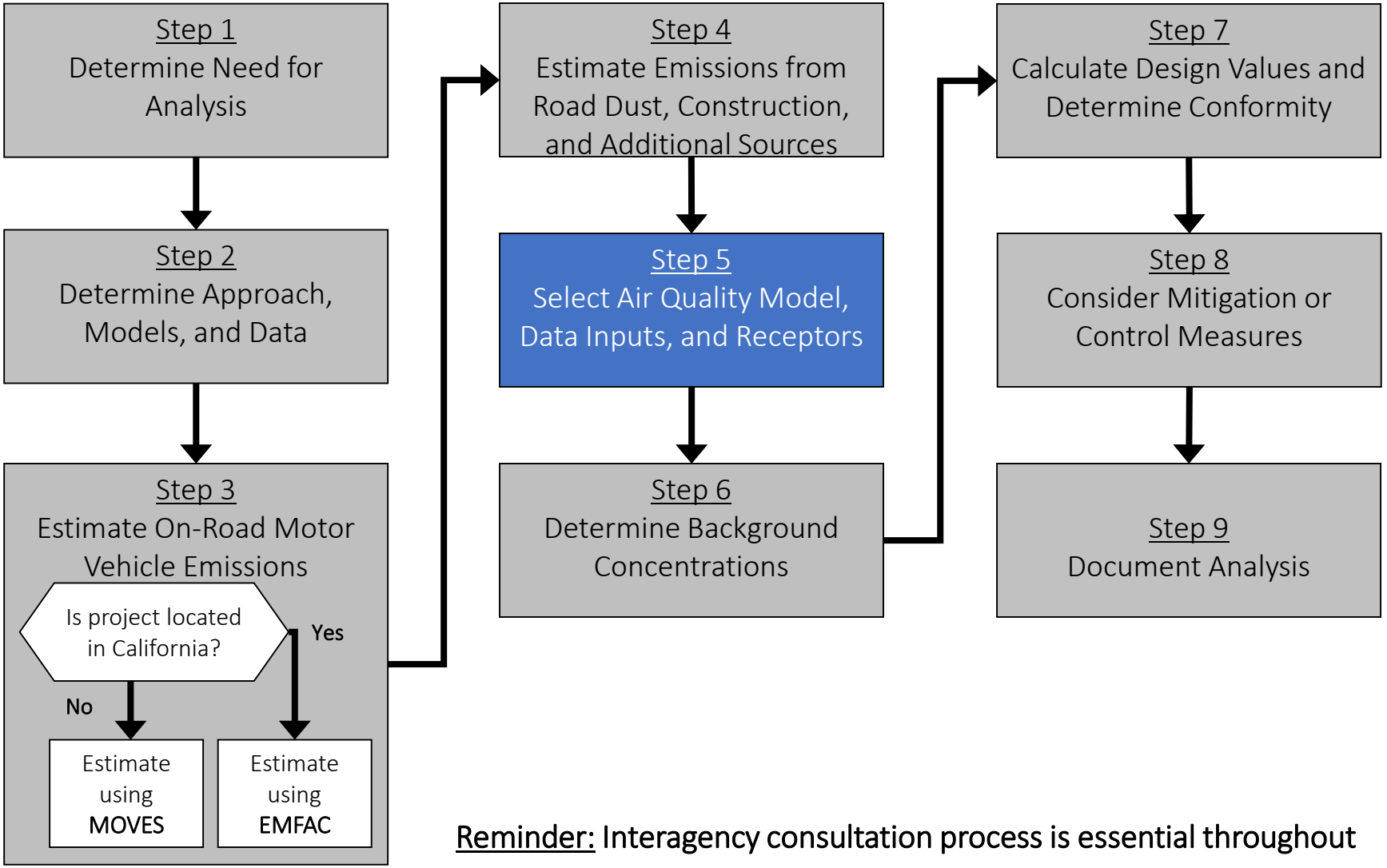
Module 4
Using AERMOD for PM Hot-Spot Analyses

EPA

Completing a PM Hot-spot Analysis



Reminder: Interagency consultation process is essential throughout

Module Overview

- What is AERMOD?
- Structure of an AERMOD input file
- Running AERMOD with the “Line” sample input file
- Hands-on exercise: AERMOD mini-run for a simple highway
- Running AERMOD for the example analysis
- Reference 4A: Example Batch File
- Reference 4B: Additional Information About Area Source

Key References

- PM Hot-spot Guidance, Sections 7, 8 and Appendix J
- AERMOD Implementation Guide
- AERMOD User Guide
- AERMET User Guide
- EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website
  - Air quality Dispersion Modeling Preferred and Recommended Models: www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

What is AERMOD?

- American Meteorological Society/EPA Regulatory MODel (AERMOD)
  - Developed by AMS/EPA Regulatory Model Improvement Committee
- Models concentrations from dispersion of any primary (i.e., directly emitted) pollutant
- A steady-state Gaussian plume model
- Includes advanced dispersion science algorithms
  - How convection affects atmospheric mixing
  - Advanced handling of urban sources
  - Links winds with surrounding surfaces

What is AERMOD?

- AERMOD design criteria:
  - Use up-to-date science
  - Capture essential physical processes
  - Apply over a range of meteorology
  - Support diverse uses with flexible options for input and output
  - Able to evolve, and be easily updated

What is AERMOD?

- Proposed as replacement for ISCST3 in 2000
  - Additional improvements made 2001
  - Notice of Data Availability for AERMOD issued 2003

- Promulgated as EPA's preferred model 2005

- Latest version of AERMOD is 18081, found on AERMOD website along with:
  - An updated AERMOD User's Guide and User's Guide Addendum, and
  - AERMOD Model Change Bulletin #13 – describes the modifications made to the model in this latest update
  - Note: This training used AERMOD version 16216r. For transportation projects, model concentrations are expected to be the same between these versions

EPA United States Environmental Protection Agency

www.epa.gov/scram

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Support Center for Regulatory Atmospheric Modeling (SCRAM)

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This website provides access to air quality models and other mathematical simulation techniques used in assessing control strategies and source impacts.

Air Quality Models

- Dispersion Modeling
- Photochemical Modeling
- Receptor Modeling

Modeling Applications and Tools

- Photochemical Modeling Applications

Announcements

02/02/17 - An informational webinar regarding the "Revisions to the Guideline on Air Quality Models" final rule has been scheduled for Thursday, February 16th, 2017 from 2pm to 4pm EST.

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www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

Support Center for Regulatory Atmospheric Modeling (SCRAM)

Air Quality Dispersion Modeling – Preferred and Recommended Models

These refined dispersion models are listed in Appendix W (PDF) (45 pp, 803 K, About PDF) and are required to be used for State Implementation Plan (SIP) revisions for existing sources and for New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs. The models in this section include the following:

AERMOD Modeling System - A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

CALPUFF Modeling System - A non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain.

Other Models - Other dispersion models including BLP, CALINE3, CAL3QHC/CAL3QHCR, CTDMPLUS, and OCD.

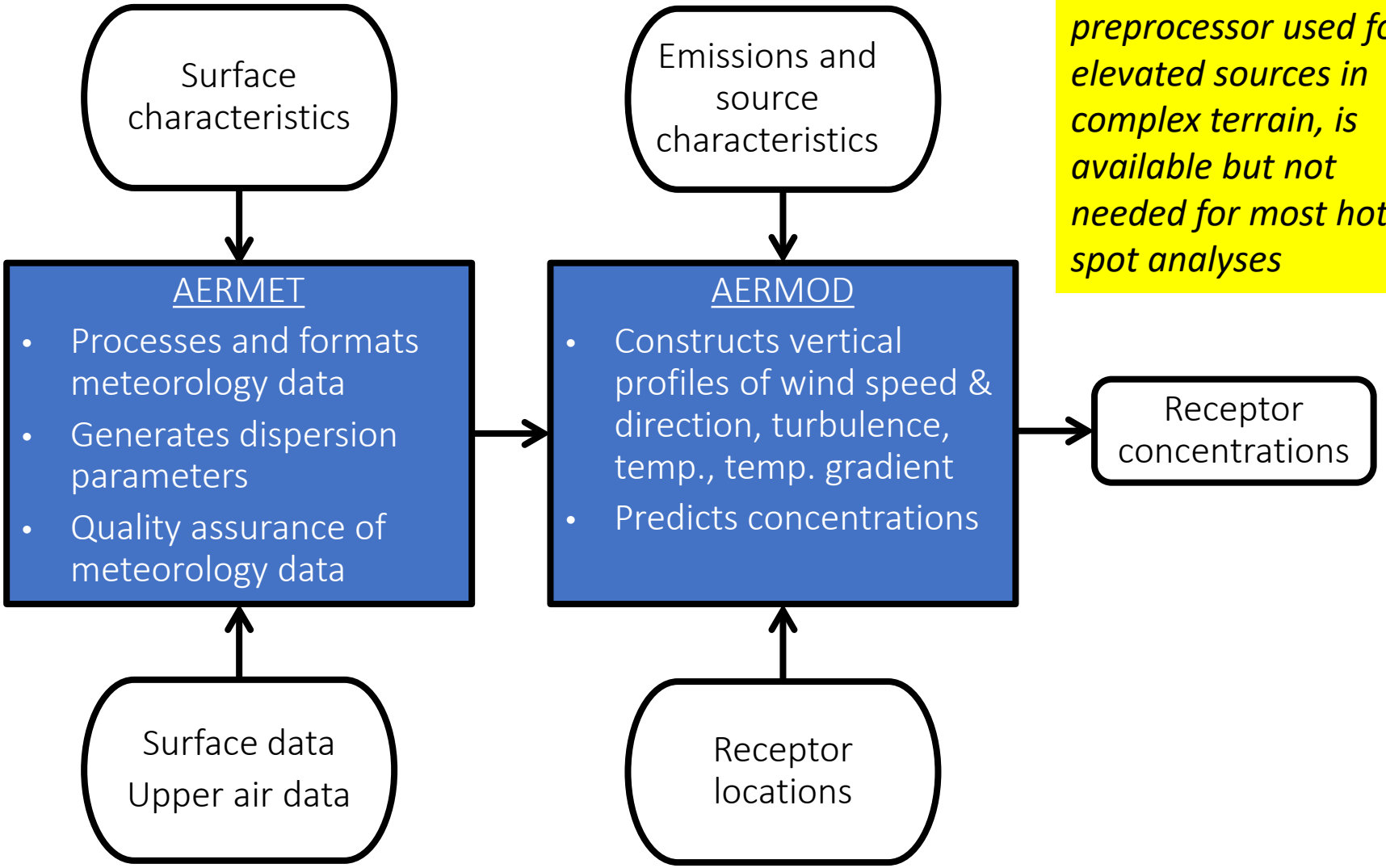
AERMOD Modeling System

The American Meteorological Society/Environmental Protection Agency Regulatory Model

AERMOD Graphical User Interfaces

- This course uses AERMOD model from EPA's website
- Users may want to obtain one of several commercial AERMOD GUIs
  - A GUI may streamline some steps (e.g., receptor placement) and offer additional features (e.g., a mapping feature of model results)
- Before using a commercial GUI, verify that it is consistent with the latest version of AERMOD
  - See Dec. 2007 OAQPS memo, "Clarification on Regulatory Status of Proprietary Versions of AERMOD (PDF)": www.epa.gov/ttn/scram/guidance_clarificationmemos.htm
- Material in Module 4 is relevant even if using a GUI

Information Flow in AERMOD



Note: *AERMAP, a regulatory preprocessor used for elevated sources in complex terrain, is available but not needed for most hot-spot analyses*

AERMET and AERMOD

- Obtaining representative met data is a critical component of PM hot-spot analyses
  - Discussed in Module 3
- AERMET is used to prepare met data for AERMOD
  - Surface met data
  - Profile met data
- Project sponsors will most likely obtain representative pre-processed met data from state or local air agencies
  - Where such met data files are available, running AERMET is not necessary
- AERMET not covered in this course

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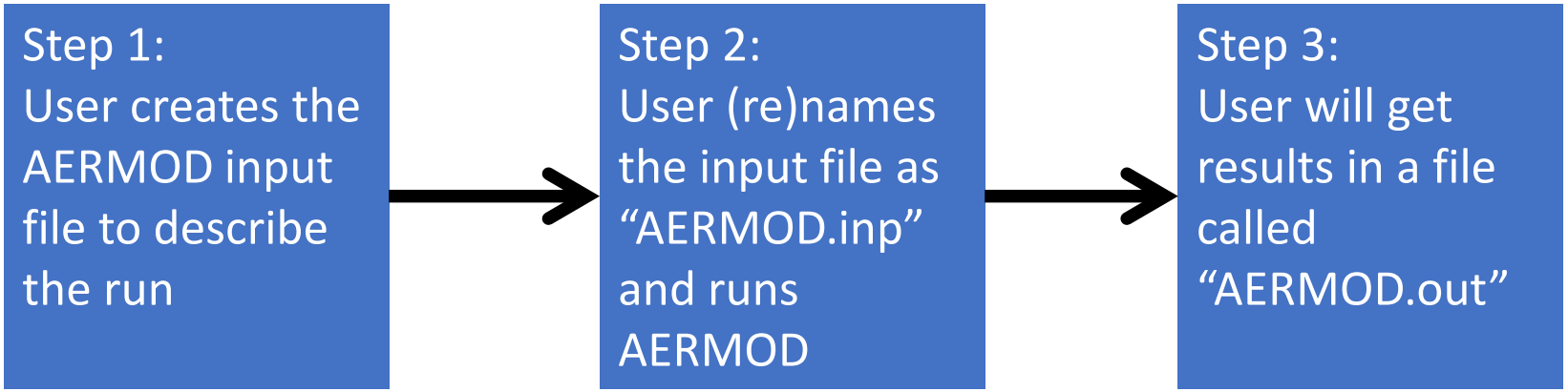
Running AERMOD

- General steps…



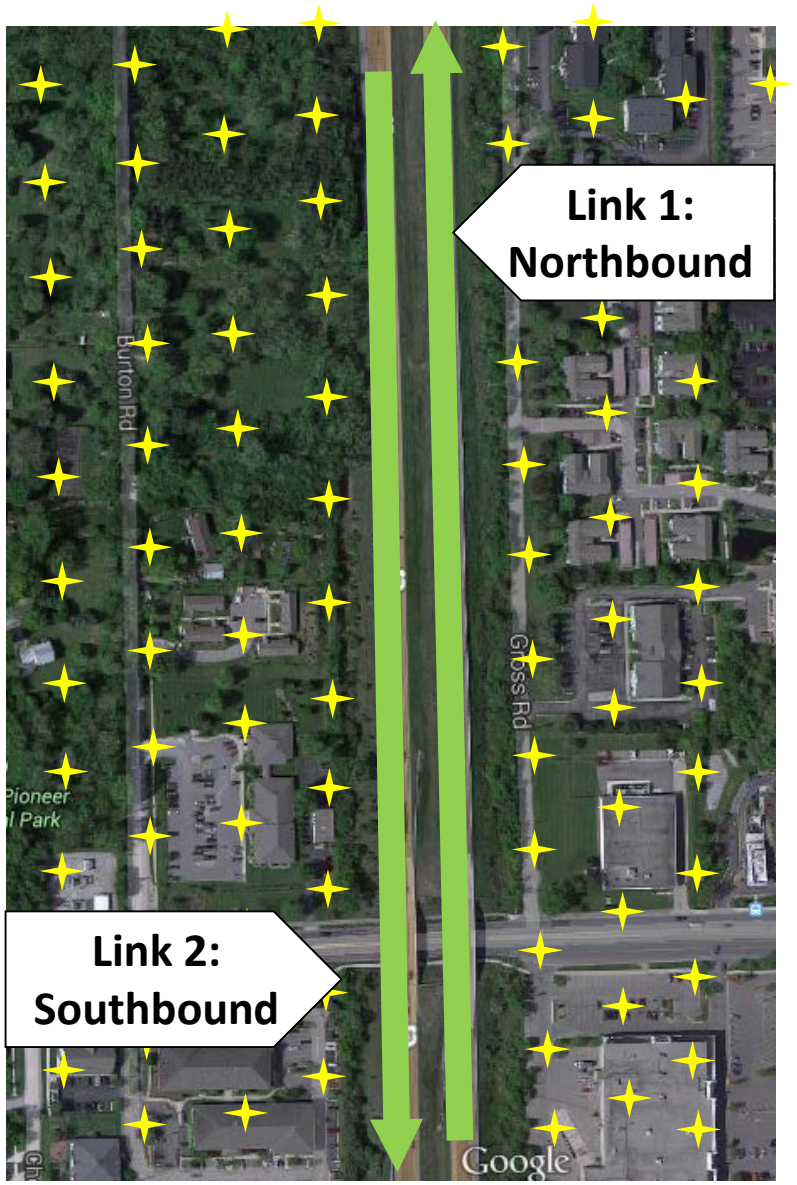
- The AERMOD input file is always named "AERMOD.inp" and the output is always named "AERMOD.out"

- ***Note:*** *These files will be overwritten when AERMOD is run again.*
- Tip: Rename files immediately to ensure they are not overwritten; this can be done using a batch file (example provided in course files and described in module appendix)

AERMOD: A Spatial Model

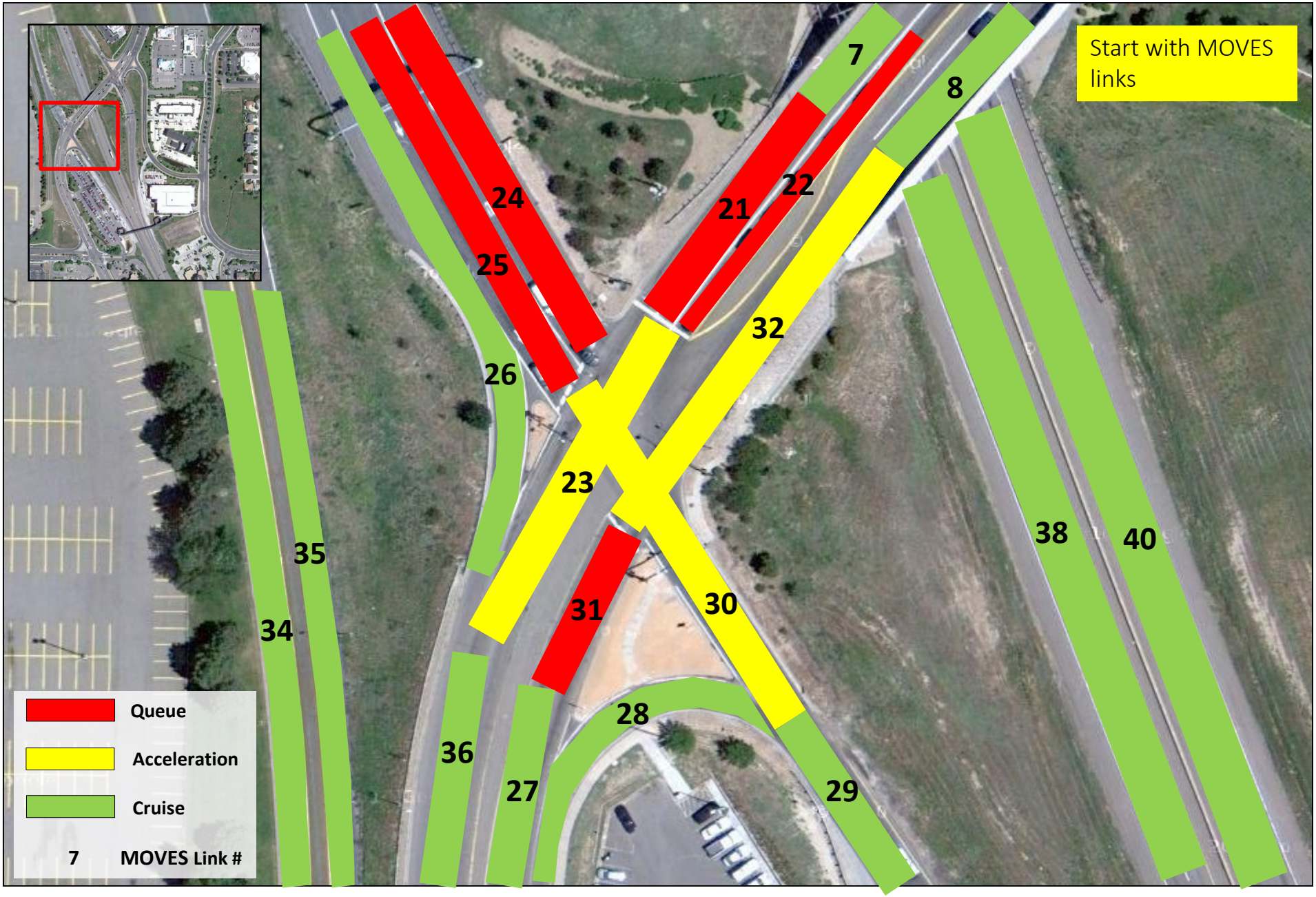
- In an AERMOD input file, users need to specify coordinates (x, y, and optional z) for:
  - locations of emission sources, (where emissions are occurring) and
  - locations of receptors (i.e., where AERMOD should compute *concentrations)*

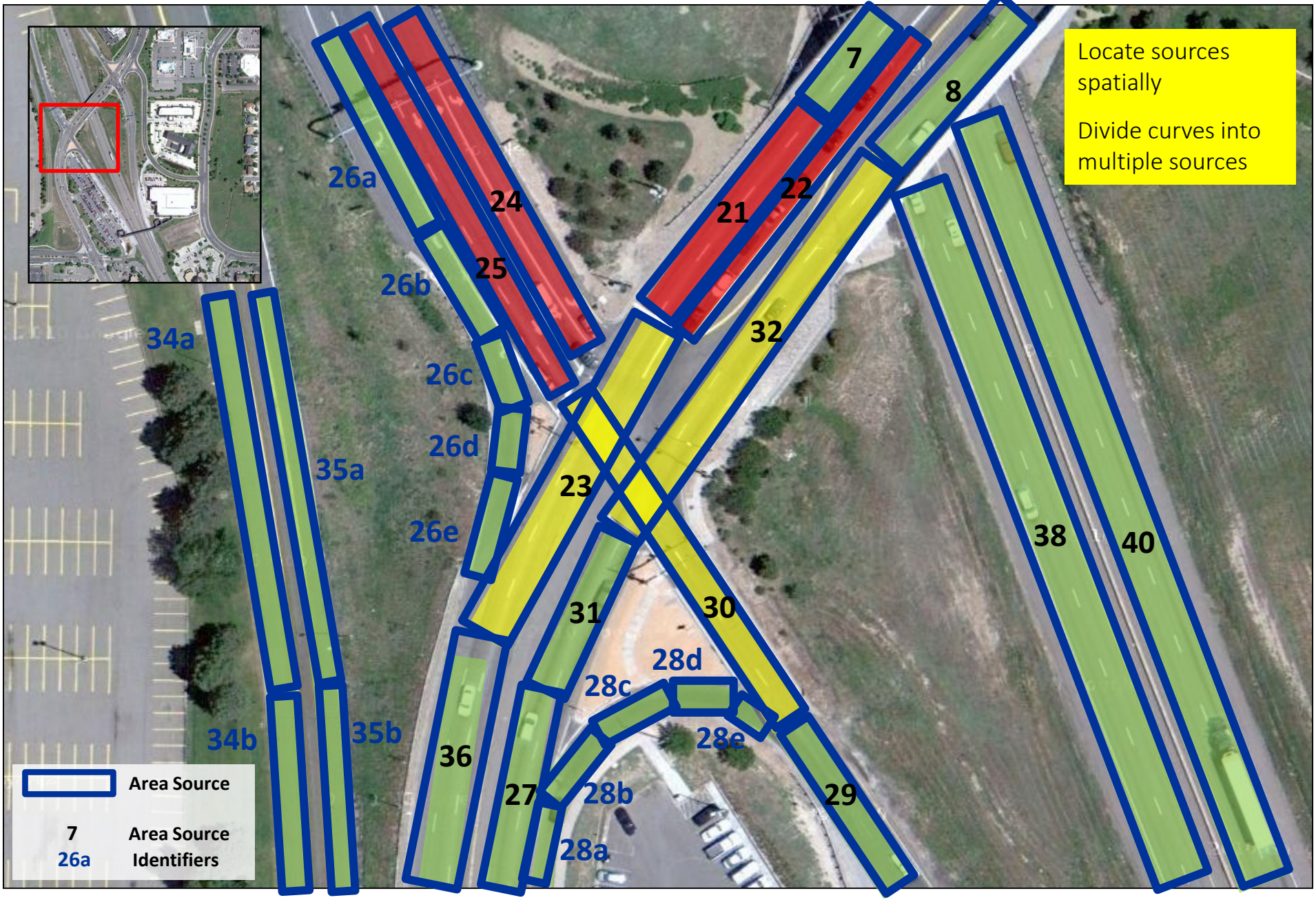
- Coordinate systems can be user-defined arbitrarily or with an existing coordinate system (e.g., Universal Transverse Mercator (UTM) coordinate system)



AERMOD Source Types

- Emission ***sources*** in AERMOD are based on ***links*** defined for MOVES
  - MOVES links differ by activity: operating modes, speeds, volumes
  - Each MOVES link will have a unique emissions rate
  - Each MOVES link will thus be *at least* one source in AERMOD
    - E.g., 3 links defined for an intersection in MOVES would need to be at least 3 different sources in AERMOD
    - Curved links can be modeled as one link in MOVES, but will need to be broken up into discrete x/y sources in AERMOD:
      - Area sources: use the same emissions rate, (g/s/m2) for each source
      - Volume sources: divide the emission rate, (g/s) among the sources


Start with MOVES links
7
8
24
25
21
22
26
32
23
35
34
31
30
38
40
28
36
27
29
Queue
Acceleration
Cruise
7 MOVES Link #


Locate sources spatially
Divide curves into multiple sources
7
8
21
22
24
25
26a
26b
26c
26d
26e
32
34a
35a
23
38
40
31
30
28d
28c
28e
34b
35b
36
27
28b
29
28a
Area Source
7
Area Source
26a
Identifiers

AERMOD Input File Structure

- An AERMOD input file describes what will be modeled and is structured by "pathways" as ordered:

Pathway	Name	Description
CO	Control	Specifies job control options, to describe the run: e.g., modeling options, pollutant and averaging period
SO	Source	Specifies emission source information: e.g., ID, type, location, release height, emissions rate
RE	Receptor	Specifies receptor location information
ME	Meteorology	Specifies meteorology information – which files to access
OU	Output	Specifies output options

- An additional pathway, EV for "Event," is not necessary for hot-spot analyses; not covered in this course

Let's look at an input file...

- On desktop, open folder "Course Files"
  - Open folder "AERMOD files"
    - Open folder "Sample AERMOD run"

- This folder includes the following files:
  - AE_line_sample_file.inp *(the input file)*
  - aermet2.pfl *(profile met data)*
  - aermet2.sfc *(surface met data)*
  - aermod.exe *(the AERMOD model)*

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AERMOD Sample Input File

We created a sample file to illustrate a transportation project for this course

- One rectangular source emitting PM_{10} – could be either a highway or transit project
- Sample input file is illustrative only, provides an example of file structure
- Introduces model concepts and syntax

Sample Input File: First half

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-----------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  ------  -------   ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

Sample Input File: Second half

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
RE STARTING
RE GRIDCART INNER STA
** User guide:          Xinit Xnum Xdelta Yinit Ynum Ydelta
**                      ----- ---- ------ ----- ---- ------
                  XYINC -100   11    25    -100   10   25
RE GRIDCART INNER END

** "Inner" receptor grid extends 100 meters beyond the project
** in both X and Y directions, at 25 meter spacing
** Some receptors will be at locations within the source

RE GRIDCART OUTER STA
** User guide:    XPNTS Gridx1 Gridx2 Gridx3 Gridx4 ...
**                YPNTS Gridy1 Gridy2 Gridy3 Gridy4 ...
**                ------ ------ ------ ------
                  XPNTS  -500   -400   -300   -200  -100 0 100 150 250 350 450 550
                  YPNTS  -500   -400   -300   -200  -100 0 100 125 225 325 425 525
RE GRIDCART OUTER END

** "Outer" receptor grid extends 500 meters beyond the project
** in both X & Y directions, 100 m apart (except X @ 100-150, and Y @ 100-125)
** Some receptors will be at locations within the source
RE FINISHED

**-------------------------------------
ME STARTING
   SURFFILE  aermet2.sfc
   PROFFILE  aermet2.pfl
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999  1988  HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
**-------------------------------------
OU STARTING
   RECTABLE 24 FIRST
** (There are only 4 days of met data in the met data file, so model cannot
** provide 6th highest concentration)
   POSTFILE  24 ALL PLOT PROJECT_24hr.pst
OU FINISHED
```

AERMOD Input File Conventions

- Example pathway, from STARTING to FINISHED:

