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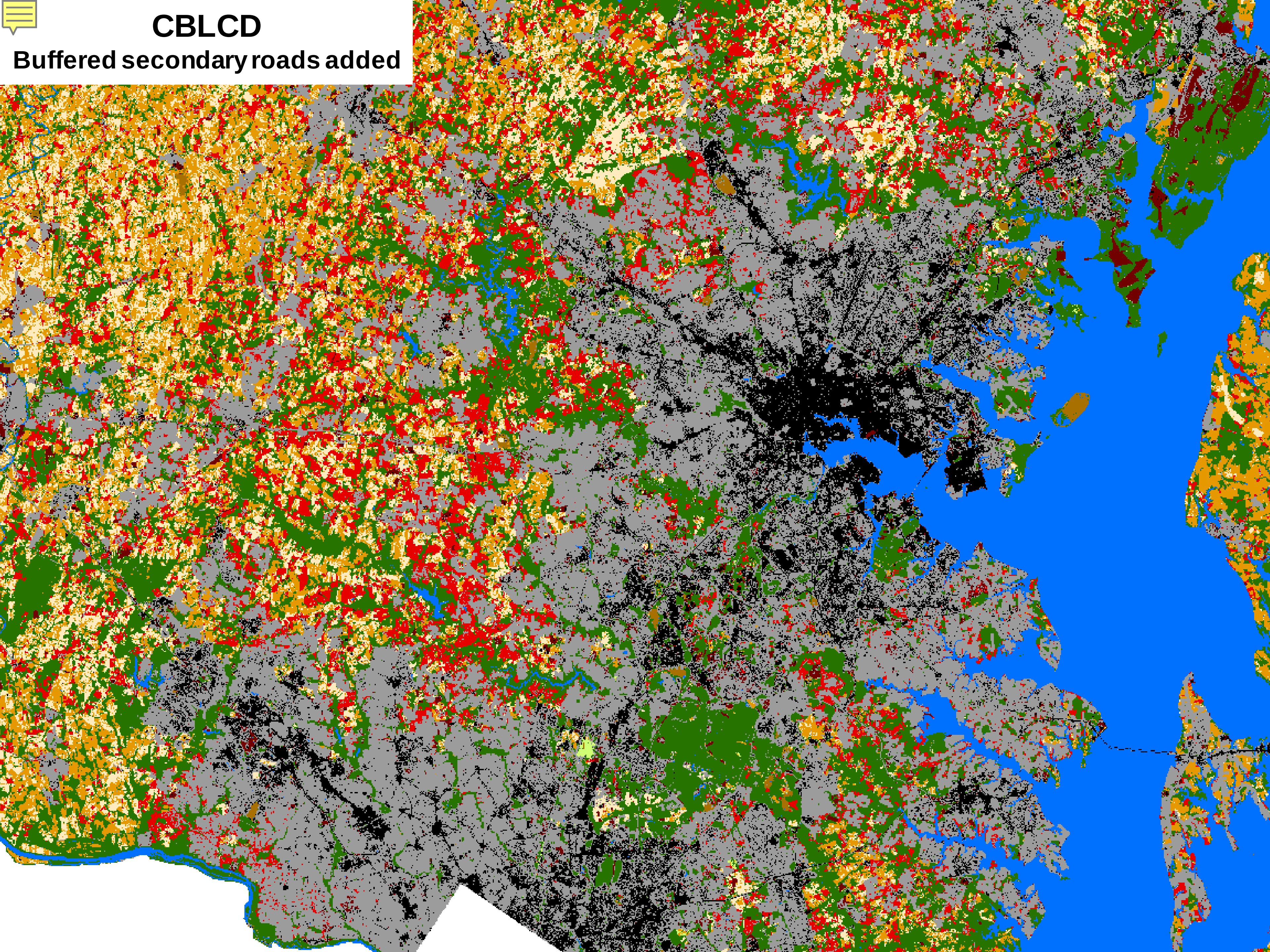
Chesapeake Bay Phase 5.3.2 Developed Land Use

