# Appendix C

# Sensitivity Analysis of ISCST3 Air Dispersion Model

# Appendix C

# Sensitivity Analysis of ISCST3 Air Dispersion Model

This appendix describes the sensitivity analysis performed on depletion options, source shape and orientation, and receptor location and spacing.

## C.1 Options with and without Depletion

A sensitivity analysis was conducted using the ISCST3 model to determine whether the wet depletion option should be used when developing dispersion factors for IWAIR. A discussion of the analysis follows.

The wet depletion option may be used when estimating air concentrations with ISCST3. The concentrations modeled without depletion are higher than those modeled with depletion. Because it takes much longer to run the ISCST3 model with wet depletion than without wet depletion, a sensitivity analysis was performed to investigate the differences in estimated air concentrations with and without selecting wet depletion.

In this investigation, the $5^{th}$ and the $95^{th}$ percentile of sizes of land application units were used to determine the relationship between concentrations with depletions and sizes of units; those areas are 1,200 $m^2$ and 1,700,000 $m^2$, respectively.

Two meteorological stations representing a wet location and a dry location were selected for the sensitivity analysis: Atlanta, Georgia, with 49.8 inches precipitation per year (a relatively high annual precipitation rate), and Winnemucca, Nevada, with 8.1 inches precipitation per year (a relatively low annual precipitation rate). The reason for selecting a wet site and a dry site was to examine (1) whether wet depletion has a more significant impact for a wet site than a dry site; and (2) the differences in ambient concentrations that a very wet site can make with and without selecting wet depletion.

Annual average concentrations with and without wet depletion also were calculated using 5 years of meteorological data from Atlanta and Winnemucca for the $5^{th}$ and $95^{th}$ percentile of areas of land application units. The results show that the differences in the maximum concentrations with and without wet depletion are small for both locations. However, the

differences in the maximum concentrations between those calculated with wet depletion and those calculated without wet depletion are about 5 to 10 times greater for the wet site (Atlanta) than the dry site (Winnemuca). Tables C-1a and C-1b show that for the 95$^{th}$ percentile unit size, at 50 meters from the edge of the unit, the differences in the maximum concentrations are only 0.03 percent and 0.37 percent for Winnemucca and Atlanta, respectively. This means that model concentrations with and without wet depletion are about the same.

## Table C-1a. Differences in Values of Vapor Air Concentration Calculated with Wet Depletion and without Wet Depletion

**(Atlanta, GA Site)**

**5th Percentile**

| Distance (m) | w/o wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | w/ wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | Difference ($ug/m^3$ / $g/m^2$-s) | Difference in Percentage |
|---|---|---|---|---|
| 19.3 [1] | 7.40752 | 7.40716 | 0.00036 | 0.005% |
| 47.3 [1] | 0.93175 | 0.93159 | 0.00016 | 0.017% |
| 75.2 [1] | 0.38178 | 0.38168 | 0.00010 | 0.026% |
| 100 | 0.25129 | 0.25121 | 0.00008 | 0.032% |
| 103.2 [1] | 0.21003 | 0.20996 | 0.00007 | 0.033% |
| 187.0 [1] | 0.06886 | 0.06882 | 0.00004 | 0.058% |
| 200 | 0.07091 | 0.07086 | 0.00005 | 0.071% |
| 300 | 0.03390 | 0.03387 | 0.00003 | 0.088% |
| 400 | 0.02026 | 0.02024 | 0.00002 | 0.099% |
| 500 | 0.01359 | 0.01357 | 0.00002 | 0.147% |
| 600 | 0.00981 | 0.00979 | 0.00002 | 0.204% |
| 800 | 0.00590 | 0.00589 | 0.00001 | 0.169% |
| 1000 | 0.00400 | 0.00399 | 0.00001 | 0.250% |
| 1500 | 0.00205 | 0.00205 | 0.00000 | 0.000% |
| 2000 | 0.00128 | 0.00128 | 0.00000 | 0.000% |
| 3000 | 0.00068 | 0.00067 | 0.00001 | 1.471% |
| 4000 | 0.00044 | 0.00043 | 0.00001 | 2.273% |
| 5000 | 0.00031 | 0.00031 | 0.00000 | 0.000% |
| 10000 | 0.00011 | 0.00011 | 0.00000 | 0.000% |

**95th Percentile**

| Distance (m) | w/o wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | w/ wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | Difference ($ug/m^3$ / $g/m^2$-s) | Difference in Percentage |
|---|---|---|---|---|
| 651.9 [1] | 0.00614 | 0.00612 | 0.00002 | 0.33% |
| 676.9 [1] | 0.00574 | 0.00573 | 0.00001 | 0.17% |
| 701.9 [1] | 0.00539 | 0.00537 | 0.00002 | 0.37% |
| 726.9 [1] | 0.00507 | 0.00505 | 0.00002 | 0.39% |
| 801.9 [1] | 0.00427 | 0.00426 | 0.00001 | 0.23% |
| 1000 | 0.00400 | 0.00399 | 0.00001 | 0.25% |
| 1100 | 0.00342 | 0.00341 | 0.00001 | 0.29% |
| 1200 | 0.00296 | 0.00295 | 0.00001 | 0.34% |
| 1300 | 0.00260 | 0.00259 | 0.00001 | 0.38% |
| 1400 | 0.00230 | 0.00229 | 0.00001 | 0.43% |
| 1500 | 0.00205 | 0.00205 | 0.00000 | 0.00% |
| 1600 | 0.00185 | 0.00184 | 0.00001 | 0.54% |
| 1800 | 0.00152 | 0.00152 | 0.00000 | 0.00% |
| 2000 | 0.00128 | 0.00128 | 0.00000 | 0.00% |
| 3000 | 0.00068 | 0.00067 | 0.00001 | 1.47% |
| 4000 | 0.00044 | 0.00043 | 0.00001 | 2.27% |
| 5000 | 0.00031 | 0.00031 | 0.00000 | 0.00% |
| 10000 | 0.00011 | 0.00011 | 0.00000 | 0.00% |

[1] These refer to the distances from the center of emission source to the maximum concentration points along 0, 25, 50, 75, and 150 meter receptor squares, respectively.

## Table C-1b. Differences in Values of Vapor Air Concentration Calculated with Wet Depletion and without Wet Depletion

**(Winnemucca, NV Site)**

**5th Percentile**

| Distance (m) | w/o wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | w/ wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | Difference ($ug/m^3$ / $g/m^2$-s) | Difference in Percentage |
|---|---|---|---|---|
| 17.3 [1] | 7.79132 | 7.79125 | 0.00007 | 0.001% |
| 42.3 [1] | 1.08468 | 1.08464 | 0.00004 | 0.004% |
| 67.3 [1] | 0.48369 | 0.48367 | 0.00002 | 0.004% |
| 92.3 [1] | 0.27965 | 0.27963 | 0.00002 | 0.007% |
| 100 | 0.24315 | 0.24313 | 0.00002 | 0.008% |
| 167.3 [1] | 0.09949 | 0.09948 | 0.00001 | 0.010% |
| 200 | 0.07296 | 0.07295 | 0.00001 | 0.014% |
| 300 | 0.03600 | 0.03599 | 0.00001 | 0.028% |
| 400 | 0.02181 | 0.02180 | 0.00001 | 0.046% |
| 500 | 0.01475 | 0.01474 | 0.00001 | 0.068% |
| 600 | 0.01070 | 0.01070 | 0.00000 | 0.000% |
| 800 | 0.00649 | 0.00648 | 0.00001 | 0.154% |
| 1000 | 0.00443 | 0.00443 | 0.00000 | 0.000% |
| 1500 | 0.00229 | 0.00229 | 0.00000 | 0.000% |
| 2000 | 0.00144 | 0.00144 | 0.00000 | 0.000% |
| 3000 | 0.00077 | 0.00077 | 0.00000 | 0.000% |
| 4000 | 0.00050 | 0.00050 | 0.00000 | 0.000% |
| 5000 | 0.00036 | 0.00036 | 0.00000 | 0.000% |
| 10000 | 0.00013 | 0.00013 | 0.00000 | 0.000% |

**95th Percentile**

| Distance (m) | w/o wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | w/ wet depletion Concentrations ($ug/m^3$ / $g/m^2$-s) | Difference ($ug/m^3$ / $g/m^2$-s) | Difference in Percentage |
|---|---|---|---|---|
| 651.9 [1] | 23.14326 | 23.13885 | 0.00441 | 0.02% |
| 676.9 [1] | 13.86979 | 13.86551 | 0.00428 | 0.03% |
| 701.9 [1] | 11.62889 | 11.62486 | 0.00403 | 0.03% |
| 726.9 [1] | 10.25373 | 10.24985 | 0.00388 | 0.04% |
| 801.9 [1] | 7.84900 | 7.84548 | 0.00352 | 0.04% |
| 1000 | 5.85241 | 5.84988 | 0.00253 | 0.04% |
| 1100 | 4.69239 | 4.68991 | 0.00248 | 0.05% |
| 1200 | 3.98357 | 3.98130 | 0.00227 | 0.06% |
| 1300 | 3.43255 | 3.43045 | 0.00210 | 0.06% |
| 1400 | 2.99083 | 2.98887 | 0.00196 | 0.07% |
| 1500 | 2.63019 | 2.62837 | 0.00182 | 0.07% |
| 1600 | 2.33211 | 2.33042 | 0.00169 | 0.07% |
| 1800 | 1.93762 | 1.93554 | 0.00208 | 0.11% |
| 2000 | 1.65686 | 1.65487 | 0.00199 | 0.12% |
| 3000 | 0.91889 | 0.91727 | 0.00162 | 0.18% |
| 4000 | 0.61160 | 0.61020 | 0.00140 | 0.23% |
| 5000 | 0.45013 | 0.44890 | 0.00123 | 0.27% |
| 10000 | 0.17843 | 0.17767 | 0.00076 | 0.43% |

[1] These refer to the distances from the center of emission source to the maximum concentration points along 0, 25, 50, 75, and 150 meter receptor squares, respectively.

## C.2 Source Shape and Orientation

A sensitivity analysis was conducted using the ISCST3 air model to determine what role source shape and orientation play in determining dispersion coefficients of air pollutants. A discussion of this analysis follows.

Three different sources were chosen for this analysis. The sources were a square (Source No. 1), a rectangle oriented east to west (Source No. 2), and a rectangle oriented north to south (Source No. 3). All three sources had an area of 400 $m^2$ in order to ensure that equal emission rates were compared. The rectangles were selected to be exactly two times longer and half as wide as the square (see Figure C-1).

Two meteorological stations. Little Rock, Arkansas, and Los Angeles, California, were selected for this modeling analysis in order to compare two different meteorological regimes. Little Rock was selected because of its evenly distributed wind directions, and Los Angeles was selected because it has a predominantly southwest wind direction (see Figure C-2). Five years of meteorological data were used for this analysis.

Each area source was modeled with similar receptor grids to ensure consistency. Sixteen receptors were placed on the edge of each of the area sources, and another 16 were placed 25 m out from the edge. Each of these two receptor groups were modeled as a Cartesian receptor grid. Two receptor rings were also placed at 50 and 100 m out from the center of the source. This polar receptor grid consisted of 16 receptors with a 22.5° interval between receptors. See Figures C-3a through C-3c for receptor locations.

The ISCST3 model was run using the meteorological data from Little Rock, Arkansas, and Los Angeles, California, and the results are shown in Tables C-2a and C-2b. The results indicated that the standard deviation of the differences in air concentrations is greatest between the two rectangular source shapes (source No. 2 and source No. 3). This difference is due to the orientation of the source. This occurs for both the Cartesian receptor grid and the polar receptor grid at both meteorological locations. This shows that the model is sensitive to the orientation of the rectangular area source.