```
CO STARTING
CO TITLEONE     Simple AERMOD Run
CO MODELOPT  CONC    FLAT
CO AVERTIME    24
CO URBANOPT  200000
CO FLAGPOLE    1.8
CO POLLUTID    PM10
CO RUNORNOT RUN
CO FINISHED
```

Pathway (2 letters) Keyword (8 letters) Parameters (one or more)

AERMOD Input File Conventions

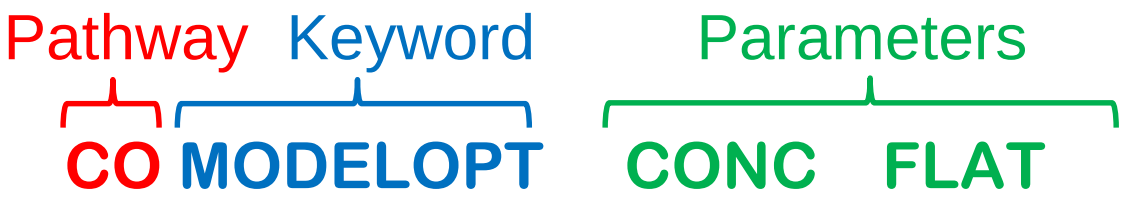
- Example pathway, from STARTING to FINISHED:

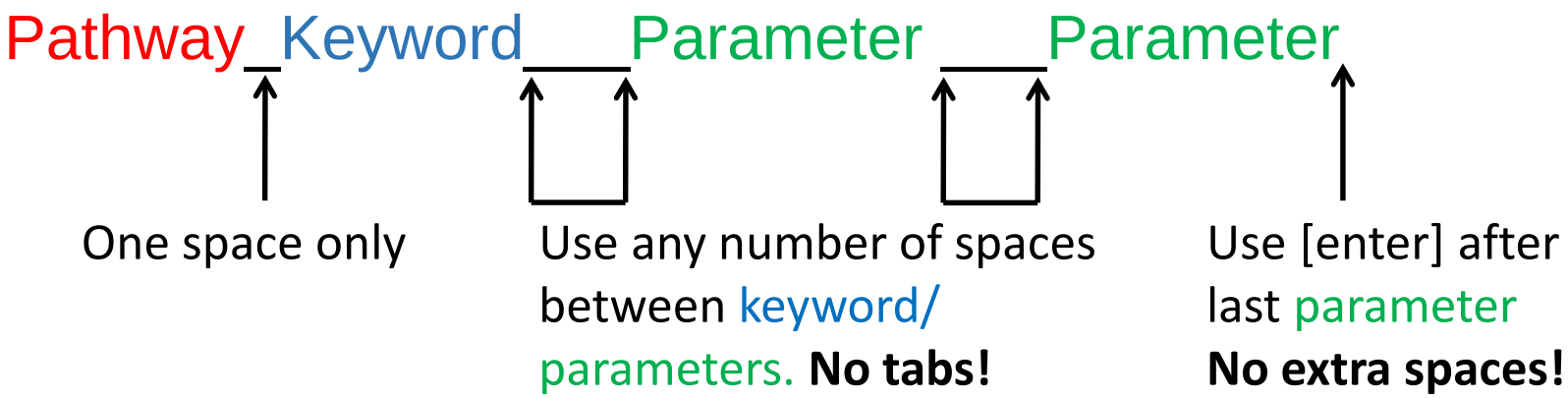
```
CO STARTING
   TITLEONE    Simple AERMOD Run
   MODELOPT  CONC    FLAT
   AVERTIME    24
   URBANOPT  200000
   FLAGPOLE    1.8
   POLLUTID    PM10
   RUNORNOT RUN
CO FINISHED
```

Pathway (2 letters) Keyword (8 letters) Parameters (one or more)

AERMOD Input File Conventions

Example of one line in an input file:





AERMOD Input File Conventions

- AERMOD User Guide refers to keywords and parameters as either "mandatory" for AERMOD to run or "optional" (in parentheses)
  - However, some "optional" keywords and parameters are necessary for PM hot-spot analyses
  - Keywords are 8 characters
    - All pathways begin with keyword STARTING and end with keyword FINISHED
    - Other keyword order not critical, except in the SO pathway
  - Parameters are either numbers or secondary keywords
    - Parameter order matters, except for secondary keywords, but spacing between them doesn't
- Consult User Guide (e.g., Appendix B reference table)
  - Indicates what's mandatory vs. optional, syntax for each keyword, whether a particular order is necessary, etc.

Input File Comment Lines

- Use "**" for adding comment lines
  - "**" tells AERMOD "don't read this"
  - Use to label information in the input file and add other descriptive information that will help you later, e.g.:

    ** North perimeter driveway

    ** I-80/Platt Rd NE exit ramp

- Use blank lines in the input file between pathways, sources, etc.
  - Helps make input file readable

AERMOD Units

- All numeric inputs (input file) are metric:
  - Length: meters
  - Speed: meters per second (refers to exit velocity, for point sources)
  - Temperature: kelvin (for point sources)
  - Emission rates: default units for inputs are
    - Grams per second (g/s) for **point** and **volume** sources
    - Grams per second per square meter ($g/s/m^2$) for **area** sources
- Output (concentrations): units are $\mu g/m^3$

Control Pathway

Pathway	Name	Description
CO	Control	Specifies job control options, to describe the run
SO	Source	Specifies emission sources information
RE	Receptor	Specifies receptor location information
ME	Meteorology	Specifies meteorology information
OU	Output	Specifies output options

- *Control* – information about the run, e.g.:
  - Run title
  - Concentration or deposition
  - Averaging time
  - Run with errors or quit?

Control Pathway – Sample Input File

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**---------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**                Srcid     Srctyp  X1 Y1   X2 Y2
**                ------    ------  -- --   -- --
   LOCATION       PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:   Srcid     Aremis  Relhgt   Width    Szinit
**                         g/s/m2
**                -------   ------  -------  ------
   SRCPARAM       PROJECT   0.00005    2       25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

For PM hot-spot analyses, CO pathway keywords needed between STARTING and FINISHED are:

- TITLEONE
- MODELOPT
- POLLUTID
- AVERTIME
- URBANOPT
- FLAGPOLE
- RUNORNOT

Keywords described on next slides

Control Pathway – TITLEONE

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-----------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

TITLEONE specifies a title line that will appear on each page of the printed output file (only first 68 characters will be printed)

Optional keyword TITLETWO can be used to add a second line

Control Pathway - MODELOPT

- Keyword MODELOPT controls the modeling options for a particular run through parameters

- Relevant parameters for PM hot-spot analyses:
  - CONC used to tell AERMOD to model concentrations (instead of deposition)
  - FLAT should be used to tell AERMOD that the terrain is flat (flat terrain assumed for most highway and transit projects)
    - DFAULT may be appropriate instead of FLAT when modeling certain nearby elevated sources; use interagency consultation
  - These parameters are secondary keywords so can be in any order

Control Pathway – MODELOPT

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**---------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**                Srcid     Srctyp  X1 Y1   X2 Y2
**                ------    ------  -- --   -- --
   LOCATION       PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:   Srcid     Aremis  Relhgt   Width    Szinit
**                         g/s/m2
**                -------   ------  -------  ------
   SRCPARAM       PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

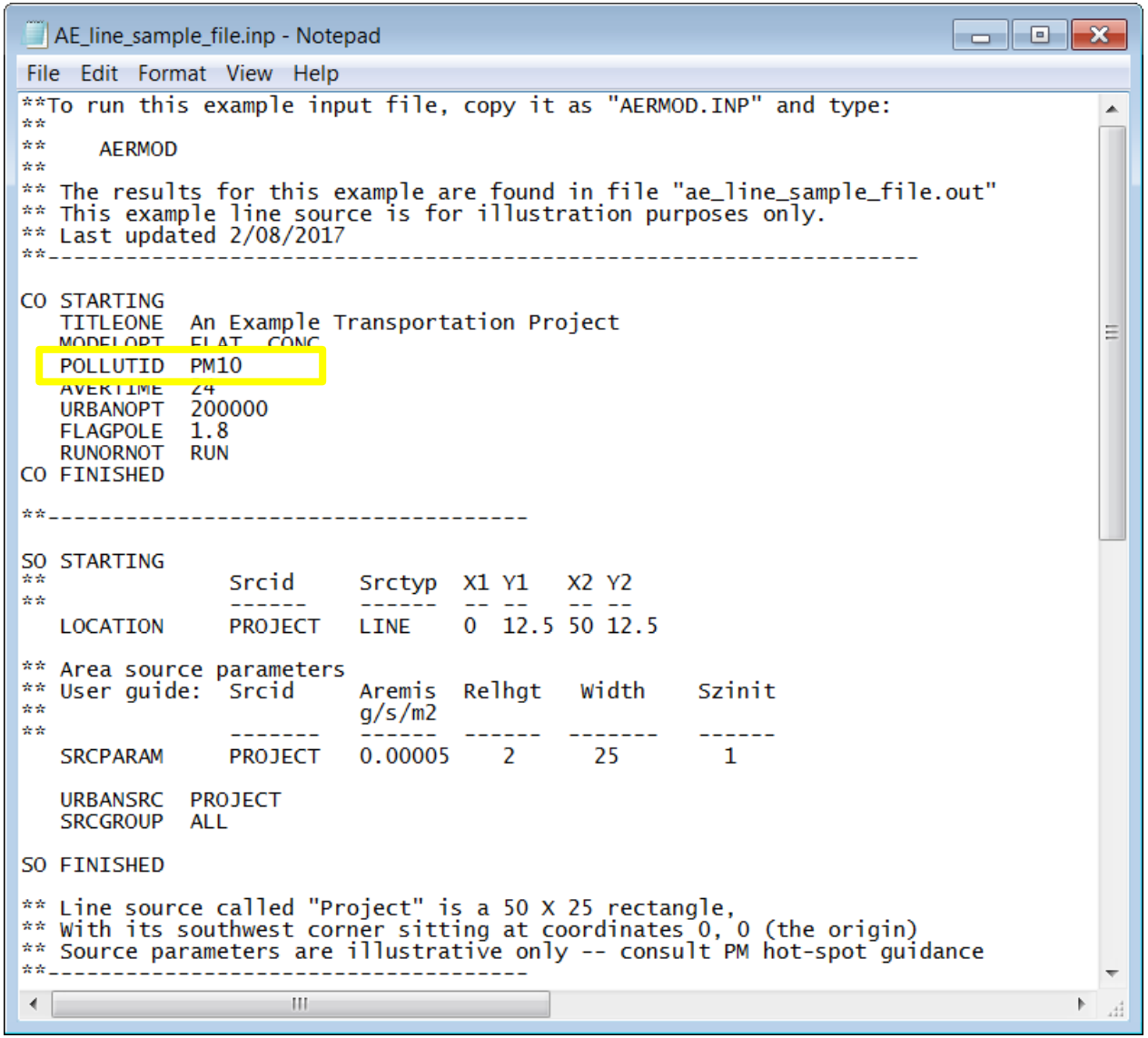
The sample input file tells AERMOD to model flat terrain and concentrations

(For numerical parameters, order matters; for secondary keywords CONC and FLAT, order doesn't matter)

Control Pathway - POLLUTID

- Keyword POLLUTID identifies which pollutant AERMOD is modeling
  - User can enter up to 8 characters (e.g., “PM2.5”)
    - $PM_{2.5}$ can be entered as: PM25, PM2.5, PM-2.5, PM-25
    - PM_{10} can be entered as: PM10, PM-10
  - Output will be labeled with what user enters
  - AERMOD has processing options that are specific to $PM_{2.5}$ and PM_{10}

Control Pathway – POLLUTID



Identifies which pollutant AERMOD is modeling: PM10

Control Pathway - AVERTIME

Keyword **AVERTIME** used to select averaging periods, with the time period following the keyword

NAAQS	Use:	Which will:
Annual $PM_{2.5}$	CO AVERTIME ANNUAL	Average concentrations over each year of met data, then averages these averages
24-hour $PM_{2.5}$	CO AVERTIME 24	Average across each 24-hour period from the available met data
24-hour PM_{10}	CO AVERTIME 24	Average across each 24-hour period from the available met data

Control Pathway – AVERTIME

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
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**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

The input file tells AERMOD to average concentrations over 24 hours

Control Pathway – URBANOPT

- Keyword URBANOPT tells AERMOD to incorporate urban effects on dispersion
  - URBANOPT should be selected based on the location of the project, not the met data site
  - Increases dispersion, because of urban heat island effect and surface roughness
  - Syntax for single urban areas:

    CO URBANOPT Urbpop (Urbname) (UrbRoughness)

  - Requires population of the urban area, e.g. “100000”
  - Use default value of 1 meter for UrbRoughness parameter (default is used when parameter omitted)
    - “Roughness” describes the amount of mechanical turbulence that wind faces when blowing across a surface

Control Pathway – URBANOPT

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**---------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

The input file tells AERMOD that the project is located in an urban area with a population of 200,000

Control Pathway - FLAGPOLE

- Keyword FLAGPOLE used to define receptor height
  - Followed by user-specified height to be applied to all receptors, unless specified in RE pathway
  - Usually 1.8 meters or less (*Q for class*: Why?)

- Note FLAGPOLE can be defined in the Control pathway for all receptors at once
  - Flagpole can also be defined in the Receptor pathway for each receptor/receptor grid

Control Pathway – FLAGPOLE

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

The input file tells AERMOD that all receptors will be 1.8 meters high

Control Pathway – RUNORNOT

- Keyword **RUNORNOT** tells the model whether to run, or to process setup information only

- Followed by "RUN" or "NOT"
  - RUN tells AERMOD to run full model calculations
    - Fatal flaws will halt the run; other potential errors will not
  - NOT tells AERMOD to process setup data and report errors, but no dispersion calculations will be made

*Tip: Set to **NOT**, review error and warning messages, then set to **RUN***

Control Pathway – RUNORNOT

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-----------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

The input file tells AERMOD to run (We know it works)

Control Pathway – Quick Exercise

- Complete (fill in the blanks) the Control pathway for an AERMOD run for a PM hot-spot analysis where:
  - The terrain is flat
  - The NAAQS of interest is annual PM2.5
  - The project will be located in a city with a population of 594,000
  - The receptors are at a typical breathing height

```
CO _____
CO TITLEONE _____________________________________
CO _____ FLAT ____
__ _____ _____
__ _____ _____
__ _____ 594000
CO FLAGPOLE ___
CO _____ NOT
CO FINISHED
```

Control Pathway – Quick Exercise

- Complete (fill in the blanks) the Control pathway for an AERMOD run for a PM hot-spot analysis where:
  - The terrain is flat
  - The NAAQS of interest is annual PM2.5
  - The project will be located in a city with a population of 594,000
  - The receptors are at a typical breathing height

```
CO STARTING
CO TITLEONE City PM2.5 hot-spot analysis
CO MODELOPT FLAT CONC
CO POLLUTID PM25
CO AVERTIME ANNUAL
CO URBANOPT 594000
CO FLAGPOLE 1.8
CO RUNORNOT NOT
CO FINISHED
```

Source Pathway

Pathway	Name	Description
CO	Control	Specifies job control options, to describe the run
SO	Source	Specifies emission sources information
RE	Receptor	Specifies receptor location information
ME	Meteorology	Specifies meteorology information
OU	Output	Specifies output options

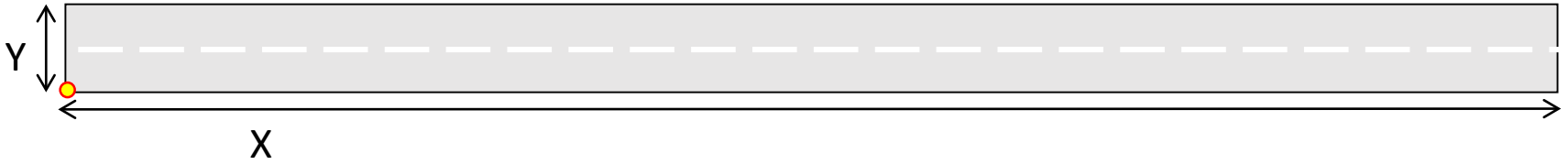
AERMOD Source Types

Source Type	Application to Transportation Projects
Point	bus garage or transit terminal exhaust stacks
Area	transit or freight terminals parking lots highways and intersections
Line	
Volume	
Open Pit	Could have application in specific situations; consult AERMOD User's Guide and EPA regional office (not covered in this course)

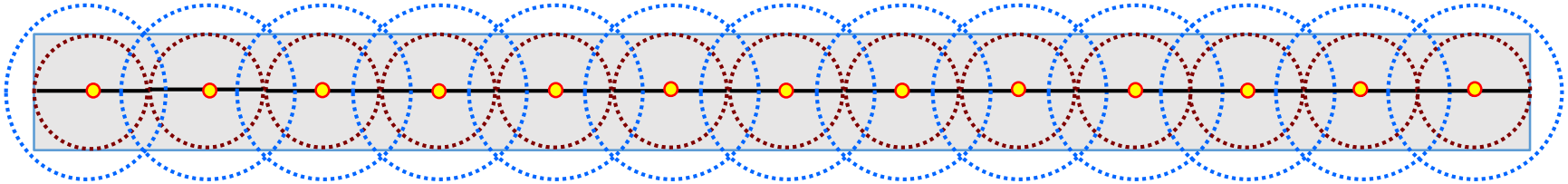
Transportation Projects as AERMOD Sources

- For modeling purposes, the *road* can be considered the source, rather than the vehicles
  - given turbulence created by vehicles, convection created by the road heating up, and other phenomena
- A road segment can be modeled as a **LINE source**:

- Or as an **AREA source:**



- Or as a series of **VOLUME sources:**



Transportation Projects as AERMOD Sources

- AERMOD sources are defined based on MOVES links
- Recall from earlier:
  - New link defined with changes in operating modes, speeds, or volumes
  - Each MOVES link will be at least one AERMOD source

- AERMOD sources should not be defined as the entire road
  - Travel in opposite directions should be modeled as different links in MOVES, and thus would be different sources in AERMOD

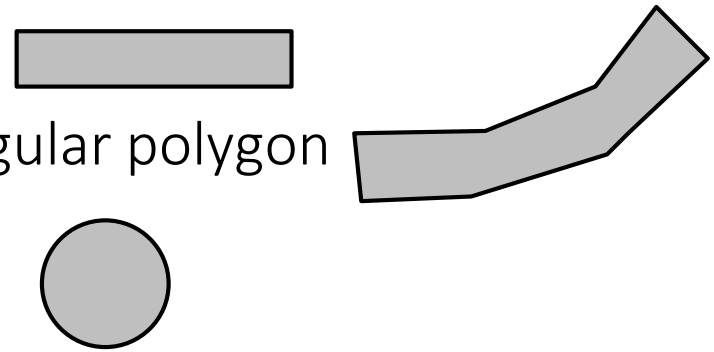
- But, an AERMOD source could include more than one lane in the same direction
  - Depends on how links were defined in MOVES, the type of AERMOD source, and width of the source

AERMOD Source Types

- Point – a single defined point of emissions, represented by a single coordinate
  - Stacks, isolated vents
  - Different configurations of point sources can be defined - see AERMOD User's Guide if the project involves a point source
  - Could apply to transportation projects, e.g.
    - Tunnel ventilation towers
    - Transit or other terminal exhaust stacks

AERMOD Source Types

- Area – emissions released over a geographic area rather than a single point, generally low-level and ground releases
  - AREA – defines a rectangle
  - AREAPOLY – defines an irregular polygon
  - AREACIRC – defines a circle



- Line – treated as a rectangular AREA source, with simpler inputs
  - Gives same result as AREA

- Transportation projects can be defined as a series of AREA sources or LINE sources

AERMOD Source Types

- Volume – sources where the plume has both initial horizontal and vertical dimensions at the time of the release
  - Transportation projects can also be defined as a series of Volume sources

- Open Pit – similar to area source, but emissions emanate from a depressed area or pit that has volume
  - Not covered in this module
  - Could be have application in transportation projects in specific situations, such as depressed roadways; consult AERMOD User's Guide and EPA regional office

Source Pathway – Keywords

- The Source pathway is where all links (and any other sources that need to be modeled) are described
- Source pathway keywords needed for PM hot-spot analyses:

SO STARTING
- LOCATION
- SRCPARAM
- URBANSRC
- EMISFACT
- SRCGROUP

SO FINISHED

Keywords are covered on subsequent slides

Source Pathway

- Each source, based on MOVES link, is defined by:
  - LOCATION: source ID, source type, and coordinates
  - SRCPARAM: meaning source parameters, including source ID, emissions rate, release height, and other defining parameters
    - Emission rate units depend on source type
      - POINT, VOLUME: grams/second
      - AREA, AREAPOLY, AREACIRC, LINE: grams/second/square meter
    - Other parameters include dimensions, orientation, initial dispersion parameters

- Another SO keyword, EMISFACT, can be used for each source to vary emissions with time

Source Pathway – Keywords

These 3 keywords must always be in this order:

- LOCATION
- SRCPARAM

} Keywords LOCATION and SRCPARAM needed for each source

- SRCGROUP - The last SO keyword before FINISHED

- LOCATION and SRCPARAM keywords can be ordered:

By keyword:	Or by source:
LOCATION LINK1…	LOCATION LINK1...
LOCATION LINK2...	SRCPARAM LINK1...
SRCPARAM LINK1...	LOCATION LINK2...
SRCPARAM LINK2...	SRCPARAM LINK2...

- A SRCGROUP keyword is needed for each group of sources (might be just one)

Source Pathway – LOCATION

- Keyword **LOCATION** identifies a single source ID (name), what type of source it is, and its location in x, y, (z) coordinates
  - Needed for each unique source (e.g., link)

POINT, AREA, VOLUME sources:

```
SO LOCATION  Srcid  Srctyp  x  y  (z)
```

LINE sources:

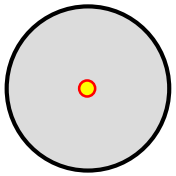
```
SO LOCATION  Srcid  LINE  x1  y1  x2  y2  (z)
```

- Srcid = user defined, alphanumeric id up to 12 characters
  - Tip: Base the source id on the MOVES link number, e.g., MOVES link 15 can be split into several source id's, each with a **LOCATION** statement (Srcid LINK15a, Srcid LINK15b etc.)
- Srctyp = POINT, AREA, VOLUME, etc.
- X, Y, Z coordinates; Z is optional and can be left out

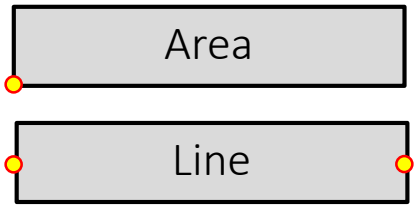
Source Pathway – LOCATION

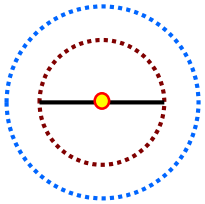
SO LOCATION Srcid Srctyp x y (z)		
Srctyp	Shape	Location of X,Y
POINT	Circle	Center of the stack
AREA	Rectangle	"Southwest corner," if no angle specified
VOLUME	3-D - could be sphere	Center of the source
AREAPOLY	User-defined; irregularly shaped polygon of 3 to 20 sides	First vertex; other vertices must be defined through Keyword AREAVERT
AREACIRC	Circular; modeled as a 20-sided polygon	Center of the circle (not often applicable to transportation projects; see AERMOD User's Guide)

LINE's LOCATION statement differs in format; see next slide



Point,
Areacirc





Volume

Source Pathway – LOCATION for **LINE** Sources

- **LINE** added to AERMOD in 2012
  - An alternative to **AREA** source type for rectangular sources
  - Produces identical results as **AREA** for equivalent source inputs
  - Specify start and end points of the line in LOCATION
  - Specify width in SRCPARAM

- SO LOCATION Srcid LINE xs1 ys1 xs2 ys2 (z)
  - Srcid = user defined, alphanumeric id up to 12 characters
  - Xs1, Ys1 are the coordinates for the midpoint of one end of the line; Xs2, Ys2 are the coordinates for the midpoint of the other end
  - Z is optional and can be left out

Source Pathway – LOCATION

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
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**
**    AERMOD
**
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** Last updated 2/08/2017
**-------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**                Srcid     Srctyp  X1 Y1   X2 Y2
**
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------  ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

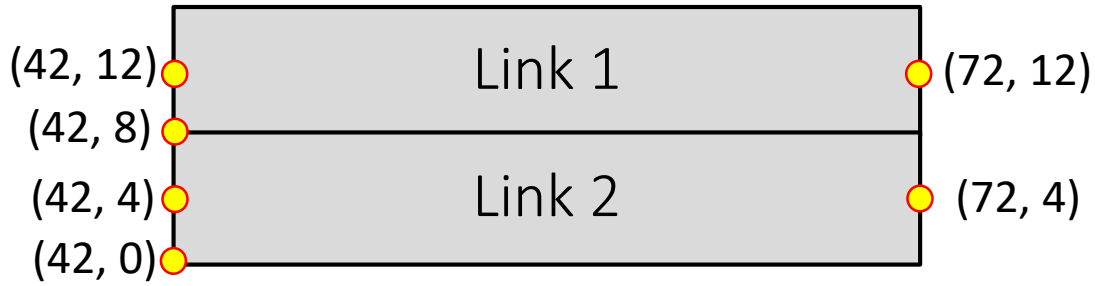
LOCATION

...the source id "PROJECT" is a LINE source with coordinates of (0, 12.5) and (50, 12.5)

The LINE source is 50 m long

Source Pathway – LOCATION

- Complete the LOCATION statement for Link1 and Link2, which are rectangular road segments



As AREA sources:

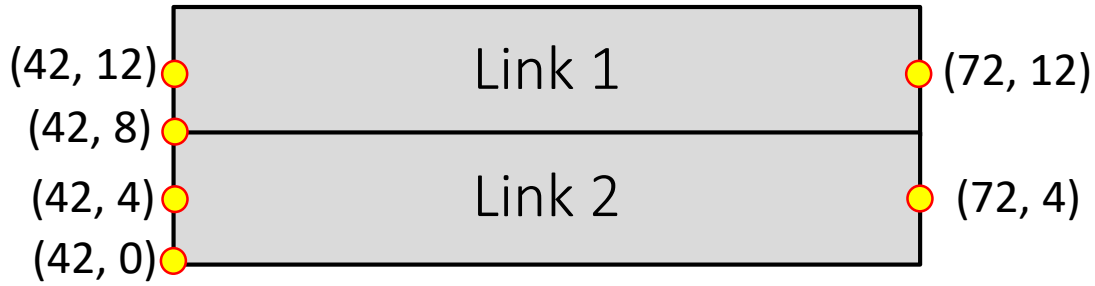
```
SO LOCATION LINK1 _____ __ __
SO LOCATION _____ _____ __ __
```

As LINE sources:

```
SO LOCATION LINK1 _____ __ __ __ __
SO LOCATION _____ _____ __ __ __ __
```

Source Pathway – LOCATION

- Complete the LOCATION statement for Link1 and Link2, which are rectangular road segments



As AREA sources:

```
SO LOCATION LINK1 AREA 42 8
SO LOCATION LINK2 AREA 42 0
```

As LINE sources:

```
SO LOCATION LINK1 LINE 42 12 72 12
SO LOCATION LINK2 LINE 42  4 72  4
```

Source Pathway – SRCPARAM

- Keyword SRCPARAM specifies source parameters for a particular source ID (named in a previous LOCATION statement)
  - e.g., how much the source emits
  - Will be needed for each unique source id

- Parameters that follow SRCPARAM vary based on source type
- All begin with id, emissions rate, and release height:

Srctyp	*SRCPARAM Statement:*
POINT	**SO SRCPARAM Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia**
AREA	**SO SRCPARAM Srcid Aremis Relhgt Xinit Yinit Angle Szinit**
AREAPOLY	**SO SRCPARAM Srcid Aremis Relhgt Nverts (Szinit)**
LINE	**SO SRCPARAM Srcid Lnemis Relhgt Width Szinit**
VOLUME	**SO SRCPARAM Srcid Vlemis Relhgt Syinit Szinit**

Source Pathway – SRCPARAM **Point** Sources

- Syntax for keyword **SRCPARAM** for POINT sources:

SO SRCPARAM Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia

  - **Srcid** – use same alphanumeric identifier as in **LOCATION**
  - **Ptemis** – emission rate in g/s
  - **Stkhgt** – release height above ground in meters
  - **Stktmp** – stack gas exit temperature in kelvin
  - **Stkvel** – stack gas exit velocity in meters per second
  - **Stkdia** – stack inside diameter in meters

Transportation Examples of Point Sources

- Tunnel ventilation towers
- Transit or other terminal exhaust stacks

Source Pathway – **Point** Sources

- May also need to address building downwash
  - Air mixing downward on the downwind side of a building

- AERMOD can model the effects through the BPIPPRIME building downwash pre-processor

- Not covered in this training (see AERMOD User Guide)

Source Pathway – SRCPARAM **Area** Sources

SO SRCPARAM Srcid Aremis Relhgt Xinit Yinit Angle Szinit

- **Srcid** = use same alphanumeric identifier as in **LOCATION**
- **Aremis** = area emission rate in g/s/m^2
- **Relhgt** = release height above ground in meters
- **Xinit** = length of X side, the side that is *counterclockwise* from the vertex defined by (X,Y) in meters
- **Yinit** = length of Y side, the side that is *clockwise* from (X,Y) in meters
  - If width & length differ by more than 100 x, AERMOD produces a warning message ; does not affect model run
- **Angle** = orientation angle for rectangular area (in deg from north, measured positive clockwise)
- **Szinit** = initial vertical dispersion coefficient in meters

- More about Area sources in the module appendix

Source Pathway – SRCPARAM **LINE** Sources

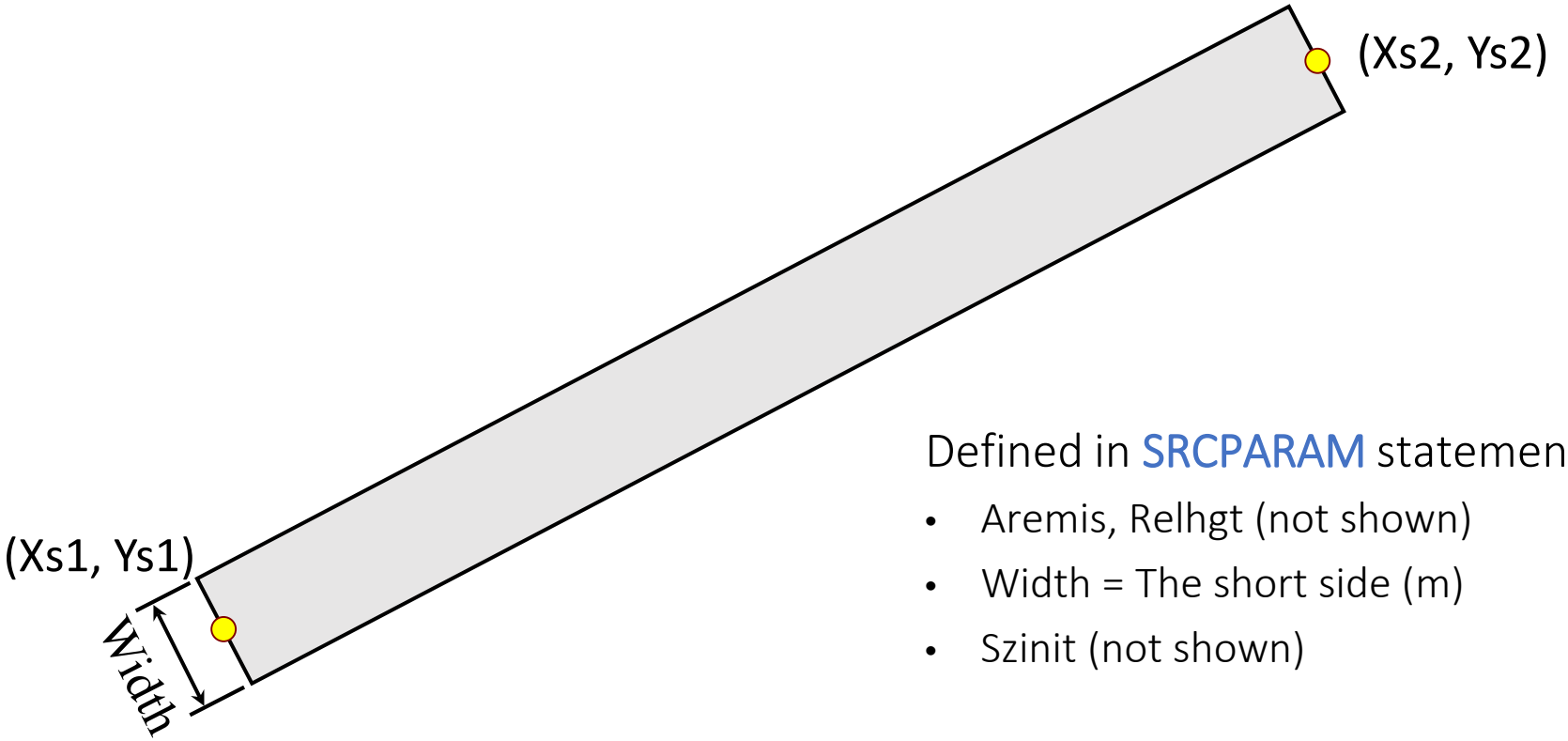
SO SRCPARAM Srcid Lnemis Relhgt Width Szinit

- **Srcid** = use same alphanumeric identifier as in **LOCATION**
- **Lnemis** = area emission rate in g/s/m^2
- **Relhgt** = release height above ground in meters
- **Width** = width of the source (travel lane(s)) in meters
  - If width & length differ by more than 100 x, AERMOD produces a warning message ; does not affect model run
- **Szinit** = "initial sigma Z" = initial vertical dispersion coefficient in meters

A Highway Link as a **LINE**-type **Area** Source

Defined in LOCATION statement:

- Xs1, Ys1, Xs2, Ys2 = Coordinates of midpoint of ends



Defined in SRCPARAM statement:

- Aremis, Relhgt (not shown)
- Width = The short side (m)
- Szinit (not shown)

Area and Line Source Emission Rate

- Emission information from MOVES, e.g., from the two MOVES mini-runs:

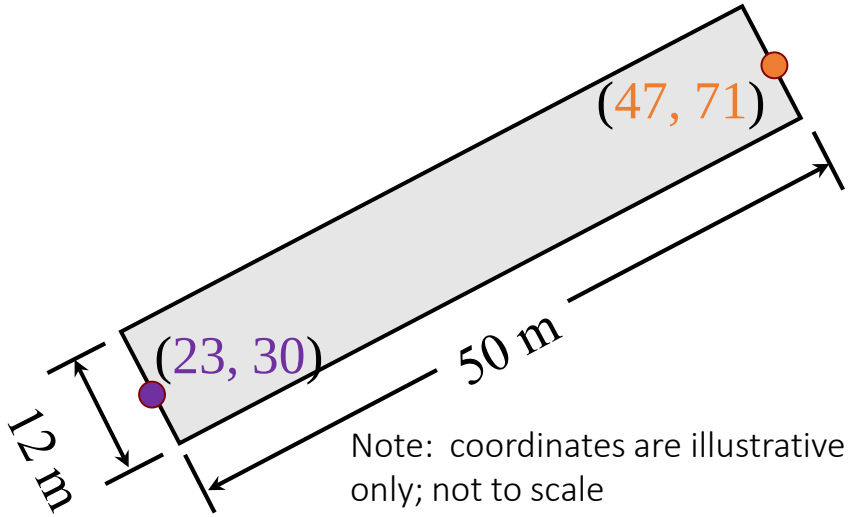
movesRunID	linkID	pollutantID	gramsPerHour
1	1	Total PM10	9.1084408434...
1	2	Total PM10	8.5155121996...
2	1	Total PM10	6.9325177883...
2	2	Total PM10	6.3830091860...

- *Q for class:* what other information do we need to convert MOVES output for an AERMOD input file?

(recall Aremis and Lnemis = area emission rate in g/s/m^2)

Source Pathway – Quick Exercise

- Complete the LOCATION and SRCPARAM statements for this source using LINE
  - Source emits 0.00042 g/s/m^2
  - From a release height of 2.5 m
  - Szinit is 1.5 m

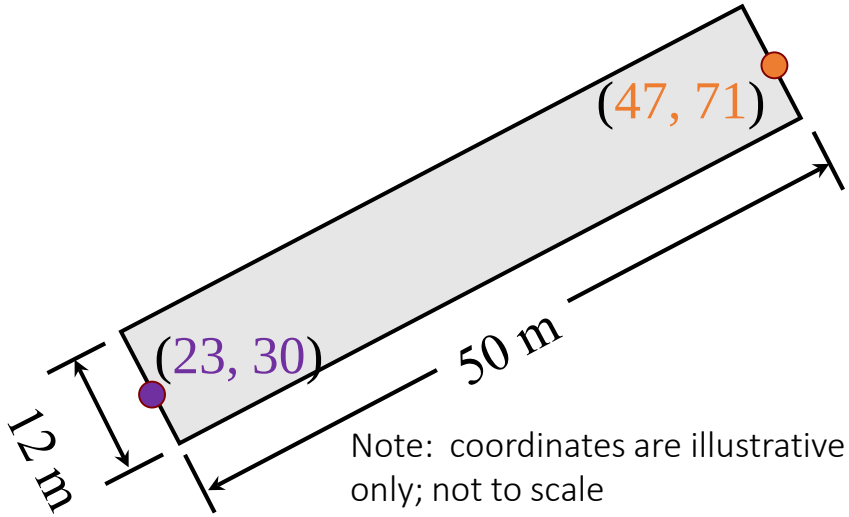


- If srctyp **LINE** is used:

```
SO ___________ LINK3A _____ __ __ __ __
SO SRCPARAM   LINK3A _______ 2.5 __ ___
```

Source Pathway – Quick Exercise

- Complete the LOCATION and SRCPARAM statements for this source using LINE
  - Source emits 0.00042 g/s/m^2
  - From a release height of 2.5 m
  - Szinit is 1.5 m



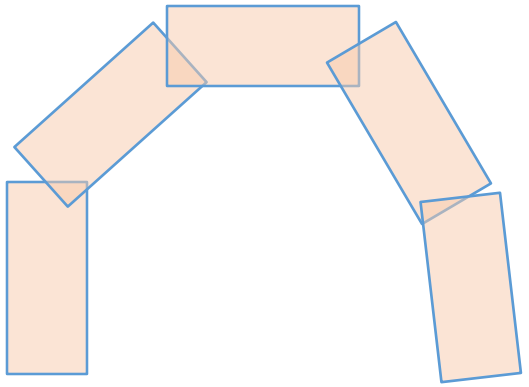
- If srctyp **LINE** is used:

```
SO LOCATION  LINK3A LINE 23 30 47 71
SO SRCPARAM  LINK3A 0.00042 2.5 12 1.5
```

Acceptable Approaches: **AREA** and **AREAPOLY**

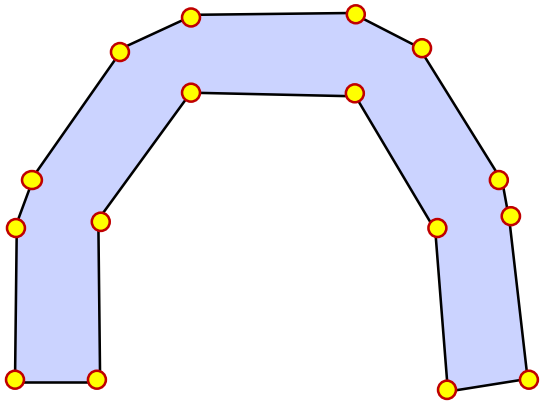
- When **AREA** is used for roadways, minimize gaps and overlaps between sources
  - Gaps can result in underestimated concentrations
  - Overlaps can result in overestimated concentrations

A curved link can be defined with **AREA** sources:



- **AREAPOLY** allows user to define source shapes more precisely
  - User defines specific coordinates of vertices (dots)
  - Commercial AERMOD interfaces may allow user to define shapes easily

The same curved link can be defined with **AREAPOLY**:



Source Pathway – SRCPARAM **Areapoly**

- Syntax for keyword SRCPARAM for **AREAPOLY** sources:

  SO SRCPARAM Srcid Aremis Relhgt Nverts (Szinit)

  - Srcid = use same alphanumeric identifier as in **LOCATION**
  - Aremis = area emission rate in $g/s/m^2$
  - Relhgt = release height above ground in meters
  - Nverts = number of vertices (or sides) of the area source polygon
  - Szinit = initial vertical dispersion coefficient in meters

- Syntax for keyword AREAVERT for **AREAPOLY** sources:

  SO AREAVERT Srcid Xv(1) Yv(1) Xv(2) Yv(2)... Xv(i) Yv(i)

  - Xv(i) and Yv(i) are the x- and y- coordinates of the vertices of the area source polygon
  - There must be Nverts pairs of coordinates for the area source
  - First vertex, Xv(1), Yv(1), must match x, y in **LOCATION** statement
  - Remaining vertices may be defined either clockwise or counter-clockwise

Source Pathway – Release Height (Relhgt)

- May be estimated from the midpoint of the initial vertical dimension:
  - For moving light-duty vehicles, 1.3 meters
  - For moving heavy-duty vehicles, 3.4 meters

Source Pathway – Release Height (Relhgt)

- Release height of mixed fleets may be estimated using an emissions-weighted average:
  - Emissions-weighted average: e.g.,

    Light-duty = 40% of emissions

    Heavy-duty = 60% of emissions,

    Source release height = (0.4 * 1.3) + (0.6 * 3.4) = 2.6 meters

- Or, could use two sources in the same location, one for light duty emissions and one for heavy duty emissions, which would have different release heights

Source Pathway – Guidance on Szinit

Initial Vertical Dispersion Coefficient, or Szinit = initial vertical dimension/2.15

- Assume the *initial vertical dimension* is about 1.7 times the average vehicle height, to account for the effects of vehicle-induced turbulence:
  - Init vertical dimension for Light-duty vehicles: 2.6 meters = (1.5 m x 1.7)
  - Init vertical dimension for heavy-duty vehicles: 6.8 meters = (4 m x 1.7)
- For mixed fleets,
  - Either: estimate the initial vertical dimension using an emissions-weighted or volume-weighted average, e.g.:
    - Light-duty vehicles= 40% of emissions
    - Heavy duty vehicles = 60% of emissions
    - Initial vertical dimension of source = (0.4 * 2.6) + (0.6 * 6.8) = 5.1 meters
  - Or: use two sources in the same location, one for light duty emissions and one for heavy duty emissions
- Calculate Initial Vertical Dispersion Coefficient (Szinit)
  - Divide the *initial vertical dimension* of the source by 2.15
  - For this example, Szinit = 5.1/2.15 = 2.37

Source Pathway – SRCPARAM

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
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**    AERMOD
**
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** Last updated 2/08/2017
**-------------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

SRCPARAM

The source "PROJECT"

- Emits 0.00005 g/s/m2, (the base emission rate)
- Release height = 2 m
- Dimensions are 50 m x 25 m (length in LOCATION; width in SRCPARAM)
- Initial sigma z of 1 m

Note: parameters are illustrative only; consult PM hot-spot guidance

Source Pathway – SRCPARAM **Volume** Sources

SO SRCPARAM Srcid Vlemis Relhgt Syinit Szinit

- Srcid = use same identifier as in **LOCATION**
- Vlemis = volume emission rate in g/s
- Relhgt = release height (center of volume) above ground in meters
- Syinit = initial lateral dispersion coefficient (i.e., length of Y side divided by 2.15) of the volume in meters
- Szinit = initial vertical dispersion coefficient (i.e., vertical dimension divided by 2.15) of volume in meters

- See PM hot-spot guidance for more information

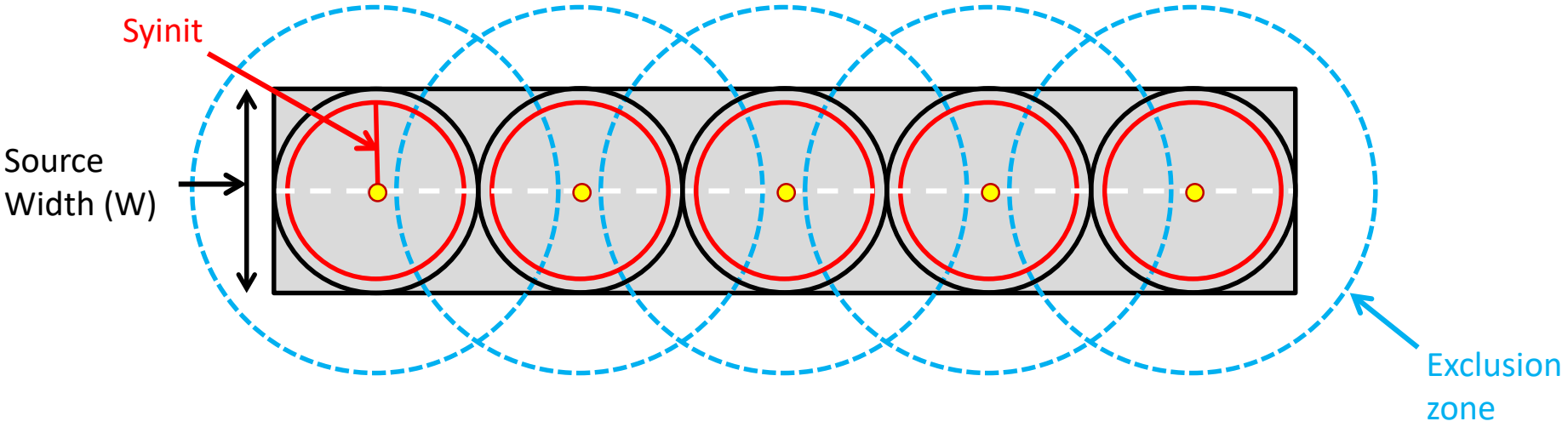
A Highway Link as a Series of **Volume** Sources

Defined in LOCATION statement:

- Xs, Ys = Coordinates of volume source center

Defined in SRCPARAM statement:

- Vlemis, Relhgt (not shown)
- Syinit = Initial lateral dispersion coefficient, (W / 2.15)
- Szinit = Initial vertical dispersion coefficient (not shown)



- Exclusion zone (radius = Syinit * 2.15 + 0.99 m)

Volume Sources

Issues to consider when using volume sources:

1. Source width

2. Spacing

Volume Sources: Appropriate Width

- Exclusion zone radius = Syinit * 2.15 + 0.99 m
- Receptors should not be placed within exclusion zone
  - based on EPA guidance from OAQPS
  - concentrations are not calculated within it
- Receptors should be sited as near as 5 m from a source (e.g., the edge of a traffic lane)
- Because of the exclusion zone, the width of a volume source should be **< 8 m**
  - Typical highway lane = 12 ft (3.6 m)
- Model any 3 lane or larger highway using
  - Volume sources for each lane, or
  - Area sources

Lane Width

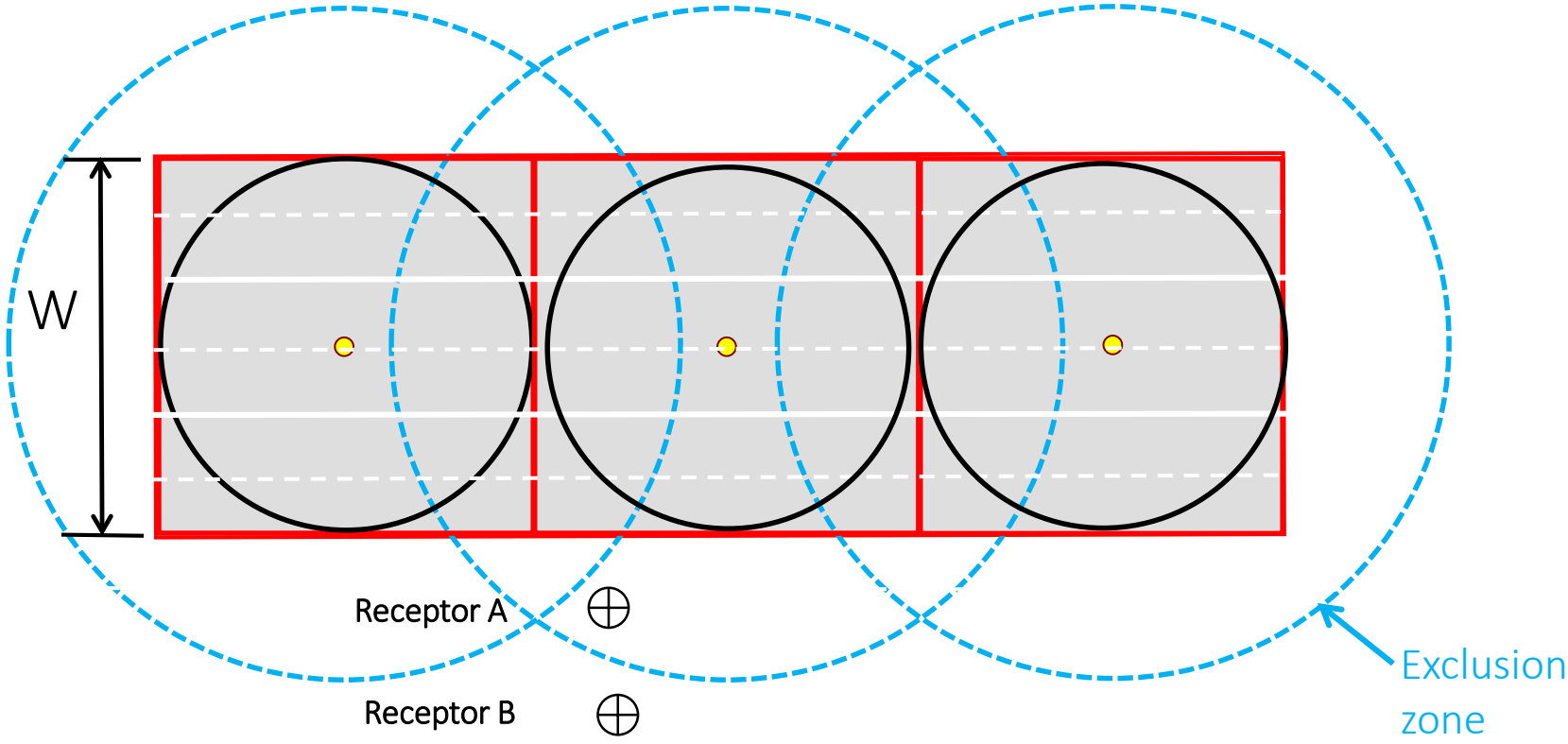
Ranges for Lane Width

Type of Roadway	Rural		Urban	
	US (feet)	Metric (meters)	US (feet)	Metric (meters)
Freeway	12	3.6	12	3.6
Ramps (1-lane)	12-30	3.6-9.2	12-30	3.6-9.2
Arterial	11-12	3.3-3.6	10-12	3.0-3.6
Collector	10-12	3.0-3.6	10-12	3.0-3.6
Local	9-12	2.7-3.6	9-12	2.7-3.6

(Source: A Policy on Geometric Design of Highways and Streets, AASHTO) Found at https://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.cfm

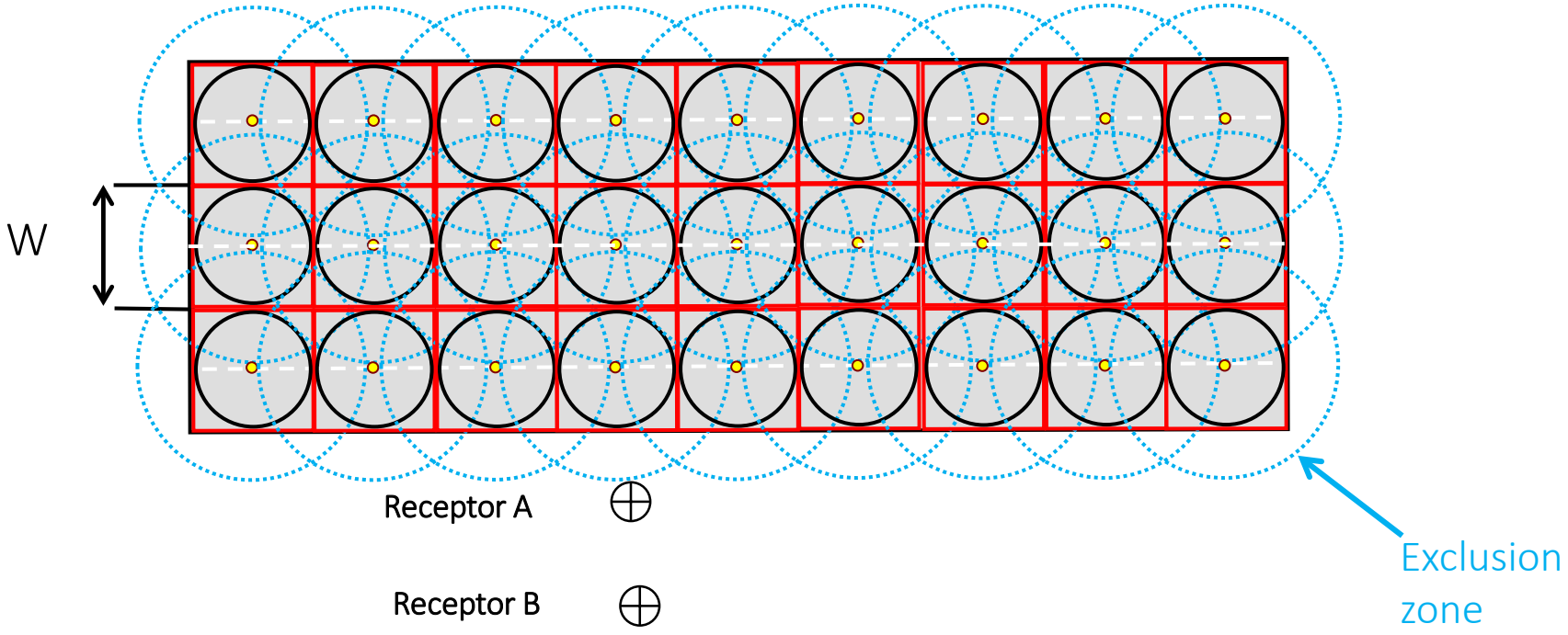
Incorrect Volume Source Width

- Volume sources are too wide (W = source width)
  - Excludes area where receptors should be placed



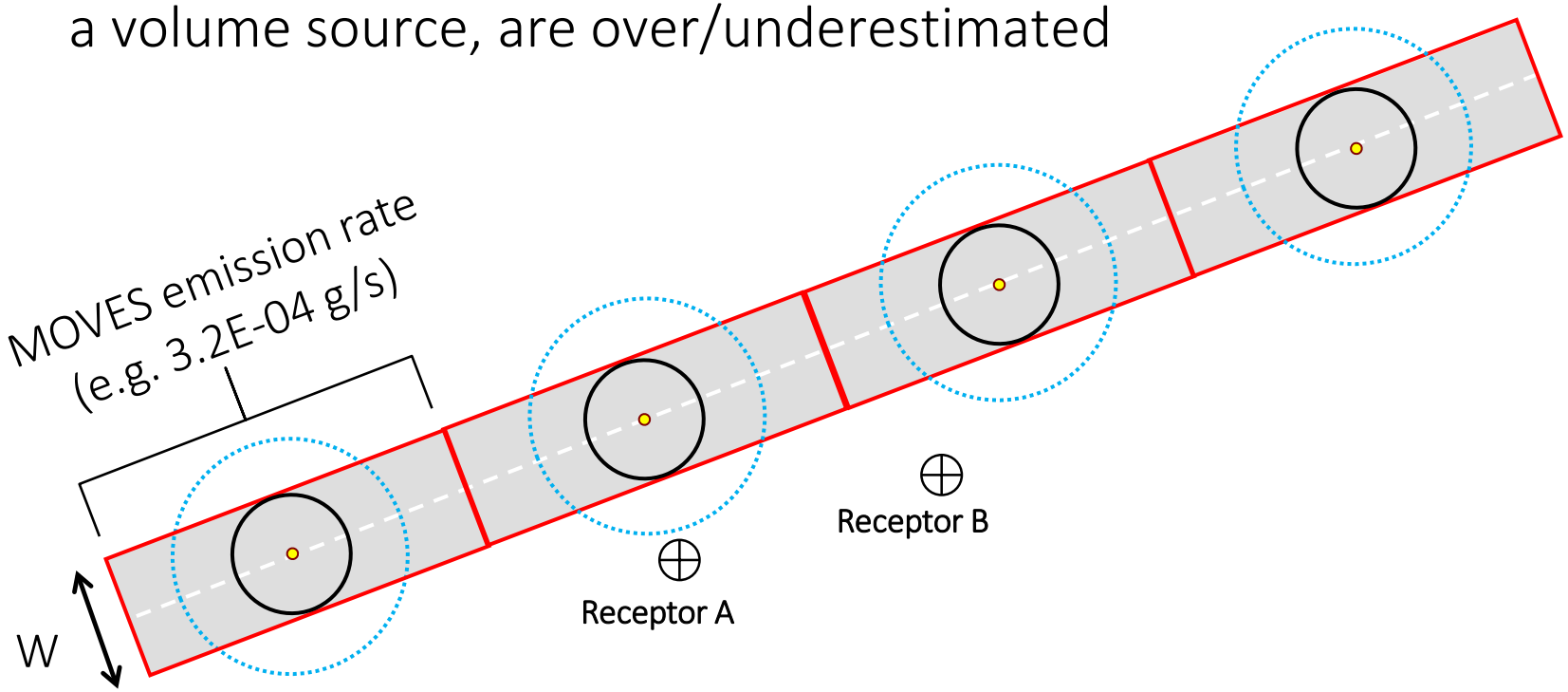
Correct Volume Source Width

- Volume sources are no more than 8 m wide
  - Receptor A is no longer in the exclusion zone



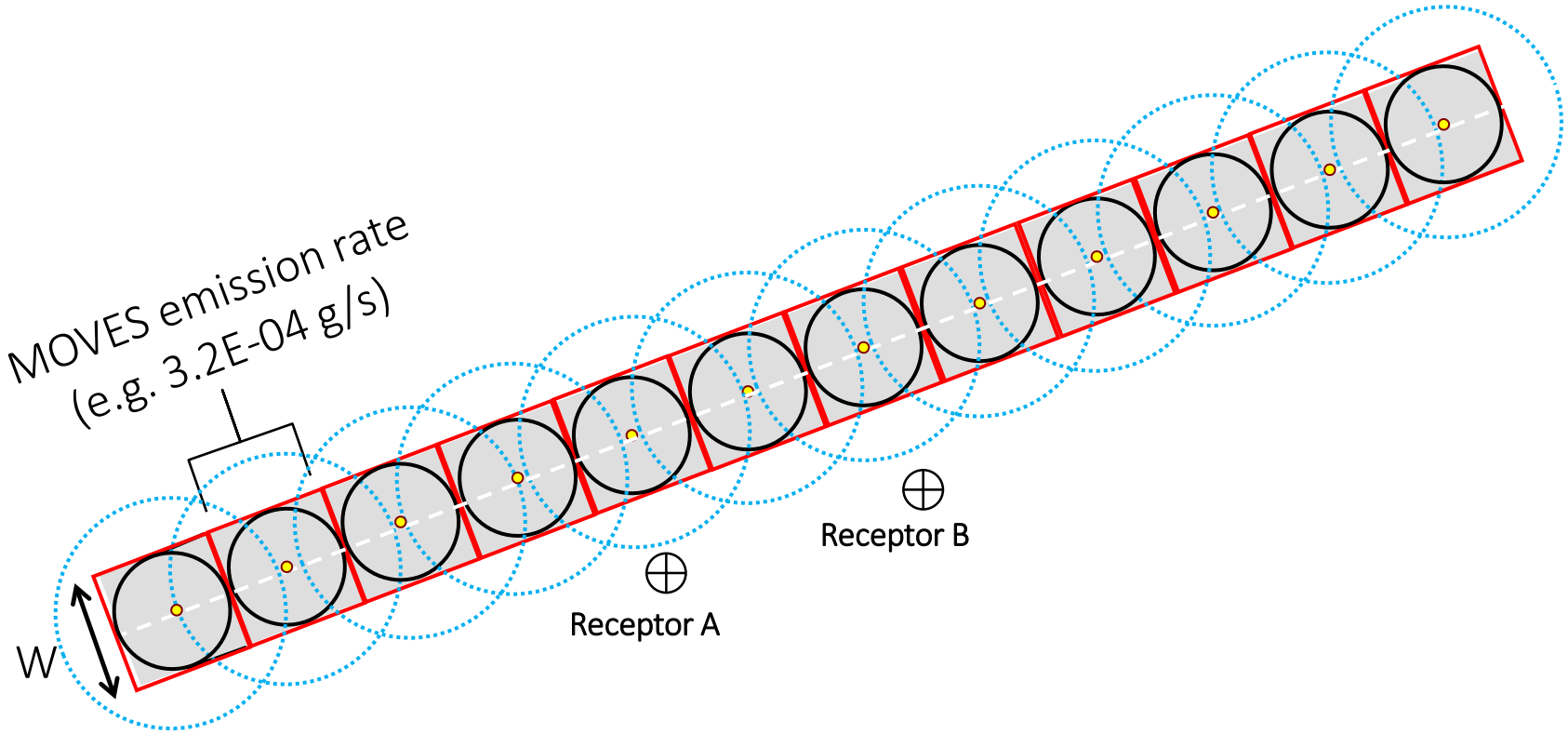
Incorrect Volume Source Spacing

- Volume sources are spaced too far apart, which creates a non-uniform emission characterization
- Adjacent receptors, depending on their proximity to the center of a volume source, are over/underestimated



Correct Volume Source Spacing

- Adjacent volume sources, spaced properly, create an even emissions characterization



Additional Options for **Line/Area** and **Volume** Sources

- For source representing both light-duty (LD) and heavy-duty (HD) vehicles, AERMOD allows Syinit, Szinit, and Relhgt to change by hour of the day
  - May want to consider if % of heavy-duty vehicles changes significantly through day
  - See the PM hot-spot guidance and AERMOD User's Guide for more information; use interagency consultation to discuss

- As mentioned, an alternative approach to modeling light-duty and heavy-duty sources could be to create two sources in the same location, one representing LD and the second HD traffic
  - Assign Syinit, Szinit, and Relhgt specific to light-duty or heavy-duty traffic for each link
  - **SRCGROUP** allows tracking HD & LD contributions separately

Source Pathway – URBANSRC

- Keyword URBANSRC defines which sources will emit under urban dispersion conditions
  - When keyword **URBANOPT** is used in **CO** pathway, keyword **URBANSRC** is used in **SO** pathway

- SO URBANSRC Source IDs and/or Source Ranges
  - SrcRanges can be used with Source IDs that vary by number (e.g., "LINK1–LINK12")
- SO URBANSRC ALL
  - When there is only one urban area, and all sources should be treated as urban (most cases)

- Examples:

  SO URBANSRC LINK1 LINK2 LINK3 LINK4 LINK5

  SO URBANSRC ALL

Source Pathway – URBANSRC

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-----------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

Use of Keyword URBANSRC

- Indicates that source “PROJECT” is an Urban source
- There is only one source in this input file

Source Pathway – EMISFACT

- Keyword EMISFACT varies emission rates by season, hour of day, etc.
  - Allows use of MOVES or EMFAC emission factors in AERMOD input file

- SO EMISFACT Srcid or SrcRange Qflag Qfact(i)
  - Qflag (secondary keyword) indicates how emissions will vary:
    - SEASON – seasonally (n=4)
    - MONTH – monthly (n=12)
    - HROFDY – by hour-of-day (n=24)
    - SEASHR – season by hour-of-day (n=96)
    - SHRDOW –season by hour-of-day and day-of-week (M-F, Sat, Sun) (n=288)
    - SHRDOW7 –season by hour-of-day by day-of-week, seven days of week (n=672)
  - Qfact(i), i=1, n: the array of factors, the number of which vary depending on Qflag, which tell AERMOD how to adjust the emissions rate

Source Pathway – EMISFACT

- Guidance recommends using **SEASHR** for MOVES output by season and hour for typical traffic data
  - **SEASHR** – season by hour-of-day (n=96)
  - Seasons defined in the following order:
    - Winter (Dec., Jan., Feb.)
    - Spring (Mar., Apr., May)
    - Summer (Jun., Jul., Aug.)
    - Fall (Sep., Oct., Nov.)
  - If additional data available, use **SHRDOW** or **SHRDOW7** to provide more detail
    - **SHRDOW** –season by hour-of-day and day-of-week (M-F, Sat, Sun) (n=288)
    - **SHRDOW7** –season by hour-of-day by day-of-week, seven days of week (n=672)

Source Pathway – EMISFACT

Example showing **EMISFACT** with **SEASHR** (factors by season, and hour of day)

SEASHR factors begin with Winter, hour ending 1 a.m. (i.e., midnight to 1 a.m.)

```
SO EMISFACT LINK1    SEASHR 0.37 0.37 0.37 0.37 0.37 0.37 0.79 0.79
SO EMISFACT LINK1    SEASHR 0.79 0.45 0.45 0.45 0.45 0.45 0.45 0.45
SO EMISFACT LINK1    SEASHR 0.27 0.27 0.27 0.37 0.37 0.37 0.37 0.37
SO EMISFACT LINK1    SEASHR 0.37 0.37 0.37 0.37 0.37 0.37 0.79 0.79
SO EMISFACT LINK1    SEASHR 0.79 0.45 0.45 0.45 0.45 0.45 0.45 0.45
SO EMISFACT LINK1    SEASHR 0.27 0.27 0.27 0.37 0.37 0.37 0.37 0.37
SO EMISFACT LINK1    SEASHR 0.37 0.37 0.37 0.37 0.37 0.37 0.79 0.79
SO EMISFACT LINK1    SEASHR 0.79 0.45 0.45 0.45 0.45 0.45 0.45 0.45
SO EMISFACT LINK1    SEASHR 0.27 0.27 0.27 0.37 0.37 0.37 0.37 0.37
SO EMISFACT LINK1    SEASHR 0.37 0.37 0.37 0.37 0.37 0.37 0.79 0.79
SO EMISFACT LINK1    SEASHR 0.79 0.45 0.45 0.45 0.45 0.45 0.45 0.45
SO EMISFACT LINK1    SEASHR 0.27 0.27 0.27 0.37 0.37 0.37 0.37 0.37
```

Winter factors

Spring factors

Summer factors

Fall factors

Three lines used for each season only for readability purposes; use any number of lines for each source

Source Pathway – EMISFACT

- The 96 factors following **SEASHR** (4 seasons, 24 hours) vary the emission rate defined for each source
  - E.g., if SEASHR factor = 0.9, and
  - Source emission rate = 5 g/s/m^2,
  - AERMOD calculates that the source emits 4.5 g/s/m^2 in that specific hour and season

- ***Tip**: Define the emission rate = 1; then in **SEASHR** use MOVES emission factors (e.g., in g/s/m^2) from the 16 runs*

Question for class: In what statement is the emission rate defined?

- Keyword: _____

Source Pathway – EMISFACT

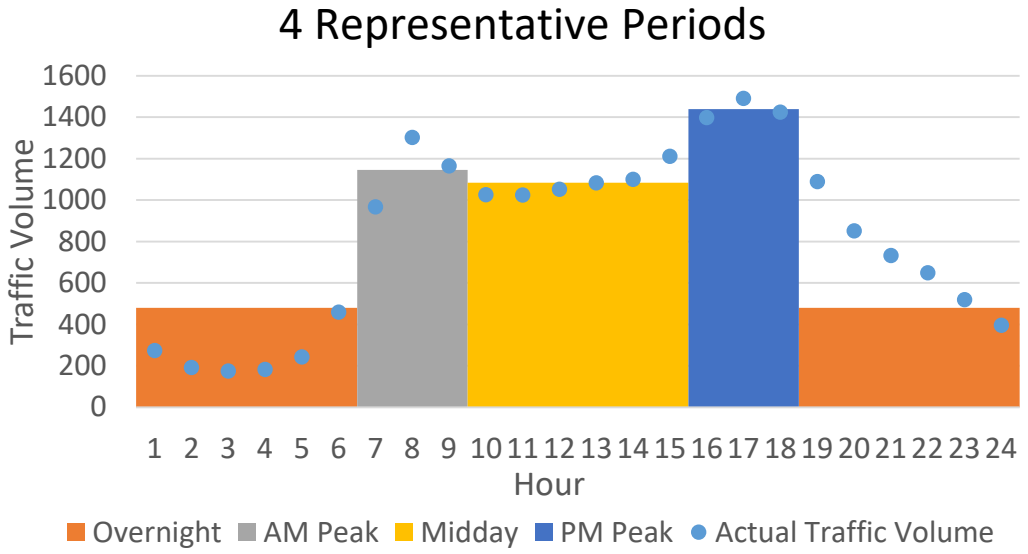
- **SEASHR** factors will be derived from MOVES output (quarters, hours)
  - Winter (Dec., Jan., Feb.): factors based on Jan MOVES runs
  - Spring (Mar., Apr., May): factors based on April MOVES runs
  - Summer (Jun., Jul., Aug.): factors based on July MOVES runs
  - Fall (Sep., Oct., Nov.): factors based on October MOVES runs

- For each of 4 quarters/seasons, you have four MOVES runs for weekday time periods:
  - Morning peak (AM)
  - Midday (MD)
  - Evening peak (PM)
  - Overnight (ON)

Source Pathway – EMISFACT

From *Module 2*, one suggested approach:

- Use morning peak MOVES run for 6 – 9 am
- Use midday MOVES run for 9 am – 4 pm
- Use evening peak MOVES run for 4 – 7 pm
- Use overnight MOVES run for 7 pm – 6 am



Fill in factors for 24 hours of Winter, if base emissions rate = 1 and MOVES output is as follows:

- Morning peak: 0.025
- Midday: 0.013
- Evening peak: 0.027
- Overnight: 0.011

SO EMISFACT LINK1 SEASHR _____ _____ _____ _____ _____ _____ _____ _____

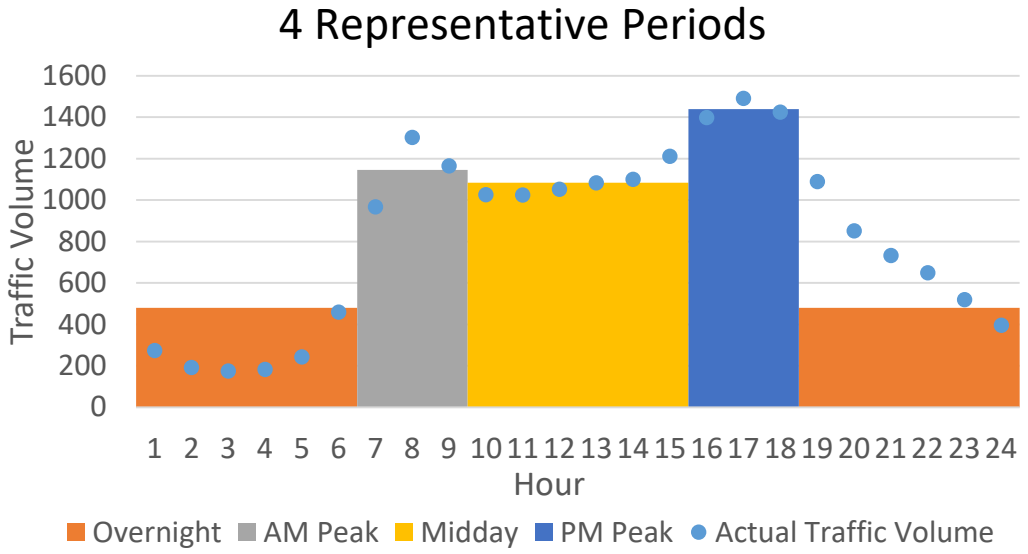
SO EMISFACT LINK1 SEASHR _____ _____ _____ _____ _____ _____ _____ _____

SO EMISFACT LINK1 SEASHR _____ _____ _____ _____ _____ _____ _____ _____

Source Pathway – EMISFACT

From *Module 2*, one suggested approach:

- Use morning peak MOVES run for 6 – 9 am
- Use midday MOVES run for 9 am – 4 pm
- Use evening peak MOVES run for 4 – 7 pm
- Use overnight MOVES run for 7 pm – 6 am



Fill in factors for 24 hours of Winter, if base emissions rate = 1 and MOVES output is as follows:

- Morning peak: 0.025
- Midday: 0.013
- Evening peak: 0.027
- Overnight: 0.011

```
SO EMISFACT LINK1  SEASHR 0.011 0.011 0.011 0.011 0.011 0.011 0.025 0.025
SO EMISFACT LINK1  SEASHR 0.025 0.013 0.013 0.013 0.013 0.013 0.013 0.013
SO EMISFACT LINK1  SEASHR 0.027 0.027 0.027 0.011 0.011 0.011 0.011 0.011
```

Source Pathway – EMISFACT

Note that:

```
SO EMISFACT LINK1  SEASHR 0.011  0.011  0.011  0.011  0.011  0.011  0.025  0.025
SO EMISFACT LINK1  SEASHR 0.025  0.013  0.013  0.013  0.013  0.013  0.013  0.013
SO EMISFACT LINK1  SEASHR 0.027  0.027  0.027  0.011  0.011  0.011  0.011  0.011
```

Could be also be written as:

```
SO EMISFACT LINK1  SEASHR  6*0.011  3*0.025  7*0.013  3*0.027  5*0.011
```

- This could be easier and may help avoid errors
- Ensure the numbers you are using to multiply rates (e.g., 6, 3, 7, 3, 5) sum to 24

Source Pathway – EMISFACT

- A unique EMISFACT table is needed for each source
- For class discussion:
  - MOVES "Link15" (curve) is divided into three AERMOD sources: Link15a, Link15b, and Link15c

For each season and hour, would the emissions rate for Link15 in g/s/m^2 apply to all three AERMOD sources? **Yes**

Should the g/s/m^2 emissions rate be divided by 3, since there are three sources? Why or why not? **No…**

The 3 sources will each have a different area (different number of square meters), but ***the same emission rate per square meter****.*

Will the EMISFACT tables for each of these three sources be different or identical? **Identical**

Source Pathway – SRCGROUP

- Keyword SRCGROUP groups contributions from particular sources together

  SO SRCGROUP GroupID (SourceIDs and/or SrcRanges)
  - "GroupID" is a user provided name
  - SourceIDs are the same as used in **LOCATION**
  - SrcRanges can be used with SourceIDs that vary by number

- There must be at least one source group, which may be **all** sources:

  SRCGROUP ALL

- *SRCGROUP must be the last keyword in the SO pathway before FINISHED*

Source Pathway – SRCGROUP

- Users may want to separate contributions of various sources, for example:
  - Terminal / highway contributions

    SRCGROUP HIGHWAY EBI40 WBI40 (shows source IDs)

    SRCGROUP TERMINAL TERM1-TERM4 (shows SrcRange)

  - Project / nearby source contributions

    SRCGROUP PROJECT LINK1-LINK15 (shows SrcRange)

    SRCGROUP PORT PORT1-PORT8 (shows SrcRange)

  - Light-duty / heavy-duty traffic (if modeled separately)

    SRCGROUP CAR LGT1-LGT12 (shows SrcRange)

    SRCGROUP TRUCK HVY1-HVY12 (shows SrcRange)

Source Pathway – SRCGROUP

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
**To run this example input file, copy it as "AERMOD.INP" and type:
**
**    AERMOD
**
** The results for this example are found in file "ae_line_sample_file.out"
** This example line source is for illustration purposes only.
** Last updated 2/08/2017
**-----------------------------------------------------------------

CO STARTING
   TITLEONE  An Example Transportation Project
   MODELOPT  FLAT  CONC
   POLLUTID  PM10
   AVERTIME  24
   URBANOPT  200000
   FLAGPOLE  1.8
   RUNORNOT  RUN
CO FINISHED

**-------------------------------------

SO STARTING
**               Srcid     Srctyp  X1 Y1   X2 Y2
**               ------    ------  -- --   -- --
   LOCATION      PROJECT   LINE    0  12.5 50 12.5

** Area source parameters
** User guide:  Srcid     Aremis  Relhgt   Width    Szinit
**                        g/s/m2
**               -------   ------  -------  ------
   SRCPARAM      PROJECT   0.00005    2      25        1

   URBANSRC  PROJECT
   SRCGROUP  ALL

SO FINISHED

** Line source called "Project" is a 50 X 25 rectangle,
** With its southwest corner sitting at coordinates 0, 0 (the origin)
** Source parameters are illustrative only -- consult PM hot-spot guidance
**-------------------------------------
```

SRCGROUP

- Concentrations from all sources (only one in this case) reported together

Receptor Pathway

Pathway	Name	Description
CO	Control	Specifies job control options, to describe the run
SO	Source	Specifies emission sources information
RE	Receptor	Specifies receptor location information
ME	Meteorology	Specifies meteorology information
OU	Output	Specifies output options

- ***Receptor***—receptor information:
  - number
  - location

Receptor Pathway – Keywords

- Receptor pathway keywords for PM hot-spot analyses:

```
RE STARTING
   DISCCART
   GRIDCART
RE FINISHED
```

- DISC-: used to define individual receptors at a discrete location
- GRID-: used to define a set of receptors
- -CART: Cartesian location
- ***Note:*** *DISCPOLR, GRIDPOLR keywords are used to define receptors around a point source (not covered in slides, see AERMOD User Guide)*

Placing Receptors for AQ Modeling

- Receptor spacing should be of sufficient resolution to capture concentration gradients around the locations of maximum modeled concentrations
  - Receptors should begin 5 m from roadway edge, extending up to 500 m if needed
  - Dense spacing (e.g., 25 m) near areas of potential high concentrations (near-road), less dense (e.g., 100 m) farther away from high emitting sources
- Place receptors in locations public can access (e.g., sidewalks, neighborhoods, parks)
- Consider excluding locations where public cannot access (e.g., within right-of-way, on-facility)

Receptor Pathway – Keywords

- Receptors can be located in discrete locations (DISCCART)
  - Advantage: receptors are placed where you want them, and not where you don't (e.g., within the project)

