Dispersion Modeling Challenges in 2017

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

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Presented by

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Agenda

- Introduction to Dispersion Modeling
- Dispersion Modeling for Air Permitting
  - Goals
  - Methodology
  - Case Study
- Challenges and Solutions
- Changes to Federal Rules / Guidelines
  - Current Status
  - Modeled Emission Rates for Precursors

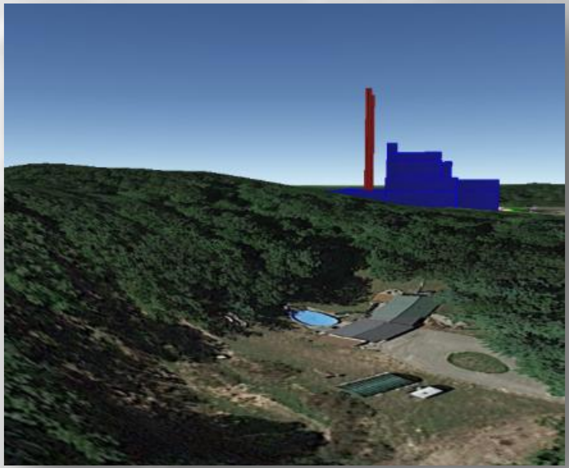
Introduction to Dispersion Modeling

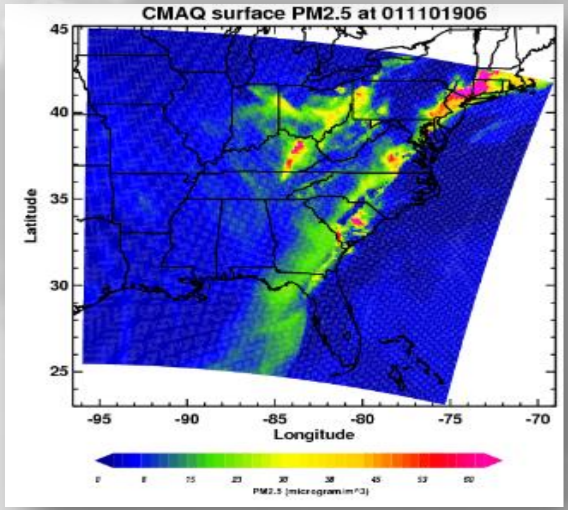
Who Should Care About Modeling?

- **Anybody Involved with an Industrial Source that Emits Pollutants**
  - Need to Obtain Air Permits Unless Exempt
- **Air Quality Regulators**
  - Tasked with Ensuring Clean, Safe Air
  - Issuing Permits
  - Modeling for Attainment Planning
- **Environmental Groups**
  - Conduct Modeling for Research
  - Verify that Regulations are Being Followed
- **Planning and Infrastructure Personnel**
  - Transportation Air Quality

Goals of Air Quality Modeling

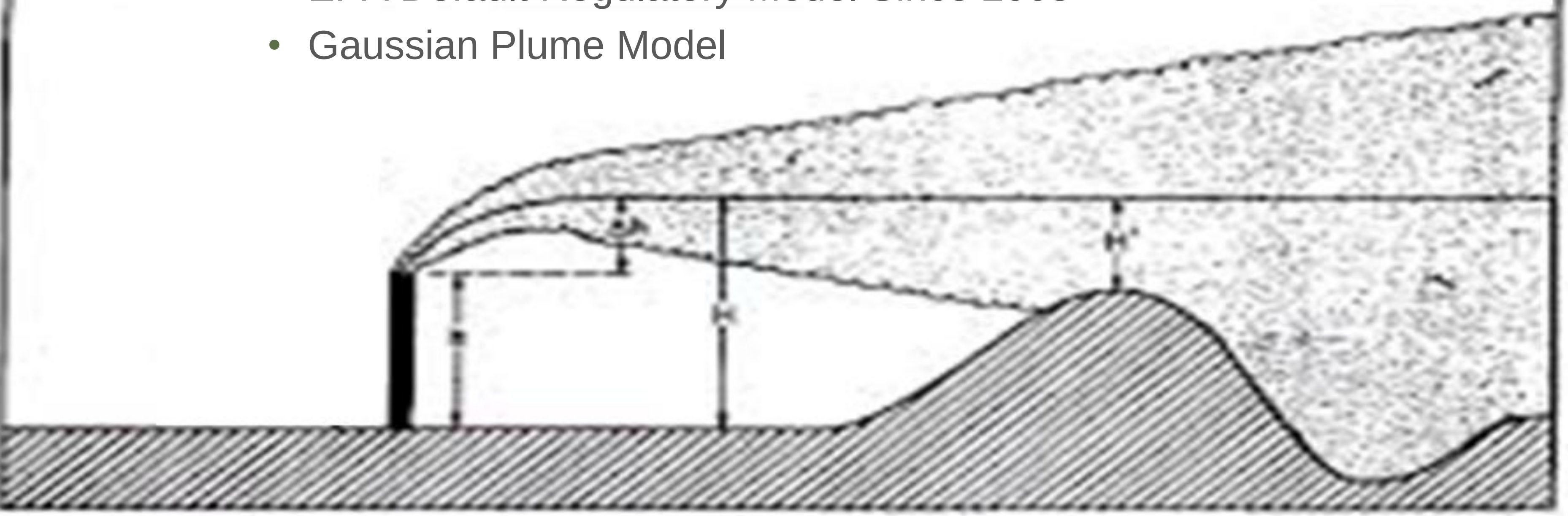
- **Ensuring the Air is Safe for the General Public**
  - Different Scales
    - Short Range
      - Impacts from Individual Projects
      - Combined Impacts from Local Sources
    - Regional
      - Interstate Transport
      - Regional Haze
    - Global
      - Cross Border Transport
      - Climate Modeling





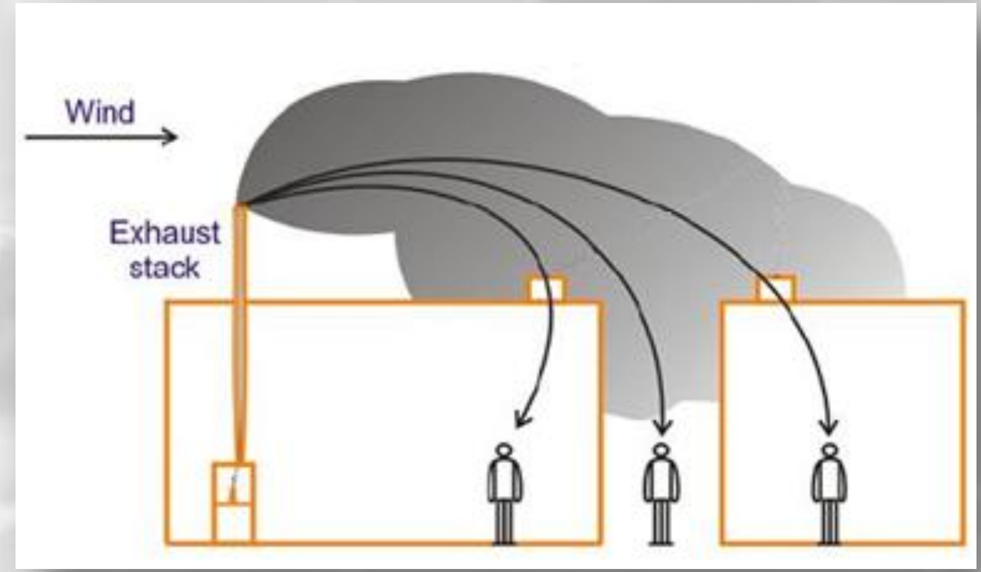
How Permit Modeling Works

- **Main Dispersion Model is AERMOD**
  - AMS/EPA Regulatory Model Improvement Committee (AERMIC) Model
    - EPA Default Regulatory Model Since 2005
    - Gaussian Plume Model

