Introduction and Purpose

On December 24, 2013, EPA released updated regulatory versions of AERMET and AERMOD (Versions 13350). This update included significant updates to AERMET, the meteorological pre-processing model, and AERMOD, the dispersion model. The updates were designed to address bug fixes with the current model formulation in addition to model enhancements.

A further AECOM update that primary corrected coding “bugs” in version 13350 was released on May 16, 2014 (version 14134). The model description does not include any significant formulation changes from version 13350. Some initial tests with this latest version are reported in this document.

The biggest change associated with the latest AERMOD releases for the low wind speed options is the AERMET modification associated with the theta-star when using the ADJ_U- Beta option (the AECOM “theta-star fix”). A related, but less-often used modification relates to the use of the Bulk Richardson Number approach under the ADJ_U- Beta option, which has been further altered in version 14134. The testing reported in this document does not include any consideration of the Bulk Richardson Number approach.

The updates in the low wind speed option in versions 13350 and 14134 mainly include the use of the modified theta-star when using the ADJ_U-, which can result in substantial differences in predictions for some cases. These changes are illustrated with this sensitivity analysis.

EPA still regards the beta v- and the LOWWIND options as non-guideline, but they appear to be receptive to supporting evidence to make case-by-case approvals easier, especially with the updated code in version 14134. However, EPA regards the beta v- option as much easier to justify than the added LOWWIND options in AERMOD, which have a “higher bar” to climb.

In order to make the case that these improvements should be made part of the default options in AERMOD, we have in mind a 2-step process. The first step, discussed in this document is a sensitivity study to determine the types of sources and application cases (e.g., flat vs. complex terrain for low-level and tall stack releases) where the low wind speed changes are significant. The second phase involves further evaluations for certain source types and available databases that show significant sensitivity to these options to reinforce the conclusion that the low wind speed enhancements, including the LOWWIND2 option in AERMOD, should be adopted as regulatory defaults.

Next year, with the 11th EPA Modeling Conference and changes to Appendix W on the horizon, EPA will consider low wind speed changes for a permanent part of the default modeling approach. In anticipation of this development, we have conducted this sensitivity analysis, to be followed up
by additional evaluations and then a peer-reviewed journal paper on this study. The Lignite Energy Council has funded some evaluations for tall stack releases, for example, but one case that needs further evaluation is a tall stack in truly complex terrain.

Prior to promulgating AERMOD in 2005, EPA conducted a comparison of regulatory concentrations, or a “consequence analysis” (the report is available at http://www.epa.gov/ttn/scram/7thconf/aermod/compar.pdf) to provide information about what changes in predicted concentrations would be expected with the adoption of AERMOD as a regulatory model. The 2003 EPA consequence analysis examined various source types in complex terrain, simple and flat terrain, with and without building downwash. For this study, we developed a similar approach as a means to determine (1) which of the low wind speed options have the most effect on predicted concentrations, and (2) which source types and terrain settings are most sensitive to these modeling options. The sensitivity study used hypothetical, but representative sources, meteorological data, and terrain settings. The results of the study provide input to the selection of low wind speed evaluation databases for further analysis.

The sections below outline specific aspects of the analysis, along with a discussion of the results.

**Processing of Meteorological Databases**

AECOM processed two meteorological databases for this sensitivity analysis. These databases consist of five recent years of National Weather Service (NWS) airport data (including 1-minute ASOS data processing). One of the distinguishing features of these two databases was a large percentage of low 10-m wind speeds (at least 25% of the wind speeds are below 1.5 m/s, and at least 60% of the wind speeds are below 2.5 m/s).

The meteorological data for both sites was prepared using recent regulatory model versions and with EPA-recommended procedures including; AERMET – Version 13350, AERMINUTE – Version 11325, and AERSURFACE – Version 13016. Additional testing was done with AERMET version 14134 to determine any differences with the version update.

The first meteorological site is representative of flat terrain and is based on five years (2007-2011) of data from Pascagoula, Mississippi Airport. Figure 1 shows a frequency distribution of the wind speeds. As shown in Figure 1, there is a high frequency of low winds (i.e., 27% of the time the winds are between 0.5 and 1.5 m/s, and about 60% of the time for speeds less than 2.5 m/s). A five-year wind rose for Pascagoula is illustrated in Figure 2.