- And/or, networks of receptors can be created (GRIDCART)
  - Advantage: cover a large area and not miss any locations
  - Will need to be supplemented with discrete receptors, e.g., closest to project

- Commercial interfaces allow users to choose areas (from map) on which to lay down a grid of receptors
  - Creates a series of discrete receptors in AERMOD

Receptor Pathway – Discrete Receptors

- Keyword DISCCART used to define discrete Cartesian coordinates
  - Defines an individual receptor in a specific location

- Discrete receptors can be placed instead of, or in addition to, a network
  - May be needed to fill in gaps in network(s)
  - Useful to avoid placing receptors in locations where not necessary (e.g., right-of-way)
  - Useful for specific locations such as
    - Those in close proximity to the project;
    - Schools, houses, buildings;
    - Areas previously identified as high concentration

Receptor Pathway – DISCART

RE DISCCART X Y (Z)

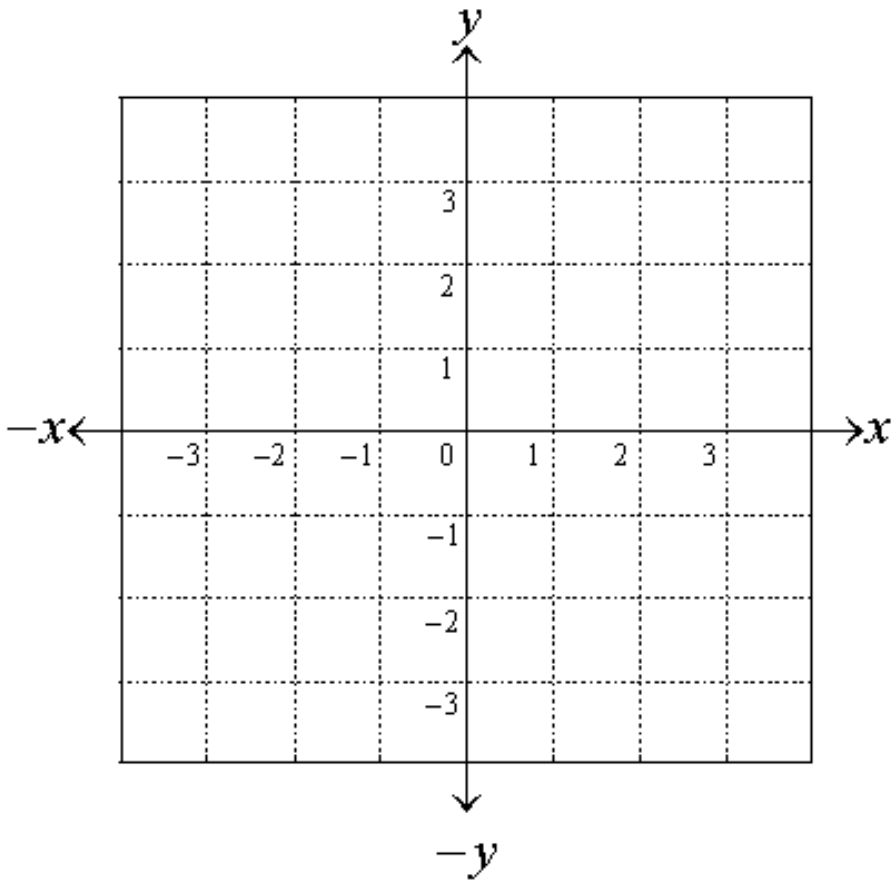
- All receptors have unique X,Y coordinates
- Z coordinates (Zelev, Zhill, Zflag) are optional and unnecessary for PM hot-spot analyses if already defined **FLAGPOLE** keyword
  - Refer to AERMOD user guide for description of different Zs
  - *Question for class*: In what pathway do you define **FLAGPOLE**?
- Example:

  RE DISCCART 9.0 212.8

Receptor Pathway – DISCCART

Plot the receptors on the grid shown, based on the following statements:

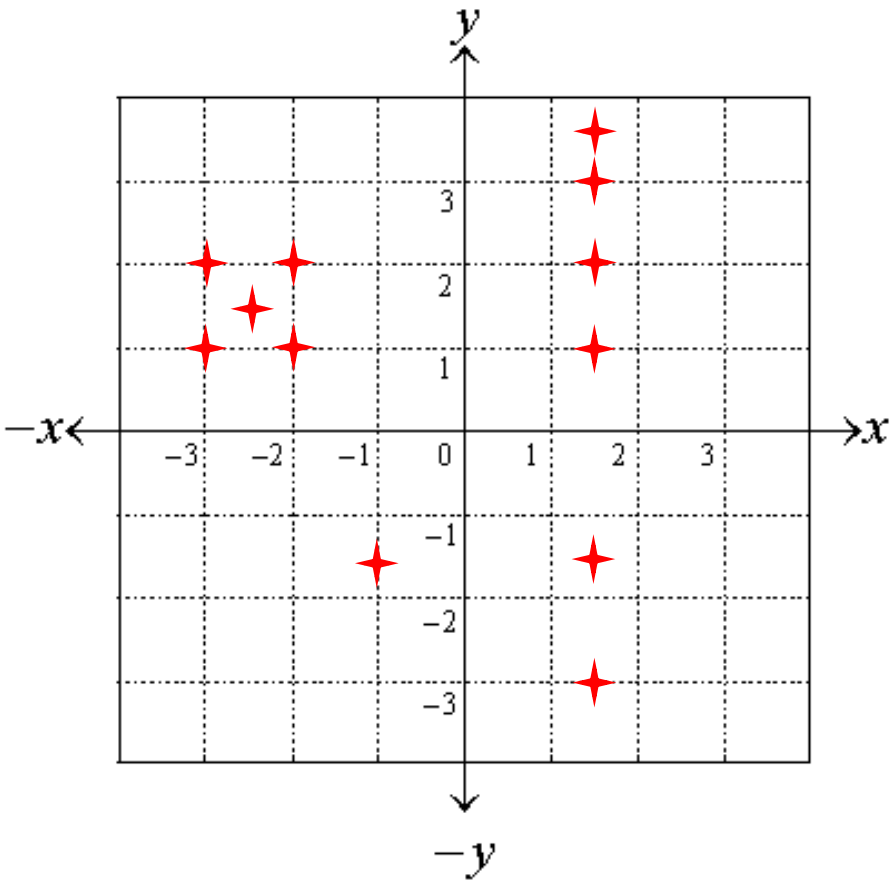
RE DISCART -3 2
RE DISCART -3 1
RE DISCART -2.5 1.5
RE DISCART -2 2
RE DISCART -2 1
RE DISCART -1 -1.5
RE DISCART 1.5 -3
RE DISCART 1.5 -1.5
RE DISCART 1.5 1
RE DISCART 1.5 2
RE DISCART 1.5 3
RE DISCART 1.5 3.5



Receptor Pathway – DISCCART

Plot the receptors on the grid shown, based on the following statements:

RE DISCART -3 2
RE DISCART -3 1
RE DISCART -2.5 1.5
RE DISCART -2 2
RE DISCART -2 1
RE DISCART -1 -1.5
RE DISCART 1.5 -3
RE DISCART 1.5 -1.5
RE DISCART 1.5 1
RE DISCART 1.5 2
RE DISCART 1.5 3
RE DISCART 1.5 3.5



Receptor Networks

- Use keyword GRIDCART to set up a network of receptors
- With a network, AERMOD will calculate concentrations at locations that may not be necessary to consider
  - E.g., in the right-of-way, or in fenced-off areas
- AERMOD allows multiple receptor networks, may be useful for….
  - Placing a coarser network over the whole project area
  - Locating a denser network over a smaller area where maximum impacts are expected
- There are multiple ways to set up a grid (choices in syntax)

Receptor Pathway – GRIDCART

- **GRIDCART** defines receptors in a Cartesian (square grid) network

- Syntax, Option 1: "XYINC"

  RE GRIDCART Netid STA

  XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta

  RE GRIDCART Netid END

  - STA/END: indicates start/end of GRIDCART subpathway; repeat for each new Netid
  - Netid: user-defined name for the receptor network
  - Xinit: starting x-axis grid location in meters
  - Xnum: number of x-axis receptors
  - Xdelta: spacing in meters between x-axis receptors
  - (Same for Yinit, Ynum, Ydelta)

Receptor Pathway – GRIDCART Option 1

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
RE STARTING
RE GRIDCART INNER STA
** User guide:          Xinit Xnum Xdelta Yinit Ynum Ydelta
**                      ----- ---- ------ ----- ---- ------
                  XYINC -100   11    25    -100   10   25
RE GRIDCART INNER END

** "Inner" receptor grid extends 100 meters beyond the project
** in both X and Y directions, at 25 meter spacing
** Some receptors will be at locations within the source

RE GRIDCART OUTER STA
** User guide:    XPNTS Gridx1 Gridx2 Gridx3 Gridx4 ...
**                YPNTS Gridy1 Gridy2 Gridy3 Gridy4 ...
**                      ------ ------ ------ ------
                  XPNTS  -500   -400   -300   -200  -100 0 100 150 250 350 450 550
                  YPNTS  -500   -400   -300   -200  -100 0 100 125 225 325 425 525
RE GRIDCART OUTER END

** "Outer" receptor grid extends 500 meters beyond the project
** in both X & Y directions, 100 m apart (except X @ 100-150, and Y @ 100-125)
** Some receptors will be at locations within the source
RE FINISHED

**-------------------------------------
ME STARTING
   SURFFILE  aermet2.sfc
   PROFFILE  aermet2.pfl
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999  1988  HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
**-------------------------------------
OU STARTING
   RECTABLE 24 FIRST
** (There are only 4 days of met data in the met data file, so model cannot
** provide 6th highest concentration)
   POSTFILE  24 ALL PLOT PROJECT_24hr.pst
OU FINISHED
```

Shows Option 1, XYINC

Network name is "Inner"

XYINC defines an 11 x 10 receptor grid:

Begins at x, y = (-100, -100)

- x and y spacing both 25 meters
- 110 receptors

- x, y, coordinates and delta between locations are in meters

Receptor Pathway – GRIDCART

- Syntax, Option 2: "XPNTS YPNTS"

RE GRIDCART Netid STA

XPNTS Gridx1 Gridx2 ... Gridxn

YPNTS Gridy1 Gridy2...Gridyn

RE GRIDCART Netid END

- STA/END: indicates start/end of GRIDCART subpathway; repeat for each new Netid
- Netid: user-defined name for the receptor network
- XPNTS: keyword followed by defined x-coordinates (Gridx1, Gridx2, etc.)
- YPNTS: keyword followed by defined y-coordinates

Receptor Pathway – GRIDCART Option 2

AE_line_sample_file.inp - Notepad

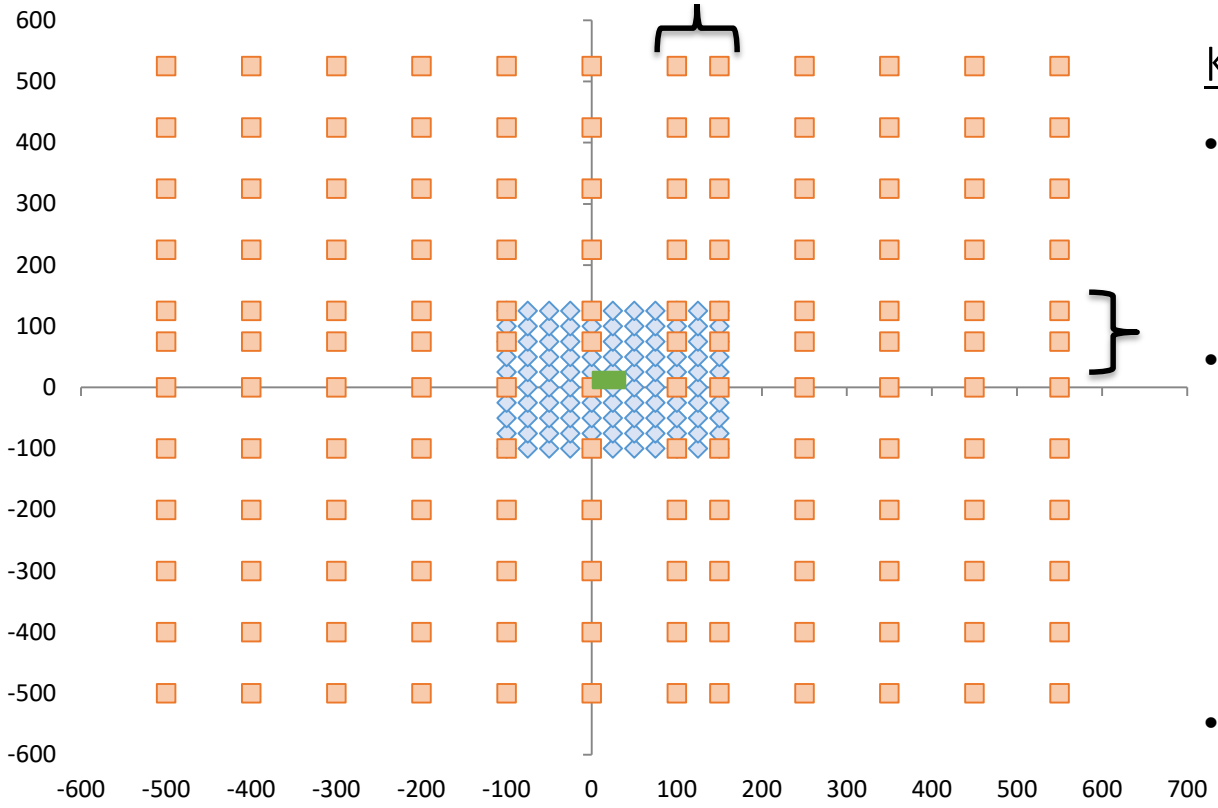
File Edit Format View Help

```
RE STARTING
RE GRIDCART INNER STA
** User guide:          Xinit Xnum Xdelta Yinit Ynum Ydelta
**                      ----- ---- ------ ----- ---- ------
                  XYINC -100   11    25    -100   10   25
RE GRIDCART INNER END

** "Inner" receptor grid extends 100 meters beyond the project
** in both X and Y directions, at 25 meter spacing
** Some receptors will be at locations within the source

RE GRIDCART OUTER STA
** User guide:    XPNTS Gridx1 Gridx2 Gridx3 Gridx4 ...
**                YPNTS Gridy1 Gridy2 Gridy3 Gridy4 ...
**                      ------ ------ ------ ------
                  XPNTS  -500   -400   -300   -200  -100 0 100 150 250 350 450 550
                  YPNTS  -500   -400   -300   -200  -100 0 100 125 225 325 425 525
RE GRIDCART OUTER END

** "Outer" receptor grid extends 500 meters beyond the project
** in both X & Y directions, 100 m apart (except X @ 100-150, and Y @ 100-125)
** Some receptors will be at locations within the source
RE FINISHED

**-------------------------------------
ME STARTING
   SURFFILE  aermet2.sfc
   PROFFILE  aermet2.pfl
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999  1988  HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
**-------------------------------------
OU STARTING
   RECTABLE 24 FIRST
** (There are only 4 days of met data in the met data file, so model cannot
** provide 6th highest concentration)
   POSTFILE  24 ALL PLOT PROJECT_24hr.pst
OU FINISHED
```

Shows Option 2, XPNTS YPNTS

- Network name is "Outer"
- XPNTS defines the X-axis coordinates for the grid, in meters
- YPNTS defines the Y-axis coordinates for the grid, in meters
- 100 meter spacing, except between 100 and 150 in X, and 100 and 125 in Y

Sample Input File Receptor Grids



Key:

- Source
  - 50 m x 25 m
- Inner grid
  - X-axis: -100 to 150, 25 m spacing,11 across
  - Y-axis: -100 to 125, 25 m spacing,10 high
- Outer grid
  - X-axis: -500 to 550
  - Y-axis: -500 to 525
  - 100 m spacing, except where bracketed

Using grids, some receptors locations may end up too close (within the project or within 5 meters); these receptors should not be used (PM Hot-spot Guidance, Section 7.6.2)

AERMOD Input File Structure

- An AERMOD input file is structured by "pathways" as ordered:

ID	Name	Description
CO	Control	For specifying job control options, to describe the run
SO	Source	For specifying emissions sources information
RE	Receptor	For specifying receptor location information
ME	Meteorology	For specifying meteorology information
OU	Output	For specifying output options

- ***Meteorology*** – meteorology information:
  - Names of met data files, surface and profile
  - Where data is from

Options for AERMOD Runs with Met Data

- If using 5 years of met data – two options for running AERMOD:

  1) Concatenate met data into one file containing all five years and run AERMOD once
     - Preferred option, as post processing AERMOD output is easier with concatenated met data
  2) Run AERMOD five times, once with each year of met data
     - Will require post-processing of five AERMOD output files

- If using one year of on-site met data, only one run necessary

Processing Met Data for AERMOD

- AERMET pre-processing program is used to produce necessary files for AERMOD
  - Many state and local air agencies will have pre-processed met files representative of project area (see Module 3) for use in AERMOD
  - Running AERMET is not covered in this course

- Surface (.sfc) and profile ("upper air") (.pfl) met data files will include a record for each hour of met data:
  - Surface: Wind speed/direction, cloud cover, sky cover, surface roughness, Bowen ratio, albedo
  - Profile: Vertical temperature profile

Meteorology Pathway Keywords

- SURFFILE identifies the surface met data file
  - Followed by the file name (.sfc)
- PROFFILE identifies the profile (upper air) met data file
  - Followed by the file name (.pfl)
- SURFDATA and UAIRDATA used to identify the met data stations
  - Followed by station ID (e.g. 14735) and beginning data year (location optional)
- PROFBASE indicates met data station elevation
  - Followed by met station elevation, above sea level (m)

Example:

```
ME SURFFILE  EWR91_95.SFC
ME PROFFILE  EWR91_95.PFL
ME SURFDATA  14734  1991
ME UAIRDATA  93755  1991
ME PROFBASE  0
```

Meteorology Pathway – Keywords

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
RE STARTING
RE GRIDCART INNER STA
** User guide:          Xinit Xnum Xdelta Yinit Ynum Ydelta
**                      ----- ---- ------ ----- ---- ------
                  XYINC -100   11    25    -100   10   25
RE GRIDCART INNER END

** "Inner" receptor grid extends 100 meters beyond the project
** in both X and Y directions, at 25 meter spacing
** Some receptors will be at locations within the source

RE GRIDCART OUTER STA
** User guide:    XPNTS Gridx1 Gridx2 Gridx3 Gridx4 ...
**                YPNTS Gridy1 Gridy2 Gridy3 Gridy4 ...
**                ------ ------ ------ ------
                  XPNTS  -500   -400   -300   -200  -100 0 100 150 250 350 450 550
                  YPNTS  -500   -400   -300   -200  -100 0 100 125 225 325 425 525
RE GRIDCART OUTER END

** "Outer" receptor grid extends 500 meters beyond the project
** in both X & Y directions, 100 m apart (except X @ 100-150, and Y @ 100-125)
** Some receptors will be at locations within the source
RE FINISHED

**----------------------------------
ME STARTING
   SURFFILE  aermet2.sfc
   PROFFILE  aermet2.pfl
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999  1988  HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
**----------------------------------
OU STARTING
   RECTABLE 24 FIRST
** (There are only 4 days of met data in the met data file, so model cannot
** provide 6th highest concentration)
   POSTFILE  24 ALL PLOT PROJECT_24hr.pst
OU FINISHED
```

SURFFILE and PROFFILE

- Files of surface and upper air profile data

SURFDATA and UAIRDATA

- Station #
- Data period
- Station name

Meteorology Pathway – Keywords

AE_line_sample_file.inp - Notepad

File Edit Format View Help

```
RE STARTING
RE GRIDCART INNER STA
** User guide:          Xinit Xnum Xdelta Yinit Ynum Ydelta
**                      ----- ---- ------ ----- ---- ------
                  XYINC -100   11    25    -100   10   25
RE GRIDCART INNER END

** "Inner" receptor grid extends 100 meters beyond the project
** in both X and Y directions, at 25 meter spacing
** Some receptors will be at locations within the source

RE GRIDCART OUTER STA
** User guide:    XPNTS Gridx1 Gridx2 Gridx3 Gridx4 ...
**                YPNTS Gridy1 Gridy2 Gridy3 Gridy4 ...
**                ------ ------ ------ ------
                  XPNTS  -500   -400   -300   -200  -100 0 100 150 250 350 450 550
                  YPNTS  -500   -400   -300   -200  -100 0 100 125 225 325 425 525
RE GRIDCART OUTER END

** "Outer" receptor grid extends 500 meters beyond the project
** in both X & Y directions, 100 m apart (except X @ 100-150, and Y @ 100-125)
** Some receptors will be at locations within the source
RE FINISHED

**----------------------------------
ME STARTING
   SURFFILE  aermet2.sfc
   PROFFILE  aermet2.pfl
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999  1988  HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
**----------------------------------
OU STARTING
   RECTABLE 24 FIRST
** (There are only 4 days of met data in the met data file, so model cannot
** provide 6th highest concentration)
   POSTFILE  24 ALL PLOT PROJECT_24hr.pst
OU FINISHED
```

SITEDATA (optional)

- If any site-specific data are used

PROFBASE

- Elevation of base of surface met. tower over mean sea level (MSL)

AERMOD Input File Structure

- An AERMOD input file is structured by "pathways" as ordered:

ID	Name	Description
CO	Control	For specifying job control options, to describe the run
SO	Source	For specifying emissions sources information
RE	Receptor	For specifying receptor location information
ME	Meteorology	For specifying meteorology information
OU	Output	For specifying output options

- *Output* – output information:
  - What output options do you want?
    - In the main output files
    - Other output files for specialized purposes

Main Output File

- AERMOD produces a main output file of model results, AERMOD.OUT, which includes:
  - An echo of the input file
  - A summary of input file setup messages
  - A summary of the inputs – modeling options, source data, receptor data, met data
  - Model results (e.g., results by receptor for each source group)
  - Summary tables of high values for each averaging period and source group, if requested (with keyword RECTABLE)
  - Summary of messages for the complete run

Output Pathway – Guidance

- For PM hot-spot analyses, the most useful keyword options for output are:

Keyword	Function
RECTABLE	Produces high value summary tables by receptor in the main output file (AERMOD.out)
PLOTFILE	Produces receptor values over the averaging period specified by user and rank specified by use (separate file, user specifies file name). Can be imported into graphics software for plotting contours
POSTFILE	Writes results to a separate file for post-processing (user specifies file name). Creates very large file of results: every day of met data for each receptor

- For each of these keywords, the user specifies
  - The averaging period, and
  - The high value of interest, which will depend on the NAAQS

Output Pathway - RECTABLE

- Syntax for keyword RECTABLE:

  OU RECTABLE Aveper FIRST SECOND…SIXTH

  Or: OU RECTABLE Aveper 1st 2nd …6th

  Or: OU RECTABLE Aveper 1 2 …6

  - Aveper: *short term averaging period* (use **24** for 24-hour averages) to be used for averaging results at each receptor
  - The secondary keywords, **FIRST, SECOND, … SIXTH,** etc., (through 999th) indicate which high values are to be summarized by receptor for that averaging period

Output Pathway - RECTABLE

Examples:

OU RECTABLE 24 SIXTH

OU RECTABLE 24 FIRST-THIRD

For each averaging period and source group combinations, the output file will include tables for only the high values selected

- Receptors networks printed first,
- Followed by discrete Cartesian receptors,
- Then discrete polar receptors

Output Pathway – PLOTFILE, POSTFILE

- To get a PLOTFILE or POSTFILE, the RECTABLE keyword must be included first, with the averaging periods and high values that will be output
  - Generally, RECTABLE is needed for any output options that require an averaging period and high value to be specified (such as PLOTFILE, POSTFILE, and RANKFILE – see user guide)
  - RECTABLE is repeatable, so it can be included more than once

```
OU STARTING
OU RECTABLE ALLAVE EIGHTH
OU PLOTFILE   24 ALL    8th   plotfile_eighth_24hr.plt
OU PLOTFILE   ANNUAL ALL   plotfile_ANNUAL.plt
OU FINISHED
```

Output Pathway – PLOTFILE

- Syntax: **OU** PLOTFILE Aveper Grpid Hivalu Filnam (Funit)
  - Aveper: the averaging period (**24** for 24-hour averages**, ANNUAL** for annual averages)
  - Grpid: Source group ID (defined in SO pathway with **SRCGROUP**) for **POSTFILE** option
  - Hivalu: specifies which short term high values are to be output (e.g., FIRST, SECOND, EIGHTH)
    - Not specified for ANNUAL averages, since there is only one annual average for each receptor
  - Filnam: specifies output file name where the **POSTFILE** results are written, up to 40 characters
  - Funit: optional, the Fortran logical file unit for the output file (see user guide)

Output Pathway – PLOTFILE

- OU PLOTFILE Aveper Grpid Hivalu Filnam (Funit)

Examples:

- OU PLOTFILE 24 ALL 8TH PLT24ALL.EIG
- OU PLOTFILE ANNUAL PROJECT ANN_PLT.OUT 75
- OU PLOTFILE ANNUAL ALL PLTPSD.OUT 75

- Resulting file includes header information identifying the averaging period, source group and high value number of the results, and
- A record for each receptor: x and y coordinates, the appropriate high value, averaging period, source group and high value number

Output Pathway - POSTFILE

- Syntax: **OU** POSTFILE Aveper Grpid Format Filnam (Funit)

  - Aveper: the averaging period (**24** for 24-hour averages**, ANNUAL** for annual averages)
  - Grpid: Source group ID (defined in SO pathway with **SRCGROUP**) for **POSTFILE** option
  - Format: Specifies format of the **POSTFILE** output:
    - UNFORM for unformatted concentration files
    - PLOT to obtain formatted files of receptor locations (x- and y-coordinates) and concentrations suitable for plotting contours of concurrent values
  - Filnam: specifies output file name where the **POSTFILE** results are written, up to 40 characters
  - Funit: optional, the Fortran logical file unit for the output file (see user guide)

Output Pathway - POSTFILE

- OU POSTFILE Aveper Grpid Format Filnam (Funit)

Examples:

- OU POSTFILE 24 ALL UNFORM PST_24_ALL.BIN
- OU POSTFILE 24 PROJECT UNFORM PST24_PROJECT.FIL
- OU POSTFILE ANNUAL ALL PLOT ALL_ANNUAL.PLT

- Note: the POSTFILE option produces very large files; for 5 years of met data, POSTFILE 24 would provide 1825 records for each receptor
- Most useful when post-processing different combinations

Output needed depends on NAAQS:

	Annual PM2.5 NAAQS	24-Hour PM2.5 NAAQS	24-Hour PM10 NAAQS
The NAAQS is defined as:	the average of three consecutive years' annual averages	the average of three consecutive years' 98th percentile concentrations of 24-hour values	$\leq$ one exceedance per year
For comparable AERMOD results, we need:	the annual average at each receptor	the 98th percentile concentration for the year at each receptor, i.e., the 8th highest value	With 5 years of met data, the 6th highest concentration at each receptor
Control Keyword:	AVERTIME ANNUAL	AVERTIME 24	AVERTIME 24
Output Keyword:	PLOTFILE ANNUAL	RECTABLE 24 8th PLOTFILE 24 ALL 8th	RECTABLE 24 6th
Post processing needed:	None; PLOTFILE produces the avg of 5 years' annual concentration	None; PLOTFILE produces the avg of 5 years' 8th highest value	None

Output Pathway – Sample Input File

AE_mobile_sample_file.inp - Notepad

File Edit Format View Help

```
** Some receptors will be at locations within the source

RE GRIDCART OUTER STA
** User guide:    XPNTS Gridx1 Gridx2 Gridx3 Gridx4 ...
**                YPNTS Gridy1 Gridy2 Gridy3 Gridy4 ...
**                      ------ ------ ------ ------
                  XPNTS  -500   -400   -300   -200  -100 0 100 150 250 350 450 550
                  YPNTS  -500   -400   -300   -200  -100 0 100 125 225 325 425 525
RE GRIDCART OUTER END

** "Outer" receptor grid extends 500 meters beyond the project
** in both X & Y directions, 100 m apart (except X @ 100-150, and Y @ 100-125)
** Some receptors will be at locations within the source
RE FINISHED

**----------------------------------

ME STARTING

   SURFFILE  aermet2.sfc
   PROFFILE  aermet2.pfl
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY

   SITEDATA  99999  1988  HUDSON
   PROFBASE  0.0  METERS
ME FINISHED

**----------------------------------

OU STARTING
   RECTABLE 24 FIRST
** (There are only 4 days of met data in the met data file, so model cannot
** provide 6th highest concentration)
   POSTFILE  24 ALL PLOT PROJECT_24hr.pst
OU FINISHED
```

RECTABLE

- For the averaging period specified (24 hours), provides the top (first) value for each receptor in AERMOD.out

POSTFILE

- Creates a file called "Project_24hr.pst" with results for post-processing
- Only 4 days of met data, so this choice is manageable

Output Pathway – Error Messages

- AERMOD provides several ways to identify errors

- Output includes message summary table, with 3 types of messages:
  - E (for errors): fatal flaws that halt the run
  - W (for warnings): indicate possible errors, but don't halt run
  - I (for informational messages): FYIs

- Letters are followed by 3-digit codes, grouped by process stage:
  - 100 - 199 Input Runstream Image Structure Processing
  - 200 - 299 Parameter Setup Processing
  - 300 - 399 Data and Quality Assurance Processing
  - 400 - 499 Run Time Message Processing
  - 500 - 599 Input/Output Message Processing

Output Pathway – Error Messages

- Example:

  CO E100 8 EXPATH: Invalid Pathway Specified. The Troubled Pathway is FF

  - (FF = Fixed format)

- Use AERMOD User Guide, Appendix C to decode and correct error

Running AERMOD with the Sample Input File

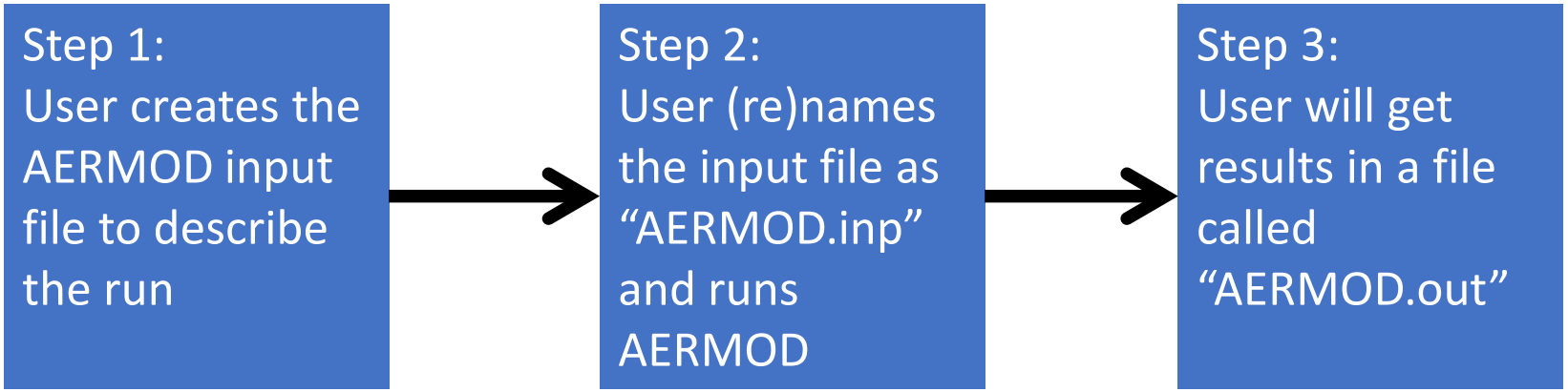
EPA

Latest Version of AERMOD

- EPA's latest release of AERMOD is AERMOD 18081
  - Previous version is AERMOD 16216r
- For transportation projects, model concentrations are expected to be the same for AERMOD version 16216r and 18081
- Any new AERMOD modeling needed for a quantitative PM hot-spot analysis for a transportation project should be done with the latest version of the model
  - Always download the latest version of AERMOD from www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models before starting new modeling

Review - Running AERMOD

- General steps…



- The AERMOD input file is always named "AERMOD.inp" and the output is always named "AERMOD.out"

- Note – These files will be overwritten when AERMOD is run again

Tips for Managing Files

Suggestions:

- Save an input file with a descriptive name
  - E.g., “AE_input_hwy10_build.inp”
- Then *copy* it as “AERMOD.inp” to run it
  - The previous “AERMOD.inp” will be overwritten when AERMOD is run again
- Use an existing input file to create additional input files
  - E.g., create no-build input file from build input file
  - Save each with a descriptive name
- To avoid overwriting your output file, immediately rename output file similar to the input file
  - E.g., “AE_output_hwy10_build.out”

Running AERMOD

- This step has already been done and the output files are located in “Sample AERMOD run” folder

How to:

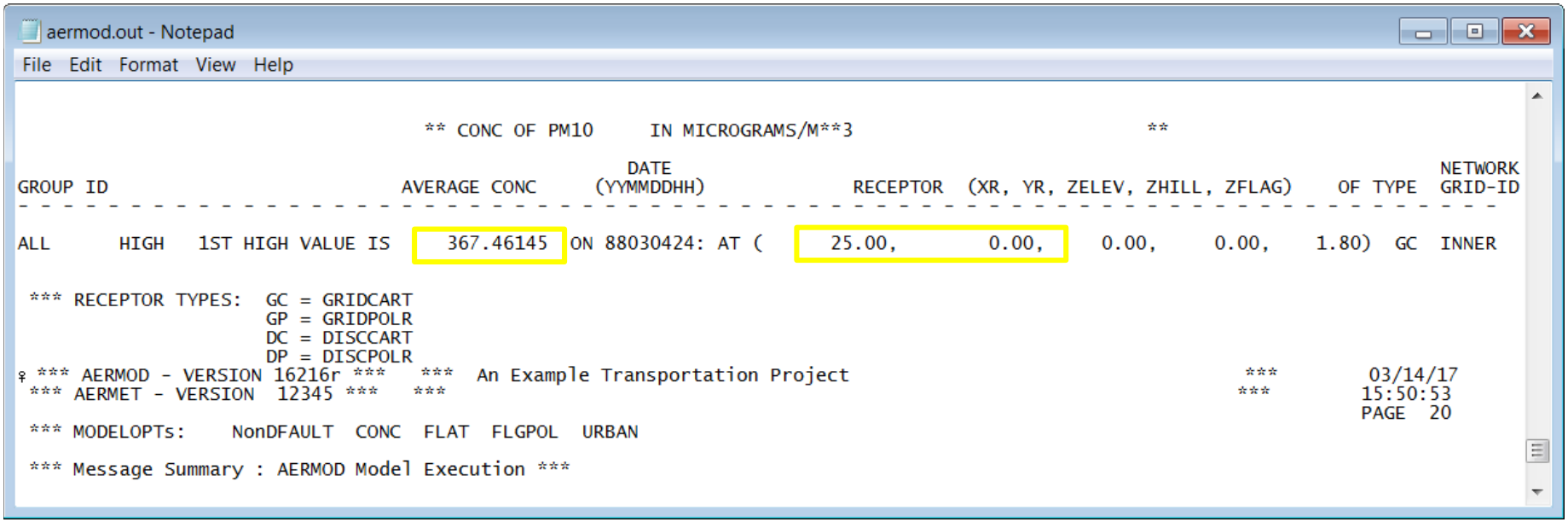
- From the Course Files\AERMOD files folder, copy “AE_line_sample_file.inp” and rename the copy “aermod.inp”
- Double-click “aermod.exe”

AERMOD Output

- Run produces “aermod.out” and “PROJECT_24hr.pst” in “Sample AERMOD run” folder
  - We re-named “aermod.out” to “AE_line_sample_file.out” to avoid overwriting
  - Question for for class: What is the maximum 24-hour concentration at any receptor?

