Area Sources

Area sources are low level sources of air pollution that are stretched over a large geographic space. The area source algorithm should be used to model fugitive emissions sources that are at or near the ground level with little to no plume rise. Examples of this type of source would be haul roads, storage piles or equipment leaks. The model offers three different options for defining the shape of these area source; rectangle shaped sources, irregularly shaped sources, and circular shaped sources with equal sides. Despite having these three different options, all three use the same integrated numerical algorithm method for estimating the fugitive emissions effects on dispersion.

Area Source Type Options

As mentioned above, there are three options to choose when defining your area source within the model input file. The rectangular shaped source is identified with the keyword AREA. The irregular shaped source is known as an AREAPOLY source. And lastly, a circular shaped source with equal sides uses the AREACIRC keyword. Each of these area source type options requires source parameter inputs so that the model can accurately define the area source. The source parameters required for each of the source types are outlined below:

AREA

- Emission Rate - in grams per second per meter squared, $g/s/m^2$.
- Release Height – height above ground in meters
- Length of x side – length of east-west direction
- Length or y side – length of north-south direction
- Angle – orientation angle of the source in degrees from north moving in the clockwise direction.
- Initial Vertical Dimension – initial vertical dimension of the plume in meters

AREAPOLY

- Emission Rate – in $g/s/m^2$
- Release Height – height above ground in meters
- Number of Vertices – could be considered the number of sides that the polygon will have. You must have at least three sides with an upper limit of 20 vertices.
    - The facility will be required to list out the locations of the vertices used to define the area poly source by using the AREAVERT keyword within the model input file.
- Initial Vertical Dimension - initial vertical dimension of the plume in meters

AREACIRC

- Emission Rate – in $g/s/m^2$
- Release Height – height above ground in meters

- Radius – radius of the circular area in meters from the outer edge to the center of the area
- Number of Vertices – number of "sides" in the circular area, will assume 20 unless otherwise given
- Initial Vertical Dimension - initial vertical dimension of the plume in meters

Emission Rates

Unlike point or volume sources the emission rate input into the model for area sources are based upon emissions per unit area. In order to determine the emissions per unit area, you must first calculate the emission rate of the source and then divide by the area of the source in meters, or m.

y length = 10 m

x length = 50 m

Area of source = 50m $*$ 10m = 500 m^2

Once the area of the source is calculated then divide the emission rate by the area of the source to get a model ready emission rate in $g/s/m^2$.

Emission Rate = 1.5 grams/second, g/s

Modeled Emission Rate for Area Source -
1.5 g/s / 500 m^2 = 0.003 $g/s/m^2$

This is the emission rate that should be used within the model input file for the area source.

Procedures and Examples

The department's Air Pollution Control Program recommends the use of the rectangular source keyword of AREA when modeling haul roads, storage piles or equipment leaks. The following sections describe in detail how to model these sources using this keyword.

Haul Roads:

Typically haul roads are very long narrow sources. To help the model deal with such a source the haul roads should be broken down into individual segments for modeling. As mentioned above when using the AREA source keyword the following source parameters are required: release height, length of x and y sides, angle and initial vertical dimension.

Area Sources

The release height for a haul road is calculated by taking one half of the top of the plume height. The top of plume height should be calculated using the average truck height and a constant that approximates the wake height of the plume occurring behind the vehicle.

Top of plume height = 1.7 (constant) $*$ Vehicular Height

If the average truck height is three meters, then top of plume height should be calculated as follows:

Top of plume height = 1.7 $*$ 3 = <u>5.1 meters</u>

Once the top of plume height is determined the release height can be calculated as follows:

Release height = 0.5 $*$ Top of the plume

= 0.5 $*$ 5.1 = <u>2.55 meters</u>

The top of plume height is also used to determine the initial vertical dimension due to the movement of the plume upon release.

Initial vertical dimension = Top of plume / 2.15 (constant)

= 5.1 / 2.15 = <u>2.37 meters</u>

The angle of an area source is the degree difference in a clockwise rotation from true North. This denotes to the model the orientation of the area source within the modeling domain.

The x and y dimensions of the haul road should be based upon the length and width of each haul road segment. It should be noted that the haul road width should be limited to the width of the driving lane. If the haul road is capable of handling two-way traffic, the width should reflect the distance covered by both driving lanes.

Length - length of the roadway segment (100:1) ratio of length to width before warning is issued)

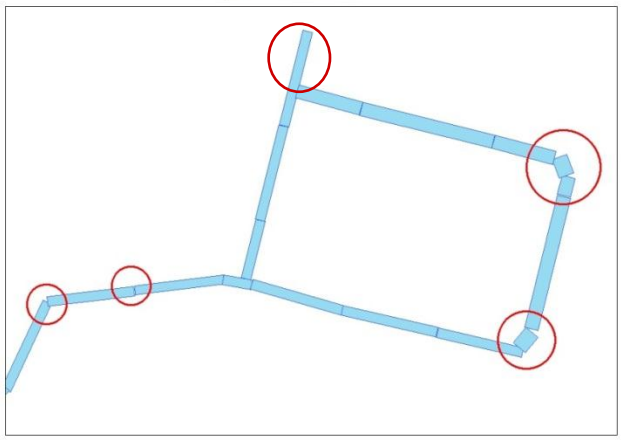
Width –

- Single Lane Road - vehicle width plus six meters to account for roadway shoulders = 6.1 meters
- Double Lane Road - the road width plus six meters = 10 meters

Applicants should be careful when defining their haul road segments, it is important not to leave gaps between segments or bypass corners. Figure 1 is an example of a poor haul road pathway

that depicts segments of the haul road that are not aligned correctly or have large gaps between segments.