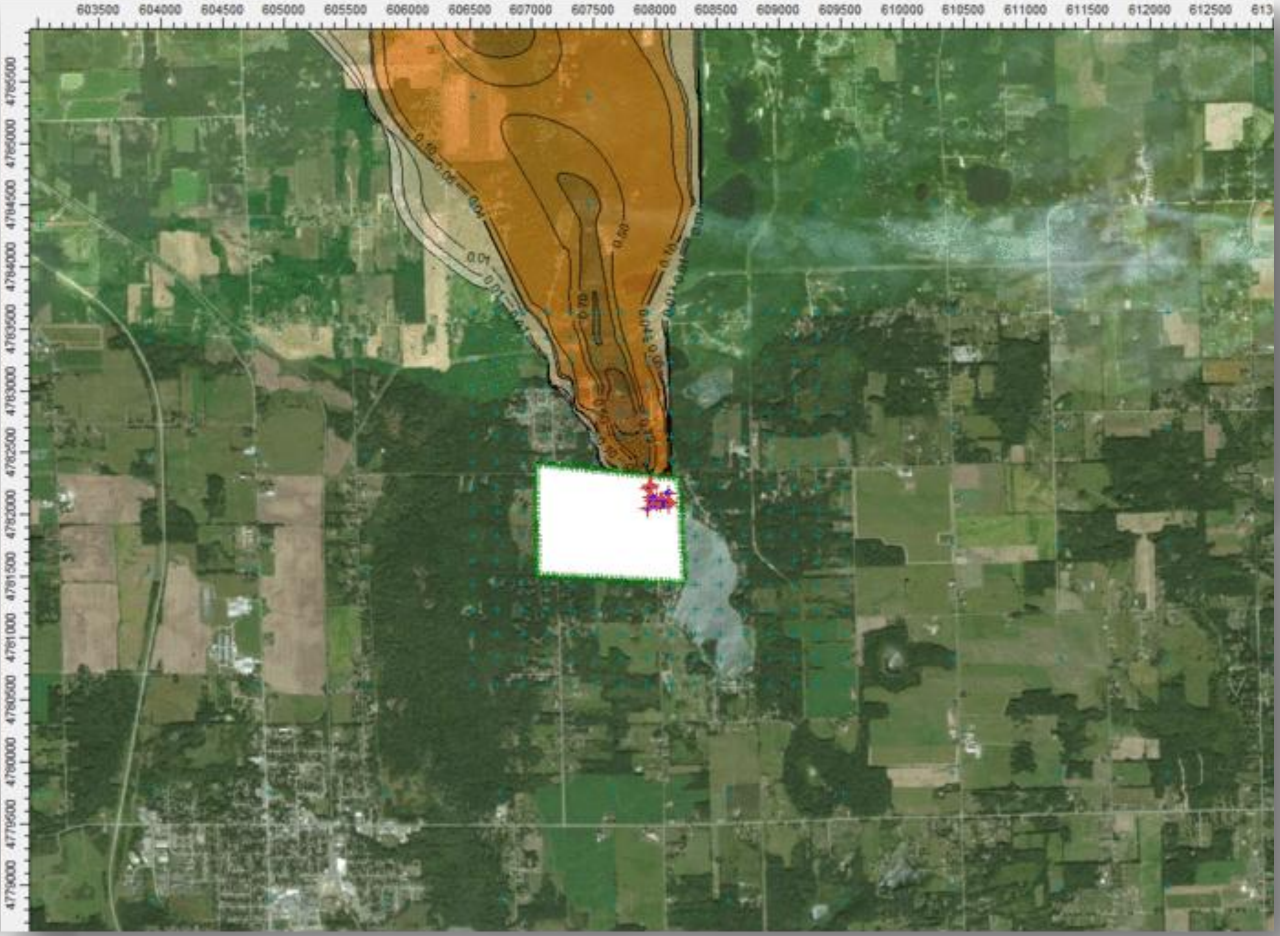


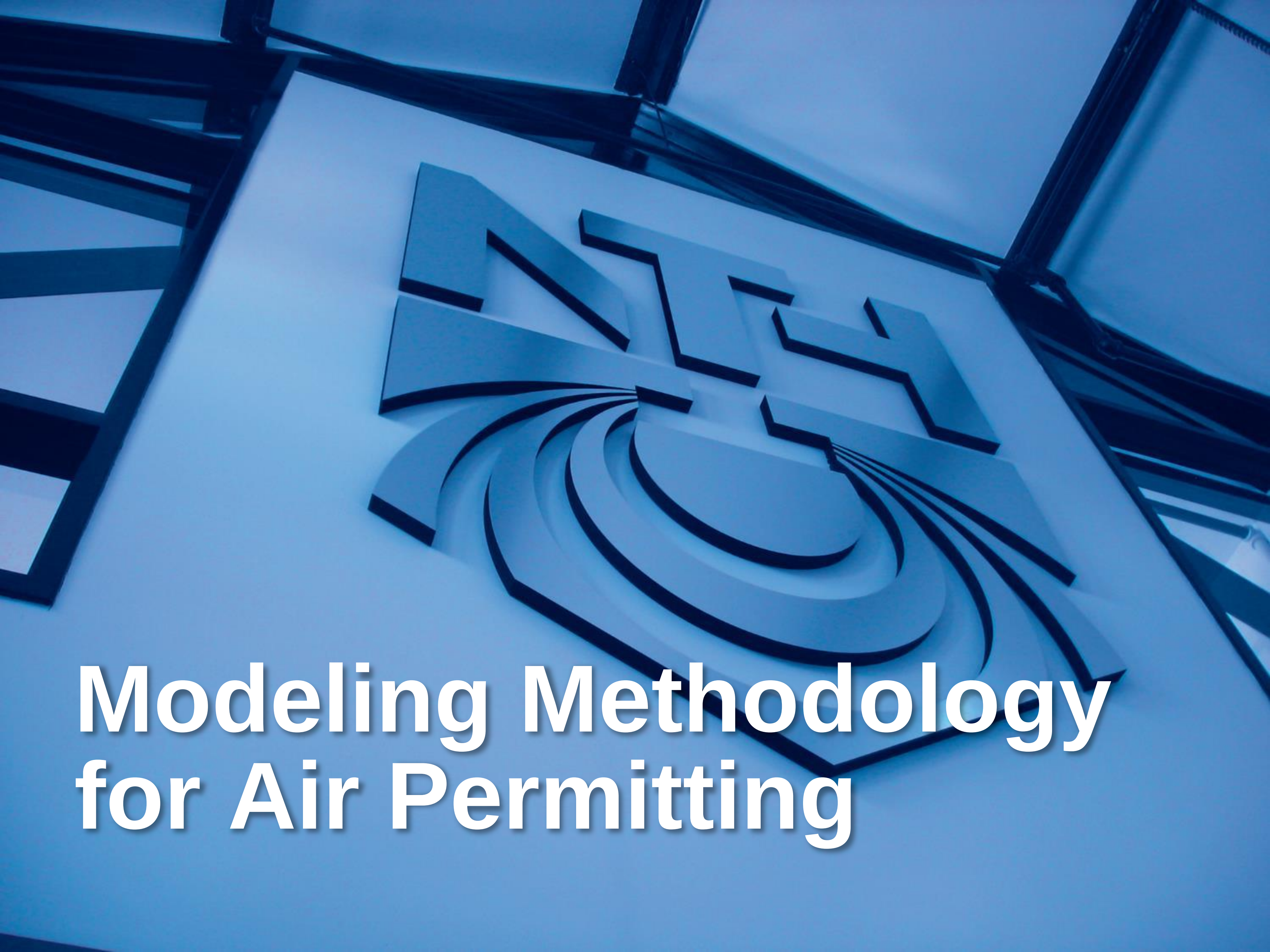
How Dispersion Modeling Works

- **What the Model Does**
  - Simulates How a Plume is Dispersed From Input Information
- **Input Information**
  - Physical Layout (Fenceline, Buildings, Roads)
  - Onsite and Offsite Sources
    - Estimation of Emission Rates
    - Source Stack Parameters
  - Nearby Environment
    - Meteorology
    - Terrain/Topography
  - Chemical Reactions



How Dispersion Modeling Works





Modeling Methodology for Air Permitting

Methodology for Permitting Projects

- **Step 1**
  - Determine if Modeling Is Necessary
- **Step 2**
  - Use Tables / Qualitative Analysis if Possible (Michigan Only)
- **Step 3**
  - Model Project Only Emissions
- **Step 4**
  - Conduct Refined Modeling:
    - Prevention of Significant Deterioration (PSD) Increments
    - National Ambient Air Quality Standards (NAAQS)

