PM Hot-spot Modeling: Lessons Learned in the Field

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Overview

- Background
- State and local lessons learned so far
- Summary and conclusions for future air quality modeling implementation

Conformity Requirements

- CAA and transportation conformity rule (40 CFR Part 93) require that federally supported transportation projects in nonattainment and maintenance areas cannot:
  - Cause or contribute to new air quality violations,
  - Worsen existing violations, or
  - Delay timely attainment of the NAAQS or interim milestones

- A **hot-spot analysis** is an estimation of likely future localized pollutant concentrations and a comparison to the CO, $PM_{2.5}$, and PM_{10} NAAQS
  - In PM areas, required for major new or expanded highways, intersections, or terminals that significantly increase diesel traffic

- A project meets conformity, if at each appropriate receptor:

  PM concentration of build $\leq$ NAAQS, *or*

  PM concentration of build $\leq$ PM concentration of no-build

EPA Guidance

- In December 2010, EPA released original PM Hot-spot Guidance
  - » Developed through Agency-wide effort and stakeholder involvement
  - » EPA's November 2013 guidance update supersedes the 2010 guidance
- Provides first-of-its-kind method for estimating air quality impacts of specific transportation projects
  - » Emissions from EPA's MOVES model → input to AQ model (AERMOD)
  - » Estimate a project's impact on air quality concentrations
  - » Relevant for other modeling applications

Example of Project Needing a PM Hot-spot Analysis

MOVES Modeling

- In general, MOVES is being successfully used for PM hot-spot analyses

- General observations include:
  - Modeling based on all four quarters (i.e., 16 MOVES runs)
  - Meteorology based on temperature and humidity from regional conformity analysis for county where projected located
  - Average speed option is being used for highway analyses
  - Some questions regarding fleet mix (see next slide)

- Interagency consultation has been important to determine appropriate MOVES inputs (including available data)

MOVES Modeling

- Some questions about fleet mix
  - » Fleet mix (linksourcetype input) should be based on latest regional conformity analysis or SIP
  - » LD/HD mix should be specific to the project

- Weight regional fleet mix by project-specific LD/HD mix
  - » LD = 11,21,31,32
  - » HD = 41,42,43,51,52,53,54,61,62

Selecting an Appropriate Air Quality Model

Type of Project	Recommended Model
Highway and intersection projects	AERMOD, CAL3QHCR
Transit, freight, and other terminal projects	AERMOD
Projects that involve both highway/intersections and terminals, and/or nearby sources	AERMOD

- Recommendations are consistent with EPA's current recommended models in 40 CFR Part 51, App. W, approved models on SCRAM

- PM hot-spot analyses are refined analyses; CAL3QHC is not appropriate for modeling refined PM hot-spot analyses

Guidance Reference:

Exhibit 7-2 & Sec. 7.3.1

Characterizing Emission Sources

	Line Source	Point Source	Area Source	Volume Source
Different source types can be used in a hot-spot analysis to represent…	• Highways and intersections	• Bus garage or transit terminal exhaust stacks	• Transit or freight terminals • Parking lots • Highways and intersections	
Model	AERMOD* CAL3QHCR	AERMOD	AERMOD	

*AERMOD can simulate line sources using a series of adjacent area or volume sources.

Note: Only approved versions of models on SCRAM can be used for PM hot-spot analyses

Guidance Reference:

Sect 7.3.2, 7.4, App J.3.3-3.5

Air Quality Modeling Issues in Field

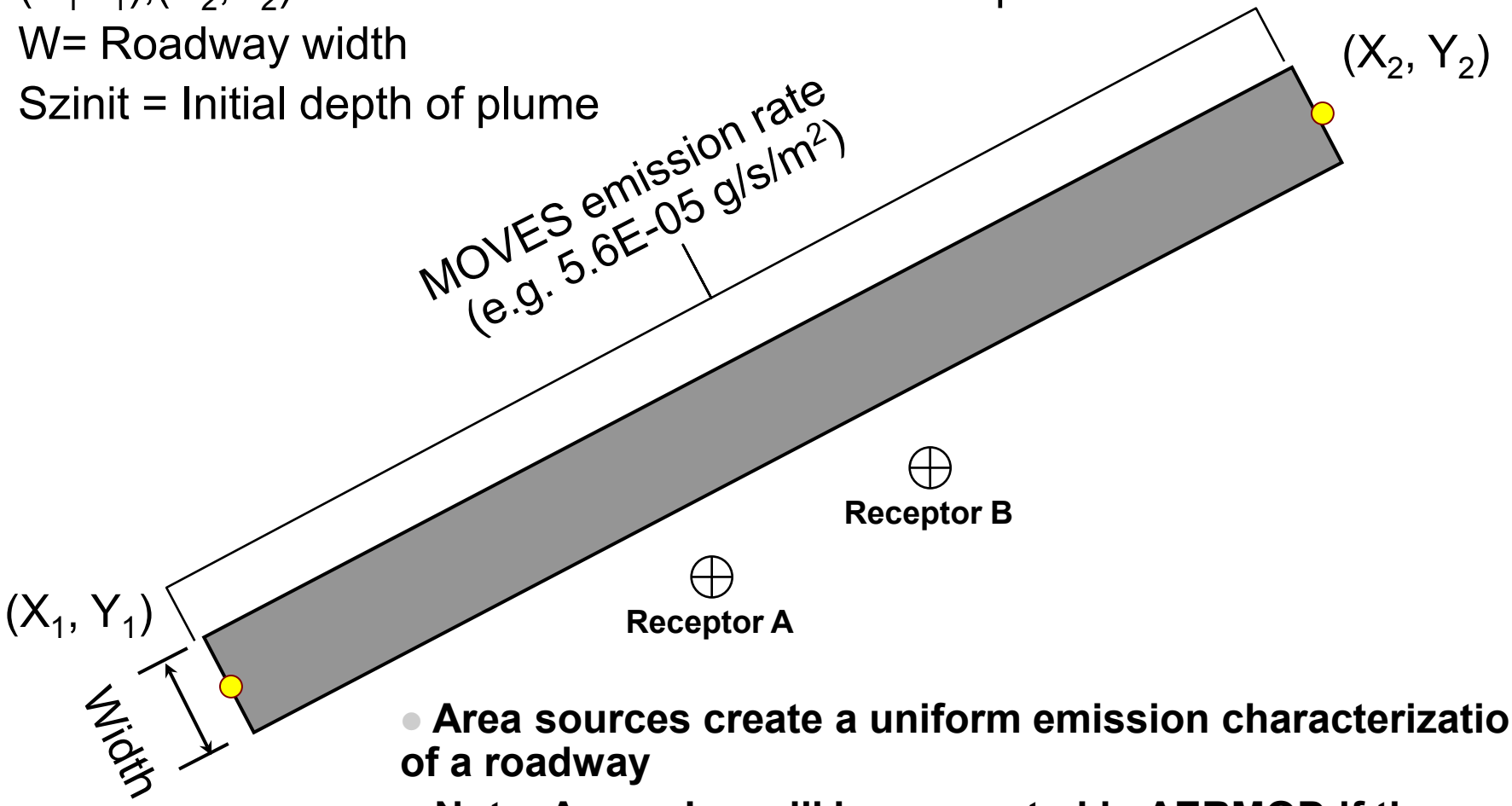
- Characterizing area and volume sources
- Obtaining representative meteorological data
- Specifying receptors in project area
- Running the air quality model
- Note: Interagency consultation has been important for determining appropriate air quality model, methods, and data