Output from the Sample Input Run

- AERMOD.out, p. 18, (also on p.13): highest concentration is at the receptor with coordinates (25, 0)
  - Receptors within 5 meters of a project should not be used (PM Hot-spot Guidance, Section 7.6.2)



Postfile from Sample Input Run

- Includes 24-hour conc. for each met data day, for each receptor

PROJECT_24hr.pst - Notepad

File Edit Format View Help

```
* AERMOD (16216r):  An Example Transportation Project                    03/14/17
* AERMET ( 12345):                                                       15:50:53
* MODELING OPTIONS USED:   NonDFAULT  CONC  FLAT  FLGPOL  URBAN
*         POST/PLOT FILE OF CONCURRENT 24-HR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   254 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)

*       X             Y       AVERAGE CONC    ZELEV    ZHILL    ZFLAG     AVE      GRP       DATE      NET ID
* _________     _________     ____________    _____    _____    _____    _____    _____    ________    ______
   -100.00000    -100.00000       0.00000     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -75.00000    -100.00000       0.00099     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -50.00000    -100.00000       0.07461     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -25.00000    -100.00000       0.80931     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
      0.00000    -100.00000       2.97572     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
     25.00000    -100.00000       5.90315     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
     50.00000    -100.00000       8.13747     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
     75.00000    -100.00000       9.26756     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    100.00000    -100.00000       9.54646     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    125.00000    -100.00000       9.25967     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    150.00000    -100.00000       8.61053     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
   -100.00000     -75.00000       0.00000     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -75.00000     -75.00000       0.00000     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -50.00000     -75.00000       0.02174     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -25.00000     -75.00000       0.82682     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
      0.00000     -75.00000       4.45146     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
     25.00000     -75.00000       9.76439     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
     50.00000     -75.00000      13.24977     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
     75.00000     -75.00000      14.38566     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    100.00000     -75.00000      14.06259     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    125.00000     -75.00000      12.83069     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    150.00000     -75.00000      11.19808     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
   -100.00000     -50.00000       0.00000     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -75.00000     -50.00000       0.00000     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -50.00000     -50.00000       0.00104     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
    -25.00000     -50.00000       0.54196     0.00     0.00     1.80    24-HR    ALL      88030124    INNER
```

Hands-on Exercise: AERMOD Mini-Run

EPA

AERMOD Mini-Run

- Goal: set up an input file, run AERMOD, review output

- Mini-run is illustrative only
  - We are making some choices that keep the run time short
  - E.g., only one year of met data used

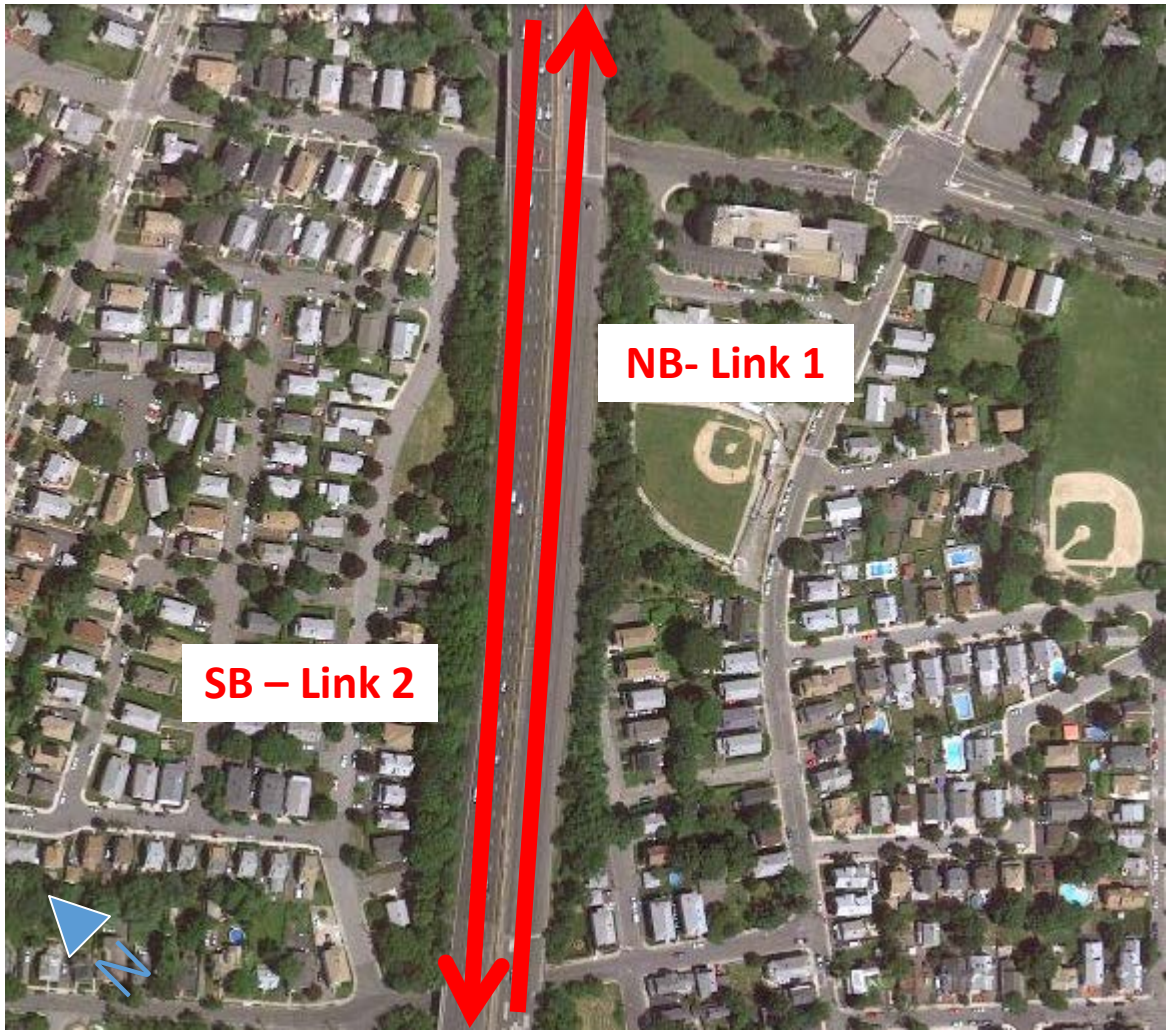
- Project consists of a two-lane highway (same project in Module 2)
  - Uses emission rates calculated from the MOVES mini-run

- Example scenario covers only one hour (12 a.m.- 1 a.m.)
  - Emission rates from 16 MOVES runs would typically be needed

- Files needed are found in “Course Files\AERMOD Files\AERMOD mini-run”

AERMOD Mini-Run

Example: Simple, 2-lane highway



AERMOD Input File Structure

- Create the AERMOD input file following the order we described earlier:

ID	Name	Description
CO	Control	For specifying job control options. Describes the run.
SO	Source	For specifying emissions sources information.
RE	Receptor	For specifying receptor location information.
ME	Meteorology	For specifying meteorology information.
OU	Output	For specifying output options

- Use information provided in hand-out to generate AERMOD input file
- Input file “aermod_mini-run.inp” in “AERMOD mini-run” folder is partially started and you will need to complete it

Information Needed for CO Pathway

- Project located in a 24-hour PM_{10} nonattainment area
  - Relevant NAAQS is the 24-hour PM10 NAAQS
  - Use 24 hours as the averaging time
- This urban area has a population of 100,000
  - Use the urban dispersion option
- Model options: Flat terrain is appropriate; we're modeling concentrations
- Set FLAGPOLE receptors to a height of 1.8 meters (per the guidance)

Information Needed for SO Pathway

- Each MOVES link will be modeled as one area source, with **LINE** option (see pp. 59 and 67):

SO LOCATION Srcid LINE xs1 ys1 xs2 ys2 (z)

SO SRCPARAM Srcid Lnemis Relhgt Width Szinit

AERMOD Parameters	Info specific to this highway
NB link: (xs1, ys1), (xs2, ys2)	(-833.0,-284.8), (600.8,1097.0)
SB link: (xs1, ys1), (xs2, ys2)	(-836.7,-288.0), (597.1,1106.4)
Lnemis	Emission rates from MOVES (next slides)
Relhgt	1.3 meters
Width of each source:	3 meters
Initial vertical dispersion coeff (Szinit)	1.2 meters

Information Needed for SO Pathway

MOVES Emission Rates:

- Rates from 2nd MOVES run (linkdrive schedules) will be used for this example (from Module 2)

- 2nd run selected because it better represents the travel activity on these links

	A	B	C	D	E	F	G	H
1	movesRun	yearId	monthId	hourId	linkId	pollutantId	GramsPerHour	
2	1	2016	7	1	1	Total PM10	14.14358	
3	1	2016	7	1	2	Total PM10	12.75696	
4	**2**	**2016**	**7**	**1**	**1**	**Total PM10**	**9.876065**	
5	**2**	**2016**	**7**	**1**	**2**	**Total PM10**	**9.089002**	
6								

MOVES Output | Source Information | Rece ...

This spreadsheet is found in “rates for aermod mini-run.xlsx”

Information Needed for SO Pathway

- Area (and Line) sources in AERMOD have emission rates in the form of g/sec/m^2

- From Module 2: emissions rates from the mini-run are:
  - Link 1: 9.876065 g/hr
  - Link 2: 9.089002 g/hr

- This rate has to be converted to g/s/m^2

  (Can be done in any order, be sure to keep track of units)

  - Divide by seconds per hour: g/~~hr~~ x ~~hr~~/sec = g/sec
  - Divide by m^2: g/sec x 1/m^2 = g/sec/m^2

Information Needed for SO Pathway

- Conversion is shown below, starting with g/hr (MOVES output in column L)
  - Divide by 3600 seconds per hour (column M)
  - Divide by 6000 m^2 (source area)
  - Result for use in AERMOD is in column N

÷ by 3600 for g/sec

÷ by m^2 (column K) for g/s/m^2

	A	B	I	J	K	L	M	N
1	Link	Description	Link Length (m)	Link Width (m)	Area (m-2)	Emission Rate (g/hr)	Emission Rate (grams/sec)	Rate (grams/sec/ m-2)
2	**1**	**NB Highway**	**2000**	**3**	6000	9.876064969	0.002743351	**4.57225E-07**
3	**2**	**SB Highway**	**2000**	**3**	6000	9.089002074	0.002524723	**4.20787E-07**
4								

MOVES Output | **Source Information** | Rece ...

This spreadsheet is found in "rates for aermod mini-run.xlsx"

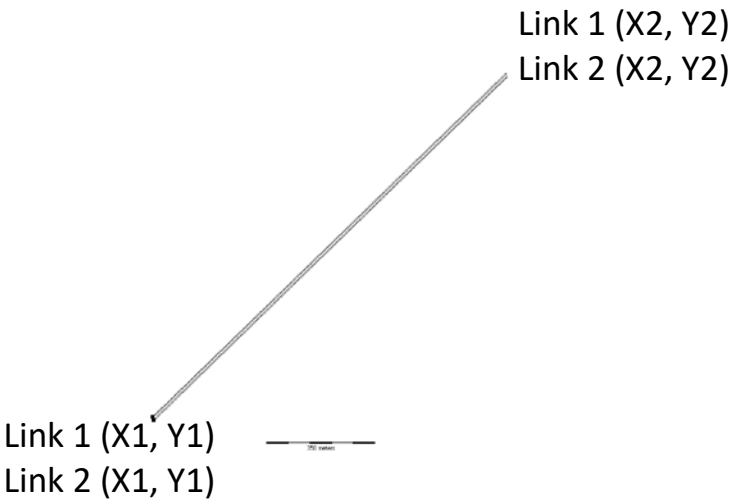
Information Needed for SO Pathway

Other parameters needed to define the LINE source are shown here:

- Coordinates of midpoints of each end (arbitrary origin), source area
- Release height and initial vertical dispersion coefficient (Szinit)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Link	Description	X1	Y1	X2	Y2	Release Height (m)	Vert. Dispersion	Link Length (m)	Link Width (m)	Area (m-2)	Emission Rate (g/hr)	Emission Rate (grams/sec)	Rate (grams/sec/ m-2)
2	**1**	**NB Highway**	**-833**	**-284.8**	**600.8**	**1097**	**1.3**	**1.2**	**2000**	**3**	6000	9.876064969	0.002743351	**4.57225E-07**
3	**2**	**SB Highway**	**-836.7**	**-288**	**597.1**	**1106.4**	**1.3**	**1.2**	**2000**	**3**	6000	9.089002074	0.002524723	**4.20787E-07**
4														

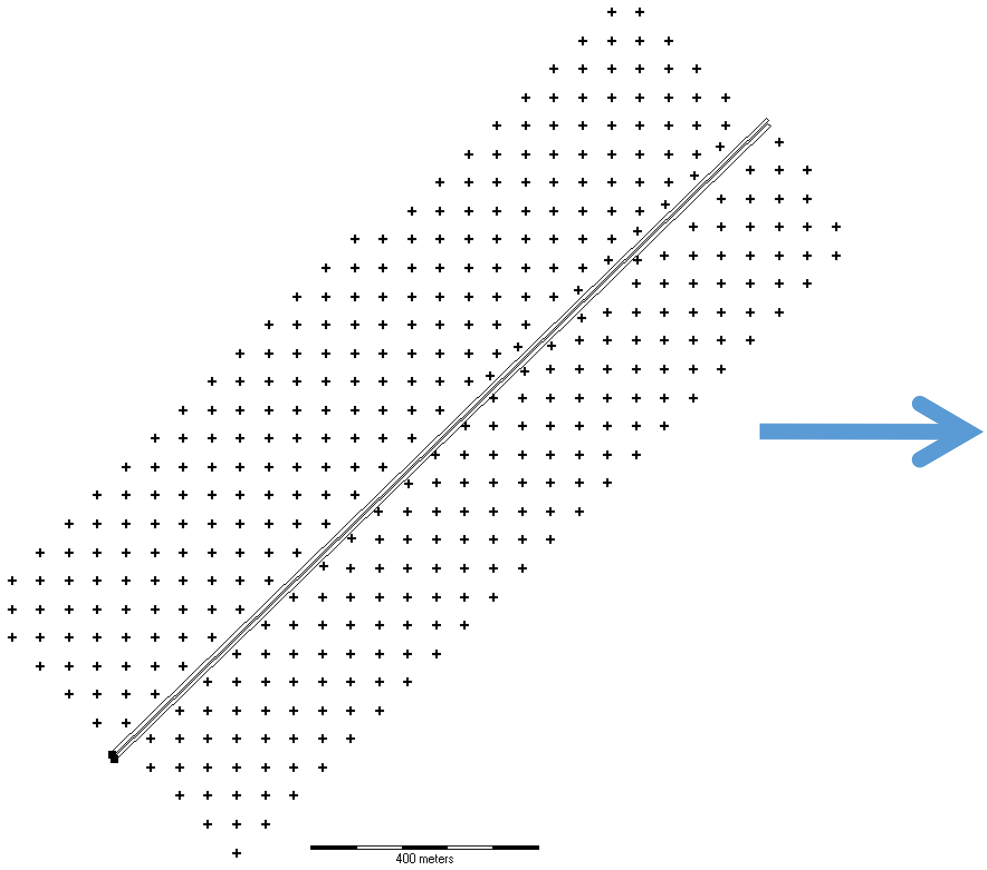
MOVES Output | **Source Information** | Receptors



Information Needed for RE Pathway

A grid is applied using discrete receptors (X,Y coordinates set-up in excel with an arbitrary 0,0 origin)

Copy “receptors.txt” into the input file



receptors.txt - Notepad

File Edit Format View Help

```
RE STARTING
RE ELEVUNIT  METERS
RE DISCCART   -862.7   -233.0
RE DISCCART   -812.7   -233.0
RE DISCCART   -912.7   -183.0
RE DISCCART   -862.7   -183.0
RE DISCCART   -812.7   -183.0
RE DISCCART   -762.7   -183.0
RE DISCCART   -962.7   -133.0
RE DISCCART   -912.7   -133.0
RE DISCCART   -862.7   -133.0
RE DISCCART   -812.7   -133.0
RE DISCCART   -762.7   -133.0
RE DISCCART   -712.7   -133.0
RE DISCCART   -1012.7   -83.0
RE DISCCART   -962.7   -83.0
RE DISCCART   -912.7   -83.0
RE DISCCART   -862.7   -83.0
RE DISCCART   -812.7   -83.0
RE DISCCART   -762.7   -83.0
RE DISCCART   -712.7   -83.0
RE DISCCART   -662.7   -83.0
RE DISCCART   -1012.7   -33.0
RE DISCCART   -962.7   -33.0
RE DISCCART   -912.7   -33.0
RE DISCCART   -862.7   -33.0
RE DISCCART   -812.7   -33.0
RE DISCCART   -762.7   -33.0
RE DISCCART   -712.7   -33.0
RE DISCCART   -662.7   -33.0
RE DISCCART   -612.7   -33.0
RE DISCCART   -1012.7   17.0
```

Information Needed for ME Pathway

Information for our AERMOD mini-run:

- Surface File: msn00.sfc
- Profile File: msn00.pfl
- Surface ID: 14837
- Surface year: 2000
- Upper Air Data ID: 00014898
- Upper Air Data year: 2000
- Base Elevation: 0 meters

Information Needed for OU Pathway

- Get output defined as a RECTABLE
  - 24-hour average
  - 6th highest

Running AERMOD

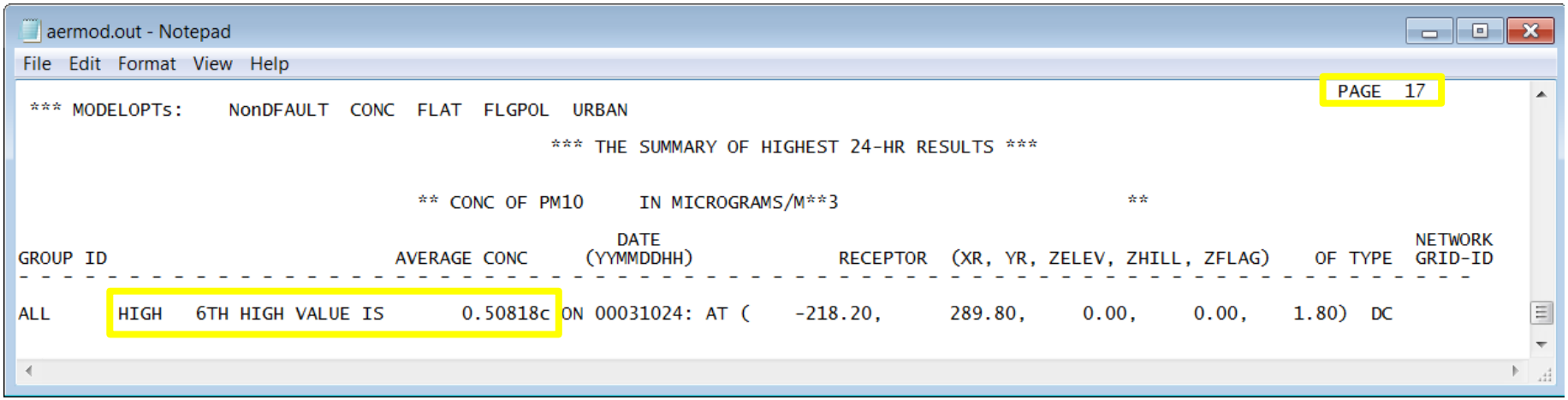
- Copy and rename your input file as “aermod.inp”

- Make sure these 3 files are in your “AERMOD mini-run” folder
  - aermod.inp *(the input file we created)*
  - Msn00.pfl *(profile met data)*
  - Msn00.sfc *(surface met data)*

- From this folder, double-click “aermod.exe”

Reviewing the AERMOD Mini-Run Results

- High-6th-high receptor reported in AERMOD.out, p. 17



AERMOD Mini-Run Completed

- The high-6th-high receptor concentration is 0.50818 µg/m^3

- Project sponsor would use this value in calculating the design value
  - These additional steps not covered for this exercise
  - Design value covered in Module 7

Running AERMOD for the Example Analysis

EPA

AERMOD Modeling Plan

- Urban dispersion option will be used
  - Population of 100,000 used
- PM concentrations will be averaged daily (for 24-hour NAAQS) and annually (for annual NAAQS)
- FLAGPOLE receptors will be set to a height of 1.8 meters (per the guidance)
- Five years of met data will be used for one AERMOD run
  - Pre-formatted data provided by state AQ agency
  - AERMET will not be run

AERMOD Modeling Plan

- Area sources will be used to simulate line sources
  - MOVES links will be modeled as one or more area sources (e.g., more may be needed to model curved links or irregularly shaped parking areas)
  - Note: project is illustrative; gaps/overlaps between sources should be minimized in practice
  - MOVES output will be converted to grams/s/m^2
    - EMISFACT table will be created for each source to vary emissions by season and hour (96 rates per source)
    - A "base-rate" will be defined as 1 for each source
  - Assigned X,Y coordinates, length, width, and orientation angle

AERMOD Modeling Plan

- Emission characterization of highway/arterial links
  - Release height of 1.3 meters
  - Initial vertical dispersion coefficient of 1.2 meters
- Emission characterization of bus-only links
  - Release height of 3.4 meters
  - Initial vertical dispersion coefficient of 3.2 meters
- Emission characterization of parking garage
  - Modeled as a single area source*
  - Release height of 25 meters
  - Initial vertical dispersion coefficient of 20 meters

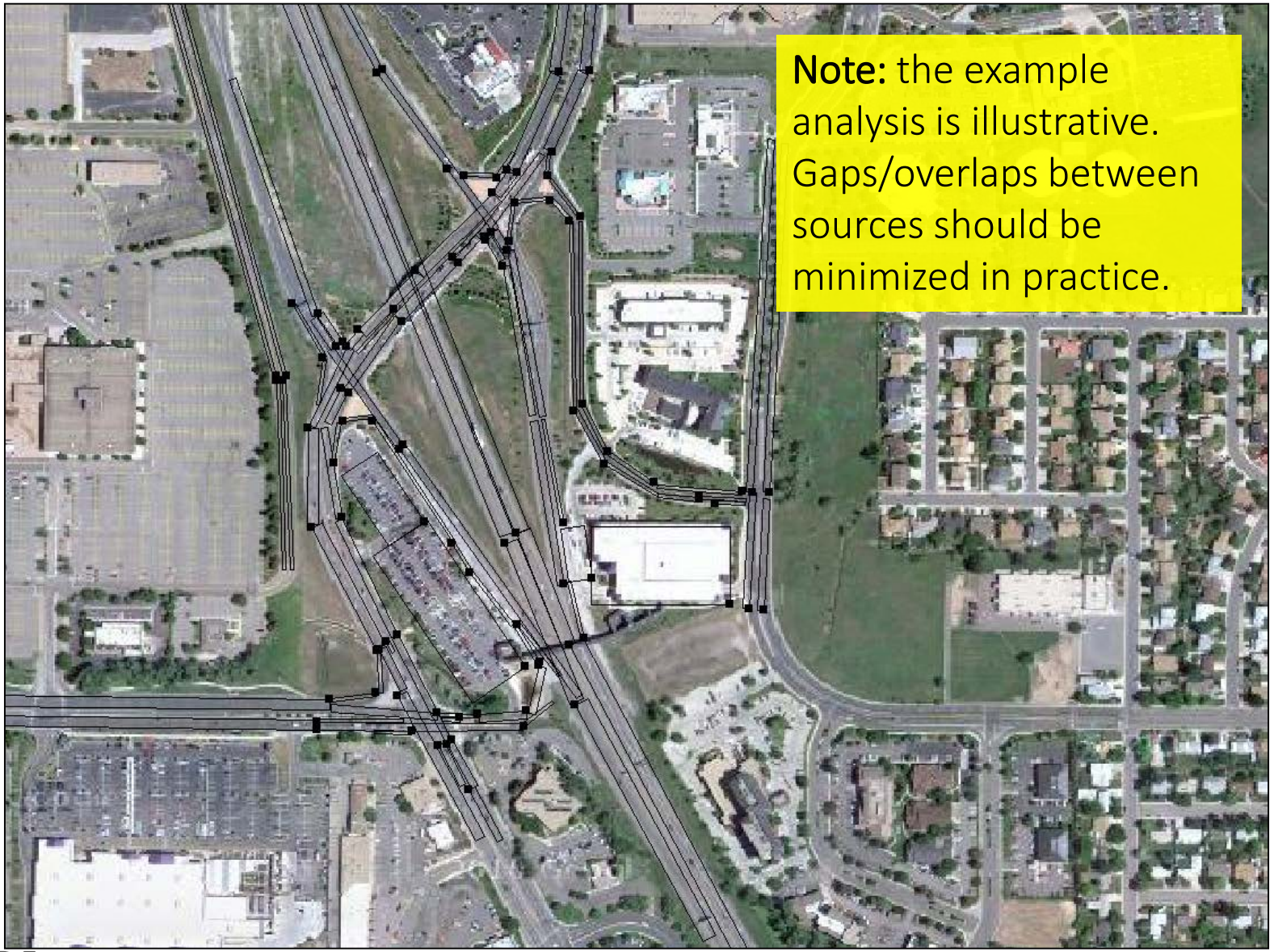
*Done for simplicity… parking garages are complicated sources and may require multiple area or volume sources arranged at multiple heights

EPA

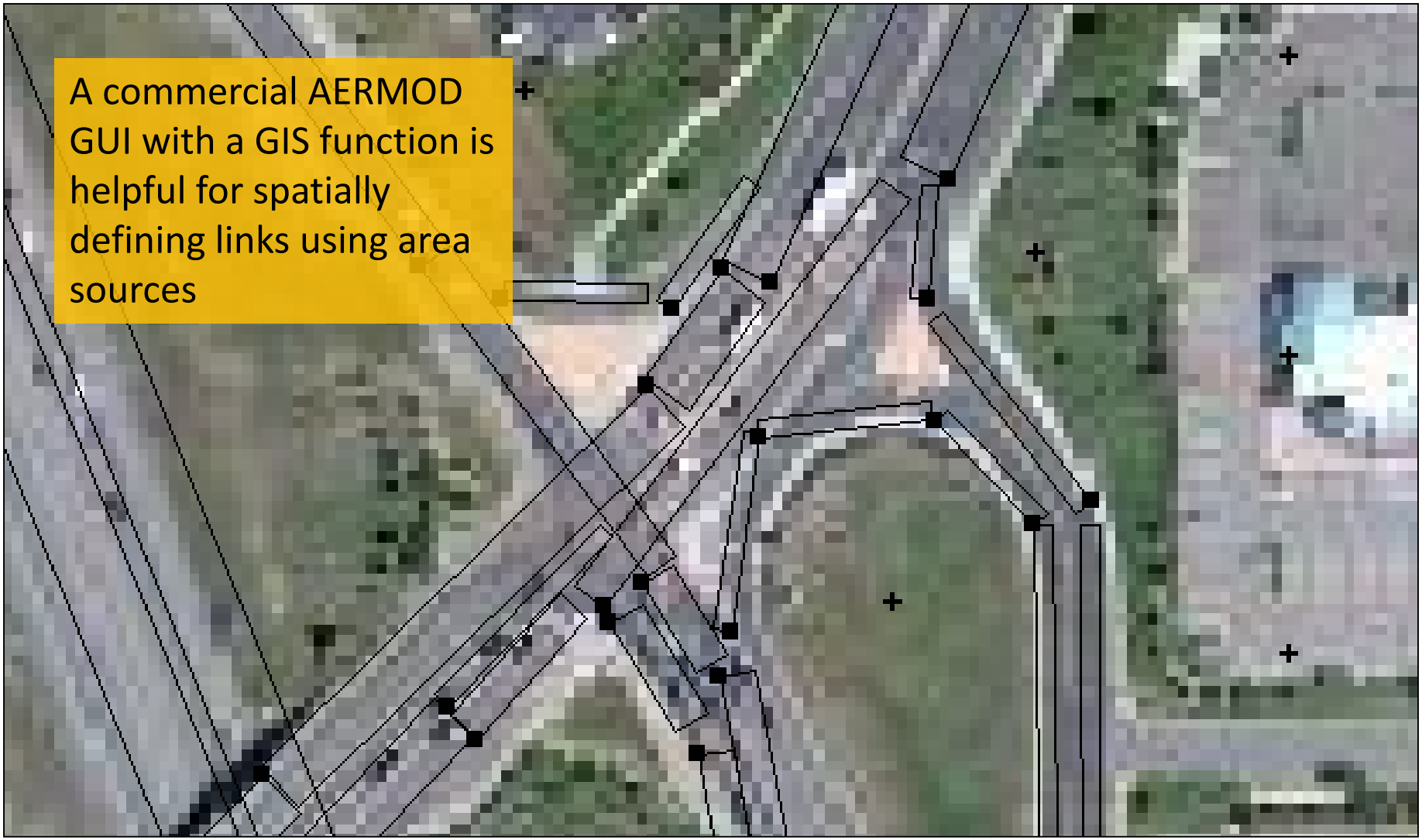
AERMOD Modeling Plan

- Output will be obtained as PLOTFILEs
  - 24 hour averages (for 24-hour $PM_{2.5}$ NAAQS)
  - Annual averages (for annual $PM_{2.5}$ NAAQS)

AERMOD Area Sources



AERMOD Area Sources



AERMOD Input File

aermod.inp - Notepad

File Edit Format View Help

```
CO STARTING
CO TITLEONE  Hotspot Training Exercise
CO MODELOPT  FLAT  CONC
CO RUNORNOT  RUN
CO AVERTIME  24  ANNUAL
CO URBANOPT  100000
CO FLAGPOLE  1.8
CO POLLUTID  PM2.5
CO FINISHED

SO STARTING
SO ELEVUNIT  METERS
SO LOCATION  1A         AREA      289.4  679.9  0
** SRCDESCR  intersection (A) NW bound entrance ramp
SO LOCATION  1B         AREA      294.2  682.9  0
** SRCDESCR  intersection (A) NW bound entrance ramp
SO LOCATION  3A         AREA      362.3  593.7  0
** SRCDESCR  intersection (A) WB RT lane
SO LOCATION  3B         AREA      390.6  592.1  0
** SRCDESCR  intersection (A) WB RT lane
SO LOCATION  4A         AREA      407.0  596.5  0
** SRCDESCR  intersection (A) SW bound approach
SO LOCATION  4B         AREA      442.9  680.9  0
** SRCDESCR  intersection (A) SW bound approach
SO LOCATION  5          AREA      398.8  598.6  0
** SRCDESCR  intersection (A) SW bound queue
SO LOCATION  6          AREA      386.4  579.0  0
** SRCDESCR  intersection (A) SW bound departure
SO LOCATION  7          AREA      322  514.2  0
** SRCDESCR  intersection (A) SW bound connect
```

CO pathway information entered

Link Locations defined as X, Y, Z coordinates

AERMOD Input File

aermod.inp - Notepad

File Edit Format View Help

```
SO LOCATION  72         AREA      602.4  229.4  0
** SRCDESCR  Parkway SB
SO LOCATION  70         AREA      614.9  227.9  0
** SRCDESCR  Parkway NB
SO LOCATION  2          AREA      348.5  599.1  0
** SRCDESCR  intersection (A) NW bound entrance ramp
SO LOCATION  52         AREA      366.2  76.6  0
** SRCDESCR  intersection (C) NB approach
SO SRCPARAM  1A         1  1.3  100  6  53.9  1.2
SO SRCPARAM  1B         1  1.3  158.5  6  -117.8  1.2
SO SRCPARAM  3A         1  1.3  24  3  1.2  1.2
SO SRCPARAM  3B         1  1.3  25  3  -54.8  1.2
SO SRCPARAM  4A         1  1.3  89  9  -65.8  1.2
SO SRCPARAM  4B         1  1.3  91.3  9  -82.4  1.2
SO SRCPARAM  5          1  1.3  22.1  9  125.5  1.2
SO SRCPARAM  6          1  1.3  90.5  9  135.6  1.2
SO SRCPARAM  7          1  1.3  68.9  9  134.5  1.2
SO SRCPARAM  8          1  1.3  68.6  9  -46.3  1.2
SO SRCPARAM  9          1  1.3  27.4  6  -48.0  1.2
SO SRCPARAM  10         1  1.3  39.6  3  -45.9  1.2
SO SRCPARAM  11         1  1.3  21.3  6  59.1  1.2
SO SRCPARAM  12         1  1.3  17.5  6  58.8  1.2
SO SRCPARAM  13         1  1.3  127.9  6  80.2  1.2
SO SRCPARAM  14         1  1.3  142.7  6  79.4  1.2
SO SRCPARAM  15A        1  1.3  33.6  3  -81.6  1.2
SO SRCPARAM  15B        1  1.3  28.9  3  -6.4  1.2
SO SRCPARAM  15C        1  1.3  23.9  3  46.0  1.2
SO SRCPARAM  15D        1  1.3  158.6  3  89.1  1.2
SO SRCPARAM  15E        1  1.3  49.1  3  60.5  1.2
SO SRCPARAM  16A        1  1.3  51.4  3  31.4  1.2
```

Source Parameters defined for each link:

- Emission Rate: “base rate” of 1 referenced by EMISFACT table for hourly/seasonal variation in emission rates
- Release Height: 1.3
- Area Source Length
- Area Source Width
- Area Source Angle (360 deg)
- Initial Vertical Dimension: 1.2

EPA

AERMOD Input File

- All sources modeled under urban dispersion conditions SO URBANSRC

aermod.inp - Notepad

File Edit Format View Help

```
SO SRCPARAM  70        1  1.3  94.1  6  -87.1  1.2
SO SRCPARAM  2         1  1.3  64  6  53.9  1.2
SO SRCPARAM  52        1  1.3  49.4  6  61.2  1.2
SO URBANSRC  1A  1B  3A  3B  4A  4B  5  6  7  8  9  10  11  12  13  14  15A  15B
SO URBANSRC  15C  15D  15E  16A  16B  18A  18B  17A  17B  17C  17D  19A  19B  4C
SO URBANSRC  20  21  22  23  24  25  26A  26B  27A  27B  28A  28B  29  30  31
SO URBANSRC  32  34A  35A  34B  35B  36A  36B  40B  39  38A  37  41  42A  42B
SO URBANSRC  43  44  45  46  48  49  50  51  53  54  55A  55B  56  58  59  60
SO URBANSRC  62  61  63  65  66  67  68  69  71  73  75A  75B  75C  33  40A  38B
SO URBANSRC  57  47  64  74  72  70  2  52
SO EMISFACT 1a SEASHR 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 3.68112E-07 3.68112E-07 3.68112E-07
SO EMISFACT 1a SEASHR 3.68112E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 3.43817E-07
SO EMISFACT 1a SEASHR 3.43817E-07 3.43817E-07 3.43817E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07
SO EMISFACT 1a SEASHR 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 3.25547E-07 3.25547E-07 3.25547E-07
SO EMISFACT 1a SEASHR 3.25547E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07
SO EMISFACT 1a SEASHR 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 3.05E-07 3.05E-07 3.05E-07
SO EMISFACT 1a SEASHR 3.05E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 2.98314E-07
```

- *Question for class*: To indicate urban dispersion conditions, we listed every source individually. How else could we have done it?

