Hazardous Air Pollutants 101: Emission Calcs, Modeling, Trends

2022 Midwest Environmental Compliance Conference

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September 2022

Presentation Roadmap

- What are Hazardous Air Pollutants (HAPs)
- How are HAPs regulated?
- Discuss Missouri's risk assessment analysis
- State construction permit regs for HAPs
- HAP emission calculations
- Risk assessment test case
- Future trends
- Conclusion/Questions

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What are Hazardous Air Pollutants?

- Under the Clean Air Act, EPA is required to regulate emissions of HAPs
- Known or suspected to cause cancer or other serious health effects
    - Reproductive effects
    - Birth defects
    - Adverse environmental effects
- Original 1990 list included 189 pollutants
- Since 1990, list modified to 188 pollutants
- Latest addition 1-bromopropane on January 5, 2022, solvent alternative to ozone depleting substances

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What are some HAP Examples?

- Metals, including cadmium, mercury, chromium, and lead compounds
  - Burning of fossil fuels such as coal or oil
  - MSW Incineration
  - Primary and secondary metal processing
- Benzene, toluene
  - Constituent in motor fuels
  - Solvent
  - Burning of fossil fuels
- Methylene chloride - used as a solvent
- Perchlorethylene – dry cleaners
- Asbestos
- 181 others

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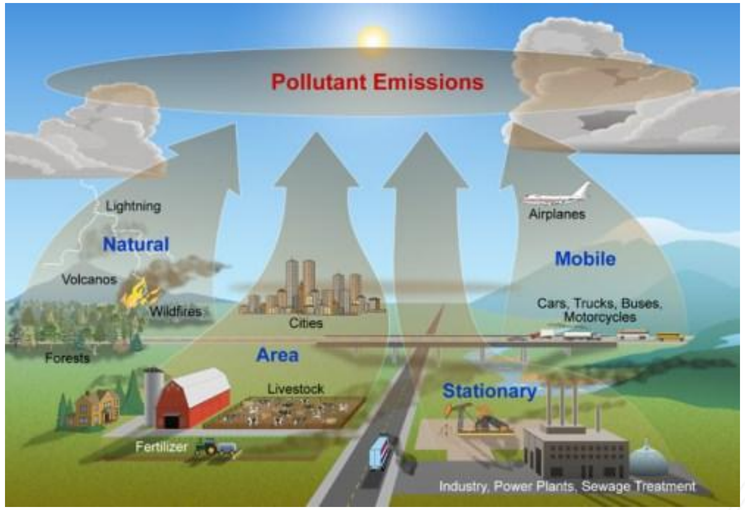
How are HAPs Regulated?

- National Emission Standards for Hazardous Air Pollutants (NESHAPS)
- Maximum Achievable Control Technology (MACT) standards
- Residual risk review
- HAP specific state permit regulations
- Indirectly criteria pollutant regulations
  - Many HAPs are PM or organic volatiles

National Emission Standards for Hazardous Air Pollutants (NESHAP)

- CAA of 1970 required the EPA to set National Emission Standards for Hazardous Air Pollutants (NESHAPS)
  - Stationary source standards for HAPs
  - Sources required to perform an initial performance test to demonstrate compliance
- Demonstrate continuous compliance, sources are generally required to
  - Monitor control device operating parameters established during initial performance test or
  - operate continuous emission monitors



Maximum Achievable Control Technology (MACT) standards and Residual Risk Review

- CAA Amendments of 1990 – new method for regulating HAPs
- Regulations broken out into 2 phases
- Phase 1 - Maximum Achievable Control Technology (MACT) standards
  - Technology Based
  - Standards already achieved by “low emitting” sources
- Phase 2 – Residual Risk Review
  - Risk Based
  - Assess remaining health risks from each source category

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State Construction Permit Regulations

- Vary by State
  - Risk assessment may be required
  - BACT/t-BACT may be required
- Missouri – Individual HAP increase above Screening Model Action Level (SMAL)
  - Risk assessment modeling required
- Nebraska - 2.5 tpy increase of any individual HAP or an aggregate 10 tpy
- Kansas – Construction/reconstruction of new/existing major HAP source
  - Post construction 10/25 tpy