Area Source Characterization

$(X_1Y_1),(X_2,Y_2)$ = Coordinates of area source end-points

W= Roadway width

Szinit = Initial depth of plume



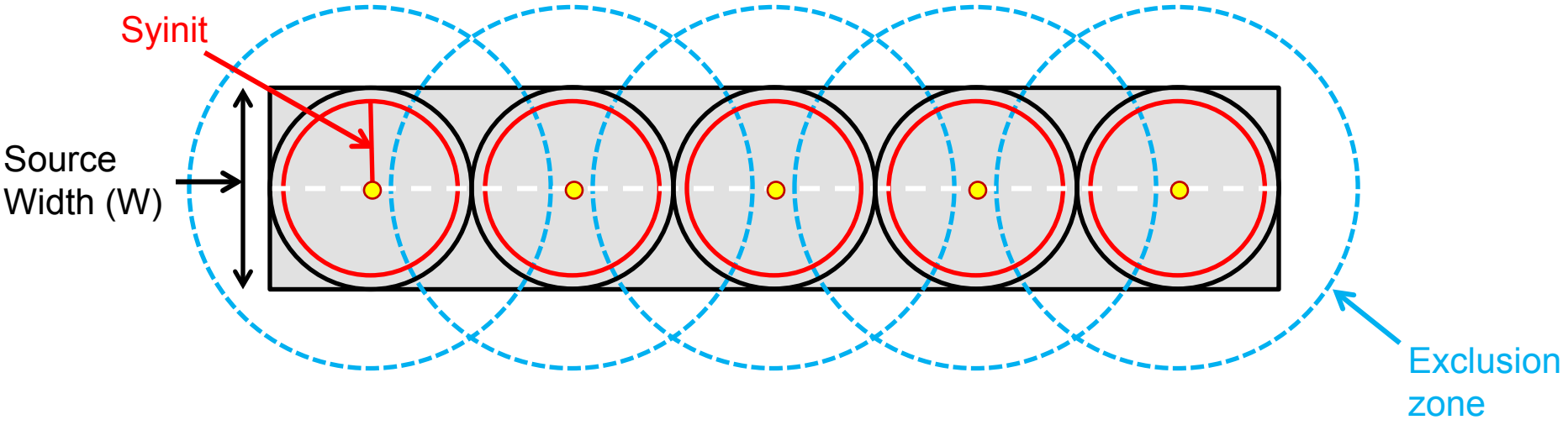
- **Area sources create a uniform emission characterization of a roadway**
- **Note: A warning will be generated in AERMOD if the aspect ratio is greater than 100 – this can be ignored**

Area Source Characterization

- Most projects will include many roadway links
- Area sources may be easier to use:
  - » $(X_1Y_1),(X_2,Y_2)$ defined for each source
- GIS software is essential for this process

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

- Xs, Ys = Coordinates of volume source center
- Syinit = Initial lateral dispersion coefficient (W / 2.15)
- Szinit 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