Water Quality Goal Implementation Team

Peter Claggett, Renee Thompson, and Fred Irani
Eastern Geographic Science Center
U.S. Geological Survey

January 24, 2011

CBLCD
Buffered secondary roads added



Variation in Developed Lands in Phase 5.x models

Model Version	Impervious Surface (acres)	Pervious Surface (acres)
Phase 5.2 (2002)	799,989	3,591,799
Phase 5.3 (2002)	675,917	1,885,935
Phase 5.3.1 (2001)	1,587,575	5,896,707
Phase 5.3.1 (2001) Excl wooded residential	1,569,377	3,442,346
Phase 5.3.2 (2001) (Mean rural lot size = 2.24 acres)	1,212,520	2,980,906*

* 2005 Turf Grass Estimate (Turf Industry Data apportioned to watershed) = 3,790,000 acres
2006 P532 estimate of turf grass = 3,387,741 acres

Phase 5.3.0

- Based on satellite derived land cover data (1984, 1992, 2001, 2006) and state mining information

Pros:

- Satellite data are comparable and consistent across space and time.
- Clear methodology.
- Impervious surfaces that may be most relevant to water quality are captured.

Cons:

- Low density residential development is not well represented.
- Roads are inconsistently represented.

Phase 5.3.2

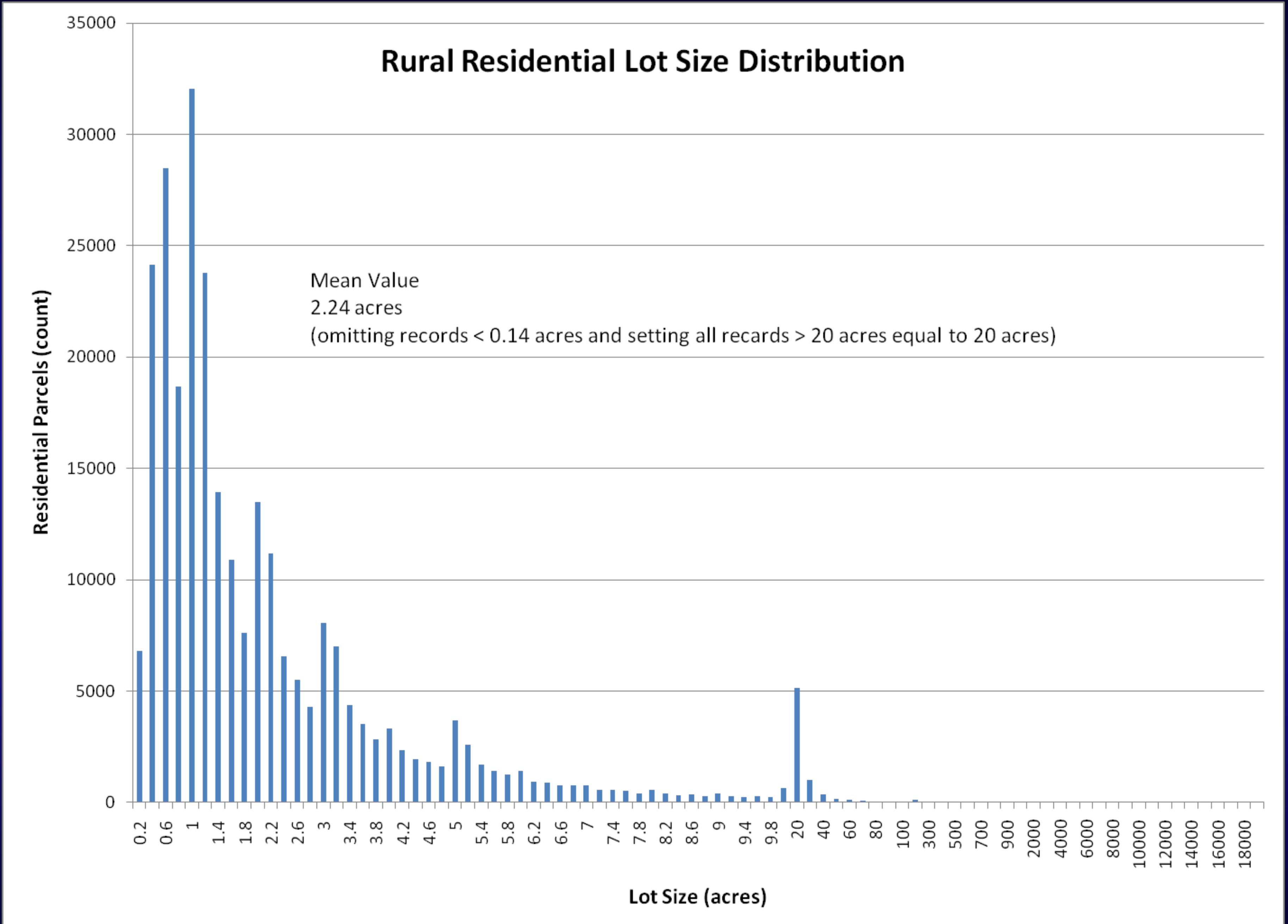
- Based on a combination of land cover, roads, housing, impervious and road width coefficients, and state mining datasets.

