Denver Department of Environmental Health
Environmental Protection Division

Steps in Conducting an Urban Air Toxics Assessment: Methodology for Converting Emission Inventories into Model-Ready Input Files

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"One Atmosphere, One Inventory, Many Challenges"

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Why Is Denver Modeling Hazardous Air Pollutants (HAPs)?

- Amendments to the Zoning provisions of the Denver Revised Municipal Code occurred in 1990. Changes apply to new or expanding industrial facilities and include:
  - Air pollution caused by a stationary source
  - An evaluation of undue concentration of uses that create environmental problems and external effects

Why Is Denver Modeling Hazardous Air Pollutants (HAPs)?

- HAP monitoring data are scarce or limited
- Alternate method is to use dispersion models that rely on emissions estimates or measurements
- ISC3ST dispersion model was used that included enhancements for air toxics applications

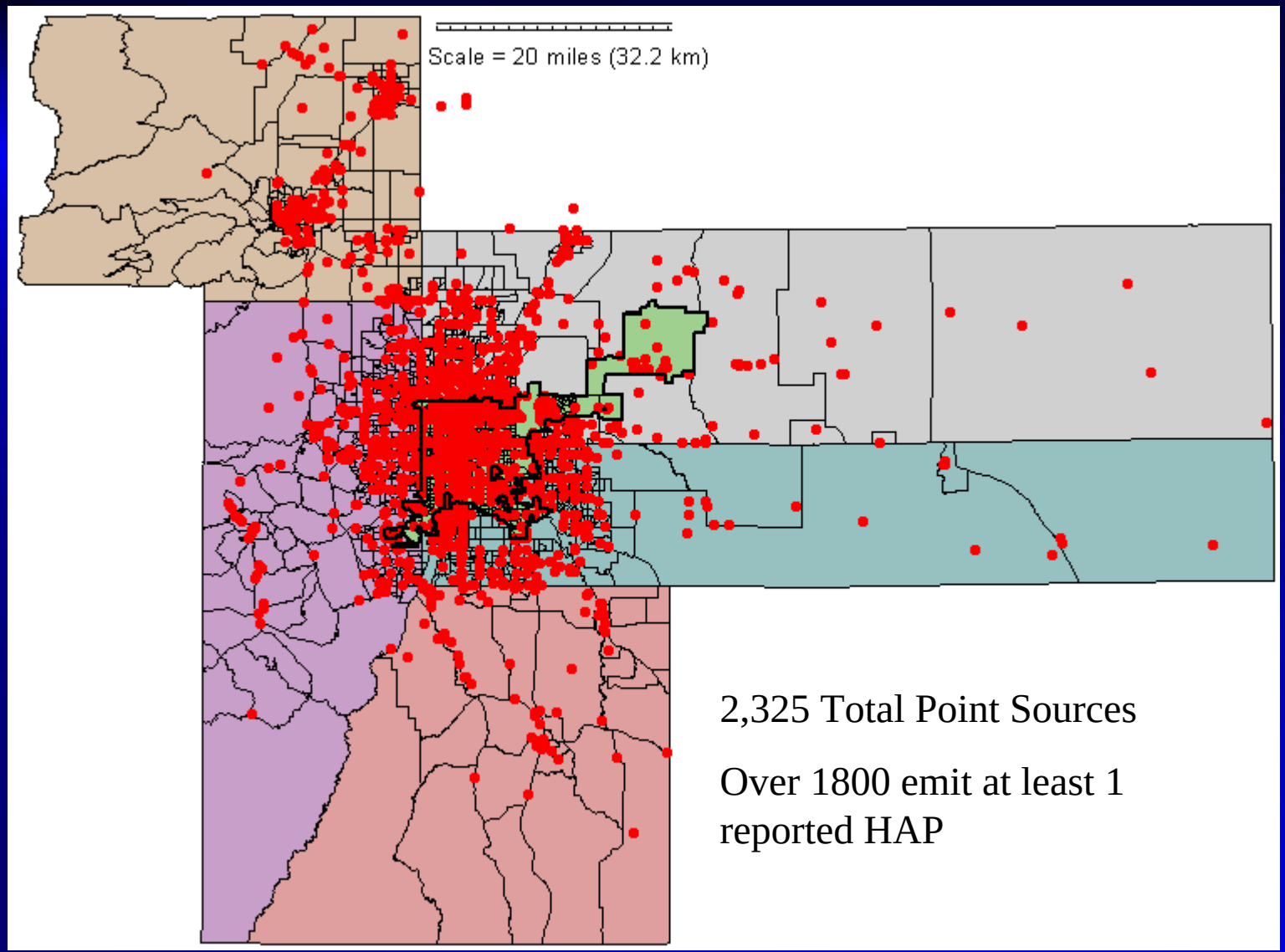
Emission Inventories Utilized

- Point Sources
  - Provided by Colorado Dept. of Public Health and Environment (CDPHE) - Air Pollution Control Division
    - not limited to “major” sources
- Area Sources
  - Obtained from 1996 NTI
    - excluded categories based on potential conflicts with point source database
      - perc dry cleaning, solvent cleaners, auto body repair
- Mobile Sources
  - Obtained from 1996 NTI
    - emissions from different source categories were kept separate