EMISFACT Keyword

- Used to vary emissions by time period
- SEASHR requires 96 factors of base rate
  - 4 seasons, 24 hours
  - Begins with [winter, hour 1], then [winter, hour 2], etc.

aermod.inp - Notepad

File Edit Format View Help

```
SO URBANSRC  32  34A  35A  34B  35B  36A  36B  40B  39  38A  37  41  42A  42B
SO URBANSRC  43  44  45  46  48  49  50  51  53  54  55A  55B  56  58  59  60
SO URBANSRC  62  61  63  65  66  67  68  69  71  73  75A  75B  75C  33  40A  38B
SO URBANSRC  57  47  64  74  72  70  2  52
SO EMISFACT 1a SEASHR 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 3.68112E-07 3.68112E-07 3.68112E-07
SO EMISFACT 1a SEASHR 3.68112E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 3.43817E-07
SO EMISFACT 1a SEASHR 3.43817E-07 3.43817E-07 3.43817E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07
SO EMISFACT 1a SEASHR 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 3.25547E-07 3.25547E-07 3.25547E-07
SO EMISFACT 1a SEASHR 3.25547E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07
SO EMISFACT 1a SEASHR 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 3.05E-07 3.05E-07 3.05E-07
SO EMISFACT 1a SEASHR 3.05E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 2.98314E-07
SO EMISFACT 1a SEASHR 2.98314E-07 2.98314E-07 2.98314E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07
SO EMISFACT 1a SEASHR 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 3.1889E-07 3.1889E-07 3.1889E-07
SO EMISFACT 1a SEASHR 3.1889E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07
SO EMISFACT 1b SEASHR 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 3.68112E-07 3.68112E-07 3.68112E-07
SO EMISFACT 1b SEASHR 3.68112E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 3.43817E-07
SO EMISFACT 1b SEASHR 3.43817E-07 3.43817E-07 3.43817E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07
SO EMISFACT 1b SEASHR 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 3.25547E-07 3.25547E-07 3.25547E-07
SO EMISFACT 1b SEASHR 3.25547E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 3.03166E-07
SO EMISFACT 1b SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07
SO EMISFACT 1b SEASHR 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 3.05E-07 3.05E-07 3.05E-07
SO EMISFACT 1b SEASHR 3.05E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 2.98314E-07
SO EMISFACT 1b SEASHR 2.98314E-07 2.98314E-07 2.98314E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07
SO EMISFACT 1b SEASHR 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 3.1889E-07 3.1889E-07 3.1889E-07
SO EMISFACT 1b SEASHR 3.1889E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 3.03166E-07
SO EMISFACT 1b SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07
SO EMISFACT 2 SEASHR 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07 2.62405E-07 2.62405E-07 2.62405E-07
SO EMISFACT 2 SEASHR 2.62405E-07 1.1185E-07 1.1185E-07 1.1185E-07 1.1185E-07 1.1185E-07 1.1185E-07 2.4442E-07
SO EMISFACT 2 SEASHR 2.4442E-07 2.4442E-07 2.4442E-07 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07
SO EMISFACT 2 SEASHR 1.03701E-07 1.03701E-07 1.03701E-07 1.03701E-07 1.03701E-07 2.31086E-07 2.31086E-07 2.31086E-07
SO EMISFACT 2 SEASHR 2.31086E-07 9.87108E-08 9.87108E-08 9.87108E-08 9.87108E-08 9.87108E-08 9.87108E-08 2.1453E-07
SO EMISFACT 2 SEASHR 2.1453E-07 2.1453E-07 2.1453E-07 1.03701E-07 1.03701E-07 1.03701E-07 1.03701E-07 1.03701E-07
```

Generating EMISFACT table

- The EMISFACT table is a list of "factors" that tell AERMOD by what to multiply the emission rate in the SRCPARAM statement, to account for variations in emission rates for each time period

- Defining the emission rate as "1" in SRCPARAM allows emission rates, in g/s/m-2, to be entered in the EMISFACT table, simplifying the generation of this table

```
SO SRCPARAM  1A          1  1.3  100  6  53.9  1.2
```

- The example here shows 96 rate factors for a source (1a): 24 hrs x 4 seasons with a SRCPARAM emission rate of 1:

```
SO EMISFACT 1a SEASHR 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 3.68112E-07 3.68112E-07 3.68112E-07
SO EMISFACT 1a SEASHR 3.68112E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 3.43817E-07
SO EMISFACT 1a SEASHR 3.43817E-07 3.43817E-07 3.43817E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07
SO EMISFACT 1a SEASHR 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 3.25547E-07 3.25547E-07 3.25547E-07
SO EMISFACT 1a SEASHR 3.25547E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07
SO EMISFACT 1a SEASHR 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 3.05E-07 3.05E-07 3.05E-07
SO EMISFACT 1a SEASHR 3.05E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 2.98314E-07
SO EMISFACT 1a SEASHR 2.98314E-07 2.98314E-07 2.98314E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07
SO EMISFACT 1a SEASHR 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 3.1889E-07 3.1889E-07 3.1889E-07
SO EMISFACT 1a SEASHR 3.1889E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07
```

Generating EMISFACT table

- AERMOD uses a specific format for EMISFACT tables
- With secondary key word SEASHR, there are 96 factors:
  - Hours 1 through 24, season 1 through season 4
- With many sources, this formatting can be automated using EPA's **MOVES2AERMOD** tool (an interface between MOVES and AERMOD)
  - Used for *running links* only
  - *Off-network* and *idle* links are post-processed separately

MOVES2AERMOD

Use to create an EMISFACT table from MOVES output when you have 16 MOVES runs:

Overview of steps that will be covered on next slides:

1. Copy the MOVES2AERMOD script to: C:\Users\Public\EPA\MOVES\MOVES2014a\database\OutputProcessingScripts

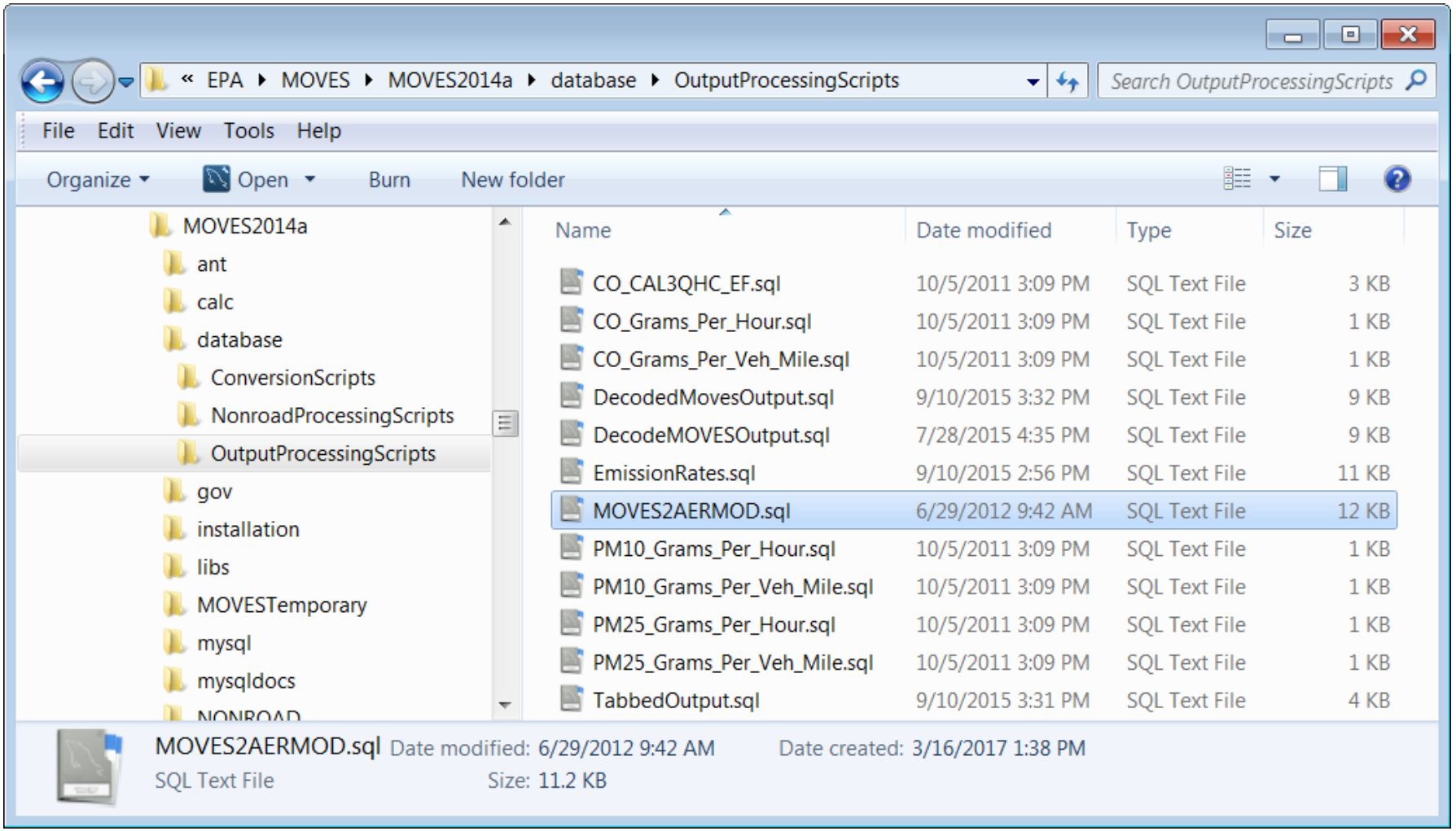
2. Copy Folder "MOVES2AERMOD input data" directly to C:\

3. Edit input files to reflect the project (existing files reflect the example):
   - Links_sources.csv – Maps MOVES links to AERMOD sources
   - Source_Area.csv – Describes area of each MOVES link
   - Traffic_Distribution.csv – Describes the peak/off-peak periods

4. Run MOVES2AERMOD in MOVES

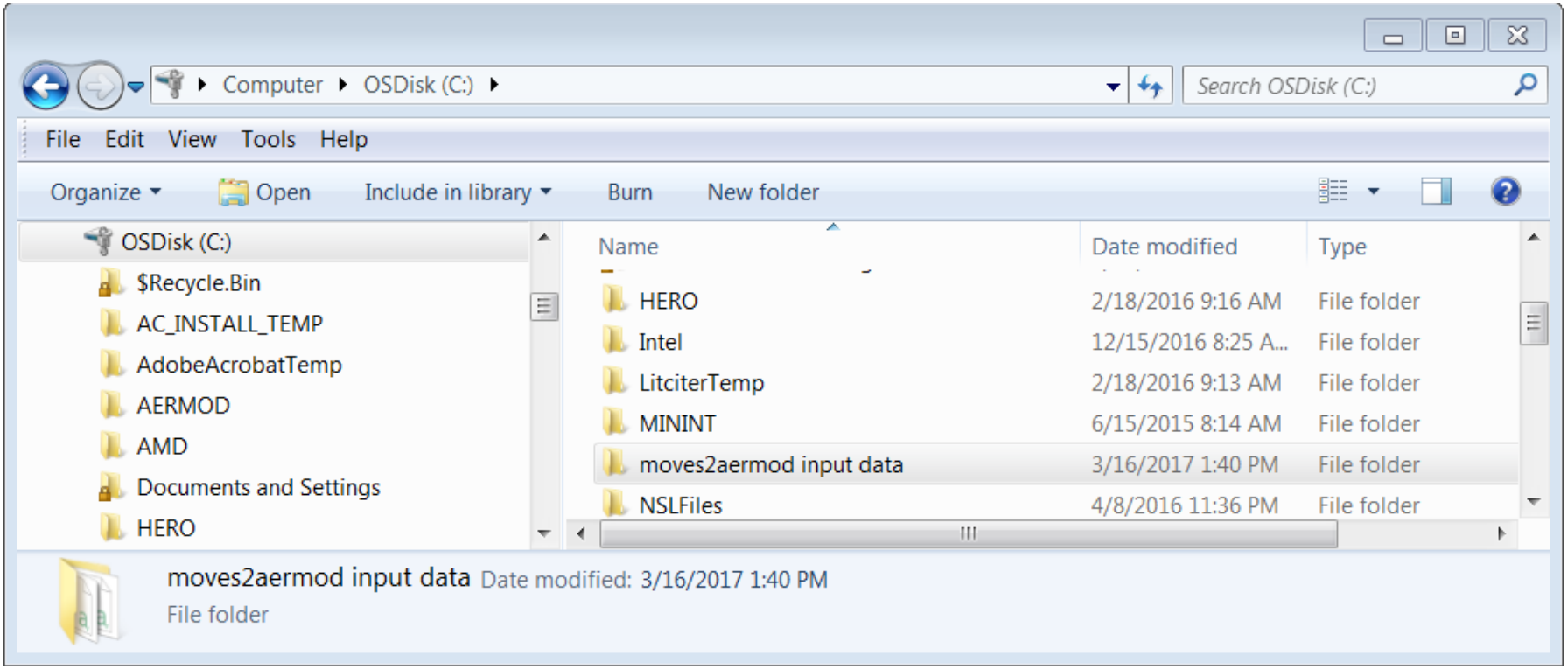
Copy Script: MOVES2AERMOD.sql

Copy from: Course Files\AERMOD files\Example Analysis\MOVES2AERMOD
Paste to: C:\Users\Public\EPA\MOVES\MOVES2014a\database\OutputProcessingScripts



Copy Folder: "MOVES2AERMOD input files"

Copy from: Course Files\AERMOD files\Example Analysis\MOVES2AERMOD
Paste to: C:\

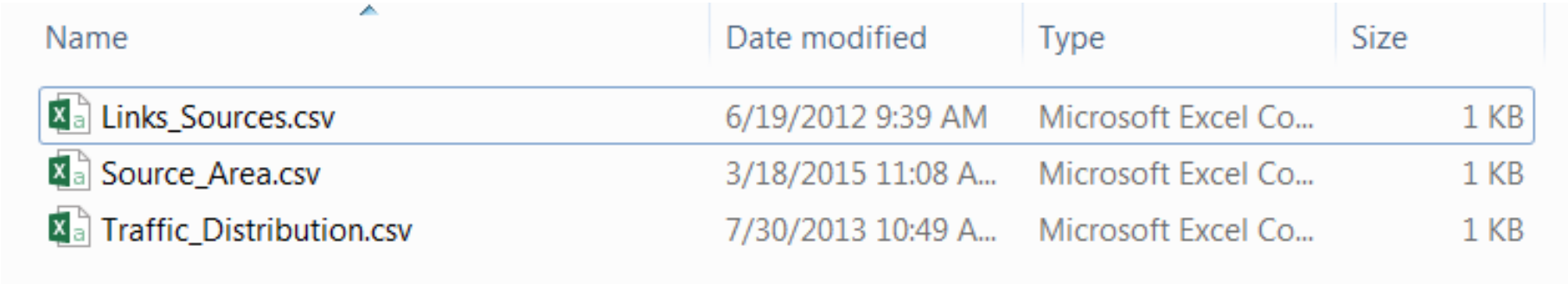


Note: If you are unable to save directly to your C: drive, modify the script (MOVES2AERMOD.sql) by finding "C:/MOVES2Aermod Input Data" and replacing it with a different location, e.g., "C:/Users/[your name]/desktop"

Folder: "MOVES2AERMOD input files"

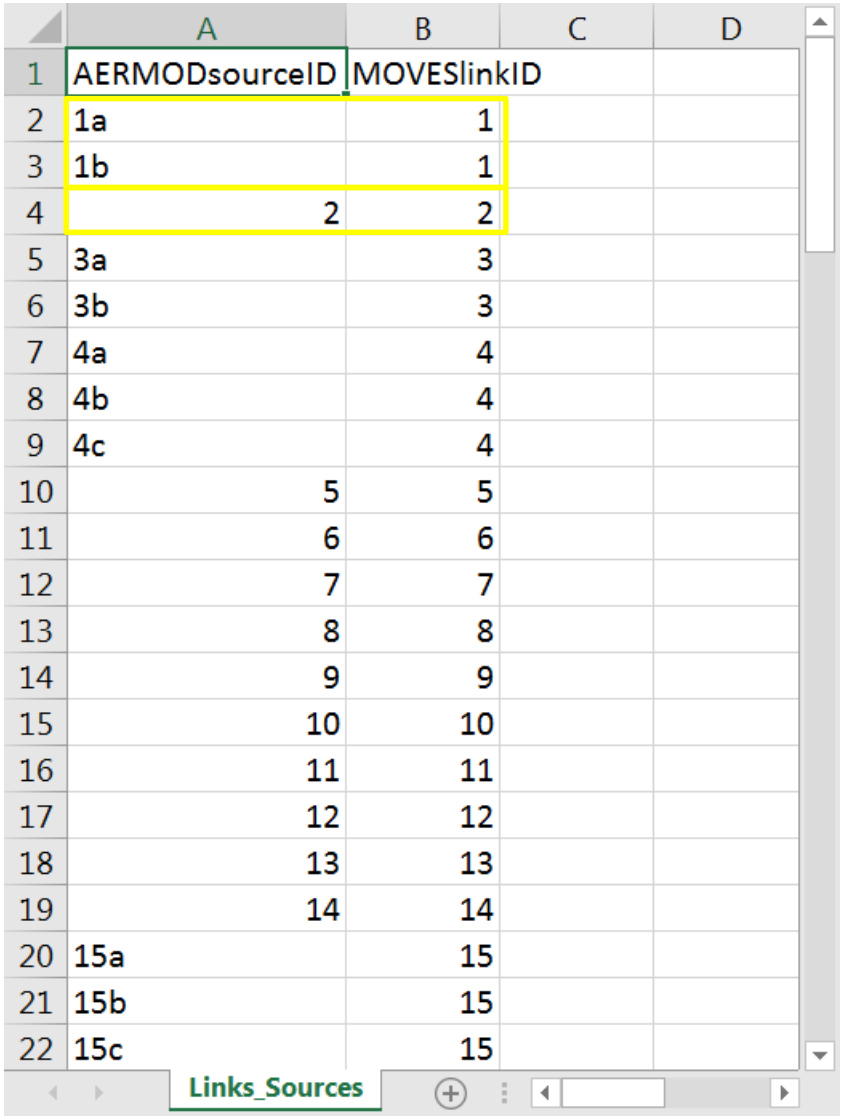
Contains three files:

- Link_Sources.csv
- Source_Area.csv
- Traffic_Distribution.csv



Name	Date modified	Type	Size
Links_Sources.csv	6/19/2012 9:39 AM	Microsoft Excel Co...	1 KB
Source_Area.csv	3/18/2015 11:08 A...	Microsoft Excel Co...	1 KB
Traffic_Distribution.csv	7/30/2013 10:49 A...	Microsoft Excel Co...	1 KB

Edit input files – Links_Sources.csv

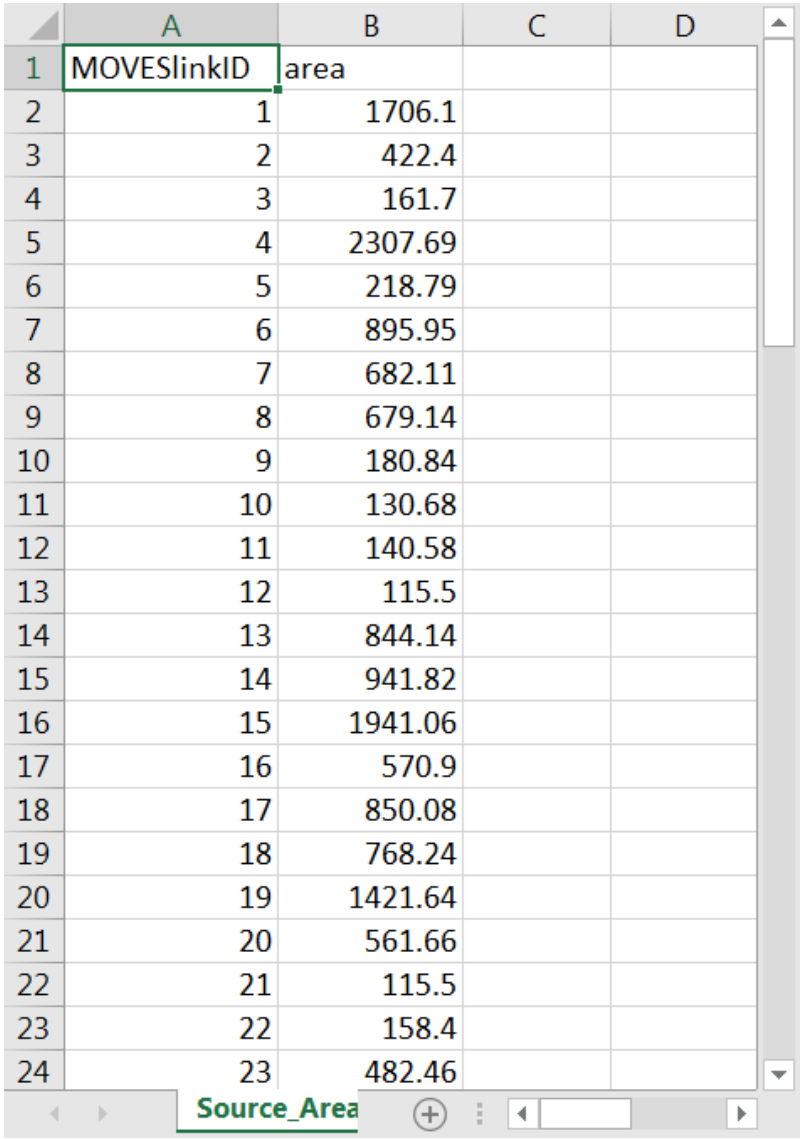


	A	B	C	D
1	AERMODsourceID	MOVESlinkID		
2	1a	1		
3	1b	1		
4	2	2		
5	3a	3		
6	3b	3		
7	4a	4		
8	4b	4		
9	4c	4		
10	5	5		
11	6	6		
12	7	7		
13	8	8		
14	9	9		
15	10	10		
16	11	11		
17	12	12		
18	13	13		
19	14	14		
20	15a	15		
21	15b	15		
22	15c	15		

Links_Sources

- In this table, list each AERMOD source and its corresponding MOVES link
- Depending on geometry, more than one AERMOD source may correspond to the same MOVES link
  - AERMOD sources 1a & 1b both correspond to MOVES link 1
  - AERMOD source 2 (and only source 2) corresponds to MOVES Link 2

Edit input files – Source_area.csv



	A	B	C	D
1	MOVESlinkID	area		
2	1	1706.1		
3	2	422.4		
4	3	161.7		
5	4	2307.69		
6	5	218.79		
7	6	895.95		
8	7	682.11		
9	8	679.14		
10	9	180.84		
11	10	130.68		
12	11	140.58		
13	12	115.5		
14	13	844.14		
15	14	941.82		
16	15	1941.06		
17	16	570.9		
18	17	850.08		
19	18	768.24		
20	19	1421.64		
21	20	561.66		
22	21	115.5		
23	22	158.4		
24	23	482.46		

Source_Area

- In this table, list each MOVES link and provide the area (m^2) of each
  - Area = roadway width (e.g., 3 m per lane of traffic) x link length

Edit input files – traffic_distribution.csv

	A	B	C	D
1	seasonId	hourId	Distribution	
2	1	1	101	
3	1	2	101	
4	1	3	101	
5	1	4	101	
6	1	5	101	
7	1	6	107	
8	1	7	107	
9	1	8	107	
10	1	9	107	
11	1	10	113	
12	1	11	113	
13	1	12	113	
14	1	13	113	
15	1	14	113	
16	1	15	113	
17	1	16	119	
18	1	17	119	
19	1	18	119	
20	1	19	119	
21	1	20	101	
22	1	21	101	
23	1	22	101	
24	1	23	101	
25	1	24	101	

Traffic_Distribution

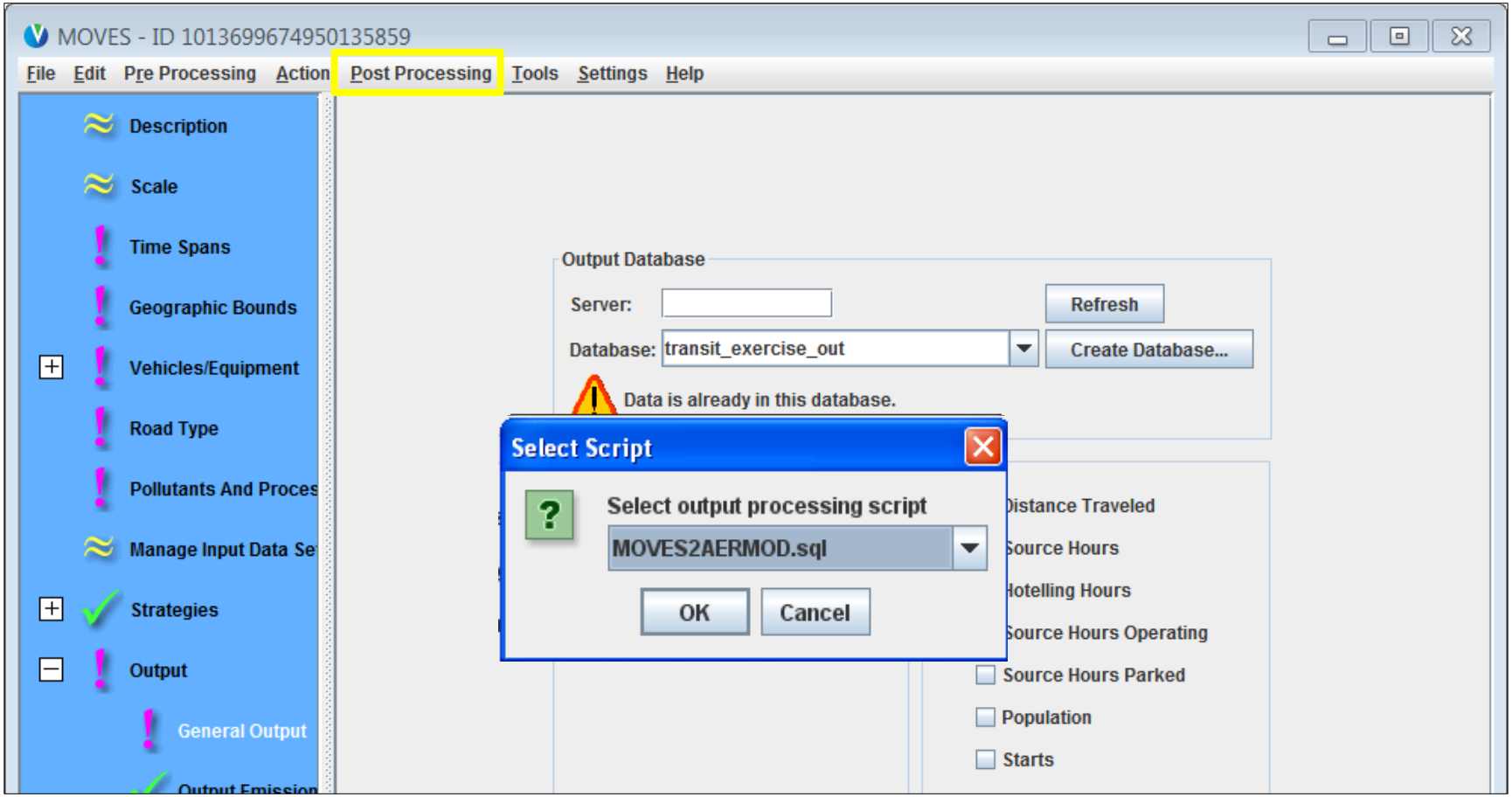
In this table:

- Column A, "seasonid" is seasons 1 – 4 (24 rows of each number)
- Column B, "hourid" is hours 1- 24, repeated for each season
- Column C, "Distribution": in this column, list the MOVES run (month+hour) to be used for each hour of each season
  - i.e., which MOVES run to pull emission rates from
  - Number in "Distribution" column is MOVES month (1, 4, 7, 10) followed by hour (01, 07, 13, 19), e.g.:
  - 101 = January 12am MOVES run
  - 1001 = October 12 am MOVES run
  - Follow this pattern for all sources
- ***Note:*** *hour 01, which is midnight to 1 am, applies to hourIDs 1-5 and 20-24 in our example*

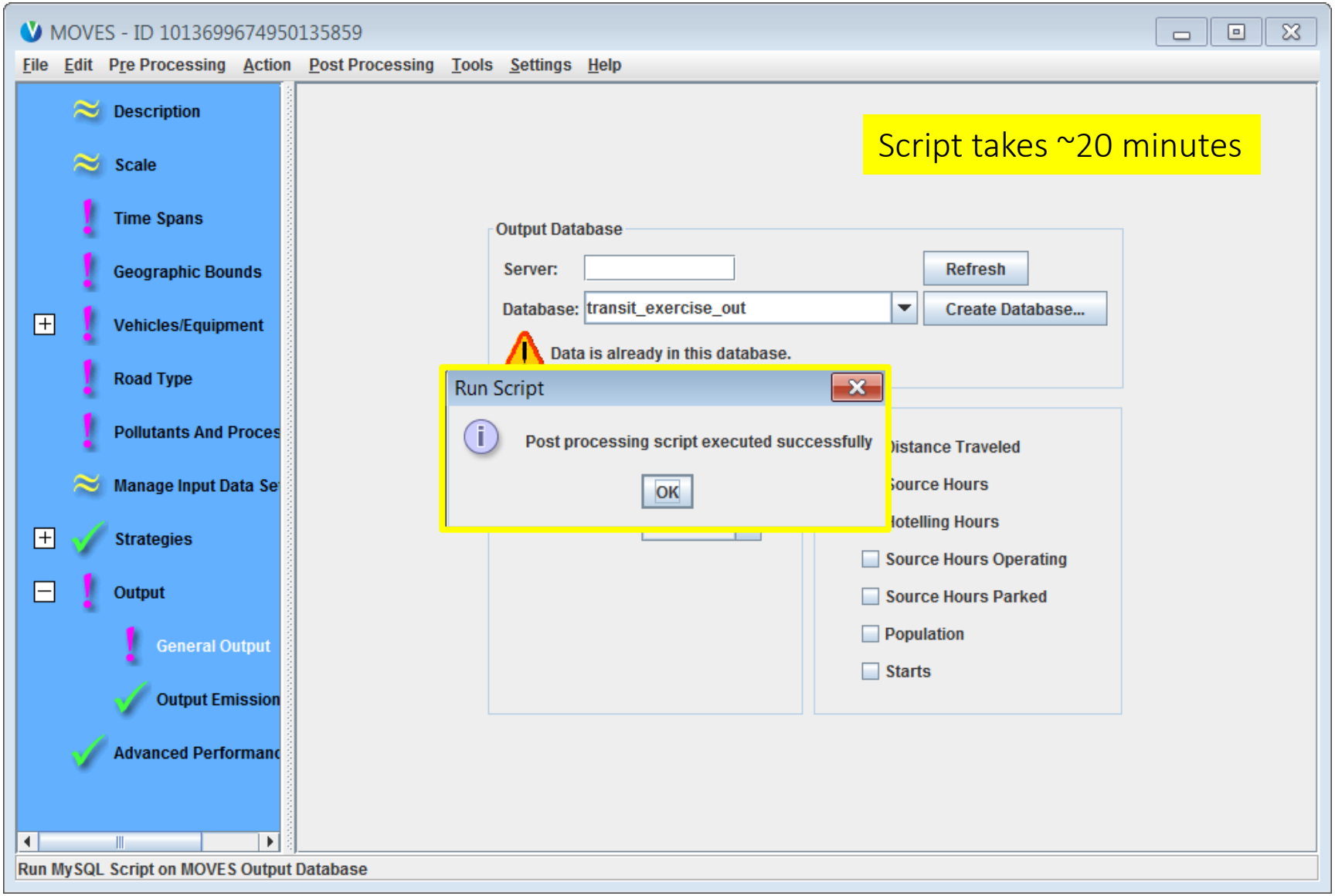
EPA

Run MOVES2AERMOD Script

- Ensure the right output database is selected in General Output
- From the Post Processing menu > Run MySQL Script on Output Database
- Using pull-down menu, select “MOVES2AERMOD.sql”

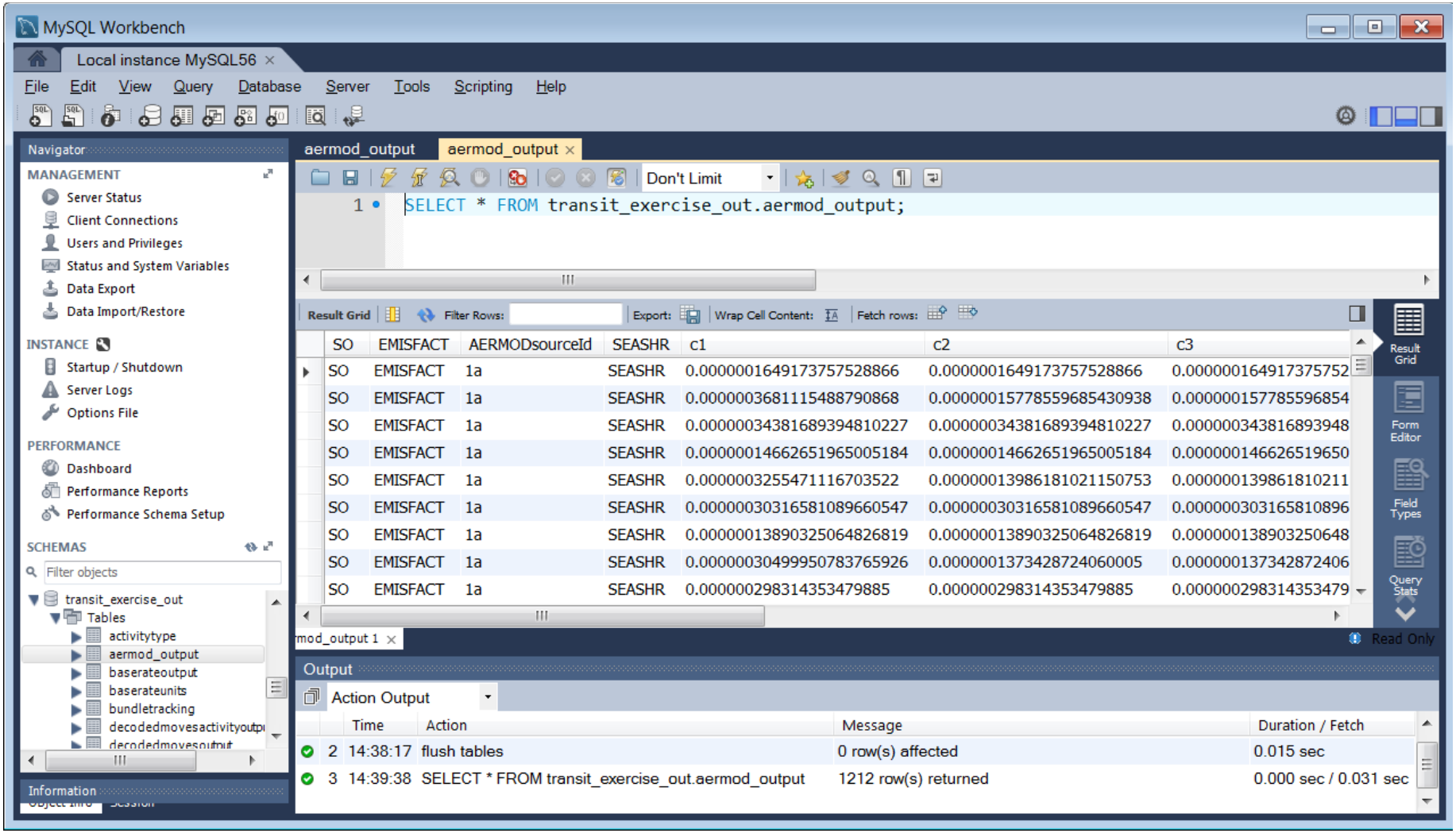


Message Returned When Script Finished



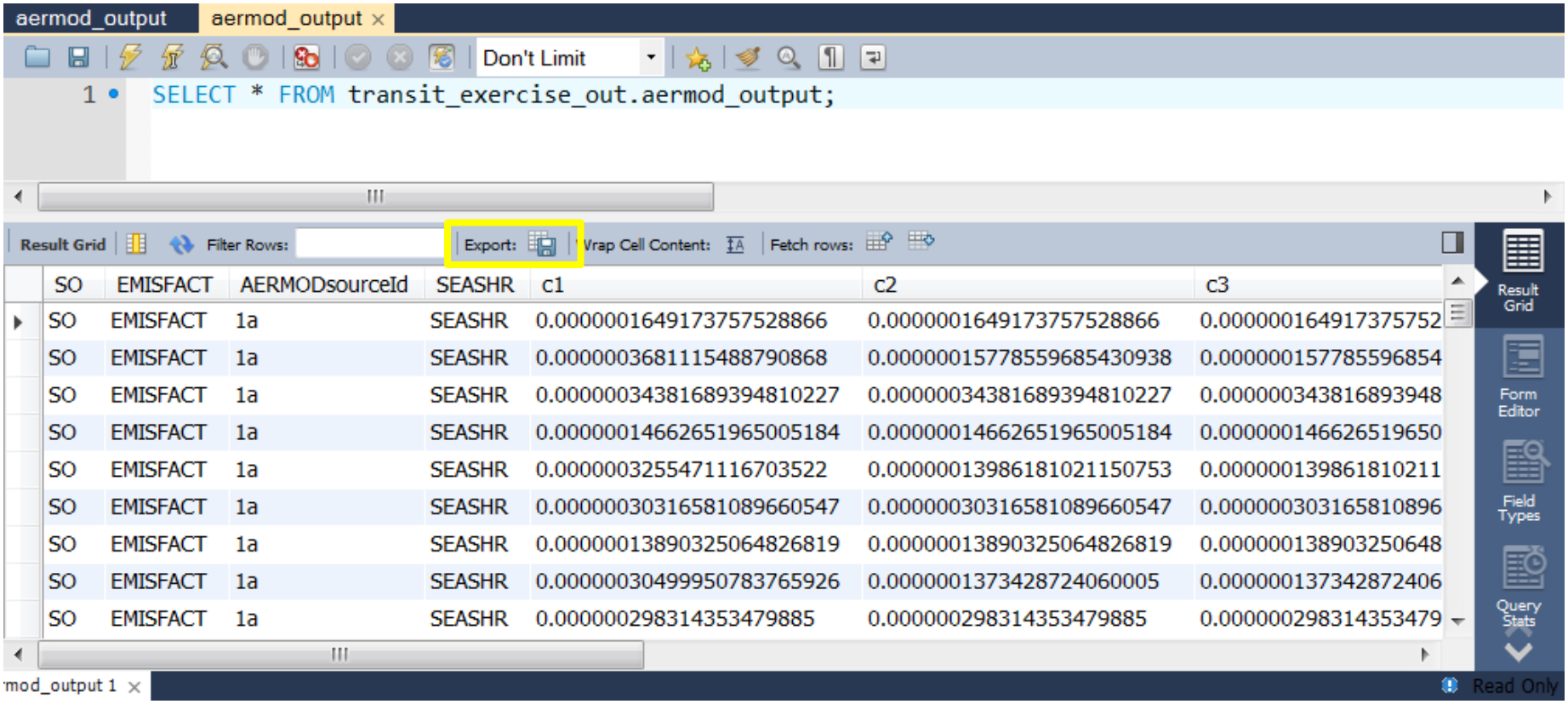
Script Generates Table “aermod_output”