Standard deviations are significantly smaller when the square source (Source No. 1) is compared with either rectangular source (Source No. 2 or 3). This shows that the differences in dispersion factors between the square source and the two rectangular sources are less than the differences between the two rectangular sources. A square area source also contributes the least amount of impact of orientation. Because the dispersion factors in IWAIR must applicable to a variety of source shapes and orientations, a square source will minimize the errors caused by different source shapes and orientations.

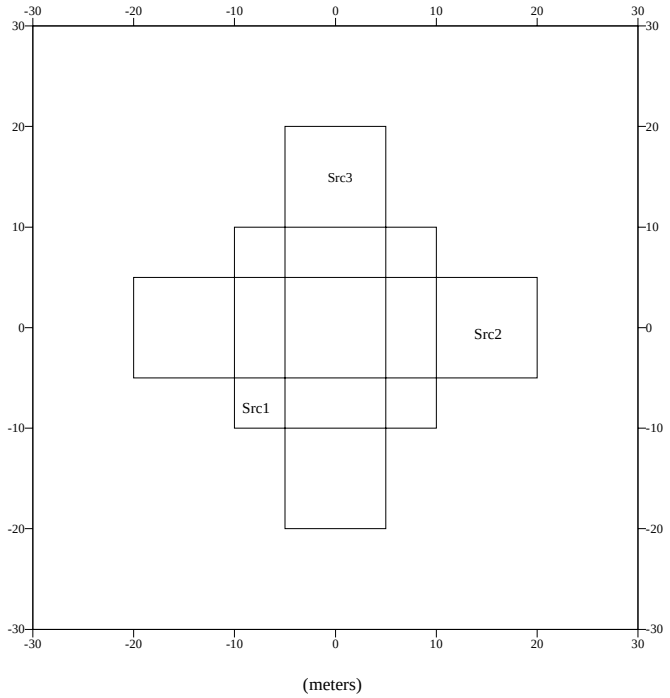
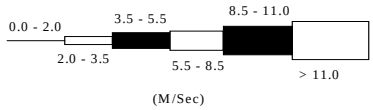
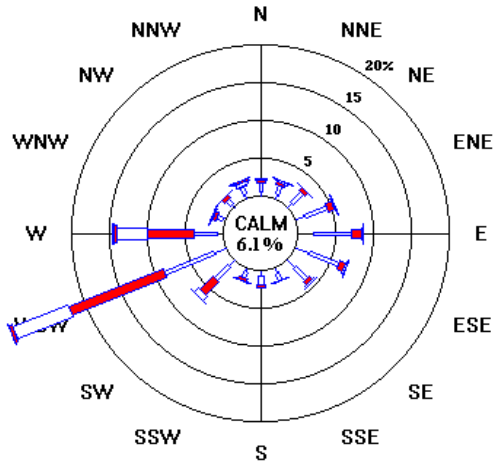


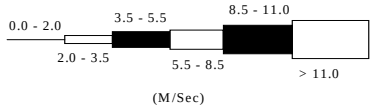

**Figure C-1. Source shapes and orientations.**

## Los Angeles, California




## Little Rock, Arkansas



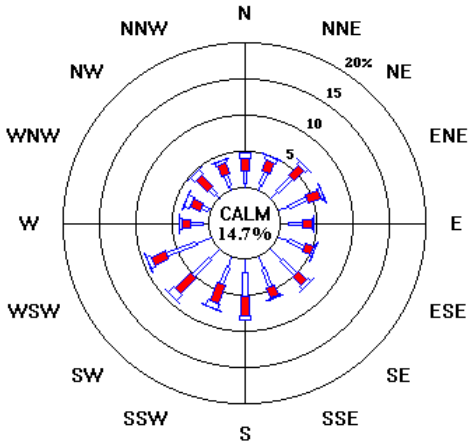




**Figure C-2. Wind roses.**

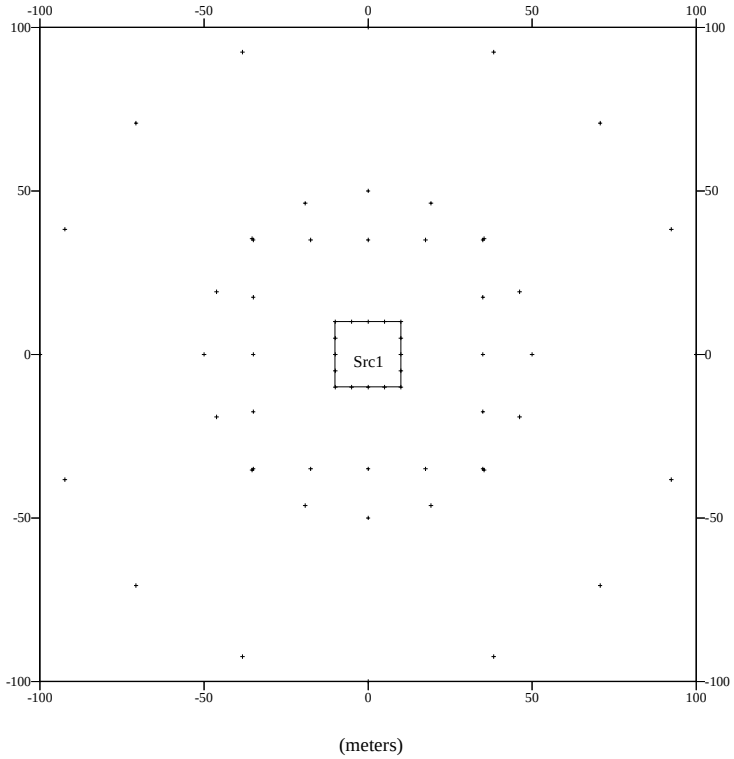



**Figure C-3a. Receptor locations (Source No. 1).**

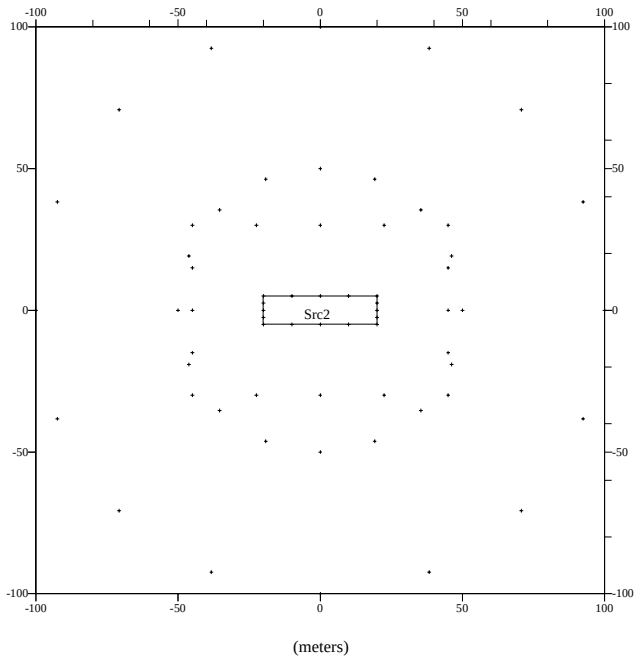



**Figure C-3b. Receptor locations (Source No. 2).**

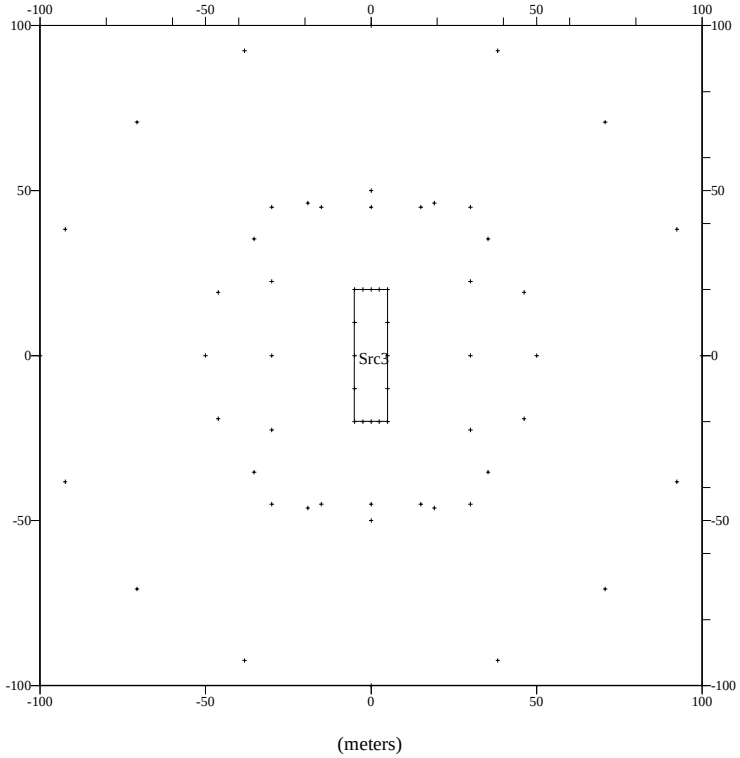



**Figure C-3c. Receptor locations (Source No. 3).**

## Table C-2a. Comparisons of Dispersion Factors (ug/m$^3$ / ug/s-m$^2$) for Different Source Shapes and Orientations (Little Rock, Arkansas)