Emission Inventory Processing

- Most difficult part of the assessment
- Required significant use of a Geographical Information System (GIS)
- Utilized widely available spreadsheet, database and word processing software

Modeling Domain with Point Sources



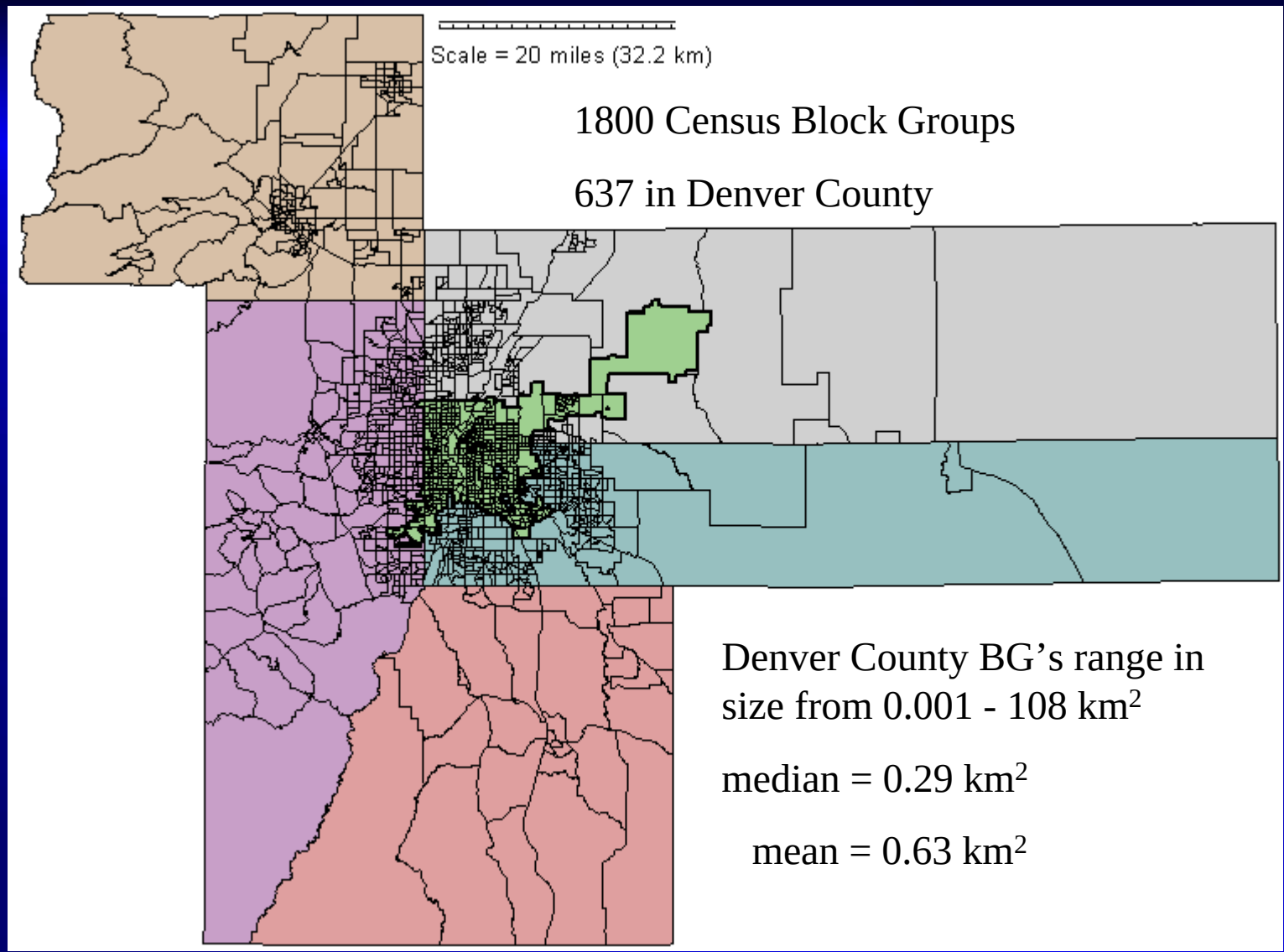
2,325 Total Point Sources

Over 1800 emit at least 1 reported HAP

Emission Inventory Processing

- Stationary/Point Sources
  - QA/QC facility coordinates using GIS (geocoding)
  - Aggregate emissions for each facility by pollutant
  - Develop weighted stack parameters (for modeling)
  - Develop emission factors by season and hour of day