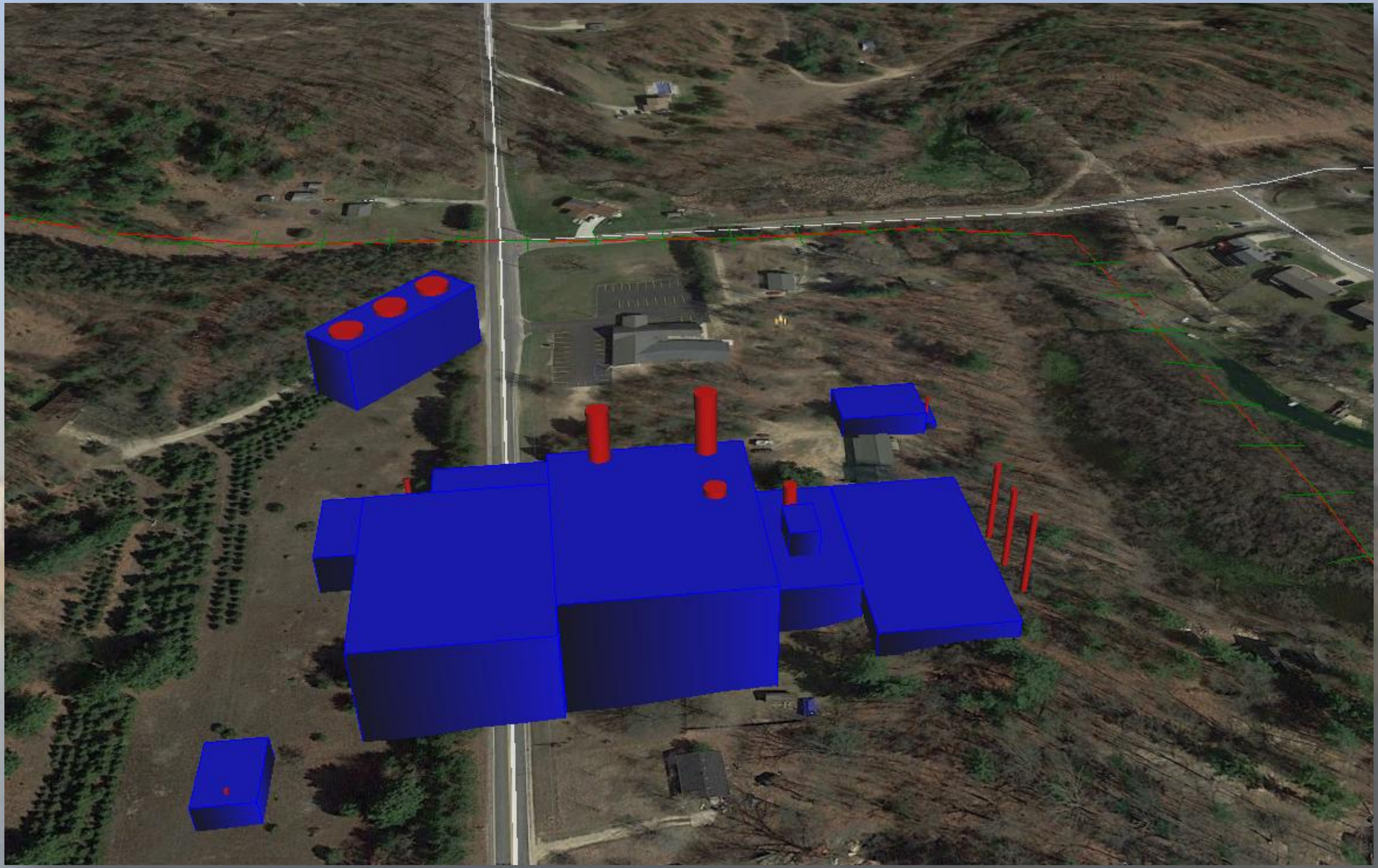
Methodology for Permitting Projects

- **Determine if Modeling is Needed**
  - Review New Emissions / Reductions
  - Compare to
    - Major Source/PSD Thresholds – Federal Level Modeling
    - Significant Emission Rate (SER) – Criteria Pollutants
    - Allowable Emission Rates (AER) – State Toxics

Methodology for Permitting Projects – Case Study

- **New Combined Cycle Combustion Turbine Facility**
  - 200 Megawatt Capacity
  - 2 Combined Cycle Turbines
  - Ancillary Equipment
    - Engines
    - Auxiliary Boiler
    - Fuel Gas Heater
    - Cooling Towers
- Pollutants of Concern Typically
  - Nitrogen Oxides (NO_x)
  - Sulfur Dioxide (SO_2)
  - Fine Particulate Matter ($PM_{10/2.5}$)
  - State Air Toxics

Methodology for Permitting Projects – Case Study



Methodology for Permitting Projects – Case Study

- **Determine if Modeling is Needed**
  - Federal Standards

Pollutant	Emission Rate (tpy)	SER (tpy)	Modeling Required?
NO_x	300	40	Yes
SO_2	39	40	Maybe
$PM_{10/2.5}$	100	10 / 15	Yes
CO	400	100	Yes
VOC	200	NA	NA

  - State Air Toxics - Allowable Emission Rates (AER)
    - No Modeling Required (Magically)

Methodology for Permitting Projects – Case Study

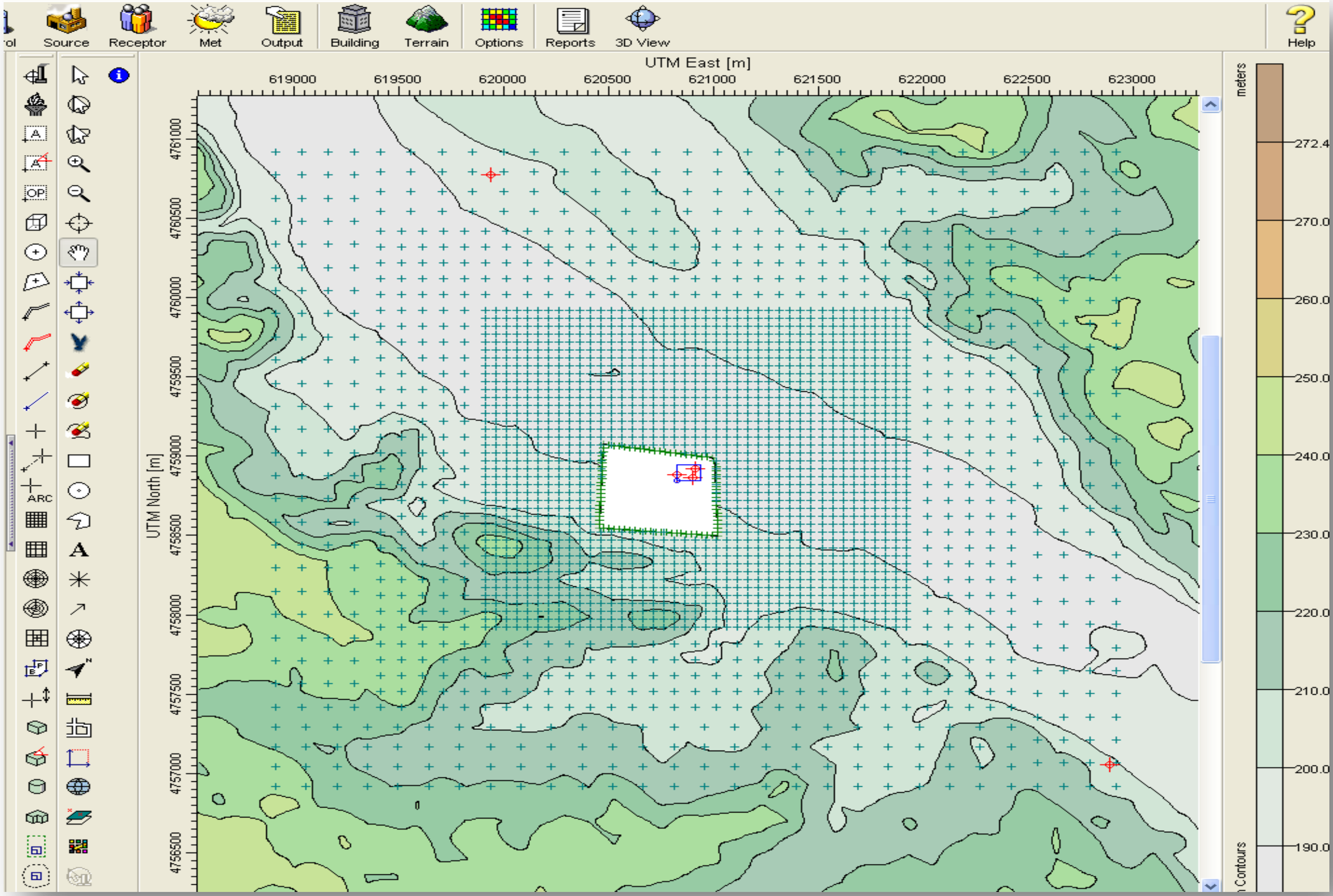
Allowable Emissions	Stack Requirements[1]	Demonstration Required[2]
Greater than SER	As necessary to meet NAAQS and PSD increment	Y[3]
100%-50% of SER	Minimum height: 60 feet and 1.5 times the building height Orientation: Vertically unobstructed	N
	Minimum height: 30 feet Orientation: Vertically unobstructed Building: No Downwash[4]	N
25%-50% of SER	Minimum height: 40 feet and 1.5 times the building height Orientation: Vertically unobstructed	N
	Minimum height: 20 feet Orientation: Vertically unobstructed Building: No Downwash[4]	N
Less than 25% of SER	None	N

