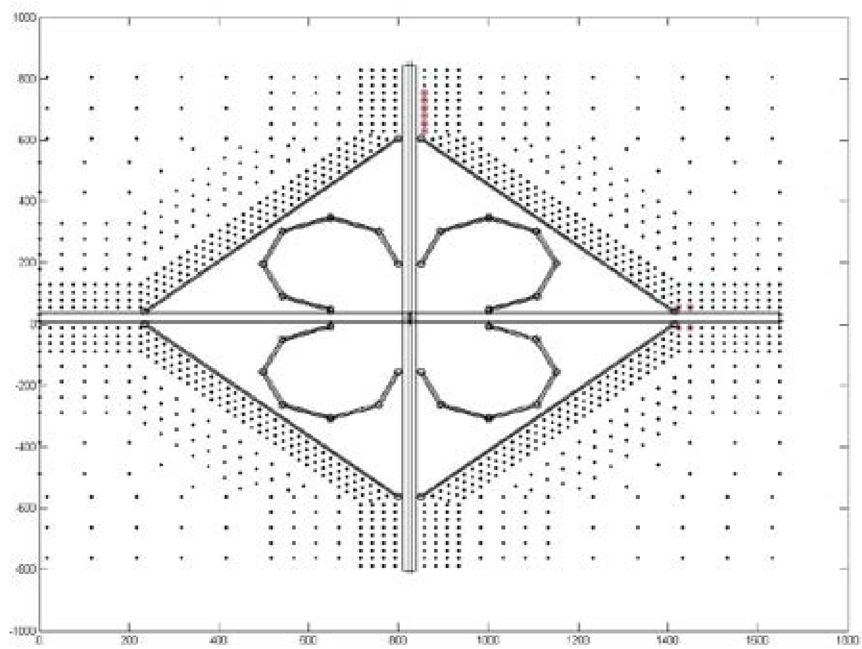


Figure 7.5 Location of highest top ten $PM_{2.5}$ annual average concentrations from AERMOD.

### 7.2.5 CAL3QHCR Modeling

The traffic volumes and composite emission rates (g/mi) from MOVES were passed on to CAL3QHCR for producing the $PM_{2.5}$ annual average concentrations. Table 7.3 gives the input parameters used for CAL3QHCR modeling.

Table 7.3 Input Parameters for CAL3QHCR

| Input | Description |
|---|---|
| Version | Tier II accounts for hourly variations in emissions (traffic volumes and emission rates) and transport meteorology over a year. Queuing algorithm was not used. |
| Averaging period | PERIOD |
| Pollutant | $PM_{2.5}$ |
| Urban option | The model is capable of being used in both rural and urban land use. A switch in the model allows the user to select for the land use being modeled by setting a switch to “U” for urban land use or to “R” for rural land use. The urban option was used for the pilot study, as indicated by the land-use type. |
| Source dimensions | A total of 36 line sources were used. |
| Surface roughness | The surface roughness coefficient (zo) of the application site should be within the range of 3 cm to 400 cm. The regulatory surface roughness default value of 1 m is used. |
| Emission rates | Emission rates are varied with respect to the season and the hour of the day. |
| Receptor placement | Receptor coordinates were the same for both AERMOD and CAL3QHCR and placed at 1.8 m height. |
| Meteorological data | The 5 years (calendar years 2005 through 2009) of meteorological data were obtained from Illinois EPA in CAL3QHCR-compatible format. The 5 years of meteorological are separated by quarter, for a total of 20 met files. |
| Output | CAL3QHCR produces concentrations for each quarter. The annual average concentrations for 5 years are obtained by off-model computation from the period averages. |

The highest annual $PM_{2.5}$ concentration obtained from CAL3QHCR without the background concentration was 2.7 μg/$m^3$ in the NE quadrant, which contrasts with the 5.8 μg/$m^3$ estimated in AERMOD. The location of the highest top ten concentrations in red circles is shown in Figure 7.6. The spatial pattern of the estimated concentrations was similar to that obtained from AERMOD (Figure 7.4).

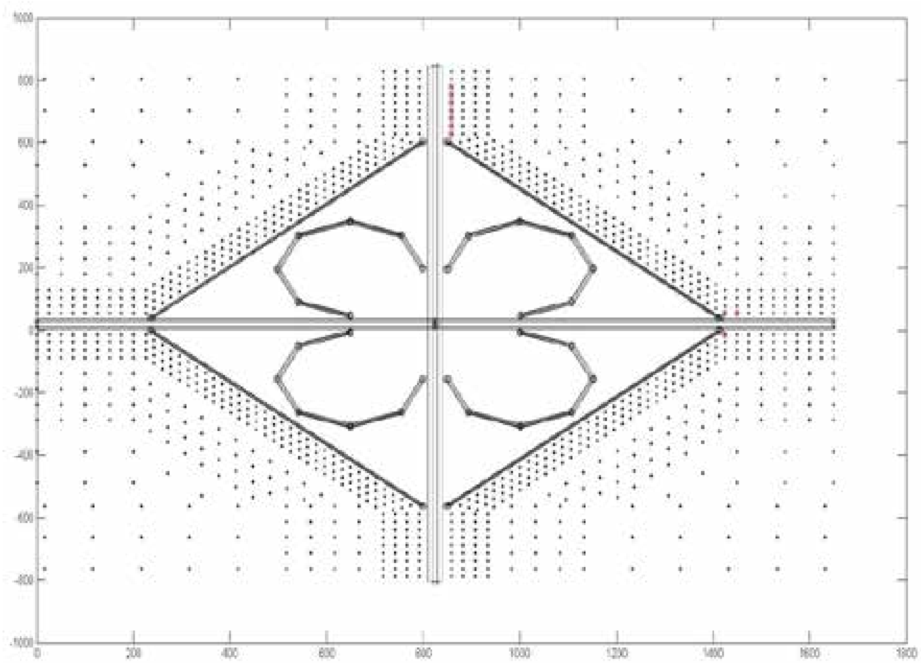


Figure 7.6 Location of highest top ten $PM_{2.5}$ annual average concentrations from CAL3QHCR.

### 7.2.6 Background Concentration

The most recent air-monitoring data for Chicago for the calendar years 2008 through 2010 was obtained from Illinois EPA. The background concentration values range from 9 to10 $\mu g/m^3$ in the rural and far-suburban portions of the nonattainment area, to 12 to13 $\mu g/m^3$ in the urban area. After interagency consultation, it was decided that the Elgin, Aurora, and Braidwood sites in the Chicago metropolitan area (see Figure 3.1) would be used to interpolate spatially (using the distance-weighted approach) the background value for the pilot study region. This approach resulted in the background concentration of 10.41 $\mu g/m^3$ for the pilot study. The final concentrations from CAL3QHCR and AERMOD, when combined with the background concentration, were 13.11 $\mu g/m^3$ and 16.21 $\mu g/m^3$, respectively, both exceeding the new $PM_{2.5}$ annual ambient standard of 12 $\mu g/m^3$.

## 7.3 SENSITIVITY TESTS

### 7.3.1 Comparison Between AERMOD AND CAL3QHCR

This sensitivity test was performed to understand how different the $PM_{2.5}$ concentrations would be when different air-dispersion models were used in the PM hot-spot modeling process. Figure 7.7 compares the location of the top ten highest concentrations between AERMOD (red circles) and CAL3QHCR (green stars). Most of them matched; the highest concentrations occurred at locations where the traffic volumes were the highest. Furthermore, these highest points were located in the NE quadrant, which matched the direction of the prevailing winds from SW to NE.

However, the magnitudes of the estimates display large discrepancies. Table 7.4, which compares the estimates between CAL3QHCR and AERMOD, show the AERMOD estimates to be two times higher than CAL3QHCR on an annual average basis. The difference in the concentrations was largely the fundamental difference between the two models (i.e., the way atmospheric stability is represented). This finding is consistent with previous studies (Radonjic et al. 2003; Claggett and Bai 2012) that have found considerable discrepancy in estimated results between AERMOD and CAL3QHCR. Because DOTs are traditionally more familiar with CAL3QHCR and AERMOD requires a substantial amount of learning effort, a workforce with an adequate skill set, and data preparation, the interagency consultation decided to use CAL3QHCR as the air-dispersion model for the case study sites.

### 7.3.2 Urban/Rural Representativeness of a Project Site

Guidelines on deciding the urban/rural representativeness of a project site are given in *Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions Final Rule* (U.S. EPA 2005), in which a land-use classification or population-density method should be employed. In the former approach, the land use within a 3 kilometer (km) radius of a source is determined; if at least 50% of the land use is of an urban type, the source is designated urban, and as rural if otherwise. In the latter approach, if the average population density per square kilometer within a 3-km radius is more than 750 people/km$^2$, the source is designated urban. In most cases, the first approach may suffice. If not, the latter approach may be taken. In reality, a project site may be situated in an area that is ambiguous to either definition above. In that case, a different designation of the project site will affect the model results. The question is by how much. That is the question to be answered in this section.

A sensitivity test to decide the urban/rural representativeness of the pilot study was performed with the AERMOD model only. More precisely, it is the meteorological input that AERMOD is sensitive to because the urban/rural classification would determine which set of meteorological data to use in AERMOD. All other input parameters in AERMOD were kept the same between the two model runs, except for the meteorological data sets. The meteorological data for the urban setting is described in Section 7.2.3. The rural meteorological data were obtained from Illinois EPA in raw format and processed using AERMINUTE and AERMET models to produce compatible data for AERMOD. The raw upper-air data for the calendar years 2006 through 2010 were obtained from Davenport, Iowa; and the surface data were from the West Chicago Airport. The wind rose diagram for Chicago representative of a rural setting is shown in Figure 7.8.

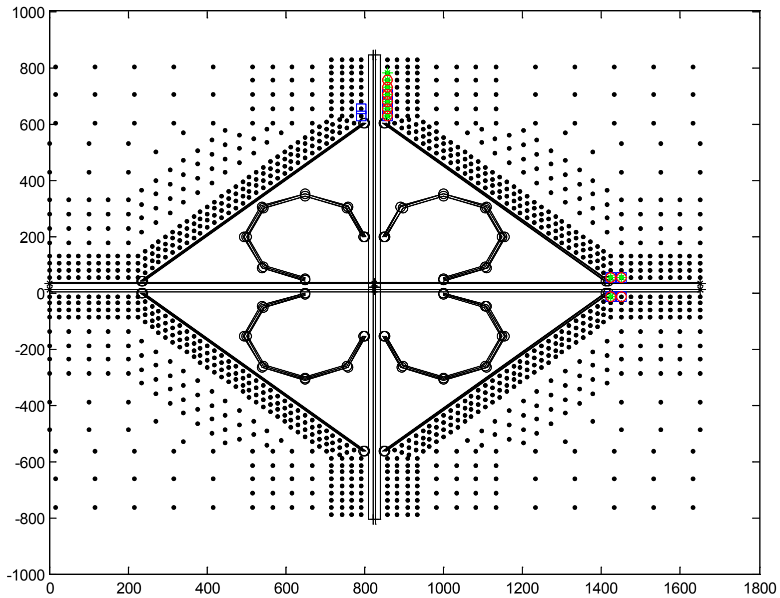



Figure 7.7 Comparison between locations of highest top ten concentrations between AERMOD urban (red circles), CAL3QHCR (green stars), and AERMOD rural (blue squares).

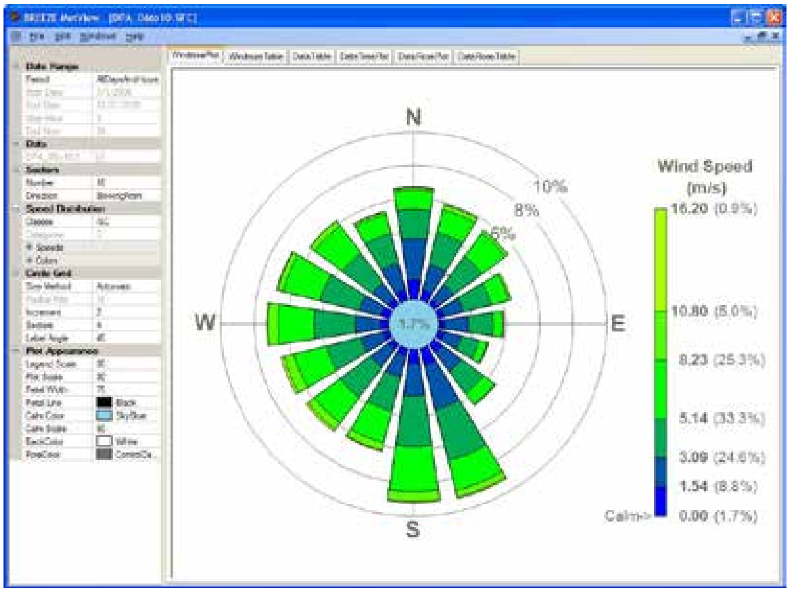



Figure 7.8 Wind rose diagram for Chicago rural area
(plotted with BREEZE ROADS wind rose software).

The highest concentration obtained with the rural meteorological input without the background concentration was 8μg/m$^3$, a 38% increase from 5.8μg/m$^3$ for the urban one in AERMOD (Table 7.4). When combined with the background concentration, these concentrations were 16.21 μg/m$^3$ and 18 μg/m$^3$ for urban and rural settings, respectively. The highest concentrations followed the prevailing wind direction and occurred at locations where the traffic volumes were the highest. The slight difference in the location of highest concentrations (Figure 7.7) between urban (red circles) and rural (blue squares) setting could be explained by looking at the wind rose diagram (Figures 7.2 and 7.8). In the rural setting, the dominant wind direction is from SE to NW, compared with SW to NE for the urban setting. This finding explains why some highest-concentration locations were situated in NW quadrant.

The rural setting in AERMOD predicted higher concentrations by a factor of 1.37 to 1.4 relative to the urban setting on an annual average basis. The lower concentrations in the urban setting shows the incorporation of an urban heat island effect, a term used to describe urban areas that are hotter than nearby rural areas, especially at night, mainly as a result of heat retention by urban materials (U.S. EPA *Heat Island Effect)*. Because of this heat retention, the vertical motion of the air is increased through convection, thereby leading to increased dispersion of pollutants (U.S. EPA 2010b). The implication of this finding is that if a project site is misclassified as rural, then unnecessary resources may be wasted; or in the reverse, then real air pollution is not predicted.

Table 7.4 Comparison of $PM_{2.5}$ Concentrations from AERMOD (Urban and Rural Setting) and CAL3QHCR

| Top ten highest | Average concentration (µg/m$^3$) | | |
|---|---|---|---|
| | **AERMOD (urban)** | **CAL3QHCR** | **AERMOD (rural)** |
| 1st | **5.8** | **2.71** | **8.03** |
| 2nd | 5.6 | 2.62 | 7.65 |
| 3rd | 5.56 | 2.57 | 7.59 |
| 4th | 5.5 | 2.52 | 7.56 |
| 5th | 5.4 | 2.51 | 7.56 |
| 6th | 5.28 | 2.48 | 7.39 |
| 7th | 5.16 | 2.45 | 7.23 |
| 8th | 5.15 | 2.43 | 7.14 |
| 9th | 5.07 | 2.36 | 7.08 |
| 10th | 5 | 2.28 | 7.07 |

Based on these results, the interagency consultation committee concluded that the urban/rural representativeness of a project site would be based on either the land-use classification or population-density method. If a project site is situated in an area that is ambiguous to either method, the proximity of the project site to the meteorological station locations would be the criteria for deciding the urban/rural representativeness, and the corresponding meteorological data would be used.

# CHAPTER 8 CASE STUDY RESULTS—CHICAGO AND METRO EAST

Case study sites were selected in Chicago and the East St. Louis metropolitan area to showcase the PM hot-spot modeling, based on the experience gained from the pilot study. The case study sites were selected through interagency consultation, based on a combination of high future projected traffic volumes and high projected future percentage of diesel truck traffic, which were provided by the Chicago Metropolitan Agency for Planning (CMAP) and East West Gateway (the MPO for the East St. Louis metropolitan area) from their long-range regional transportation-demand models, respectively. The future model year was set at 2015, based on the interagency consultation discussion that the nearest “worse-case” future year in which transportation projects could be impacted is 2015.

As a result, one highway site in Metro East (the Poplar Street Bridge) and two arterial intersection sites (the intersection of State Route 3 and Piasa Lane in Metro East and the intersection of Algonquin Road and Route IL 53 in Chicago) were selected. In addition, the Poplar Street Bridge site was used as a surrogate highway site for Chicago by replacing the emission rates and meteorological data with that of Chicago. By doing so, the effect of geographical area on $PM_{2.5}$ concentration levels, with the geometry and traffic activity data held constant, could be analyzed.

## 8.1 POPLAR STREET BRIDGE, METRO EAST

The Poplar Street Bridge, one of the case study sites selected, is over the Mississippi River between the states of Missouri and Illinois. Three interstates (55, 64, and 70) cross the Mississippi River on the Poplar Street Bridge. The case study was modeled starting from the Illinois side. Figure 8.1 shows the Google Maps image and the extent of the case study modeled. The urban/rural representativeness of the site was found to be urban, based on the land-use classification method.


Figure 8.1 Extent of the case study site modeled (Source: Google Maps).

### 8.1.1 Traffic Data Preparation

Traffic data was obtained from East-West Gateway for the calendar years 2010 (actual observations) and 2040 (model projections), in the form of GIS files. The geometry of the project from the CADD drawing was matched with the GIS files to extract the corresponding traffic activity data for all roadway links in the case study site. The traffic data extracted for the roadway links consisted of the total traffic volume, truck volume, and speed by time of day. The extracted data for the years 2010 and 2040 were used to produce traffic data for the year 2015 by interpolation. The time periods contained in the GIS files consisted of hours different from the time periods required for PM hot-spot analysis. To bridge this gap, the traffic data from the GIS files were converted into hourly time periods. For this purpose, the traffic pattern in terms of percent of AADT by hour for downstate Illinois urban interstate from Illinois travel statistics was used (Illinois Department of Transportation 2011). The hourly data were then grouped into PM hot-spot analysis time periods. Similar to the pilot study, the highest hourly total traffic volume and truck volume were used for the corresponding time periods. See Appendix D for the traffic volumes used for this project site.

Owing to the lack of data on the percentage of single- and multiple-unit trucks from truck volume, data from Illinois travel statistics were used (Illinois Department of Transportation 2011). The annual vehicle miles traveled (AVMT) by vehicle type for urban freeways gave the split of truck volume as 62.5% multiple-unit and 37.5% single-unit trucks. The difference between total traffic volume and truck volume gave the four-tire vehicle volume. The next step consisted of mapping the vehicle split for three categories (four-tire, single-unit, and multiple-unit) into the 13 MOVES vehicle types. The mapping among the three categories of vehicles and the 13 MOVES vehicle types was done similarly to the way it was handled in the pilot study. The total traffic volume, fleet composition, and speed data were passed on to MOVES for producing composite emission rates. A total of 26 distinct roadway links were obtained, based on traffic activity data (volume, speed). Each of these links was modeled separately in MOVES. For CAL3QHCR modeling, each of these links can be modeled with one or more than one source to preserve the geometry.

### 8.1.2 MOVES Modeling

MOVES was run in “Emission Rate” scale to produce composite emission rates in grams/mile. Refer to Table 6.1 for MOVES input parameters.

### 8.1.3 Meteorological Data

The 5 years of the St. Louis area meteorological data were obtained from the Lambert–St. Louis International Airport surface station and the Lincoln, IL upper-air site. The prevailing wind rose diagram for the case study region is shown in Figure 8.2. The dominant wind direction is from SE to NW.

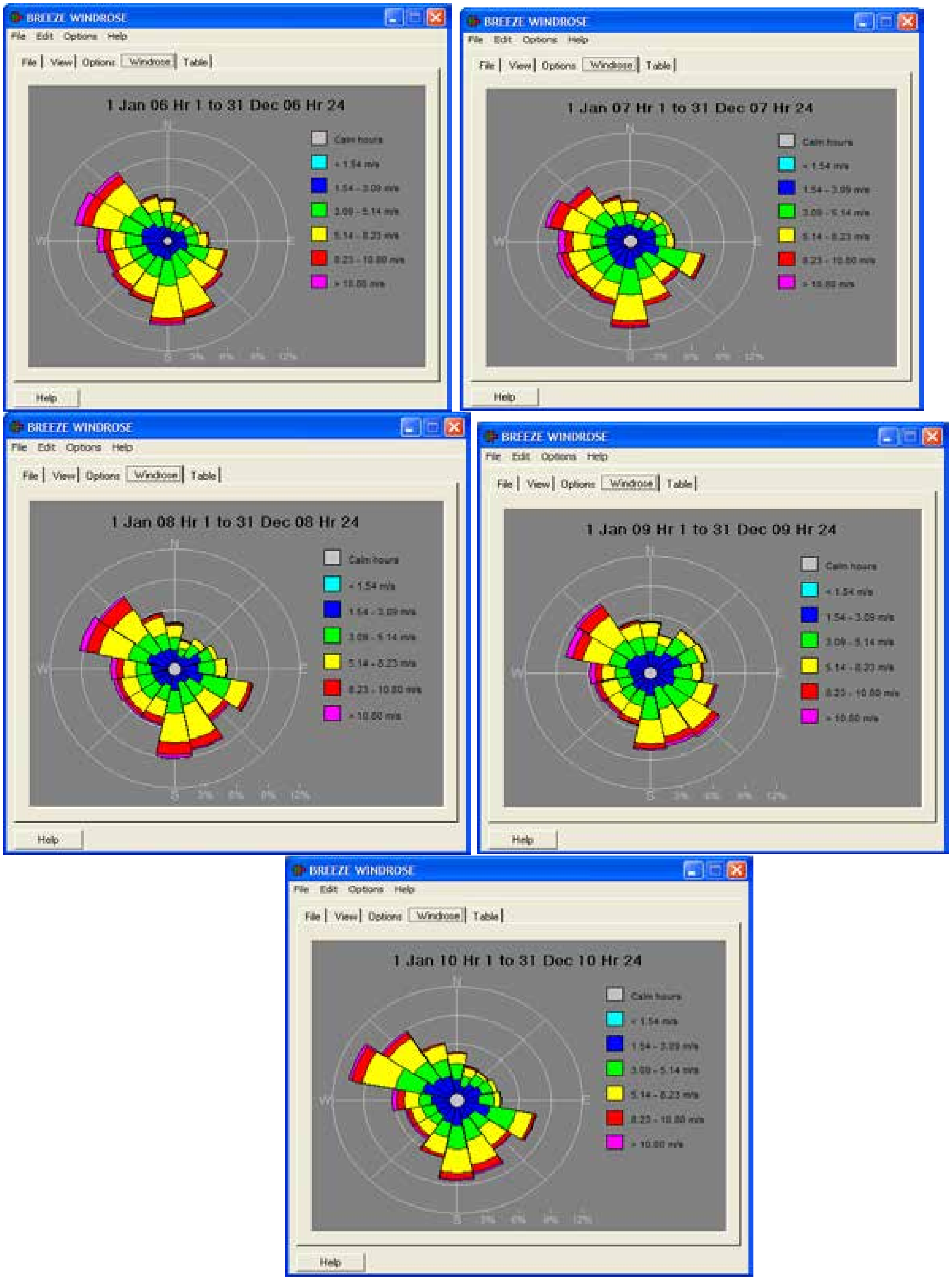



Figure 8.2 Wind rose diagram for St. Louis urban area (plotted with BREEZE ROADS wind rose software).