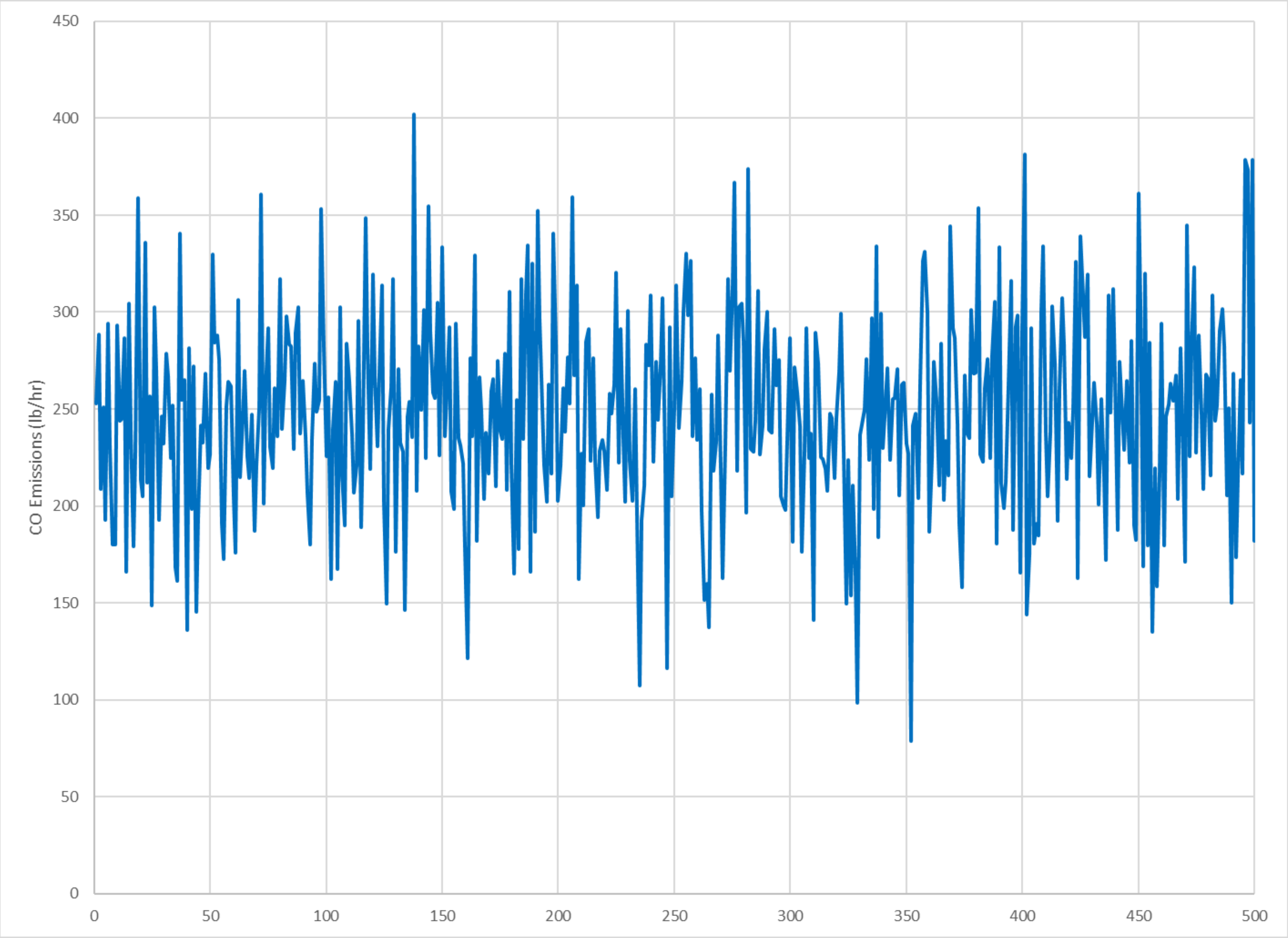
Missouri Risk Assessment – model for future

- Step 1 - Calculate Emissions
  - RA required for HAP emission increases above Screening Model Action Level (SMAL)
- Step 2 - Model Project Emissions
  - Compare Model Results to 4% of Risk Assessment Level (RAL)
- If >4%, cumulative (all sources) analysis required
- Step 3 - Cumulative analysis compared to full RAL
  - Including background and outside sources, if significant
  - Major sources may use Residual Risk Review completed by EPA, if applicable.