Pollutant	Emission Rate (tpy)	SER (tpy)	Stack Height Meets AQD-22 Table 1?	Modeling Required?
SO_2	39	40	Yes	No

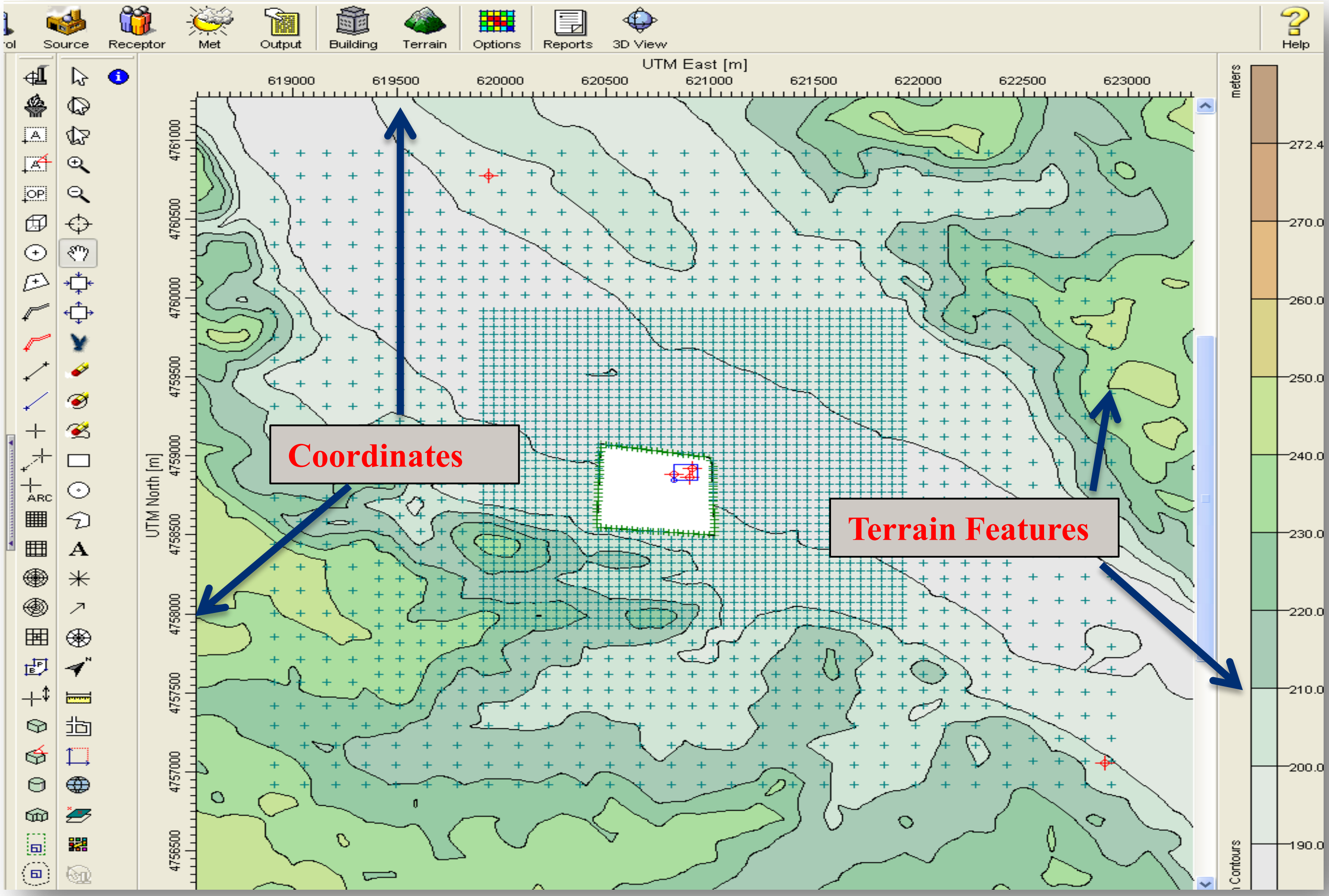
Methodology for Permitting Projects

- **Qualitative Analysis (Michigan)**
  - Some Factors to Consider:
    - Current Air Quality Conditions
    - Expected Impact of Permitted Source
    - Previous Modeling Results if Available
    - Meteorology
    - Terrain
    - Distance to Ambient Air
    - Emissions Decreases
    - Associated Release Characteristics
    - Quality of Data
    - Other