The second meteorological site was selected for complex terrain modeling and is based on five years (2008-2012) of data from Page, Arizona. The meteorological data for the complex terrain model application was used for hypothetical sources strategically placed so that the prevailing winds would blow towards a significant terrain feature. Figure 3 shows a frequency distribution of the wind speeds. As shown in Figure 3, there is a high frequency of low winds (i.e., 25% of the time the winds are between 0.5 and 1.5 m/s, and about 60% of the time for speeds less than 2.5 m/s). A five-year wind rose for Page is illustrated in Figure 4.
Figure 1: Wind Speed Frequency Distribution for Pascagoula, Mississippi Airport (2007-2011)
Figure 2: Wind Rose for Pascagoula, Mississippi Airport (2007-2011)
Figure 3: Wind Speed Frequency Distribution for Page, Arizona (2008-2012)
Figure 4: Wind Rose for Page, Arizona (2008-2012)
Receptor Grid Configuration

The modeled sources were assumed to have a 50-meter buffer to the nearest receptor. The same grid setup was used for simple/flat terrain and complex terrain applications for all the sources. The receptor spacing is specified below:

- 50 meter spacing out to 500 meters
- 100 meter spacing out to 1,000 meters
- 200 meter spacing out to 2,000 meters
- 500 meter spacing out to 5,000 meters
- 1,000 meter spacing out to 10,000 meters
- 2,000 meter spacing out to 20,000 meters.

In addition, receptors were placed on the major terrain feature in the complex terrain runs to adequately resolve the terrain impacts for those cases. The near-field and entire receptor grids are shown in Figures 5 and 6, respectively.

Figure 5: Near-Field Receptors
**Figure 6: Entire Receptor Grid**

The source model source configurations for the simple and complex terrain model runs were identical. Table 1 provides details about the 11 hypothetical sources that were modeled for this sensitivity analysis. Figures provided in Appendix A show the modeling layout for each source, any nearby controlling building (if applicable), the fenceline, and nearby model receptors.

**Modeled Source Configurations**

The source model source configurations for the simple and complex terrain model runs were identical. Table 1 provides details about the 11 hypothetical sources that were modeled for this sensitivity analysis. Figures provided in Appendix A show the modeling layout for each source, any nearby controlling building (if applicable), the fenceline, and nearby model receptors.
### Table 1: Source Configuration and Model Input Data