HAP Emission Calculations

- Calculated using same general procedures as criteria pollutants
  - Emission factors (WebFIRE, AP42)
  - Direct measurement (stack test, CEM, etc)
  - Correlation to surrogate (ie, correlation of cadmium to PM or organic HAP to CO)
    - Continuous measurement of surrogate required
    - Paired subset required to develop correlation
  - Speciation profiles for particulate HAPs
- Use appropriate safety factor
  - Factor reliability
  - Emission variability

HAP Emission Calculations-Correlation Example



- Hourly CO CEM Data
- Avg= 247 lb/hr
- Max = 402 lb/hr
- Max/Avg = 1.63

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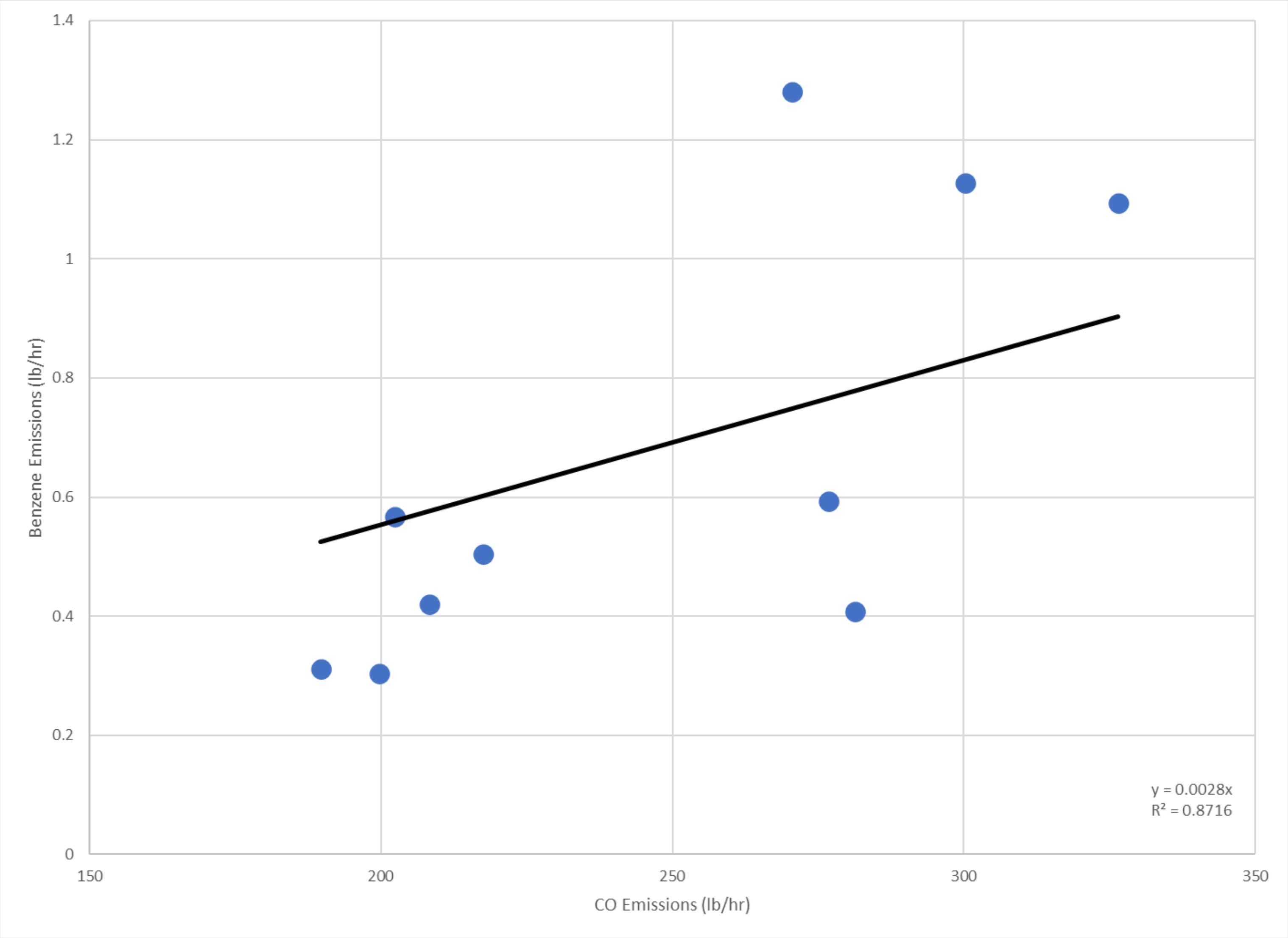
HAP Emission Calculations-Correlation (Continued)



- CO/Benzene Linear Correlation Plot
- R^2 – Correlation Coefficient =0.8716
- Use SF = 1.25
- Benzene (lb/hr) = 0.0028 * CO (lb/hr) * 1.25

