Hyperlocal Air Monitoring

2021 Missouri Air Compliance Seminar

Joseph Stolle, PE, Senior Environmental Engineer

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Introduction

- Hyperlocal air monitoring has recently become a hot topic
  - Significant grant funding available through the EPA regions later this year to conduct hyperlocal monitoring
  - Private funding through community and environmental groups-mostly for specific locations and sources directly impacting their immediate community

To understand what hyperlocal monitoring is:

- Discuss how traditional air monitoring differs from hyperlocal
- Look at a regional scale example of hyperlocal air monitoring
- Examine a neighborhood scale hyperlocal air monitoring test case
- Discuss the purpose of hyperlocal air monitoring and what it is used for
- Discuss some tools to protect your facility against inaccurate hyperlocal data collection

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Traditional Ambient Air Monitoring

- 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring

Site type	Appropriate siting scales
Highest concentration	Micro, middle, neighborhood (sometimes urban or regional for secondarily formed pollutants).
Population oriented	Neighborhood, urban.
Source impact	Micro (<100m), middle (100-500m), neighborhood.
General/background & regional transport	Urban, regional.
Welfare-related impacts	Urban, regional.

- Appropriate scales established based on-site type
- Requires knowledge of where to site (modeling or demographics)
- Limited to a specific site, or a few sites

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Ambient Air Monitoring Spatial Scales

Scale	Range
Microscale	Several meters up to about 100 meters.
Middle Scale	Up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.
Neighborhood Scale	City that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range
Urban Scale	Area of city-like dimensions, on the order of 4 to 50 kilometers
Regional Scale	Reasonably homogeneous geography without large sources, and extends from tens to hundreds of kilometers
National and Global Scales	Nation and the globe as a whole

- Each scale is valid over a specific geographic range
- Data is considered homogeneous within its range (1-dimensional)

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Traditional Source Impact Air Monitoring

- Use modeling to define locations of maximum impact and/or impact frequency
- Site monitors (typically 1-3) based on impact, local conditions and access
- Site BG monitor, if needed

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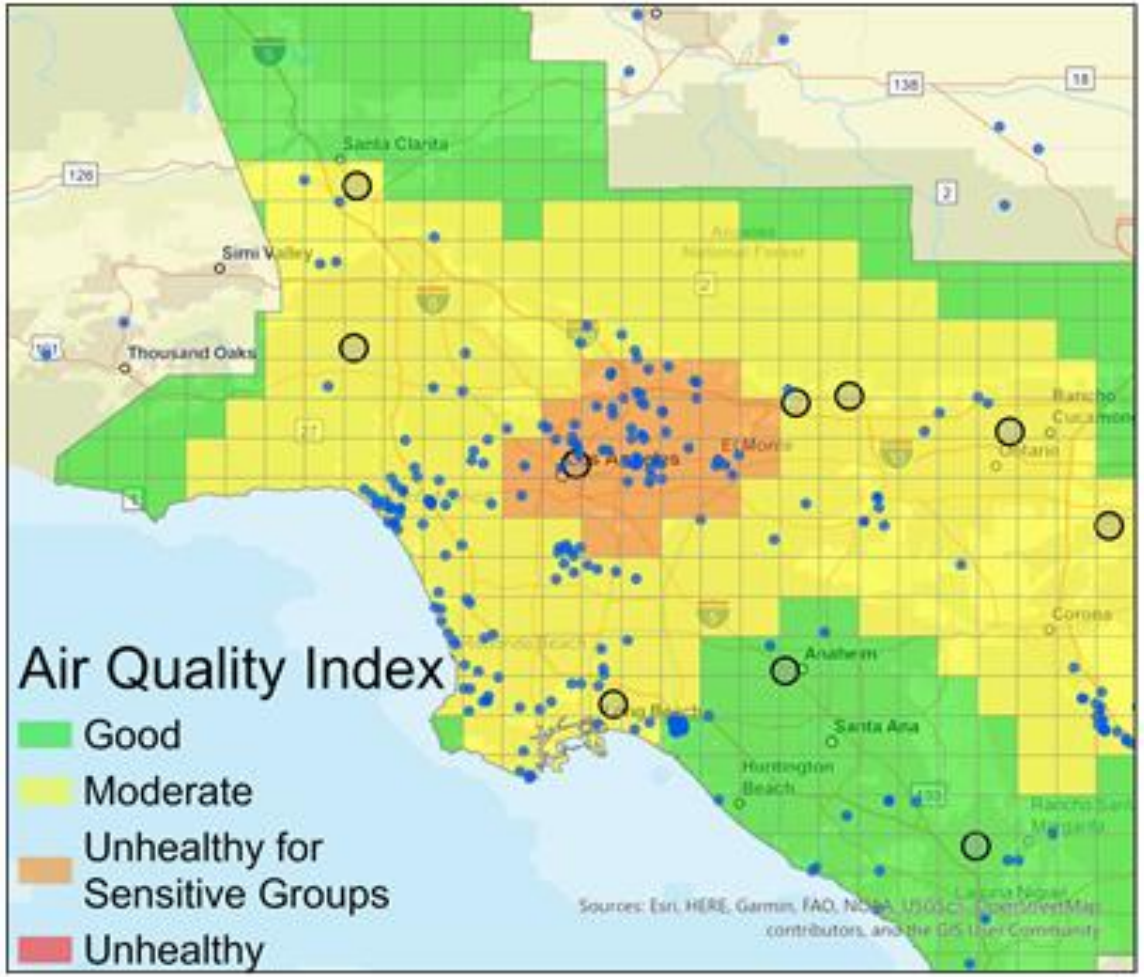
What is Hyperlocal Air Monitoring?



- Regional scale example
- Uses many samples to develop a 2 or 3-dimensional grid of concentration data
- Concentration data calculated for each grid node