Area and Mobile Source Emissions Allocated to Census Block Groups



1800 Census Block Groups

637 in Denver County

Denver County BG's range in size from 0.001 - 108 km^2

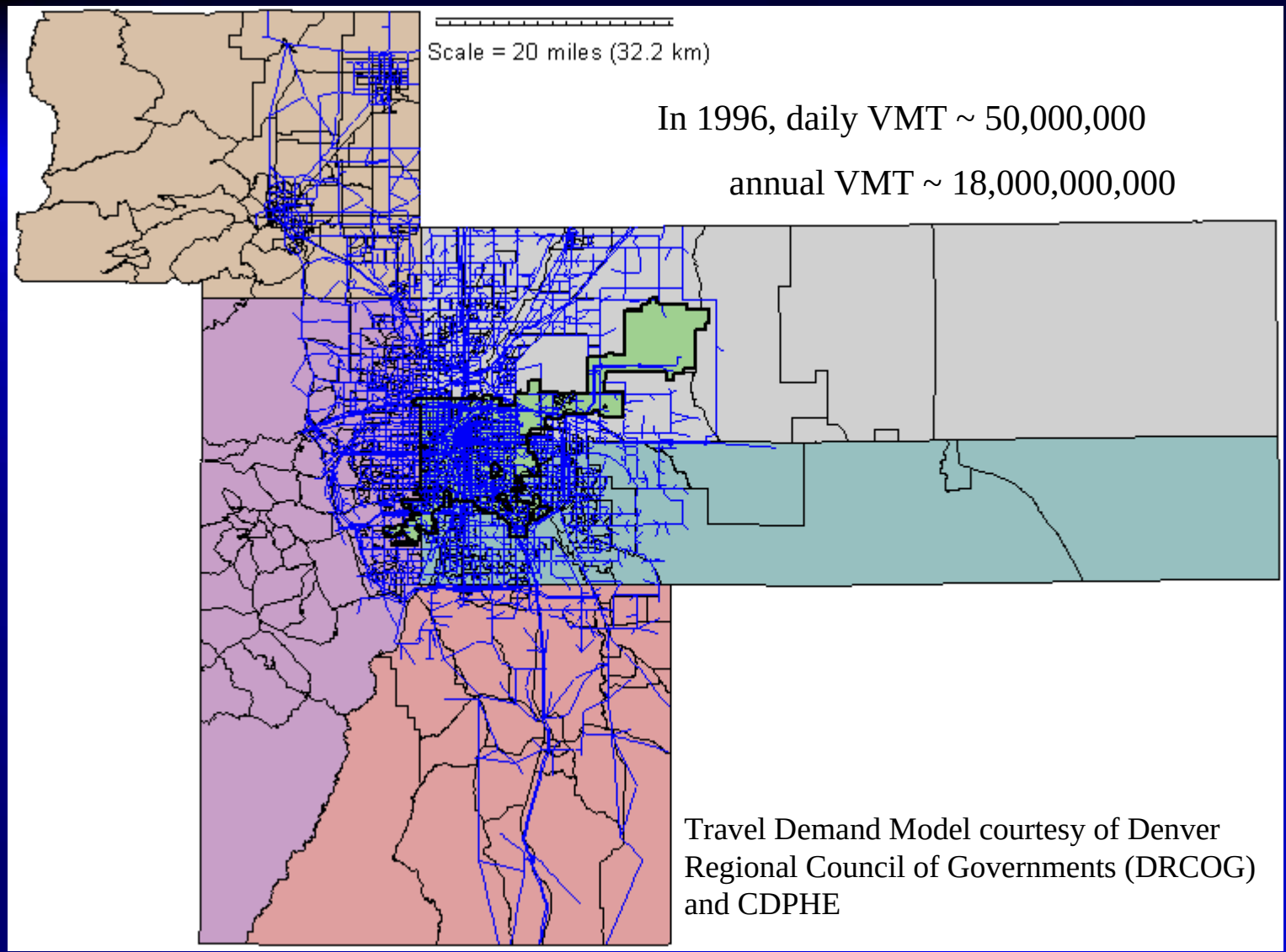
median = 0.29 km^2

mean = 0.63 km^2

Emission Inventory Processing

- Area Sources
  - Use GIS to extract census polygon vertices
  - Spatially allocate emissions using surrogates: population, inverse pop. density, and vehicle miles traveled (VMT) - easily determined using GIS
  - Exclude categories where potential double counting of point source emissions was likely to occur
  - Develop emission factors by season and hour of day
    - 90% of daily emissions between 6am-10pm