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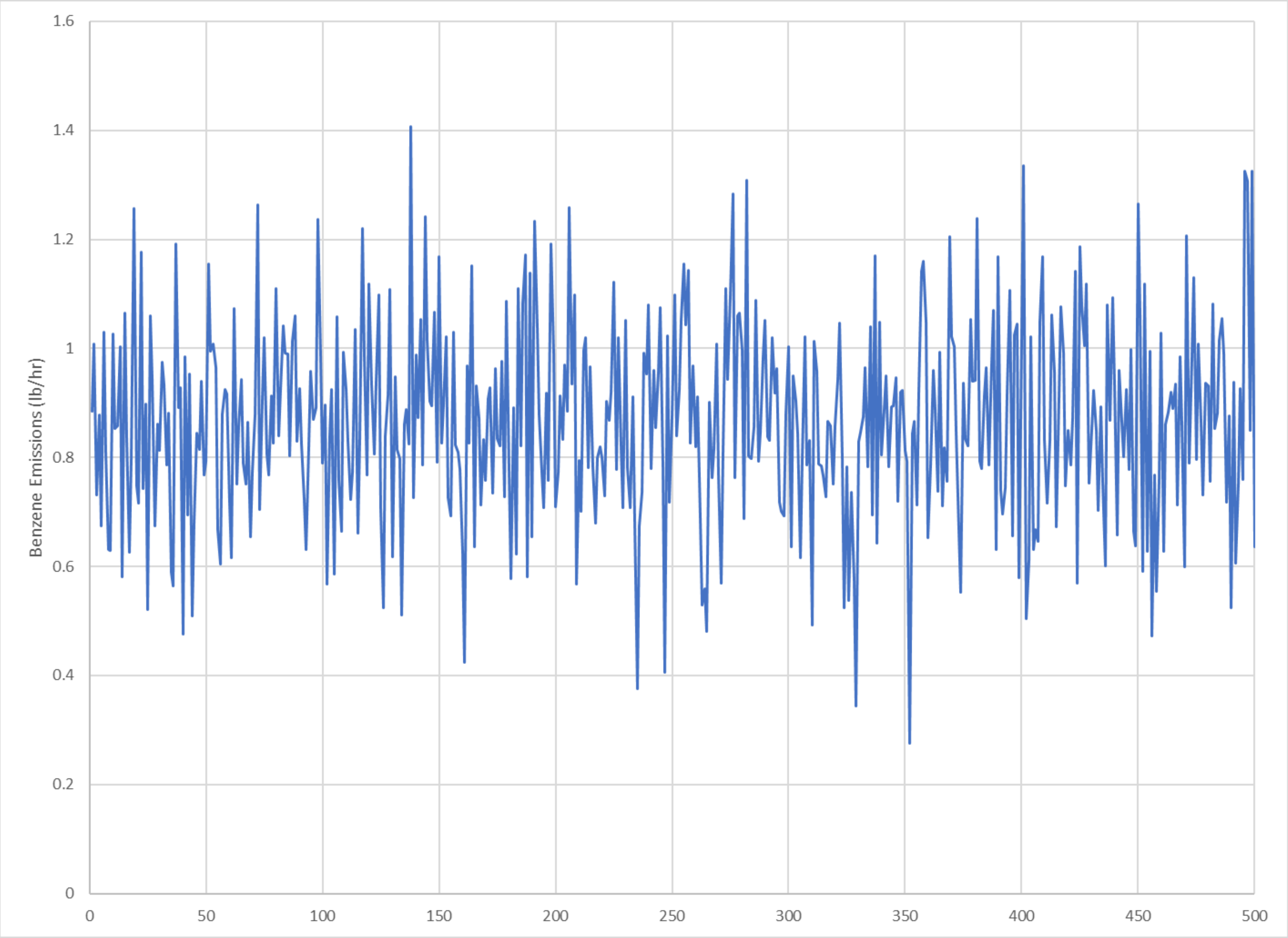
HAP Emission Calculations-Correlation (Continued)



- Hourly Benzene Emissions
- Estimated
- Avg= 0.87 lb/hr
- Max = 1.41 lb/hr
- Actual = 3.81 ton/yr

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Speciation Example-PM Emissions Known