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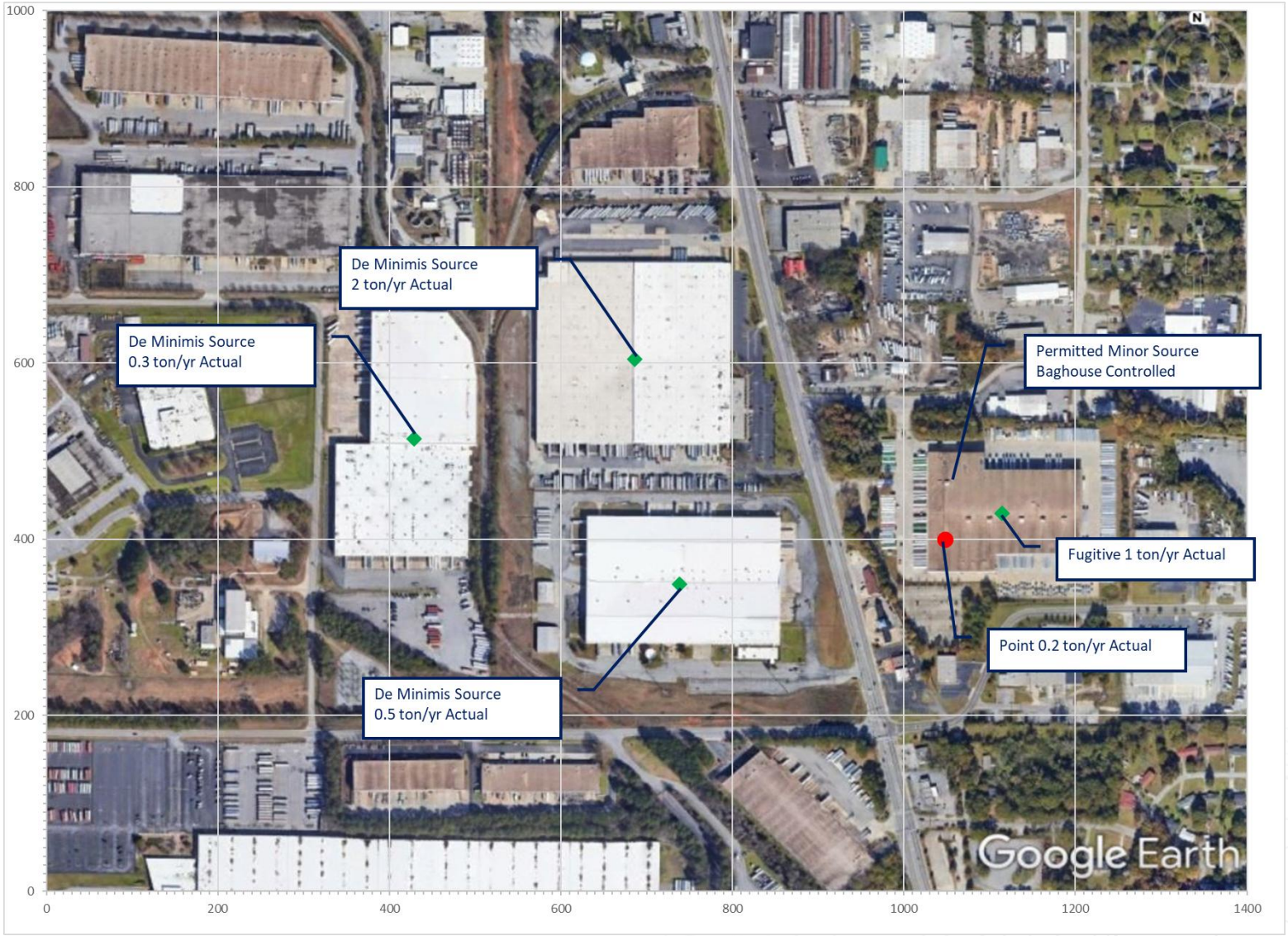
Source:www.aqmd.gov/home/air-quality/current-air-quality-data/aqi-information-and-faqs

Hyperlocal Air Monitoring Test Case



- Primary $PM_{2.5}$ Emissions
- Neighborhood Scale (0.5-4 km Range)

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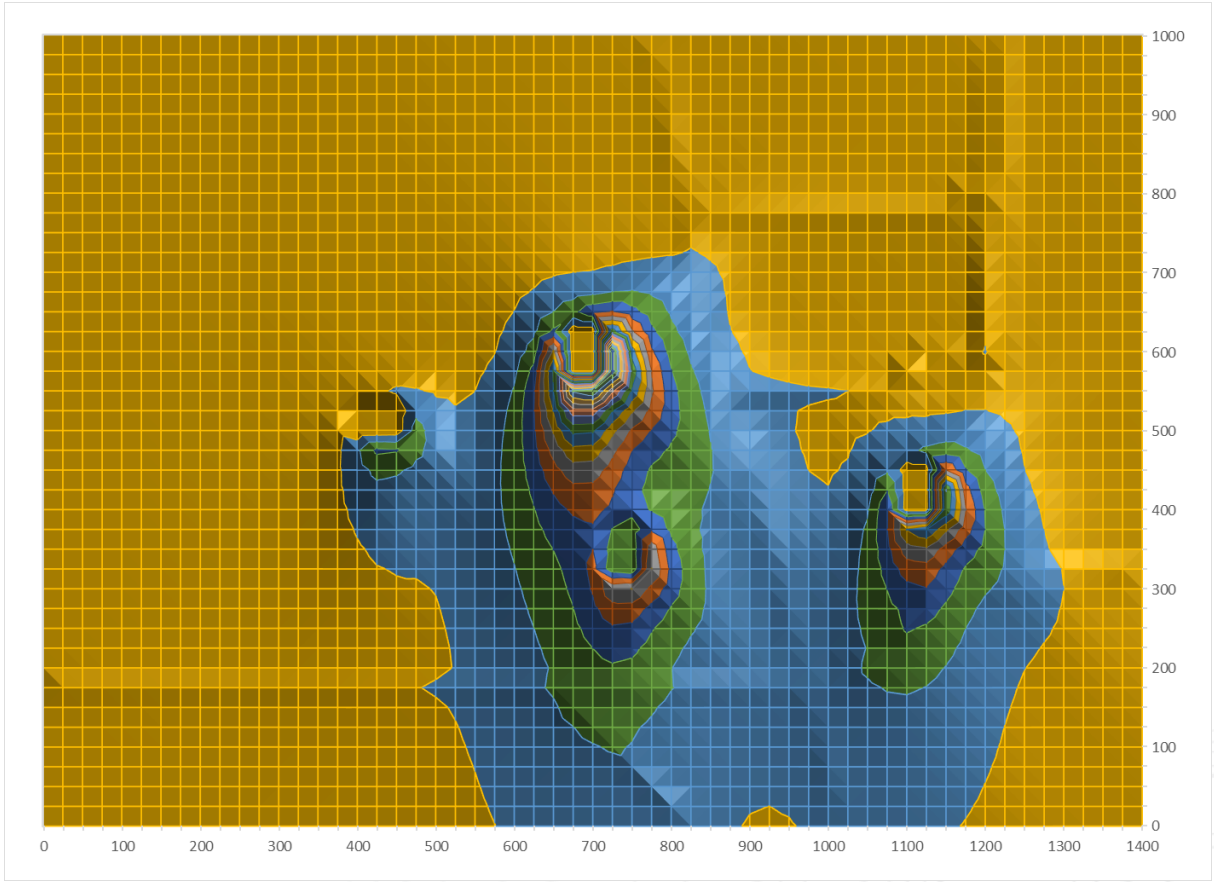
Hyperlocal Test Case-Actual Air Concentration Data