| Source No. 1 (20m x 20m) | | | Source No. 2 (40m x 10m) | | | Source No. 3 (10m x 40m) | | | Differences in UACs Sources No. 1 and No. 2 | | Differences in UACs Sources No. 1 and No. 3 | | Differences in UACs Sources No. 2 and No. 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polar Receptor Grid | | | | | | | | | | | | | | |
| X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. |
| 19 | 46 | 0.190 | 19 | 46 | 0.199 | 19 | 46 | 0.211 | 0.010 | 5% | 0.021 | 11% | 0.012 | 6% |
| 38 | 92 | 0.050 | 38 | 92 | 0.051 | 38 | 92 | 0.051 | 0.001 | 1% | 0.001 | 2% | 0.000 | 1% |
| 35 | 35 | 0.249 | 35 | 35 | 0.243 | 35 | 35 | 0.278 | -0.007 | -3% | 0.028 | 11% | 0.035 | 14% |
| 71 | 71 | 0.067 | 71 | 71 | 0.067 | 71 | 71 | 0.069 | -0.001 | -1% | 0.001 | 2% | 0.002 | 3% |
| 46 | 19 | 0.321 | 46 | 19 | 0.361 | 46 | 19 | 0.256 | 0.041 | 13% | -0.065 | -20% | -0.105 | -29% |
| 92 | 38 | 0.095 | 92 | 38 | 0.098 | 92 | 38 | 0.088 | 0.003 | 3% | -0.007 | -7% | -0.010 | -10% |
| 50 | 0 | 0.124 | 50 | 0 | 0.128 | 50 | 0 | 0.147 | 0.004 | 3% | 0.023 | 19% | 0.020 | 15% |
| 100 | 0 | 0.030 | 100 | 0 | 0.030 | 100 | 0 | 0.033 | 0.000 | -1% | 0.003 | 9% | 0.003 | 11% |
| 46 | -19 | 0.085 | 46 | -19 | 0.096 | 46 | -19 | 0.084 | 0.011 | 12% | -0.001 | -1% | -0.011 | -12% |
| 92 | -38 | 0.023 | 92 | -38 | 0.024 | 92 | -38 | 0.023 | 0.001 | 2% | -0.001 | -2% | -0.001 | -5% |
| 35 | -35 | 0.106 | 35 | -35 | 0.109 | 35 | -35 | 0.103 | 0.003 | 3% | -0.003 | -3% | -0.006 | -6% |
| 71 | -71 | 0.030 | 71 | -71 | 0.030 | 71 | -71 | 0.029 | 0.000 | 0% | 0.000 | -1% | -0.001 | -2% |
| 19 | -46 | 0.117 | 19 | -46 | 0.113 | 19 | -46 | 0.128 | -0.005 | -4% | 0.011 | 9% | 0.016 | 14% |
| 38 | -92 | 0.033 | 38 | -92 | 0.032 | 38 | -92 | 0.034 | -0.001 | -4% | 0.001 | 2% | 0.002 | 7% |
| 0 | -50 | 0.122 | 0 | -50 | 0.117 | 0 | -50 | 0.143 | -0.005 | -4% | 0.021 | 17% | 0.026 | 22% |
| 0 | -100 | 0.035 | 0 | -100 | 0.033 | 0 | -100 | 0.037 | -0.002 | -5% | 0.002 | 5% | 0.004 | 11% |
| -19 | -46 | 0.134 | -19 | -46 | 0.128 | -19 | -46 | 0.150 | -0.006 | -4% | 0.016 | 12% | 0.022 | 17% |
| -38 | -92 | 0.038 | -38 | -92 | 0.036 | -38 | -92 | 0.038 | -0.002 | -4% | 0.001 | 2% | 0.002 | 6% |
| -35 | -35 | 0.161 | -35 | -35 | 0.158 | -35 | -35 | 0.170 | -0.003 | -2% | 0.009 | 6% | 0.012 | 8% |
| -71 | -71 | 0.043 | -71 | -71 | 0.043 | -71 | -71 | 0.045 | 0.000 | 1% | 0.001 | 3% | 0.001 | 3% |
| -46 | -19 | 0.159 | -46 | -19 | 0.185 | -46 | -19 | 0.140 | 0.026 | 16% | -0.019 | -12% | -0.045 | -24% |
| -92 | -38 | 0.044 | -92 | -38 | 0.046 | -92 | -38 | 0.043 | 0.002 | 4% | -0.002 | -4% | -0.004 | -8% |
| -50 | 0 | 0.103 | -50 | 0 | 0.114 | -50 | 0 | 0.107 | 0.011 | 11% | 0.004 | 4% | -0.007 | -6% |
| -100 | 0 | 0.027 | -100 | 0 | 0.027 | -100 | 0 | 0.027 | 0.000 | 2% | 0.000 | 1% | 0.000 | 0% |
| -46 | 19 | 0.126 | -46 | 19 | 0.145 | -46 | 19 | 0.118 | 0.019 | 15% | -0.008 | -6% | -0.027 | -18% |
| -92 | 38 | 0.035 | -92 | 38 | 0.036 | -92 | 38 | 0.034 | 0.001 | 4% | -0.001 | -4% | -0.003 | -7% |
| -35 | 35 | 0.152 | -35 | 35 | 0.160 | -35 | 35 | 0.153 | 0.008 | 5% | 0.001 | 0% | -0.007 | -5% |
| -71 | 71 | 0.041 | -71 | 71 | 0.042 | -71 | 71 | 0.041 | 0.001 | 3% | 0.001 | 2% | -0.001 | -2% |
| -19 | 46 | 0.173 | -19 | 46 | 0.179 | -19 | 46 | 0.187 | 0.007 | 4% | 0.014 | 8% | 0.008 | 4% |
| -38 | 92 | 0.047 | -38 | 92 | 0.047 | -38 | 92 | 0.048 | 0.000 | 0% | 0.001 | 3% | 0.001 | 3% |
| 0 | 50 | 0.224 | 0 | 50 | 0.191 | 0 | 50 | 0.276 | -0.032 | -14% | 0.052 | 23% | 0.085 | 44% |
| 0 | 100 | 0.068 | 0 | 100 | 0.061 | 0 | 100 | 0.074 | -0.008 | -11% | 0.006 | 9% | 0.014 | 22% |
| | | | | | | | | **Standard Deviation:** | **0.012** | **7%** | **0.018** | **9%** | **0.028** | **14%** |

*(continued)*

## Table C-2a. (continued)

| Source No. 1 (20m x 20m) | | | Source No. 2 (40m x 10m) | | | Source No. 3 (10m x 40m) | | | Differences in UACs Sources No. 1 and No. 2 | | Differences in UACs Sources No. 1 and No. 3 | | Differences in UACs Sources No. 2 and No. 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cartesion Receptor Grid | | | | | | | | | | | | | | |
| X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. |
| -10 | -10 | 3.014 | -20 | -5 | 2.675 | -5 | -20 | 2.673 | -0.339 | -11% | -0.341 | -11% | -0.002 | 0% |
| -5 | -10 | 4.266 | -10 | -5 | 4.219 | -2.5 | -20 | 3.451 | -0.047 | -1% | -0.815 | -19% | -0.769 | -18% |
| 0 | -10 | 4.354 | 0 | -5 | 4.307 | 0 | -20 | 3.526 | -0.047 | -1% | -0.827 | -19% | -0.781 | -18% |
| 5 | -10 | 3.961 | 10 | -5 | 4.069 | 2.5 | -20 | 3.152 | 0.109 | 3% | -0.809 | -20% | -0.918 | -23% |
| 10 | -10 | 2.175 | 20 | -5 | 1.899 | 5 | -20 | 2.011 | -0.276 | -13% | -0.164 | -8% | 0.112 | 6% |
| 10 | -5 | 5.211 | 20 | -2.5 | 3.875 | 5 | -10 | 5.567 | -1.337 | -26% | 0.355 | 7% | 1.692 | 44% |
| 10 | 0 | 5.968 | 20 | 0 | 4.704 | 5 | 0 | 5.913 | -1.264 | -21% | -0.055 | -1% | 1.209 | 26% |
| 10 | 5 | 6.012 | 20 | 2.5 | 4.918 | 5 | 10 | 5.834 | -1.094 | -18% | -0.178 | -3% | 0.916 | 19% |
| 10 | 10 | 4.946 | 20 | 5 | 4.468 | 5 | 20 | 4.344 | -0.477 | -10% | -0.602 | -12% | -0.125 | -3% |
| 5 | 10 | 6.804 | 10 | 5 | 6.758 | 2.5 | 20 | 5.550 | -0.047 | -1% | -1.254 | -18% | -1.208 | -18% |
| 0 | 10 | 6.846 | 0 | 5 | 6.830 | 0 | 20 | 5.604 | -0.016 | 0% | -1.242 | -18% | -1.226 | -18% |
| -5 | 10 | 6.157 | -10 | 5 | 6.353 | -2.5 | 20 | 4.954 | 0.196 | 3% | -1.203 | -20% | -1.399 | -22% |
| -10 | 10 | 3.245 | -20 | 5 | 2.793 | -5 | 20 | 3.052 | -0.451 | -14% | -0.193 | -6% | 0.259 | 9% |
| -10 | 5 | 4.923 | -20 | 2.5 | 3.801 | -5 | 10 | 5.166 | -1.121 | -23% | 0.244 | 5% | 1.365 | 36% |
| -10 | 0 | 5.169 | -20 | 0 | 4.032 | -5 | 0 | 5.287 | -1.137 | -22% | 0.118 | 2% | 1.255 | 31% |
| -10 | -5 | 4.809 | -20 | -2.5 | 3.727 | -5 | -10 | 4.991 | -1.081 | -22% | 0.182 | 4% | 1.264 | 34% |
| -35 | -35 | 0.164 | -45 | -30 | 0.158 | -30 | -45 | 0.132 | -0.006 | -4% | -0.032 | -19% | -0.026 | -16% |
| -17.5 | -35 | 0.219 | -22.5 | -30 | 0.247 | -15 | -45 | 0.167 | 0.027 | 12% | -0.052 | -24% | -0.079 | -32% |
| 0 | -35 | 0.243 | 0 | -30 | 0.284 | 0 | -45 | 0.179 | 0.041 | 17% | -0.063 | -26% | -0.104 | -37% |
| 17.5 | -35 | 0.186 | 22.5 | -30 | 0.192 | 15 | -45 | 0.147 | 0.006 | 3% | -0.039 | -21% | -0.045 | -23% |
| 35 | -35 | 0.108 | 45 | -30 | 0.088 | 30 | -45 | 0.100 | -0.020 | -19% | -0.008 | -7% | 0.012 | 14% |
| 35 | -17.5 | 0.141 | 45 | -15 | 0.105 | 30 | -22.5 | 0.160 | -0.036 | -25% | 0.019 | 14% | 0.055 | 52% |
| 35 | 0 | 0.277 | 45 | 0 | 0.164 | 30 | 0 | 0.401 | -0.113 | -41% | 0.124 | 45% | 0.236 | 144% |
| 35 | 17.5 | 0.503 | 45 | 15 | 0.396 | 30 | 22.5 | 0.466 | -0.107 | -21% | -0.037 | -7% | 0.070 | 18% |
| 35 | 35 | 0.254 | 45 | 30 | 0.263 | 30 | 45 | 0.200 | 0.009 | 3% | -0.054 | -21% | -0.063 | -24% |
| 17.5 | 35 | 0.315 | 22.5 | 30 | 0.373 | 15 | 45 | 0.234 | 0.058 | 18% | -0.081 | -26% | -0.139 | -37% |
| 0 | 35 | 0.417 | 0 | 30 | 0.445 | 0 | 45 | 0.341 | 0.028 | 7% | -0.076 | -18% | -0.104 | -23% |
| -17.5 | 35 | 0.272 | -22.5 | 30 | 0.286 | -15 | 45 | 0.214 | 0.014 | 5% | -0.057 | -21% | -0.071 | -25% |
| -35 | 35 | 0.155 | -45 | 30 | 0.131 | -30 | 45 | 0.146 | -0.024 | -15% | -0.009 | -6% | 0.015 | 11% |
| -35 | 17.5 | 0.211 | -45 | 15 | 0.155 | -30 | 22.5 | 0.232 | -0.056 | -27% | 0.022 | 10% | 0.078 | 50% |
| -35 | 0 | 0.213 | -45 | 0 | 0.145 | -30 | 0 | 0.298 | -0.068 | -32% | 0.084 | 40% | 0.153 | 106% |
| -35 | -17.5 | 0.265 | -45 | -15 | 0.193 | -30 | -22.5 | 0.264 | -0.073 | -27% | -0.002 | -1% | 0.071 | 37% |
| | | | | | | | | **Standard Deviation:** | **0.463** | **15%** | **0.435** | **17%** | **0.747** | **41%** |