Pros:

- Captures 94% (vs. 74%) of impervious surfaces in Montgomery County, MD.
- Pervious developed lands, representing mostly lawns, approximate the extent of turf grass estimated from Turf Grass Industry data (3.79 million acres).
- Estimates the number of septic systems within 1% of Maryland Dept. of Planning data (+ ~15% in Phase 5.3.0)

Cons:

- Very complex methodology involving a large number of assumptions.
- Impervious surface associated with farm buildings and rural warehouses are excluded.



Rural Residential Lot Size Distribution
Mean Value
2.24 acres
(omitting records < 0.14 acres and setting all recards > 20 acres equal to 20 acres)
Residential Parcels (count)
35000
30000
25000
20000
15000
10000
5000
0
0.2
0.6
1
1.4
1.8
2.2
2.6
3
3.4
3.8
4.2
4.6
5
5.4
5.8
6.2
6.6
7
7.4
7.8
8.2
8.6
9
9.4
9.8
20
40
60
80
100
300
500
700
900
2000
4000
6000
8000
10000
12000
14000
16000
18000
Lot Size (acres)

P532 Turf Grass Acres in Maryland = 971,963 acres
NASS Estimate = 1,134,000 acres

Why the difference?

1. P532 does not capture turf grass associated road right-of-ways, and isolated commercial, industrial, and institutional establishments.
2. Turf Industry estimate is used to substantiate the economic importance of the industry. Therefore, it probably represents the upper bounds of the probable extent of turf grass.

Turfgrass areas used and maintained in Maryland, 2005

Sector	Turf Acres	Percent of Turf Acres	New Turf Established	Cost of Establishing New Turf	Average Cost per Acre to Establish New Turf
	- acres -	- percent -	- acres -	- dollars -	- dollars -
Airports	5,000	0.4	----	----	
Cemeteries	4,200	0.4	130	361,000	2,777
Religious Facilities	9,400	0.8	250	581,000	2,324
Parks and Athletic Fields	21,800	1.9	320	3,275,000	10,234
Golf Courses	16,400	1.4	310	2,105,000	6,790
County Government	78,200	6.9	480	3,914,000	8,154
State Highways	9,000	0.8	650	1,570,000	2,415
Apartments	7,500	0.7	200	765,000	3,825
Lawn Care	1/		1/	1/	
Sod Farms	8,000	0.7	2/	2/	
Single Family Homes	936,900	82.6	28,190	73,112,000	2,594
Schools	38,400	3.4	360	3,481,000	9,669
Total	1,134,800		30,890	89,164,000	2,887

[1] Maryland Department of Natural Resources, 2006.
[2] USDA, National Agricultural Statistics Service, Maryland Field Office, 2006.