Located in MOVES output database



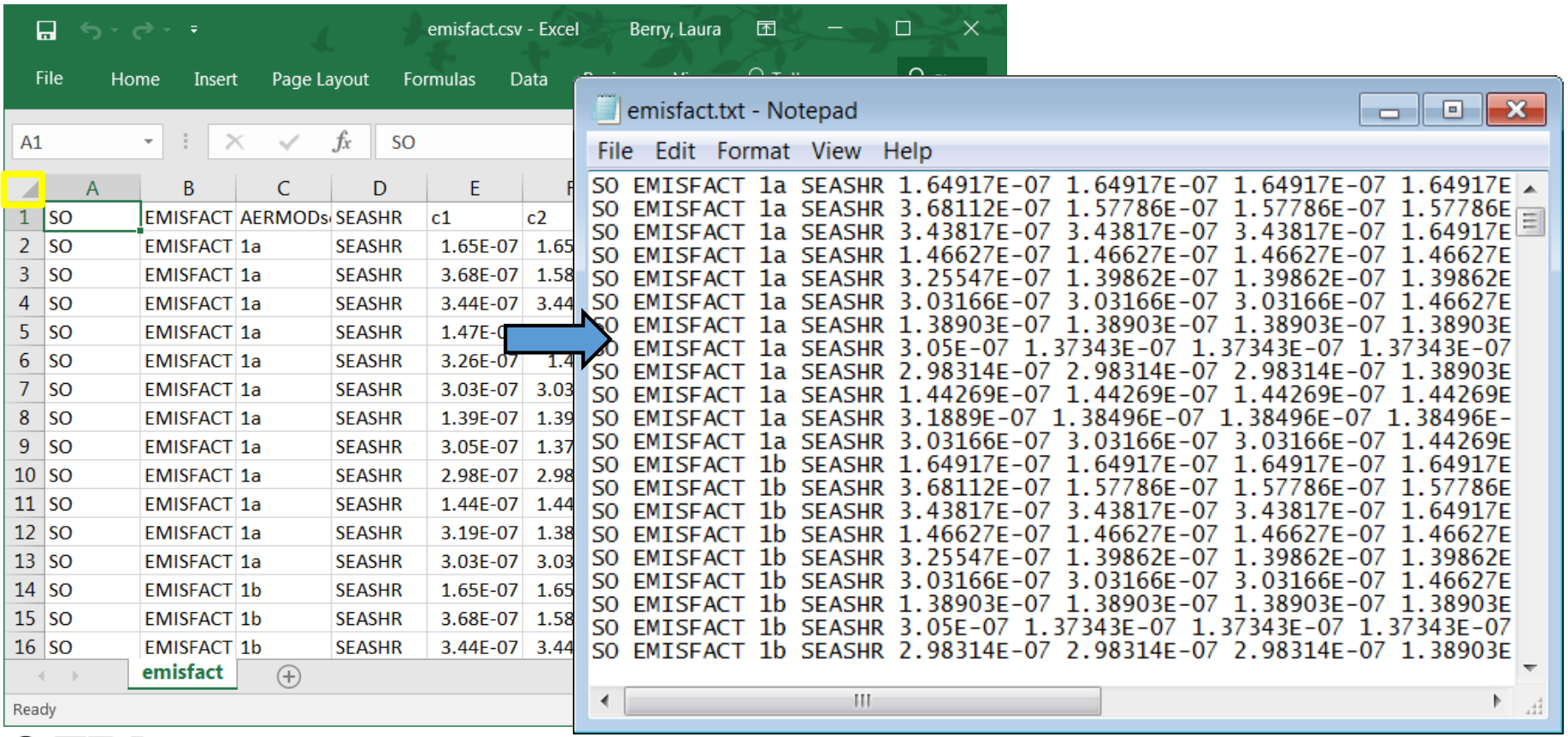
Export “aermod_output” to an External File

- Click on the “Export” button
- Save new file to desktop, name it “emisfact.csv”



Make the CSV File into a Txt File

- Open “emisfact.csv,” select entire sheet (click at top left corner), and copy
- Paste into a text editor (e.g. Notepad)
- Delete first row in text file, then use “Find and Replace” to replace tabs with a single space (copy a tab into the “Find” box) to create a space delimited file

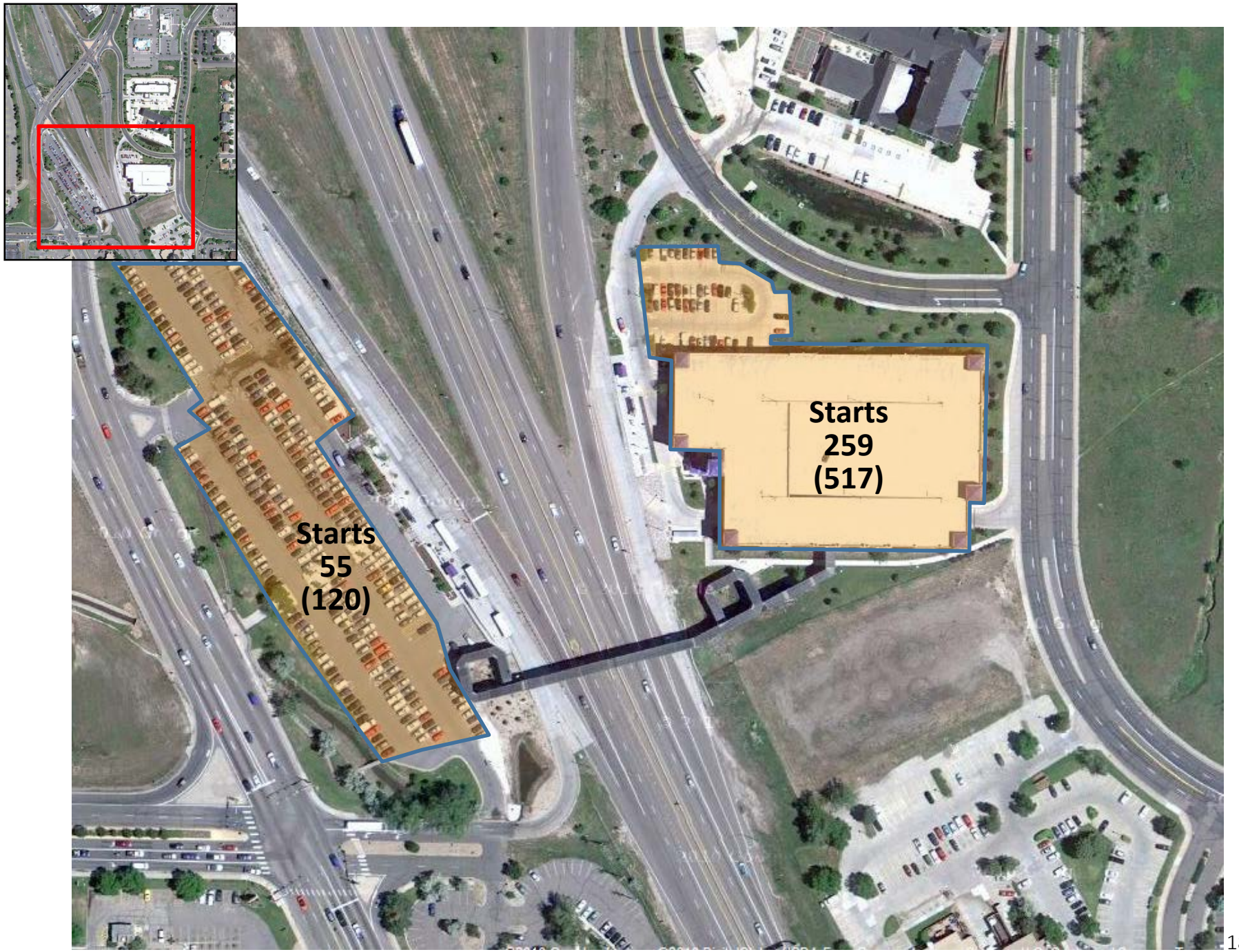


Creating the EMISFACT Table for Parking Lots

- MOVES can model only one off-network link per run
- Many projects may have multiple areas of starting vehicles, including the example analysis

<u>Solution for the Example Analysis:</u>

- A grams/start rate can be calculated for each of the 16 time periods
- These rates can be applied to each area of start activity (grams/start x number of starts)
  - Fleet mix must be identical in all areas of start activity for this approach to be valid


Starts
55
(120)
Starts
259
(517)

Emission Rates for Parking Lots - Starts

- Only one off-network link modeled in MOVES: Link 75

- The project has multiple areas of start activity with differing area sizes and number of starts
  - For this example, we assume the only activity in link 75 is starts

- We need to convert MOVES results to an area specific emission rate:

  total start emissions > grams/start > total grams per parking area > grams/sec/m^2

  Demonstrated in **Starts_EMISFACT.xls** spreadsheet

Start Rates

- Project traffic data has vehicle start data for two areas:
  - West parking lot (orange), and
  - East parking garage (green)

- Only LD vehicles are expected to be starting

- Area is calculated for each respective off-network link:

	A	B	C	D	E	F	G	H
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area	
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**		
3	75B	west parking lot	71.3	36.2	2581.06			
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**	

Start Rates – Link 75

- "LinkSeasonHourID" is link 75, followed by the month and hour
  - 7511 = link 75, month 1, hour 1; 75119 = link 75, month 1, hour 19
- "Gramsperhour" is from the MOVES output

	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

- Starts obtained from MySQL MOVESactivityOutput table (activitytypeid = 7)

	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

- Grams per start for each time period calculated: Gramsperhour divided by starts

	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

- An “actual” grams per hour for each time period is calculated: grams per start is multiplied by the “actual” number of starts (obtained from the traffic data)

	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

- Grams per hour is divided by 3600 to get a grams/second for each time period

	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

- Grams per second is divided by the total parking lot area for grams/sec/m^2

	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

- Copy the grams/sec/m^2 values into the MOVES2AERMOD-generated EMISFACT table in the appropriate source (75a, 75b, 75c) and seasonhr (more next slide)

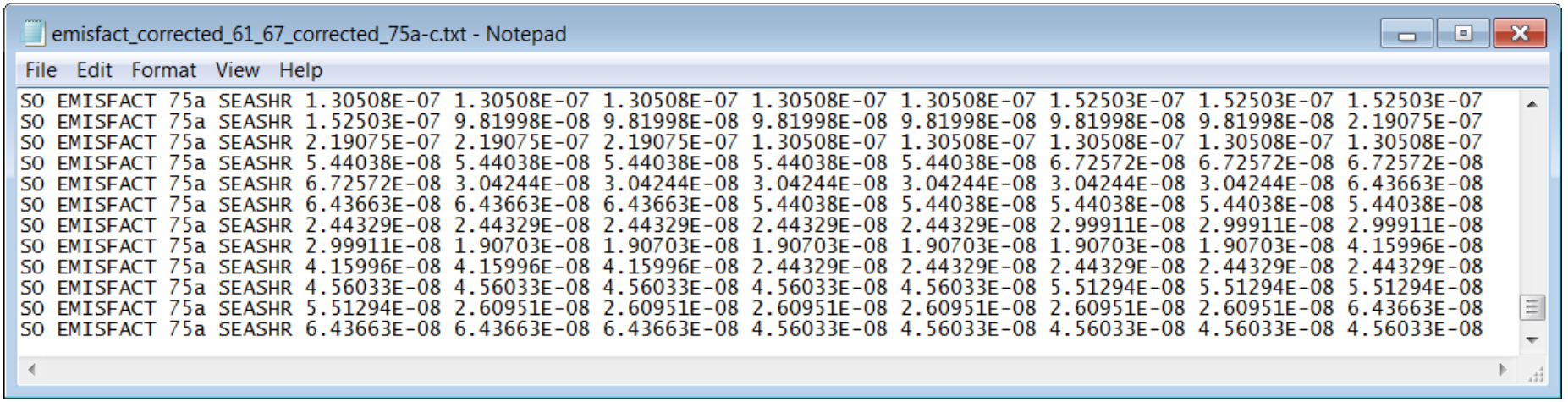
	A	B	C	D	E	F	G	H	I	J
1	off-network link	off-network area	length (meters)	width (meters)	m-2	total parking lot area	total parking garage area			
2	75A	west parking lot	149.5	54.5	8147.75	**10728.81**				
3	75B	west parking lot	71.3	36.2	2581.06					
4	75c	east parking garage	65.8	117.1	7705.18		**7705.18**			
5										
6										
7	**Link 75a and 75b**									
8	**Start Emission calculations**	linkseasonhourid	GramsPerHour	starts (from MOVESactivityoutput)	grams per start	actual starts	Update GramsperHour	GramsPerSecond	total area (m2)	grams per sec per m2
9	**west parking lot**	7511	58.38070792	637	0.091649463	55	5.040720464	0.0014002	10728.81	1.30508E-07
10		7517	68.21939297	637	0.107094808	55	5.890214464	0.001636171	10728.81	1.52503E-07
11		75113	43.92800649	637	0.068960764	55	3.792842004	0.001053567	10728.81	9.81998E-08
12		75119	44.91650401	637	0.070512565	120	8.46150782	0.002350419	10728.81	2.19075E-07
13		7541	24.33661944	637	0.038205054	55	2.101277974	0.000583688	10728.81	5.44038E-08
14		7547	30.0863514	637	0.047231321	55	2.597722649	0.00072159	10728.81	6.72572E-08
15		75413	13.6098561	637	0.021365551	55	1.175105314	0.000326418	10728.81	3.04244E-08
16		75419	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08
17		7571	10.92964466	637	0.017157998	55	0.943689884	0.000262136	10728.81	2.44329E-08
18		7577	13.41601728	637	0.021061252	55	1.158368839	0.000321769	10728.81	2.99911E-08
19		75713	8.530765923	637	0.013392097	55	0.736565347	0.000204601	10728.81	1.90703E-08
20		75719	8.529064201	637	0.013389426	120	1.60673109	0.000446314	10728.81	4.15996E-08
21		75101	20.39984422	637	0.032024873	55	1.761368025	0.000489269	10728.81	4.56033E-08
22		75107	24.6611944	637	0.038714591	55	2.129302499	0.000591473	10728.81	5.51294E-08
23		751013	11.67318529	637	0.018325252	55	1.007888839	0.000279969	10728.81	2.60951E-08
24		751019	13.19687026	637	0.020717222	120	2.48606661	0.000690574	10728.81	6.43663E-08

Off-model Start Calcs

Start Rates – Link 75

linkseasonhourid	grams per sec per m2
7511	1.30508E-07
7517	1.52503E-07
75113	9.81998E-08
75119	2.19075E-07
7541	5.44038E-08
7547	6.72572E-08
75413	3.04244E-08
75419	6.43663E-08
7571	2.44329E-08
7577	2.99911E-08
75713	1.90703E-08
75719	4.15996E-08
75101	4.56033E-08
75107	5.51294E-08
751013	2.60951E-08
751019	6.43663E-08

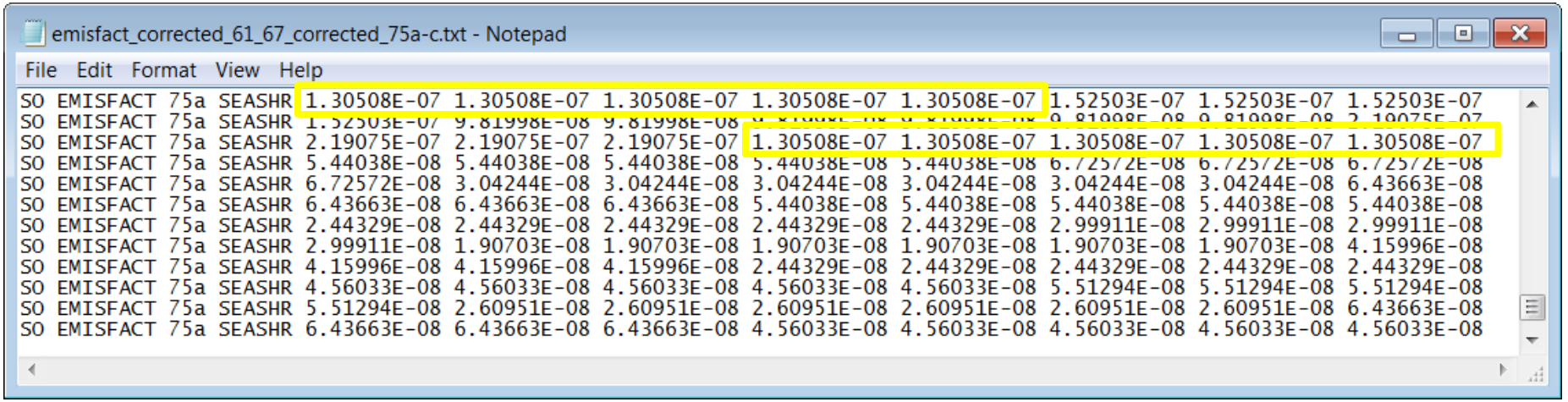
- To copy the grams/sec/m^2 values into the MOVES2AERMOD-generated EMISFACT table in the appropriate source (75a, 75b, 75c) and seasonhr:
  - Linkseasonhourid number = link number followed by MOVES month (1, 4, 7, 10) followed by hour (01, 07, 13, 19), e.g.:
    - 7511 = January 12am MOVES run
    - 75101 = October 12 am MOVES run



Start Rates – Link 75

linkseasonhourid	grams per sec per m2
7511	1.30508E-07
7517	1.52503E-07
75113	9.81998E-08
75119	2.19075E-07
7541	5.44038E-08
7547	6.72572E-08
75413	3.04244E-08
75419	6.43663E-08
7571	2.44329E-08
7577	2.99911E-08
75713	1.90703E-08
75719	4.15996E-08
75101	4.56033E-08
75107	5.51294E-08
751013	2.60951E-08
751019	6.43663E-08

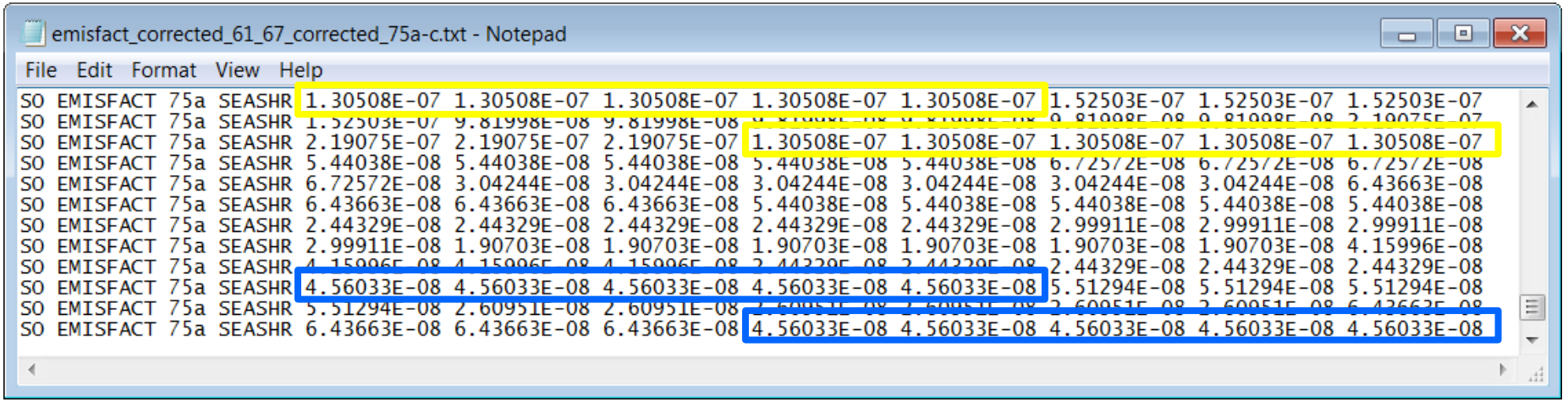
- Use the same distribution of hours as you set up in the MOVES2AERMOD "traffic_distribution.csv" file
  - E.g., January 12 am MOVES run rate of 1.305 x 10^7 applies to the first season, hours 1-5 and 20-24 in our example



Start Rates – Link 75

linkseasonhourid	grams per sec per m2
7511	1.30508E-07
7517	1.52503E-07
75113	9.81998E-08
75119	2.19075E-07
7541	5.44038E-08
7547	6.72572E-08
75413	3.04244E-08
75419	6.43663E-08
7571	2.44329E-08
7577	2.99911E-08
75713	1.90703E-08
75719	4.15996E-08
75101	4.56033E-08
75107	5.51294E-08
751013	2.60951E-08
751019	6.43663E-08

- Use the same distribution of hours as you set up in the MOVES2AERMOD "traffic_distribution.csv" file
  - E.g., January 12 am MOVES run rate of 1.305 x 10^7 applies to the first season, hours 1-5 and 20-24 in our example
  - October 12 am MOVES run rate of 4.560 x 10^8 applies to the 4th season, hours 1-5 and 20-24
  - Etc.



Emission Rates for Bus Pick-Up Lanes

- Modeled as link 61 (west) and link 67 (east) with "0 mph" average speed in MOVES, to represent buses idling

- MOVES calculates emissions on these links for the hour, i.e., as if the buses were idling for *the entire hour*

- MOVES results need to be adjusted based on dwell time, as mentioned in Module 2

- In our example, buses only idle 3 minutes out of the hour (3/60):

  From the MOVES2AERMOD generated EMISFACT table, for links 61 and 67, multiply the grams/s/m2 rate by (3 min/60 min)

  Replace the hourly emission values with the corrected emission values in the EMISFACT table for links 61 and 67

EPA

Paste EMISFACT table into AERMOD input file

aermod.inp - Notepad

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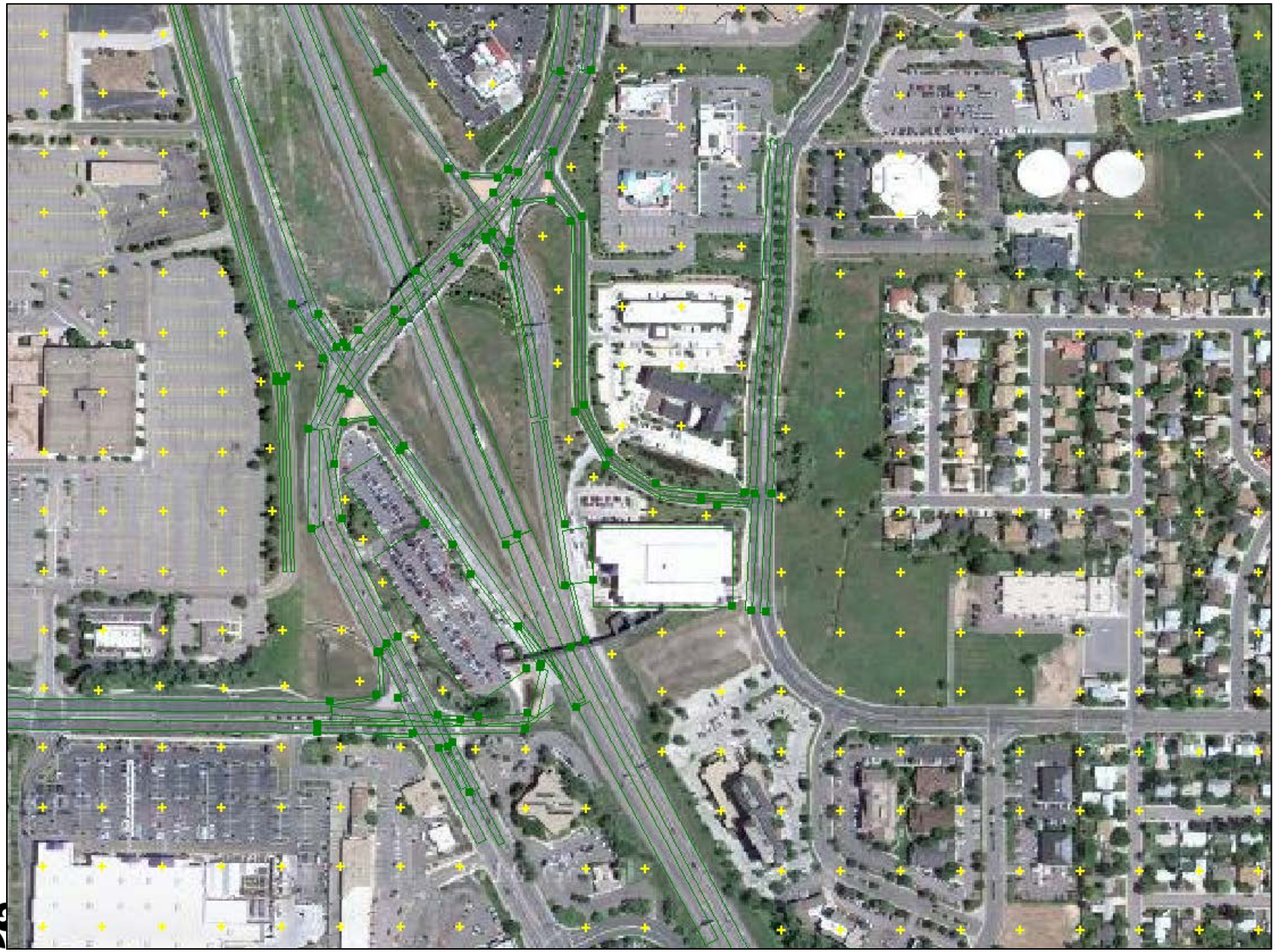
```
SO SRCPARAM  2         1  1.3  64  6  53.9  1.2
SO SRCPARAM  52        1  1.3  49.4  6  61.2  1.2
SO URBANSRC  1A  1B  3A  3B  4A  4B  5  6  7  8  9  10  11  12  13  14  15A  15B
SO URBANSRC  15C  15D  15E  16A  16B  18A  18B  17A  17B  17C  17D  19A  19B  4C
SO URBANSRC  20  21  22  23  24  25  26A  26B  27A  27B  28A  28B  29  30  31
SO URBANSRC  32  34A  35A  34B  35B  36A  36B  40B  39  38A  37  41  42A  42B
SO URBANSRC  43  44  45  46  48  49  50  51  53  54  55A  55B  56  58  59  60
SO URBANSRC  62  61  63  65  66  67  68  69  71  73  75A  75B  75C  33  40A  38B
SO URBANSRC  57  47  64  74  72  70  2  52
SO EMISFACT 1a SEASHR 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 3.68112E-07 3.68112E-07 3.68112E-07
SO EMISFACT 1a SEASHR 3.68112E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 3.43817E-07
SO EMISFACT 1a SEASHR 3.43817E-07 3.43817E-07 3.43817E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07
SO EMISFACT 1a SEASHR 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 3.25547E-07 3.25547E-07 3.25547E-07
SO EMISFACT 1a SEASHR 3.25547E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07
SO EMISFACT 1a SEASHR 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 3.05E-07 3.05E-07 3.05E-07
SO EMISFACT 1a SEASHR 3.05E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 2.98314E-07
SO EMISFACT 1a SEASHR 2.98314E-07 2.98314E-07 2.98314E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07
SO EMISFACT 1a SEASHR 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 3.1889E-07 3.1889E-07 3.1889E-07
SO EMISFACT 1a SEASHR 3.1889E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 3.03166E-07
SO EMISFACT 1a SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07
SO EMISFACT 1b SEASHR 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 3.68112E-07 3.68112E-07 3.68112E-07
SO EMISFACT 1b SEASHR 3.68112E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 1.57786E-07 3.43817E-07
SO EMISFACT 1b SEASHR 3.43817E-07 3.43817E-07 3.43817E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07 1.64917E-07
SO EMISFACT 1b SEASHR 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 3.25547E-07 3.25547E-07 3.25547E-07
SO EMISFACT 1b SEASHR 3.25547E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 1.39862E-07 3.03166E-07
SO EMISFACT 1b SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07 1.46627E-07
SO EMISFACT 1b SEASHR 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 3.05E-07 3.05E-07 3.05E-07
SO EMISFACT 1b SEASHR 3.05E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 1.37343E-07 2.98314E-07
SO EMISFACT 1b SEASHR 2.98314E-07 2.98314E-07 2.98314E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07 1.38903E-07
SO EMISFACT 1b SEASHR 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 3.1889E-07 3.1889E-07 3.1889E-07
SO EMISFACT 1b SEASHR 3.1889E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 1.38496E-07 3.03166E-07
SO EMISFACT 1b SEASHR 3.03166E-07 3.03166E-07 3.03166E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07 1.44269E-07
SO EMISFACT 2 SEASHR 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07 2.62405E-07 2.62405E-07 2.62405E-07
SO EMISFACT 2 SEASHR 2.62405E-07 1.1185E-07 1.1185E-07 1.1185E-07 1.1185E-07 1.1185E-07 1.1185E-07 2.4442E-07
SO EMISFACT 2 SEASHR 2.4442E-07 2.4442E-07 2.4442E-07 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07 1.17115E-07
```

EPA

Defining Receptors



Defining Receptors in AERMOD.inp

aermod.inp - Notepad

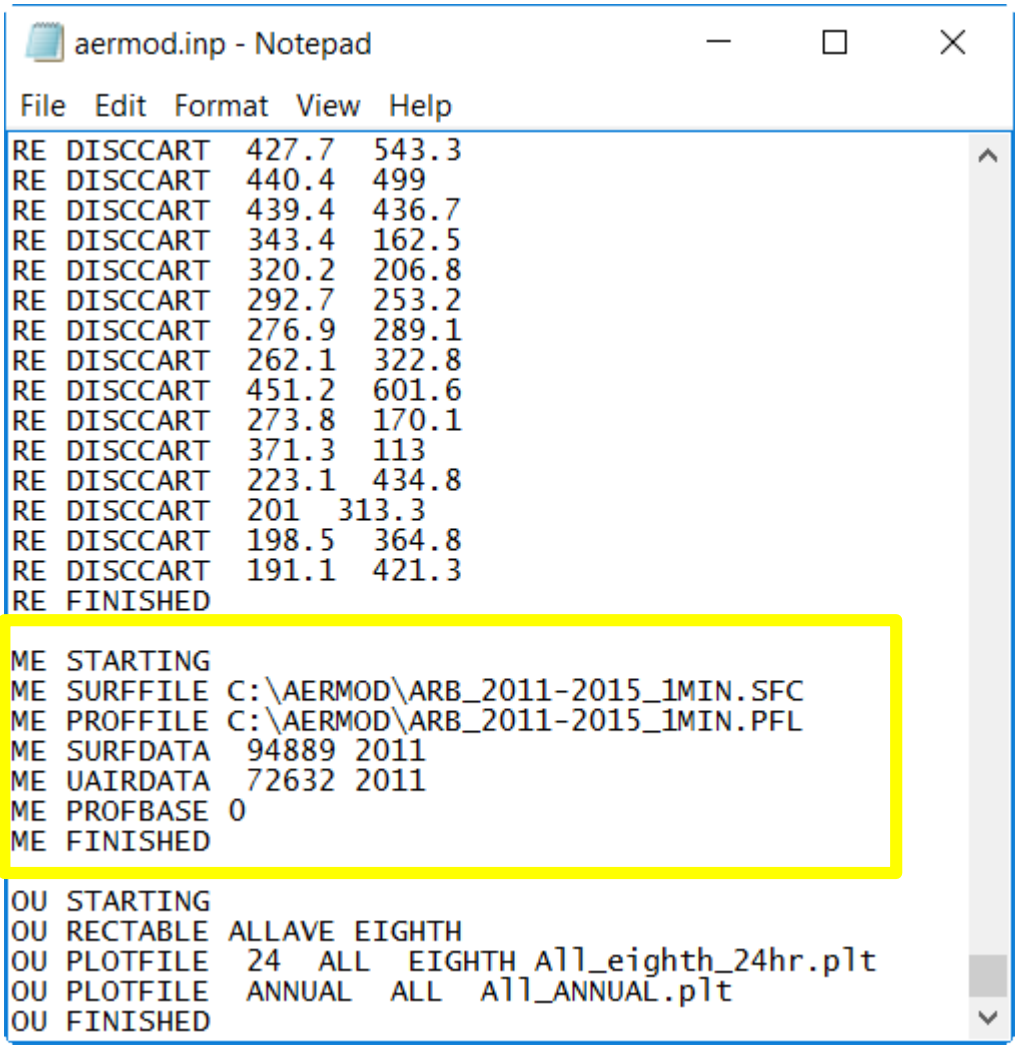
File Edit Format View Help

```
SO EMISFACT 75c SEASHR 3.61484E-07 1.71106E-07 1.71106E-07 1.71106E-07 1.71106E-07 1.71106E-07 1.71106E-07 3.86133E-07
SO EMISFACT 75c SEASHR 3.86133E-07 3.86133E-07 3.86133E-07 2.99021E-07 2.99021E-07 2.99021E-07 2.99021E-07 2.99021E-07
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE ELEVUNIT  METERS
RE DISCCART  9.0  212.8
RE DISCCART  59.0  212.8
RE DISCCART  109.0  212.8
RE DISCCART  159.0  212.8
RE DISCCART  209.0  212.8
RE DISCCART  259.0  212.8
RE DISCCART  9.0  262.8
RE DISCCART  59.0  262.8
RE DISCCART  109.0  262.8
RE DISCCART  159.0  262.8
RE DISCCART  9.0  312.8
RE DISCCART  59.0  312.8
RE DISCCART  109.0  312.8
RE DISCCART  159.0  312.8
RE DISCCART  9.0  362.8
RE DISCCART  59.0  362.8
RE DISCCART  109.0  362.8
RE DISCCART  159.0  362.8
RE DISCCART  9.0  412.8
RE DISCCART  59.0  412.8
RE DISCCART  109.0  412.8
RE DISCCART  159.0  412.8
RE DISCCART  9.0  462.8
RE DISCCART  59.0  462.8
RE DISCCART  109.0  462.8
RE DISCCART  159.0  462.8
RE DISCCART  9.0  512.8
RE DISCCART  59.0  512.8
RE DISCCART  109.0  512.8
RE DISCCART  159.0  512.8
RE DISCCART  9.0  562.8
RE DISCCART  59.0  562.8
```

- Discrete receptors are defined with X,Y coordinates
- Flagpole height specified earlier as 1.8 m in CO FLAGPOLE

Defining Meteorological Data



- Meteorological data *must* be located at the path included in the input file
  - Using data from Ann Arbor, MI from 2011 -2015
- Station IDs & beginning measurement year
  - 94889 for surface data
  - 72632 for upper air data
  - Beginning year 2011
- Base elevation (0) in m

Specifying Output Format

aermod.inp - Notepad

File Edit Format View Help

```
RE DISCCART   427.7   543.3
RE DISCCART   440.4   499
RE DISCCART   439.4   436.7
RE DISCCART   343.4   162.5
RE DISCCART   320.2   206.8
RE DISCCART   292.7   253.2
RE DISCCART   276.9   289.1
RE DISCCART   262.1   322.8
RE DISCCART   451.2   601.6
RE DISCCART   273.8   170.1
RE DISCCART   371.3   113
RE DISCCART   223.1   434.8
RE DISCCART   201   313.3
RE DISCCART   198.5   364.8
RE DISCCART   191.1   421.3
RE FINISHED

ME STARTING
ME SURFFILE C:\AERMOD\ARB_2011-2015_1MIN.SFC
ME PROFFILE C:\AERMOD\ARB_2011-2015_1MIN.PFL
ME SURFDATA  94889 2011
ME UAIRDATA  72632 2011
ME PROFBASE 0
ME FINISHED

OU STARTING
OU RECTABLE ALLAVE EIGHTH
OU PLOTFILE  24  ALL  EIGHTH All_eighth_24hr.plt
OU PLOTFILE  ANNUAL  ALL  All_ANNUAL.plt
OU FINISHED
```

- PLOTFILE recommended for both 24-hour and annual standard
- In addition to "aermod.out," two plotfiles will be generated:
  - "ALL_eighth_24hr.plt"
  - "ALL_ANNUAL.plt"

Running AERMOD

- The completed AERMOD input file and met data files for the example analysis are found on your desktop...