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Stack Height (m)</th>
<th>Stack Temp (K)</th>
<th>Stack Velocity (m/s)</th>
<th>Stack Diameter (m)</th>
<th>Emission Rate (g/s)</th>
<th>Building Height (m)</th>
<th>Building Width (m)</th>
<th>Building Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCC</td>
<td>Source 1: a tall buoyant point source indicative of an FCC (fluid catalytic cracking) refinery source (including building downwash)</td>
<td>54.0</td>
<td>561.0</td>
<td>49.1</td>
<td>2.0</td>
<td>1.0</td>
<td>24.8</td>
<td>10.6</td>
<td>14.6</td>
</tr>
<tr>
<td>FLARE</td>
<td>Source 2: a tall buoyant point source representing a flare</td>
<td>75.6</td>
<td>1273.0</td>
<td>20.0</td>
<td>1.1</td>
<td>1.0</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>REGENHTR</td>
<td>Source 3: a tall buoyant point source indicative of a CCR (continuous catalytic regenerative reformer) refinery source (including building downwash)</td>
<td>104.2</td>
<td>450.0</td>
<td>12.2</td>
<td>3.7</td>
<td>1.0</td>
<td>30.5</td>
<td>18.3</td>
<td>36.6</td>
</tr>
<tr>
<td>GASTURB</td>
<td>Source 4: a buoyant point source indicative of a gas turbine at a compressor station (including building downwash)</td>
<td>13.7</td>
<td>777.0</td>
<td>41.6</td>
<td>1.2</td>
<td>1.0</td>
<td>11.6</td>
<td>24.4</td>
<td>24.4</td>
</tr>
<tr>
<td>DIESENG</td>
<td>Source 5: a short-stack horizontal release point source indicative of a diesel generator (including building downwash)</td>
<td>9.1</td>
<td>697.0</td>
<td>0.001</td>
<td>0.60</td>
<td>1.0</td>
<td>10.0</td>
<td>18.5</td>
<td>26.93</td>
</tr>
<tr>
<td>DRILLRIG</td>
<td>Source 6: a buoyant point source indicative of a drill rig (e.g., used at a fracking site, including building downwash)</td>
<td>6.1</td>
<td>665.0</td>
<td>45.0</td>
<td>0.3</td>
<td>1.0</td>
<td>3.1</td>
<td>6.1</td>
<td>18.3</td>
</tr>
<tr>
<td>LGNTURB</td>
<td>Source 7: a combustion turbine source indicative of drilling or LNG facility operations.</td>
<td>13.7</td>
<td>777.0</td>
<td>30.0</td>
<td>3.0</td>
<td>1.0</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>PNTTANK</td>
<td>Source 8: a non-buoyant point source located on a tank (including downwash)</td>
<td>14.6</td>
<td>ambient</td>
<td>0.001</td>
<td>0.001</td>
<td>1.0</td>
<td>14.6</td>
<td>55.0 radius</td>
<td></td>
</tr>
<tr>
<td>COMPRSTA</td>
<td>Source 11: buoyant point source associated with a compressor station at a coal bed methane drilling site (including downwash)</td>
<td>14.33</td>
<td>449.8</td>
<td>22.8</td>
<td>1.8</td>
<td>1.0</td>
<td>12.2</td>
<td>18.3</td>
<td>27.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Release Height (m)</th>
<th>X-Dimension (m)</th>
<th>Y-Dimension (m)</th>
<th>Initial Sigma-Z (m)</th>
<th>Emission Rate (g/s/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AREA</td>
<td>Source 9: a ground-level area source</td>
<td>0.0</td>
<td>50.0</td>
<td>50.0</td>
<td>0.0</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Source Description</th>
<th>Release Height (m)</th>
<th>Initial Sigma-Y (m)</th>
<th>Initial Sigma-Z (m)</th>
<th>Emission Rate (g/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROADVOL</td>
<td>Source 10: a volume source representing roadway traffic</td>
<td>10.0</td>
<td>14.0</td>
<td>16.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Model Configurations

The following model runs were conducted for the two meteorological data sets (one with flat terrain, and one with complex terrain) for the 11 source listed above. Specifically, three AERMOD configurations were tested with AERMET/AERMOD version 13350, and with additional testing with version 14134:

1. AERMET/AERMOD Version 13350 → Current Default Settings
2. AERMET/AERMOD Version 13350 → beta u, alone
3. AERMET/AERMOD Version 13350 → beta u, LOWWIND 2 (minimum sigma-v = 0.3 m/s)

These options were selected to determine the sensitivity of the modeling results to each option and to provide strategic information regarding these options. Each AERMOD configuration was run to determine the 1-hour NO$_2$ (using Tier 1 – 100% conversion of NOx to NO$_2$) maximum and design concentrations (98th percentile peak daily 1-hour maximum concentrations).

Sensitivity Modeling Results

The modeling results are presented in Tables 2 and 3, respectively for the complex and flat terrain runs, for each model run for the maximum and design concentrations. The results are also shown graphically in Figures 18 and 19 as a concentration relative to the default model maximum concentration. A results discussion matrix for each source is presented in Table 4. Appendix B shows isopleth plots for all 22 default AERMOD model runs (11 source types in flat and complex terrain). There are also isopleth plots for each source/terrain setting for the beta u- and LOWWIND2 model runs for which the corresponding source/terrain setting is sensitive to AERMOD’s low-wind options.

Limited testing was conducted with AERMET and AERMOD version 14134. The new model version was shown to have identical results for the maximum modeled concentrations presented in Tables 2 and 3. A discussion of the result for complex and flat terrain cases is provided below.

Complex Terrain Case

- The following sources, when modeled for the complex terrain case, show maximum modeled impacts to occur in at receptors located close to the modeled source in simple terrain; DIESENG, DRILLRIG, PNTTANK, AREA, and ROADVOL.

- Tall buoyant stacks (FCC, FLARE, REGENHTR) are quite sensitive to AERMOD’s low-wind speed options; lower modeled concentrations are predicted with these options in complex terrain. When using the default model options, AERMOD’s maximum impacts occur under light wind speed stable conditions. The use of the beta u- option in AERMET increases effective wind speed, mechanical mixing, vertical dispersion, and plume rise, thus reducing the predicted concentrations. The use of LOWWIND2 also increases lateral dispersion and lowers the modeled concentrations.