Using GIS to Spatially Allocate County Level Emissions



In 1996, daily VMT ~ 50,000,000

annual VMT ~ 18,000,000,000

Travel Demand Model courtesy of Denver Regional Council of Governments (DRCOG) and CDPHE

Emission Inventory Processing

- Mobile Sources
  - On-road Sources
    - Allocate emissions to each block group based on ratio of block group VMT to county VMT
    - Emission factors by season and hour of day
      - 70% 6am-8pm (65% of 70% 6-9am, 2-6pm), 20% 8pm -1am, 10% 1am-6am
  - Off-road Sources
    - Combination VMT-inverse pop. density surrogate for construction equipment emissions (2/3 VMT weighted)
    - Inverse pop. density surrogate used for agricultural emissions
    - Population surrogate for 2 and 4 stroke engine emissions
    - Emission factors different than for on-road sources
      - 90% of daily emissions assumed between 6am-10pm

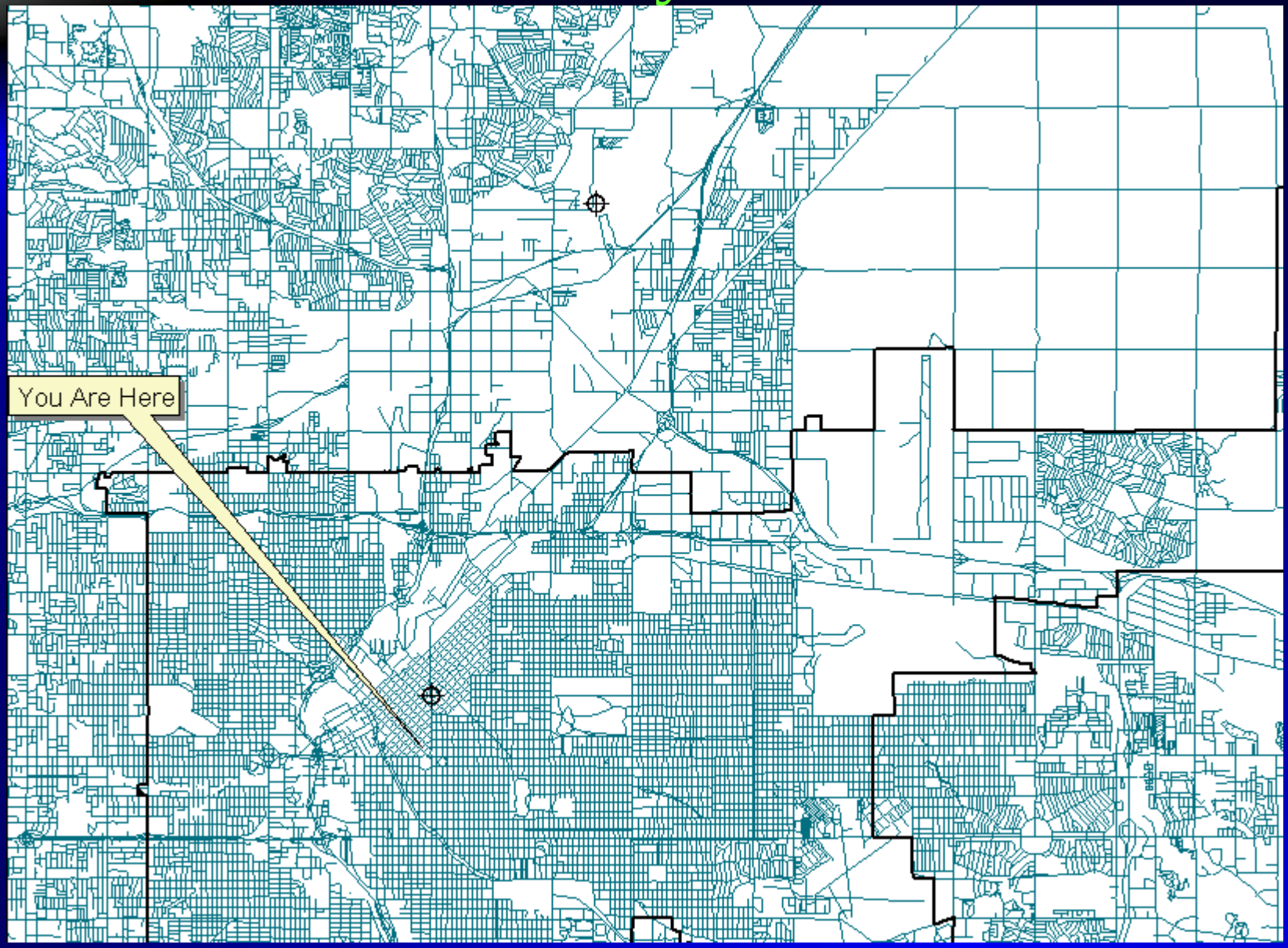
Uncertainties Associated with Emission Inventories