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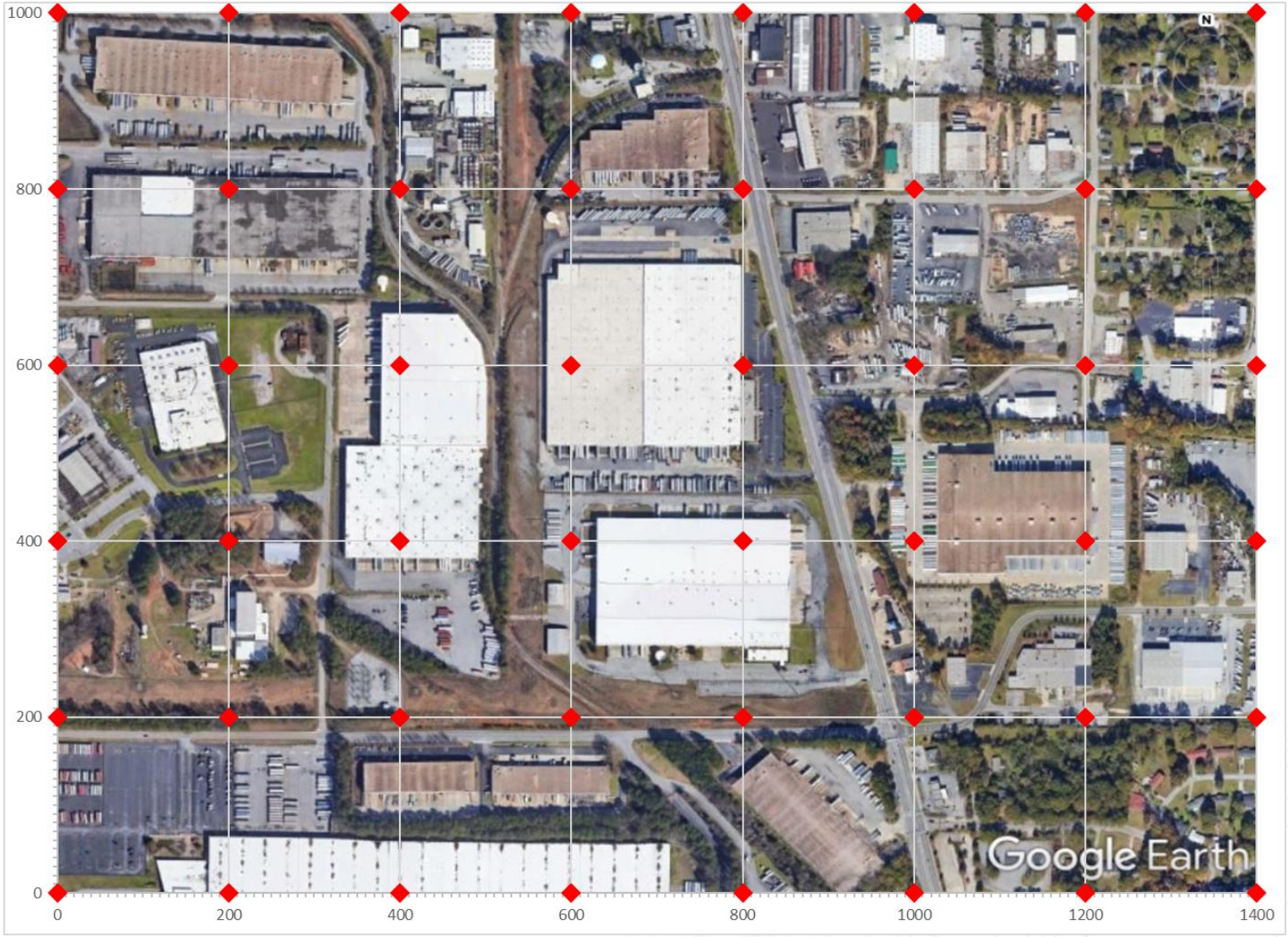
Hyperlocal Air Monitoring Test Case-200m Grid Sample



- Sample within domain on a 200m by 200m grid