- LNGTURB, a short, non-downwashing source, is sensitive to AERMOD’s low-wind speed options. When using AERMOD’s default options, the maximum modeled impacts occur under light wind stable conditions. The use of the beta u- option in AERMET increases mechanical mixing and vertical dispersion, thus reducing the predicted concentrations.

- COMPRSTA (short, downwashing) is not very sensitive to LW options, although the change to the boundary layer for the LW options affects the controlling meteorological conditions.
Flat Terrain Case

- Tall buoyant stacks were insensitive to AERMOD’s low-wind speed options as the maximum modeled impacts were due to building downwash or occurred during unstable conditions.

- Short buoyant stacks with downwash were also insensitive to AERMOS’s low-wind speed options as the maximum modeled impacts did not occur under light wind speeds.

- Short stacks without either momentum or buoyancy with downwash (DIESENG, PNTTANK) and fugitive sources are sensitive to AERMOD’s low-wind speed options resulting in lower concentrations. The maximum modeled impacts for these sources occurred under light wind stable conditions. The use of the beta u* option in AERMET increases mechanical mixing and vertical dispersion thus reducing the predicted concentrations.

- LNGTURB, a short buoyant non-downwashing source, experienced a high wind “side effect” of AERMOD’s low-wind speed options. The maximum modeled impacts occurred under high wind neutral conditions. The use of AERMET’s beta u* causes higher turbulence and plume touch down closer to the stack.

Table 2: AERMOD Maximum and Design NO₂ concentrations (µg/m³) for Complex Terrain

<table>
<thead>
<tr>
<th>Source</th>
<th>Complex Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Default Option</td>
</tr>
<tr>
<td></td>
<td>MAX₁</td>
</tr>
<tr>
<td>FCC</td>
<td>11.99</td>
</tr>
<tr>
<td>FLARE</td>
<td>21.01</td>
</tr>
<tr>
<td>REGENHTR</td>
<td>8.06</td>
</tr>
<tr>
<td>GASTURB</td>
<td>41.78</td>
</tr>
<tr>
<td>DIESENG</td>
<td>4892.11</td>
</tr>
<tr>
<td>DRILLRIG</td>
<td>159.15</td>
</tr>
<tr>
<td>LNGTURB</td>
<td>10.46</td>
</tr>
<tr>
<td>PNTTANK</td>
<td>2012.93</td>
</tr>
<tr>
<td>COMPRSTA</td>
<td>39.48</td>
</tr>
<tr>
<td>AREA</td>
<td>48352.48</td>
</tr>
<tr>
<td>ROADVOL</td>
<td>1022.58</td>
</tr>
</tbody>
</table>

¹ MAX = Maximum Concentration
² DC = Design Concentration
Table 3: AERMOD Maximum and Design NO₂ concentrations (µg/m³) for Flat Terrain

<table>
<thead>
<tr>
<th>Source</th>
<th>Flat Terrain</th>
<th>Default Option</th>
<th>Default Option</th>
<th>Default Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MAX¹</td>
<td>DC²</td>
<td>MAX¹</td>
<td>DC²</td>
</tr>
<tr>
<td>FCC</td>
<td>1.65</td>
<td>0.83</td>
<td>1.65</td>
<td>0.88</td>
</tr>
<tr>
<td>FLARE</td>
<td>2.90</td>
<td>1.64</td>
<td>2.90</td>
<td>1.64</td>
</tr>
<tr>
<td>REGENHTR</td>
<td>1.84</td>
<td>0.60</td>
<td>1.84</td>
<td>0.60</td>
</tr>
<tr>
<td>GASTURB</td>
<td>57.30</td>
<td>12.28</td>
<td>57.47</td>
<td>12.26</td>
</tr>
<tr>
<td>DIESENG</td>
<td>6684.83</td>
<td>5325.29</td>
<td>5721.93</td>
<td>4456.33</td>
</tr>
<tr>
<td>DRILLRIG</td>
<td>272.95</td>
<td>230.30</td>
<td>269.92</td>
<td>227.42</td>
</tr>
<tr>
<td>LNGTURB</td>
<td>2.99</td>
<td>1.11</td>
<td>4.64</td>
<td>1.11</td>
</tr>
<tr>
<td>PNTTANK</td>
<td>2971.34</td>
<td>2621.17</td>
<td>2249.09</td>
<td>1812.95</td>
</tr>
<tr>
<td>COMPRSTA</td>
<td>49.82</td>
<td>34.41</td>
<td>49.78</td>
<td>33.36</td>
</tr>
<tr>
<td>AREA</td>
<td>71519.73</td>
<td>63435.99</td>
<td>20001.71</td>
<td>14856.82</td>
</tr>
<tr>
<td>ROADVOL</td>
<td>1400.22</td>
<td>1356.47</td>
<td>1242.79</td>
<td>1189.71</td>
</tr>
</tbody>
</table>