- Point Sources
  - Are reported emissions actual emissions?
- Area Sources
  - Quality of emission factors
- Mobile Sources
  - "Top-down" inventory (for area sources as well)
  - Quality of VOC speciation factors
  - Accuracy of *Mobile* model input data
    - Fleet age and distribution, basic emission rates

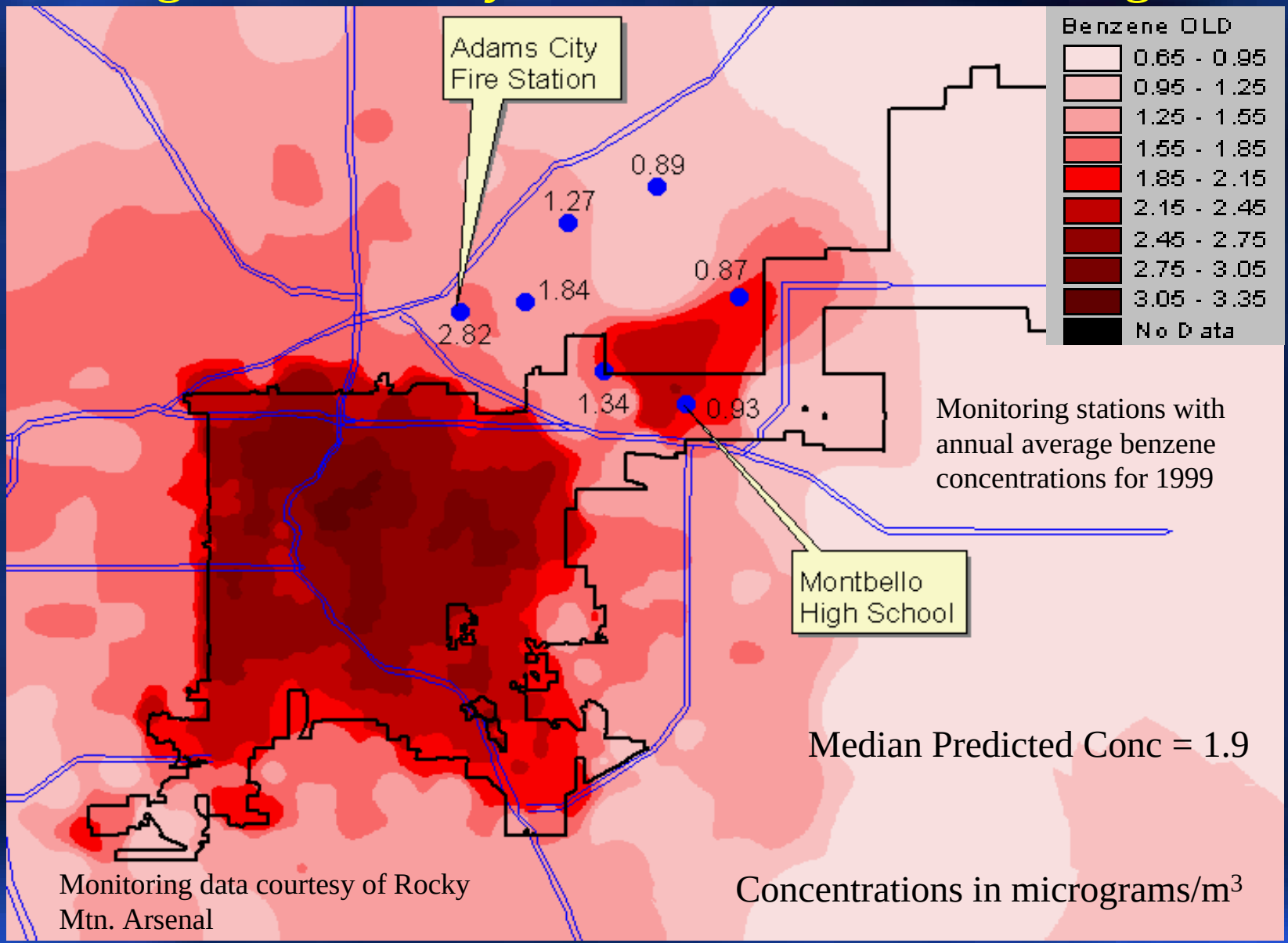
Denver County Benzene Emissions

- Total Benzene Emissions ~ 720 tons/year
  - 550 tons/year - Onroad Mobile (76%)
  - 150 tons/year - Nonroad Mobile (21%)
    - includes aircraft & railroad emissions
  - 2 tons/year - Area (0.3%)
  - 20 tons/year - Point (3%)