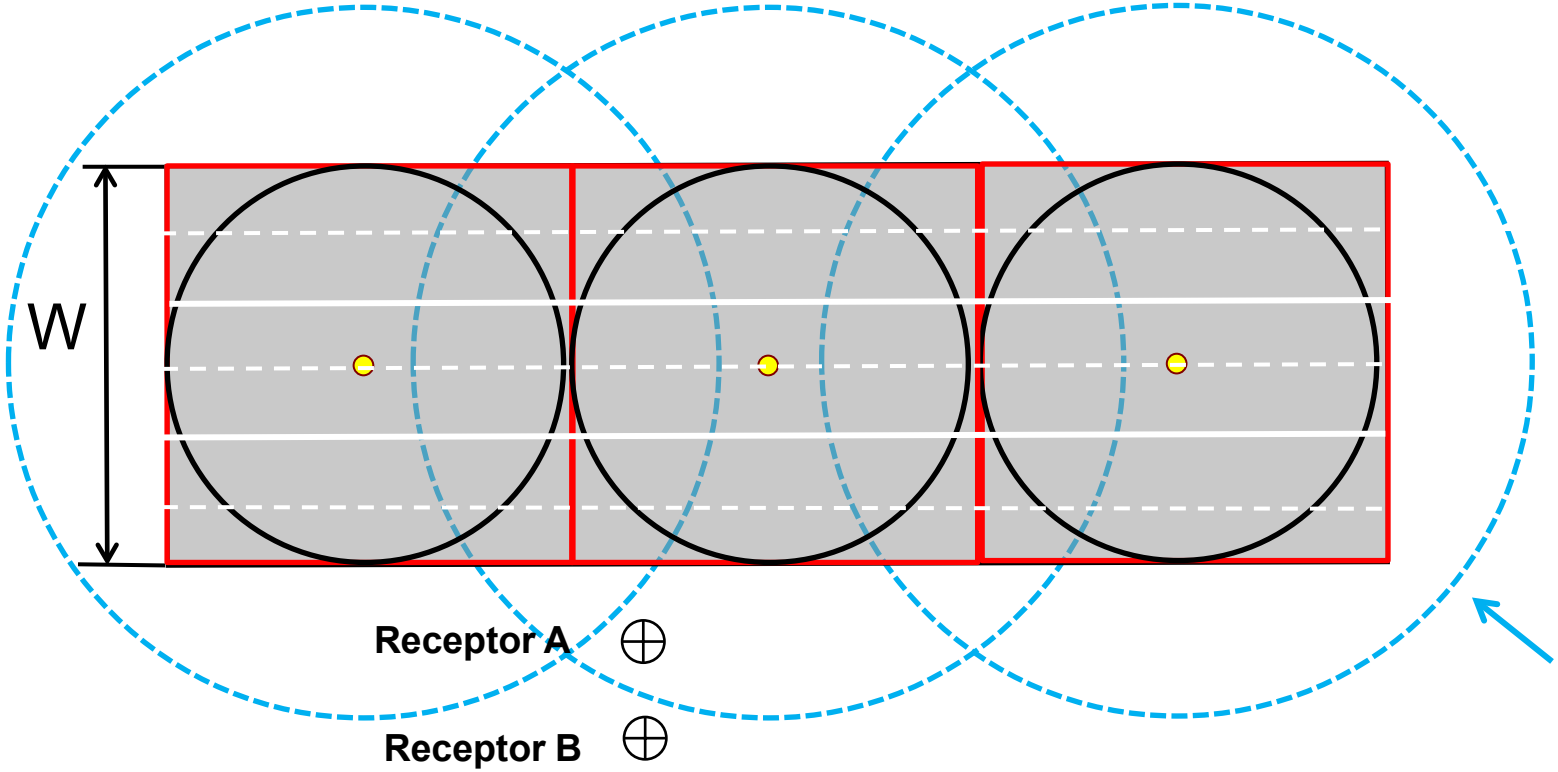
- Receptors should not be placed within exclusion zone
  - based on EPA guidance from OAQPS
  - concentrations are not calculated within it
- Receptors should be sited as near as 5 m from a source (e.g., the edge of a traffic lane)
- Because of the exclusion zone, the width of a volume source should 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

Guidance Reference:

Section 7.6.2

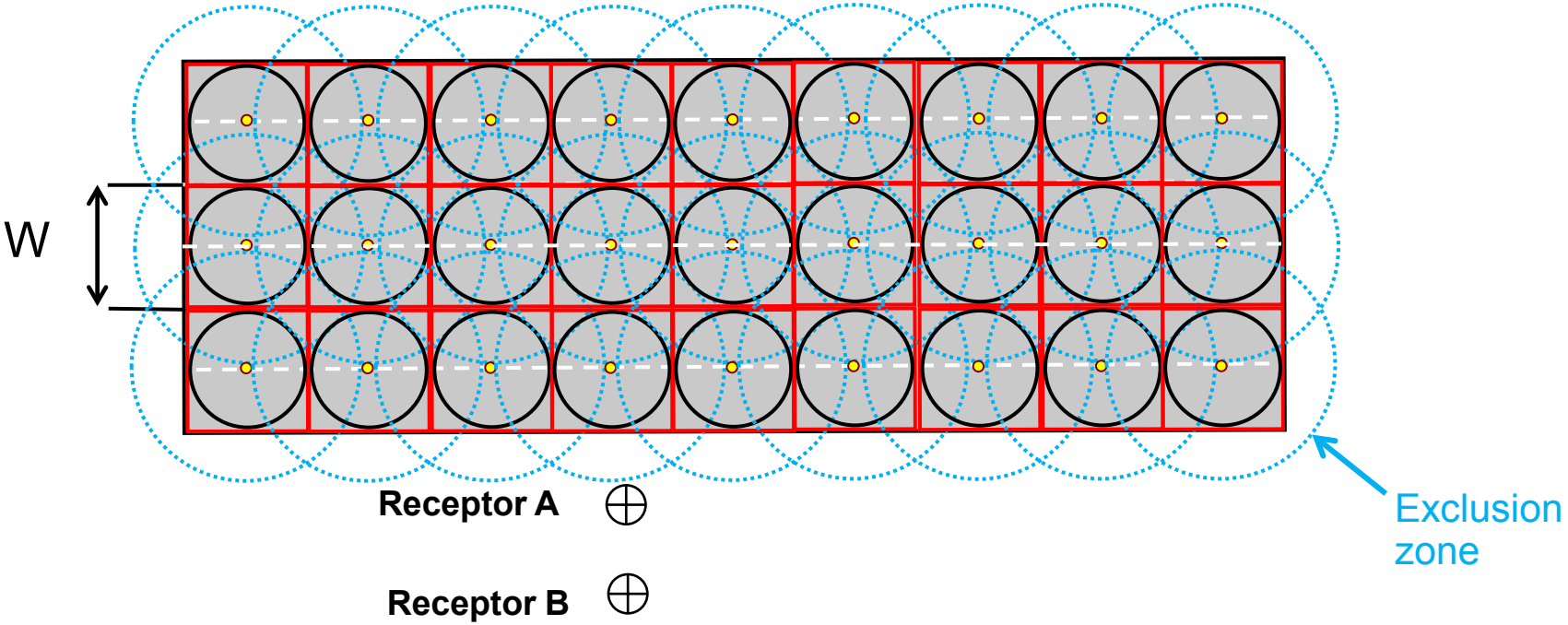
Incorrect Volume Source Width

- Volume sources are too wide, excluding area where receptors should be placed
- W = Link width