¹ MAX = Maximum Concentration
² DC = Design Concentration
Table 4: Results Discussion Matrix for Each Modeled Source in Complex in Flat Terrain

<table>
<thead>
<tr>
<th>Source</th>
<th>Short or Tall?</th>
<th>Subject to Downwash?</th>
<th>Buoyant?</th>
<th>Momentum?</th>
<th>Complex Terrain</th>
<th>Flat Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCC</td>
<td>Tall</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Sensitive to LW options - max impact occurred under light wind speed stable conditions. Beta ( u^* ) option increases effective wind speed, mechanical mixing height, and vertical dispersion so that plume escapes the building wake. Application of the LW2 option increases the lateral dispersion.</td>
<td>Insensitive to LW options - max impacts occur under very light winds during stable conditions.</td>
</tr>
<tr>
<td>FLARE</td>
<td>Tall</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Sensitive to LW options - max impact occurred under light wind speed stable conditions. Beta ( u^* ) option increases effective wind speed, mechanical mixing height, and vertical dispersion. Application of the LW2 option increases the lateral dispersion.</td>
<td>Insensitive to LW options - max impacts occur under very light winds during stable conditions.</td>
</tr>
<tr>
<td>REGENHTR</td>
<td>Tall</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Sensitive to LW options - max impact occurred under light wind speed stable conditions. Beta ( u^* ) option increases effective wind speed, mechanical mixing height, and vertical dispersion. Application of the LW2 option increases the lateral dispersion.</td>
<td>Insensitive to LW options - max impacts occur under very light winds during stable conditions.</td>
</tr>
<tr>
<td>GASTURB</td>
<td>Short</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Max impacts occur in flat terrain.</td>
<td>Insensitive to LW options - max impacts do not occur under low winds.</td>
</tr>
<tr>
<td>DIESENG</td>
<td>Short</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Max impacts occur in flat terrain.</td>
<td>Sensitive to LW options - max impacts occur under very light winds during stable conditions. Impacts are controlled by building downwash, however the beta ( u^* ) option seems to increase the mechanical mixing height and vertical dispersion. Application of the LW2 option increases the lateral dispersion.</td>
</tr>
<tr>
<td>DRILLRIG</td>
<td>Short</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Max impacts occur in flat terrain.</td>
<td>Insensitive to LW options - max impacts do not occur under low winds.</td>
</tr>
<tr>
<td>Source</td>
<td>Short or Tall?</td>
<td>Subject to Downwash?</td>
<td>Buoyant?</td>
<td>Momentum?</td>
<td>Complex Terrain</td>
<td>Flat Terrain</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>----------------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LNGTURB</td>
<td>Short</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Sensitive to LW options - max impacts occurred under light wind and stable conditions. Beta u-opt increases mechanical mixing height and vertical dispersion. <em>Effective wind speed remains about the same.</em> Application of the LW2 option increases the lateral dispersion.</td>
<td>Sensitive to LW options - max impacts occur under high wind and neutral conditions. Beta u- is causing higher turbulence and plume touch down closer to the stack. Note, this is rare occurrence as the design concentration is insensitive to the LW options.</td>
</tr>
<tr>
<td>PNTTANK</td>
<td>Short</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Max impacts occur in flat terrain.</td>
<td>Sensitive to LW options - max impacts occur under very light winds during stable conditions. Impacts are controlled by building downwash, however the beta u-opt seems to increase the mechanical mixing height and vertical dispersion. Application of the LW2 option increases the lateral dispersion.</td>
</tr>
<tr>
<td>COMPRSTA</td>
<td>Short</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Sensitive to LW options - max impact occurred under stable conditions due to downwash. Beta u-opt increases plume height so building downwash is not as dramatic. Max impact for beta u-opt occurs during high wind unstable conditions. LW options are insensitive under these conditions.</td>
<td>Insensitive to LW options - max impacts do not occur under low winds.</td>
</tr>
<tr>
<td>AREA</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td>Max impacts occur in flat terrain.</td>
<td>Sensitive to LW options - max impacts occur under very light winds during stable conditions. The beta u-opt seems to increase the mechanical mixing height and vertical dispersion. Application of the LW2 option increases the lateral dispersion.</td>
</tr>
<tr>
<td>ROADVOL</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td>Max impacts occur in flat terrain.</td>
<td>Sensitive to LW options - max impacts occur under very light winds during stable conditions. The beta u-opt seems to increase the mechanical mixing height and vertical dispersion. Application of the LW2 option increases the lateral dispersion.</td>
</tr>
</tbody>
</table>
Figure 18: Model Sensitivity Results for Complex Terrain
Figure 19: Model Sensitivity Results for Flat Terrain
Discussion and Conclusions