### 8.1.4 CAL3QHCR Modeling

The traffic volumes and composite emission rates from MOVES were input into CAL3QHCR for producing the $PM_{2.5}$ annual average concentrations. BREEZE ROADS, commercial software developed by Trinity Consultants, was used to help with the source and receptor coding. Each of the 26 distinct roadway links was modeled with one or more line sources to preserve the geometry, resulting in a total of 99 line sources. The first set of receptors was placed at a 25-m spacing for a distance of 100 m. The first line of receptors in the first set was placed at a distance of 15 m (50 ft) from the edge of the roadway to account for the right-of-way distance. The second set of receptors was placed at a 50-m spacing for a distance of 100 m. The third set of receptors was placed at a 100-m spacing for a distance of 600 m. This placement resulted in a total of 1,590 receptors. The other input parameters were similar to those of pilot study (Table 7.3). Figure 8.3 shows the placement of the sources and receptors for the case study.

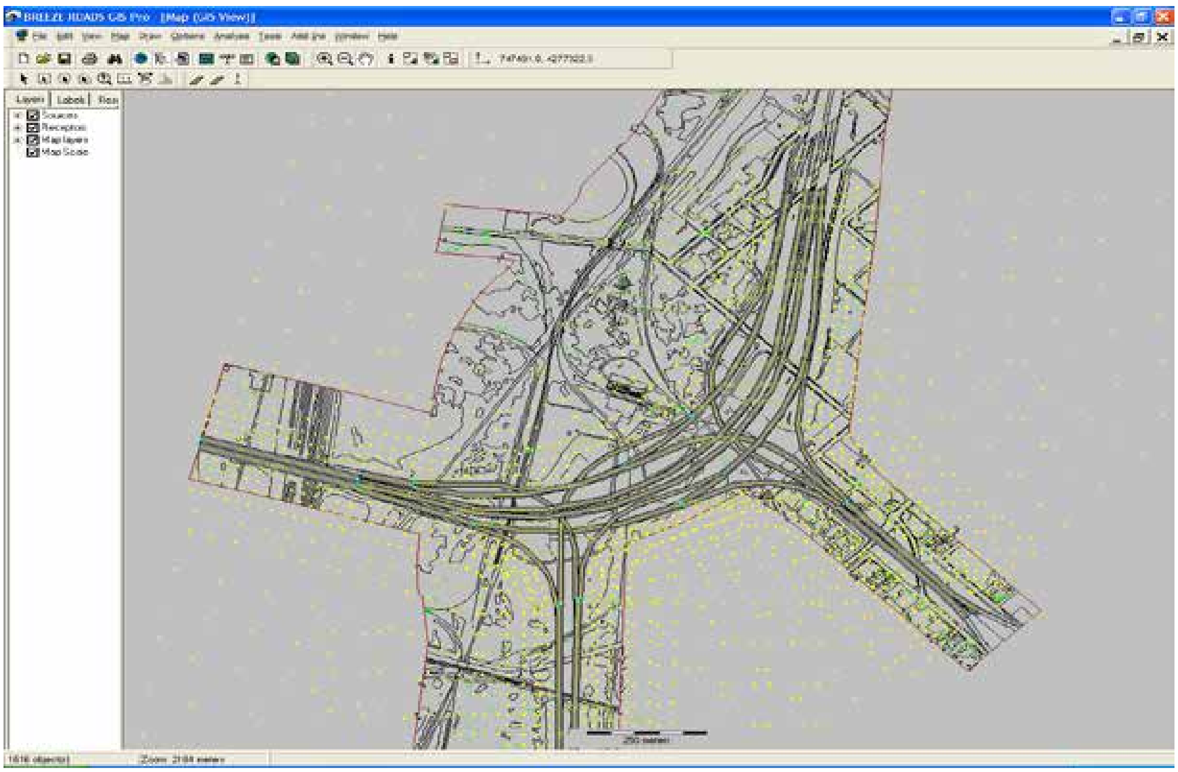



Figure 8.3 Placement of sources and receptors.

### 8.1.5 Background Concentration

The most recent monitoring data for the St. Louis area for the calendar years 2009 through 2011 were obtained from Illinois EPA. Based on the proximity of the case study site to the monitoring sites, it was decided that the Blair site in Missouri and the East St. Louis site in Illinois (see Figure 3.2) would be used to interpolate spatially (using the distance-weighted approach) the background values for the case study region. This approach resulted in the background concentration of 12.18 $\mu g/m^3$ for the case study, which already exceeds the $PM_{2.5}$ annual standard.

### 8.1.6 Results

BREEZE ROADS software was used only for modeling the sources and receptors. The coordinates were exported and processed using U.S. EPA's CAL3QHCR (version No.12355). The resulting concentrations were divided into four categories, as shown in Figure 8.4. The highest-concentration category (equal to or greater than 3 μg/m$^3$) was indicated by red circles; the second category consists of concentrations in the range of 2 to 2.99 μg/m$^3$, indicated by blue circles; the third category consists of concentrations in the range 1 to 1.99 μg/m$^3$, indicated by green circles; and the fourth category consists of concentrations less than 1 μg/m$^3$, indicated by yellow dots. Higher concentrations were obtained near the roadway links 1, 2, 3, and 4 (Figure 8.4). These correspond to roadway links where I-64, I-55, and I-70 merge; accordingly, these links have the highest volumes for all the time periods, compared with the other links. The highest concentration obtained was 3.1 μg/m$^3$. The highest concentration when combined with the background concentration was 15.3 μg/m$^3$.

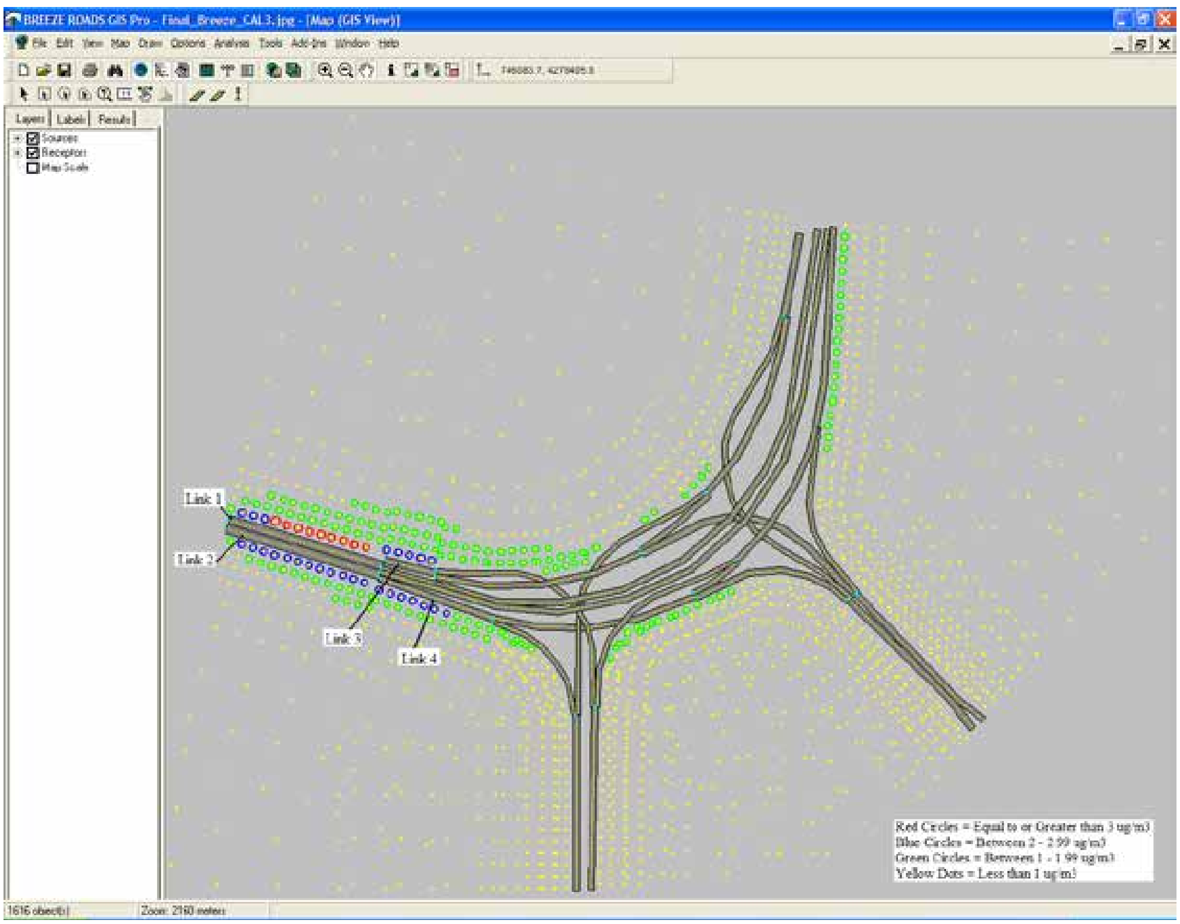



Figure 8.4 Location of four categories of $PM_{2.5}$ annual average concentrations for Poplar Street Bridge in the St. Louis area (Metro East).

### 8.1.7 Effect of Geographic Location

Another objective was to test the effect of geographic location (e.g., meteorology, fuel supply, age distribution, and I/M program) of a project site on the $PM_{2.5}$ concentration levels, after controlling for the geometry of the case study site, which is hypothesized to have effects on the concentration, as well as traffic conditions. The analysis was performed as follows: using the same Poplar Street Bridge site configuration (both in terms of traffic and geometry), the research team first applied the Metro East–specific emission factors and meteorological conditions in the hot-spot modeling, and then applied the Chicago-specific emission factors and meteorological conditions in the same modeling. Afterwards the two sets of results were compared.

The resulting concentrations for Metro East are already shown in Figure 8.4 and Chicago in Figure 8.5. In the latter, the highest concentration obtained was 4.1μg/m$^3$, which translates to a 30% increase from Metro East with the same site configuration, except moving it from Metro East to Chicago. The difference in the concentrations between locations is attributed to the differences in the local-specific conditions such as meteorology, fuel supply, and age distribution. These local conditions are found to have a significant impact on the EFs, especially the effect of temperature on the emission rates. Chicago has lower temperatures, compared with Metro East, with the temperature difference ranging between 3°F and 9°F for the four seasons of a year. These results are consistent with the MOVES sensitivity analysis performed with respect to temperature, where a decrease of 3°F led to a 9% increase in MOVES emission rates (Section 6.2.1). Thus, the lower temperatures in Chicago, combined with other local conditions, led to an increase in the MOVES emission rates, thereby resulting in higher $PM_{2.5}$ concentrations, compared with Metro East.

It is worth noting that, in MOVES, temperature affects only gasoline vehicle $PM_{2.5}$ emission rates and has no effect on diesel vehicles (primarily medium and heavy trucks). In other words, although the focus can easily be skewed toward diesel vehicle traffic when talking about PM hot-spot conformity, gasoline vehicles make up the majority of roadway traffic in most cases and their overall effect on PM2.5 emissions is just as significant, if not more so. Furthermore, this finding also points to the fact that there are so many factors at work, to various degrees, in the case of PM2.5 hot-spot conformity. The degree each of these factors affects the PM2.5 concentration levels, as well as the combined effect of them all, is still not well understood. Therefore, it is difficult (if not nearly impossible) to generalize the findings of one case study to another.

The spatial distribution of the highest concentrations is similar between the two cases. That is, higher concentrations were obtained near roadway links 1, 2, 3, and 4 (Figures 8.4 and 8.5), which correspond to roadway links where I-64, I-55, and I-70 merge, and which have the highest volumes for all time periods, compared with the other links. However, more locations were identified in the top two highest categories (> 3 μg/m$^3$, 2 to 3 μg/m$^3$). This finding is because of the higher emission rates from Chicago, compared with Metro East, and because of the meteorological data (Figures 7.2 and 8.2), which indicated a change in the predominant wind direction between Chicago (SW to NE) and Metro East (SE to NW).

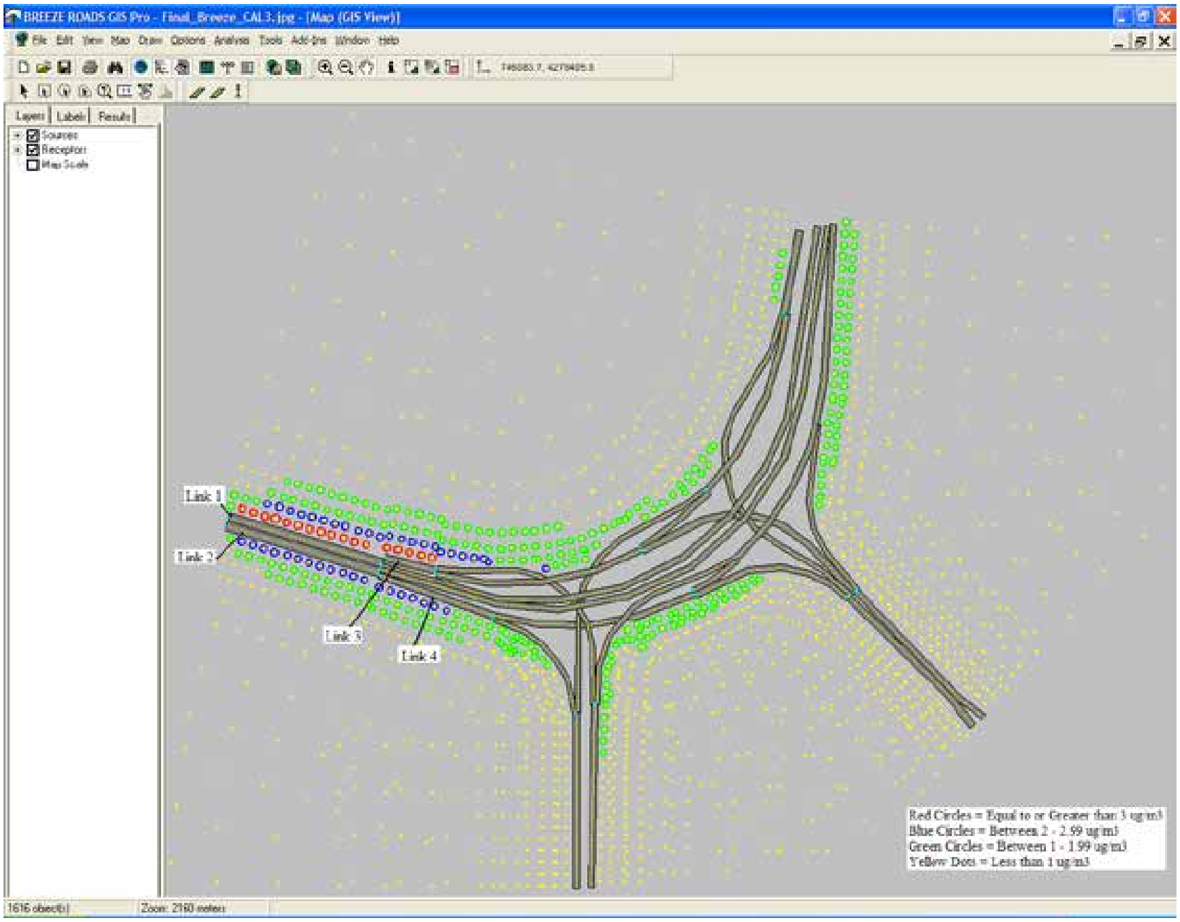



Figure 8.5 Location of four categories of $PM_{2.5}$ annual average concentrations for Poplar Street Bridge in Chicago.

### 8.2 INTERSECTION OF ALGONQUIN AND IL 53, CHICAGO

The intersection of Algonquin and IL 53 was one of the arterial case study sites selected for showcasing the PM hot-spot modeling process in Chicago. Figure 8.6 shows the Google Maps image and the extent of the case study modeled. The urban/rural representativeness of the site was found to be urban, based on the land-use classification method.

#### 8.2.1 Traffic Data Preparation

Traffic data were obtained from CMAP for the calendar years 2010 (actual observations) and 2040 (model projections) in the form of GIS files. The geometry of the project from the CADD drawing was matched with the GIS files to extract the corresponding traffic-activity data for all roadway links in the case study site. The traffic data extracted for the roadway links consisted of the total traffic volume, truck volume, and speed by the time of day. The extracted data for the years 2010 and 2040 were used to produce traffic data for the year 2015 by interpolation. The time periods contained in the GIS files consisted of hours different from the time periods expected for PM hot-spot analysis. To bridge this gap, the traffic data from the GIS files were converted into hourly time periods. For this purpose, traffic pattern data in terms of AADT percentage by hour for northeastern Illinois, urban, noninterstate from Illinois travel statistics (Illinois Department of Transportation 2011) were used. The hourly data were grouped into PM hot-spot analysis time periods. For incorporating the worst-case scenario, the total traffic volume and truck volume selected consisted of the highest volume within those hours in the corresponding time periods. See Appendix D for the traffic volumes used in this case study.

Owing to the lack of data on the percentage of single- and multiple-unit trucks from truck volume, data from Illinois travel statistics were used (Illinois Department of Transportation 2011). The AVMT by vehicle type for urban principal arterials gave the split of truck volume as 45% multiple-unit and 55% single-unit. The difference between the total traffic volume and the truck volume gave the four-tire vehicle volume. The mapping of the truck and four-tire vehicles into the 13 MOVES vehicle types was done similar to the process used in the Poplar Street Bridge case study (Section 8.1.1).


Figure 8.6 Extent of the case study site modeled (Source: Google Maps).

### 8.2.2 Representation of Traffic Queuing at Signalized Intersection

When employing the average-speed approach in MOVES, an arterial street segment connecting to a signal intersection is composed of cruise, queue, and acceleration links (U.S. EPA *Project Level Training for Quantitative PM Hot-Spot Analyses*). For each of these links, the link length, average speed, and time taken to traverse the link are required.

For the case study, the queue link was assumed to begin at the stop bar and extend backwards from there. The *Highway Capacity Manual* (Highway Capacity Manual 2010) procedure was used to calculate the average queue length. The calculated average queue length provides an estimated length for the area where the majority of queuing would occur.

The acceleration link was assumed to begin at the stop bar, moving forward. The average speed on the acceleration link was equal to half of the cruise link speed. The acceleration link length is calculated based on $d = v_o * t + 0.5 * a * t^2$; where the acceleration rate $a = (v_i – v_o) / t$, where $v_o$ is the queue link speed, and $v_i$ is the cruise speed. A uniform acceleration value of 1.5 m/sec$^2$ was assumed for calculating the acceleration link length, based on interagency consultation. This value was slightly lower than for passenger cars, mainly to account for the heavier vehicles in the fleet mix.

The cruise link length is measured from the end of the acceleration link to the back of the next queue link. The average speed is equal to cruise speed.

The four time periods considered in the PM hot-spot modeling led to different queue, acceleration, and cruise link lengths. Instead of modeling the sources in CAL3QHCR each time for four different time periods, the peak hour link lengths was used to define the length of the sources in CAL3QHCR and was used for all time periods. By this method, the source link lengths for all time periods were based on the peak hour calculation in CAL3QHCR but with the volume and emission rates corresponding to the individual time periods. A total of 42 unique roadway links were obtained, based traffic activity data (signal plan, traffic volume and speed) for the case study site. The total traffic volume, fleet composition, and speed were passed on to MOVES for producing the emission rates.

### 8.2.3 MOVES Modeling

For nonqueue links, MOVES was run in the “Emission Rate” scale to obtain directly the emission rates in terms of grams/mile. For queue links, MOVES was run in the “Emission Inventory” mode, and the results were post-processed to produce emission rates in terms of grams/mile. As shown in Eq. 8.1, post-processing consists of accounting for the fraction of the time during the hour that the vehicles are queuing, the number of lanes, the idle traffic volume, and the vehicle spacing (assumed to be 6 m per vehicle in CAL3QHCR). MOVES was run in the batch mode, and the results were extracted from the MySQL database. Refer to Table 6.1 for MOVES input parameters used for PDM.

$$\begin{aligned}&\textit{Emission Rate}(grams/mile) = \\ &[\textit{MOVES Idle Emission Rate}(grams/veh\text{-}hr) \times \textit{No of Lanes} \times \textit{Idle Time Fraction} \times 1609.3m/mile] \\ &\qquad / [\textit{Spacing}(6meters/veh) \times \textit{Idle Traffic Volume}(veh/hr)]\end{aligned} \tag{8.1}$$

### 8.2.4 Meteorological Data

The meteorological data were obtained from the O’Hare Airport surface station and the Davenport, Iowa, upper-air station for the calendar years 2005 through 2009. The prevailing wind rose diagram for the case study region is shown in Figure 8.7. The dominant wind direction is from SW to NE.