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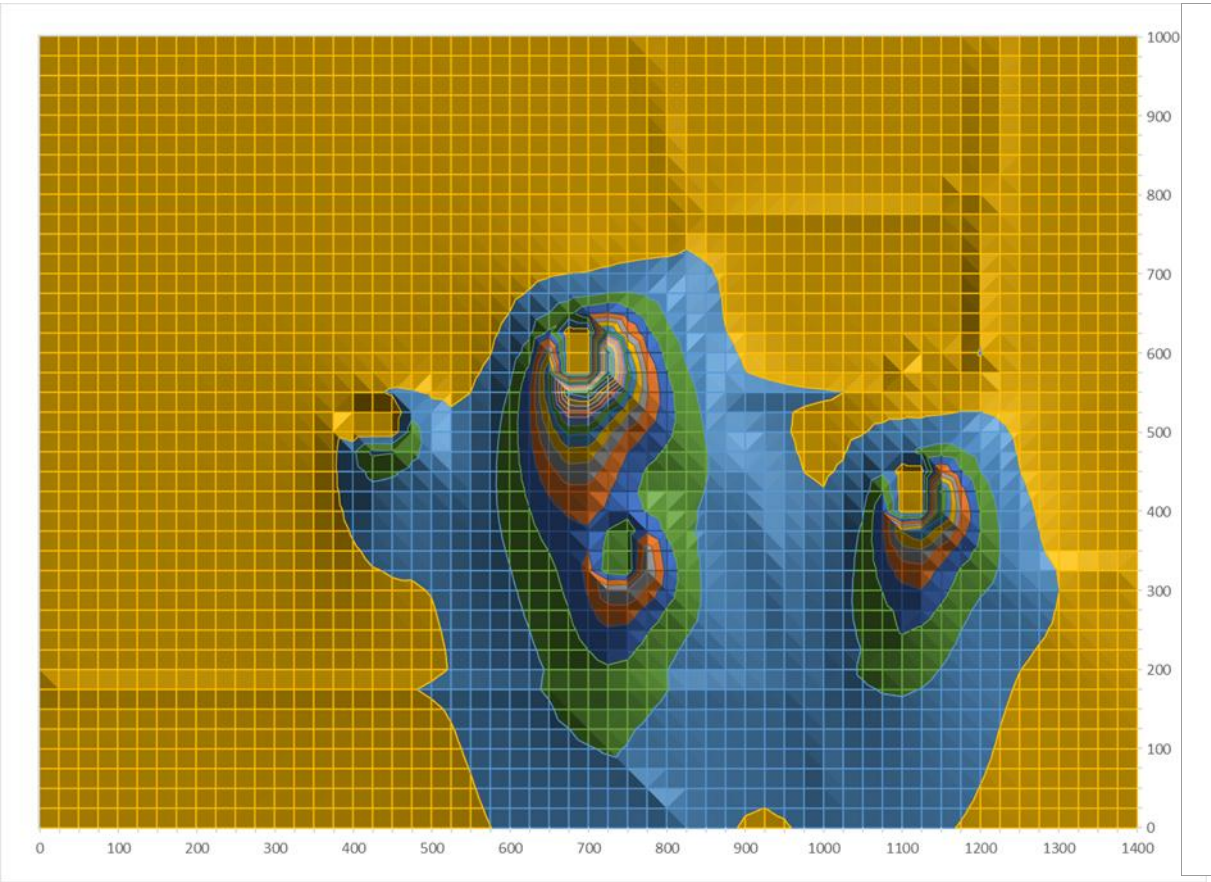
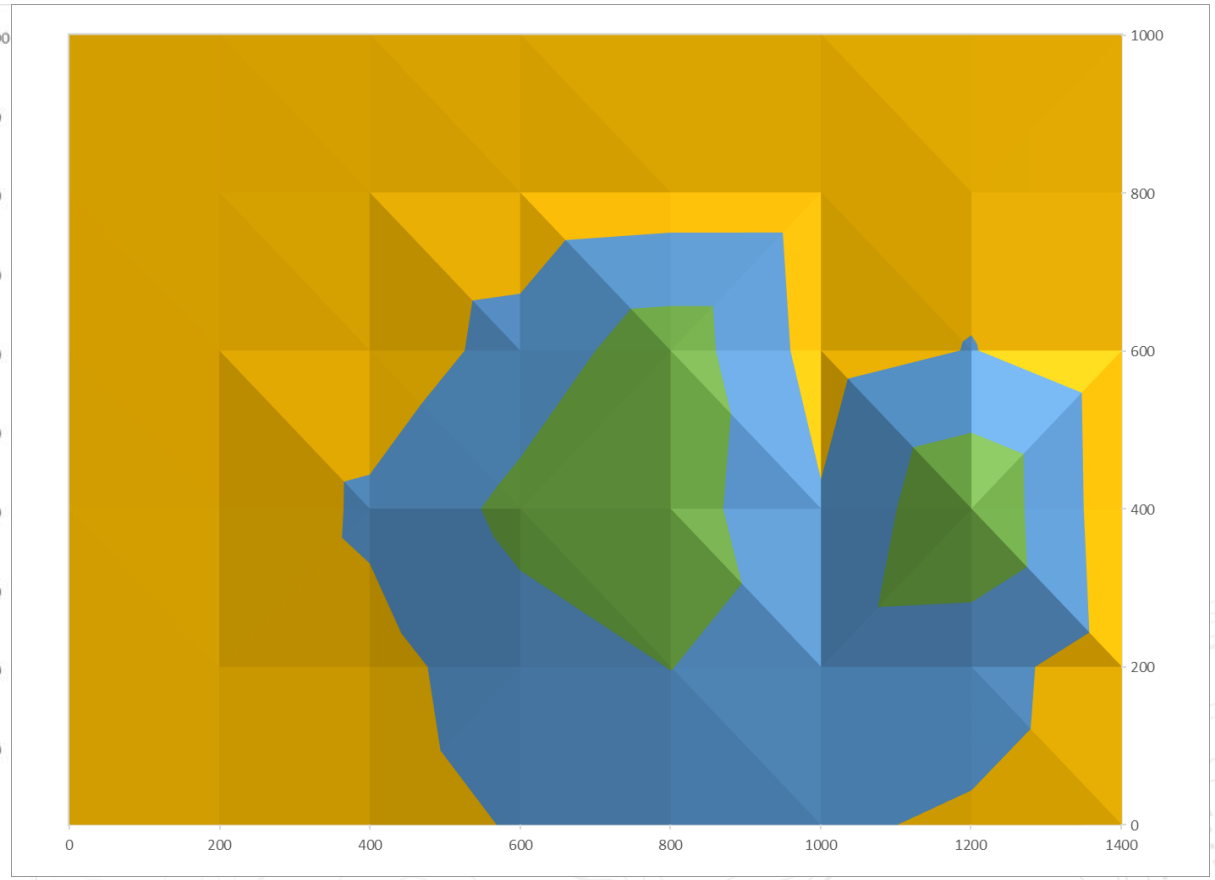
Grid Resolution Comparison – 200m Grid