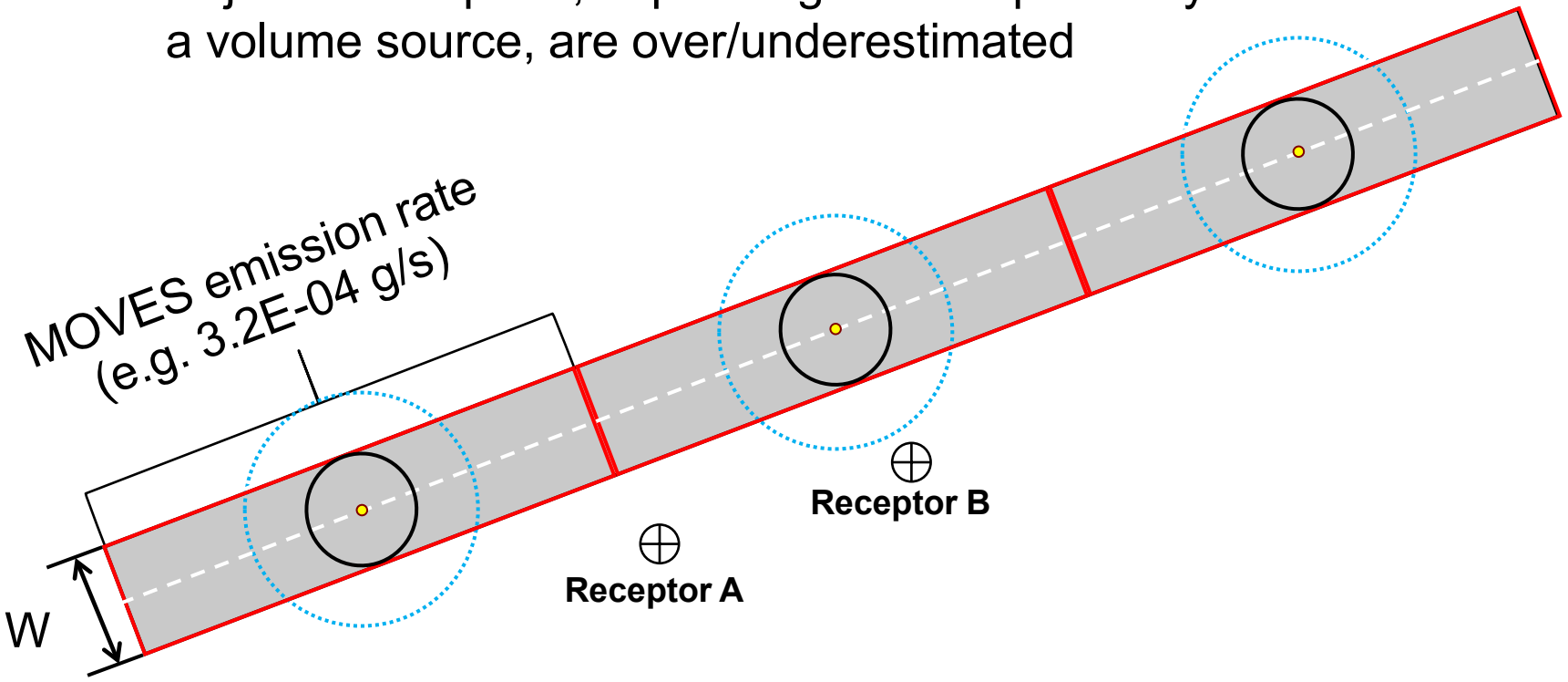
Correct Volume Source Width

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



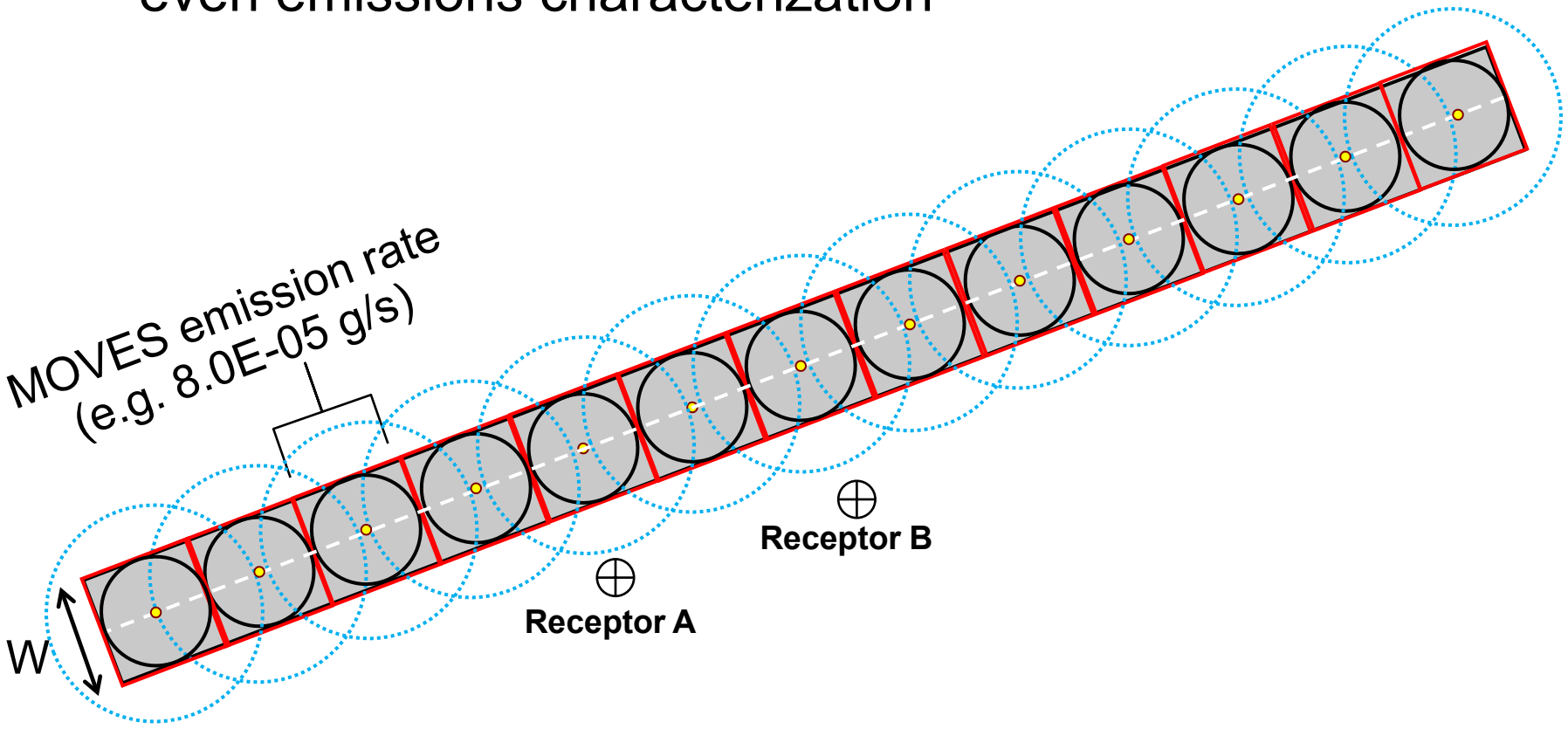
Incorrect Volume Source Spacing

- 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



Obtaining Met Data

- Use most recent 5 consecutive years of representative off-site data (most common)
  - » Assess representativeness based on latest *AERMOD Implementation Guide*
  - » State air quality agency has experience providing met data for NSR/PSD permitting applications, will likely have pre-processed data available
- Surface station data should be from an ASOS station
  - » Met data should be processed with AERMINUTE and the most recent version of AERMET
  - » Appropriate threshold value: 0.5 m/s (Consistent with *OAQPS guidance in March 8, 2013 memo)*
- Most PM hot-spot analyses will be done in urban or suburban areas, where URBANOPT should be used

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 out ~500 m
  - » Dense spacing (e.g., 25 m) near areas of potential high concentrations (near-road), less dense (e.g., 100 m) further 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., fenced private property, within right-of-way, on-facility)

Guidance Reference:

Sections 7.5 and 7.6

Defining Receptors

Running the Model

- Hot-spot analyses may cover large geographic areas (e.g., a 15 mile long highway expansion) and include hundreds of sources and potentially thousands of receptors
- EPA recommends the following strategy to minimize AERMOD run-times:
  - » Modeling the areas of highest likely impact:
    - – May be evident from traffic volumes, emission rates
    - – Can be determined from an iterative modeling process (using FASTALL and/or coarse receptor grid)
- Some users have expressed interest in parallel processing