Methodology for Permitting Projects - Sample Model Setup



Methodology for Permitting Projects - Sample Model Setup



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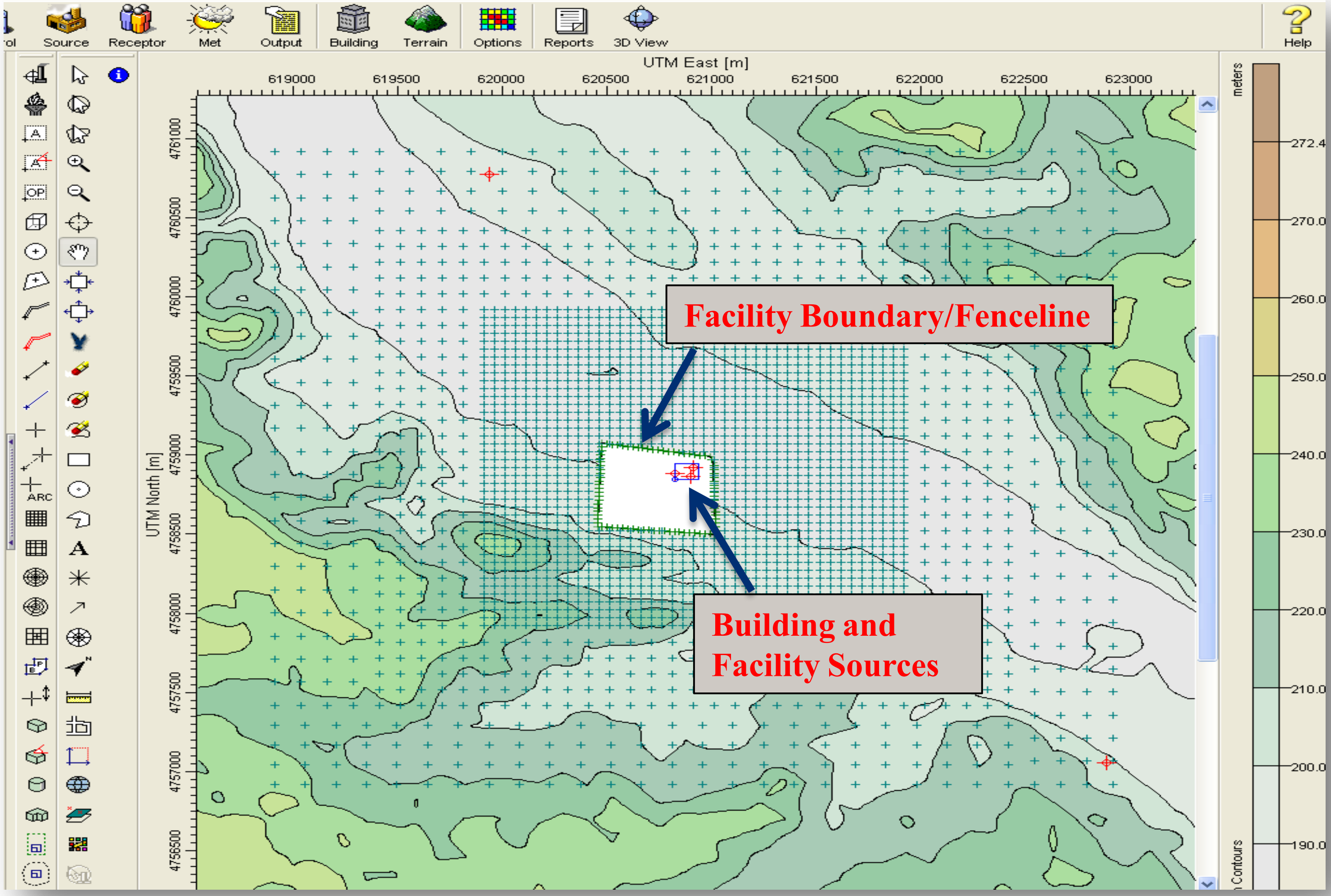
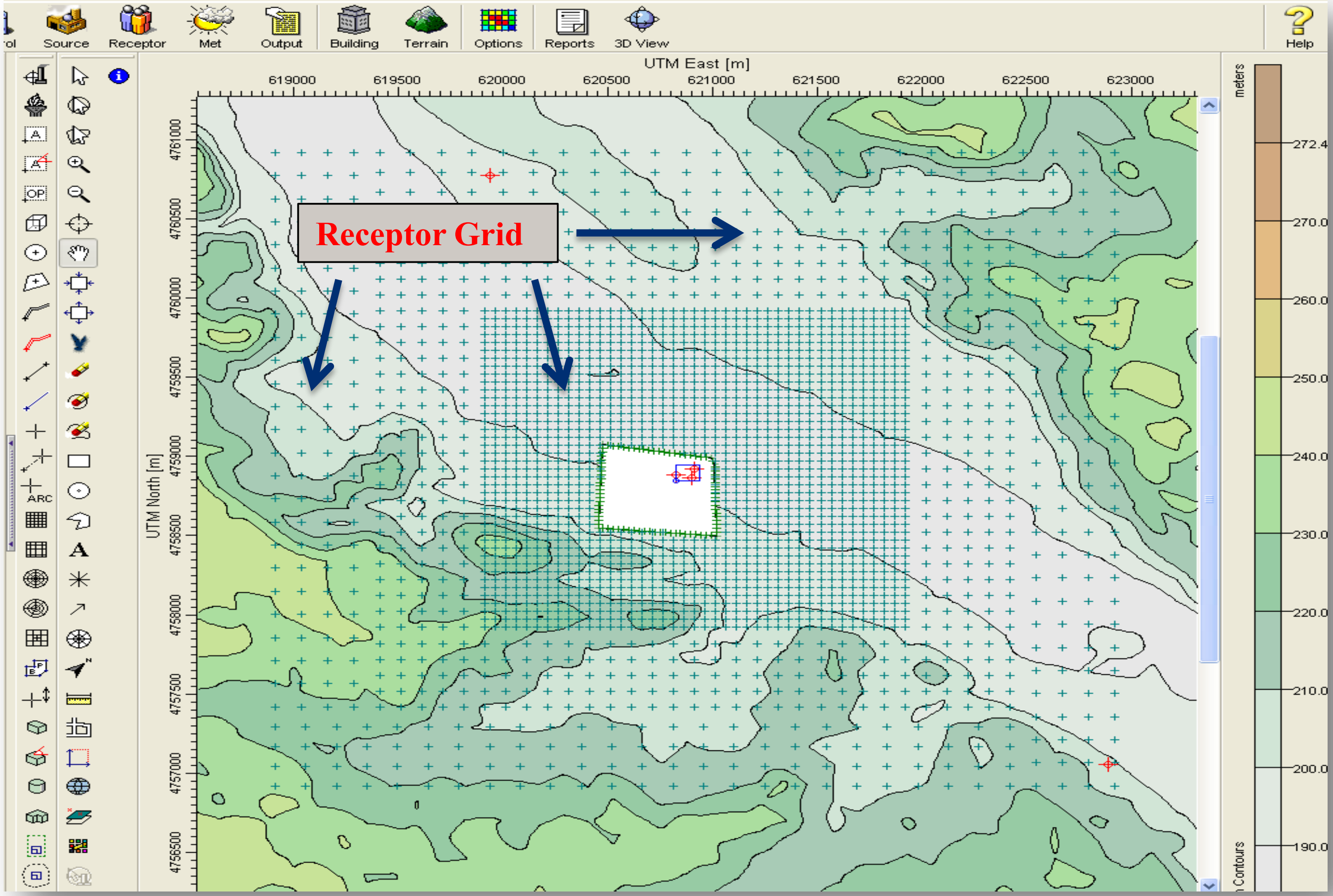
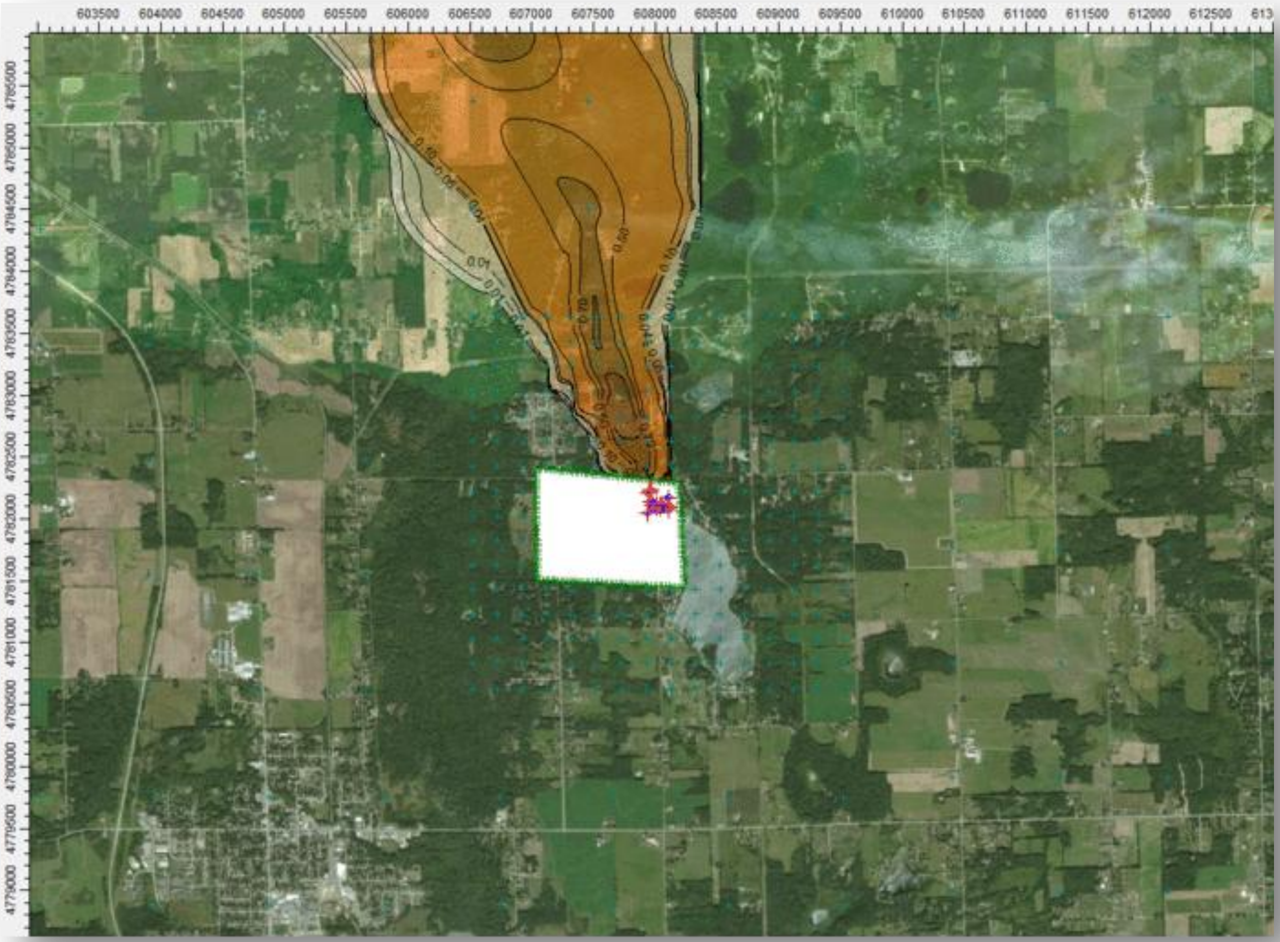