Actual Concentration



200m Grid (48 sample locations)



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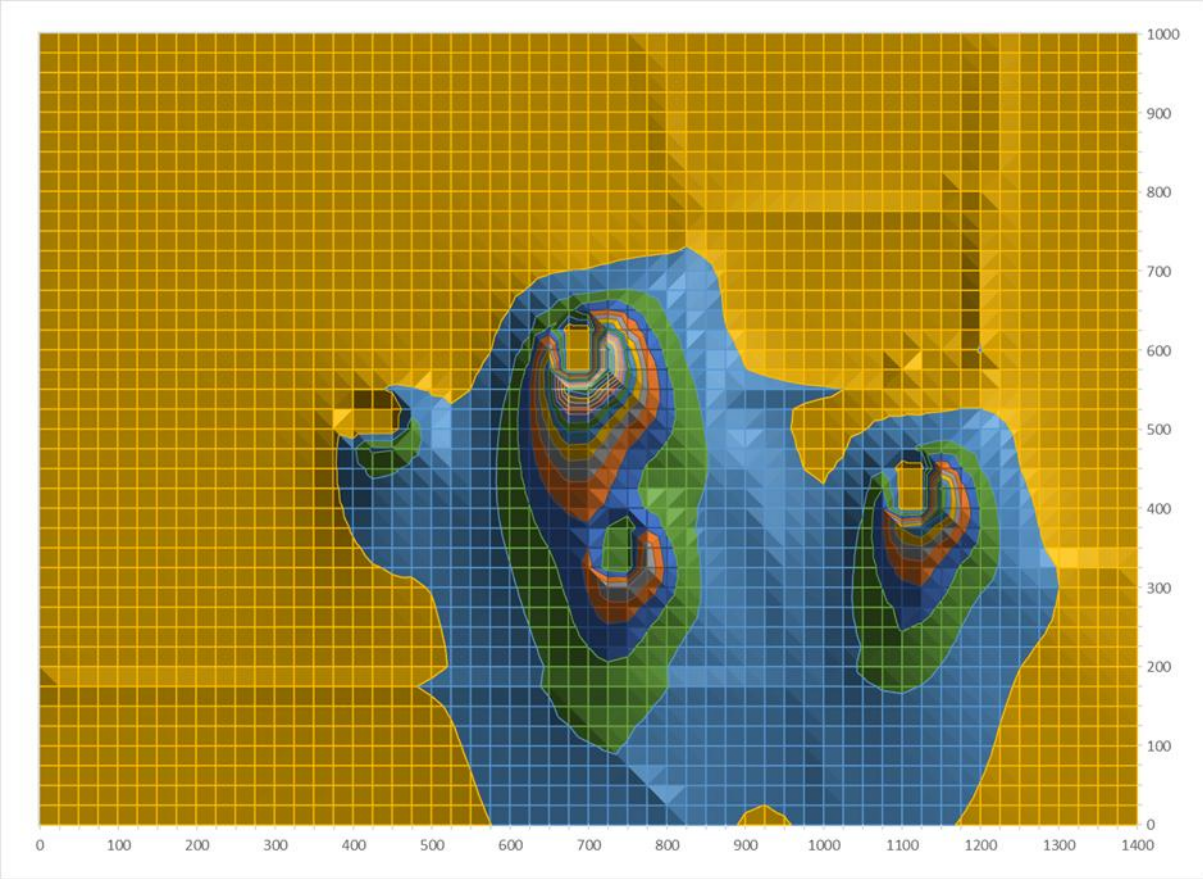
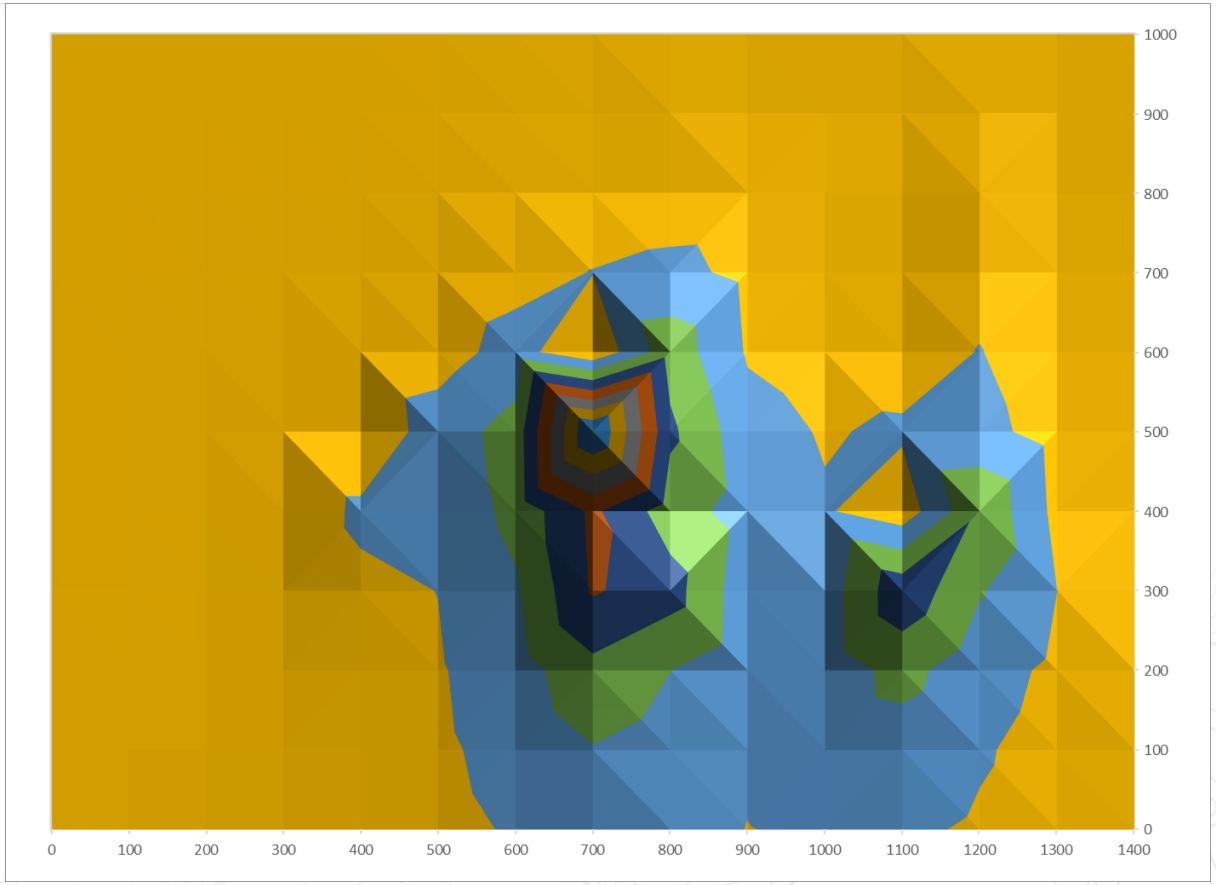
Grid Resolution Comparison – 100m Grid

Actual Concentration



100m Grid (180 sample locations)