  - » Use of commercial software is covered in a Dec 2007 EPA clarification memo
  - » Decisions on the use of third-party software is the EPA Region's responsibility

MOVES2AERMOD

- EPA created an interface between the MOVES emission model and the AERMOD dispersion model
- Designed specifically for use in PM Hot-spot Analyses – Available only for **Area** sources at this time
  - » Uses output from 16 MOVES runs (representative time periods)
  - » Produces SEASONHR EMISFACT table that can be used directly in an AERMOD input file
- Script can be run through the MOVES GUI
- Download package available on the MOVES Tools website: http://www.epa.gov/otaq/models/moves/tools.htm

Other EPA PM Hot-spot Tools

- Emission Rate Post-processing Tool (now in MOVES2010b)
  - » Automates the summing of MOVES emissions for PM or CO project-level analyses (e.g., PM grams/hour or grams/mile)

- 24-hour $PM_{2.5}$ NAAQS Design Value Tool
  - » Automates a computationally intensive process for this NAAQS
  - » Design value calculations for other PM NAAQS are less complicated and can be done using a spreadsheet

- If you have suggestions for other tools, contact EPA at: conformity-hotspot@epa.gov

For More Information

- See EPA's conformity project-level website for:
  - Regulations, policy guidance, FR notices, training
  - www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm
- See EPA's MOVES website for:
  - Software, MOVES MySQL scripts, technical documentation, and other helpful background materials
  - www.epa.gov/otaq/models/moves/
- Questions?
  - Specific questions on a particular project analysis
    - Contact appropriate EPA Region or DOT field office
  - General questions on PM hot-spot guidance and training
    - patulski.meg@epa.gov
  - Technical questions about guidance document
    - conformity-hotspot@epa.gov