### 8.2.5 CAL3QHCR Modeling

The traffic volumes and composite emission rates from MOVES were input into CAL3QHCR for producing the $PM_{2.5}$ annual average concentrations. Each of the 42 distinct roadway links was modeled with one or more line sources to preserve the geometry, resulting in a total of 95 line sources. The first set of receptors was placed at a 25-m spacing for a distance of 150 m. The first line of receptors in the first set was placed at a distance of 15 m (50 ft) from the edge of the roadway, to account for the right-of-way distance. The second set of receptors was placed at a 50-m spacing for a distance of 100 m. This pattern resulted in a total of 558 receptors. The other input parameters were similar to those of the pilot study (Table 7.3). Figure 8.8 shows the placement of the sources and receptors for the case study.

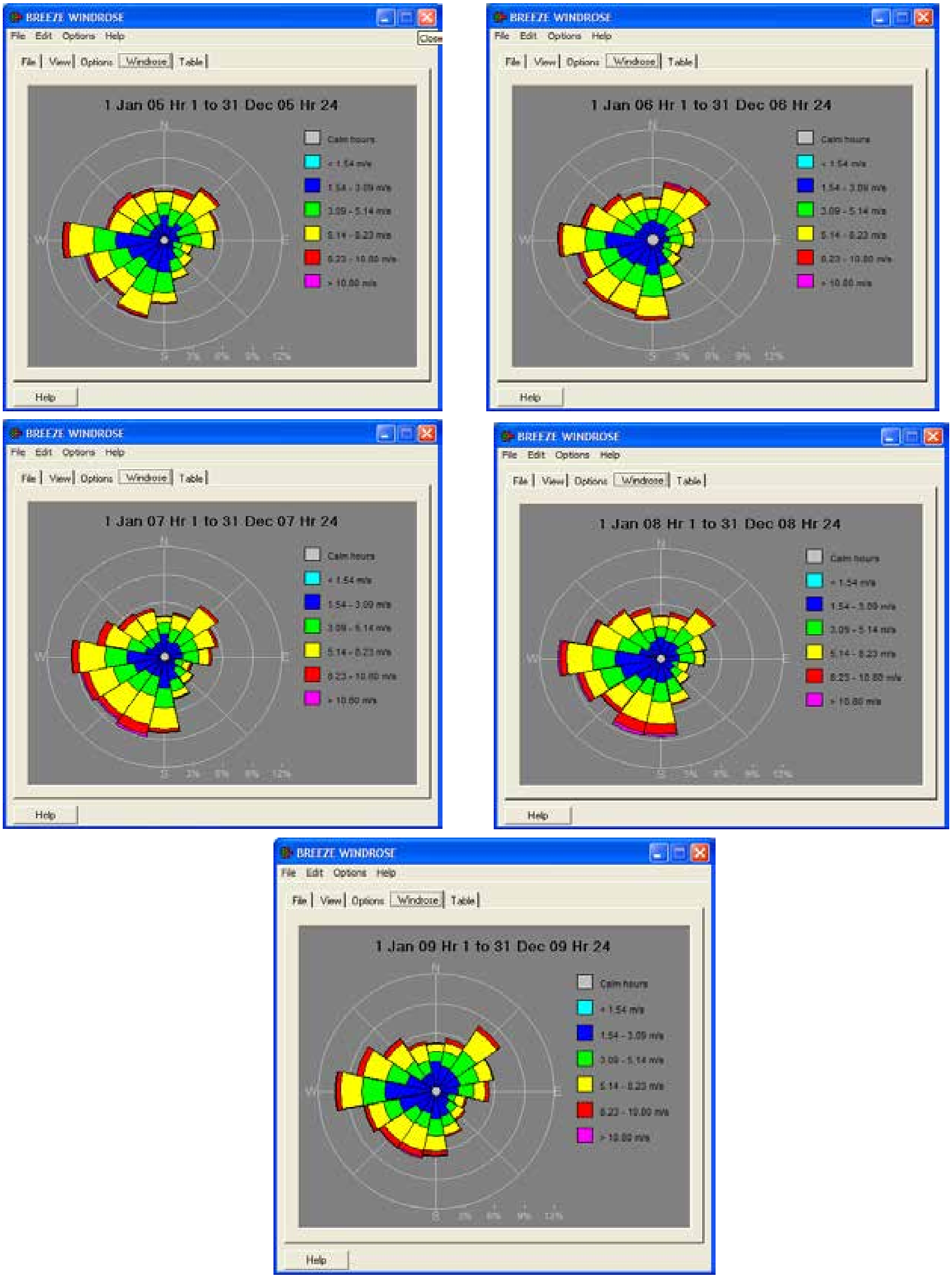



Figure 8.7 Wind rose diagram for Chicago urban area (plotted with BREEZE ROADS wind rose software).

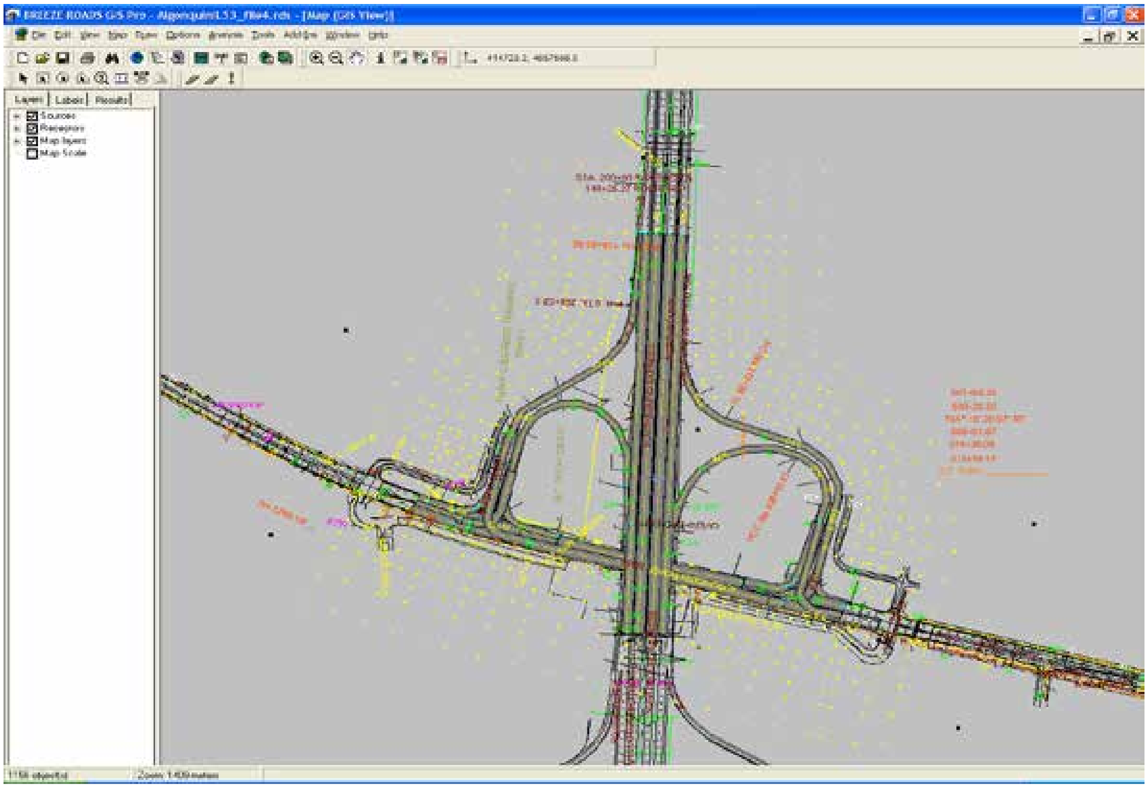


Figure 8.8 Placement of sources and receptors.

### 8.2.6 Background Concentration

The most recent monitoring data for the Chicago area for the calendar years 2008 through 2010 were obtained from Illinois EPA. Based on the proximity of the case study site to the monitoring sites, it was decided that the Elgin, Des Plaines, and Northbrook sites (see Figure 3.1) would be used to interpolate spatially (using the distance-weighted approach) the background values for the case study region. This approach resulted in the background concentration of 10.33µg/$m^3$ for the case study.

### 8.2.7 Results

The concentrations resulting from CAL3QHCR were divided into three categories, as shown in Figure 8.9. The first category consists of concentrations in the range 2 to 3 µg/$m^3$ (red circles), the second category consists of concentrations in the range 1 to 1.99 µg/$m^3$ (blue circles), and the third category consists of concentrations less than 1 µg/$m^3$ (yellow dots). Higher concentrations were obtained near the highway IL 53 links, as indicated in Figure 8.9. These links have significantly higher traffic volumes for all time periods, compared with the other links. Furthermore, the locations of the highest concentrations also coincided with the predominant wind direction from SW to NE. The highest concentration obtained was 2.6 µg/$m^3$. The highest concentration when combined with the background concentration was 12.93 µg/$m^3$.

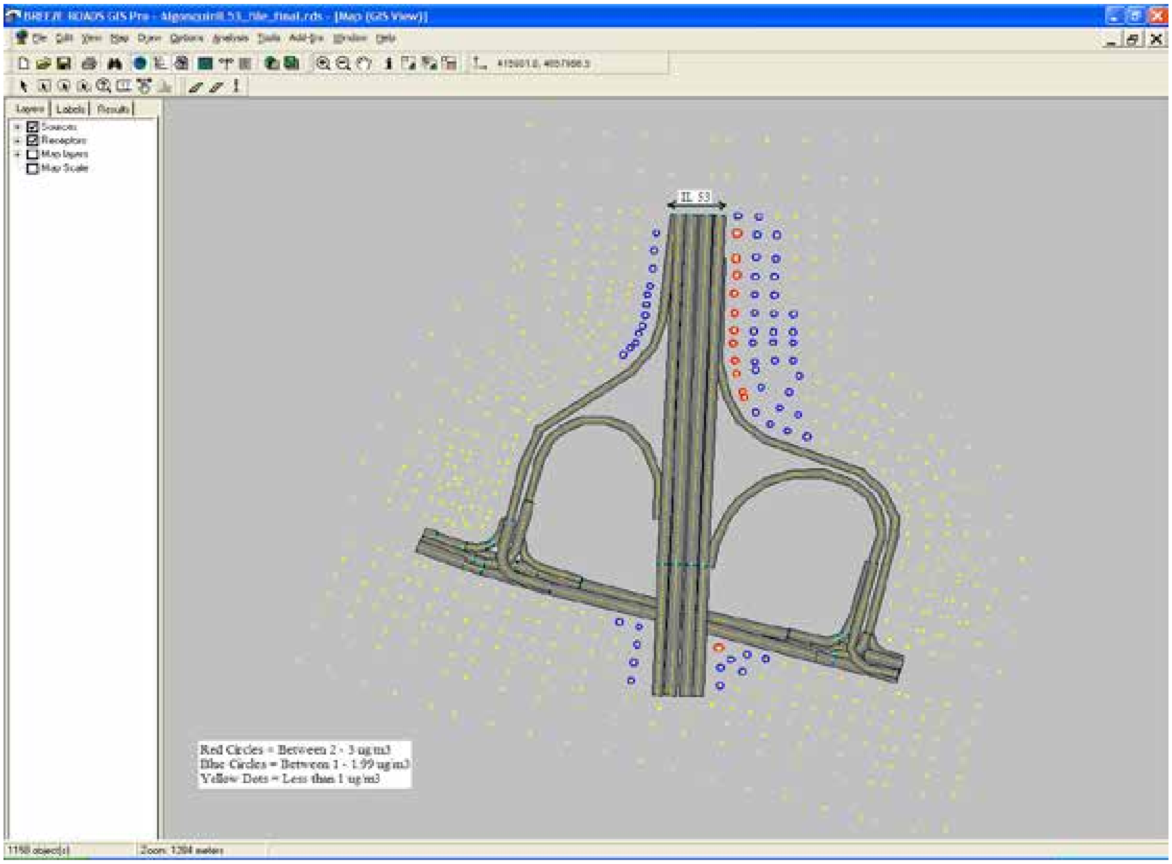



Figure 8.8 Location of four categories of $PM_{2.5}$ annual average concentrations.

### 8.3 INTERSECTION OF STATE ROUTE 3 AND PIASA LANE, METRO EAST

The intersection of State Route 3 and Piasa Lane was one of the arterial case study sites selected for showcasing the PM hot-spot modeling process in Metro East. Figure 8.9 shows the Google Maps image and the extent of the case study modeled. The urban/rural representativeness of the site was found to be rural because more than 50% of the land was used for farming.

#### 8.3.1 Traffic Data Preparation

The process of obtaining the traffic data for the year 2015 for the four time periods as required for PM hot-spot analysis for highway and arterial links was similar to that of the Algonquin and IL 53 arterial case study site (Section 8.2.1). A total of 14 unique roadway links were obtained, based traffic activity data (signal plan, traffic volume, and speed) for the case study. The total traffic volume, fleet composition, and speed were input into MOVES for producing the emission rates. See Appendix D for the traffic volumes used in this case study.


Figure 8.9 Extent of the case study site modeled (Source: Google Maps).

### 8.3.2 MOVES Modeling

The process of obtaining the MOVES emission rates for both highway and queue links was done in a manner similar to that for the Algonquin and IL 53 arterial case study site (Section 8.2.3).

### 8.3.3 Meteorological Data

The 5 years of St. Louis area meteorological data were obtained from the Lambert–St. Louis International Airport surface station and the Lincoln, Illinois upper-air site in the St. Louis area[1]. The prevailing wind rose diagram for the case study region is shown in Figure 8.2.

### 8.3.4 CAL3QHCR Modeling

The traffic volumes and composite emission rates from MOVES were input into CAL3QHCR for producing the $PM_{2.5}$ annual average concentrations. The case study was modeled with 14 line sources. The first set of receptors was placed at a 25-m spacing for a distance of 150 m. The first line of receptors in the first set was placed 15 m (50 ft) from the edge of the roadway, to account for the right-of-way distance. The second set of receptors was placed at a 50-m spacing for a distance of 100 m. This pattern resulted in a total of 492 receptors. The other input parameters were similar to those of the pilot study (Table 7.3), the

[1] The Lambert-St. Louis International Airport surface meteorological station is about 25 kilometers away from the Route 3 & Piasa intersection and the Lincoln upper air site is 162 kilometers away. St. Louis is the closest first order ASOS NWS station and Lincoln is the closest NWS upper air station. Note that although the Route 3 project site is classified as a rural site, the meteorological data input used in the analysis here is the same as the Poplar Street Bridge site which is classified as urban. This is a result of a personal communication with (Matt Will) the Illinois EPA staff who is an AERMOD modeling expert. Per Matt Will's suggestion, the urban meteorological input is used, without using the URBANOPT and URBANSRC commands in AERMOD.

only difference being the rural land-use option for this case study. Figure 8.11 shows the placement of the sources and receptors for the case study.

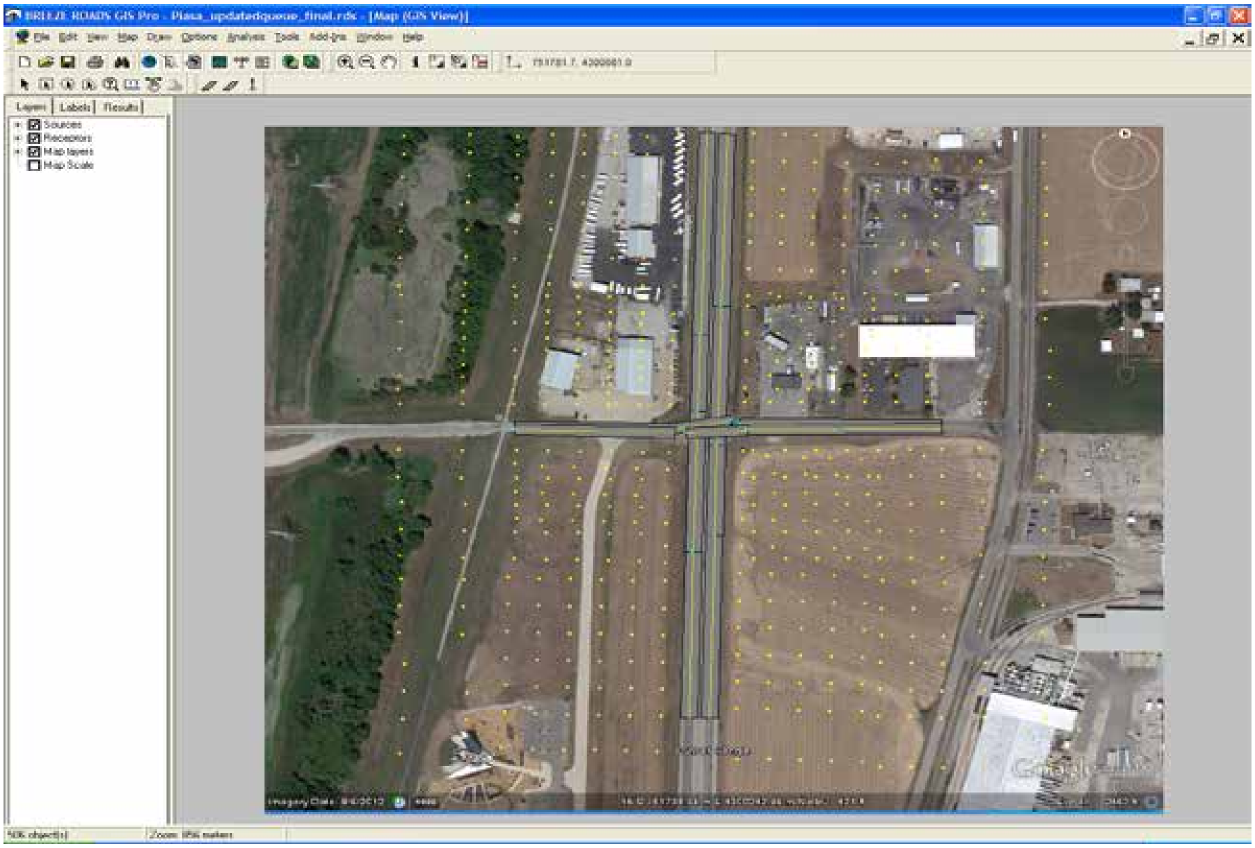


Figure 8.11 Placement of sources and receptors.

### 8.3.5 Background Concentration

The most recent monitoring data for the Metro-East area for the calendar years 2008 through 2010 were obtained from Illinois EPA. Based on the proximity of the case study site to the monitoring sites, it was decided that the Alton and Wood River sites (see Figure 3.2) would be used to interpolate spatially (using the distance-weighted approach) the background values for the case study region. This approach resulted in the background concentration of 11.9 μg/m$^3$ for the case study.

### 8.3.6 Results

The concentrations resulting from CAL3QHCR were divided into three categories, as shown in Figure 8.12. The first category consists of concentrations in the range 1 to 2 μg/m$^3$ (red circles), the second category consists of concentrations in the range 0.5 to 0.99 μg/m$^3$ (blue circles), and the third category consists of concentrations less than 0.5 μg/m$^3$ (yellow dots). Higher concentrations were obtained near State Route 3. These links have high traffic volumes for all time periods, compared with the intersecting Piasa Lane. The highest concentration obtained was 1.12 μg/m$^3$. The highest concentration when combined with the background concentration was 13.02 μg/m$^3$.

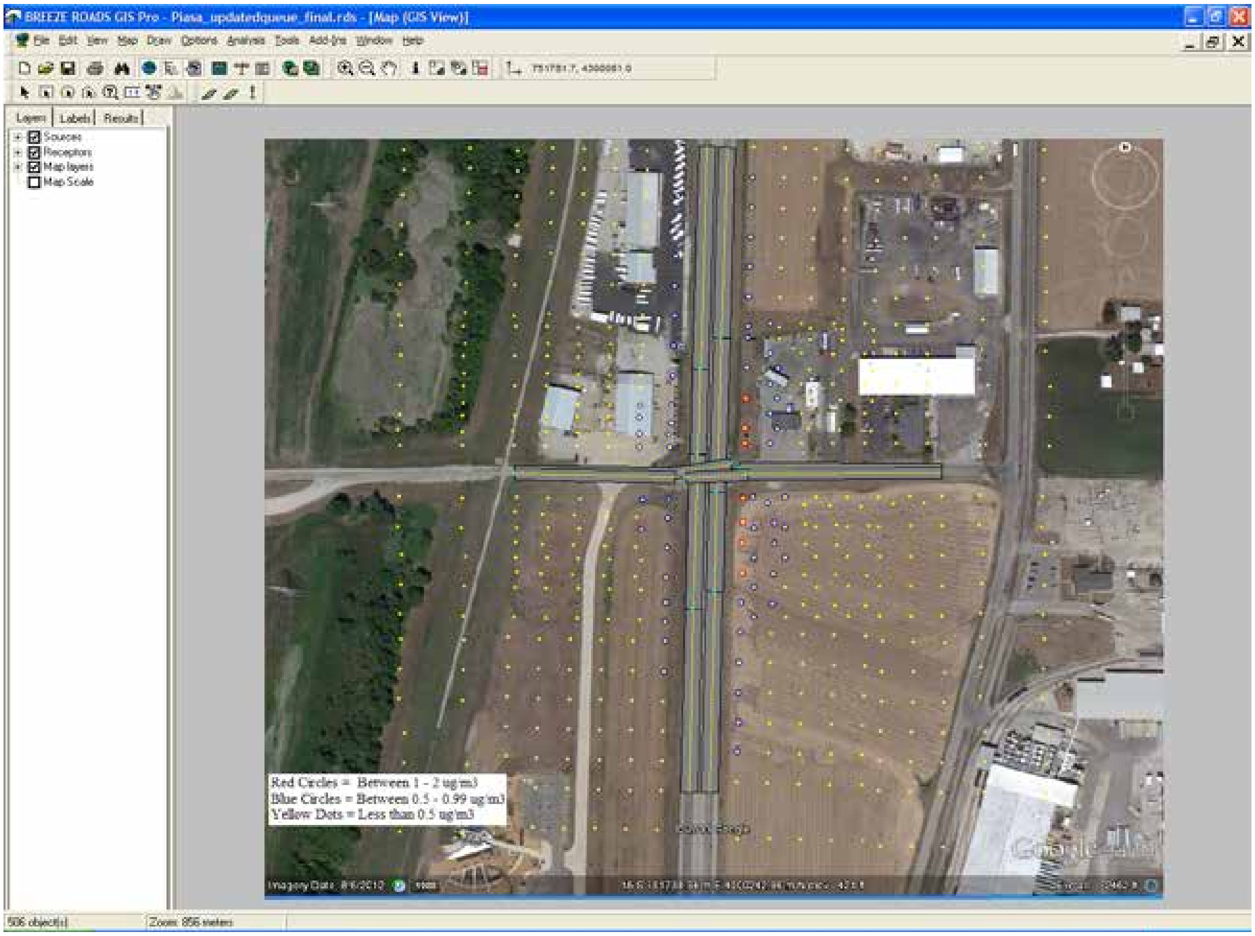



Figure 8.12 Location of four categories of $PM_{2.5}$ annual average concentrations.

# CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

This study is among the first undertakings by a state DOT to implement PM hot-spot analyses in accordance with the U.S. EPA guidance. Over the course of the project, there has been a tremendous learning process for the research group, as well as for the TRP, with respect to understanding the technical requirements in every single step in the guidance. This project would not have been completed without the TRP and interagency consultation, which have been critical to the success of the project.

The project initially set out to find Illinois-specific threshold values for defining “projects of potential air quality concern” and to develop a graphical user interface (GUI) that IDOT could use to determine easily whether a project is of air quality concern. Over the course of the study the research team, together with the TRP concluded that the $PM_{2.5}$ hot-spot analyses differ from project-to-project and the findings are difficult to generalize across projects because: (1) $PM_{2.5}$ has a complicated chemical composition and may vary from site to site, (2) each project has specific source and receptor placements, and (3) many factors [e.g., site geometry, traffic composition, meteorological conditions, project location (urban vs. rural), background concentration levels, and air-dispersion model parameters] are at work.

The revised objective, therefore, was to provide insights into the PM hot-spot modeling process with respect to input-data preparation for emission and air quality models, model setup, sensitivity testing of MOVES, and comparison of AERMOD and CAL3QHCR models. The research team first assessed the amount of modeling effort and technical requirements through a pilot study at the interchange of I-80 and I-55 south of Chicago. It was a typical cloverleaf-shaped highway interchange with a modest amount of traffic. However, the truck traffic can go as high as 70% at some locations. The modeling results showed that in the worst-case scenario, this interchange could exceed the $PM_{2.5}$ annual ambient standard because of a very high percentage of truck traffic.

Three case studies were then evaluated, one highway project in Metro East and two arterial street signal intersection projects, with one each from Chicago and Metro East. Furthermore, the team also tested the effect of a project’s geographic location (in this context, Chicago or Metro East) on the $PM_{2.5}$ concentration levels, after controlling for geometry and traffic conditions of the case study site. Owing to factors such as different meteorological conditions, fuel supply, vehicle fleet age distribution, and I/M program, geographic location would have an effect on the $PM_{2.5}$ concentration levels, even if the traffic conditions, site geometry, and other site configurations are exactly the same.

In addition, sensitivity analyses on MOVES were performed, with respect to a number of input parameters, including temperature, calendar year, season, and time of day. Two air-dispersion models were also compared, AERMOD and CAL3QHCR, in terms of model performance.

The general findings in all of the model investigations during the project are as follows:

- For the limited-access roadway projects, the contribution from traffic ranges roughly from 0 to 4 $\mu g/m^3$ in Chicago and 0 to 3 $\mu g/m^3$ in Metro East. These results are comparable with studies in other parts of the country.
- For the arterial projects, the contribution from traffic ranges roughly from 0 to 3 $\mu g/m^3$ in Chicago and 0 to 1.5 $\mu g/m^3$ in Metro East. These results are comparable with studies in other parts of the country.

- The geographic location of a roadway project plays an obviously important role in $PM_{2.5}$ hot-spot conformity. Roadway projects in the Chicago area tend to have higher contributions to $PM_{2.5}$ concentrations near roadways, even after controlling for the geometry and traffic conditions. One major cause is temperature because Chicago is on average 3°F to 9°F lower than Metro East. Because $PM_{2.5}$ emissions from diesel vehicles are not affected by temperature, this means the difference is attributed to gasoline vehicles.
- The background concentrations in both Chicago and Metro East are already very high, typically above 10 $\mu g/m^3$ in Chicago and above 11 $\mu g/m^3$ in St. Louis. Even a small contribution from a roadway project in either region may push the project to exceed the annual $PM_{2.5}$ NAAQS standard. In that case, the build versus no-build analysis is required in determining a project of "potential air quality concern."
- Furthermore, Metro East and Chicago have comparable total $PM_{2.5}$ levels from roadway projects, after taking into account the background concentration levels. Metro East has a higher background concentration level in general. On the other hand, its traffic volumes and percent diesel trucks, as well as temperature, are generally lower than Chicago.
- The urban/rural classification of a project site matters considerably because it directly determines which local meteorological inputs (from a nearby urban or rural representative weather station) to use in emission and air-dispersion modeling. The pilot study found that using the rural meteorological representation can result in 1.4 times that of the urban concentration levels (without the background level).
- In this study, AERMOD and CAL3QHCR show considerable discrepancies in model results for the same project setting. In this preliminary investigation, the research team found that the spatial distribution of the estimated pollutant concentrations was quite consistent between AERMOD and CAL3QHCR. However, the magnitudes of the AERMOD estimates were twice as high as that of CAL3QHCR on an annual average basis. This finding is in agreement with some but not all in the literature, which points to the need for further investigation.
- Most important, there are so many factors at work to various degrees in the case of $PM_{2.5}$ hot-spot conformity that it is generally difficult, if not nearly impossible, to generalize the findings of one case study to another.

All of the modeling exercises proved to be helpful and informative in obtaining a good handle on the amount of modeling work, model setup and parameter values, data requirements, and other technical details. Tremendous experience was gained in $PM_{2.5}$ hot-spot conformity analyses from the project. Additional findings include:

- The PM hot-spot modeling procedure defined in the U.S. EPA guidance requires a considerable amount of time for state DOTs, MPOs, and transportation-consulting companies to understand fully, as well as a workforce to implement it. Not only because MOVES and AERMOD are new to most of them but also because of the great deal of technical details specific to the PM hot-spot conformity procedure defined in the guidance. For example, the arterial street case studies presented in Chapter 8 required approximately 4 to 5 weeks to set up the model run, which does not even include the time spent on assembling the data required by the models. Moreover, that amount of time was after the research team had gained insightful modeling experience from the pilot study. The amount of time could very well increase as the complexity of case study site increases such as the Poplar Street Bridge site.

- Based on this study, it is clear that careful selection of input parameters for all models (MOVES, AERMOD, and CAL3QHCR) is required to avoid possible variation in the concentration results.
- Technical Review Panel and interagency consultation are critical to the success of the $PM_{2.5}$ hot-spot conformity analyses. In our study, all model input parameters were discussed with the TRP and determined through interagency consultation. The TRP members for this study came from IDOT, FHWA, U.S. EPA, Illinois EPA, and CMAP. Having these agencies' continual and close engagement proved to be valuable to the PM hot-spot conformity analysis project.
- A considerable data gap exists between what the models (MOVES and air-dispersion models) need and what currently is being collected by transportation agencies (or what is being modeled, in the case of the regional transportation model). The data gap is summarized and presented in Chapter 3.3. It is recommended that transportation agencies revisit their data collection protocols and procedures and update them accordingly to meet the new modeling requirements.

Given the time limit and the complexity of the problem, this study provides only an initial understanding of the $PM_{2.5}$ modeling requirements. The team still does not have an adequate grasp of the degree to which each of these factors affects the $PM_{2.5}$ concentration levels, nor the combined effect of them all. For future work, the following is recommended:

- Additional case studies to examine the effects of various project configurations and settings to determine if there are any trends
- Further investigations in model performance with respect to key model input parameters (e.g., site geometry, traffic composition, fleet age distribution, and meteorology)
- Further comparison between AERMOD and CAL3QHCR
- Detailed documentation of activity data needs, potential sources, and methods to collect or generate the data

# REFERENCES

Almeida, S.M., Pio, C.A., Freitas, M.C., Reis, M.A., and Trancoso, M.A. 2005. Source Apportionment of Fine and Coarse Particulate Matter in a Sub-Urban Area at the Western European Coast. *Atmospheric Environment* 39:3127–3138.

Bai, S., Eisinger, D., and Niemeier, D. 2009. "MOVES vs. EMFAC: A Comparison of Greenhouse Gas Emissions Using Los Angeles County." Presented at the Transportation Research Board 88th Annual Meeting, Paper #09-0692, Washington DC, January 11–15, 2009.

Beardsley, M. 2004. "MOVES Model Update." Presented at the 14th CRC On-Road Vehicle Emissions Workshop, San Diego, CA, March 29–31, 2004.

Beardsley, M., Dresser, C., Hillson, S., Koupal, J., and Warila, J. 2010. "Update on EPA's Motor Vehicle Emissions Simulator." Presented at the 20th CRC On-road Vehicle Emission Workshop, San Diego, CA, March 22–24, 2010.

Caputo, M., Gimenez. M., and Schlamp, M. 2003. "Intercomparison of Atmospheric Dispersion Models." *Atmospheric Environment* 37:2435–2449.

Chen, H., Bai, S., Eisinger, D., Niemeier, D., and Claggett, M. 2009. "Predicting Near-Road $PM_{2.5}$Concentrations: Comparative Assessment of CALINE4, CAL3QHC, and AERMOD." *Transportation Research Record, Journal of the Transportation Research Board* 2123:26–37.

Choi, D. 2011. MOVES Sensitivity Analysis: The Impacts of Temperature and Humidity on Emissions. Presented at MOVES Workshop 2011. Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Ann Arbor, MI.

Chow, J.C., Watson, J.G., Fujita, E.M., Lu, Z.Q., Lawson, D.R., and Ashbaugh, L.L. 1994. "Temporal and Spatial Variations of $PM_{2.5}$ and PM10 Aerosol in the Southern California Air-Quality Study." *Atmospheric Environment* 28:2061–2080.

Cimorelli, A.J., Perry, S.G., Ventatram, A., Weil, J.C., Paine, R.J., Wilson, R.B., Lee, R.F., Peters, W.D., and Brode, R.W. 2005. "AERMOD: A Dispersion Model for Industrial Source Applications. Part 1: General Model Formulation and Boundary Layer Characterization." *Journal of Applied Meteorology* 44:682–693.

Claggett, M., and Bai, S. 2012. "Comparing Predictions from the CAL3QHCR AERMOD Models for Highway Applications." Presented at the Transportation-Related Environmental Analysis, Ecology, and Air Quality Summer Conference, Little Rock, AR, June 24–27, 2012.

Faulkner, W.B., Shaw, B.W., and Grosch, T. 2008. "Sensitivity of Two Dispersion Models (AERMOD and ISCST3) to Input Parameters for a Rural Ground-Level Area Source." *Journal of the Air and Waste Management Association* 58(10):1288–1296.

Glaze, M., and Wayson, R. 2012. "MOVES Sensitivity Analysis Update." Presented at the Transportation Research Board Summer Meeting, Little Rock, AR, June 24–27, 2012.

Golder, D. 1972. "Relations Among Stability Parameters in the Surface Layer." *Boundary Layer Meteorology* 3:47–58.

Grosch, T.G., and Lee, R.F. 1999. "Sensitivity of the AERMOD Air Quality Model to the Selection of Land Use Parameters." *Transactions on Ecology and Environment* 37.

Highway Capacity Manual. 2010. http://www.trb.org/Main/Blurbs/164718.aspx. Assessed January 23, 2013.

Illinois Department of Transportation. 2011. Illinois Travel Statistics. http://www.dot.state.il.us/travelstats/2011_ITS.pdf. Office of Planning and Programming. Assessed May 10, 2012.

Long, D.J. 2004. "Comparison of the Performance of AERMOD and ISC on Elevated Point Sources." *Proceedings of the Air and Waste Management Annual Conference and Exhibition*, pp. 597–613.

Long, E.L., Cordova, F.J., and Tanrikulu, S. 2004. "An Analysis of AERMOD Sensitivity to input Parameters in the San Francisco Bay Area." Presented at the 13th Conference on the Applications of Air Pollution Meteorology, with the Air and Waste Management Association, American Meteorological Society, Vancouver, BC, August 23–25, 2004.

National Oceanic and Atmospheric Administration. http://www.weather.gov. Accessed February 03, 2011.

Radonjic, Z., Chambers, D.B., and Kirkaldy, J. 2003. "Modelling Line Sources (Roads) Using CAL3QHCR, ISC3, AERMOD and CALPUFF." Presented at the Air and Waste Management Annual Conference and Exhibition, Mystic, CT, October 22–24, 2003.

Schroeder, A.J., and Schewe, G.J. 2009. "Sensitivity of AERMOD to Meteorological Data Sets Based on Varying Surface Roughness." Presented at the Air and Waste Management Annual Conference and Exhibition, Paper No. 168, Detroit, MI, June 16–19, 2009.

Silverman, K.C., Tell, J.G., Sargent, E.V., and Qiu, Z. 2007. "Comparison of the Industrial Source Complex and AERMOD Dispersion Models: Case Study for Human Health Risk Assessment." *Journal of the Air and Waste Management Association* 57(12):1439–1446.

Singh, R.B., Desloges, C., and Sloan, J.J. 2006. "Application of a Microscale Emission Factor Model for Particulate Matter to Calculate Vehicle Generated Contributions to Fine Particulate Emissions." *Journal of the Air and Waste Management Association* 56(1):37–47.

Sonntag, D.B., and Gao, H. 2007. "The MOVES from MOBILE: Preliminary Comparisons of EPA's Current and Future Mobile Emissions Models." Presented at the Transportation Research Board 86th Annual Meeting, Paper #07-3090, Washington DC, January 21–25, 2007.

Turner, D.B. 1994. *Workbook of Atmospheric Dispersion Estimates: An Introduction to Dispersion Modeling*, 2nd ed. Boca Raton, FL: Lewis Publishers.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. 2010 *Transportation Energy Data Book*. Edition 29 of ORNL-5198.

U.S. Environmental Protection Agency. 1995a. *User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentration Near Roadway Intersections*. U.S. EPA report EPA-454-R-92-006, Office of Air Quality Planning and Standards.

U.S. Environmental Protection Agency. 1995b. *Addendum to the User's Guide to CAL3QHC Version 2.0 (CAL3QHCR User's Guide)*, Office of Air Quality Planning and Standards.

U.S. Environmental Protection Agency. 2000. *Meteorological Monitoring Guidance for Regulatory Modeling Applications.* U.S. EPA report EPA-454-R-99-005, Office of Air Quality Planning and Standards, February 2000.

U.S. Environmental Protection Agency. 2002. *Draft Design and Implementation Plan for EPA's Multi-Scale Motor Vehicle and Equipment Emission System (MOVES)*. U.S. EPA report EPA420-P-02-006, Office of Transportation and Air Quality.

U.S. Environmental Protection Agency. 2004a. *User's Guide for the AMS/EPA Regulatory Model—AERMOD*, U.S. EPA report EPA-454-B-03-001, Office of Air Quality Planning and Standards.

U.S. Environmental Protection Agency. 2004b. *AERMOD: Description of Model Formulation*. U.S. EPA report EPA-454-R-03-004, Office of Air Quality Planning and Standards.

U.S. Environmental Protection Agency. 2005. *Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions*. Final Rule. 40 CFR Part 51*, Federal Register*, Vol. 70, Appendix W.

U.S. Environmental Protection Agency. 2010a. *Transportation Conformity Rule $PM_{2.5}$ and $PM_{10}$ Amendments*. Final Rule. 40 CFR Part 93, *Federal Register*, Vol. 75, No. 56.

U.S. Environmental Protection Agency. 2010b. *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in $PM_{2.5}$ and $PM_{10}$ Nonattainment and Maintenance Areas*. U.S. EPA report EPA-420-B-10-040, Office of Transportation and Air Quality, December 2010.

U.S. Environmental Protection Agency. 2012. *Motor Vehicle Emission Simulator (MOVES): User Guide for MOVES 2010b*. U.S. EPA report EPA-420-B-12-001, Office of Transportation and Air Quality.

U.S. Environmental Protection Agency. *Particulate Matter Standards*. http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_index.html. Accessed June 10, 2011.

U.S. Environmental Protection Agency. *Regulatory Actions*. http://www.epa.gov/airquality/particlepollution/actions.html. Accessed February 10, 2013.

U.S. Environmental Protection Agency. *Preferred/Recommended Models*. http://www.epa.gov/scram001/dispersion_prefrec.htm. Accessed February 21, 2011.

U.S. Environmental Protection Agency. *Tools to Convert MOBILE6 Input Data to MOVES Format*. http://www.epa.gov/otaq/models/moves/tools.htm. Accessed June 25, 2010.

U.S. Environmental Protection Agency. *Meteorological Processors*. http://www.epa.gov/scram001/metobsdata_procaccprogs.htm. Accessed April 12, 2011

U.S. Environmental Protection Agency. *Heat Island Effect*. http://www.epa.gov/hiri/. Accessed July 20, 2012.

US Environmental Protection Agency. *Project Level Training for Quantitative PM Hot-Spot Analyses.* http://www.epa.gov/oms/stateresources/transconf/training3day.htm#description. Accessed January 10, 2013

Vallamsundar, S., Lin, J. 2011. "MOVES versus MOBILE: A comparison of GHG and Criteria Pollutant Emissions." *Transportation Research Record: Journal of Transportation Research Board* 2233: 27-35.

Zou, B., Zeng, Y., Liu, H., Zhang, H., Qiu, L., and Zhan, B.F. 2010. "Sensitivity Analysis of AERMOD in Modeling Local Air Quality under Different Model Options." Presented at Bioinformatics and Biomedical Engineering, 4th International Conference, pp.1–4.

# APPENDIX A MINUTES OF TECHNICAL REVIEW PANEL MEETINGS

# APPENDIX A: MINUTES OF TECHNICAL REVIEW PANEL MEETINGS

| 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|
| November 3 | January 14 | February 21 | February 8 (notes) |
| December 8 | February 10 | May 3 (notes) | March 15 |
| | February 23 | July 9 | |
| | April 14 | November 29 | |
| | May 25 | | |
| | July 14 | | |
| | September 28 | | |
| | November 9 | | |
| | December 1 | | |

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling
Wednesday, November 03, 2010

Attendance

The launch meeting of the TRP for Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling was held via conference call. The meeting was held at 11 a.m. on November 3, 2010. The following were present via conference call during the meeting:

| | | |
|---|---|---|
| Jane Lin | Thomas Bukowski | Mike Rogers |
| Matt Fuller | Walt Zyznieuski | Sam Long |
| Michael Brownlee | Mike Claggett | Suriya Vallamsundar |

**Introduction**

Walt Zyznieuski introduced the meeting and introduced Dr. Jane Lin to the panel. Zyznieuski said that because some panel members are located in Chicago, out of state, and others in Springfield, conference calls will be the primary mode of communication. He briefly discussed the history of the project and when it was approved. He asked Lin whether the contract was officially approved by ICT. Jane said that she had not heard back from ICT but the contract was set with a 11/1/10 start date. The project contract is for 12-months.

Next, Zyznieuski provided a brief project overview. He said that the purpose of the project is to define what a "Project of air quality concern" is and to establish solid thresholds (ADT, percent diesel vehicles, etc.) for Illinois particulate matter (PM) nonattainment and maintenance areas, to comply with new Environmental Protection Agency (EPA) -Hot-Spot regulations. The EPA has provided some guidance on what could be considered a project of air quality concern, but this project will hopefully create thresholds that can be used and defended in Illinois' PM nonattainment and maintenance areas. These thresholds will then be communicated to various other -agencies in Illinois, and the results may be presented at environment conferences.

This project will use the MOVES model that was developed by USEPA. -. Dr. Lin will obtain the MOBILE6.2 input files from IEPA and convert them to MOVES emission factors. Her team will also identify other local specific data sources relevant to this project. According to the RFP, part of the research team and members from this panel will meet November 18 at the Chicago Metropolitan Agency for Planning; the FHWA and EPA will be present. Then, on January 11, a meeting will take place at East-West Gateway Council of Governments. Arrangements have already been made for IDOT's participation.

Zyznieuski then briefly discussed the quarterly report process as well as the semi-annual evaluations of the TRP and the PIs.

**Goals and Implementation**

Zyznieuski said that in terms of project outcomes, the goal is to be able to determine which projects are of air quality concern and then be able to defend the findings. Zyznieuski said that the researchers and panel will be seeking FHWA and EPA approval of the model and methods developed. Another outcome is a graphic interface that will be easy to use by IDOT staff and will require basic inputs, such as average daily traffic (ADT), average number of diesel trucks, and year of analysis. The model would then provide some sort of answer on whether the

project is of air quality concern or not that IDOT will be able to use and document in their NEPA documents or project reports. An additional outcome is that Dr. Lin may present the research at a conference.
Zyznieuski said he does not know of any states that have a project similar to this one taking place. Mike Claggett asked about how IDOT would get the model approved. Mike said that hopefully the EPA can use the results of this project to develop something a little more local-specific. Sam Long said that the first major approval body would likely be FHWA. FHWA would need to provide approval before anyone else can do so. . Zyznieuski confirmed that it will be vital to have FHWA membership on board on the panel in order for this project to be successful.