½ grid size – 3.75 times more samples

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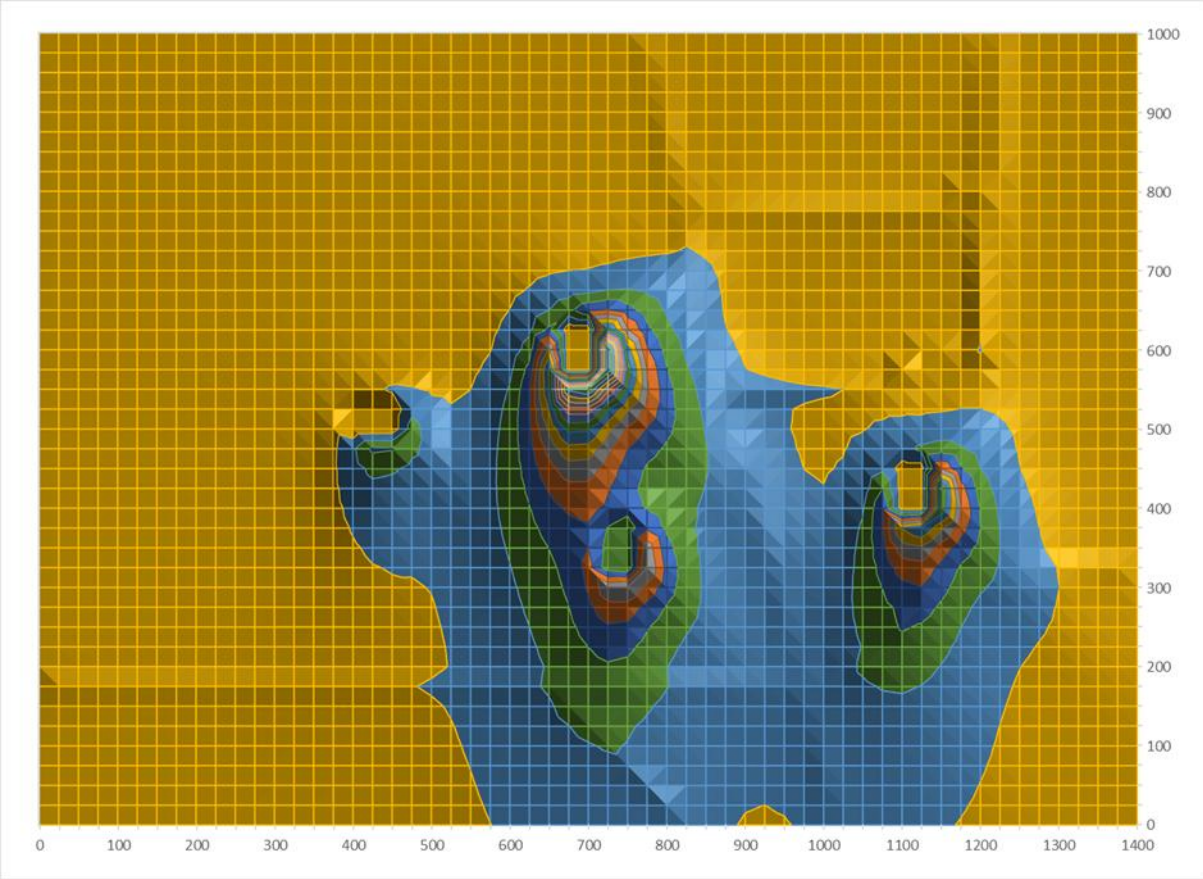
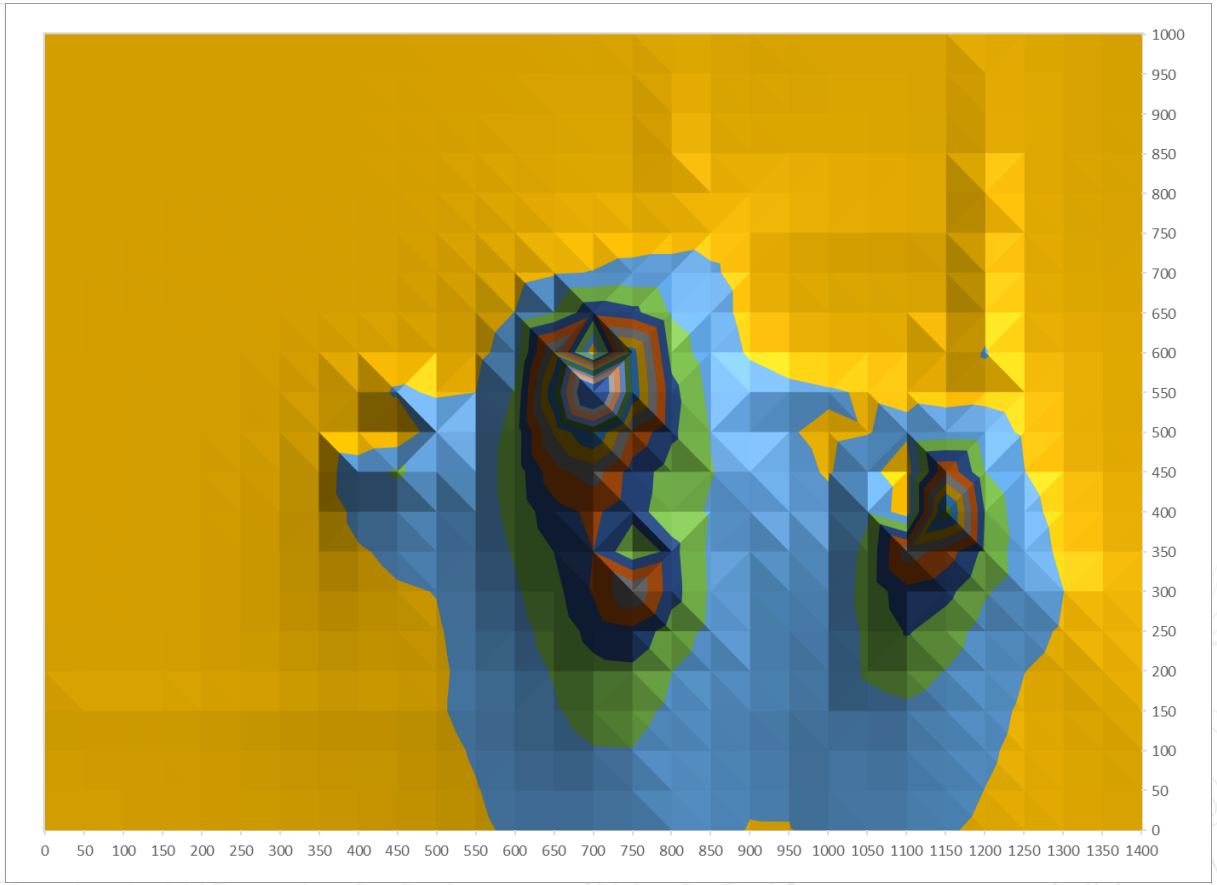
Grid Resolution Comparison – 50m Grid

Actual Concentration



50m Grid (580 sample locations)



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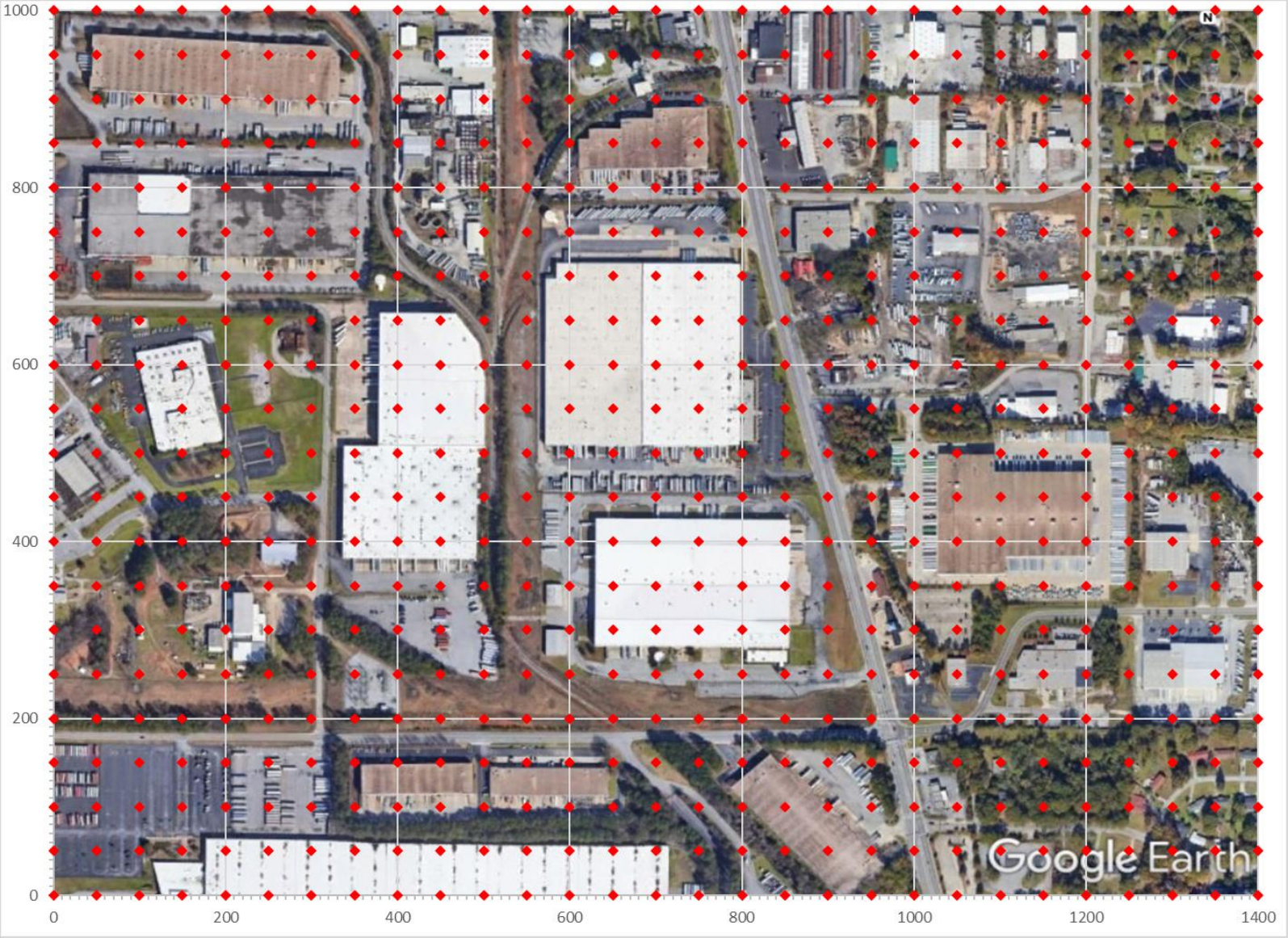
You may need a lot of samples!