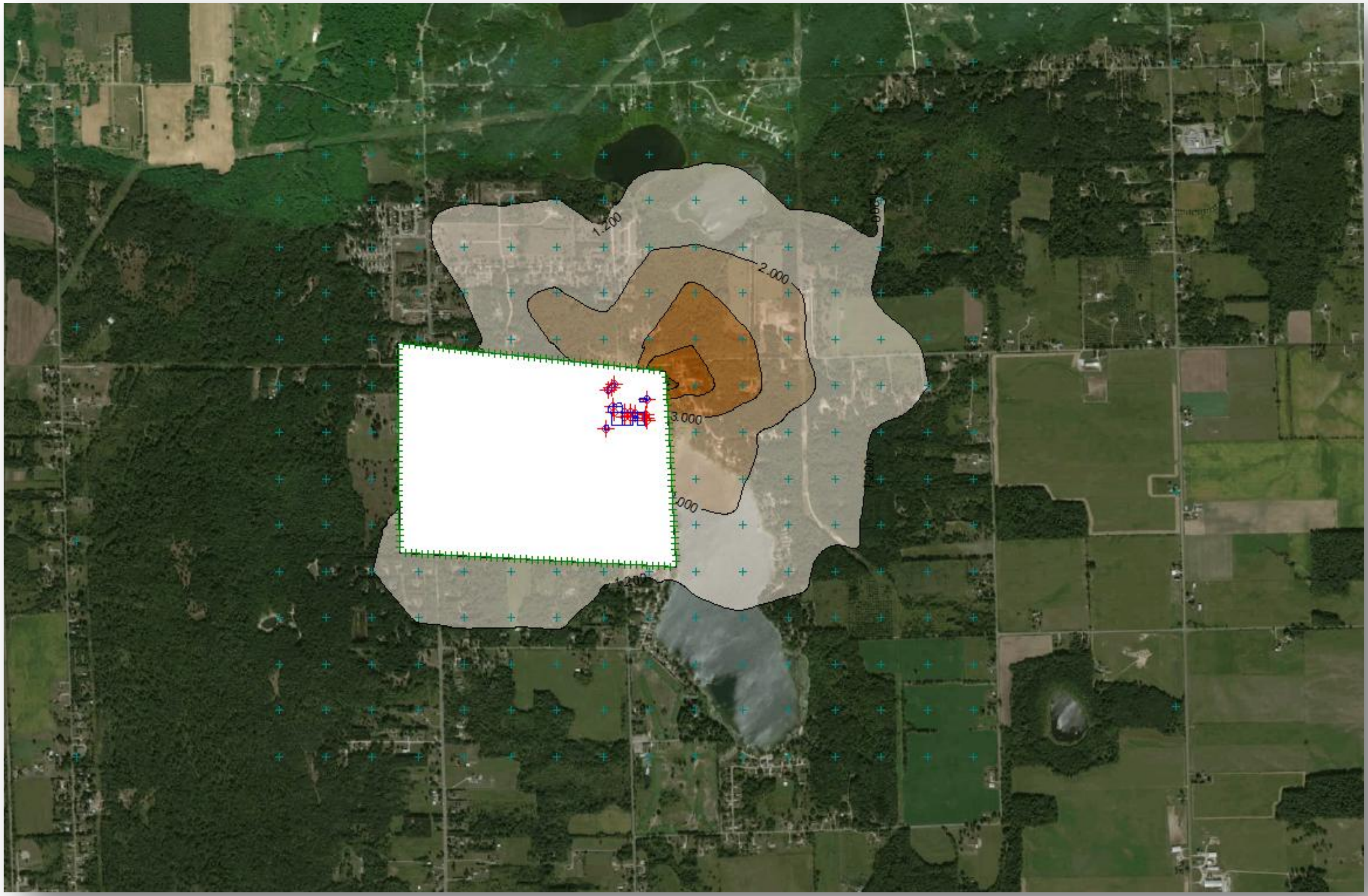
Methodology for Permitting Projects - Sample Model Setup



Methodology for Permitting Projects - Sample Model Setup (AERMOD)



Methodology for Permitting Projects - Sample Model Setup (AERMOD)

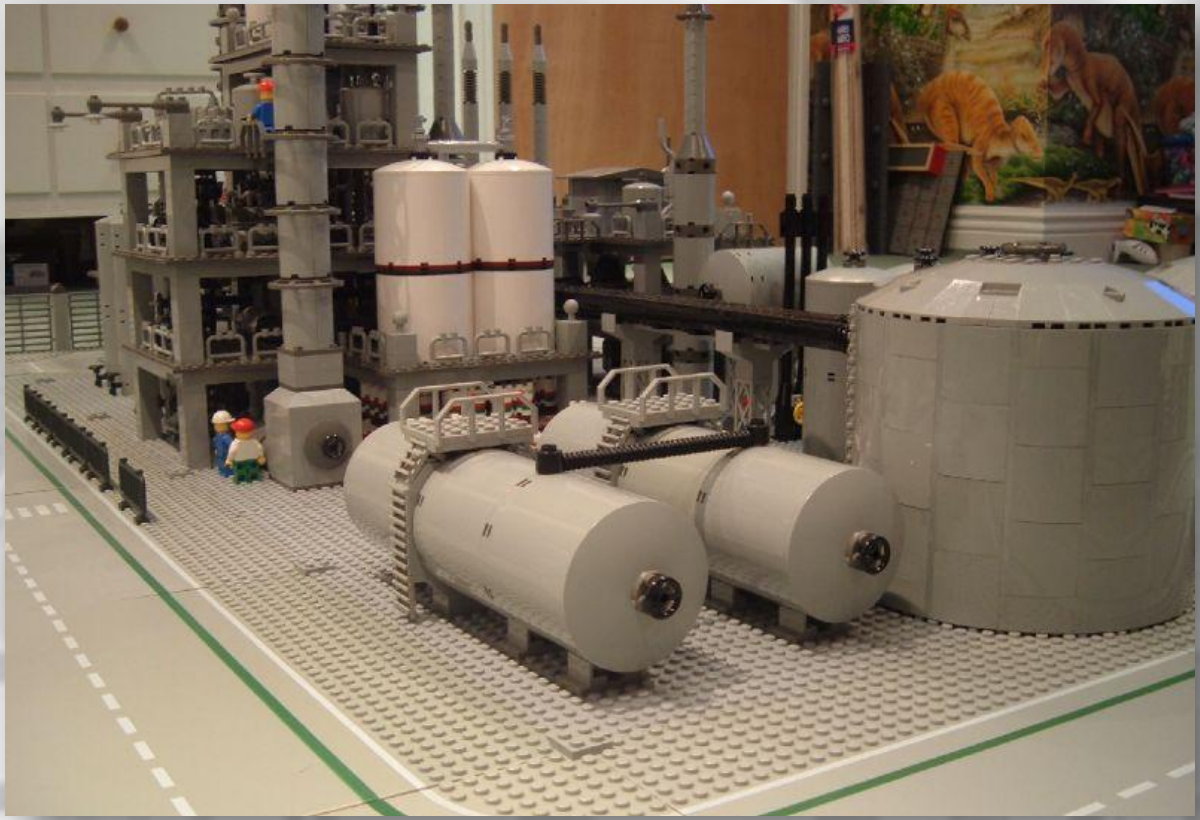


Methodology for Permitting Projects

- **Other Considerations While Building a Model**
  - Meteorology
    - Representative of Site – Wind Speeds and Directions
    - Federal Modeling Requires
      - 1 Year of Onsite Data
      - Last 5 Years of Representative Data from NWS/FAA
    - Michigan Toxics
      - Most Recent 1 Year of Representative Data
  - Ozone Background Data for NO_x to NO_2 Conversion
  - Rural vs. Urban Land Use

Methodology for Permitting Projects

- **Modeling Project Impacts vs. State Air Toxics Screening Levels**
  - Project Emission Unit Emissions Only
  - Model at Maximum Potential to Emit (PTE)