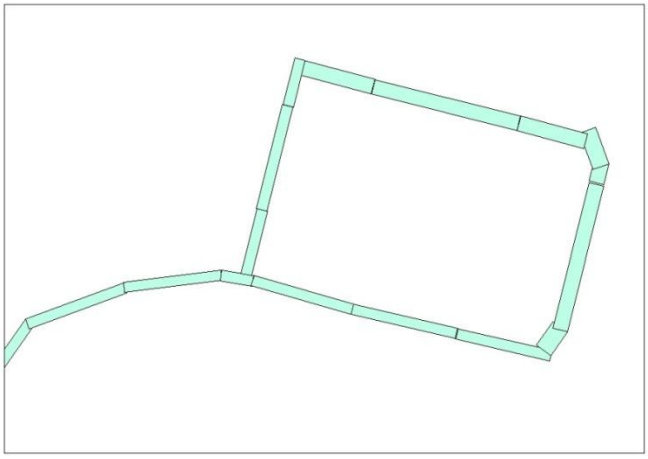
Figure 1
Example of a Poor Haul Road



Red Circles depict gaps within the Haul Road Pathway

Figure 2 below is a picture of a correctly depicted haul road with all of the segments touching both on the straightaways and through the corners.

Figure 2
Example of a Good Haul Road



Storage Piles

Storage piles can vary greatly in shape and size from one operation to another, therefore applicants should be careful when characterizing storage piles. As stated above, the department's Air Pollution Control Program recommends modeling storage piles using the AREA keyword to define a rectangular area source. The following inputs are required when using this keyword: emission rate, release height, length of x and y sides, angle and initial vertical dimension.

The release height of a storage pile should be the height of the pile above ground in meters. Since the height of a storage pile can vary greatly during the course of a year or even daily, an average height of the pile can be used to define the release height. The initial vertical dimension is used to account for the initial growth of a plume once it has been released. Since there is a limited amount of growth from a storage pile plume release, the initial vertical dimension should be considered zero in the input file.

The angle of an area source is the degree difference in a clockwise rotation from true North. This denotes to the model the orientation of the area source within the modeling domain.

Lastly, the model input requires the length of both the x and y sides of the storage pile in meters. If the storage pile is rectangle in shape, the actual length and width of the pile should be used. If the storage pile is irregular or circular in shape, a square shape surrounding the entirety of the pile should be assumed. To do this you must convert the acres to metric units, meters squared, or m^2. Once you have the area in the correct units you can take the square root to get both the x and y length in meters.

Size of storage pile = 2 acres

2 acres = 8093.651 m^2

$\sqrt{8093.651}$ = 89.9647 meters to be used as both the x and y length

Please note, as mentioned above the emission rate input into the modeling input file is required to be in $g/s/m^2$ for all area sources. The convereted m^2 number from the acreage size should be divided by the g/s emission rate to get the required $g/s/m^2$ number.

This same philosophy can be used if there are several storage piles within one area. For example a quarry might have several piles of crushed rock, each with a different size of rock that is considered one large rock storage pile. In this instance the use of the area covered in acres can be used to determine an x and y length.

Area Sources

A storage pile has four different components where emissions may be released. Applicants will be required to account for each of these emission components in some form in the model input file. These components are: Load In, Load Out, Vehicular Activity and Wind Erosion. Each of these components are discussed in detail below.

Load In

The load in component represents the amount of particulate emissions that will result from the loading of material onto a storage pile. If the storage pile is fed by a front end loader, the load in portion should be classified as an area source and modeled as such. It is common for storage piles to use conveyors to feed the storage pile, in these instances the load in should be modeled as a volume source instead. Please refer to the volume source document for more information.

Load Out

Opposite of the load in factor, load out represents the amount of particulate emissions that will result from the removal of the material from a storage pile. Load out should be modeled as an area source, if the process uses a front end loader to remove material. If a conveyor is used to unload from the storage pile a volume source characterization would be more appropriate to use in the model input file. In cases where an underground conveyor system is used, which result in very little emissions due to the fact that they are fully contained underground, the load out emissions would be considered zero. The applicant is required to outline this information within their permit application to be reviewed and approved by the department's Air Pollution Control Program.

Vehicle Activity

The vehicle activity represents the amount of particulate emissions released into the atmosphere due to the maintenance of a storage pile by a vehicle, such as a front end loader. Currently the Air Pollution Control Program classifies the vehicular activity around a storage pile as a haul road. In cases where the maintenance of the pile requires the vehicle to drive around on the pile, such as a bulldozer, an area source classification would be more appropriate.

Wind Erosion

The wind erosion factor represents the amount of particulate emissions released into the atmosphere solely from the wind blowing across a pile. Wind blowing across the

storage pile causes fine particles to become airborne. These emissions should always be modeled as an area source.

Equipment Leaks

Equipment leaks can occur over a large area within a facility complex, making it an area source. Similar to a storage pile a large square can be drawn around the entire area containing the leaks. It should be noted that only the area containing the leaks should be included, not the entire facility itself. For more information on equipment leaks please contact the department's Air Pollution Control Program.