*(continued)*

## Table C-2b. Comparisons of Dispersion Factors (ug/m$^3$ / ug/s-m$^2$) for Different Source Shapes and Orientations (Los Angeles, California)

| Source No. 1 (20m x 20m) | | | Source No. 2 (40m x 10m) | | | Source No. 3 (10m x 40m) | | | Differences in UACs Sources No. 1 and No. 2 | | Differences in UACs Sources No. 1 and No. 3 | | Differences in UACs Sources No. 2 and No. 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polar Receptor Grid | | | | | | | | | | | | | | |
| X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. |
| 19 | 46 | 0.059 | 19 | 46 | 0.065 | 19 | 46 | 0.069 | 0.006 | 9% | 0.010 | 17% | 0.005 | 7% |
| 38 | 92 | 0.016 | 38 | 92 | 0.016 | 38 | 92 | 0.016 | 0.000 | -1% | 0.000 | 3% | 0.001 | 4% |
| 35 | 35 | 0.188 | 35 | 35 | 0.168 | 35 | 35 | 0.284 | -0.020 | -11% | 0.096 | 51% | 0.116 | 69% |
| 71 | 71 | 0.046 | 71 | 71 | 0.045 | 71 | 71 | 0.052 | -0.001 | -3% | 0.006 | 13% | 0.007 | 16% |
| 46 | 19 | 0.582 | 46 | 19 | 0.607 | 46 | 19 | 0.461 | 0.025 | 4% | -0.121 | -21% | -0.146 | -24% |
| 92 | 38 | 0.172 | 92 | 38 | 0.174 | 92 | 38 | 0.161 | 0.003 | 2% | -0.011 | -6% | -0.014 | -8% |
| 50 | 0 | 0.278 | 50 | 0 | 0.293 | 50 | 0 | 0.293 | 0.014 | 5% | 0.015 | 5% | 0.001 | 0% |
| 100 | 0 | 0.068 | 100 | 0 | 0.067 | 100 | 0 | 0.074 | -0.001 | -2% | 0.005 | 8% | 0.007 | 10% |
| 46 | -19 | 0.061 | 46 | -19 | 0.062 | 46 | -19 | 0.087 | 0.002 | 3% | 0.026 | 43% | 0.025 | 40% |
| 92 | -38 | 0.015 | 92 | -38 | 0.015 | 92 | -38 | 0.016 | 0.000 | 0% | 0.002 | 10% | 0.002 | 11% |
| 35 | -35 | 0.062 | 35 | -35 | 0.068 | 35 | -35 | 0.062 | 0.006 | 10% | 0.000 | 0% | -0.006 | -9% |
| 71 | -71 | 0.016 | 71 | -71 | 0.017 | 71 | -71 | 0.017 | 0.001 | 4% | 0.001 | 3% | 0.000 | -1% |
| 19 | -46 | 0.080 | 19 | -46 | 0.076 | 19 | -46 | 0.087 | -0.004 | -4% | 0.007 | 9% | 0.011 | 14% |
| 38 | -92 | 0.023 | 38 | -92 | 0.022 | 38 | -92 | 0.024 | -0.001 | -5% | 0.001 | 3% | 0.002 | 8% |
| 0 | -50 | 0.086 | 0 | -50 | 0.084 | 0 | -50 | 0.096 | -0.003 | -3% | 0.009 | 11% | 0.012 | 15% |
| 0 | -100 | 0.023 | 0 | -100 | 0.024 | 0 | -100 | 0.024 | 0.000 | 1% | 0.001 | 3% | 0.000 | 2% |
| -19 | -46 | 0.099 | -19 | -46 | 0.092 | -19 | -46 | 0.108 | -0.006 | -7% | 0.009 | 9% | 0.016 | 17% |
| -38 | -92 | 0.028 | -38 | -92 | 0.027 | -38 | -92 | 0.028 | -0.001 | -2% | 0.000 | 1% | 0.001 | 3% |
| -35 | -35 | 0.122 | -35 | -35 | 0.119 | -35 | -35 | 0.143 | -0.003 | -2% | 0.021 | 18% | 0.024 | 20% |
| -71 | -71 | 0.033 | -71 | -71 | 0.032 | -71 | -71 | 0.034 | 0.000 | -1% | 0.001 | 4% | 0.002 | 5% |
| -46 | -19 | 0.218 | -46 | -19 | 0.223 | -46 | -19 | 0.226 | 0.005 | 2% | 0.008 | 4% | 0.003 | 2% |
| -92 | -38 | 0.060 | -92 | -38 | 0.061 | -92 | -38 | 0.061 | 0.001 | 1% | 0.001 | 1% | 0.000 | 0% |
| -50 | 0 | 0.320 | -50 | 0 | 0.378 | -50 | 0 | 0.278 | 0.057 | 18% | -0.042 | -13% | -0.099 | -26% |
| -100 | 0 | 0.093 | -100 | 0 | 0.098 | -100 | 0 | 0.087 | 0.005 | 6% | -0.006 | -6% | -0.011 | -11% |
| -46 | 19 | 0.264 | -46 | 19 | 0.273 | -46 | 19 | 0.260 | 0.009 | 3% | -0.005 | -2% | -0.013 | -5% |
| -92 | 38 | 0.074 | -92 | 38 | 0.075 | -92 | 38 | 0.073 | 0.001 | 1% | -0.001 | -2% | -0.002 | -2% |
| -35 | 35 | 0.137 | -35 | 35 | 0.123 | -35 | 35 | 0.164 | -0.014 | -10% | 0.027 | 20% | 0.041 | 33% |
| -71 | 71 | 0.037 | -71 | 71 | 0.035 | -71 | 71 | 0.039 | -0.002 | -5% | 0.002 | 4% | 0.003 | 9% |
| -19 | 46 | 0.063 | -19 | 46 | 0.066 | -19 | 46 | 0.073 | 0.003 | 4% | 0.010 | 15% | 0.007 | 11% |
| -38 | 92 | 0.017 | -38 | 92 | 0.017 | -38 | 92 | 0.018 | 0.000 | -2% | 0.001 | 3% | 0.001 | 5% |
| 0 | 50 | 0.067 | 0 | 50 | 0.058 | 0 | 50 | 0.080 | -0.008 | -12% | 0.014 | 21% | 0.022 | 37% |
| 0 | 100 | 0.020 | 0 | 100 | 0.018 | 0 | 100 | 0.021 | -0.002 | -9% | 0.001 | 6% | 0.003 | 15% |
| | | | | | | | | **Standard Deviation:** | **0.013** | **6%** | **0.030** | **14%** | **0.040** | **18%** |

*(continued)*

## Table C-2b. (continued)

| Source No. 1 (20m x 20m) | | | Source No. 2 (40m x 10m) | | | Source No. 3 (10m x 40m) | | | Differences in UACs Sources No. 1 and No. 2 | | Differences in UACs Sources No. 1 and No. 3 | | Differences in UACs Sources No. 2 and No. 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cartesion Receptor Grid | | | | | | | | | | | | | | |
| X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | X (m) | Y (m) | UAC | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. | Diff. In UAC | % of Diff. |
| -10 | -10 | 3.225 | -20 | -5 | 3.241 | -5 | -20 | 2.674 | 0.016 | 1% | -0.551 | -17% | -0.567 | -17% |
| -5 | -10 | 4.025 | -10 | -5 | 4.333 | -2.5 | -20 | 3.119 | 0.308 | 8% | -0.906 | -23% | -1.214 | -28% |
| 0 | -10 | 3.952 | 0 | -5 | 4.297 | 0 | -20 | 3.050 | 0.345 | 9% | -0.902 | -23% | -1.247 | -29% |
| 5 | -10 | 3.431 | 10 | -5 | 3.871 | 2.5 | -20 | 2.564 | 0.440 | 13% | -0.867 | -25% | -1.307 | -34% |
| 10 | -10 | 1.683 | 20 | -5 | 1.592 | 5 | -20 | 1.511 | -0.091 | -5% | -0.172 | -10% | -0.081 | -5% |
| 10 | -5 | 5.931 | 20 | -2.5 | 4.787 | 5 | -10 | 5.570 | -1.143 | -19% | -0.360 | -6% | 0.783 | 16% |
| 10 | 0 | 6.636 | 20 | 0 | 5.882 | 5 | 0 | 5.644 | -0.754 | -11% | -0.992 | -15% | -0.238 | -4% |
| 10 | 5 | 6.640 | 20 | 2.5 | 6.294 | 5 | 10 | 5.524 | -0.346 | -5% | -1.116 | -17% | -0.770 | -12% |
| 10 | 10 | 5.600 | 20 | 5 | 5.866 | 5 | 20 | 4.325 | 0.266 | 5% | -1.275 | -23% | -1.541 | -26% |
| 5 | 10 | 6.893 | 10 | 5 | 8.126 | 2.5 | 20 | 4.939 | 1.232 | 18% | -1.955 | -28% | -3.187 | -39% |
| 0 | 10 | 6.860 | 0 | 5 | 8.285 | 0 | 20 | 4.913 | 1.424 | 21% | -1.947 | -28% | -3.371 | -41% |
| -5 | 10 | 6.031 | -10 | 5 | 7.442 | -2.5 | 20 | 4.156 | 1.411 | 23% | -1.875 | -31% | -3.286 | -44% |
| -10 | 10 | 3.393 | -20 | 5 | 3.497 | -5 | 20 | 2.702 | 0.103 | 3% | -0.691 | -20% | -0.794 | -23% |
| -10 | 5 | 5.649 | -20 | 2.5 | 5.102 | -5 | 10 | 5.015 | -0.547 | -10% | -0.634 | -11% | -0.088 | -2% |
| -10 | 0 | 5.944 | -20 | 0 | 5.373 | -5 | 0 | 5.167 | -0.572 | -10% | -0.777 | -13% | -0.205 | -4% |
| -10 | -5 | 5.663 | -20 | -2.5 | 5.028 | -5 | -10 | 5.104 | -0.635 | -11% | -0.559 | -10% | 0.076 | 2% |
| -35 | -35 | 0.124 | -45 | -30 | 0.139 | -30 | -45 | 0.095 | 0.014 | 11% | -0.029 | -23% | -0.043 | -31% |
| -17.5 | -35 | 0.158 | -22.5 | -30 | 0.183 | -15 | -45 | 0.123 | 0.025 | 16% | -0.035 | -22% | -0.060 | -33% |
| 0 | -35 | 0.172 | 0 | -30 | 0.199 | 0 | -45 | 0.121 | 0.028 | 16% | -0.050 | -29% | -0.078 | -39% |
| 17.5 | -35 | 0.123 | 22.5 | -30 | 0.124 | 15 | -45 | 0.100 | 0.001 | 0% | -0.024 | -19% | -0.024 | -20% |
| 35 | -35 | 0.064 | 45 | -30 | 0.053 | 30 | -45 | 0.063 | -0.011 | -17% | -0.001 | -2% | 0.010 | 19% |
| 35 | -17.5 | 0.095 | 45 | -15 | 0.076 | 30 | -22.5 | 0.119 | -0.019 | -20% | 0.024 | 25% | 0.043 | 57% |
| 35 | 0 | 0.592 | 45 | 0 | 0.377 | 30 | 0 | 0.696 | -0.215 | -36% | 0.104 | 18% | 0.319 | 85% |
| 35 | 17.5 | 0.829 | 45 | 15 | 0.739 | 30 | 22.5 | 0.683 | -0.090 | -11% | -0.146 | -18% | -0.055 | -7% |
| 35 | 35 | 0.192 | 45 | 30 | 0.304 | 30 | 45 | 0.101 | 0.112 | 58% | -0.091 | -47% | -0.203 | -67% |
| 17.5 | 35 | 0.109 | 22.5 | 30 | 0.195 | 15 | 45 | 0.072 | 0.086 | 78% | -0.037 | -34% | -0.122 | -63% |
| 0 | 35 | 0.125 | 0 | 30 | 0.144 | 0 | 45 | 0.100 | 0.019 | 15% | -0.025 | -20% | -0.044 | -31% |
| -17.5 | 35 | 0.113 | -22.5 | 30 | 0.160 | -15 | 45 | 0.077 | 0.047 | 42% | -0.035 | -31% | -0.082 | -52% |
| -35 | 35 | 0.139 | -45 | 30 | 0.166 | -30 | 45 | 0.089 | 0.026 | 19% | -0.050 | -36% | -0.077 | -46% |
| -35 | 17.5 | 0.387 | -45 | 15 | 0.335 | -30 | 22.5 | 0.370 | -0.053 | -14% | -0.017 | -4% | 0.036 | 11% |
| -35 | 0 | 0.603 | -45 | 0 | 0.472 | -30 | 0 | 0.603 | -0.131 | -22% | 0.000 | 0% | 0.131 | 28% |
| -35 | -17.5 | 0.318 | -45 | -15 | 0.275 | -30 | -22.5 | 0.316 | -0.043 | -13% | -0.002 | -1% | 0.041 | 15% |
| | | | | | | | | **Standard Deviation:** | **0.542** | **24%** | **0.614** | **15%** | **1.026** | **33%** |

## C.3 Receptor Locations and Spacings

A sensitivity analysis was conducted using the ISCST3 model to determine the impact of receptor locations and spacings on estimated air concentrations. A discussion of the analysis follows.