**Project Tasks Discussion**

Zyznieuski asked about Lin's research on dispersion models. Lin said that the major issue is determining the correct approach to: using county level data or project scale data. - - -Project level analysis is currently very local-specific. Mike Claggett recommended we use project scale approach for our project. A second issue is being able to assemble various data into the model.

The second task for this project is which dispersion model to use. Certain models require more detail in order to get better results. The current plan of action for this project is to -use two models (CAL3HHC and AERMOD) and then to decide to go with one model or both. Zyznieuski asked whether Lin will perform some tests of the model. She said yes; the researchers will run some experiments and then run the models and compare the two. Zyznieuski said that for task one, determining the emission factors, Lin should provide the panel with the emission data first before moving forward. Claggett said that hopefully a lot of the issues that contractors are grappling with may not be as local-specific. Hopefully this research will assist contractors with these issues.

Zyznieuski said that most DOTs he knows are not familiar with the AERMOD model. He said that he will look to the IEPA for inputs for these models. -Rogers said that EPA will be happy to provide Lin with some default inputs for the MOVES model. Claqgget also mentioned –that meteorological data in AERMOD is DOS based. . Lin said that another thing about MOVES is finding out what types of data are already available. Zyznieuski said he has a dataset from Sam from the Chicago region. Walt asked whether Sam has a dataset for Metro-East St. Louis as well. Sam said he has MOBILE 6 inputs for Metro-East St. Louis and the Chicago area and can provide those to us.

There was a question about years of analysis for the project modeling. MOBILE Emission rates - - decrease rapidly over time. That should be a component on the look-up tables. Long recommended using base year values and discussed how and when base year values are determined. The base year values for 2011, for instance, will come out some time into 2012.

Lin last discussed communication of input values between the research team and the panel and the final task, the final report. Lin commented that there will be a lot of back-and-forth communication in the coming months between the research team and the panel. Lin said that the last task, compiling the final report, will hopefully lead to some good discussions in the future about hot-spot air quality modeling.

**Further Questions**

After Lin completed her prepared presentation, Zyznieuski asked whether there are any further questions. Someone asked Lin to briefly review the timeline for the project. Lin said that for the first three months, they hope to determine the emission factors for the model and the necessary inputs from -IEPA will be required to do so. Claggett inquired if Lin was familiar with USEPA's hotspot -guidance.

Lin continued to discuss the timeline. Next was the actual PM Hot-Spot Dispersion modeling. She expects that both the emission factors and dispersion modeling will be completed in about six months. Lin asked for questions and comments on the timeline. Zyznieuski said that this is a good timeline to work with for now, and they can make adjustments to it as the project progresses. He also commented that there will be many questions over the next 12 months and a lot of conversations between the panel and the research team.

Lin said that she will have many questions about the graphical interface, for Zyznieuski. She expects six months to complete the GUI from conceptual design to coding to final testing. However, this schedule may be subject to modification. Dr. Lin asked how the new modeling information will work for IDOT. Zyznieuski said that it will involve inputting the number of diesel trucks and ADT, and the analysis year, at a minimum. From there, IDOT will know what the thresholds are for Illinois' PM nonattainment and maintenance areas. Lastly, Dr. Lin expects to complete the final project report within the last three months of the project duration.

**New Business and Next Meeting**

Zyznieuski reminded the panel of the November and January meetings and then asked when the panel would like to meet again. Matt Fuller commented that he is planning on traveling to the CMAP meeting. Zyznieuski asked the panel whether they would like to meet on a monthly basis. It was suggested that the panel next meets again during the first week of December. The panel then scheduled the next meeting to tentatively take place on Wednesday, December 1 at 11 a.m.

**Action Items**

- Jane Lin will touch base with Zyznieuski about what to discuss at the Chicago Metropolitan Agency for Planning meeting. There is no official meeting agenda yet.
- Sam Long will provide Lin the MOBILE6 inputs for St. Louis Metro-East and Chicago.
- Lin will convert the provided inputs within the next three months and forward the new emission factors to the panel for discussion and approval.
- Claggett will provide, and Lin will investigate the results of the currently ongoing FHWA study on characteristics of concentrations of particulate matter.

# ICT R27-93 Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling TRP Conference Call
# December 8, 2010

## Attendance

A Technical Review Panel meeting for "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (R27-93)" was held via conference call December 8, 2010 at 1 p.m. Those present for the conference call were:

| | | |
|---|---|---|
| Mike Claggett | Sam Long | Cecilia Ho |
| Mike Rogers | Jane Lin | Matt Fuller |
| Ross Patronsky | Walt Zyznieuski | Thomas Bukowski |

## Introduction

Before the meeting, Jane Lin sent an e-mail to the panel with a list of items to discuss over the conference call. The first item was preliminary design of emission factor lookup tables (or database). The second topic in the list was to discuss background concentrations and annual 24-hour particulate matter (PM) hotspot analyses. The third item was to discuss thresholds and criteria for determining what projects are of air quality concern. The last item was to discuss comparisons between MOBILE6.2 and MOVES.

Walt Zyznieuski and Jane Lin began the conference call and asked everyone to provide introductions. The first topic was some measurements Mike Claggett provided to Sam Long. Long stated that the conclusion was that the emission factors do not make that much of a difference. Long said that emission factors tend to fall over 10 to 15 years; this may be a problem with the MOBILE model. For the purposes of this project, especially in terms of altitudes, the research team should carefully examine the MOVES outputs in comparison.

Next, Zyznieuski queried the panel and Lin, "Where do we go from here?" It was commented that PM emissions with MOVES do change depending on vehicle speed. Another complicating factor is how emission rates vary at the project level compared to the regional level. It was recommended to do the modeling at the project level. A panel member stated that he had asked the Environmental Protection Agency about providing different profiles for each region. They could not provide a reason why they provide different profiles. In analyzing vehicles leaving interstates, the emissions may not reveal much of a difference, though slower traffic tends to increase emission rates. There was a mention of a *New York Times* article on this issue.

Zyznieuski commented that the panel should tailor its discussion to PM. Zyznieuski asked the panel if anyone had any questions on the topics discussed thus far.

The next discussion was on the information that Claggett provided the panel and any effect this will have on Lin's research. Lin discussed some of the next steps in the research process. Zyznieuski commented on the highway scenario for modeling. He said that once the research team is comfortable with that evaluation, they can move into arterials. He said he is fine with the approach that Lin described so far. He asked the panel if anyone else had any thoughts or comments on the research moving forward.

A panel member commented on the highway analyses moving forward. Lin discussed the details for the upcoming analyses for this study. Zyznieuski commented that the researchers should keep in mind the main goal of the study when discussing the analyses.

Additional topics of discussion during the meeting were the following:

- What aspects of the experiments may break from the USEPA PM guidance manual.
- Lin mentioned that she and Claggett spoke the day previously about MOVES and its general design.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Technical Review Panel Meeting Minutes
January 14, 2011

Attendance

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on January 14, 2011. Those present for the meeting included:

| | | |
|---|---|---|
| Walter Zyznieuski, Chair | Ross Patronsky | Cecilia Ho |
| Jane Lin | Mike Claggett | Lori Carpenter |
| Mike Rogers | Sam Long | Rob Kaleel |

**Introduction**

Walt Zyznieuski introduced those who were participating in the meeting. Jane Lin sent an e-mail to the panel with a list of items to discuss for the meeting, including the discussion on MOVES results and runs, PM idling EFs (for arterials), timeline for completing MOVES model runs, and background PM. Walt also discussed the briefing on the Inter Agency Consultation Group.

**January 11, 2011 briefing to the Inter Agency Consultation Group at East-West Gateway Council of Governments**

Walt stated that Jane Lin, Mike Rogers, and he were involved via phone with the above mentioned meeting. Jane and Walt briefed the Agency Consultation Group on this project as far as the background and what has been done to-date. Walt stated that they received good comments from the group; they thought it was a good project. Walt stated to the group that they would come back to them at the end of the project for their approval. Mike Rogers stated that Region 7 was very interested in the project and that it was beneficial. Mike stated that the MPO would be interested, but restated that it is an Illinois project. Mike will get a list of participants that were at the meeting.

Postscript: Walt received the participant list.

**Discussion on MOVES results and runs**

Jane Lin provided the TRP via email some charts that show some preliminary results for PM2.5 emission factors. The charts show PM2.5 emission factors for gasoline passenger car and diesel combination short-hall truck for the calendar year 2011 in the Chicago area. Jane then discussed the preliminary results on each chart. Jane stated that if the number of runs could be cut down that would be helpful. Walt stated that in the Chicago region the MPO currently came out with a new go to GO TO 2040 Comprehensive Regional Plan and it goes out to 2040 and the East-West Gateway Council of Governments is working on a plan for the Metro East Area that goes out to 2040. Walt suggested to do a modeling run from 2040 to 2050 to see if the emission factors flatten out after 2040. If they do, it was suggested perhaps we can use the 2040 EF for the 2040 to 2050 timeframe so we wouldn't have to model beyond 2040. Another TRP member suggested doing separate runs for calendar year, temperature, and length. Walt stated to Jane to run the data and then bring those results back to the TRP for review. Jane is concerned about the database being too big (fields, vehicle types, calendar years, roadway types, etc.). Jane and Mike Claggett will sit down at TRB and discuss the database and PM idling EFs for arterials.

**Timeline for completing MOVES model runs**

Jane stated that it is possible to have the model runs done by the end of this month or by early February. Walt stated that was fine and to keep the TRP posted. Then when Jane gets a better feel, at that point she can send out a request for a meeting when she is comfortable to show the data to the TRP.

**Comparing numbers**

Jane asked if she should compare the numbers that she runs to modals to make sure what she is looking at are reasonable. Mike C. suggested just comparing the run numbers to the national average numbers.

Mike C. stated that the PM HS is a function of temperature at any given hour. Mike C. asked if there was a contact person at Illinois EPA with a recommended meteorological database for the Chicago and St Louis Metro East Area. Rob Kaleel stated that his section could help with that. Sam recommended using the same locations as MOBILE. Rob and Jane will work together in setting up a face-to-face/meeting within the next couple of weeks to discuss modeling (meteorology regulatory dataset).

Mike C. stated as an FYI that the screen version for air models is not recommended for PM hot spots (PM hot spot guidance).

**Background PM**

Walt stated that the transportation PM hot-spot guidance that came out in December has a Chapter (8) that discusses background values and Rob's group deals with background values. Rob stated that in his opinion a regional background can be done, unless there is a nearby major industrial source.

Jane and Walt will discuss modeling and background PM issues with Rob's group at their meeting in the next couple of weeks. Jane asked if Rob's group could send her a sample meteorological dataset. Rob stated that he will send out to everyone what they have that shows met data in a format that inputs to the model to the air mod processors and the output of the air mod processors (input model might be more user-friendly).

**Other**

Cecilia Ho suggested documenting everything in the final report including the discussions on identifying data sources and the cooperation with agencies. Cecilia also mentioned that they are working with the USEPA in setting up a webinar to discuss and give a general introduction of the guidance. This will be in the early part of February (possibly the 9$^{th}$ from 1-3 p.m.). Cecilia will let everyone know for sure.

Ross Patronsky stated that a consultation meeting for sometime the week of February 21. Ross suggested to Jane and Walt to get on the agenda for that meeting.

The meeting was adjourned at 11:15 a.m.

**Action Items:**

- Mike Rogers will get a list of attendees who were at the briefing for the Inter Agency Consultation Group at East-West Gateway Council of Governments. Postscript: This task has been completed.
- Jane Lin and Mike Claggett will sit down at TRB and discuss the database and PM idling EFs for arterials.
- Rob and Jane will work together in setting up a face-to-face meeting within the next couple of weeks. Postscript: A tentative meeting has been arranged for February $10^{th}$.
- Rob will send out to Walt the data input/output of the air mod processors. Postscript: Rob provided the data to Walt, and Walt forwarded the data to Jane.

# Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling
# at
# ILLINOIS-EPA
# Thursday, February 10, 2011

Attendance

The PM Hot Spot Air Quality modeling meeting was held at Illinois EPA from 10:30 am to 12:45pm on February 10, 2011. The following were present during the meeting except Mike Claggett who participated via conference call:

| | | |
|---|---|---|
| Jane Lin (UIC) | Walt Zyznieuski (IDOT) | Matt Will (IEPA) |
| Suriya Vallamsundar (UIC) | Mike Claggett (FHWA) | Rob Kaleel (IEPA) |
| Matt Fuller (FHWA) | Mike Rogers (IEPA) | |

**Project Tasks**

Walt Zyznieuski introduced the meeting and briefly discussed the project and the tasks involved. He said the purpose of the project is to establish thresholds based on average daily traffic [ADT], percent diesel vehicles, etc. for Illinois particulate matter (PM) nonattainment and maintenance areas, to comply with new United States Environmental Protection Agency (USEPA) Hot Spot regulations. To develop these thresholds, the MOVES model developed by USEPA will be the emission model used. Air dispersion models to be evaluated include CAL3QHCR and AERMOD, both developed by USEPA. Dr. Lin stated that MOVES will be run for calendar years 2011 to 2040 and 2050 – a total of 31 years. Four seasons and four time periods corresponding to morning peak, midday, evening peak and overnight will be selected resulting in a total of 16 runs for each calendar year. Focus of this meeting is to discuss the meteorological inputs for MOVES and air dispersion models.

Meteorological data for the Chicago and St. Louis regions were sent to Dr. Lin by the ILEPA for calendar years 2005 to 2009 prior to this meeting. Matt Will of IEPA stated that meteorological data for 2010 is under processing and will be sent to Dr. Lin in the next few months. The meteorological data is in AERMOD format and the data format has to be converted for CAL3QHCR. Matt Will will send some guidelines for using the meteorological data. Matt Will will also send the AERMET version used in developing these data. He also stated that the new AERMOD version which is not available on the USEPA website can be used as ILEPA has permission to share the new version. It was decided that consistent meteorological data will be used for both MOVES and the air dispersion models. Regarding the meteorological data for future years, it is not clear if MOVES default data, which is a 30-yr climatological average, or the 5-yr average of IL meteorological data (prepared by ILEPA) should be used. This is important because PM is sensitive to temperature. Both Jane Lin and Mike Claggett will check the PM guidance for the exact language for what meteorological data to use. At the same time, it was decided that this question will be consulted with Michael Leslie of USEPA. Mike Rogers will also check with Michael Leslie to see if he is able to participate in the project's next conference call (initially scheduled on Feb 17$^{th}$ and has been rescheduled on Feb 23$^{rd}$).

The team decided to consult with Michael Leslie about PM10 hot spot analyses for this project. This is because industrial sources are responsible for PM10 maintenance areas in Illinois and the project needs to document why PM10 is not being evaluated. Rob Kaleel of IEPA will send an email to say what is currently in SIP regarding PM10. The team also agreed that it will be good to include someone from USEPA on the project's TRP.

Regarding which air dispersion model to be used, EPA guidance states that either AERMOD or CAL3QHCR can be used for modeling pollutant concentration for highways and intersection projects. Dr. Lin stated that her team will perform some sensitivity tests on both models and will present the results to the TRP. In addition, literature review on use of the two models will be presented as well. Dr. Lin stated that according to the literature, there are mixed reviews with respect to AERMOD and hence it is essential to justify the balance between the air dispersion modeling effort (esp. the amount of effort in input data preparation) and model accuracy. Mike Claggett concurred with the literature findings. Therefore, model selection criteria are something that needs to be decided at some point during the project. Dr. Lin proposed using both the literature findings and the model sensitivity test results. The team agreed to revisit this subject later when it comes. Dr. Lin further added that her team will start working on the air dispersion models in March. Walt Zyznieuski said he is leaning more towards CAL3QHCR as IDOT is comfortable using CAL3QHCR compared to AERMOD.

Receptors locations were discussed in detail as a large number of receptors are required in PM hotspot analysis and no guidance on the number to be used (as presented in the USEPA PM Hot Spot Conformity Guidelines webinar on Feb 09, 2011). Mike Claggett stated that receptors should capture the short-term peak concentrations for areas in violation of the 24-hour standard and/or community wide exposure for areas in violation of the annual standard. Both Chicago and Metro East are annual PM2.5 nonattainment areas. So the feeling among the group was that we need to place as many receptors as possible to capture the community wide exposure. Rob Kaleel stated that it is essential to have enough receptors to see the decrease in pollutant concentration from the source. Also it is essential to use consistent number of receptors for both CAL3QHCR and AERMOD.

In AERMOD modeling, there is an issue about whether to model the on-road emissions as area source or as line source. Mike Claggett stated that there was not much of difference in the two approaches. Matt Will of IEPA mentioned the Trinity guideline and a paper which compares the two approaches. He will share that paper with Dr. Lin. In the mean time, Dr. Lin will check the USEPA PM guidance for this issue; the bottom line is to follow the guidance.

Sensitivity tests will be performed by Dr. Lin's team to test the (1) effect of temperature increase on emission rates and (2) using an average speed interval of 5 mph. Sensitivity tests for temperature shows that effect of temperature variation does not affect diesel heavy duty trucks. Mike Claggett stated that he has also observed a similar trend on effect of temperature. Initial sensitivity test results for average speed shows that currently used speed interval of 5mph is not sufficiently sensitive especially for trucks. Effect of speed is found to vary with the vehicle type and the speed itself. Overall difference between emission rates for all vehicle types obtained from MOVES and from interpolation is between 0.1% and 12%. Walt Zyznieuski was interested in knowing if a pattern is observed in these sensitivity test results for trucks. Dr. Lin stated that for the next meeting, sensitivity test results for average speed and temperature will be presented. Also sample emission rates lookup table will be presented at the next meeting.

The team discussed background concentrations for PM2.5 is a critical input and also is tricky to handle in the model. There was a concern that PM2.5 background level may already be high (close to the annual standard of 15 $ug/m^3$) in both Illinois' nonattainment areas and so what is the implication of that to the direction of this project. Should it go on with the initial objectives? Should it be a refined hotspot analysis project? Or else? At this point, the team suggested looking into the current PM2.5 concentration readings in Chicago and St. Louis PM monitoring stations and in consult with IEPA. Furthermore, it is not clear how to predict the future background concentration for PM2.5. The USEPA PM hotspot guidance recommends using CTM model to predict future PM background concentrations.

Walt Zyznieuski asked the team if re-entrained road dust is not an issue in SIP budgets for Illinois. Mike Rogers said that the re-entrained road dust was not a part of motor emission budget. Further the USEPA PM guidelines stated that re-entrained road dust has to be considered only if it is a part of the SIP. It was decided to inform Michael Leslie that re-entrained road dust will not be considered for this project as it is not a part of SIP motor emission budget.

**Action Items**

The team agreed that the following items will be consulted with Michael Leslie:

1. PM10 maintenance SIP - what needs to be documented on why PM hotspot analysis is not required for projects in Illinois?
2. Inform him about the re-entrained road dust not needing to be considered as it is not part of SIP motor emission budget.
3. Met data: should the 30-yr or 5-yr average be used? MOVES default is believed to be the 30-yr average.
4. Model selection criteria: AERMOD vs CAL3QHCR (modeling effort vs result accuracy)
5. A future issue to bring up to him is the background concentration forecasting.

Matt Will of IEPA will send Dr. Lin the following items:

1. Description of AERMET data
2. The latest version of AERMET used by IEPA
3. Web link to the NCDC 1-minute met data
4. Interim files from AERMOD model run
5. The article about on-road source modeling in AERMOD

In addition, Rob Kaleel will send an email to say what is in the SIP regarding PM10 emissions. Mike Rogers will ask Michael Leslie to participate in the next project conference call. And Dr. Lin will check the PM guidance again for met data requirements and AERMOD handling of on-road emission sources.

# Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling
## Thursday, February 23, 2011

Attendance

The PM Hot Spot Air Quality modeling meeting was held via conference call from 10 am to 11 am on February 23, 2011. The following were present via conference call during the meeting:

| | | |
|---|---|---|
| Jane Lin (UIC) | Mike Claggett (FHWA) | David Bizot (USEPA) |
| Suriya Vallamsundar (UIC) | Mike Rogers (IEPA) | Matt Will (IEPA) |
| Matt Fuller (FHWA) | Ross Patronsky (CMAP) | Rob Kaleel (IEPA) |
| Walt Zyznieuski (IDOT) | Michael Leslie (USEPA) | |
| Cecilia Ho (IDOT) | Sam Long (IEPA) | |

**Project Tasks**

Walt Zyznieuski introduced the meeting and summarized minutes of meeting held on February 10th and earlier meetings held in December and January. Michael Leslie agreed to be on the Technical Review Panel for the project. Jane said she is waiting for the meteorology data from IEPA followed by discussion on using either the 30 years climate average or 5 years average of IEPA meteorological data. MOVES default meteorological data cannot be used as the USEPA Transportation Conformity PM Hot-Spot Guidance states that default data cannot be used for conformity analysis. Michael Leslie stated that it is reasonable to use the 5 years average of meteorological data from IEPA. Further he added that it is sufficient to use the average of latest 5 years data available. The 5 years data from IEPA needs to be processed to obtain the average data for each day and month.

**PM 10** – Rob stated that PM10 is mainly released from industrial sources in Illinois. Transportation sources account for the background concentration. The team agreed that it is essential to look at the SIP about PM10. Michael Leslie said that he will look at the SIP and let the team know about the PM10 status.

Background Concentration – Rob said that he had worked on the PM2.5 demonstration in Chicago and Metro East using photochemical modeling. He will send the data which is in form of graphical plots to the team to get an idea about the background concentration in the future. Further, it is not clear if a single background concentration should be used for all areas or different concentrations be used for different areas.

**Receptor Placement** – Jane gave a brief overview and stated that it is essential to place many receptors along the highways. But it is not clear as how many and how far the receptors should be placed to capture the community exposure effect. Leslie stated that the placement of receptors depends on the project and study area. David stated that there is no rule of thumb that can be followed for number and placement of receptors. The receptor placement should be sufficient to capture the gradient effect to see decrease in pollutant concentration from the source. Receptor spacing need not be consistent throughout the study area – more receptors are needed near the source. An example for the receptor spacing is to start with 10 m spacing near the source and reduce the spacing from the source. Rob gave another example where spacing near a stationary source is 25-50m and decreases to 100m away from the source. Having more receptors should not be a problem with AERMOD; however CAL3QHCR might take more time.