Methodology for Permitting Projects

- **Modeling Project Impacts vs. Significant Impact Levels (SILs)**
  - Project Emissions Only
  - Modeled at Maximum Potential to Emit (PTE)
  - Increases and Decreases Allowed
  - SILs are Very Small Compared to NAAQS or PSD Increments

Methodology for Permitting Projects– Case Study

- **Modeling Project Impacts vs. Significant Impact Levels (SILs)**

Pollutant	Averaging Period*	Modeled Impact (µg/m³)	SIL (µg/m³)	Passing?
NO_x	1-Hour	4.5	7.5	Yes
$PM_{2.5}$	24-Hour	5	1.2	No
CO	1-Hour	15	2,000	Yes

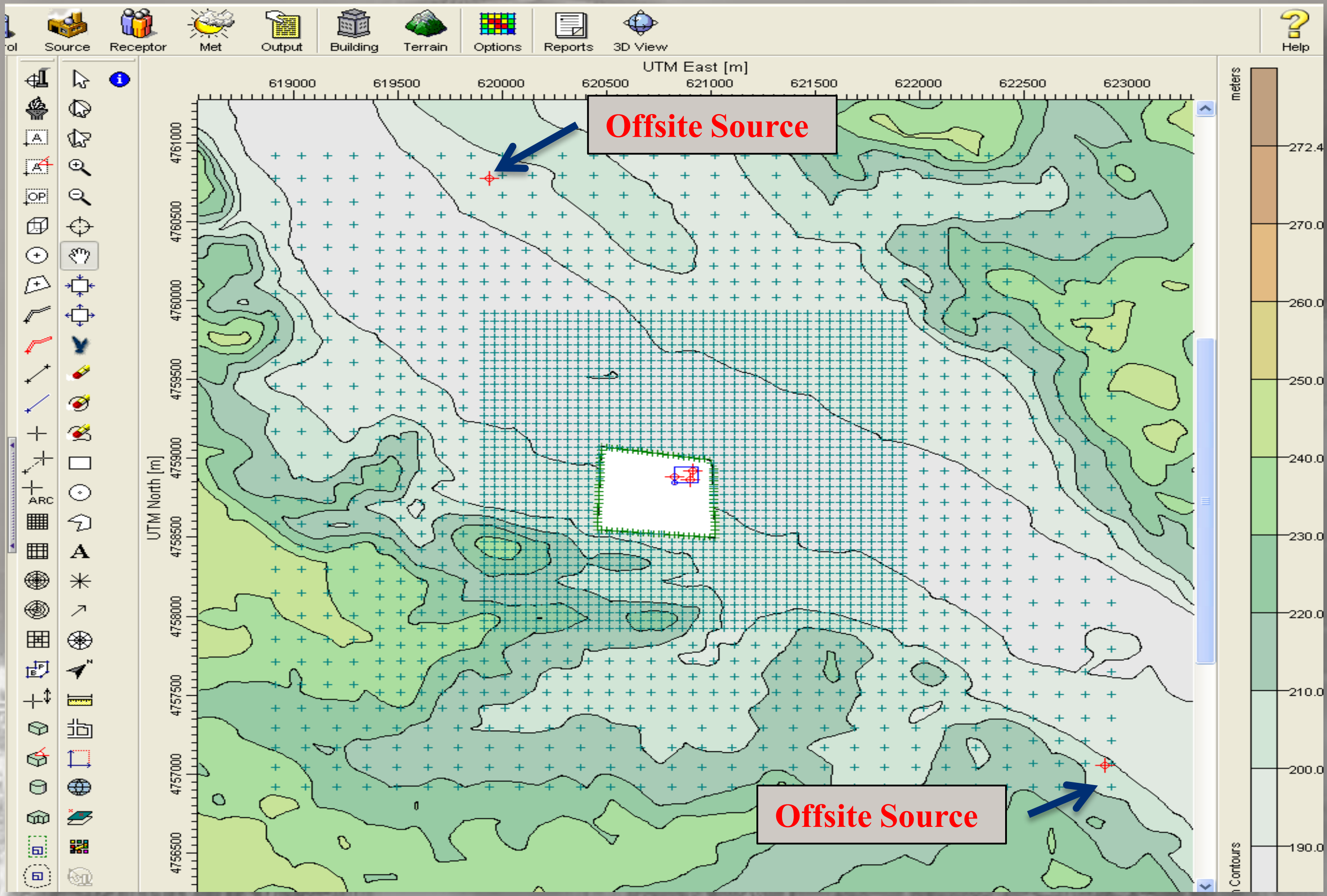
*Only Most Stringent Averaging Period Shown

Methodology for New Projects

- **Facility-Wide Impacts vs. National Ambient Air Quality Standards**
  - Project at PTE
  - All On and Offsite Sources
  - Ambient Background from Representative Air Quality Monitors

- **Facility-Wide Impacts vs. PSD Increments**
  - Project at PTE
  - On and Offsite Increment Consuming Sources at Actual Emission Rates
  - Model Calculations Different from NAAQS and SIL

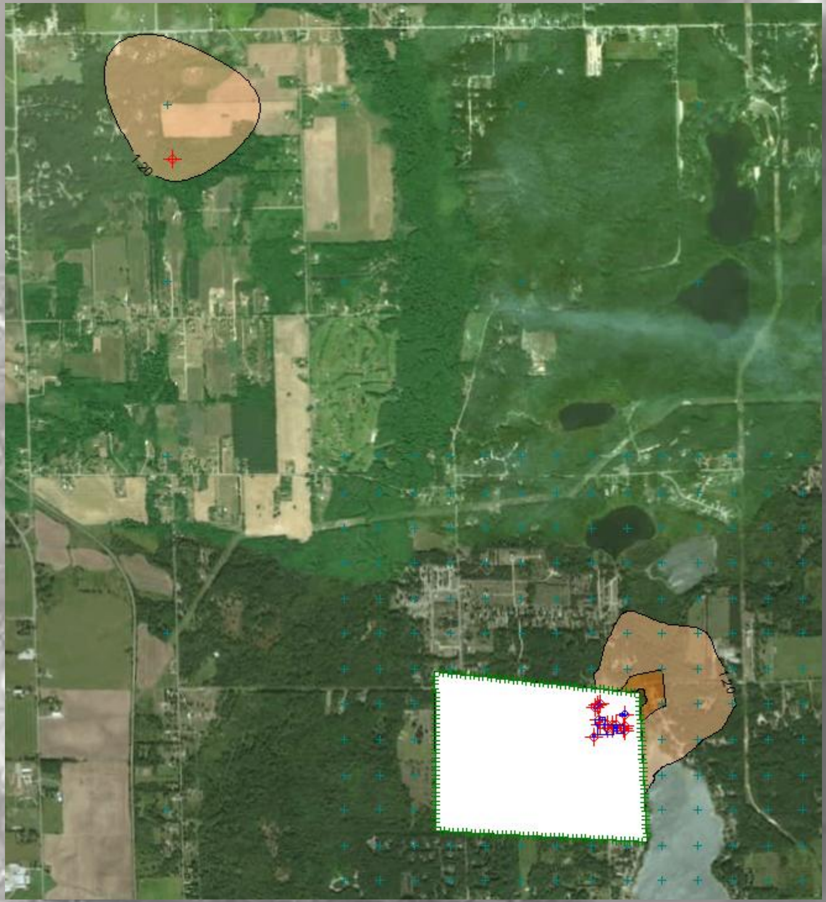
Methodology for Permitting Projects - Sample Model Setup (AERMOD)



Methodology for Permitting Projects

PSD Increment

National Ambient Air Quality Standards



Methodology for New Projects

- **Facility-Wide Impacts vs. PSD Increments**

Pollutant	Averaging Period*	Modeled Impact ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)	Passing?
$PM_{2.5}$	24-Hour	5	9	Yes

- **Facility-Wide Impacts vs. National Ambient Air Quality Standards**

Pollutant	Modeled Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Passing?
$PM_{2.5}$	2.7	20.1	22.8	35	Yes

Challenges and Solutions

Challenge 1: High Project Impacts

- **Causes**
  - High Emissions
  - Bad Dispersion
  - High Background
- **Generally Improved By**
  - Reducing Emission Rates
  - Restricting Operation
  - Running Non-Default Options or Alternative Models
  - Increasing Stack Heights
  - Increasing Stack Flow Rate or Temperatures
  - Changing Building Configurations
  - Moving Equipment Locations
  - Purchasing Property

Challenge 2: High Impacts from Other Sources

- **Can be a Problem with NAAQS and/or PSD Increment Modeling**

- **Generally Improved By:**
  - Modeling Actual Emissions Rather than PTE (New)
  - Running Non-Default Options or Alternative Models
  - Source Contribution Analysis

Modeling Updates

Timeline of Rules and Guidance

- **2005 40 CFR Part 51, Appendix W Promulgated in Federal Register**
  - Incorporated AERMOD
  - Lots of Guidance Since 2005

- **2016 "Final" Appendix W Updates Promulgated**
  - Postponed by Trump EPA
  - Tentative New Effective Date May 22, 2017
  - Applies to All Permits Issued After January 17, 2018 (So Far)

- **2016 Draft Guidance on MERPs**
  - Modeled Emission Rates of Precursors
  - Public Comment Period Extended by Trump EPA
  - Still Not Final

2016 Appendix W Updates

- **General**
  - More Flexibility, but More Consultation with EPA
  - New Regulatory AERMOD Version 16216r
  - We Can Use the New Appendix W Immediately

- **Important**
  - Revised Acceptable NO_x to NO_2 Conversion Methods
  - New “USTAR” Meteorological Option Allowed
  - Must Consider Secondary Formation Due to Precursors

Modeled Emission Rates of Precursors (MERPs)

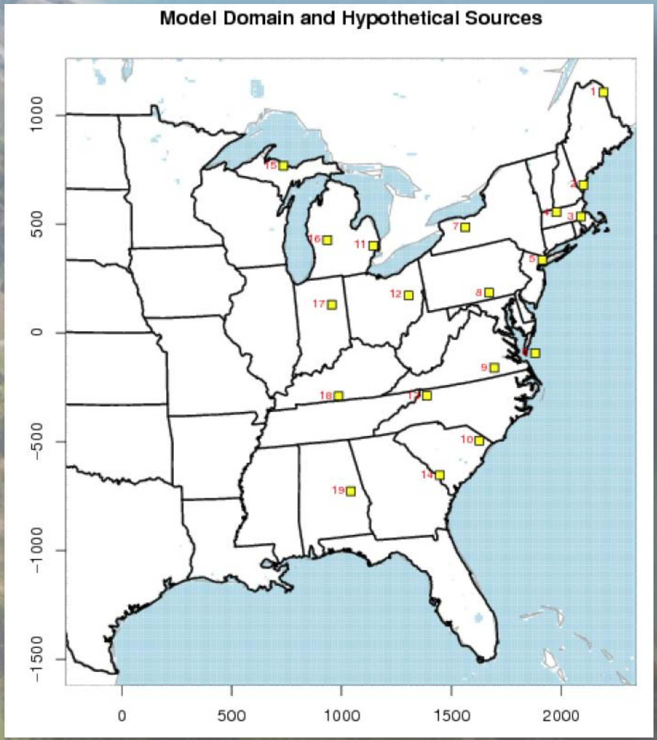
- **Ozone (O_3) Formation**
  - NO_x
  - VOCs
- **Fine Particulate Matter ($PM_{2.5}$) Formation**
  - Primary $PM_{2.5}$
  - NO_x
  - SO_2
- **Options for Precursor Assessment**
  - Significant Emission Rates (SER)
  - Modeled Emission Rates of Precursors (MERPs)
  - Other Screening Models (Not Developed Yet)
  - Full Photochemical Modeling

Modeled Emission Rates of Precursors (MERPs)

- **What are MERPs?**
  - EPA Conducted Photochemical Modeling
    - Link Precursor Emissions to Impacts
    - 1,800 Model Runs
    - Varied Heights, Locations, and Emissions
      - Macomb County
      - Montcalm County
      - Marquette County

  - Default MERPs
    - Based on Comparing to SILs

  - Allows Development of Site-Specific MERPs



Modeled Emissions Rates of Precursors (MERPs)

- **Back to Case Study**

Emissions (tpy)	Height	County	NO_x (tpy)	VOC (tpy)	SO_2 (tpy)
< 500 Each Pollutant	~ 90m (~300')	Macomb	300	200	41

Modeled Emissions Rates of Precursors (MERPs)

- Case Study – Ozone Formation

Emissions (tpy)	Height	County	NO_x (tpy)	VOC (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	200

Region	EPA Default MERPs	
	8-hour O_3	
	NO_x (tpy)	VOC (tpy)
Eastern U.S.	170	1,159

- Solution (Hopefully): Create Site-Specific MERPs

Modeled Emissions Rates of Precursors (MERPs)

- Case Study – Ozone Formation

Emissions (tpy)	Height	County	NO_x (tpy)	VOC (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	200

Region	EPA Default MERPs 8-hour O_3	
	NO_x (tpy)	VOC (tpy)
Eastern U.S.	170	1,159

County	Site Specific MERPs 8-hour O_3	
	NO_x (tpy)	VOC (tpy)
Macomb	532	1,786

- Now We Need to Look at Both Pollutants

Modeled Emissions Rates of Precursors (MERPs)

- **Case Study – Ozone Formation**

Emissions (tpy)	Height	County	NO_x (tpy)	VOC (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	200

County	Site Specific MERPs	
	8-hour O_3	
	NO_x (tpy)	VOC (tpy)
Macomb	532	1,786

Easier to Show than Explain

NO_x (300/532) + VOC (200/1,768) = 56% + 11% = 68% of Critical AQ Threshold

Modeled Emissions Rates of Precursors (MERPs)

- Case Study – $PM_{2.5}$ Formation

Emissions (tpy)	Height	County	NO_x (tpy)	SO_2 (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	41

Region	EPA Default MERPs			
	24-hour $PM_{2.5}$		Annual $PM_{2.5}$	
	NO_x (tpy)	SO_2 (tpy)	NO_x (tpy)	SO_2 (tpy)
Eastern U.S.	2,295	628	10,144	4,013

County	Site Specific MERPs			
	24-hour $PM_{2.5}$		Annual $PM_{2.5}$	
	NO_x (tpy)	SO_2 (tpy)	NO_x (tpy)	SO_2 (tpy)
Macomb	10,000	2,500	75,000	37,500

Modeled Emissions Rates of Precursors (MERPs)

- **Case Study – $PM_{2.5}$ Formation**

Emissions (tpy)	Height	County	NO_x (tpy)	SO_2 (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	41

County	Site Specific MERPs			
	24-hour $PM_{2.5}$		Annual $PM_{2.5}$	
	NO_x (tpy)	SO_2 (tpy)	NO_x (tpy)	SO_2 (tpy)
Macomb	10,000	2,500	75,000	37,500

NO_x (300/10,000) + SO_2 (41/2,500) = 3% + 2% = 5% of Critical AQ Threshold

Modeled Emissions Rates of Precursors (MERPs)

- **Case Study – $PM_{2.5}$ Formation**

Emissions (tpy)	Height	County	NO_x (tpy)	SO_2 (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	41

  - From Precursors 3% + 2% = 5% of Critical AQ Threshold (SIL)

Modeled Emissions Rates of Precursors (MERPs)

- **Case Study – $PM_{2.5}$ Formation**

Emissions (tpy)	Height	County	NO_x (tpy)	SO_2 (tpy)
< 500 Each Pollutant	~ 90m	Macomb	300	41

- From Precursors 3% + 2% = 5% of Critical AQ Threshold (SIL)

But We Need to Include in Modeled SIL Impacts

24-hr Primary $PM_{2.5}$ Model Impact ($\mu g/m^3$)	24-hr $PM_{2.5}$ SIL ($\mu g/m^3$)
5	1.2

SIL Modeled Impacts 5/1.2 = 417% of Critical AQ Threshold (SIL)

Modeled Emissions Rates of Precursors (MERPs)

- **Case Study – $PM_{2.5}$ Formation**
  - From Precursors 3% + 2% = 5% of Critical AQ Threshold (SIL)
  - Plus Modeled Impacts of 417%
  - **Gives a Total of 421% of Critical AQ Threshold (SIL)**
- **Possible Workarounds:**
  - Make “Obvious” Case that Precursors Won’t Contribute at 5% of SIL
  - Choose Critical AQ Thresholds Other than the SIL (NAAQS/PSD Increment?)

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