Because it takes a substantial amount of time for the ISCST3 model to execute, it was necessary to choose a limited number of receptors to be represented in the dispersion factor database in IWAIR. The larger the number of receptor points, the longer the run time. However, modeling fewer receptors may result in the omission of the maximum point for assessing exposure impacts. Therefore, a sensitivity analysis was conducted to determine the number of receptors needed to adequately capture maximum air concentrations and to locate ideal receptor placements.

A wind rose was plotted for each of the 60 meteorological stations to be included in IWAIR for a 5-year time period in order to choose two meteorological stations for this sensitivity analysis. The stations at Little Rock, Arkansas, and Los Angeles, California, were selected. The wind roses show that Little Rock has very evenly distributed wind directions, and Los Angeles has a predominant southwest to west wind (Figure C-2). Little Rock and Los Angeles were chosen to determine if a higher density of receptors should be placed downwind of a site near Los Angeles, as compared to a site near Little Rock. Similarly, the 5$^{th}$, 50$^{th}$, and 95$^{th}$ percentile of areas of land application units were used in the sensitivity analysis to determine the extent of which the area of the unit affects receptor locations and spacings. The areas of the 5$^{th}$, 50$^{th}$, and 95$^{th}$ percentile of sizes of land application units are 1,200 m$^2$, 100,000 m$^2$, and 1,700,000 m$^2$, respectively.

The dispersion modeling was conducted using two sets of receptor grids. The first set of receptor points (Cartesian receptor grid) was placed around the modeled source with distances of 0, 25, 50, 75, and 150 m from the edge of the unit. Square-shaped, ground-level area sources were used in the modeling. Therefore, these receptors are located on five squares surrounding the source. The second set of receptor points (polar receptor grid) was placed outside of the first set of receptors to 10 km from the center of the source. Because the ISCST3 model's area source algorithm does not consider elevated terrain, receptor elevations were not entered in the modeling.

In this sensitivity analysis, both downwind and lateral receptor spacings were investigated for the three unit sizes using 5 years of meteorological data from Little Rock and Los Angeles. For the first set of receptor points (i.e., Cartesian receptor grid), five downwind distances of 0, 25, 50, 75, and 150 m from the edge of the source were used. For lateral receptor spacing, choices of 64, 32, and 16 equally spaced receptor points for each square were used in the modeling to identify the number of receptors needed to adequately characterize the maximum impacts (see Figures C-4a through C-4c for Cartesian receptor locations and spacings ((50$^{th}$ percentile)). For the second set of receptor points (i.e., polar receptor grid), about 20 downwind distances (i.e., receptor rings) were used. Receptor lateral intervals of 22.5° and 10° were used to determine whether 22.5° spacing can adequately characterize the maximum impacts. With a

22.5° interval, there are 16 receptors on each ring. There are 36 receptors on each ring for the 10° interval. See Figures E-5a and C-5b for polar receptor locations ($5^{th}$ percentile).

The results (Figures C-6a through C-6f) show that the maximum downwind concentrations decrease sharply from the edge of the area source to 150 m from the source. The maximum concentrations decrease more sharply for a smaller area source than for a larger one. This means that more close-to-source receptors are generally needed for a small area source than for a large one.

The results also show that the maximum impacts are generally higher for a dense receptor grid (i.e., 64 or 32 receptors on each square) than for a scattered receptor grid (i.e., 16 receptors on each square). However, the differences of the maximum receptor impacts are not significant between a dense and a scattered receptor grid (Figures C-6a through C-6f). The above conclusions apply to both Little Rock and Los Angeles. This means that the distribution of wind directions does not play an important role in determining receptor lateral spacings.

Figures C-7a through C-7f compare the maximum concentrations at each ring for 22.5° and 10° intervals. The results show that the differences of the maximum concentrations are greater for close-to-source receptors than for more distant receptors, and the differences are greater for larger area sources than for smaller area sources. The differences of the maximum concentrations for 22.5° and 10° intervals are generally small, and the concentrations tend to be the same at 10 km. The conclusions were drawn from both Little Rock and Los Angeles meteorological data.