- 50m by 50m grid sample
- Many (probably most) of the sites will:
  - Not allow proper siting
  - Lack access
- Stationary monitors not possible
  - Too many locations
  - Most locations not allow siting

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Possible solution-Mobile sampling

- Can be installed on:
  - Dedicated vehicles
  - Public transportation
  - Private delivery vehicles
- Likely need to be coupled with strategically placed stationary monitors
  - Fill in data gaps (no roads)
  - Depends on resolution needed
  - Necessary for validation
- Needs advanced analytics-compared to grid sampling

Source:ww2.arb.ca.gov/resources/documents/mobile-monitoring-research-studies

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Limitations of mobile sampling technology

Source:www.aqmd.gov/aq-spec/special-projects/mobile-sensors

What do you give up for multidimensional concentration data?

- Needs alternative monitoring techniques to fill in gaps (off-roads)
- High volume (high emission) roads could bias results
- Mobile monitors mounted on vehicles using combustion engines could bias
- Requires advanced analytics for accurate interpolation
- Sample data is not paired in time

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What can hyperlocal data be used for?
Evaluate peak concentration around known source

- Stationary source impact monitors are generally sited based on modeling
- May be differences between predicted and actual peak locations
- Land-use, access, etc. may not allow siting at max

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What can hyperlocal data be used for?
Locating unknown emission sources

- Elevated concentration contours in areas without documented sources may be an area of concern
- Can be used to quickly screen areas for possible permitting issues

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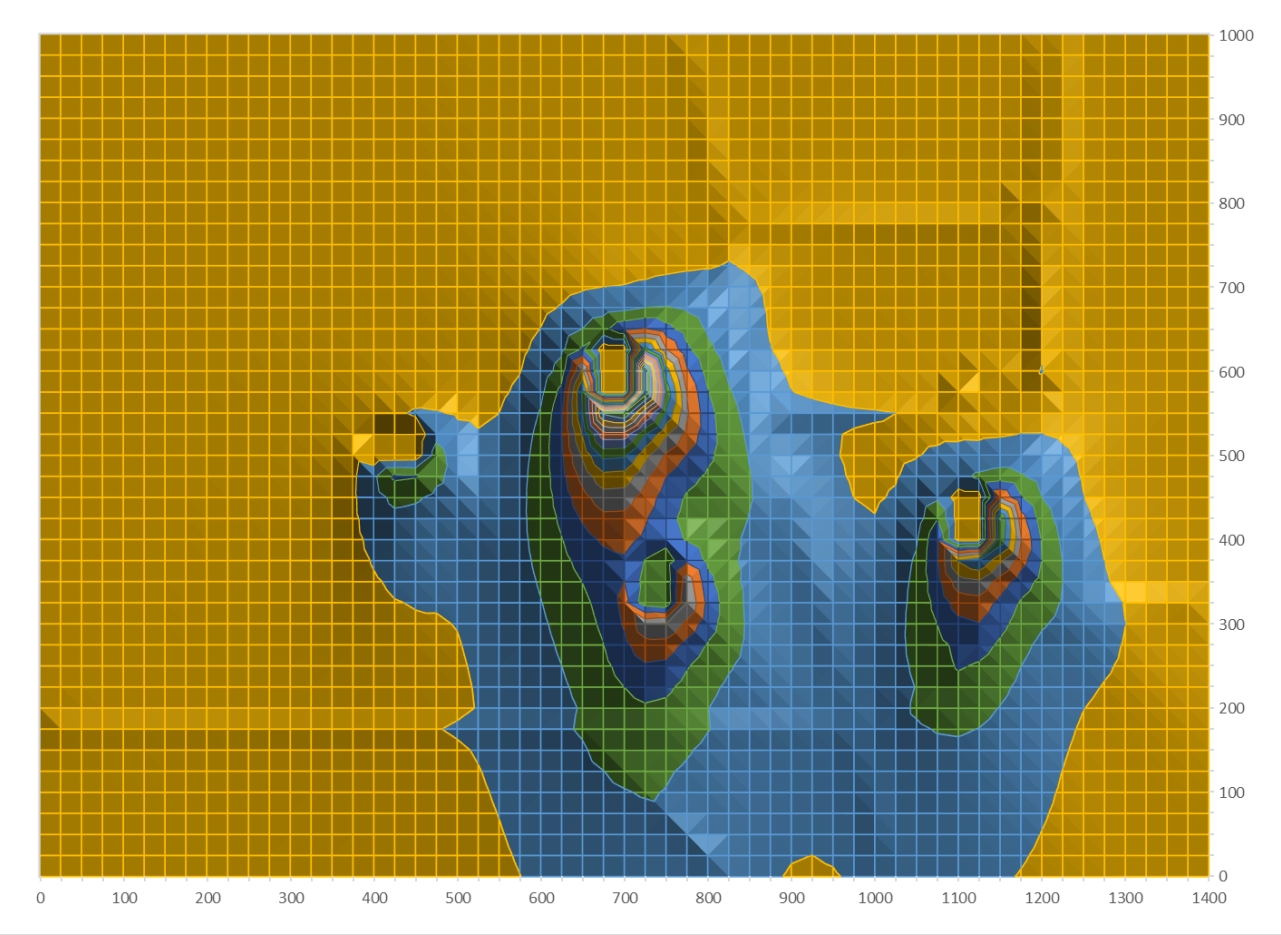
What can hyperlocal data be used for?
Estimate/verify emission estimates



Concentration profile and local meteorological data can be used to back calculate (model) source emissions

Models are generally accurate within a factor of 2, emissions are proportional to concentration