- Open folder “Course Files”
  - Open folder “AERMOD files”
  - Open folder “Example Analysis” containing
    - AERMOD.inp *(the input file described)*
    - AERMOD.exe *(the aermod executable program)*
    - ARB_2011-2015_1MIN.pfl *(profile met data)*
    - ARB_2011-2015_1MIN.sfc *(surface met data)*

- To run, double click AERMOD.exe

EPA

AERMOD Output – Annual Plotfile

All_ANNUAL.plt - Notepad

File Edit Format View Help

```
* AERMOD (16216r):  Hotspot Training Exercise                                  07/18/17
* AERMET ( 14134):                                                            16:02:12
* MODELING OPTIONS USED:   NonDFAULT  CONC  FLAT  FLGPOL  URBAN
*         PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS   5 YEARS FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   311 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)

*        X             Y        AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE      GRP      NUM YRS   NET ID
* ____________  ____________  ____________  ________ ________ ________ ________ ________ ________ ________
      9.00000     212.80000       0.25635     0.00     0.00     1.80 ANNUAL   ALL      00000005
     59.00000     212.80000       0.31296     0.00     0.00     1.80 ANNUAL   ALL      00000005
    109.00000     212.80000       0.36868     0.00     0.00     1.80 ANNUAL   ALL      00000005
    159.00000     212.80000       0.43278     0.00     0.00     1.80 ANNUAL   ALL      00000005
    209.00000     212.80000       0.51881     0.00     0.00     1.80 ANNUAL   ALL      00000005
    259.00000     212.80000       0.68399     0.00     0.00     1.80 ANNUAL   ALL      00000005
      9.00000     262.80000       0.22662     0.00     0.00     1.80 ANNUAL   ALL      00000005
     59.00000     262.80000       0.27676     0.00     0.00     1.80 ANNUAL   ALL      00000005
    109.00000     262.80000       0.34062     0.00     0.00     1.80 ANNUAL   ALL      00000005
    159.00000     262.80000       0.43983     0.00     0.00     1.80 ANNUAL   ALL      00000005
      9.00000     312.80000       0.22309     0.00     0.00     1.80 ANNUAL   ALL      00000005
     59.00000     312.80000       0.27317     0.00     0.00     1.80 ANNUAL   ALL      00000005
    109.00000     312.80000       0.34548     0.00     0.00     1.80 ANNUAL   ALL      00000005
    159.00000     312.80000       0.47458     0.00     0.00     1.80 ANNUAL   ALL      00000005
      9.00000     362.80000       0.22532     0.00     0.00     1.80 ANNUAL   ALL      00000005
     59.00000     362.80000       0.27730     0.00     0.00     1.80 ANNUAL   ALL      00000005
    109.00000     362.80000       0.35541     0.00     0.00     1.80 ANNUAL   ALL      00000005
    159.00000     362.80000       0.50269     0.00     0.00     1.80 ANNUAL   ALL      00000005
      9.00000     412.80000       0.22890     0.00     0.00     1.80 ANNUAL   ALL      00000005
     59.00000     412.80000       0.28356     0.00     0.00     1.80 ANNUAL   ALL      00000005
    109.00000     412.80000       0.36753     0.00     0.00     1.80 ANNUAL   ALL      00000005
    159.00000     412.80000       0.52764     0.00     0.00     1.80 ANNUAL   ALL      00000005
      9.00000     462.80000       0.23300     0.00     0.00     1.80 ANNUAL   ALL      00000005
     59.00000     462.80000       0.29179     0.00     0.00     1.80 ANNUAL   ALL      00000005
    109.00000     462.80000       0.38419     0.00     0.00     1.80 ANNUAL   ALL      00000005
```

AERMOD Output – 24-hour Plotfile

All_eighth_24hr.plt - Notepad

File Edit Format View Help

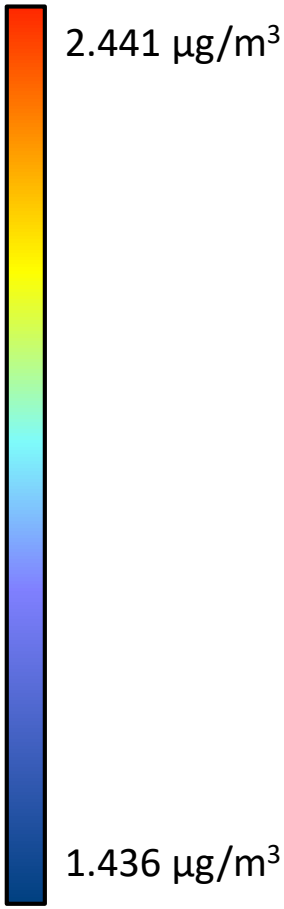
```
* AERMOD (16216r):  Hotspot Training Exercise                                  07/18/17
* AERMET ( 14134):                                                            16:02:12
* MODELING OPTIONS USED:   NonDFAULT  CONC  FLAT  FLGPOL  URBAN
*         PLOT FILE OF   8TH-HIGHEST MAX DAILY 24-HR VALUES AVERAGED OVER   5 YEARS FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   311 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,A5,5X,A8,2X,10(F13.5,2X,I8.8,2X:))
*        X             Y          AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE      GRP       RANK      NET ID
*  ____________  ____________  ____________  ____________  ____________  ____________  ____________  ____________  ____________  ____________
      9.00000     212.80000       1.06449     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     212.80000       1.20855     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     212.80000       1.39418     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     212.80000       1.56871     0.00      0.00      1.80    24-HR   ALL       8TH
    209.00000     212.80000       1.84679     0.00      0.00      1.80    24-HR   ALL       8TH
    259.00000     212.80000       2.40604     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     262.80000       1.04415     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     262.80000       1.22309     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     262.80000       1.46143     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     262.80000       1.82328     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     312.80000       1.06637     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     312.80000       1.25979     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     312.80000       1.54948     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     312.80000       2.01823     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     362.80000       1.12623     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     362.80000       1.33756     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     362.80000       1.62587     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     362.80000       2.06709     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     412.80000       1.13331     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     412.80000       1.34387     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     412.80000       1.64164     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     412.80000       2.13205     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     462.80000       1.11008     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     462.80000       1.36754     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     462.80000       1.69022     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     462.80000       2.28465     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     512.80000       1.11853     0.00      0.00      1.80    24-HR   ALL       8TH
     59.00000     512.80000       1.40058     0.00      0.00      1.80    24-HR   ALL       8TH
    109.00000     512.80000       1.76956     0.00      0.00      1.80    24-HR   ALL       8TH
    159.00000     512.80000       2.57747     0.00      0.00      1.80    24-HR   ALL       8TH
      9.00000     562.80000       1.16024     0.00      0.00      1.80    24-HR   ALL       8TH
```

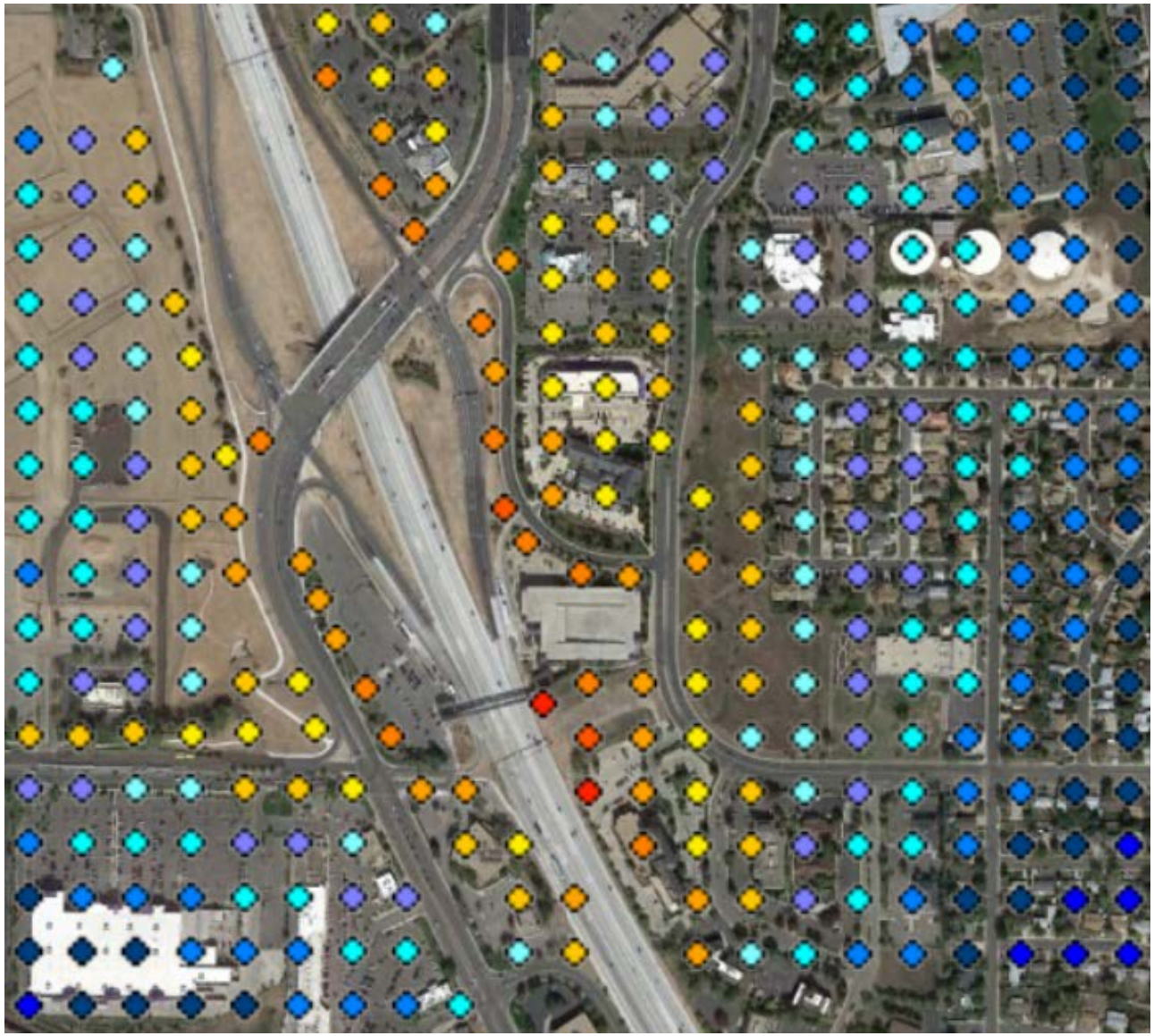
This file extends farther right - Includes columns with the 8th highest concentration for each year, and date it occurs

The "Average Conc" column is the average of these 5 years' 8th highest value

Plot of Annual Average Concentrations

$PM_{2.5}$ Receptor Concentrations ($\mu g/m^3$)



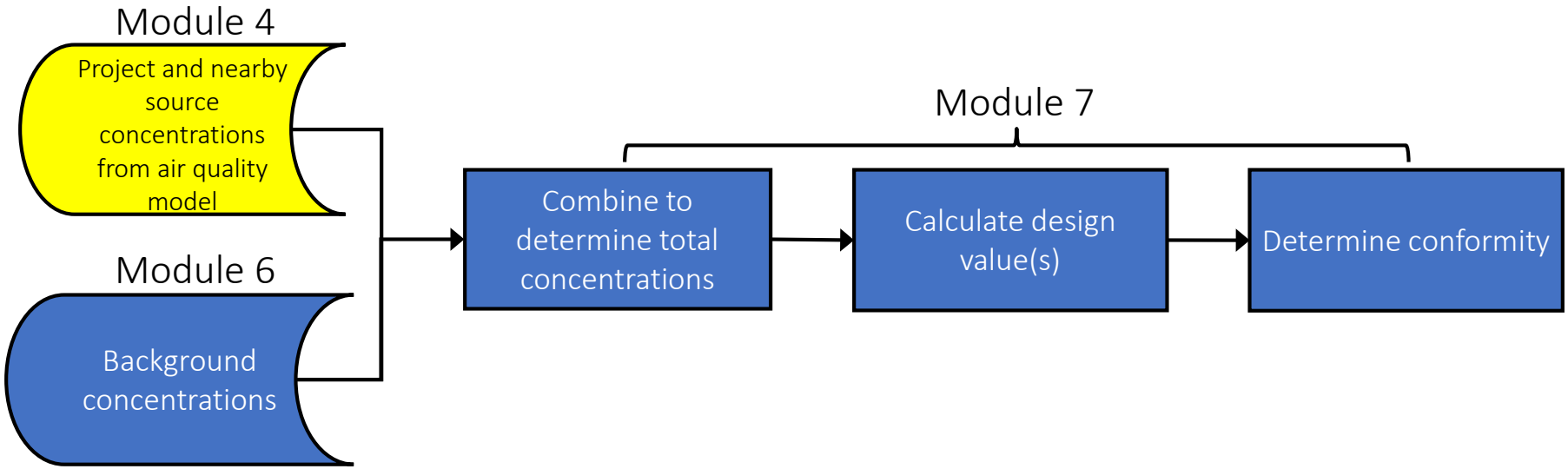


AERMOD Output – Next Steps

- We now have AERMOD output files for the example analysis for both the annual and 24-hour $PM_{2.5}$ NAAQS

- We will combine these air quality modeling results with representative background data (from **Module 6**) to calculate project design values in **Module 7**

- Complete for the Example Analysis of the highway/transit project



End of Module 4

Additional material follows in Reference section

Questions?

EPA

Reference 4A: Example Batch File

EPA

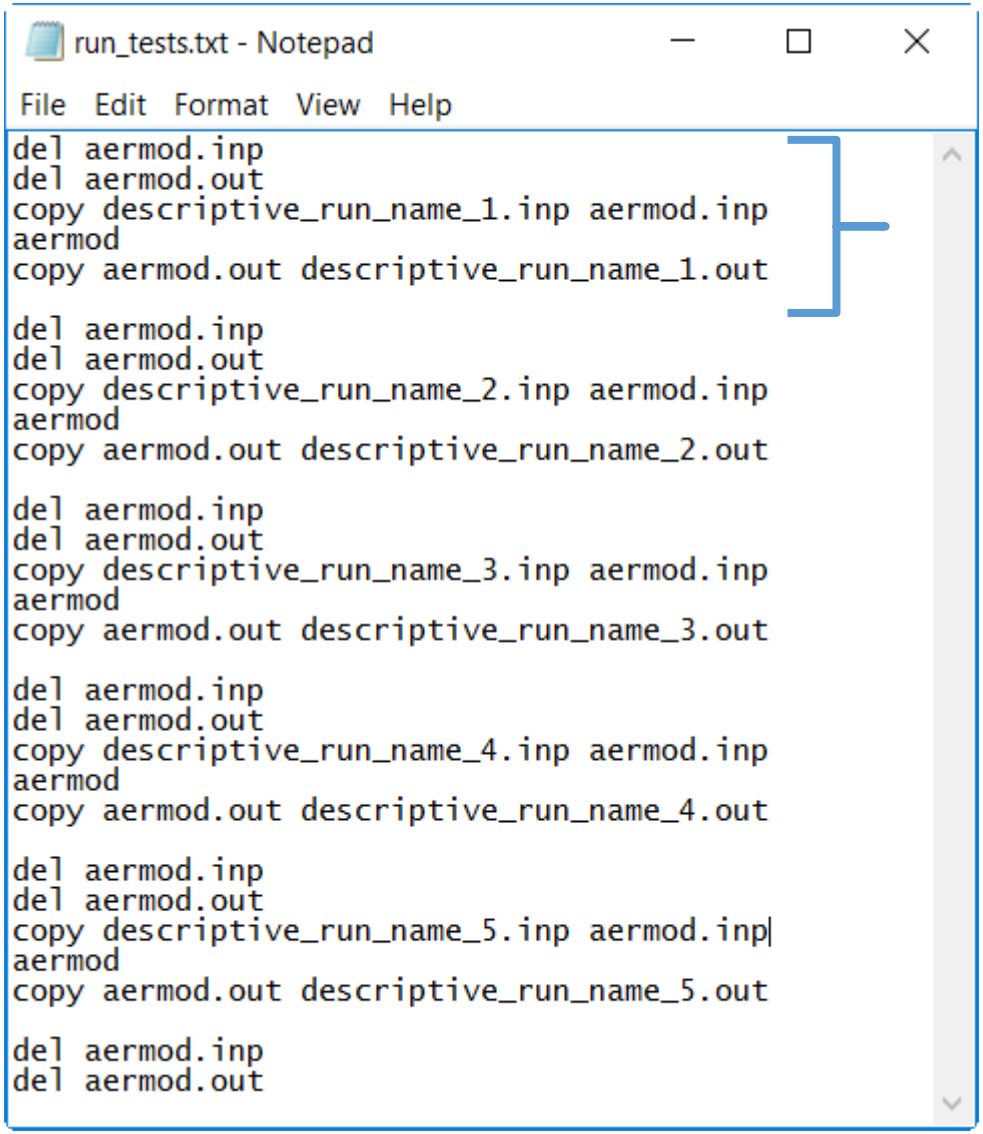
Example Batch File

- Example located in downloaded ZIP file, under

  Course Files\AERMOD files\Example batch file

- General instructions:
  - Open text file and edit:
    - Repeat bracketed sets of lines as necessary (see next slide) for the number of input files you need to run – the example includes 5
    - Edit the file names ("descriptive_file_name_1", etc.) with your own file names; ensure input file name and output file name match
  - Resave text file as a batch file - ".bat" in the folder
  - Click on the .bat file to run all the AERMOD input files you included
  - *Tip:* Make sure your computer does not power off during the run

Example Batch File – included in Course Files



Each bracketed set of lines does the following:

- Deletes the last input file that was run
- Deletes the last output file created
- Copies your run input file as "AERMOD.inp"
- Runs AERMOD
- Copies "AERMOD.out" as your output file name

This occurs 5 times in this file; copy this set of lines as many times as needed

Replace "descriptive_run_name_1" , etc. throughout text file with your file names

Make sure that for each run, your input and output file names match, and only differ by ".in" or ".out"

Reference 4B: Additional Information about Area Sources

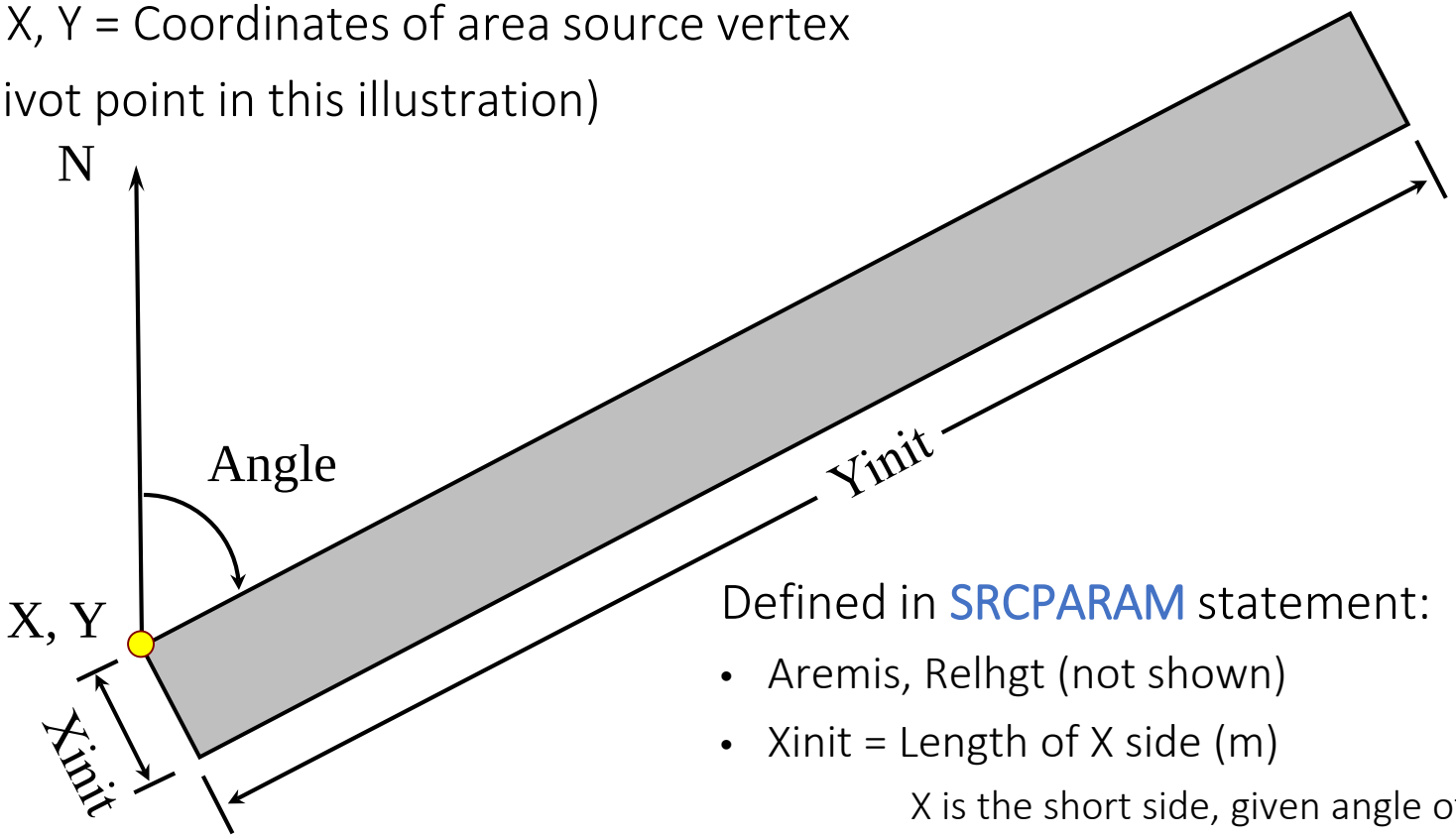
EPA

A Highway Link as an **Area** Source

Defined in LOCATION statement:

- X, Y = Coordinates of area source vertex

(pivot point in this illustration)



Defined in SRCPARAM statement:

- Aremis, Relhgt (not shown)
- Xinit = Length of X side (m)

  X is the short side, given angle of rotation
- Yinit = Length of Y side (m)
- Angle = orientation angle
- Szinit (not shown)

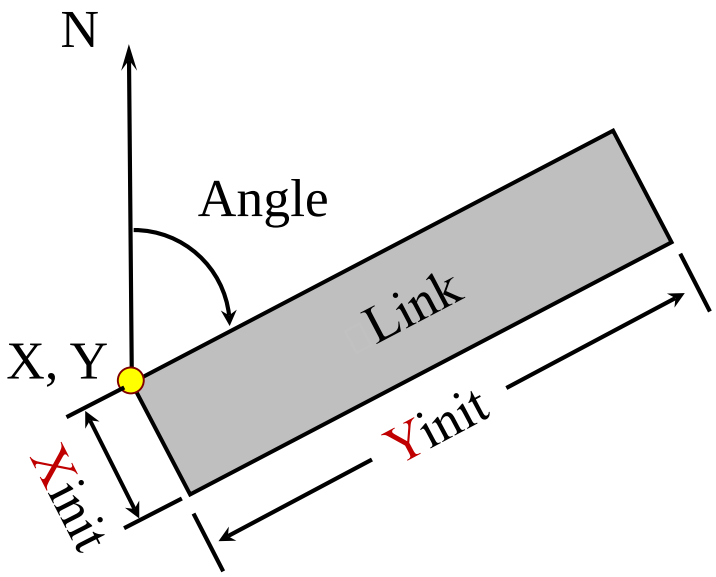
A Highway Link as an **Area** Source

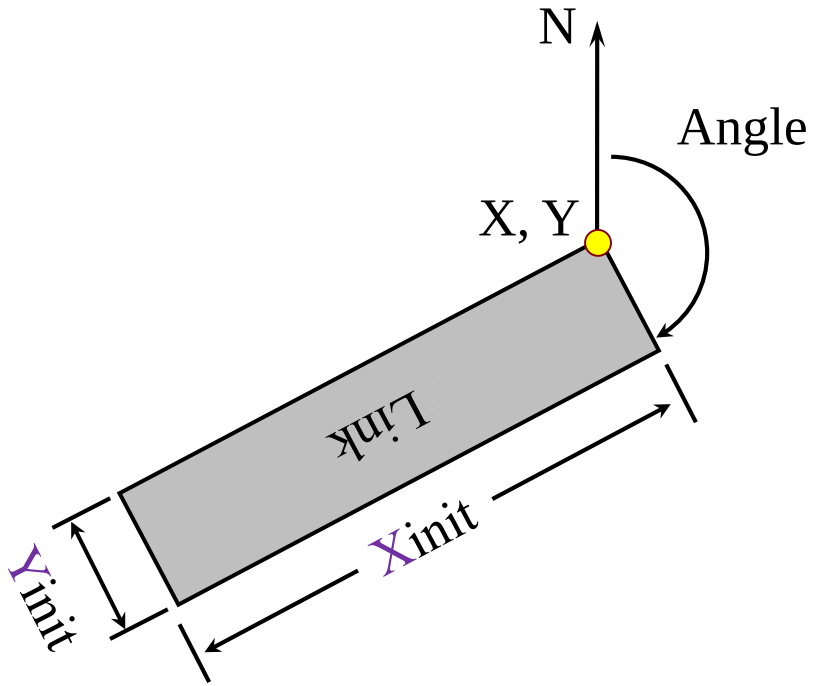
Note: Selection of area source vertex (X,Y) is not critical, as long as relationship between Xinit, Yinit, and Angle parameters is maintained:

Xinit: Length of side that is *counterclockwise* from vertex

Yinit: Length of side that is *clockwise* from vertex

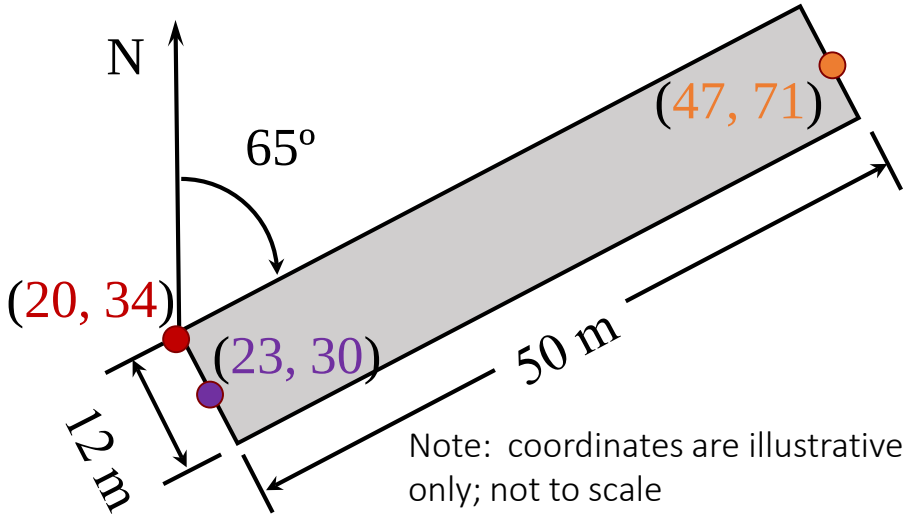
Angle: Degrees from North, measured positive clockwise





Source Pathway – Quick Exercise

- Complete the LOCATION and SRCPARAM statements for this source using AREA and LINE
  - Source emits 0.00042 g/s/m^2
  - From a release height of 2.5 m
  - Szinit is 1.5 m



Note: coordinates are illustrative only; not to scale

- If srctyp **AREA** is used:

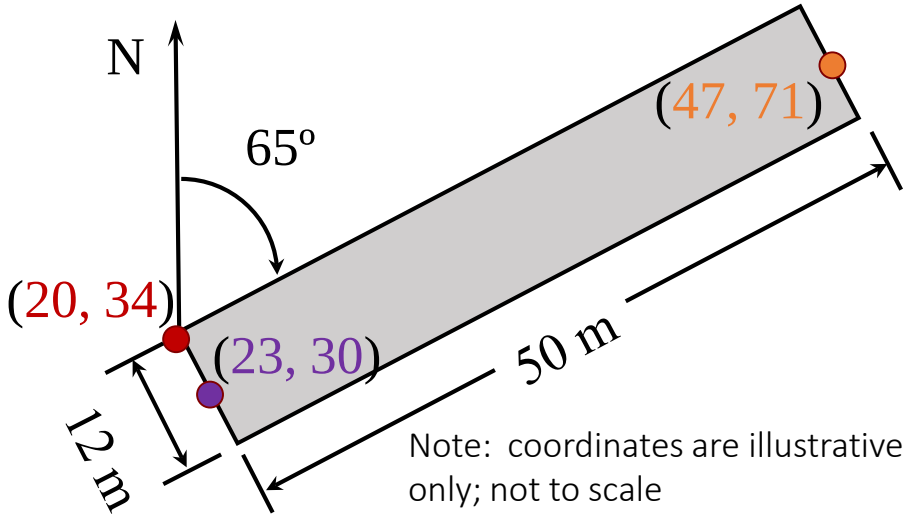
```
SO ___________ LINK3A _____ __ __
SO SRCPARAM LINK3A _______ ___ __ __ 65 __
```

- If srctyp **LINE** is used:

```
SO ___________ LINK3A ____ __ __ __ __
SO SRCPARAM LINK3A ______ 2.5 __ ___
```

Source Pathway – Quick Exercise

- Complete the LOCATION and SRCPARAM statements for this source using AREA and LINE
  - Source emits 0.00042 g/s/m^2
  - From a release height of 2.5 m
  - Szinit is 1.5 m



- If srctyp **AREA** is used:

```
SO LOCATION  LINK3A AREA 20 34
SO SRCPARAM LINK3A 0.00042 2.5 12 50 65 1.5
```

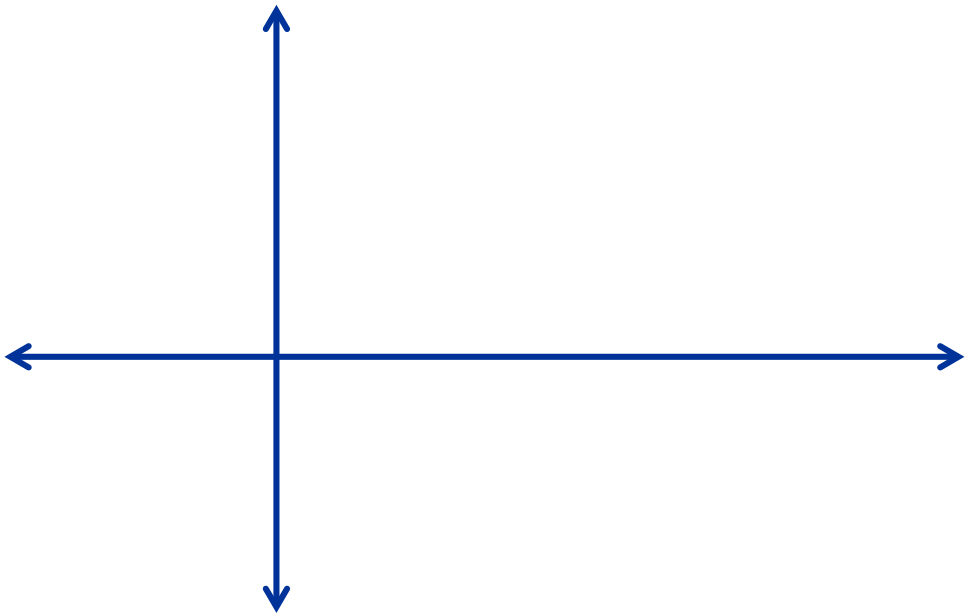
- If srctyp **LINE** is used:

```
SO LOCATION  LINK3A LINE 23 30 47 71
SO SRCPARAM LINK3A 0.00042 2.5 12 1.5
```

Source Pathway – Quick Exercise

- *Sketch the source below based on LOCATION and SRCPARAM statements:*

```
SO LOCATION PROJECT AREA  0  0  0
SO SRCPARAM PROJECT 0.00005  2  50  25  0  1
```



Source Pathway – Quick Exercise

- *Sketch the source below based on LOCATION and SRCPARAM statements:*

```
SO LOCATION PROJECT AREA  0  0  0
SO SRCPARAM PROJECT 0.00005  2  50  25  0  1
```