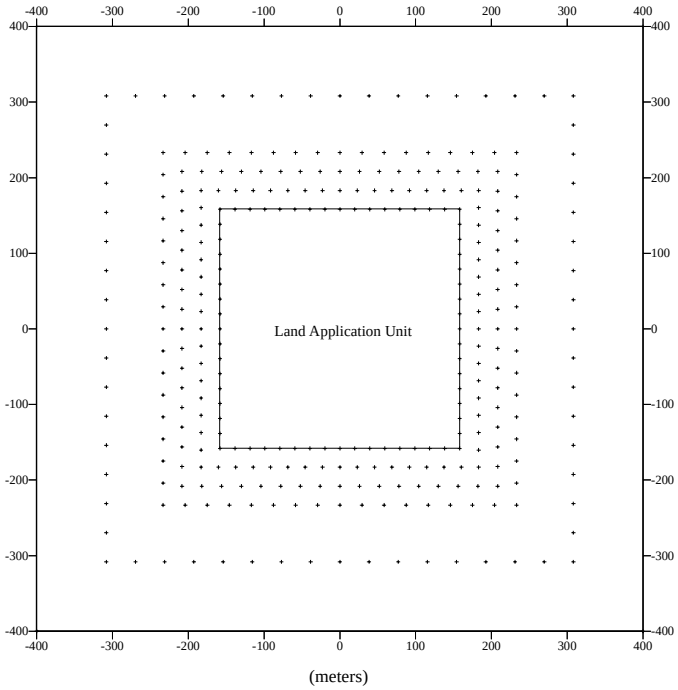



**Figure C-4a. Cartesian receptor grid (64 receptors each square).**

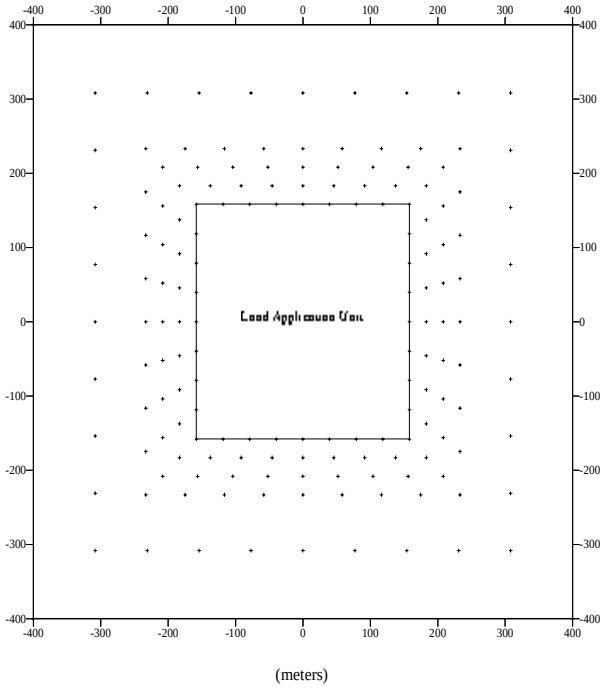



**Figure C-4b. Cartesian receptor grid (32 receptors each square).**

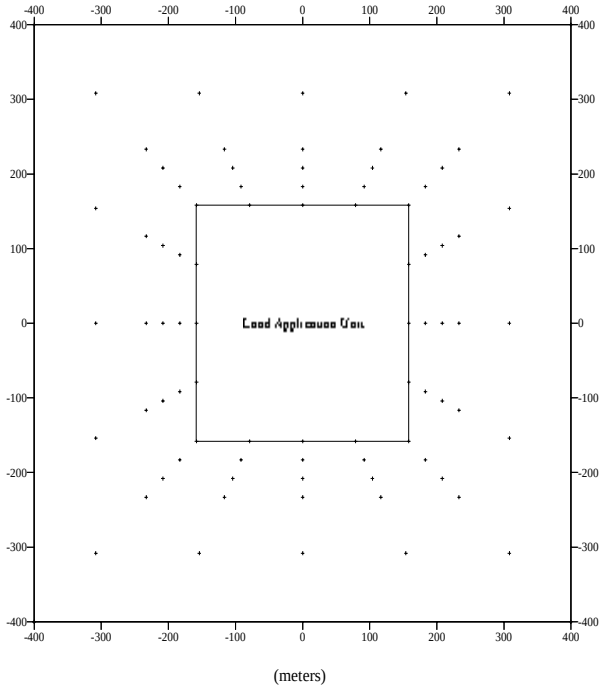



**Figure C-4c. Cartesian receptor grid (16 receptors each square).**

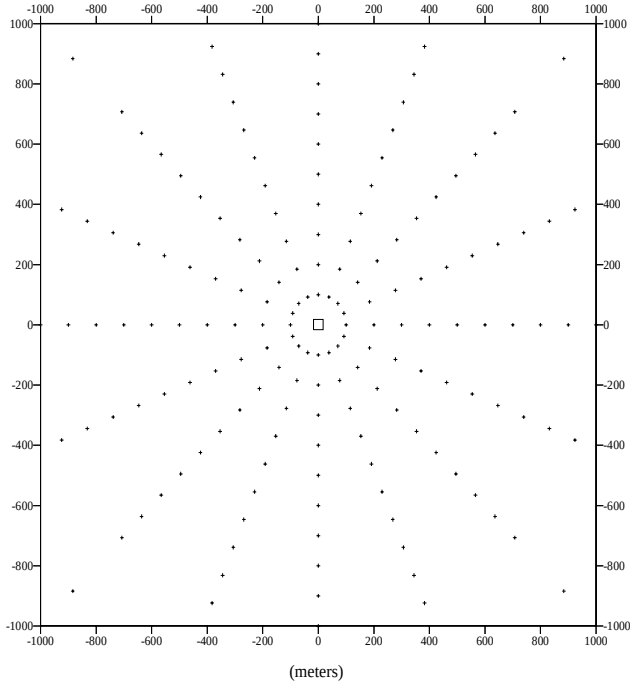



**Figure C-5a. Polar receptor grid (22.5 degree).**

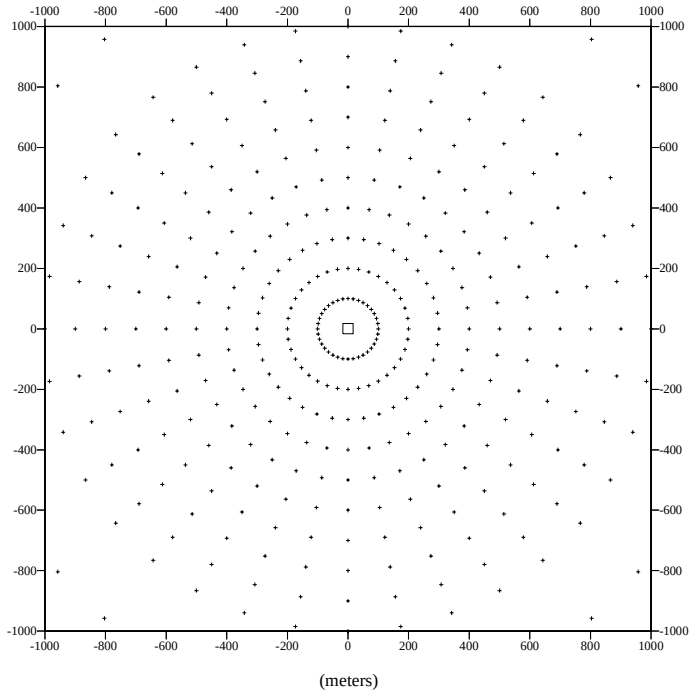



**Figure C-5b. Polar receptor grid (10 degree).**

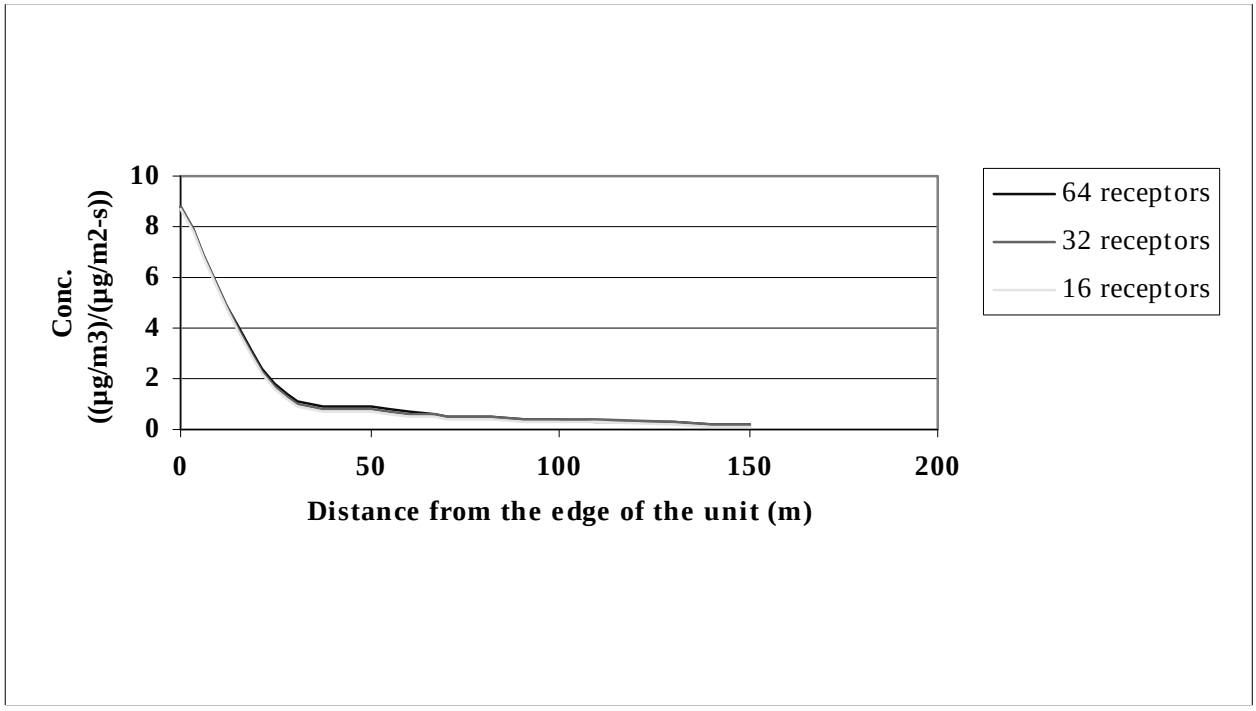



**Figure C-6a. Maximum concentrations, Cartesian grid (5th percentile area, land application unit, Los Angeles, CA).**

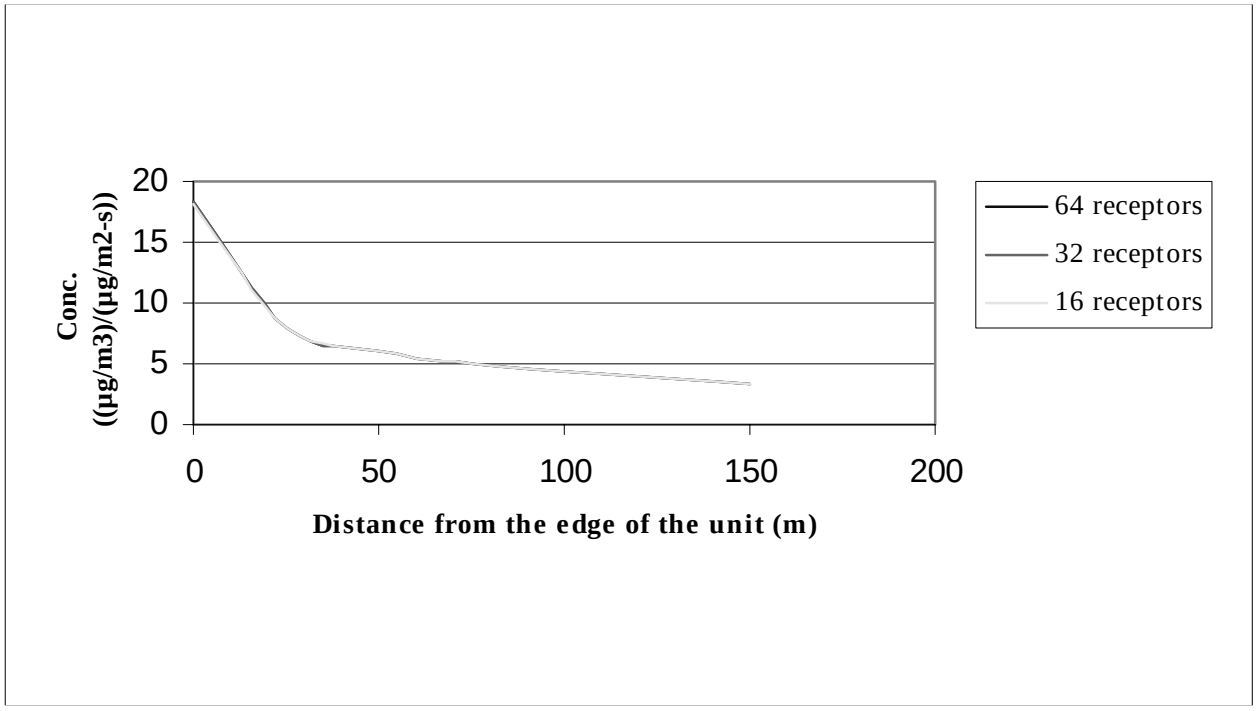



**Figure C-6b. Maximum concentrations, Cartesian grid (50th percentile area, land application unit, Los Angeles, CA).**

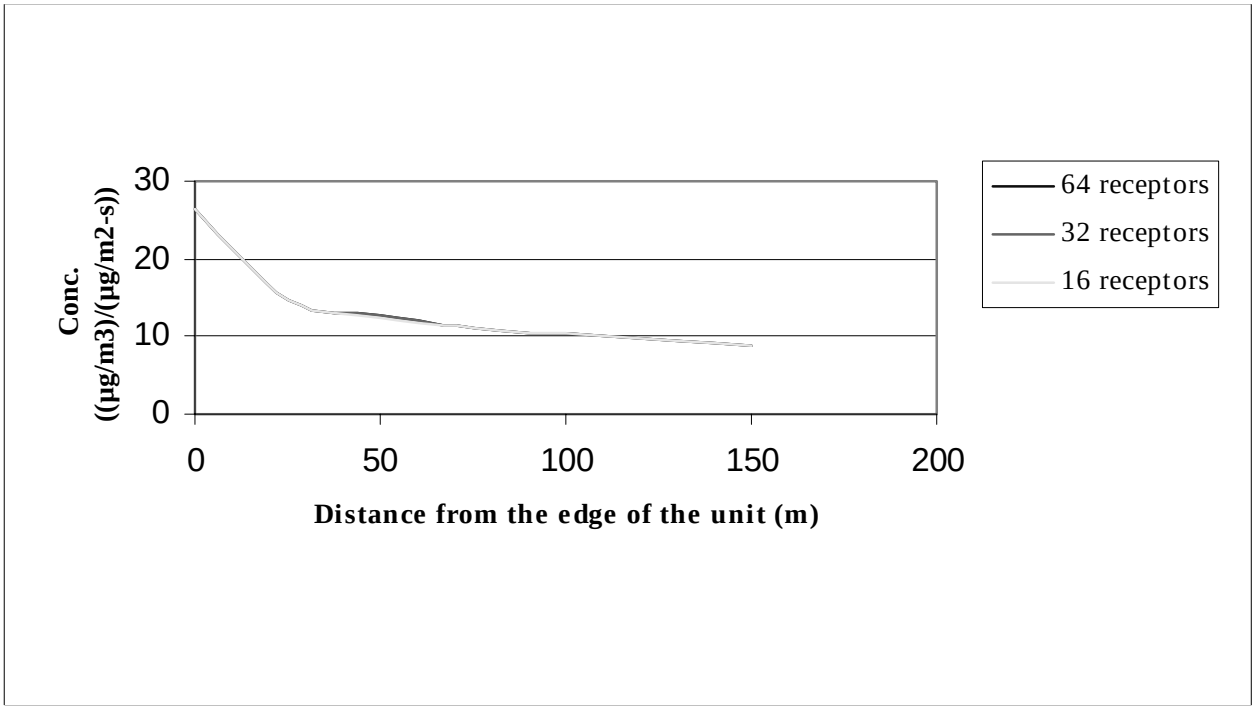