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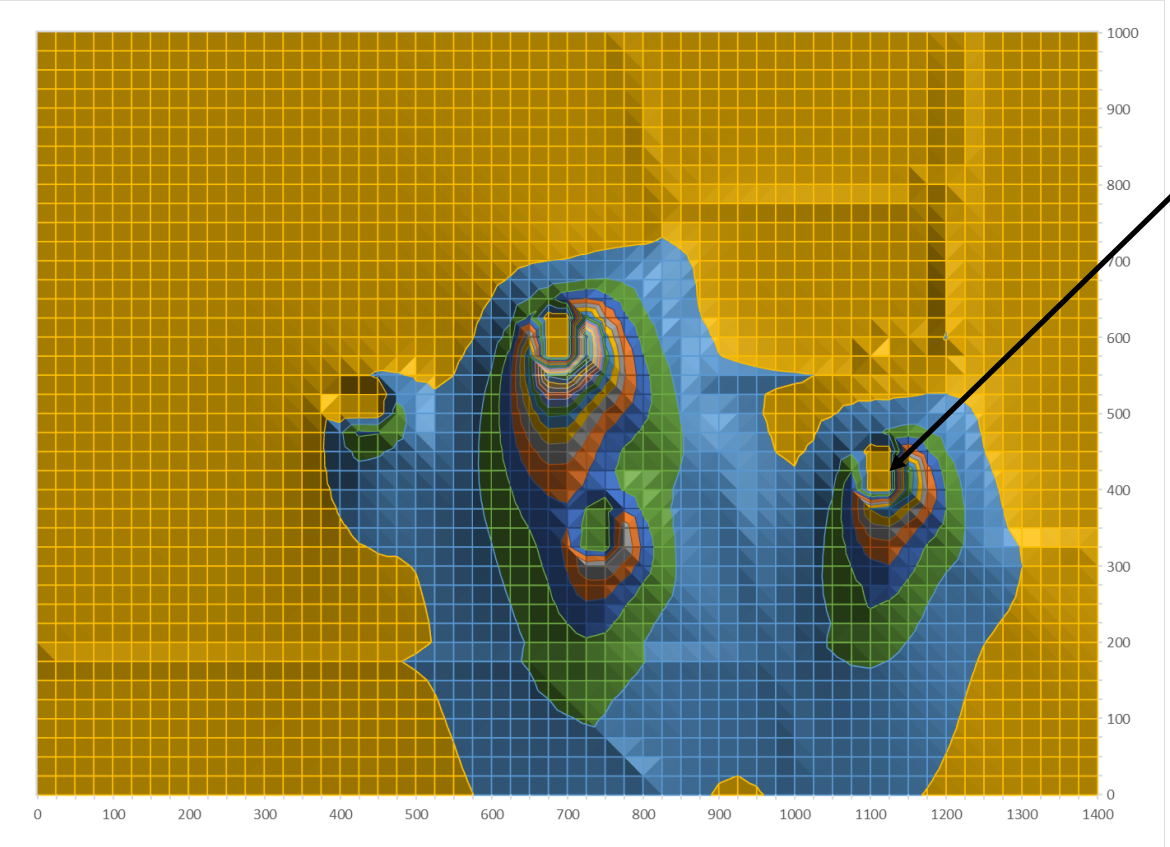
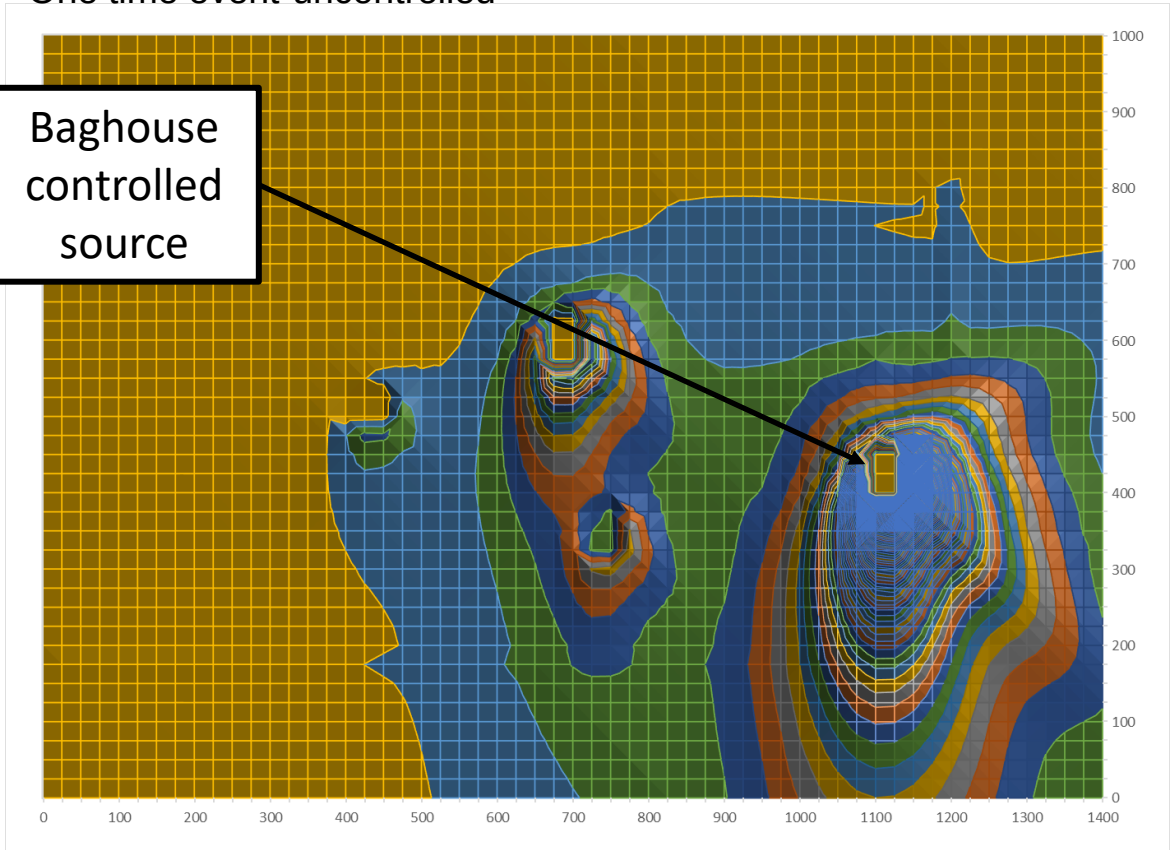
What can hyperlocal data be used for?
Control device verification

Typical-control device operating



One time event-uncontrolled



Short-term event with large change in concentration gradient around controlled source could indicate issue with control device or SSM event

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What can be done to protect?

- Evaluate and verify reported emission estimates for accuracy
- Ensure that De Minimis and unpermitted sources are properly permitted/classified and have been evaluated without controls
- Regular environmental compliance audits
- Small-scale low-cost hyperlocal air monitoring study around your facility

Pollutant	Averaging Period	NAAQS
CO	8-hour	9 ppm
CO	1-hour	35 ppm
Lead	Rolling 3-month	0.15 $\mu g/m^3$
NO_2	1-hour	100 ppb
NO_2	1-year	53 ppb
Ozone	8-hour	70 ppb
$PM_{2.5}$	1-year	12 $\mu g/m^3$
$PM_{2.5}$	24-hour	35 $\mu g/m^3$
PM_{10}	24-hour	150 $\mu g/m^3$
SO_2	1-hour	75 ppb

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Conclusion

- Low cost air pollution monitors are making hyperlocal air quality monitoring possible on a large scale
- Much of the data collected will have significant limitations for certain applications.
- Ensure that compliance/ emissions data is accurate and properly reported
- Consider conducting a small-scale low-cost study to estimate your potential exposure to hyperlocal air monitoring

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Contact

- Joseph Stolle, PE, Senior Environmental Engineer

  Mobile: 620.252.9033

  jstolle@geoengineers.com

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