**Re-entrained road dust** – is more of a PM10 issue. Leslie stated that it is not an issue with PM2.5 and need not be considered for this project.

**Emission Factor Look-up Tables** - Jane discussed the sensitivity test results for temperature and average speed. Sensitivity test results shows that for an increase/ decrease of 0.5 F and 3 F, the emission factor increase/ decreases by 1.5% and 9% respectively. Sensitivity test for average speed shows that certain speed ranges at (8mph to 14mp), 32.5 mph and 47.5 mph, difference between MOVES results and results obtained from interpolation are the highest especially for trucks. As a result of the sensitivity test results, average speed values will be fine tuned and the final list of average speed values were shared with the team. Emission factor lookup table was developed by Jane's team for 5 years (2011, 2020, 2030, 2040 and 2050), for Chicago. Plots showing time of day, seasonal variation between these years were shared with the team. The plots show that there is not much difference in emission factors between calendar years 2040 and 2050. The team agreed that it is reasonable to use emission factors for calendar year 2040 for projects beyond 2040.

ICT R27-93 Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling
TRP Conference Call

April 14, 2011

Attendance:

A meeting of the Technical Review Panel for “Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)” was held via conference call April 14, 2011 at 1:00 pm. Those present for the conference via phone were:

| | | |
|---|---|---|
| Jane Lin (UIC) | Suriya Vallamsundar (UIC) | Matt Fuller (FHWA) |
| Walt Zyznieuski (IDOT) | Mike Claggett (FHWA) | Mike Rogers (IEPA) |
| Matt Will (IEPA) | Rob Kaleel (IEPA) | Michael Brownlee (IDOT) |

Jane Lin Sent an e-mail to the panel with a list of items in which were going to be discussed. First on agenda was the draft February 23rd meeting minutes. Walt inquired if there were any additional comments before he would finalize the minutes. Mike Claggett said that he may provide comments by the day’s end.

Next was the progress in past month on MOVES presented by Jane. Third were the technical issues with dispersion modeling and fourth was project description/type.

Jane Lin stated in the past month, they have completed the MOVES runs. The only thing left to do is a validation or some type of check of the numbers. Jane will work with Mike Claggett and see if numbers are more or less in line with national numbers. Suriya Vallamsundar stated she has been working on that and will have an update at the next meeting.

Jane then briefed the TRP on the air dispersion models. A lot time has been spent on converting meteorological data (2005-2009) between AERMOD and CAL3QHCR, and finding that there is no converter between the two models. The CAL3QHCR model uses a different format. The best solution is to go back to and use the raw meteorological data in CAL3QHCR. Mike and Suriya will work on that aspect. Mike said he will help in preparing the input data for CAL3QHCR. He further added that MPRM and AERMET are very similar with different names. It was also agreed that we would use the 05-09 data met data to model out to the 2040 timeframe with no meteorological prediction for future years. This is consistent with the PM Guidance.

The PM hot-spot study is not looking at any specific project, therefore generic project description type(s) will have to input into the models to help place the receptors to be analyzed. Jane stated she took several interchange project types from the Illinois Highway Design Manual. Walt stated he could talk with the geometric engineer in his Bureau to try and help narrow down the types of interchanges to analyze. Walt suggested having a conference call with him, Jane and their geometric engineer to discuss further, and will follow-up on this.

A discussion also took place in regard to what PM background values to use in the models. It was agreed that Jane will look at Chapter 8 of the PM Hot-Spot Guidance and coordinate this issue further with Michael Leslie. Also, she will provide some insight into what background concentration values should be used in future. The team also suggested looking at GIS maps to look for which background concentration location has to be used. She will report back to us at the next TRP meeting.

The next meeting is scheduled for May.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Technical Review Panel Meeting Minutes
May 25, 2011

Attendance

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on May 25, 2011. Those present for the meeting included:

| | | |
|---|---|---|
| Walter Zyznieuski, Chair | Jane Lin | Chuck Gebhardt |
| Mike Claggett | Michael Leslie | Lori Carpenter |
| Michael Brownlee | Mike Rogers | |

**Introduction**

Walt Zyznieuski introduced those who were participating in the meeting. Jane Lin sent an e-mail to the panel with a list of items to discuss for the meeting, including approval of the last meeting minutes, MOVES PM emission factor validation, highway project type, background PM2.5 values, and an update on AERMOD modeling.

**Minutes**

Walt stated that the TRP has until this Friday, May 27 to provide their comments on the April 14 meeting minutes.

**MOVES PM emission factor validation**

Jane sent out conversion results to the TRP from the IL specific MOVES PM2.5 emission factor comparison with the national average MOVES PM2.5 emission factors provided by Mike Claggett. Jane stated that with the exception of the different vehicle types, all the other vehicle types have a difference within 20% of the national average. Mike Rogers suggested doing a Q and A to find out what is going on with the broad difference in the passenger trucks and the light commercial trucks in the early years (fuel difference).

**Highway project type**

Jane stated that it is hard to generalize the project type. Jane suggested looking at the interchange highway design and using the design values from the IDOT design manual to plug into the hot-spot analysis to see how the parameters affect the PM values. Walt asked how many interchange types will be run. Jane stated that they will be looking at 8 different types so it will be hard to narrow down. Walt suggested running one example of each and then present the results of what is being seen for the interchange types and then the next step would be to modify the radius or the speeds to see if that would have any influence. Mike C. stated that vehicle queuing at stop lights would be a priority for an interchange with an arterial, if there is any traffic control at a conventional cloverleaf intersection. Mike C. suggested starting with a conventional cloverleaf and cloverleaf with CD roadways (preferably with a signal light). Jane suggested that she start out using the minimum dimension design value in the AERMOD model. Mike C. stated that he could help out with the CAL3QHCR.

**Background PM2.5 values**

Jane then discussed the background PM2.5 values and whether they should be single site value versus multiple site interpolation. Jane suggested looking at the sites within a 10 mile radius. Walt suggested doing interpolation on the multiple sites presented. Michael Leslie agreed with Walt and stated that it seemed reasonable. Michael Leslie suggested starting with the sites in far south and west in the Chicago region (e.g., sites at Cary, Elgin, Aurora and Braidwood) given the prevailing south-west wind direction in the region. Background values will be the most critical inputs to the analysis. Michael Leslie also suggested looking at the St Louis Missouri data, and will send this data to Jane.

**Update on AERMOD modeling**

Jane stated that she is ready to move forward. Jane stated that studies have showed that area source approach is theoretically more defendable than the volume source approach and produces almost indistinguishable results. The PM guidance recommends either approach for highway projects. The TRP agreed to go with the area source approach.

**Other items**

The next meeting will be scheduled sometime at the end of June.

Mike C. will send the information regarding the web conference that will be held tomorrow, 5/26. The web conference is about MOVES and PM Hotspot training. Jane will be one of the presenters.

The meeting was adjourned at 11:02 a.m.

**Action Items:**

- Jane will do Q and A to find out what is going on with the broad difference in the passenger trucks and the light commercial trucks in the early years.
- Mike C. will send the information about the web conferencing on MOVES and PM Hotspot training.
- Michael L. will provide Missouri monitoring data.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Technical Review Panel Meeting Minutes
July 14, 2011

Attendance

A meeting of the Technical Review Panel for, “Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)” was held via teleconference, on July 14, 2011. Those present for the meeting included:

| | | |
|---|---|---|
| Walter Zyznieuski, Chair | Suriyapriya Vallamsundar | Matt Fuller |
| Jane Lin | Ross Patronsky | Megan Swanson |
| Mike Rogers | Mike Leslie | Mike Claggett |
| Lori Carpenter | | |

**Introduction**

Walt Zyznieuski introduced those who were participating in the meeting. Jane Lin sent an e-mail to the panel with a list of items to discuss for the meeting, including approval of the last meeting minutes, AERMOD modeling of highway project preliminary results, and next steps.

**Minutes**

The minutes from the May 25 meeting will be finalized and sent out to the TRP.

**AERMOD modeling**

The AERMOD modeling setup includes, model input parameters, missing data, I80 and I55 at Joliet example run, and source characterization for I80 and I55. The research team used the TRP recommendation of using AREA sources in AERMOD. Jane stated that one of the key things in the AREA source approach is the source dimension. The AERMOD modeling guide had some recommendations in terms of how many AREA sources you can have and what the dimension of the AREA source configurations can be. Jane stated that the research team came up with 32 AREA sources for I55, 46 for I80, and 64 for ramps; for a total of 142 sources. The research team did not include the circular ramps in the preliminary model run and that is because computational time is a lot and because of AREA sources and not knowing what number to use for accuracy. The example shows the concentration distribution. The research team tried two different methods for placing receptors. Jane stated that it took 72 hours to run with a little over a thousand receptors. Jane also stated that when they used the 5-year meteorological input it increases the computational time linearly. Walt asked if the modeling results had a background concentration built in. Jane stated that the research team did not add the background concentration but AERMOD does not require the input of background concentration, which can simply be added to the model estimated values to get the final concentration levels. The preliminary results show that some areas are much higher than the standard. It could have to do with traffic volume that was entered (much higher than it should be). Walt suggested going onto the IDOT website to get the ADT’s. Walt suggested using 45 mph for the ramp. Mike Leslie will have his AERMOD experts look at the inputs. Jane asked what a reasonable running time should be. Mike C. suggested changing the area sources to reduce the number of area sources.

Jane stated that the research team is waiting on IDOT to provide information about the dimensions and fraction of vehicle type. Walt will send Jane the percentage numbers for vehicle types.

Jane asked how they should set the urban boundaries. Currently, they are using a ½ mile beyond the entry/exit point. Mike C. stated that a ½ mile is fine to use.

**Other items**

Walt suggested having a meeting with a smaller group to discuss AERMOD inputs. Jane will send a meeting request to meet within the next 3 weeks.

The next TRP meeting will be scheduled sometime at the end of August.

The meeting was adjourned at 11:53 a.m.

**Action Items:**
- The research team will make all the suggested changes made by the TRP.
- Mike Leslie will have his AERMOD experts look at the inputs.
- Walt will send Jane the percentage numbers for vehicle types.
- Jane will send out a meeting request to the small group to discuss AERMOD inputs.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling
Technical Review Panel Meeting Minutes
September 28, 2011

Attendance

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on September 28, 2011. The meeting went on from 10AM to 12PM (CDT). Those present for the meeting included:

| | | |
|---|---|---|
| Walter Zyznieuski, Chair | Suriyapriya Vallamsundar | Matt Fuller |
| Jane Lin | Mike Rogers | Michael Leslie |
| Mike Claggett | Cecilia Ho | Matt Will |

**Introduction**

Jane Lin started the meeting by asking if anyone had any comments on the previous minutes of the meeting on July 14. As there were no comments, the minutes from the July 14 meeting will be finalized.

**AERMOD modeling**

Jane asked the team if anyone had any suggestions/comments on the new AERMOD input and output results. Jane noted the reduction in the concentration values from the previous run was due to the change in the traffic volume and corresponding time periods which were more realistic, receptors were moved further away from the sources compared to previous run and were placed at a distance of 50 ft. from the roadway edge, and errors were corrected in the calculation of MOVES emission factors.

Mike Claggett wanted the urban population to be changed from two census tracts to the whole urban region. Mike Claggett suggested that the population should be representative of the area where the population density exceeds 750 people per $km^2$. Michael Leslie suggested using 39% of Chicago population which comes to 1.04 million as the urban population. More was discussed about the urban population later in the meeting.

Walt went over the traffic volume calculation and felt the assumption of using 90% passenger cars and 10% combination short haul trucks should be revised. He asked Jane's team to look at the vehicle split in the data he sent. The traffic volume data he sent has three main categories on vehicles namely single unit, multiple unit and 4-tire. However, there is no information on the fuel split between each vehicle type. Mike suggested looking at the default MOVES split of fuel types for each vehicle type.

Mike asked Jane’s team on how they computed the release height and initial vertical dispersion coefficient, for which they said the emission factors were weighted by the traffic volumes. Walt said the project results  are getting closer to what he envisioned as the results were more reasonable. Mike added that the results were in line with another project. Everyone was fine with maintaining the first line of receptors at 50ft from the roadway edge. Jane said that her team has got the BREEZE-AERMOD software and now it will be easier for them to code the source and receptor locations better than before.

Walt then discussed the future direction for the project. He added that the project deadline has been extended from Oct to end of the year. The next step he proposed would be to talk to MPOs and look at the long range plans and give us the projects which will have the highest traffic volume projections. Jane’s team will then work on those projects and try to come up with some threshold values for traffic volume. More discussion is required on the project direction.

Mike questioned why we are using the current example of I-80 and I-55 interchange near Joliet as the AADT is below 40,000. He said that a project should have an AADT of 125,000 to qualify as a project of air quality concern. Walt and Jane said that the current example is more for modeling exercise and to get all the input parameters right before going to other projects.

Cecilia Ho wanted to know why Jane’s team is using AERMOD instead of CAL3QHC as both are recommended models for highway projects. Jane replied that they are eventually going to use both models, but for now, concentrate on AERMOD as EPA is pushing to use AERMOD more than CAL3QHCR. Further, Walt added that IDOT wants to gain experience with AERMOD through this project.

The next steps would be to run the project again after changing the traffic volume and urban population. Jane said she will contact CMAP and get the latest population information. She will send the team a map with all the populations marked near the project to finalize what the urban population would be for this project. Walt said he will help Jane with some contacts in St. Louis to get the population figures for that area.

**Action Items:**

- Jane’s team will rerun the project after changing the traffic volume
- Jane will send out a map with populations marked so the team can help decide what the urban population would be for this project.
- Walt will help out Jane with a contact for the St. Louis region MPO.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
November 09, 2011

Attendance

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on November 09, 2011. Those present for the meeting included:

| | | |
|---|---|---|
| Mike Claggett | Michael Leslie | Jane Lin |
| Ross Patronsky | Carolyn Persoon | Michael Rogers |
| Suriya Vallamsundar | | |

**Introduction**

The objective of this meeting was to reach a consensus on the urban population and urban dispersion option in AERMOD runs.

**AERMOD modeling**

Jane Lin started the meeting asking about the urban population parameter. Carolyn from USEPA suggested that since the aim of the project is to come up with a screening-like tool, it is fine not to specify this parameter. Mike Claggett responded saying that it is important especially for urban areas like Chicago to have such a parameter to account for the heat island effect. Carolyn mentioned a study done in New York City to test the sensitivity of urban population parameter on concentration. The results showed that as the urban population increased, the concentration decreased. Furthermore, by not specifying the URBANOPT parameter, she said the concentration increased by around 20-25%. Hence as the objective of this study is to come up with a screening-like tool, not specifying the urban population would be a conservative approach. This parameter is required for detailed analysis on a specific project with more data available. Hence, for our purposes she suggested leaving out the URBANOPT to have conservative results.

Mike Claggett stated that if the URBANOPT is specified and the corresponding URBANSRC keyword for sources it is expected that concentrations predicted for an elevated point source, such as the study mentioned by Carolyn, would be sensitive to the urban population specified since it can have an effect on the height of the nocturnal mixing layer employed. Changes to the population specified for a ground-level urban source would not materially affect the concentration predicted. Mike Claggett added that it is essential to include the URBANOPT parameter because otherwise AERMOD will consider rural dispersion for the study area and it is fine to assume for example 2 Million for urban population in Chicago as an option, but his preference is to adhere to AERMOD implementation guidance.

Carolyn pointed out that there are two properties in AERMOD that would reflect an urban area - the meteorology and the surface characteristics - both of which are input to the model independently of URBANOPT. Since the meteorological data being used for Chicago is from O'Hare whose surface data reflects that of an urban land area, even if the URBANOPT is not specified, AERMOD will consider the area to be urban. She further added that it might be redundant to specify the urban characteristics using the meteorological data and then specify the URBANOPT parameter. Jane mentioned that the URBANOPT parameter is not mandatory in AERMOD modeling and the language in the PM guidance is vague about that.

Jane then asked the group if we are making recommendation for detailed site specific analysis, what urban population and urban roughness length should be used. Currently she said her research team is using the default regulatory urban roughness length of 1m. Carolyn recommended using the census tract population density surrounding the study area as this is more specific to the project. Mike Claggett suggested that urban population should adhere to AERMOD implementation guidance, for example, the MSA census data corresponding to Chicago and St. Louis. Mike also added that in the end the consultation team should decide what to do for the state.

As a consensus was not reached, the TRP members suggested we present all arguments raised at the meeting to Walt and let him decide what appropriate plan to proceed with. On the other hand, there is an agreement to develop separate sets of threshold values for urban and rural sources. Carolyn said she will help in identifying the rural meteorological data as the current O'Hare meteorological data represents urban conditions.

Postscript.: As a result of the meeting, Jane's research grop has re-run the model with (1) no URBANOPT input, (2) 2m urban population input and (3) 8m urban population input. The model specification and results are as attached. After Thanksgiving, a TRP meeting will be requested to finalize the issue.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
December 01, 2011

Attendance

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on December 01, 2011. Those present for the meeting included:

| | | |
|---|---|---|
| Mike Claggett | Walter G Zyznieuski | Jane Lin |
| Ross Patronsky | Carolyn Persoon | Michael Rogers |
| Suriya Vallamsundar | Matt Fuller | Chris Dresser |
| Cecilia Ho | Michael Leslie | |

**Introduction**

The objective of this meeting was to finalize AERMOD modeling approach with respect to urban population and urban dispersion option in AERMOD runs.

**AERMOD modeling**

Jane Lin started the meeting discussing the sensitivity test results her research team performed with the urban population parameter. She said they performed three runs; the first two changing the urban population from 2million to 8million and the third by not specifying the urban population for conservative results. They observed the concentration to decrease by 1% when the population was increased and in the third run the concentration increased by 25-30% when urban population was not specified. She asked the team if they had any comments/ suggestions with these results.

Mike Claggett stressed it was essential to apply the URBANOPT keyword if the project area is within an urban area, as not specifying this keyword was unrealistic. Jane added that urban population did not have any effect on concentrations but the surface roughness does have an effect. To this Carolyn extended saying that there are other parameters in the meteorological data to characterize a project area as urban or rural and hence even if the URBANOPT keyword is not specified, still the project will be considered as either urban/ rural based on the meteorological data.

However, she added that the current project site should be classified as rural and not urban as the area is predominantly in a rural location.

Ross Patronsky suggested using appropriate land use characteristics for the project area to decide the area types as urban or rural. For this, Jane replied saying it was possible for her to get updated maps showing the land covers which could be used for this purpose. Further Ross asked the definition for an urban and rural area, to which Mike gave the definition and said he will email him the same. Ross said he will help with the land cover maps.

Jane added that it was difficult to get the rural meteorological data for the project site. The data she got from Carolyn was from Ohio for calendar years '91-'95. Michael Rogers responded that ILEPA will help Jane with the rural meteorological data. He said they have data for Rockford, Peoria and it is appropriate to use the Rockford meteorological data for Chicago. For Metro East, rural meteorology data from Paducah or Evansville is required. He suggested that Jane discuss the rural meteorological data with Matt Will in a separate meeting.

Walt inquired what the next steps and time frame would be. Jane responded saying that the next step was to obtain the rural meteorological data, use this data for the same project site and see how different the results are. Further she added that it is not possible now to give a time line without seeing the rural data and which format it is in. If the data is in a different format, it needs to reformatted to match the format compatible for AERMOD which might take some time. Walt felt the next step after incorporating the rural met data is to work on CAL3QHCR and compare results between AERMOD and CAL3QHCR. For this, Jane replied that her research team will be working with Mike Clagget for CAL3QHCR modeling. After this comparison, Walt stated that other project sites will be discussed. Walt stated that the project will be now be extended till May 15th but will be mostly wrapped up, by April.

Action items:

- Jane will get in touch with Matt Will about the rural meteorological data. Once the met data is obtained, her group will run AERMOD for the Joliet site as an example with the rural met data for sensitivity analysis.
- Jane's research team will start working with Mike Claggett on CAL3QHCR modeling.
- Mike Claggett will send the EPA's air dispersion modeling guide on urban/rural definition. Ross Patronsky will help with the land cover data.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
February 21, 2012

**Attendance**

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on February 21, 2012. Those present for the meeting included:

| | |
|---|---|
| Mike Claggett | Walt Zyznieuski |
| Ross Patronsky | Michael Rogers |
| Jane Lin | Matt Fuller |
| Suriya Vallamsundar | |

**Meeting Agenda**

1. AERMOD results using rural met data and the Joliet site
2. Update on Cal3QHCR and AERMOD comparison
3. Update on worst case project site selection: data acquisition status, selection criteria

**AERMOD modeling**

Jane Lin started the meeting discussing the sensitivity test results her research team performed with the rural meteorological data. In addition to previous sensitivity tests on urban meteorological data, her team evaluated the effect of using rural meteorological data for the same project site. They obtained the raw meteorological data (surface and upper air data) for West Dupage Airport as a representative site for rural meteorological conditions from Matt Will at IL EPA. They processed the raw data using AERMET and AERMINUTE models and obtained the data in a compatible format for AERMOD. They performed a sensitivity test at stage 3 in AERMET with and without snow cover data and found the snow cover data to produce conservative results. Based on rural meteorological data for same case study location, her team found the concentration results to increase by around 37% compared to the urban meteorological data. She summarized the previous sensitivity tests with urban meteorological data at O'hare – the first two changing the urban population from 2million to 8million and third by not specifying the URBANOPT parameter. They observed the concentration to decrease by 1% when the population was increased from 2M to 8M and in the third run the concentration increased by 25-30% when URBANOPT parameter was not specified. She asked the team if they had any comments/ suggestions with these results.