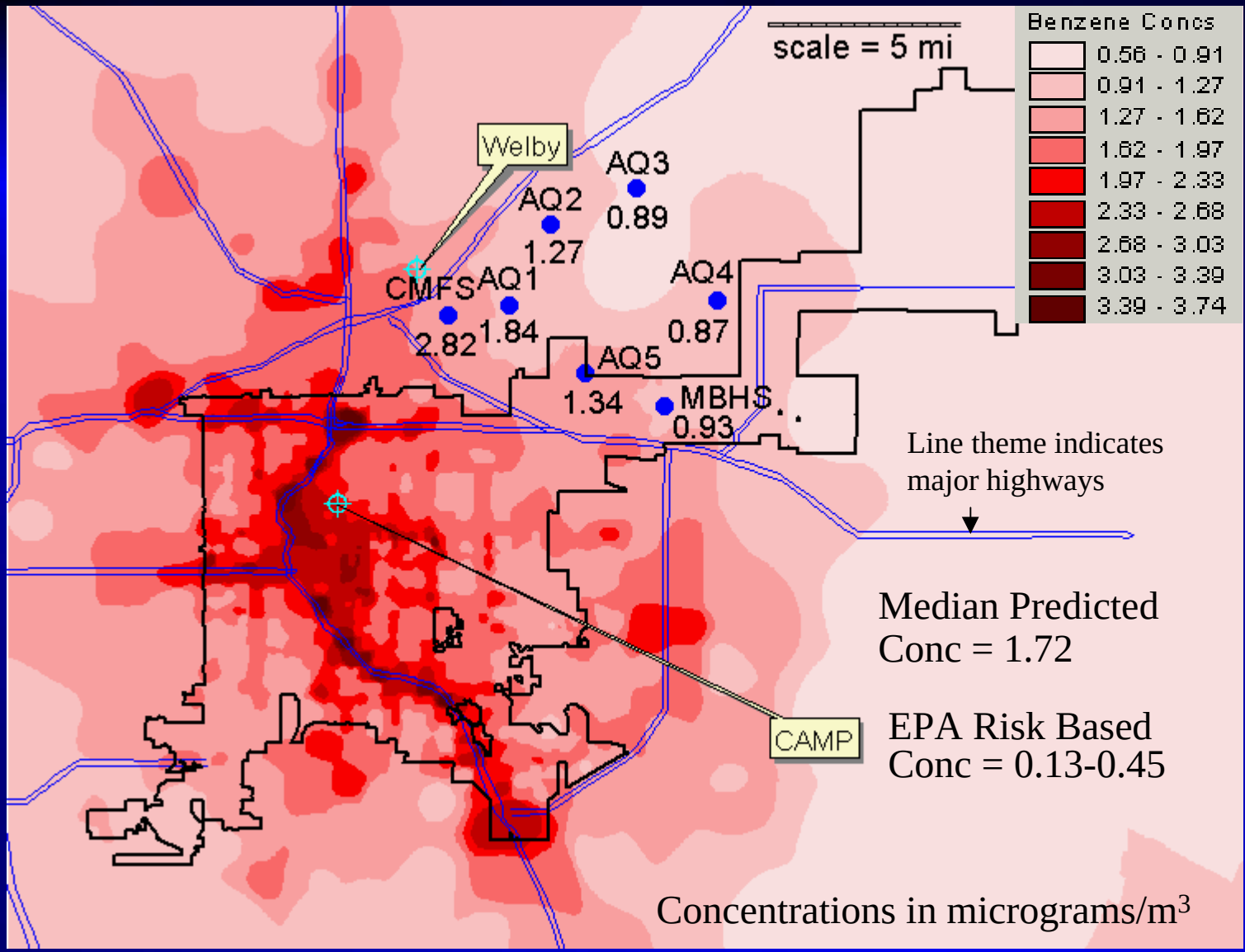
Road Density in Denver



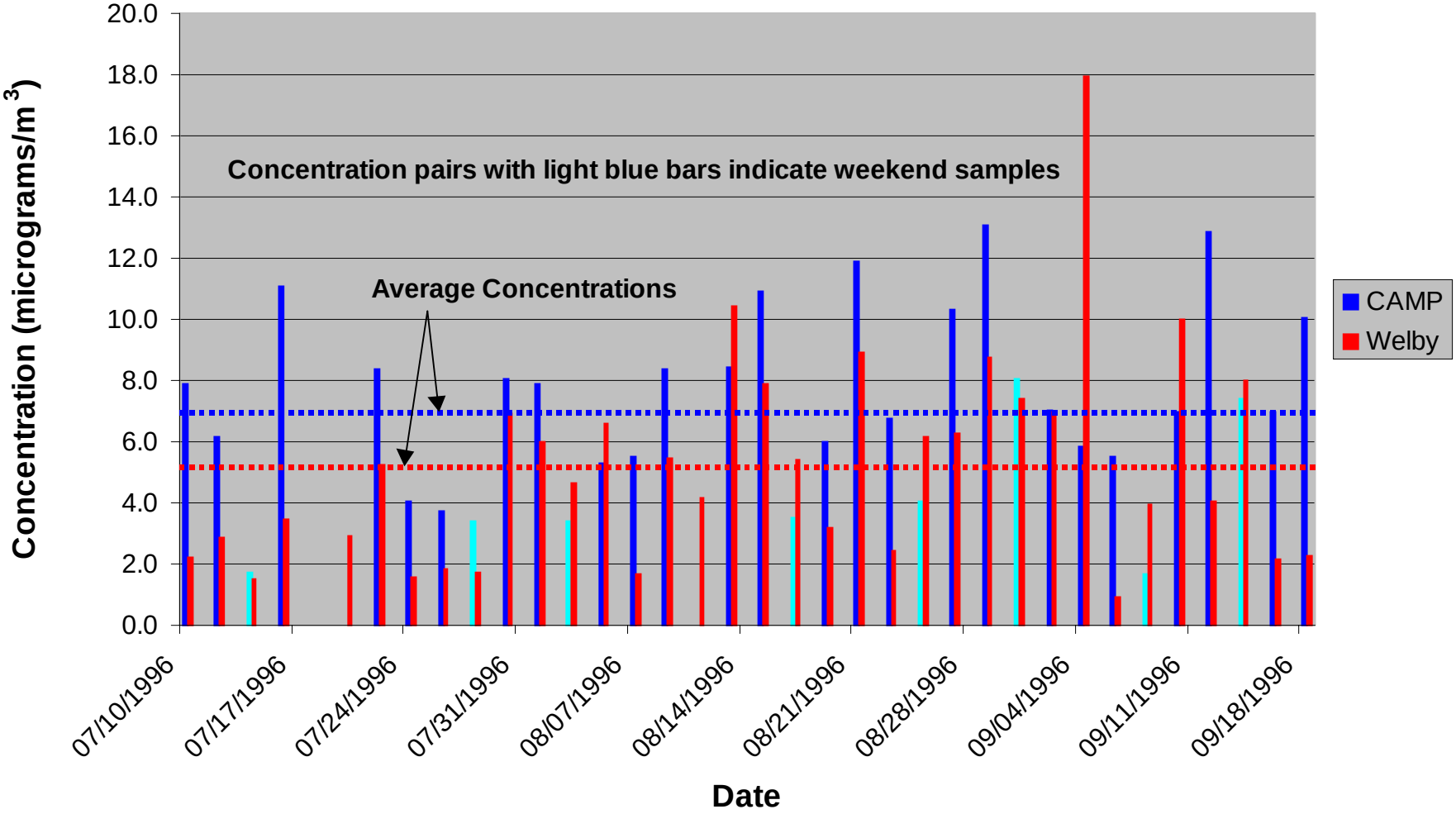
Predicted Annual Average Benzene Concentrations using *Road Density* as a Mobile Source Surrogate