**Figure C-6c. Maximum concentrations, Cartesian grid (95th percentile area, land application unit, Los Angeles, CA).**

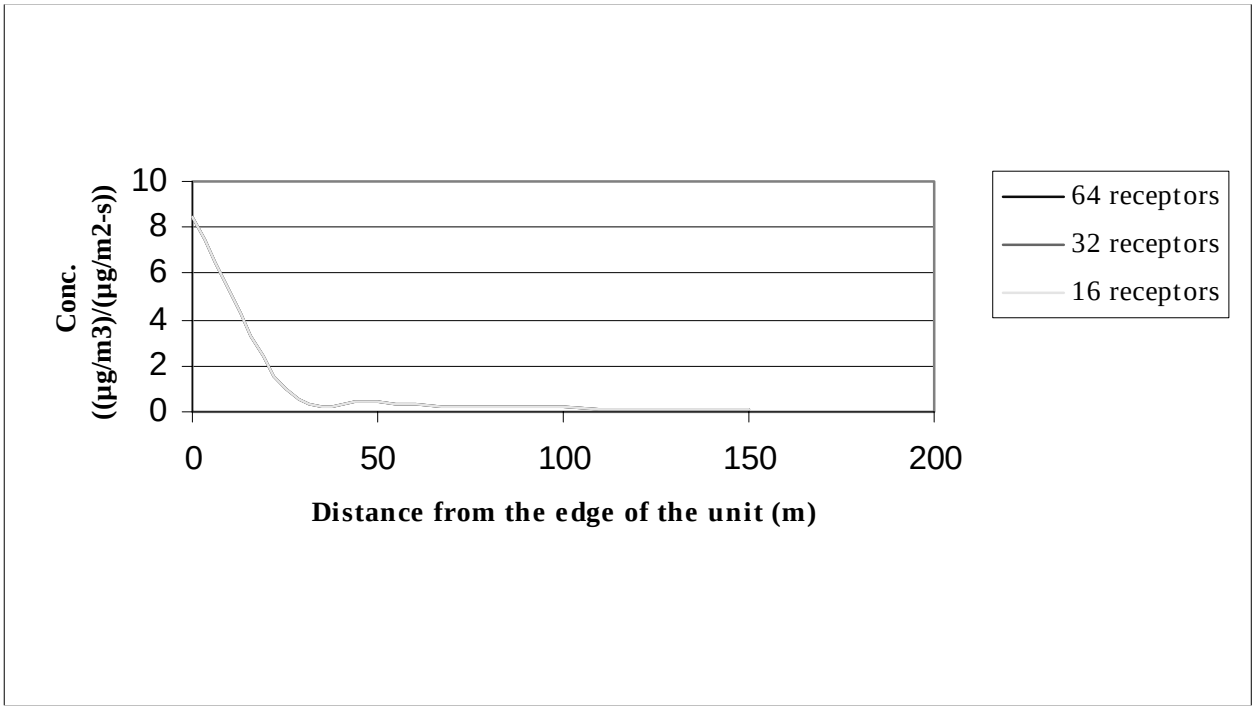



**Figure C-6d. Maximum concentrations, Cartesian grid (5th percentile area, land application unit, Little Rock, AR).**

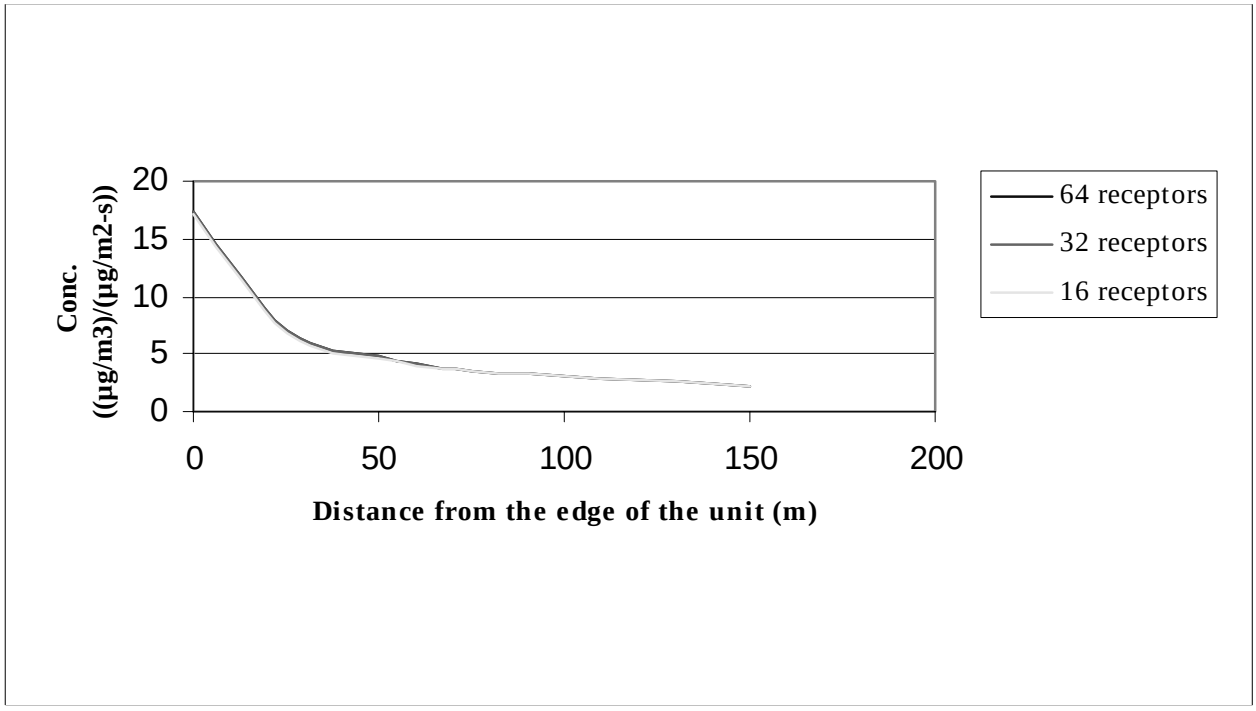



**Figure C-6e. Maximum moncentrations, Cartesian grid (50th percentile area, land application unit, Little Rock, AR).**

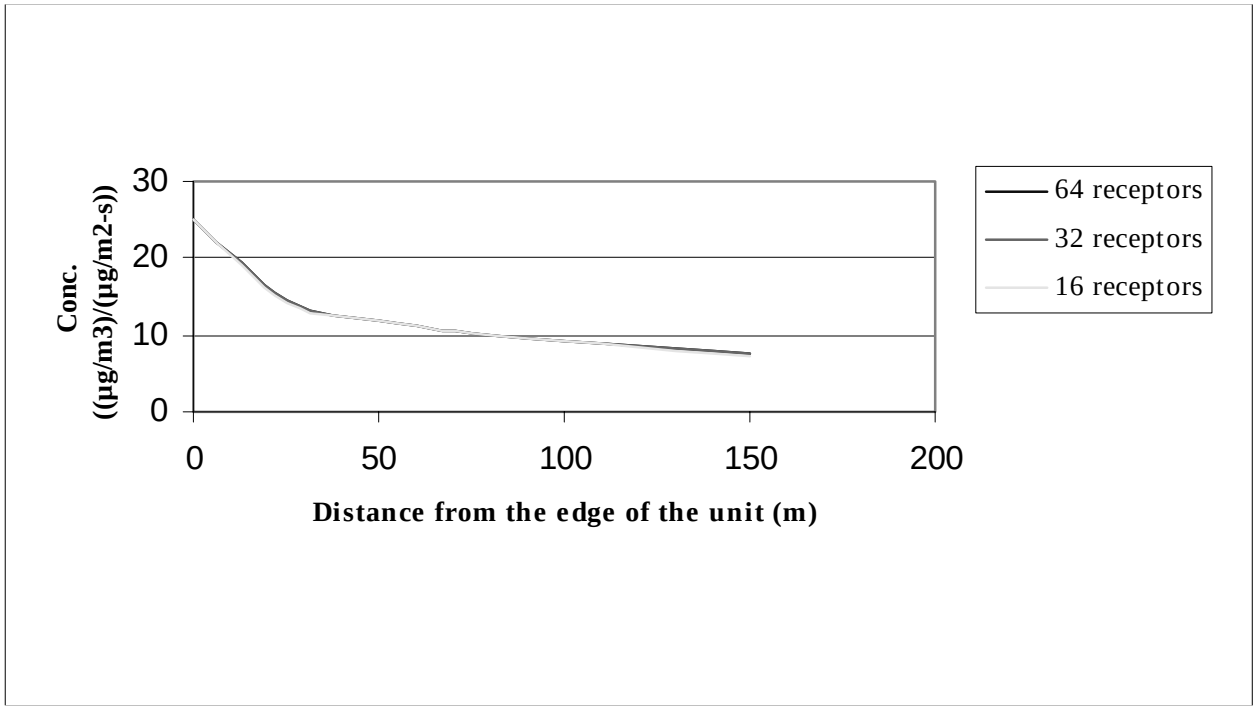



**Figure C-6f. Maximum concentrations, Cartesian grid (95th percentile area, land application unit, Little Rock, AR).**

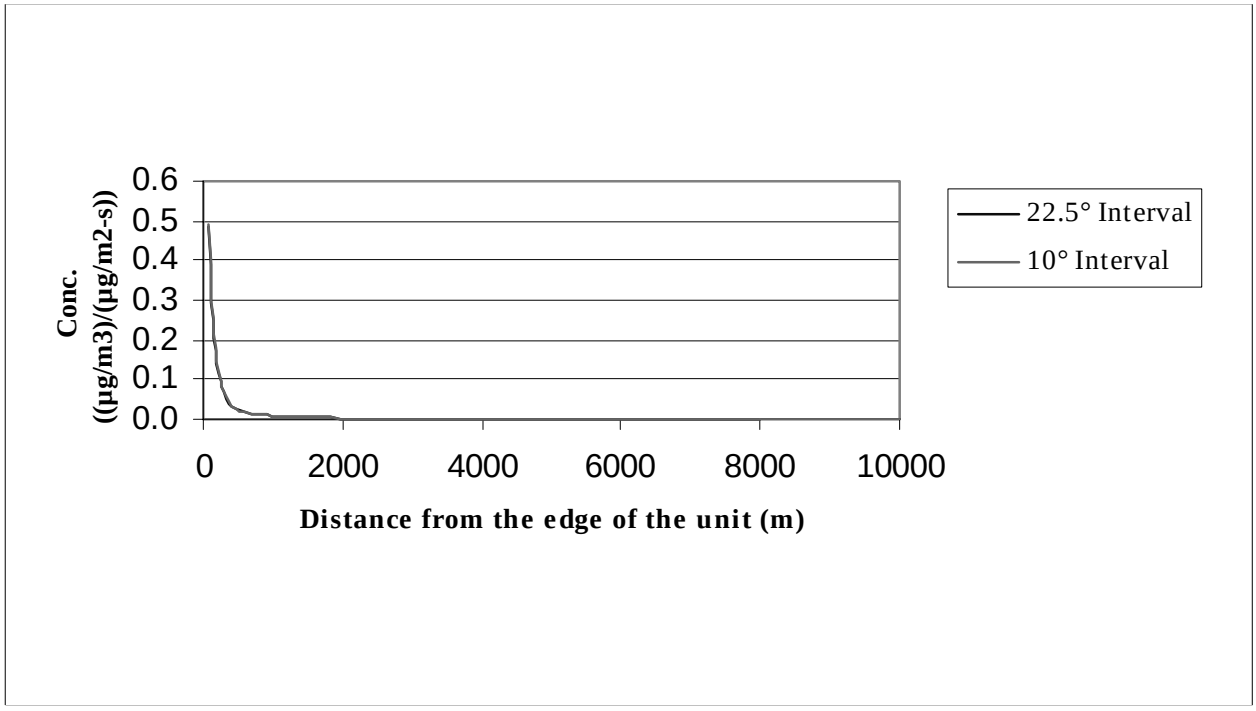



**Figure C-7a. Maximum concentrations, polar grid (5th percentile area, land application unit, Los Angeles, CA).**

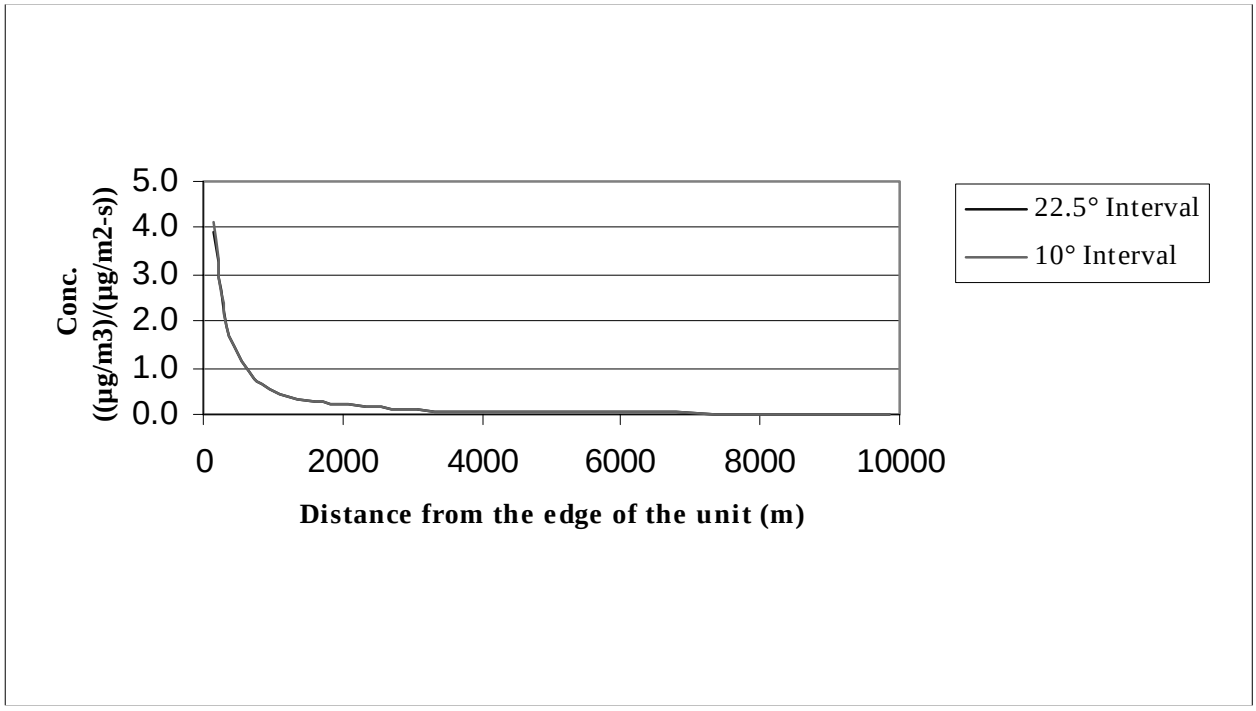