Mike Claggett, looking at the results, stated that the major difference in concentrations was between using/ not using the URBANOPT option. He added that it made more sense to turning on/off the URBANOPT parameter than changing the meteorological station location. Mike also recommended that the write-up should document these findings in more detail. He added that proximity of case studies to the meteorological station locations needs to be given more importance. He further asked Jane if her team had enough confidence in the quality of rural meteorological data processed. Jane responded saying that the quality of the rural meteorological data was very similar to that of urban meteorological data provided by IL EPA. Finally it was agreed that proximity of case study location to urban/ rural meteorological station will be the criteria for deciding which meteorological data to use.

Regarding the comparison between AERMOD and CAL3QHCR, Mike Clagget said he is converting the AERMOD data with respect to meteorology, source and receptor characterization, traffic volume and emission factors from Jane's team into a compatible format for CAL3QHCR. He stated he has completed processing the meteorological data and is currently working on source and receptor characterization. He expects to have the results completed by the third week of March. Walt said it would be interesting to look at the difference in AERMOD and CAL3QHCR results. Walt asked what would be the deciding factor for which model to use for future case studies. Mike stated that CAL3QHCR would be more appropriate for modeling highway sources as it has been evaluated specific to these sources. He added that AERMOD is difficult to implement compared to CAL3QHCR due to its detailed input requirements. Jane added it would be better to stick to one model for project. Walt asked Jane to document everything regarding the model comparison, input data preparation in the final project report.

Regarding the next steps, Jane said she obtained the traffic projections from CMAP and East-West Gateway for calendar year 2040, but wasn't able to review the CMAP data in detail. She asked the team the deciding criteria for picking projects that are worse-case. She highlighted the projects with the highest AADT and high fraction of truck traffic for the year 2040 provided by East-West Gateway Council of Governments for the Metro east area. She said for highways, those projects with highest AADT have highest truck traffic but such a pattern cannot be seen with arterial projects. Mike suggested following the AADT of 125,000 and 8% truck traffic recommended by EPA in their guidance manual. Jane and Walt responded saying that these values were just examples and not threshold values to be followed. Ross felt that the current data Jane sent out needs to be updated to show the total truck traffic instead of percentages. After this, Walt said that the potential project sites will be discussed with the team.

Action items:

- Jane will send out the updated traffic projections data and recommend potential project sites for both the Chicago and Metro east area
- Mike Claggett will report the CAL3QHCR results by end of March
- Jane’s team will work on preparing the final project report

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
Thursday, May 3, 2012

[Minutes are missing. These are meeting notes]

**Attendance**

A meeting of the Technical Review Panel for, “Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)” was held via teleconference, on May 3, 2012

**Introduction**

The agenda of the meeting is as follows:

1. Selection of case study sites (Walt forwarded the candidate sites information last week)
2. Project report structure (see the attached Table of Contents)
3. Update on CAL3QHCR analysis
4. New version of MOVES 2010b

**Discussion**

Based on the candidate case study sites sent by Walt to the TRP members, the team decided to select the sites based on highest AADT and percentage diesel truck traffic. Based on this approach, Dan Ryan expressway west before 1-55 junction in Chicago was selected as the highway site. On the Metro East area, the Poplar street bridge at border of Missouri and Illinois for highway site and Intersection of State Route 3 and Piasa Lane for arterial site were selected. A consensus was not reached w:r:t to arterial site in Chicago as there were a number of sites with either high AADT or high percent truck traffic. Jane asked the team if they had any questions/ comments on the project report. All TRP members were fine with the table of contents.

Next, Suriya gave an overview of the new MOVES2010b version. Changes to the new model were mostly related to improved model performance, newer versions of Java and MySQL. W:r:t pollutants, the newer version includes a number of mobile source air toxics. W:r:t criteria pollutants, the newer version does not affect the criteria pollutant emissions compared to previous version. To use the newer version, all old RunSpecs and databases are required to be converted to be compatible with the newer version. For this purpose, a new tool called database converter has been added to menu to facilitate conversion of older databases to newer formats. Suriya added that she performed a comparison between MOVES2010a and MOVES2010b version for Joliet pilot study and found no change in the emission results. W:r:t to comparison between AERMOD and CAL3QHCR, Jane informed that her team is working with Mike Clagget for the CAL3QHCR modeling and will schedule a meeting with him to discuss about the conversion process from AERMOD to CAL3QHCR.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Meeting Minutes
Thursday, July 19, 2012

**Attendance**

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via conference call on July 19, 2012. Those present for the meeting included:

| | | |
|---|---|---|
| Mike Claggett | Walt Zyznieuski | Jane Lin |
| Matt Fuller | Michael Rogers | Suriya Vallamsundar |
| Chuck Gebhardt | | |

**Introduction**

The agenda of the meeting is as follows:

1. PM2.5 EFs of future years - Sensitivity analysis: what model year to choose?
2. Case study sites: urban or rural sites?
3. Case study sites: input data status?
4. AERMOD and CAL3QHCR model comparison
5. PM hotspot project extension

**Discussion**

1. PM2.5 EFs of future years - Sensitivity analysis: what model year to choose?

Jane Lin started the meeting discussing the sensitivity test results her research team performed with the MOVES emission factors for different calendar years. Sensitivity test results showed that after calendar year 2011, emission factors decreased significantly for trucks compared to passenger cars. She said based on the 2040 traffic data from CMAP, her research team performed a comparison between calendar years 2011 and 2040 for same project site at Joliet, Illinois. Although the traffic volume for 2040 was twice that of 2011, the emission factors were 6-8 times lower compared to 2011 which led to lower concentration results for 2040. Jane said she was not sure of using calendar year 2040 as the modeling year for all case study sites due to the lower emission factors. Walt had proposed an idea of combining 2040 traffic volumes with 2020 emission factors to produce conservative results. Mike Claggett said the guideline suggests looking at the year of highest emissions associated with the project. He asked Walt what he thinks would be a reasonable timeline for a project to be completed. Walt replied that the time line would depend on the project, but the earliest time would be year 2015. Jane said it would be possible for her team to generate the emission factors for 2015. Mike Claggett added that they have been using calendar year 2015 for some categorical finding studies. Hence it was decided to use calendar year 2015 traffic volume with 2015 emission factors for all the case study sites. Jane's research team will have to interpolate between calendar years 2011 and 2040 traffic volume to generate volumes for 2015.

2. Case study sites: urban or rural sites?

Mike Claggett suggested looking at the EPA guidance for deciding the land use type for the case studies. But looking at the aerial photos, all case study sites except Illinois Route 3 at Paisa lane intersection are obvious urban sites. For Route 3, although it seems like a rural site, it is essential to look at the entire picture and decide the land use type. Jane said she will get back to the TRP members after looking at the EPA guidelines. She further added that in case the site is classified as rural, her team needs to process the rural meteorological data for MetroEast which would take some time.

3. Case study input data

As all the case study sites do not have the electronic AUTOCAD drawing in a format required for the graphical user interface for AERMOD, Jane asked the team if it is okay to use satellite photos for placing the sources and receptors. All the TRP member replied they were fine with using the satellite image. Mike Claggett added that the EPA/DOT PM hot spot training also used satellite imagery as processed by EPA, hence using the satellite image should be fine.

4. AERMOD vs CAL3QHCR

Jane presented the results of the comparison study between AERMOD and CAL3QHCR models her team performed. They found the concentrations from AERMOD to be twice that of CAL3QHCR. Jane asked Mike Claggett is he has seen any similar results. Mike Claggett replied that the general finding is obtaining the highest concentration from AERMOD area sources, lowest from AERMOD volume sources and CAL3QHCR produces concentrations in between the two. He added that he has performed some comparison studies between AERMOD and CAL3QHCR and would share the results with the group. With respect to running time, AERMOD took around 30-35 hours compared to 5 hours for CAL3QHCR for the same project site. Further, CAL3QHCR has been validated against observations adjacent to roadways. Based on the comparison study results, the team agreed to use CAL3QHCR for all the case study sites.

Mike Claggett informed the team that FHWA has modified the CAL3QHCR code to make it easier to use by allowing the users to run all 5 years of data in a single run. Although EPA has not approved this version, it is an extension of the version used in EPA/DOT training. He asked the team members to look at the EPA policy regarding the status of the preferred model in cases where changes have been made to the code (Guideline on Air Quality Models, Appendix W to 40 CFR Part 51). Examples of such modifications cited in paragraph 3.1.2b of Appendix W are changes that enable the use of the model or changes that only affect the format or averaging time of the results. In these situations, Appendix W stipulates that when any changes are made, the Regional Administrator should require a test example to demonstrate the concentration estimates are not affected. The team agreed that pursuant to Appendix W, a request for the Regional Administrator's approval to use the modified FHWA version of the CAL3QHCR model will be made and coordinated through Michael Leslie. A memo documenting the modifications along with a test case example to demonstrate that the concentration estimates are not affected will be sent to Region 5 EPA for their review.

5. Project extension

Jane informed the team that officially the project had ended and she is in the process of obtaining an extension to Feb 28, 2013.

To do:

1. Mike Claggett will send Michael Leslie a memo on his new CAL3QHCR Fortran version.
2. Jane will investigate further the urban-rural classification of the IL Route 3 site in East St. Louis.
3. Jane's research team will start working on CAL3QHCR modeling.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
Thursday, Nov 29, 2012

**Attendance**

A meeting of the Technical Review Panel for, “Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)” was held via teleconference, on November 29, 2012. Those present for the meeting included:

| | | |
|---|---|---|
| Mike Claggett | Walter G Zyznieuski | Jane Lin |
| Ross Patronsky | Michael Rogers | Suriya Vallamsundar |
| Matt Fuller | Chuck Gebhardt | Michael Leslie |

**Introduction**

The agenda of the meeting is as follows:

1. Model set-up and results from Poplar street bridge
2. Background concentration for Metro East
3. Future Steps

**Discussion**

Suriya gave an overview of the steps involved in the model set-up, assumptions made and results for the Poplar street bridge. Walt had 2 comments with respect to the model setp-up: first, if the model setup for Poplar street bridge was similar to the I55 and I80 project at Joliet, second, if the meteorological data which consisted of surface data from O’hare was appropriate for this case study site. Michael Leslie said IL EPA uses surface data from Lambert airport for modeling project sites in Metro East. Jane enquired if ILEPA has this data in a format compatible for AERMOD or CAL3QHCR. Michael will get in touch with Matt Will and let the team know about the meteorological data.

Walt asked Mike Clagget if he knows how much of an impact choosing the meteorological data from a different site will have on the concentration results. Mike replied that it was difficult to say exactly how much of a difference the meteorological data would cause but his opinion is that it should not cause a huge difference. Mike felt the results were interesting compared to the Joliet project and asked Jane and Suriya if they could point out reasons for the higher concentrations from Poplar street bridge compared to Joliet. Suriya stated the reasons which could explain the higher concentrations from Poplar street bridge as higher traffic volumes especially from the links where I64, I55 an I70 are merged and use of a different meteorological data.

Mike wanted to know the CAL3QHCR version used for the modeling. Suriya confirmed that she used the version on EPA's PM Hotspot training website (http://www.epa.gov/otaq/stateresources/transconf/training3day.htm#download). Michael Leslie told the team that EPA is evaluating Mike's CAL3QHCR version with EPA's version but a decision will not be made any sooner. Mike's version will be capable of handling all 5 years of data compared to a quarter of data with current EPA's version.

Jane asked the team which monitoring sites should be used for calculating the background concentration for the project area. She added that for Chicago metropolitan area, Elgin, Aurora and Braidwood sites were used to spatially interpolate (using the distance weighted approach) the background values for the region. This approach resulted in the background concentration of 10.41 $ug/m^3$ for the study region. Michael Leslie suggested looking at monitoring sites on Missouri side and agreed to help with this.

Walt asked Jane the future steps for the project. Jane stated that they have selected 4 projects (2 in Chicago and 2 in Metro East). Her team will start working on the arterial project in Chicago. Jane asked Walt to check if he can provide the CADD drawing for Dan Ryan in Chicago. Suriya added that for a complicated project such as Dan Ryan, it will not be possible to model the source and receptors using Google maps. Mike said he will help Jane with USGS maps in digitized format. Mike wanted Jane to send him the GIS files for Poplar street bridge.

Walt asked Suriya if she can give a timeline for the arterial project. She replied that it was not possible to give a time line as of now as they have to learn about intersection modeling in MOVES which might take time and do rest of the modeling. Jane informed the team that the project will end in February and they will have to apply for another extension.

To do:

1. Michael Leslie will help Jane with meteorological data using Lambert airport surface data
2. Michael Leslie will find out about the other monitoring sites in Metro East and interagency consultation team will decide on the sites to be used for calculating the background concentration.
3. Suriya will rerun Poplar street bridge with new meteorological data and add the background concentration and report back to the team.
4. Jane and Suriya will work on arterial project in Chicago

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
Friday, February 8, 2013

[Minutes are missing. These are meeting notes]

**Attendance**

A meeting of the Technical Review Panel for, “Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)” was held via teleconference, on February 8, 2013

**Introduction**

The agenda of the meeting is as follows:

1. Updated results of the Poplar Street Bridge site in St. Louis
2. Confirmation on the arterial street PM hotspot analysis procedure
3. Project status and next steps

**Discussion**

Jane and Suriya summarized the results from the Poplar street bridge case study site with more appropriate meteorological data representative of St.Louis area. Walt asked Jane if they have the background concentration value for the case study. Jane said she is waiting on Michael Leslie to send her the GIS map showing the locations of the monitoring sites to calculate the background concentration by distance weighted approach. She added that the background concentration for the St. Louis might exceed 10ug/m3 and that combined with the highest concentration from the project (3ug/m3) might be well above the new standards. Mike Clagget added that because the background concentration is so high, even if the project contribution is small the combined design value might violate the standard easily.

Walt asked Jane for the update on arterial sites. Suriya gave an overview of the approach for modeling arterial sites based on PM hot-spot guidance and training material. She asked the team a couple of issues related to arterial site modeling. Q1: In calculating the acceleration link length, is assuming a value of $1.5m/s^2$ reasonable? For this, Mike Clagget stated a few values used in practice such as 2mi/hr/sec for conservative approach, 4mi/hr/sec for average approach and 2.5mi/hr/sec for regulatory purposes. Based on these numbers, he added that 1.5m/sec2 is reasonable to use. Q2. Is it reasonable to model the sources in CAL3QHCR based on the peak hour queue and apply it for all time periods to minimize time and effort. In other words, the source lengths for all time periods will be based on the peak hour queue but the volumes and emission rates from MOVES will correspond to the individual time period. Mike Clagget responded that he needs to look at the emission rates, queue link lengths to make sure this approach does not underestimate the concentrations from the off-peak period. Suriya will send those calculations to Mike Clagget.

With regard to the project status, Jane informed the team that they were running out of time and it might not be possible to extend the deadline further. Due to this, Jane asked the team if they felt it was important to model Dan Ryan as the site is very complicated and CADD drawing in electronic form was not available. Walt suggested performing sensitivity analysis with respect to traffic volume, truck traffic controlling for geometry, meteorological conditions. Jane will set up a follow-up meeting to discuss more about the sensitivity analysis.

Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)
Interagency Consultation Meeting Minutes
Friday, March 15, 2013

**Attendance**

A meeting of the Technical Review Panel for, "Transportation Conformity Particulate Matter Hot-Spot Air Quality Modeling (ICT R27-93)" was held via teleconference, on March 15, 2013 Those present for the meeting included:

| | | |
|---|---|---|
| Mike Claggett | Walter G Zyznieuski | Jane Lin |
| Ross Patronsky | Suriya Vallamsundar | Michael Leslie |
| Chuck Gebhardt | | |

**Introduction**

The agenda of the meeting is as follows:

1. Model set-up and results from Algonquin and IL53 intersection
2. Sensitivity Analysis
3. Future Steps

**Discussion**

Suriya gave an overview of the steps involved in the model set-up, assumptions made and results for the Algonquin and IL53 arterial site. Walt felt the concentration results were reasonable. Suriya added that the highest concentrations were obtained near the highways compared to the intersection links mainly because the intersection was not a busy one with less queueing. When enquired about the background concentration, Jane told the team that she is waiting to hear from Michael Leslie about which sites to consider for calculating the background concentration. Michael Leslie pointed the Table containing the concentration results be corrected as concentrations were being repeated. Mike Clagget felt the figure showing the division of the arterial link into queue, acceleration and cruise segments from PM hotspot training material be changed. He further added that there were inconsistencies between the PM hotspot guidance and PM training material.

Walt asked Jane an update on the sensitivity analysis. Jane responded that although her team will perform the sensitivity analysis, but these analyses will not generate any threshold values. This is due to the presence of a number of input parameters and it is not possible to control all of them. Further due to the limited time available, it is not possible to generate threshold values based on the limited number of sensitivity tests. Mike Clagget agreed that generating threshold values based on a few sensitivity tests might not be acceptable. He added that so far, Jane's team has demonstrated how the PM hot-spot modeling exercise can be applied and performing a few sensitivity analyses will not add any value to the initial objective of the project.

Jane discussed the sensitivity analysis of the Poplar street bridge by changing the emission rates and meteorological data representative of Chicago. This resulted in the higher concentrations by about 30% compared to the site located in Metro East. Suriya added that the higher concentrations were mainly due to the lower temperatures in Chicago compared to MetroEast. Mike Clagget felt the results were interesting as temperature does not affect truck emission rates but added that he has seen similar results. Walt wanted Jane to document all these findings in the project report. Jane asked the team if they were fine with removing the sensitivity analyses from the scope. Mike Clagget agreed that the objective of Jane's work would be to demonstrate the PM hot-spot modeling process and not to come up with threshold values. Hence for the next steps, Jane's team will complete the modeling for the two arterial sites and finish up the project report. Walt wanted Jane to document in detail how the scope has changed during the course of the project. Jane informed the team that she will submit the project report to ICT by March 31st.

# APPENDIX B MOVES RUNSPEC FILE

**Sample MOVES Runstream File (Pilot study at Joliet, year 2011, Cook County, January –morning peak)**


```
<runspec>
	<description><![CDATA[Chicago Region
* All vehicle types and speed range from 0 to 70mph
*Scale is Emission Inventory
* road type - urban restricted
* January, April, October and December
*Morning peak (6am-9am), midday (9am-4pm), evening peak(4pm-7pm) and overnight (7pm-6am)
* Calendar years 2011]]></description>
	<modelscale value="Inv"/>
	<modeldomain value="PROJECT"/>
	<geographicselections>
		<geographicselection type="COUNTY" key="17031" description="ILLINOIS - Cook County"/>
	</geographicselections>
	<timespan>
		<year key="2011"/>
		<month id="1"/>
		<day id="5"/>
		<beginhour id="7"/>
		<endhour id="7"/>
		<aggregateBy key="Hour"/>
	</timespan>
	<onroadvehicleselections>
```

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<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41" sourcetypename="Intercity Bus"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54" sourcetypename="Motor Home"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetypename="Passenger Car"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetypename="Passenger Truck"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51" sourcetypename="Refuse Truck"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43" sourcetypename="School Bus"/>

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<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>

<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetypename="Transit Bus"/>

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<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>

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<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="11" sourcetypename="Motorcycle"/>

<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21" sourcetypename="Passenger Car"/>

<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31" sourcetypename="Passenger Truck"/>

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<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="42" sourcetypename="Transit Bus"/>

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<offroadvehicleselections>

</offroadvehicleselections>

<offroadvehiclesccs>

</offroadvehiclesccs>

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</roadtypes>

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<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="116" pollutantname="Primary PM2.5 - Brakewear Particulate" processkey="9" processname="Brakewear"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 - Elemental Carbon" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 - Elemental Carbon" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Primary PM2.5 - Organic Carbon" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Primary PM2.5 - Organic Carbon" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate Particulate" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate Particulate" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="117" pollutantname="Primary PM2.5 - Tirewear Particulate" processkey="10" processname="Tirewear"/>

<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="1" processname="Running Exhaust"/>

</pollutantprocessassociations>

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</databaseselections>

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useParameters No

]]></internalcontrolstrategy>

</internalcontrolstrategies>

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<uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>

<geographicoutputdetail description="LINK"/>

<outputemissionsbreakdownselection>

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<fueltype selected="false"/>

<emissionprocess selected="true"/>

<onroadoffroad selected="true"/>

<roadtype selected="true"/>

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<sector selected="false"/>

<engtechid selected="false"/>

<hpclass selected="false"/>

</outputemissionsbreakdownselection>

<outputdatabase servername="" databasename="octrun_out" description=""/>

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<outputvmtdata value="true"/>

<outputsho value="true"/>

<outputsh value="false"/>

<outputshp value="false"/>

<outputshidling value="false"/>

<outputstarts value="false"/>

<outputpopulation value="true"/>

<scaleinputdatabase servername="localhost" databasename="octrun_in" description=""/>

```xml
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    <outputfactors>
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        <distancefactors selected="true" units="Miles"/>
        <massfactors selected="true" units="Grams" energyunits="Joules"/>
    </outputfactors>
    <savedata>
    </savedata>
    <donotexecute>
    </donotexecute>
    <generatordatabase shouldsave="false" servername="" databasename="" description=""/>
        <donotperformfinalaggregation selected="false"/>
    <lookuptableflags scenarioid="1" truncateoutput="false" truncateactivity="false"/>
</runspec>
```