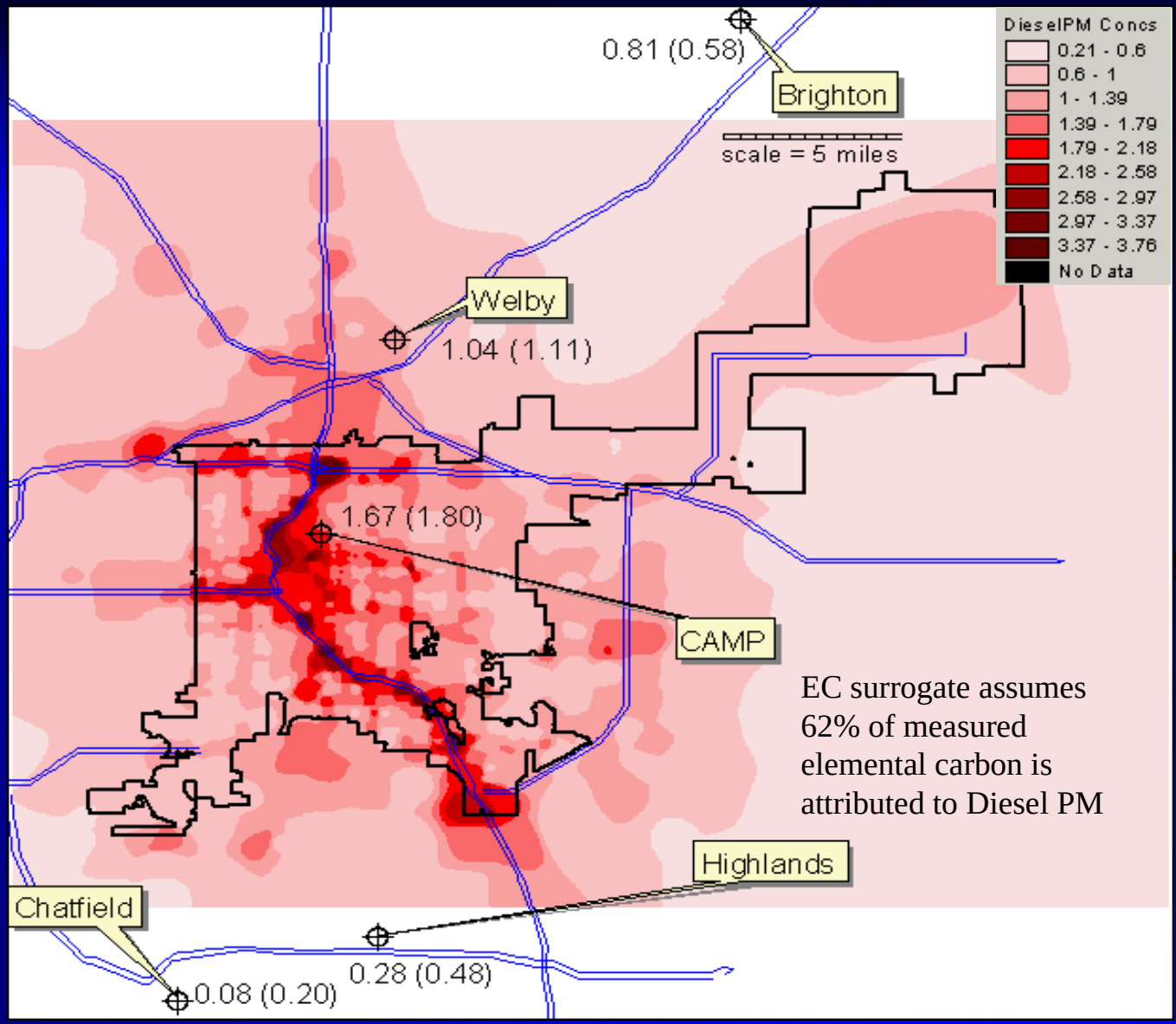
Predicted Annual Average Benzene Concentrations with Monitoring Data for 1999



Monitored 3 Hour Average Benzene Concentrations at CAMP and Welby, Summer 1996 6am-9am



Modeled Annual Avg. Diesel PM concentrations with Winter 96-97 Diesel PM concentrations obtained from CMB model and an EC surrogate ( )



Conclusions

- Very good model-to-monitor agreement for benzene and diesel PM (within a factor of two)
  - Limited data in urban core
  - Without emission factors predicted benzene concs ~15% higher
- Significant under prediction of metallic HAPs
  - Re-suspension may be an important source
    - not accounted for in emission inventory

Next Steps

- Determine best way to present data to the public
- EMPACT grant ????? Decision due in May 2001
  - Propose to monitor BTX and Carbonyl concs with real-time fixed monitors (1 hr avgs) at 4 locations (1 location every 6 months)
  - Collocated 3-hr avg samples via TO-17 and TO-11

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Thank You For Your Participation !

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