HAP	Base Metal CAS No.	Element from Speciate Profile	Element/PM Mass Ratio (Unitless)	Hourly Element Emissions (lb/hr)	Compound Used to Estimate HAP Emissions	HAP/Element Mass Ratio (Unitless)	Hourly HAP Emissions (lb/hr)
Lead Compounds	20-11-1	Pb	0.114	0.57	PbO	1.08	0.6141
Manganese Compounds	20-12-2	Mn	0.00033	0.00165	MnO	1.29	0.0021
Cobalt Compounds	20-07-5	Co	0.00002	0.0001	CoO	1.27	0.0001
Nickel Compounds	20-14-4	Ni	0.00022	0.0011	NiO	1.27	0.0014
Arsenic Compounds	20-01-9	As	0.00355	0.01775	As2O3	1.32	0.0234
Cadmium Compounds	20-04-2	Cd	0.00645	0.03225	CdO	1.14	0.0369
Antimony Compounds	20-00-8	Sb	0.01893	0.09465	Sb2O3	1.20	0.1133
Mercury Compounds	20-13-3	Hg	0.00108	0.0054	HgO	1.08	0.0058
Chromium Compounds	20-06-4	Cr	0.00118	0.0059	Cr2O3	1.46	0.0086

PM Emissions = 5 lb/hr (Filterable)

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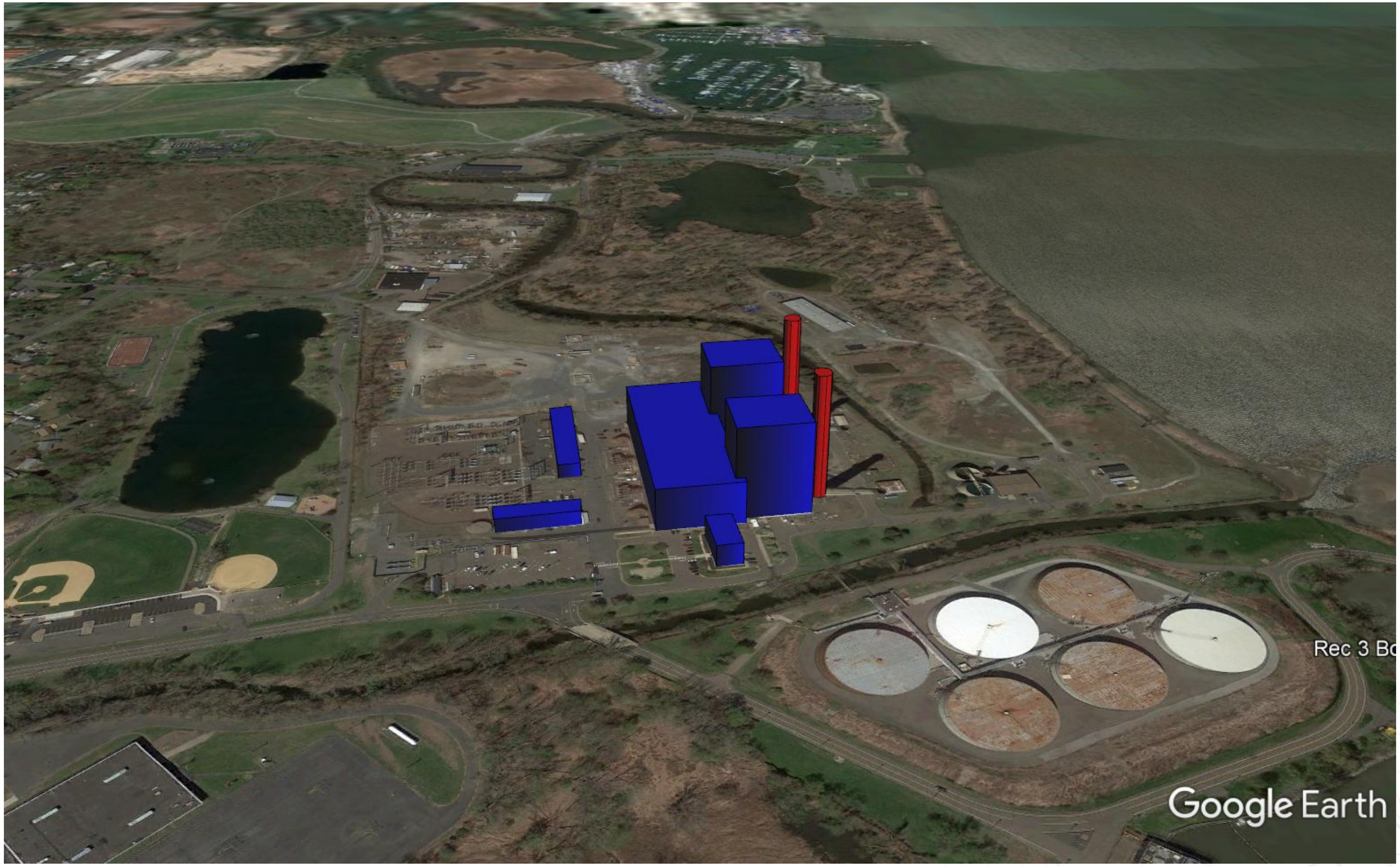
Speciation Example-Primary HAP Emissions Known