# APPENDIX C AERMOD AND CAL3QHCR CONTROL FILES

**Sample AERMOD Runstream File (Pilot study at Joliet, year 2011, Cook County)**

```
 CO STARTING
  TITLEONE PM Hot-spot Example - OctRun Interstate I-55 and I-80 near Joliet
  MODELOPT  CONC  FLAT
  AVERTIME  PERIOD
  POLLUTID  PM2.5
  FLAGPOLE  1.8
  RUNORNOT  RUN
  ERRORFIL  ERRORS.OUT
CO FINISHED
SO STARTING
  ELEVUNIT  METERS
  LOCATION  S1  AREA  0  3  0
  LOCATION  S2  AREA  824.67  3  0
  LOCATION  S3  AREA  0  30.3  0
  LOCATION  S4  AREA  824.67  30.3  0
  LOCATION  S5  AREA  809.672  -804.672  0
  LOCATION  S6  AREA  809.672  20.298  0
  LOCATION  S7  AREA  828.672  -804.672  0
  LOCATION  S8  AREA  828.672  20.298  0
  LOCATION  S9  AREAPOLY  233.4  40.6  0
  LOCATION  S10  AREAPOLY  1410.94  40.6  0
  .
  . (other source coordinates)
  .
  SRCPARAM  S1  1  2.1  824.67  7.3  0  1.96
  SRCPARAM  S2  1  2.02  824.67  7.3  0  1.88
  SRCPARAM  S3  1  2.02  824.67  7.3  0  1.88/
  SRCPARAM  S4  1  1.92  824.67  7.3  0  1.79
  SRCPARAM  S5  1  1.84  11  824.97  0  1.71
  SRCPARAM  S6  1  1.81  11  824.97  0  1.68
  SRCPARAM  S7  1  1.87  11  824.97  0  1.74
  SRCPARAM  S8  1  1.87  11  824.97  0  1.74
  SRCPARAM  S9  1  1.97  4  1.83
  SRCPARAM  S10  1  1.96  4  1.82
  .
  . (other area source dimensions)
  .
  AREAVERT  S9  233.4  40.6  238.4  40.6  801.67  603.87  796.67  603.87
  AREAVERT  S10  1410.94  40.6  1415.94  40.6  852.67  603.87  847.67  603.87
  .
  . (other areapolygon source dimensions)
  .
```

```
   EMISFACT  s1  SEASHR 2.48201E-07 2.48201E-07 2.48201E-07 2.48201E-07 2.48201E-07 2.48201E-
07 6.0923E-07 6.0923E-07 6.0923E-07
   EMISFACT  s1  SEASHR 1.01602E-06  1.01602E-06  1.01602E-06  1.01602E-06  1.01602E-06  1.01602E-06  1.01602E-06  5.43307E-07 5.43307E-07
   EMISFACT  s1  SEASHR 5.43307E-07 2.48201E-07 2.48201E-07 2.48201E-07 2.48201E-07 2.48201E-07 2.42394E-07 2.42394E-07 2.42394E-07
   EMISFACT  s1  SEASHR 2.42394E-07 2.42394E-07 2.42394E-07 5.91022E-07 5.91022E-07 5.91022E-07 9.89845E-07 9.89845E-07 9.89845E-07
   EMISFACT  s1  SEASHR 9.89845E-07 9.89845E-07 9.89845E-07 9.89845E-07 5.04533E-07 5.04533E-07 5.04533E-07 2.42394E-07 2.42394E-07
   EMISFACT  s1  SEASHR 2.42394E-07 2.42394E-07 2.42394E-07 2.39812E-07 2.39812E-07 2.39812E-07 2.39812E-07 2.39812E-07 2.39812E-07
   EMISFACT  s1  SEASHR 5.81745E-07 5.81745E-07 5.81745E-07 9.81315E-07 9.81315E-07 9.81315E-07 9.81315E-07 9.81315E-07 9.81315E-07
   EMISFACT  s1  SEASHR 9.81315E-07 4.92799E-07 4.92799E-07 4.92799E-07 2.39812E-07 2.39812E-07 2.39812E-07 2.39812E-07 2.39812E-07
   EMISFACT  s1  SEASHR 2.41944E-07 2.41944E-07 2.41944E-07 2.41944E-07 2.41944E-07 2.41944E-07 5.89731E-07 5.89731E-07 5.89731E-07
   EMISFACT  s1  SEASHR 9.88556E-07 9.88556E-07 9.88556E-07 9.88556E-07 9.88556E-07 9.88556E-07 9.88556E-07 5.03547E-07 5.03547E-07
   EMISFACT  s1  SEASHR 5.03547E-07 2.41944E-07 2.41944E-07 2.41944E-07 2.41944E-07 2.41944E-07
   .
   . (other emission factors)
   .
SRCGROUP  ALL
SO FINISHED

RE STARTING
   ELEVUNIT  METERS
   DISCCART  0  53.6
   DISCCART  25  53.6
   DISCCART  50  53.6
   DISCCART  75  53.6
   DISCCART  100  53.6
   DISCCART  125  53.6
   DISCCART  150  53.6
   DISCCART  175  53.6
   DISCCART  200  53.6
   DISCCART  225  53.6
   .
   . (other receptors)
   .
RE FINISHED
ME STARTING
   SURFFILE  DPA_06to10.sfc
   PROFFILE  DPA_06to10.pfl
   SURFDATA  94892  2011  DPA
   UAIRDATA  94982  2011  KDPA
   PROFBASE  228.904
```

```
ME FINISHED
OU STARTING
OU POSTFILE  PERIOD  ALL  PLOT  ALL_PERIOD.pst
OU FINISHED
```

**Sample CAL3QHCR Runstream File (Pilot study at Joliet, year 2011, Cook County)**

```
        'I80 and I55 at Joliet-yr2011',60,100,0,0,1168,1,0
        01,01,05,03,31,05
        94846,05,94982,05
        0,0,'U'
        1,0,53.6,1.8
        2,25,53.6,1.8
        3,50,53.6,1.8
        4,75,53.6,1.8
        5,100,53.6,1.8
        6,125,53.6,1.8
        7,150,53.6,1.8
        8,175,53.6,1.8
        9,200,53.6,1.8
10,225,53.6,1.8
          .
          . (other receptors)
          .
2,'P'
1,1,1,1,1,1,1
'1st Quarter - 2005',36
1,1
's1-I80 W of I55- Eleg','AG',0,6.65,824.67,6.65,0,13.3
2,1
's2-I80 E of I55- Eleg','AG',824.67,6.65,1649.34,6.65,0,13.3
3,1
's3-I80 W of I55- Wleg','AG',0,33.95,824.67,33.95,0,13.3
4,1
's4-I80 E of I55- Wleg','AG',824.67,33.95,1649.34,33.95,0,13.3
5,1
's5-I55 S of I80- Sleg','AG',815.172,-804.672,815.172,20.298,0,17
6,1
's6-I55 N of I80- Sleg','AG',815.172,20.298,815.172,845.268,0,17
7,1
's7-I55 S of I80- Nleg','AG',834.172,-804.672,834.172,20.298,0,17
8,1
's8-I55 N of I80- Nleg','AG',834.172,20.298,834.172,845.268,0,17
9,1
's9-I80 WB On Ramp from I55 SB - IR','AG',235.9,40.6,799.17,603.87,0,11
10,1
's10-I55 NB On Ramp from I80 WB - IR','AG',1413.44,40.6,850.17,603.87,0,11
          .
          . (other sources dimensions)
          .
2,'P'
1,1,1,1,1,1,1
```

```
'1st Quarter - 2005',36
1,1
's1-I80 W of I55- Eleg','AG',0,6.65,824.67,6.65,0,13.3
2,1
's2-I80 E of I55- Eleg','AG',824.67,6.65,1649.34,6.65,0,13.3
3,1
's3-I80 W of I55- Wleg','AG',0,33.95,824.67,33.95,0,13.3
4,1
's4-I80 E of I55- Wleg','AG',824.67,33.95,1649.34,33.95,0,13.3
5,1
's5-I55 S of I80- Sleg','AG',815.172,-804.672,815.172,20.298,0,17
6,1
's6-I55 N of I80- Sleg','AG',815.172,20.298,815.172,845.268,0,17
7,1
's7-I55 S of I80- Nleg','AG',834.172,-804.672,834.172,20.298,0,17
8,1
's8-I55 N of I80- Nleg','AG',834.172,20.298,834.172,845.268,0,17
9,1
's9-I80 WB On Ramp from I55 SB - IR','AG',235.9,40.6,799.17,603.87,0,11
10,1
's10-I55 NB On Ramp from I80 WB - IR','AG',1413.44,40.6,850.17,603.87,0,11
          .
          . (other emission rates)
          .
```

# APPENDIX D TRAFFIC VOLUME DATA

## 1. PILOT STUDY: I-80 AND I-55 INTERCHANGE NEAR JOLIET, ILLINOIS

TABLE D.1 Range of traffic volume and percentage truck traffic at pilot study site

| Identification | Roadway Links | Range for 4 time periods (Morning peak, Midday, Evening peak and Overnight) | |
|---|---|---|---|
| | | Hourly Traffic Volume | Percentage Truck Traffic (%) |
| (a) | I55 NB On Ramp from I80 EB | 173 – 637 | 13 – 30 |
| (b) | I55 NB On Ramp from I80 WB | 165 – 913 | 5 – 30 |
| (c) | I55 North of I80 – N Leg | 694 – 2847 | 10 – 30 |
| (d) | I55 North of I80 – S Leg | 740 – 2889 | 9 – 25 |
| (e) | I55 SB On Ramp from I80 EB | 30 – 124 | 43 – 67 |
| (f) | I55 SB On Ramp from I80 WB | 160 – 737 | 14 – 36 |
| (g) | I55 South of I80 – N leg | 547 – 2486 | 14 – 30 |
| (h) | I55 South of I80 – S leg | 608 – 2273 | 13 – 28 |
| (i) | I80 East of I55- E leg | 587 – 2912 | 12 – 34 |
| (j) | I80 East of I55- W leg | 619 – 2945 | 18 – 30 |
| (k) | I80 EB On Ramp from I55 NB | 177 – 841 | 20 – 32 |
| (l) | I80 EB On Ramp from I55 SB | 178 – 1016 | 10 – 21 |
| (m) | I80 WB On Ramp from I55 NB | 30 – 110 | 35 – 71 |
| (n) | I80 WB On Ramp from I55 SB | 159 – 729 | 12 – 34 |
| (o) | I80 West of I55- E leg | 450 – 2086 | 20 – 46 |
| (p) | I80 West of I55- W leg | 465 – 1817 | 23 – 35 |

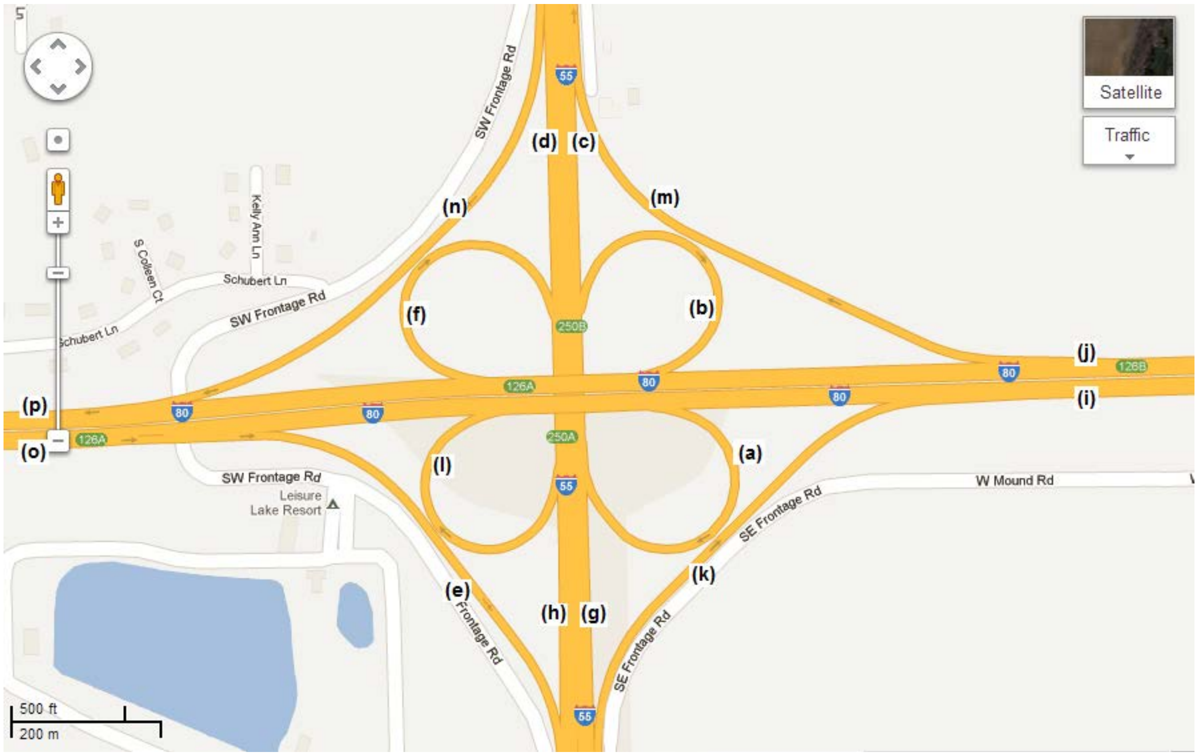


FIGURE D.1 Pilot study site

## 2. CASE STUDY 1: POPLAR STREET BRIDGE, METRO EAST

TABLE D.2 Range of traffic volume and percentage truck traffic at case study site 1

| Identification | Range for 4 time periods (Morning peak, Midday, Evening peak and Overnight) | |
|---|---|---|
| | **Hourly Traffic Volume** | **Percentage Truck Traffic (%)** |
| (a) | 1898 - 7129 | 3 - 22 |
| (b) | 2160 - 6186 | 4 - 18 |
| (c) | 1315 - 3977 | 2 - 19 |
| (d) | 1158 - 3029 | 3 - 16 |
| (e) | 487 - 1278 | 2 - 12 |
| (f) | 671 - 1751 | 4 – 18 |
| (g) | 126 - 420 | 11 - 39 |
| (h) | 614 - 1698 | 4 - 19 |
| (i) | 371 - 1378 | 2 - 13 |
| (j) | 122 - 377 | 12 – 40 |
| (k) | 493 - 1646 | 4 - 21 |
| (l) | 344 - 892 | 4 - 20 |
| (m) | 944 - 2600 | 3 - 23 |
| (n) | 661 - 1611 | 3 - 25 |
| (o) | 283 - 989 | 2 - 19 |
| (p) | 327 - 859 | 4 - 17 |
| (q) | 32 - 130 | 22 - 44 |
| (r) | 787 - 1793 | 4 - 28 |
| (s) | 824 - 1870 | 4 - 29 |
| (t) | 365 - 989 | 5 - 20 |
| (u) | 38 - 105 | 14 - 49 |
| (v) | 320 - 1072 | 3 - 23 |
| (w) | 420 - 1073 | 9 - 32 |
| (x) | 465 - 1262 | 6 - 27 |
| (y) | 583 - 3151 | 3 - 25 |
| (z) | 1002 - 3157 | 5 - 20 |

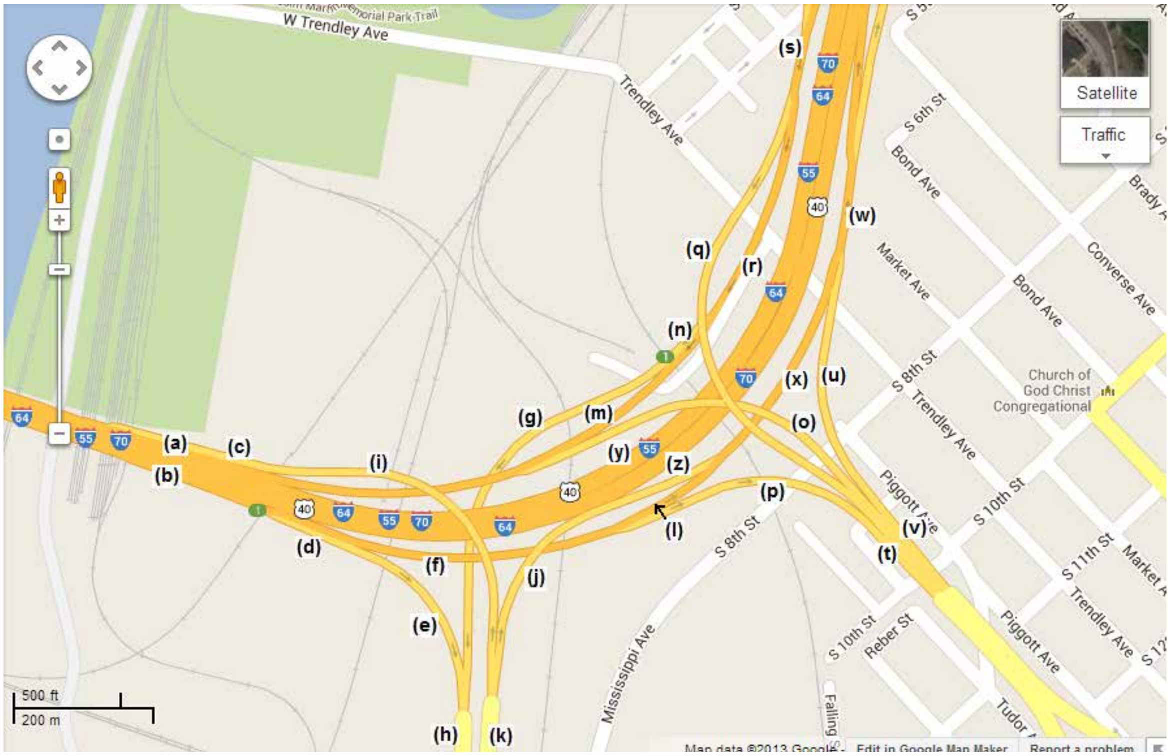


FIGURE D.2 Case study site 1

## 3. CASE STUDY 2: INTERSECTION OF ALGONQUIN AND IL53, CHICAGO

TABLE D.3 Range of traffic volume and percentage truck traffic at case study site 2

| Identification | Range for 4 time periods (Morning peak, Midday, Evening peak and Overnight) | |
|---|---|---|
| | Hourly Traffic Volume | Percentage Truck Traffic (%) |
| (a) | 2275 - 6616 | 6 - 17 |
| (b) | 2377 - 6489 | 5 - 17 |
| (c) | 2646 - 7832 | 5 - 16 |
| (d) | 2337 - 7969 | 5 - 17 |
| (e) | 683 - 2335 | 3 - 9 |
| (f) | 609 - 1290 | 2 - 7 |
| (g) | 215 - 661 | 2 - 8 |
| (h) | 372 - 1783 | 4 - 12 |
| (i) | 729 - 1913 | 2 - 10 |
| (j) | 358 - 740 | 3 - 8 |

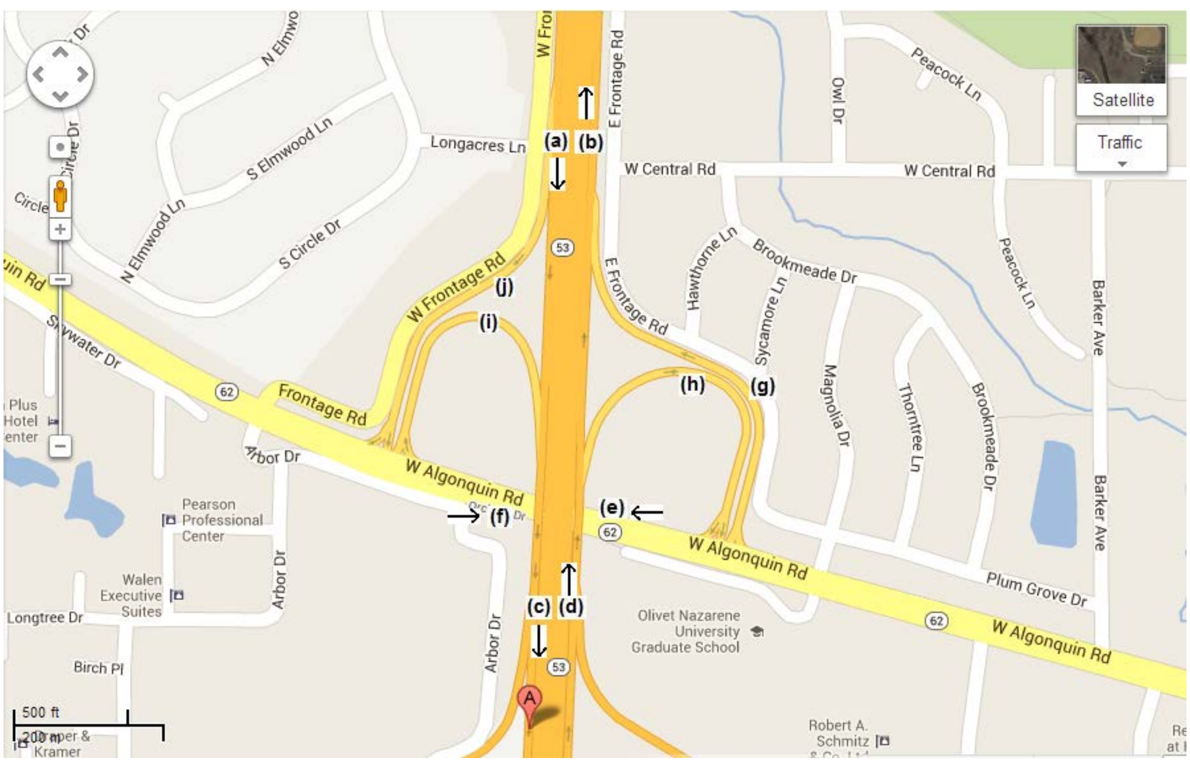


FIGURE D.3 Case study site 2

## 4. CASE STUDY 3: INTERSECTION OF STATE ROUTE 3 AND PIASA LANE, METRO EAST

TABLE D.4 Range of traffic volume and percentage truck traffic at case study site 3

| Identification | Range for 4 time periods (Morning peak, Midday, Evening peak and Overnight) | |
|---|---|---|
| | Hourly Traffic Volume | Percentage Truck Traffic (%) |
| (a) | 280 – 1004 | 10 – 46 |
| (b) | 267 – 944 | 8 – 48 |
| (c) | 288 – 1028 | 10 – 46 |
| (d) | 275 – 959 | 8 – 48 |
| (e) | 8 – 24 | 16 – 47 |
| (f) | 8 – 24 | 18 – 47 |


FIGURE D.4 Case study site 3

Illinois Department of Transportation

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN