Surveying Air-borne Mercury at the Landscape Level

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What is the objective of this study?

- **Test as many sites as possible at various locations within a landscape.**
- **We are not trying to obtain precise measures of Hg in the air; but looking for an indexed value.**
- **Looking for locations that are consistently impacted by relatively high or low concentrations of air-borne Hg over long periods of exposure.**

How is air-borne Hg detected?

- **We are testing the feasibility of using an inexpensive passive monitor.**
  - **Made out of plastic petri plates poured with "tangle trap."**
  - **Cost about $1 each maximum**
  - **Much less expensive than the more precise passive samplers on the market which may cost as much as $250 each.**

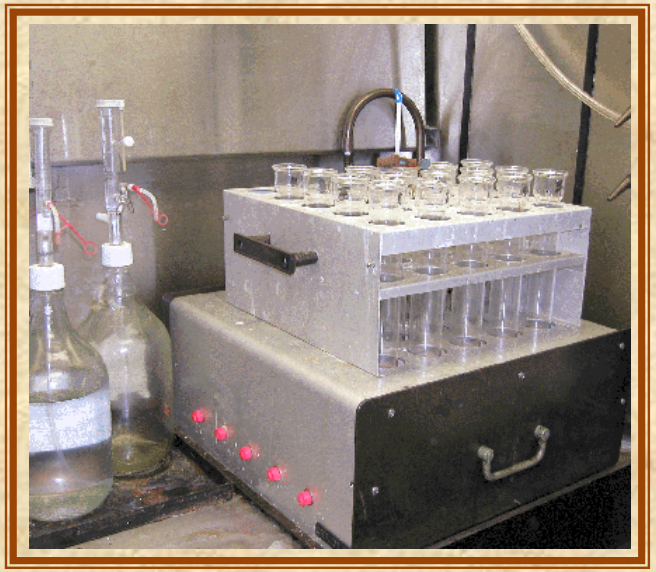
What are the limitations?

- **Does not capture a complete sample of air-borne Hg.**
  - **Each monitor collects dust, insects, Hg vapor, suspended wet and dry particulates and other air-borne materials in the a gelatinous “tangle trap matrix.**
  - **Wet particulate and dissolved Hg is underestimated for heavy precipitation events due to overflow.**
  - **Sample periods vary from 4 to 10 months and are at different times during the year. There would be no expectation for the conditions to be the same.**
  - **Therefore, concentration data (even on an amount per unit area per month basis) are not directly comparable**

Analyzing the Plates for Hg

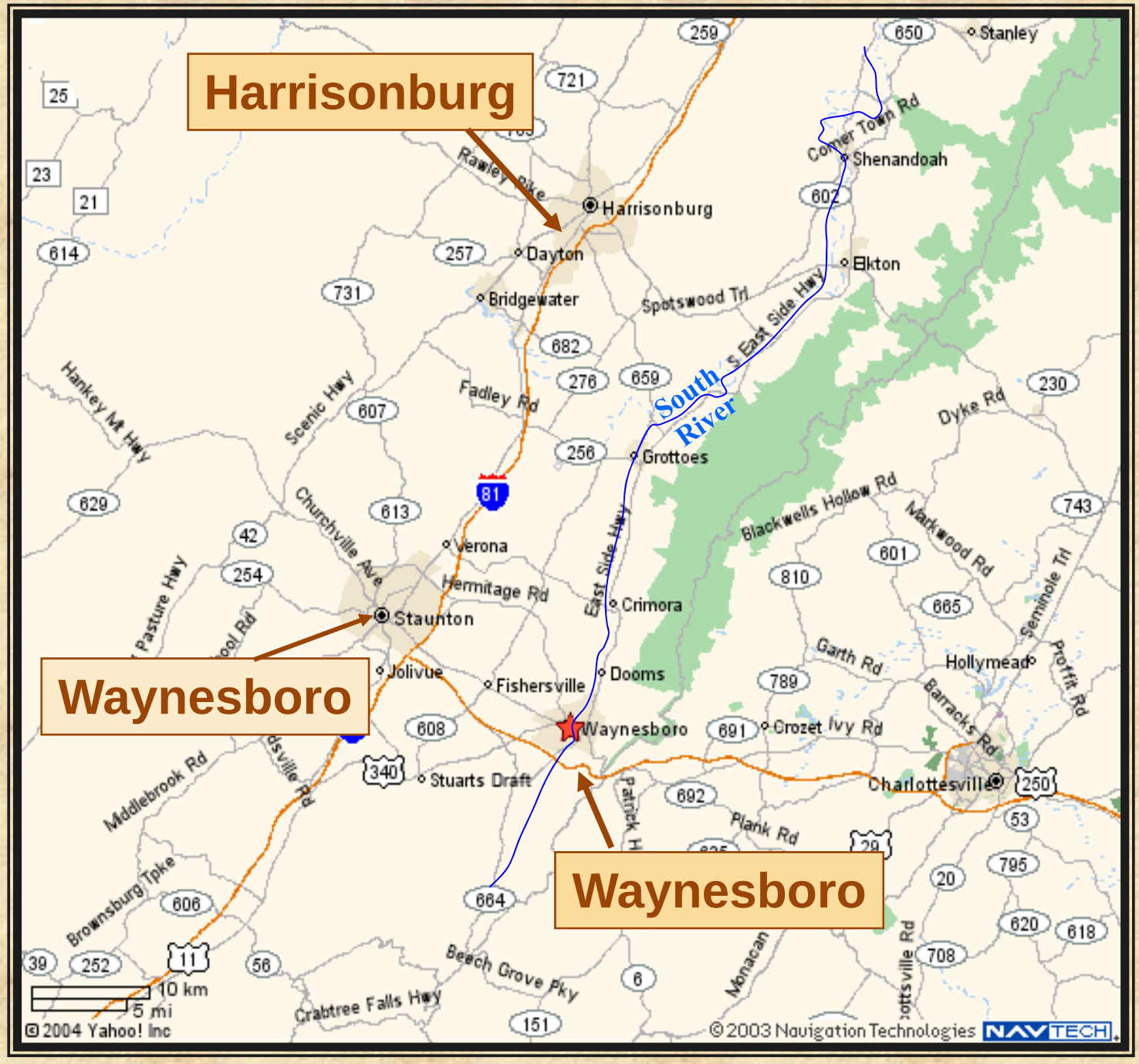
- **The gelatinous material is scraped from the plate and digested with hot concentrated nitric and sulfuric acid using a LabConco digestion block.**
- **The sample digestate is poured into snap top vials, brought to 50 ml volume and refrigerated until analysis.**

(usually the same day)



Mercury analysis at JMU

- **Perkin Elmer FIMS Flow Injection Mercury System coupled with a cold vapor atomic absorption spectrophotometer.**
- **Cost is much lower than a commercial laboratory.**
  - **For example: Data from100 locations with a pair of monitors at each cost less than $500 in comparison with about $50,000 initial cost for that many commercial samplers plus up to $10,000 more for analyses. (120X the cost plus much higher maintenance and potential for vandalism)**


Harrisonburg
Waynesboro
Waynesboro
South River
Harrisonburg
Dayton
Bridgewater
Spotswood Trl
Elkton
Shenandoah
Stanley
Corner Town Rd
Rawley Pike
Fadley Rd
Scenic Hwy
Hankey Mt Hwy
Grottoes
Verona
Churchville Ave
Hermitage Rd
Staunton
Jolivue
Fishersville
Dooms
Crimora
East Side Hwy
Blackwells Hollow Rd
Markwood Rd
Dyke Rd
Seminole Trl
Proffit Rd
Hollymead
Garth Rd
Barracks Rd
Crozet
Ivy Rd
Charlottesville
Plank Rd
Middlebrook Rd
Brownsburg Tpke
Stuarts Draft
Beach Grove Pky
Crabtree Falls Hwy
Monacan
10 km
5 mi
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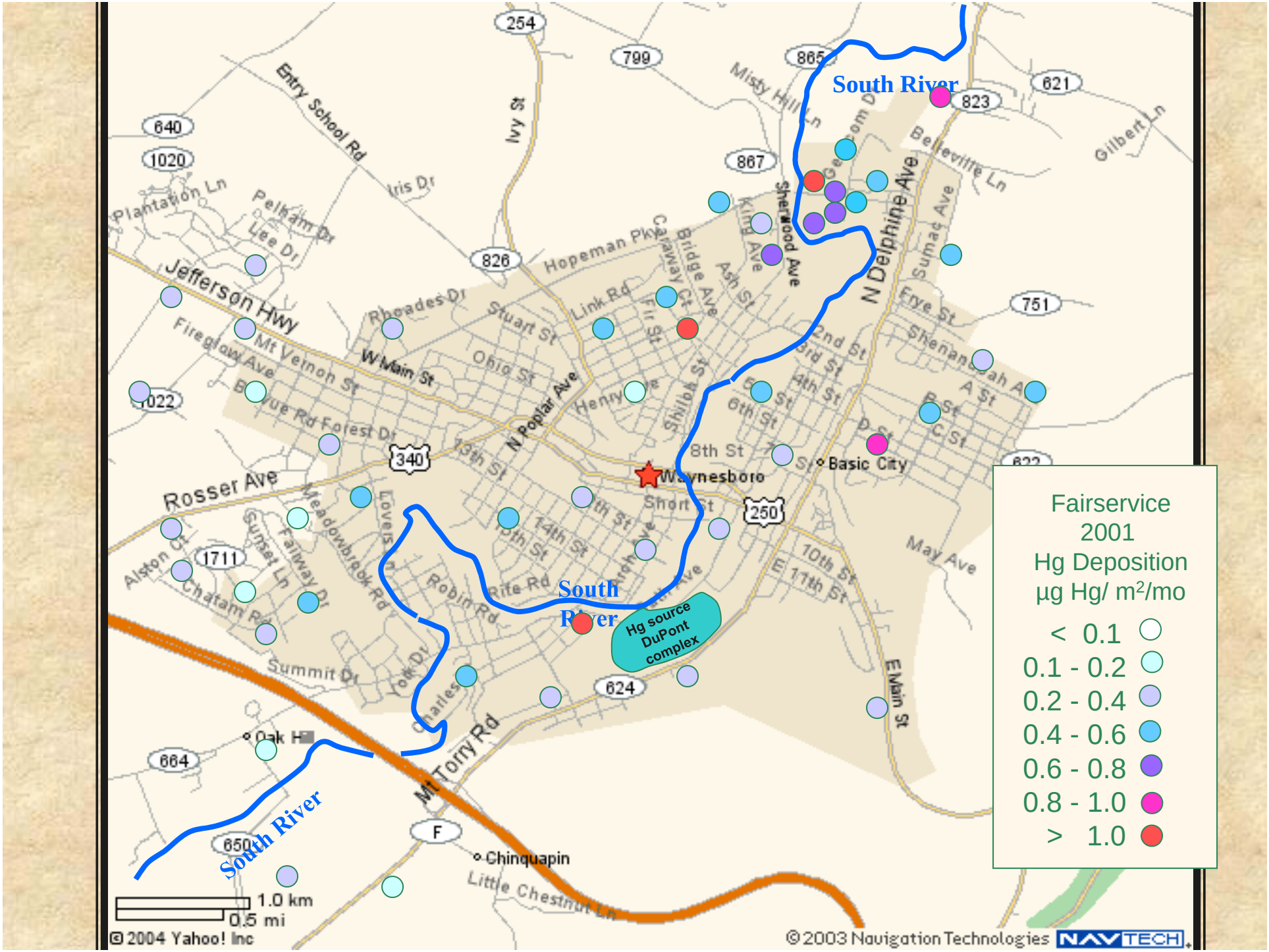
We have surveyed Waynesboro during three different time periods.

- Here are two examples of the actual measures of Hg captured in the plates


Fairservice
2001
Hg Deposition
µg Hg/ m²/mo
< 0.1
0.1 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
> 1.0
South River
South River
South River
Hg source
DuPont
complex
Waynesboro
Basic City
Chinquapin
Oak Hall
Jefferson Hwy
Rosser Ave
Mt Torry Rd
N Delphine Ave
W Main St
E Main St
Hopeman Pky
Rhoades Dr
Stuart St
Ohio St
Link Rd
Bridge Ave
Ash St
King Ave
Sherwood Ave
Frye St
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Iris Dr
Plantation Ln
Pelham Dr
Lee Dr
Fireglow Ave
Mt Vernon St
Forest Dr
N Poplar Ave
Henry St
Shiloh St
13th St
14th St
Meadowbrook Rd
Fairway Dr
Sunset Ln
Alston Ct
Chatam Rd
Robin Rd
Rite Rd
Summit Dr
Oak Dr
Charles St
Little Chestnut Ln
Missy Hill Ln
Belleville Ln
Sumac Ave
Gilbert Ln
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867
826
823
621
751
340
250
624
F
1.0 km
0.5 mi
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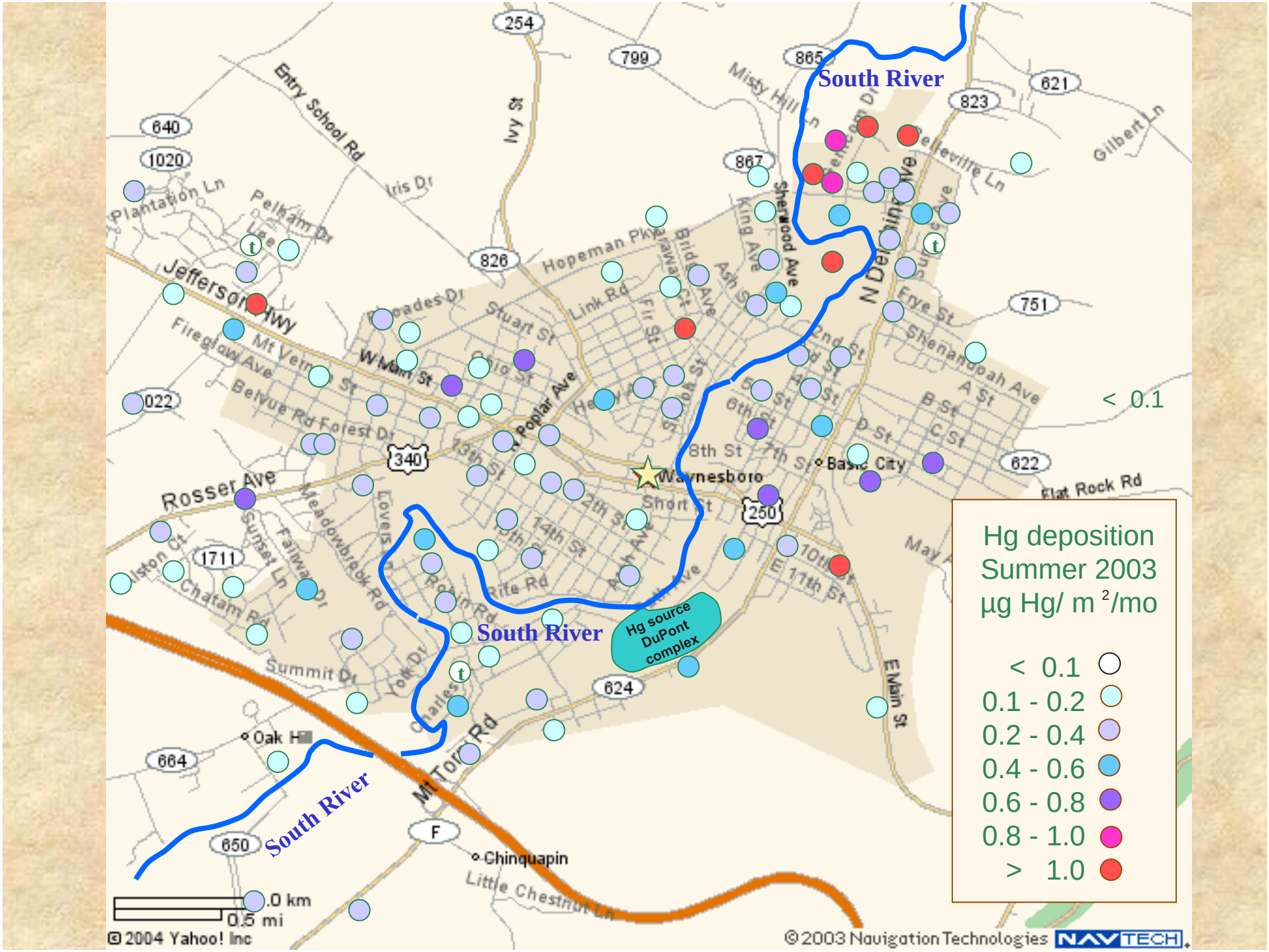
South River
South River
South River
Hg source DuPont complex
Waynesboro
Basic City
Chinquapin
Oak Hill
Hopeman Pky
Jefferson Hwy
Rosser Ave
Mt Torrey Rd
Summit Dr
Link Rd
Ivy St
Entry School Rd
Iris Dr
Plantation Ln
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Fireglow Ave
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May Ave
Meadowbrook Rd
Lovers Ln
Sunset Ln
Fairway Dr
Alston Ct
Chatam Rd
Rite Rd
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York Dr
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1711
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F
0.0 km
0.5 mi
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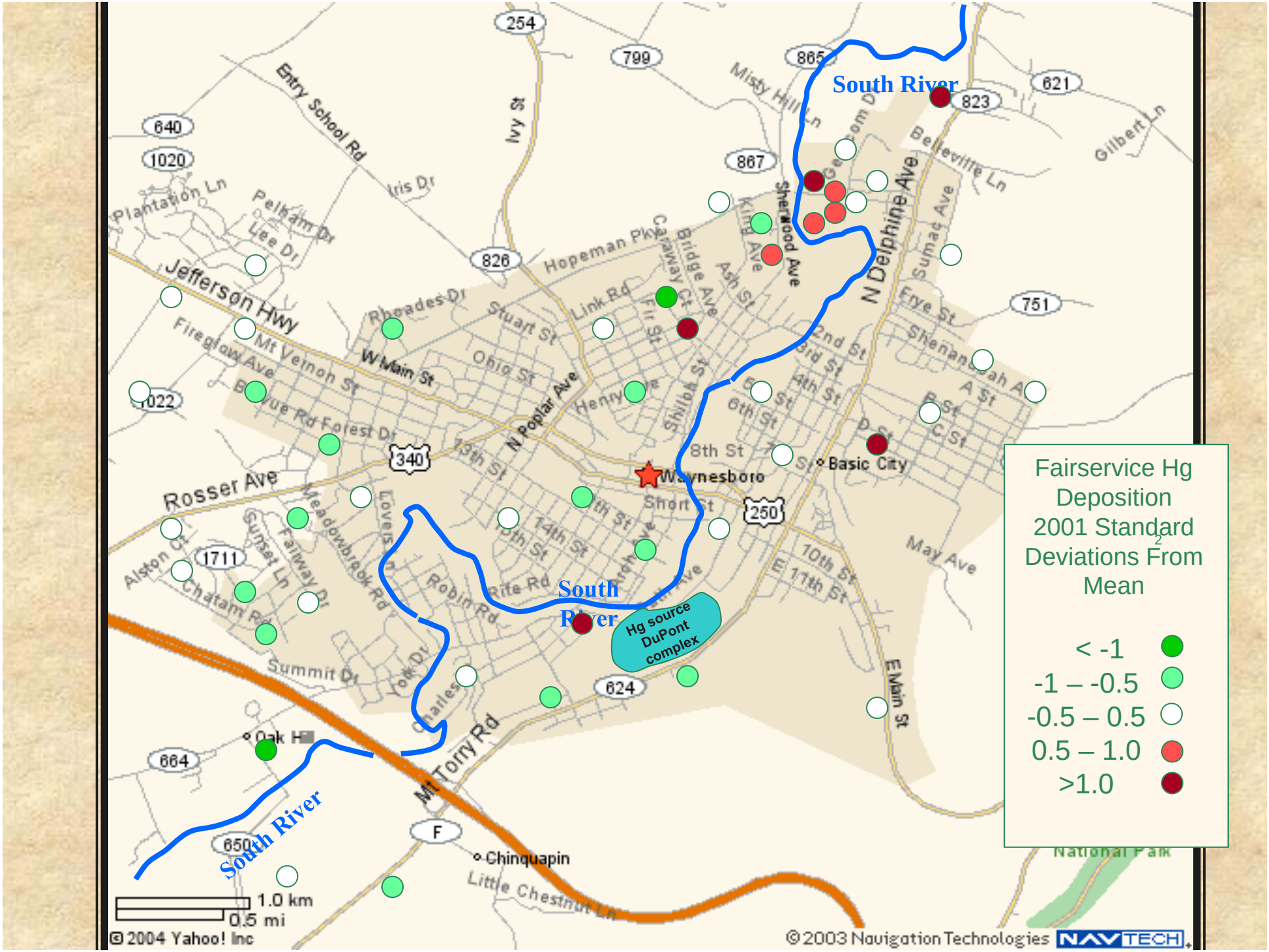
Hg deposition
Summer 2003
µg Hg/ m 2/mo
< 0.1
0.1 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
> 1.0

In order to compare the data from different years, the grand mean during the sample period of all stations was determined.

- The standard deviation was calculated and then the individual sites were ranked to identify locations above and below the mean.


Fairservice Hg Deposition 2001 Standard Deviations From Mean
< -1
-1 – -0.5
-0.5 – 0.5
0.5 – 1.0
>1.0
South River
Hg source DuPont complex
Waynesboro
Basic City
Chinquapin
Oak Hill
Jefferson Hwy
Rosser Ave
Mt Torry Rd
W Main St
E Main St
N Delphine Ave
N Poplar Ave
May Ave
Summit Dr
Rite Rd
Robin Rd
Short St
Link Rd
Hopeman Pky
Entry School Rd
Ivy St
Missy Hill Ln
Belleville Ln
Gilbert Ln
Sherwood Ave
Bridge Ave
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Rhoades Dr
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Fireglow Ave
Forest Dr
Meadowbrook Rd
Fairway Dr
Sunset Ln
Chatam Rd
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Little Chestnut Ln
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1711
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624
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650
F
1.0 km
0.5 mi
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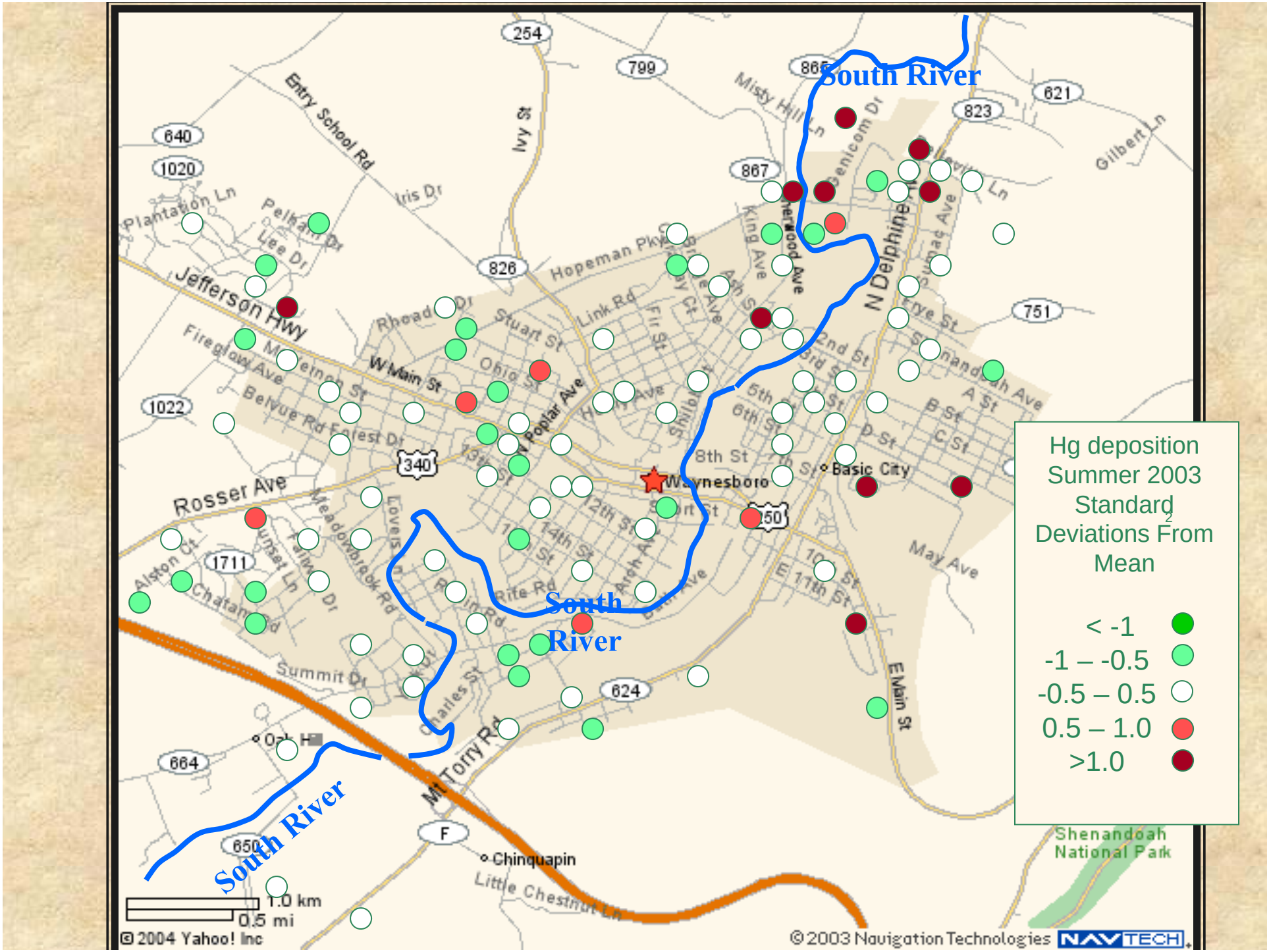
South River
South River
South River
Hg deposition
Summer 2003
Standard
2
Deviations From
Mean
< -1
-1 – -0.5
-0.5 – 0.5
0.5 – 1.0
>1.0
Waynesboro
Basic City
Chinquapin
Oak Hill
Shenandoah
National Park
Jefferson Hwy
W Main St
Rosser Ave
N Delphine
E Main St
Mt Torry Rd
Summit Dr
Rhoad Dr
Stuart St
Ohio St
Link Rd
Hopeman Pkwy
Entry School Rd
Ivy St
Misty Hill Ln
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Gilbert Ln
Plantation Ln
Pelham Dr
Lee Dr
Iris Dr
Fireglow Ave
Belvue Rd
Forest Dr
Meadowbrook Rd
Lovers Ln
Alston Ct
Chatam Rd
Sunset Ln
Palm Dr
Rite Rd
Rolling Rd
Charles St
Little Chestnut Ln
Sherwood Ave
King Ave
Poplar Ave
Shiloh Ave
Birch Ave
Bell Ave
Fir St
Ash St
Hickory Ct
Hickory Ave
Locust Ave
Oak Ave
Maple Ave
Pine Ave
Cherry Ave
Willow Ave
Spruce St
Frye St
Shenandoah Ave
May Ave
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1.0 km
0.5 mi
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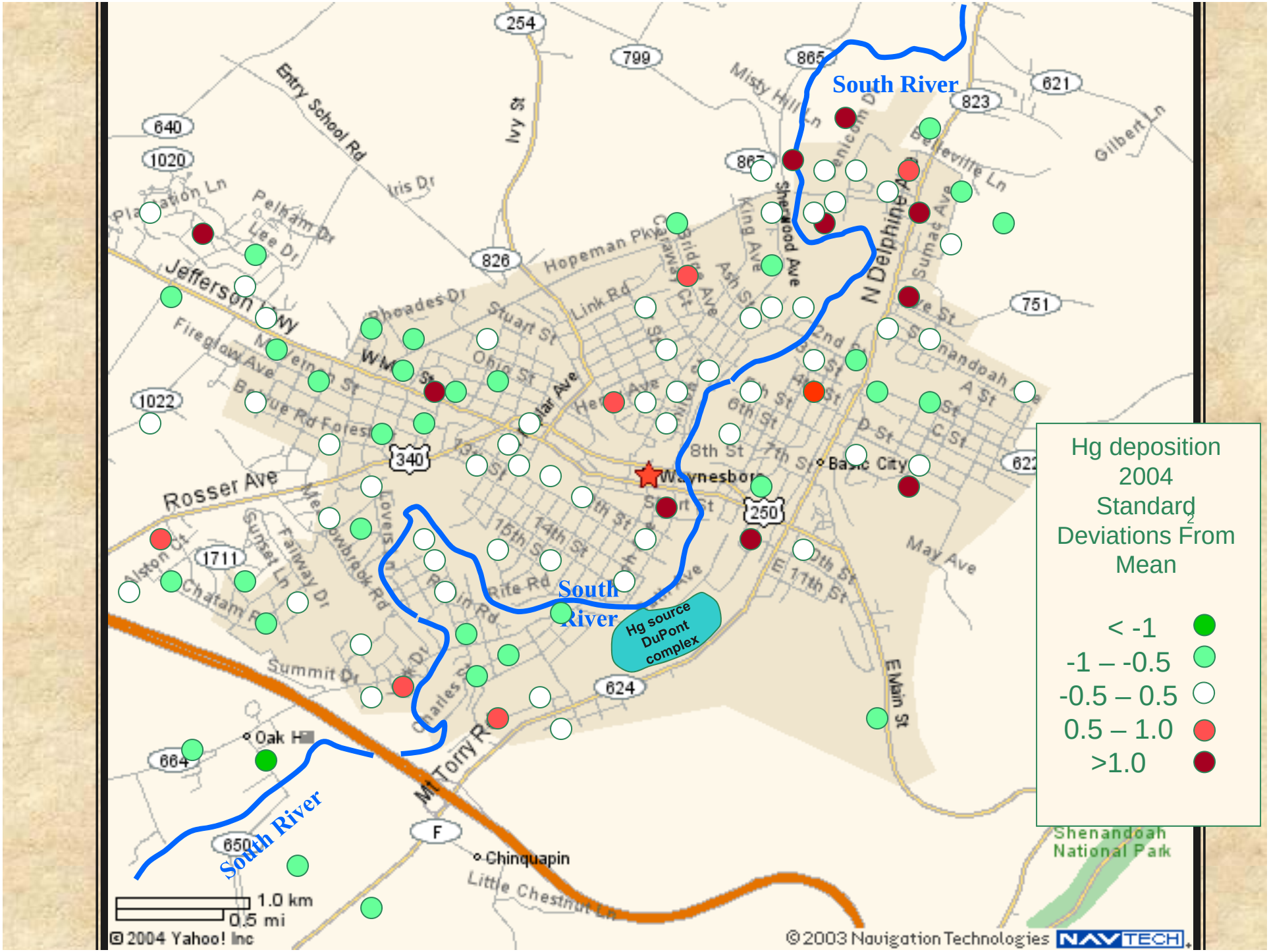
Hg deposition
2004
Standard
Deviations From
Mean
< -1
-1 – -0.5
-0.5 – 0.5
0.5 – 1.0
>1.0
South River
South River
South River
Hg source
DuPont
complex
Waynesboro
Basic City
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Shenandoah
National Park
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Mt Torry Rd
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Pelham Dr
Lee Dr
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Ohio St
Rhoades Dr
Fairway Dr
Sunset Ln
Chatam Pl
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Rife Rd
Robin Rd
Charles Dr
Missy Hill Ln
Belleville Ln
Gilbert Ln
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Crawley Ct
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1.0 km
0.5 mi
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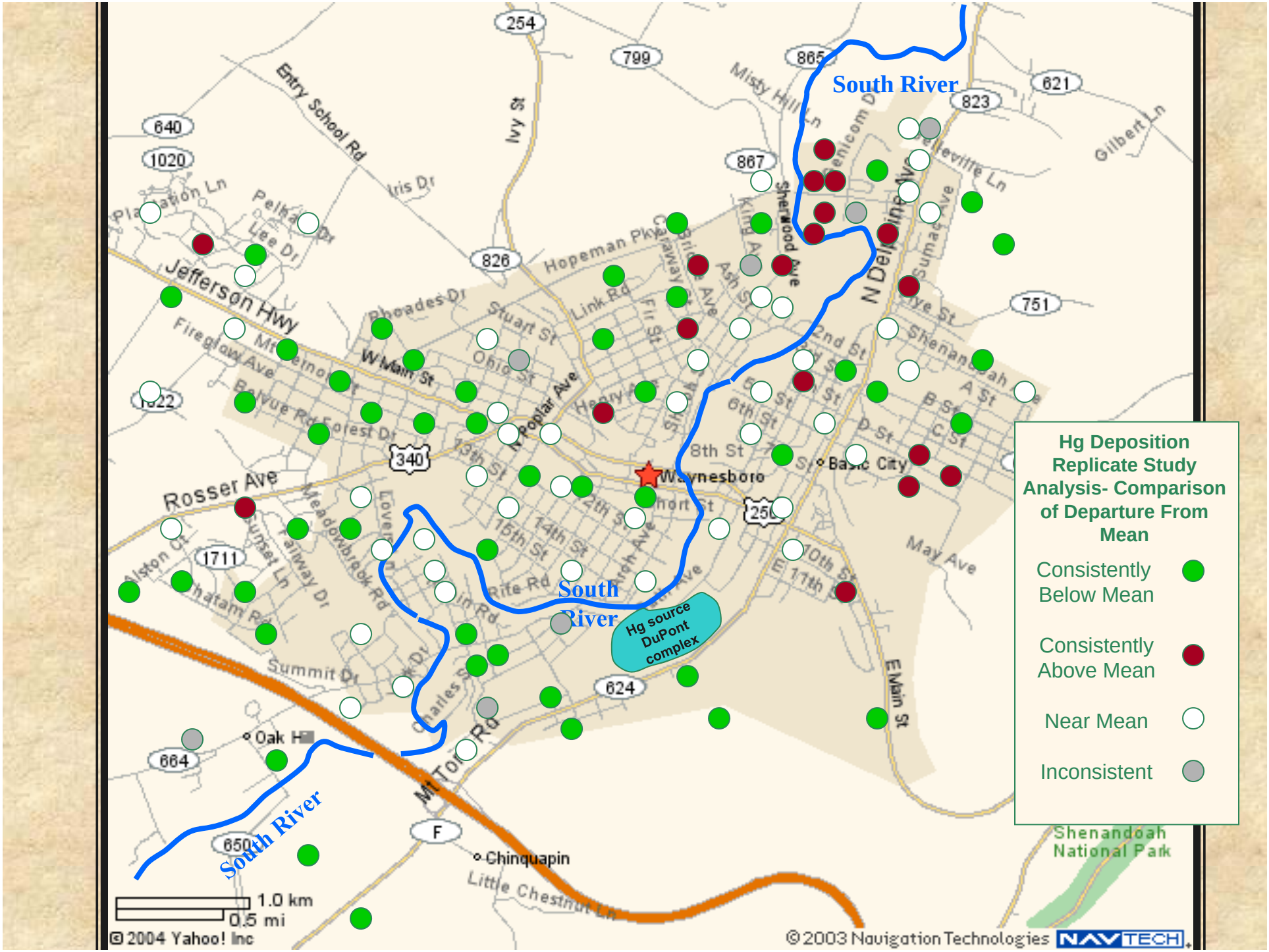
The data from the three years were then sorted by their relative deviations above and below the grand means in each sample period.


Hg Deposition Replicate Study Analysis- Comparison of Departure From Mean
Consistently Below Mean
Consistently Above Mean
Near Mean
Inconsistent
South River
Hg source DuPont complex
Waynesboro
Basic City
Oak Hill
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Gilbert Ln
Missy Hill Ln
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14th St
15th St
Short St
Rite Rd
Meadowbrook Rd
Railway Dr
Sunset Ln
Alston Ct
Chatam Rd
Charles St
Birch Ave
Ash St
Fir St
Briarwood Ave
King Ave
Venicom Dr
Belleville Ln
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867
826
621
823
751
250
624
F
1.0 km
0.5 mi
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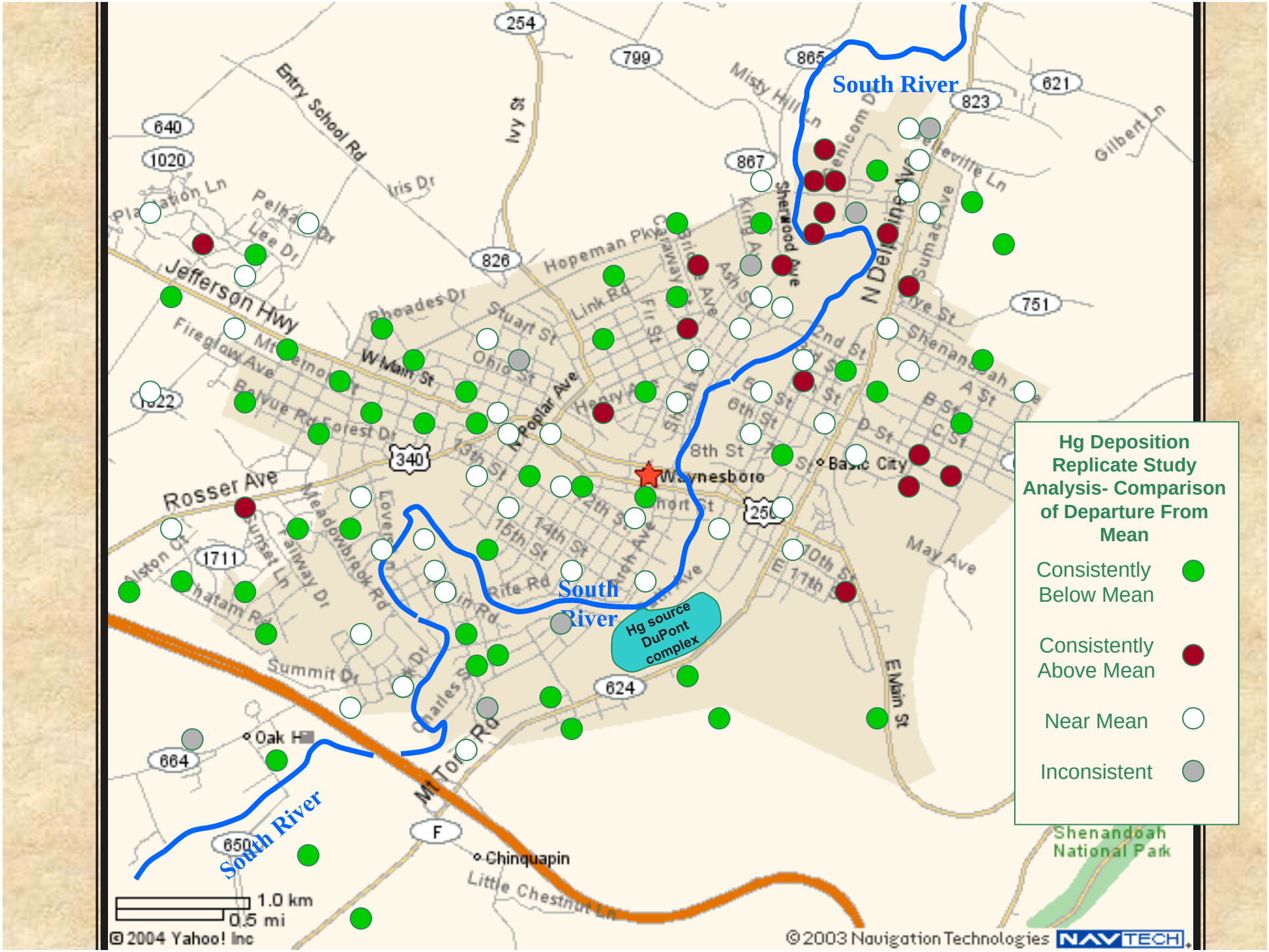
What does this imply?

- There are some locations, particularly those along the South River in the vicinity of Hopeman Parkway that appear to consistently have higher air-borne Hg levels
- There are a few other areas of interest.
- Many areas appear to have considerably lower amounts of air-borne Hg.
- The pattern does not appear to be random


Hg Deposition Replicate Study Analysis- Comparison of Departure From Mean
Consistently Below Mean
Consistently Above Mean
Near Mean
Inconsistent
South River
Hg source DuPont complex
Waynesboro
Basic City
Oak Hill
Chinquapin
Shenandoah National Park
Jefferson Hwy
Rosser Ave
Summit Dr
Mt Torrey Rd
Little Chestnut Ln
N Delphine Ave
E Main St
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Meadowbrook Rd
Railway Dr
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Birch Ave
Ash St
Fir St
Briarwood Ave
King Ave
Venicom Dr
Belleville Ln
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621
823
751
250
624
F
1.0 km
0.5 mi
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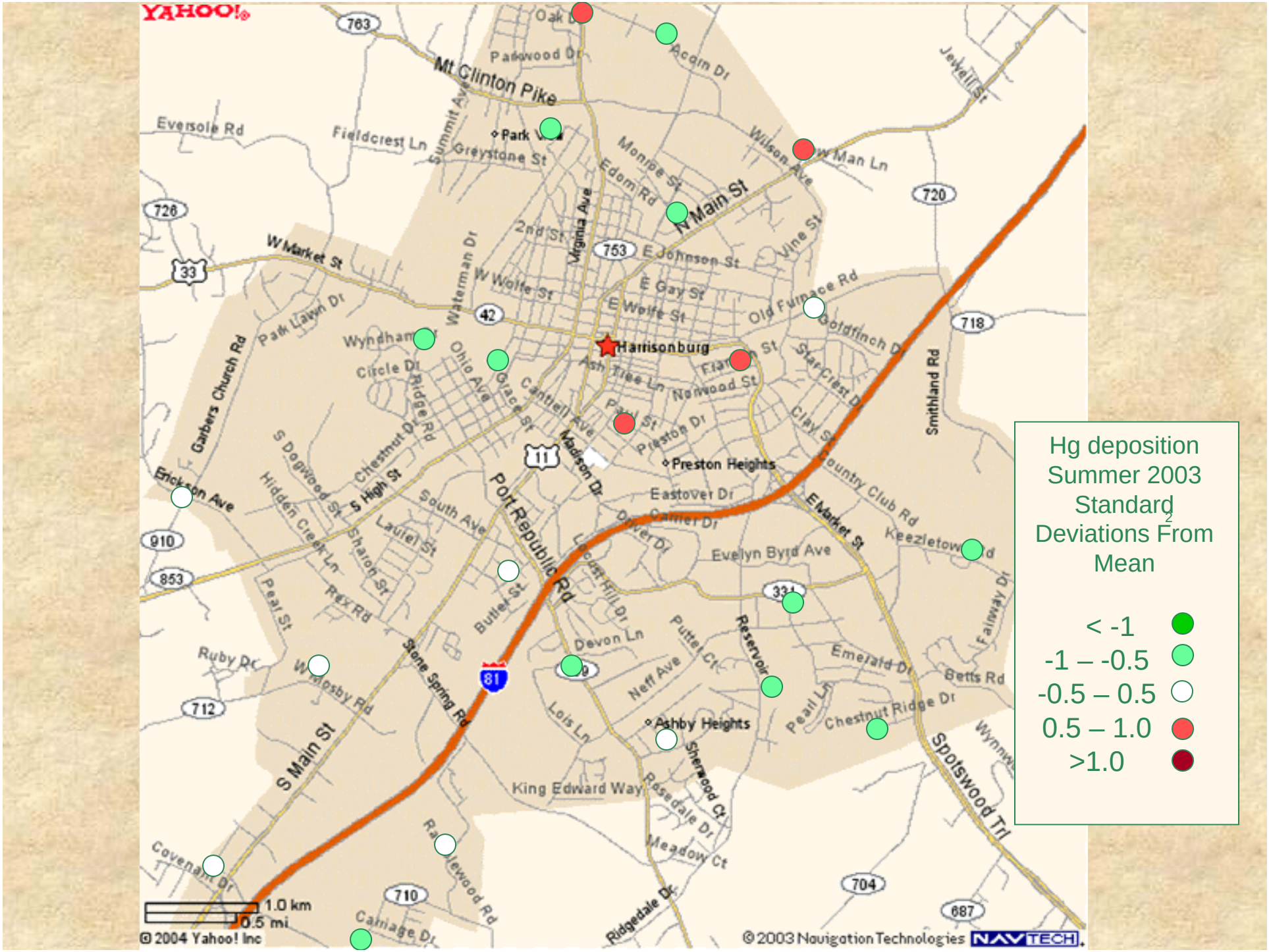
Similar data were collected from Harrisonburg and Staunton

- Once they are completely added to the data set a more complete analysis will be made.
- These two cities were thought of as control locations for the known Waynesboro Hg presence.
- In 2003 it appeared that there were several higher than presence sites than anticipated which were located in Harrisonburg.


Hg deposition
Summer 2003
Standard
2
Deviations From
Mean
< -1
-1 – -0.5
-0.5 – 0.5
0.5 – 1.0
>1.0
Harrisonburg
Preston Heights
Ashby Heights
Mt Clinton Pike
N Main St
S Main St
W Market St
E Market St
Port Republic Rd
Stone Spring Rd
Spotswood Trl
Smithland Rd
Evelyn Byrd Ave
Eastover Dr
King Edward Way
Chestnut Ridge Dr
Emerald Dr
Betts Rd
Devon Ln
Neff Ave
Lois Ln
Meadow Ct
Ridgedale Dr
Rosedale Dr
Sherwood Ct
Reservoir
Puttel Ct
Pearl Ln
Fairway Dr
Keezletown Rd
Old Furnace Rd
Goldfinch Dr
Star Crest Dr
Clay St
Country Club Rd
Vine St
Wilson Ave
Monroe St
Edom Rd
Virginia Ave
Summit Ave
Waterman Dr
2nd St
E Johnson St
E Gay St
E Wolfe St
W Wolfe St
Ash Tree Ln
Norwood St
Preston Dr
Paul St
Madison Dr
Cantrell Ave
Grace St
Ohio Ave
Circle Dr
Ridge Rd
Chestnut Dr
S Dogwood St
Hidden Creek Ln
S High St
South Ave
Laurel St
Sharon St
Rex Rd
Pearl St
Ruby Dr
Woodsby Rd
Butler St
Lee Hill Dr
Dover Dr
Carrier Dr
Park Lawn Dr
Garbers Church Rd
Erickson Ave
Eversole Rd
Fieldcrest Ln
Greystone St
Parkwood Dr
Acorn Dr
Jewell St
W Man Ln
Covenant Dr
Carriage Dr
Ralelewood Rd
1.0 km
0.5 mi
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YAHOO!
763
726
33
42
753
720
718
910
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712
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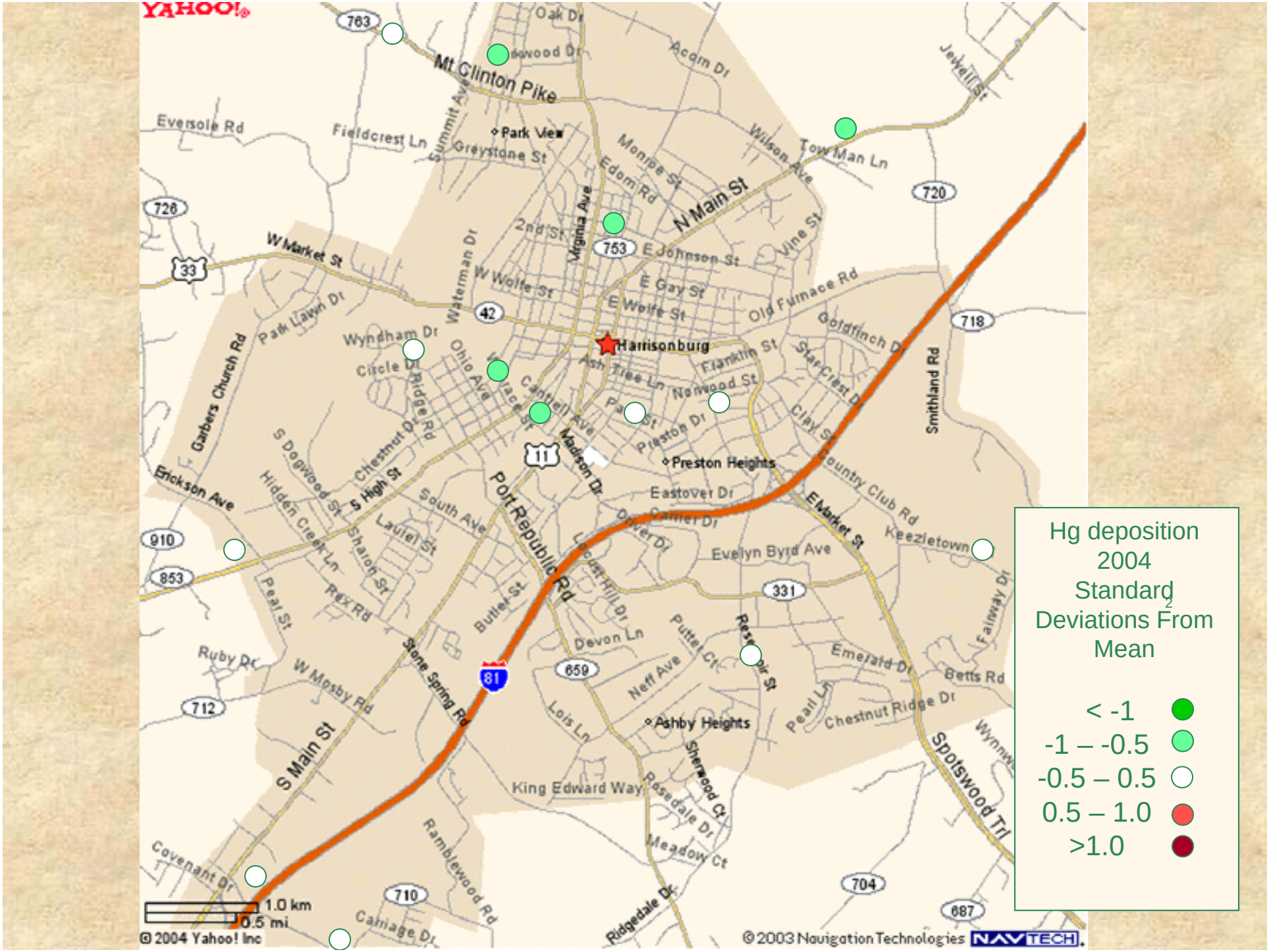
704
687
11
81

Similar data were collected from Harrisonburg and Staunton

- Once they are completely added to the data set a more complete analysis will be made.
- These two cities were thought of as control locations for the known Waynesboro Hg presence.
- In 2003 it appeared that there were several higher than anticipated located in Harrisonburg.
- However, the 2004 data did not repeat these patterns and therefore these cities may prove to be more random control locations after all.


Hg deposition
2004
Standard
Deviations From
Mean
< -1
-1 – -0.5
-0.5 – 0.5
0.5 – 1.0
>1.0
Harrisonburg
Preston Heights
Ashby Heights
Park View
Mt Clinton Pike
N Main St
S Main St
E Market St
W Market St
Port Republic Rd
Stone Spring Rd
Spotswood Trl
Smithland Rd
Keezletown
1.0 km
0.5 mi
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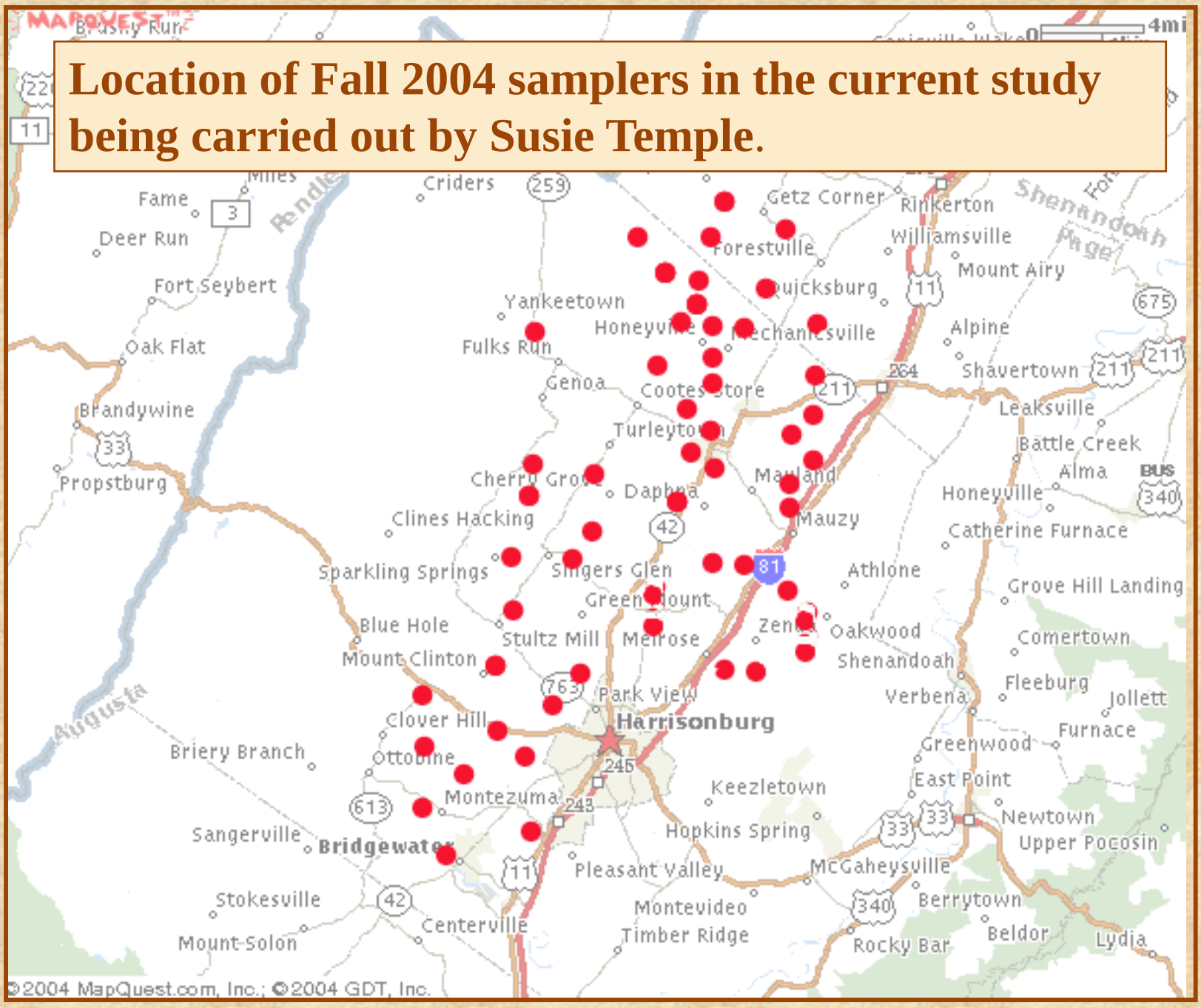
Path forward:

- **Complete the analysis of the 2001, 2003 and 2004 data.**
- **Another full set of samplers will be collected during the next 30 days for a fourth set of data.**
- **A fifth group of plates will be set out and collected next year giving further replication.**
- **These data do not provide any specific information about whether or not this air-borne Hg is environmentally significant.**
- **They should be viewed as screening data only.**
- **A more accurate sampling station with a full array of deposition samplers could be established somewhere within Waynesboro if the same locations continue to be of interest in the above studies.**

Addenda:

- When it was found that air-borne Hg in Harrisonburg could be comparable to that in Waynesboro, it became obvious that other factors beyond South River contamination could be involved.
- We hypothesized that one possible source could be residual mercurial fungicides used in Rockingham Co apple orchards up until the 1970's
- Therefore, associated with the present study is a network of new sampler locations in Rockingham Co. north and west of Harrisonburg.


Location of Fall 2004 samplers in the current study being carried out by Susie Temple.
MAPQUEST
4mi
Fame
Deer Run
Fort Seybert
Oak Flat
Brandywine
Propstburg
Criders
Yankeetown
Fulks Run
Genoa
Getz Corner
Rinkerton
Forestville
Williamsville
Mount Airy
Quicksburg
Honeyville
Mechanicsville
Alpine
Shavertown
Cootes Store
Turleytown
Leaksville
Battle Creek
Alma
Honeyville
Mauland
Daphna
Cherry Grove
Clines Hacking
Mauzy
Catherine Furnace
Sparkling Springs
Singers Glen
Athlone
Grove Hill Landing
Green Mount
Blue Hole
Stultz Mill
Melrose
Zenda
Oakwood
Comertown
Mount Clinton
Shenandoah
Fleeburg
Park View
Verbena
Jollett
Clover Hill
Harrisonburg
Furnace
Briery Branch
Ottobine
Greenwood
East Point
Montezuma
Keezletown
Hopkins Spring
Newtown
Upper Pocosin
Sangerville
Bridgewater
Pleasant Valley
McGaheysville
Stokesville
Montevideo
Berrytown
Centerville
Timber Ridge
Beldor
Lydia
Mount Solon
Rocky Bar
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Other people who contributed to this project….

- Jennifer Fairservice
- Jennifer Loder
- Zamda Lumbi

Acknowledgements

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  UMEB and REU Programs at JMU
* Department of Biology at JMU