HAP	Base Metal CAS No.	Element from Speciate Profile	Element/Pb Mass Ratio (Unitless)	Hourly Element Emissions (lb/hr)	Compound Used to Estimate HAP Emissions	HAP/Element Mass Ratio (Unitless)	Hourly HAP Emissions (lb/hr)
Lead Compounds	20-11-1	Pb	1	0.5	PbO	1.08	0.5386
Manganese Compounds	20-12-2	Mn	0.0029	0.001447368	MnO	1.29	0.0019
Cobalt Compounds	20-07-5	Co	0.0002	8.77193E-05	CoO	1.27	0.0001
Nickel Compounds	20-14-4	Ni	0.0019	0.000964912	NiO	1.27	0.0012
Arsenic Compounds	20-01-9	As	0.0311	0.015570175	As2O3	1.32	0.0206
Cadmium Compounds	20-04-2	Cd	0.0566	0.028289474	CdO	1.14	0.0323
Antimony Compounds	20-00-8	Sb	0.1661	0.083026316	Sb2O3	1.20	0.0994
Mercury Compounds	20-13-3	Hg	0.0095	0.004736842	HgO	1.08	0.0051
Chromium Compounds	20-06-4	Cr	0.0104	0.005175439	Cr2O3	1.46	0.0076

Pb Emissions = 0.5 lb/hr

Risk Assessment Test Case



- Test case for Site in Missouri

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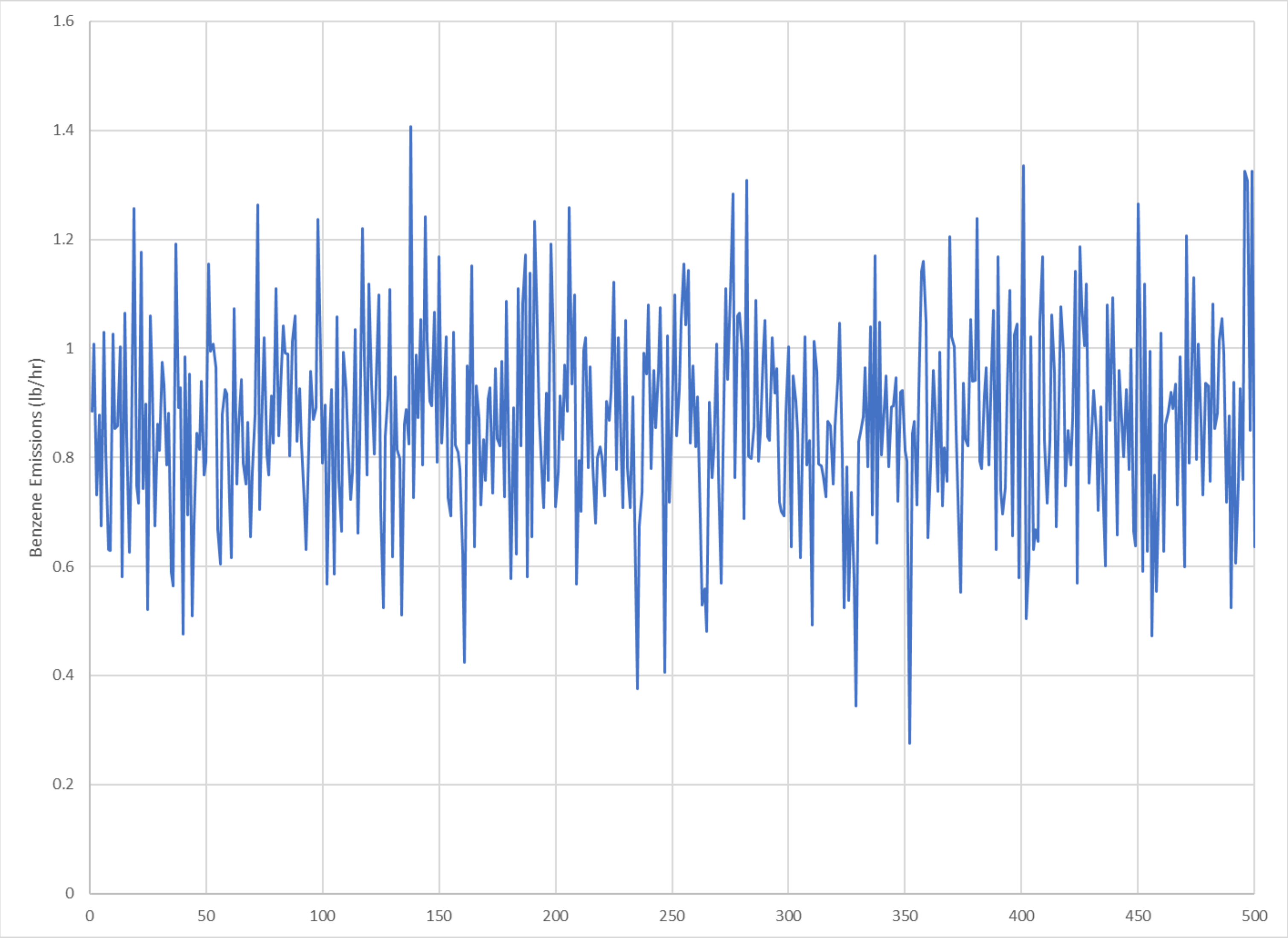
Test Case Emissions