From comments heard at the 2014 EPA modeling workshop on May 20, 2014, here is EPA’s current thinking on the low wind speed options.

- The beta $u^*$ method has been evaluated for both the prediction of $u^*$ (this is independent of source type) and the concentration prediction with AERMOD, especially for low-level sources. EPA is not sure about whether concentration predictions are more accurate for tall stacks for the concentration predictions.
- EPA has done the “heavy lifting” for the beta $u^*$ option, but that does not mean that modelers can use it without some demonstration or justification until Appendix W is changed. EPA has “taken the ball into the red zone, and the modeler has to get it over the goal line.”
- EPA is not receptive to approving the LOWWIND options in AERMOD without further testing and evaluation, which they are not planning to do.
- The first approvals of these will likely go through Model Clearinghouse review, and that will take time.

The results of this sensitivity study indicate that the AERMOD results are sensitive to the low wind options for low-level sources at relatively short distances from the release points. Therefore, even with more distant terrain, the impacts from these sources remain in the flat terrain near the facility “fenceline”. Results for tall stacks generally indicate low sensitivity in flat terrain, but high sensitivity in complex terrain. More testing is needed for complex terrain situations for tall stacks.

In an independent project, the Lignite Energy Council has funded AECOM to conduct testing of tall stacks in “rolling terrain”, but a test of AERMOD in complex terrain for a tall stack release is not part of this project. AECOM has located a 5-year evaluation database for the Mt. Tom Generating Station in Holyoke, MA, near complex terrain, associated with 4 SO$_2$ monitors and an on-site meteorological tower. We recommend that API fund the evaluation of this database to further promote EPA acceptance of the low wind options for tall stack releases.
Appendix A:
Source / Building Configurations
Figure A1: FCC - Source 1 is a tall buoyant point source indicative of an FCC (fluid catalytic cracking) refinery source (including building downwash)
Figure A2: FLARE - Source 2 is a tall buoyant point source representing a flare
Figure A3: REGENHTR - Source 3 is a tall buoyant point source indicative of a CCR (continuous catalytic regenerative reformer) refinery source (including building downwash)

30.48 m Building Height
Figure A4: GASTURB - Source 4 is a buoyant point source indicative of gas turbine at a compressor station (including building downwash)

11.6 m Building Height
Figure A5: DIESENG - Source 5 is a short-stack horizontal release point source indicative of a diesel generator (including building downwash)

10.0 m Building Height
Figure A6: DRILLRIG - Source 6 is a buoyant point source indicative of a drill rig (e.g., used at a fracking site, including building downwash)

3.1 m Building Height
Figure A7: LNGTURB - Source 7 is a combustion turbine source indicative of drilling or LNG facility operations.
Figure A8: PNTTANK - Source 8 is a non-buoyant point source located on a tank (including downwash)

14.6 m Tank Height
Figure A9: COMPRSTA - Source 11 is buoyant point source associated with a compressor station at a coal bed methane drilling site (including downwash)
Figure A10: AREA - Source 9 is a ground-level area source
Figure A11: ROADVOL - Source 10 is a volume source representing a roadway traffic source
Appendix B:
Model Concentration Isopleths
Isopleths for Default Model Runs
Flat and Complex Terrain*