**Figure C-7b. Maximum concentrations, polar grid (50th percentile area, land application unit, Los Angeles, CA).**

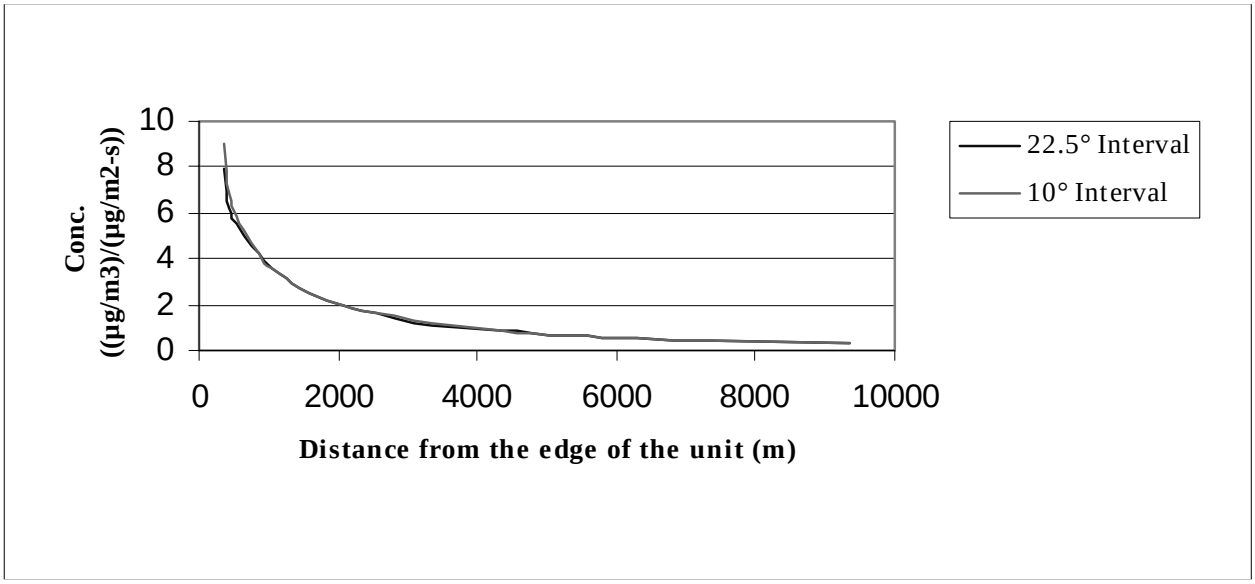



**Figure C-7c. Maximum concentrations, polar grid (95th percentile area, land application unit, Los Angeles, CA).**

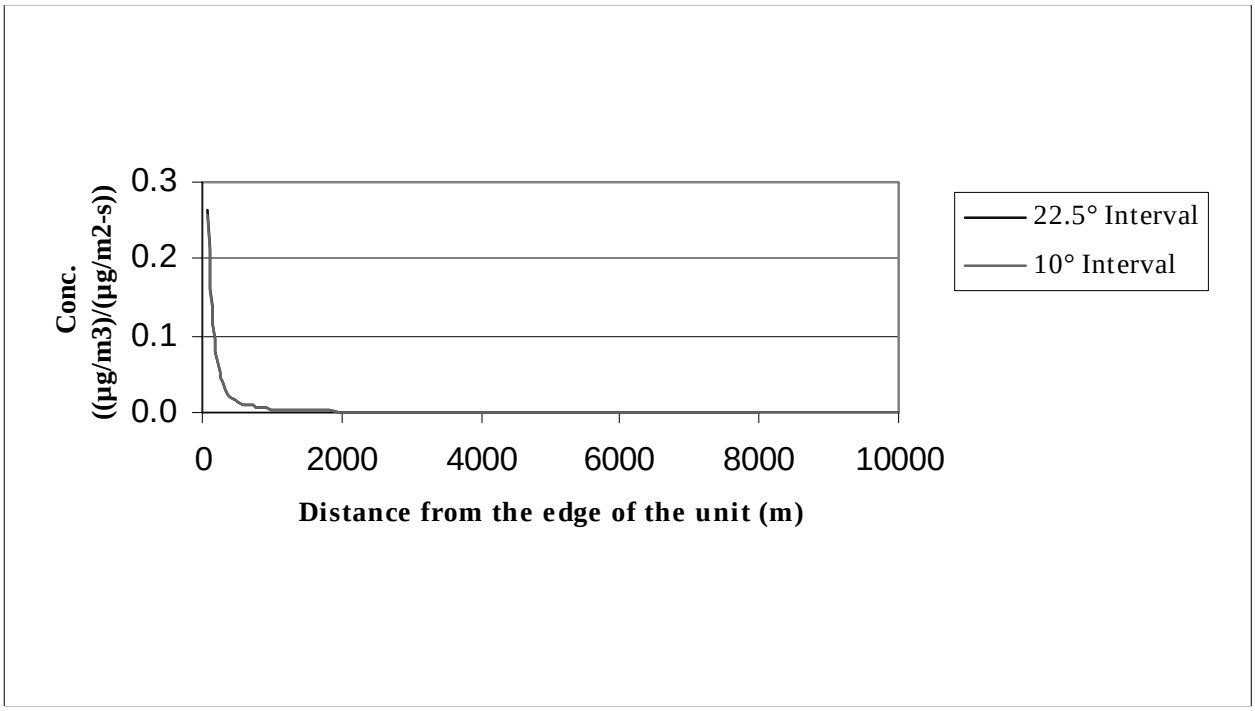



**Figure C-7d. Maximum concentrations, polar grid (5th percentile area, land application unit, Little Rock, AR).**

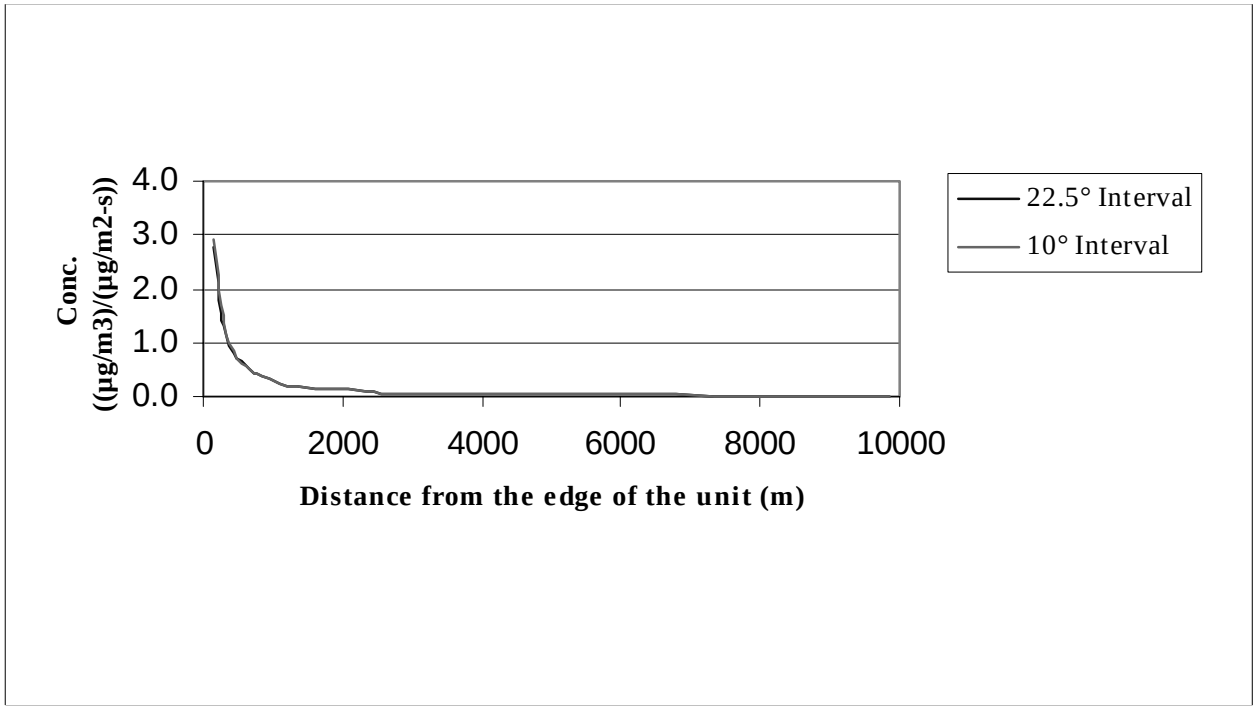



**Figure C-7e. Maximum concentrations, polar grid (50th percentile area, land application unit, Little Rock, AR).**

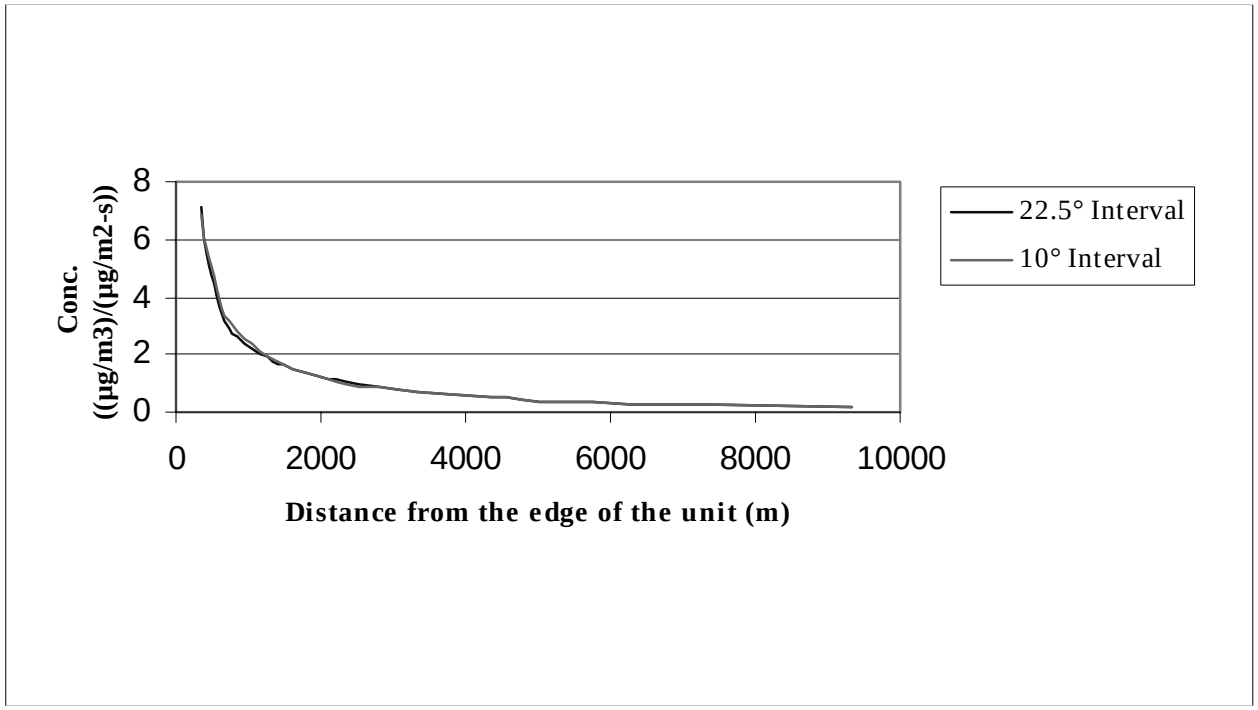



**Figure C-7f. Maximum concentrations, polar grid (95th percentile area, land application unit, Little Rock, AR).**