- Hourly Benzene Emissions
- Estimated
- Avg= 0.87 lb/hr
- Max = 1.41 lb/hr
- PTE = 6.2 ton/yr
  - Max lb/hr
  - Continuous Op
  - 8,760 hr/yr

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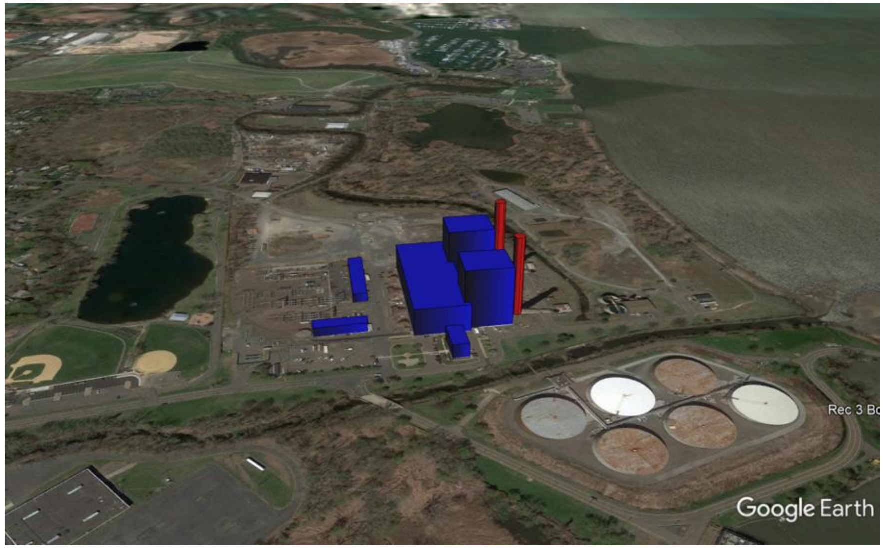
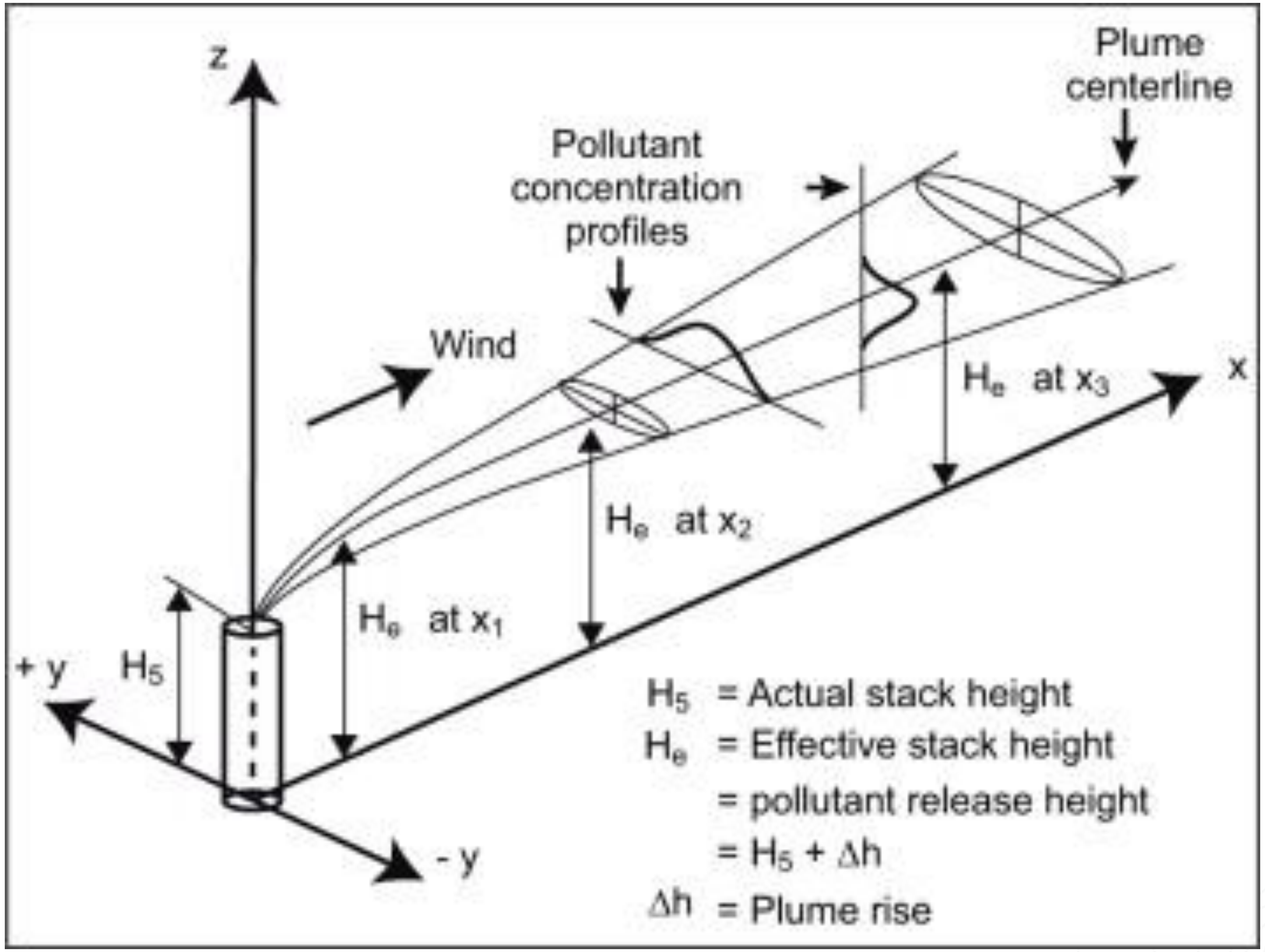
Test Case Source Input Summary