*See Figures 2 and 4 for the wind roses and terrain map
Isopleths for FCC Source in Complex Terrain and Default Model Settings

Note peak impacts on the high terrain →
Isopleths for FCC Source in Flat Terrain and Default Model Settings

Note peak impacts within 1-3 km due to plume trapping conditions
Isopleths for FLARE Source in Complex Terrain and Default Model Settings

Note peak impacts on the high terrain →
Isopleths for FLARE Source in Flat Terrain and Default Model Settings

Note peak impacts within 1-3 km due to plume trapping conditions.
Isopleths for REGENHTR Source in Complex Terrain and Default Model Settings

Note peak impacts on the high terrain →
Note peak impacts within 1-3 km due to plume trapping conditions.
Isopleths for GASTURB Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to downwash.
Isopleths for DIESENG Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to downwash.
Isopleths for DRILLRIG Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to downwash.
Isopleths for LNGTURB Source in Complex Terrain and Default Model Settings

Note peak impacts on the high terrain.
Isopleths for LNGTURB Source in Flat Terrain and Default Model Settings

Note peak impacts in plume trapping within 1 km.
Isopleths for PNTTANK Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to downwash.
Isopleths for COMPRSTA Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to downwash.
Isopleths for AREA Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to low winds.
Isopleths for ROADVOL Source in Flat Terrain and Default Model Settings

Note peak impacts near the fenceline due to low winds.
Isopleths for Beta $u^*$ and LOWWIND AERMOD Default Model Runs for Complex Terrain (only for sources sensitive to Low Wind options)
Note peak impacts on the high terrain.
Isopleths for FCC Source in Complex Terrain and LOWWIND2 Model Setting

Note peak impacts on the high terrain.
Note peak impacts on the high terrain.
Isopleths for FLARE Source in Complex Terrain and LOWWIND2 Model Setting

Note peak impacts on the high terrain.
Isopleths for REGENHTR Source in Complex Terrain and Beta u- Model Setting

Note peak impacts on the high terrain →
Isopleths for REGENHTR Source in Complex Terrain and LOWWIND2 Model Setting

Note peak impacts on the high terrain →
Isopleths for LNGTURB Source in Complex Terrain and Beta u- Model Setting

Note peak impacts on the high terrain.
Isopleths for LNGTURB Source in Complex Terrain and LOWWIND2 Model Setting

Note peak impacts on the high terrain.
Isopleths for COMPRSTA Source in Complex Terrain and Beta u- Model Setting

Note peak impacts near the fenceline due to downwash.
Isopleths for COMPRSTA Source in Complex Terrain and LOWWIND2 Model Setting

Note peak impacts near the fenceline due to downwash.
Isopleths for Beta $u^*$ and LOWWIND AERMOD Default Model Runs for Flat Terrain (only for sources sensitive to Low Wind options)
Isopleths for DIESENG Source in Flat Terrain and Beta u- Model Setting

Note peak impacts near the fenceline due to downwash.
Isopleths for DIESENG Source in Flat Terrain and LOWWIND2 Model Setting

Note peak impacts near the fenceline due to downwash
Isoptehs for LNGTURB Source in Flat Terrain and Beta u+. Model Setting

Note peak impacts within 1 km in high winds.
Isopleths for LNGTURB Source in Flat Terrain and LOWWIND2 Model Setting

Note peak impacts within 1 km in high winds
Isopleths for PNTTANK Source in Flat Terrain and Beta $u_*$ Model Setting

Note peak impacts near the fenceline due to downwash.
Isopleths for PNTTANK Source in Flat Terrain and LOWWIND2 Model Setting

Note peak impacts near the fenceline due to downwash.
Isopleths for AREA Source in Flat Terrain and Beta u- Model Setting

Note peak impacts near the fenceline due to low winds.
Isopleths for AREA Source in Flat Terrain and LOWWIND2 Model Setting

Note peak impacts near the fenceline due to low winds.
Isopleths for ROADVOL Source in Flat Terrain and Beta u- Model Setting

Note peak impacts near the fenceline due to low winds.
Isopleths for ROADVOL Source in Flat Terrain and LOWWIND2 Model Setting

Note peak impacts near the fenceline due to low winds.