Parameter	Value
Benzene Emission Rate	1.41 lb/hr (MHDR) 6.2 ton/year (PTE)
Stack Height	285 ft
Exhaust Temperature	180-314 °F (225 °F average)
Stack Exit Velocity	1500-5900 fpm (2600 fpm average)
Stack Diameter	18.8 ft



What Model for HAP Risk Assessment?



- AERSREEN
  - Reduced Inputs
  - Conservative Screen
  - Worst Case Met
- AERMOD Refined Dispersion Model
  - EPA's preferred near-field dispersion model
  - Applicable to a wide range of regulatory modeling studies in all types of terrain

Test Case RA Process Flow

- Step 1. Compare PTE to Benzene SMAL
  - PTE = 6.2 ton/yr, SMAL = 2 ton/yr (Benzene)
  - Unable to limit PTE < 2 ton/yr
- Step 2. Project level modeling analysis
  - Run AERSCREEN for project and compare to RAL
  - 24-hour RAL for Benzene = 1.2 µg/m^3
  - Run model at max hourly emission rate of 1.41 lb/hr
  - Max 24-hour Avg Conc = 0.29 µg/m^3
  - Compare project level max to 4% of RAL (4% of 1.2 = 0.048 µg/m^3)
- Step 3. Cumulative analysis
  - No other benzene sources at site
  - Assume background = 0.05 µg/m^3
  - Total Impact = 0.29 µg/m^3 **+** 0.05 µg/m^3 = 0.34 µg/m^3 (< RAL)

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Trends – Where are we going?

- Substantial private and public funds to be spent on ambient monitoring (traditional, short-term, hyperlocal)
  - Some EPA/state, mostly citizen science
- Environmental Justice (EJ)
- Existing federal regulations expanded
  - Additional testing requirements (eliminate surrogates, CEM)
  - Significantly expanded monitoring
- Expanded state permitting regulations
  - Most states will likely require risk assessments for HAP increases
  - Require BACT (or something similar)
  - Reduced RA action levels
  - Cumulative risk assessments

Questions?

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