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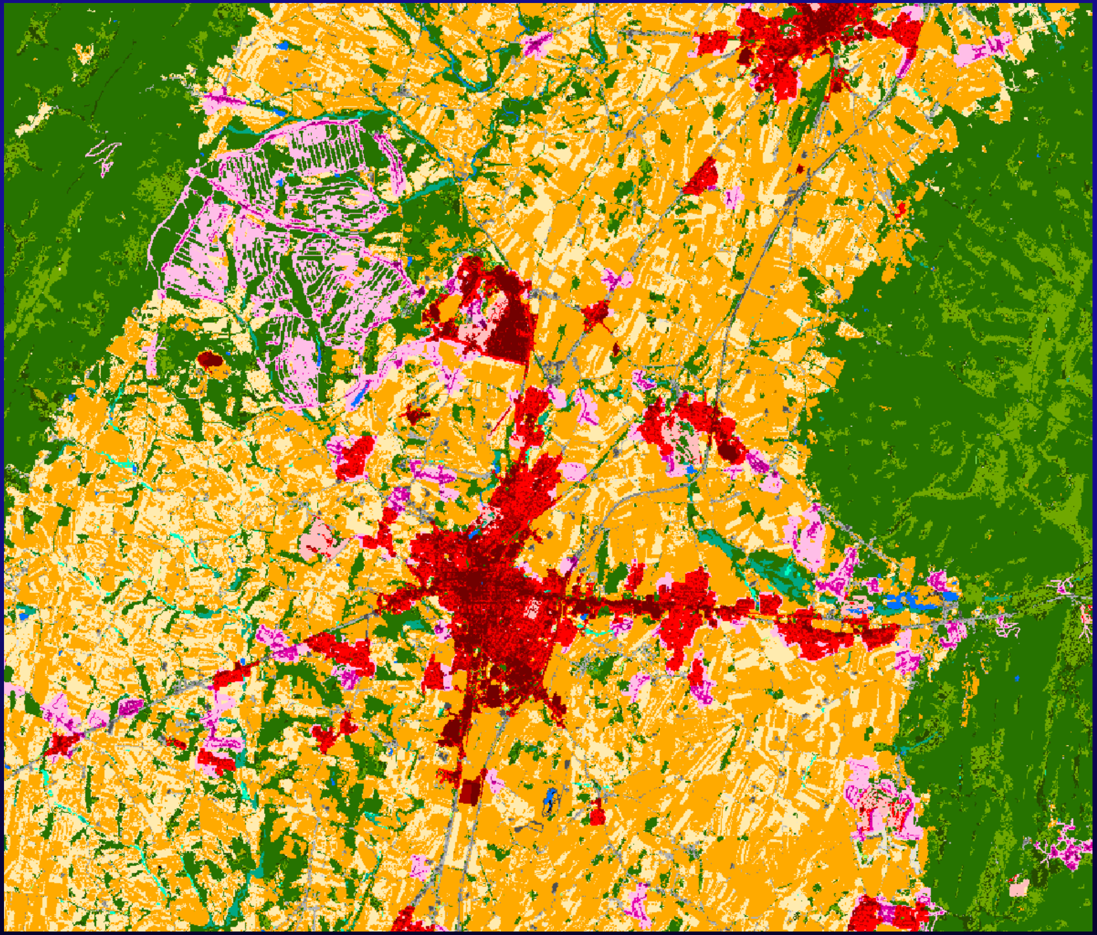
Capturing low density residential development improved accuracy of agricultural classes

P530 2006 Farmland Acres in Maryland	=	2,116,531 acres
P532 2006 Farmland Acres in Maryland	=	1,639,198 acres
USDA 2007 Ag Census	=	1,558,546 acres

P 5.3.2



Chambersburg, PA

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Bay Watershed Phase 5.3.2 Land Use Stats (Draft)

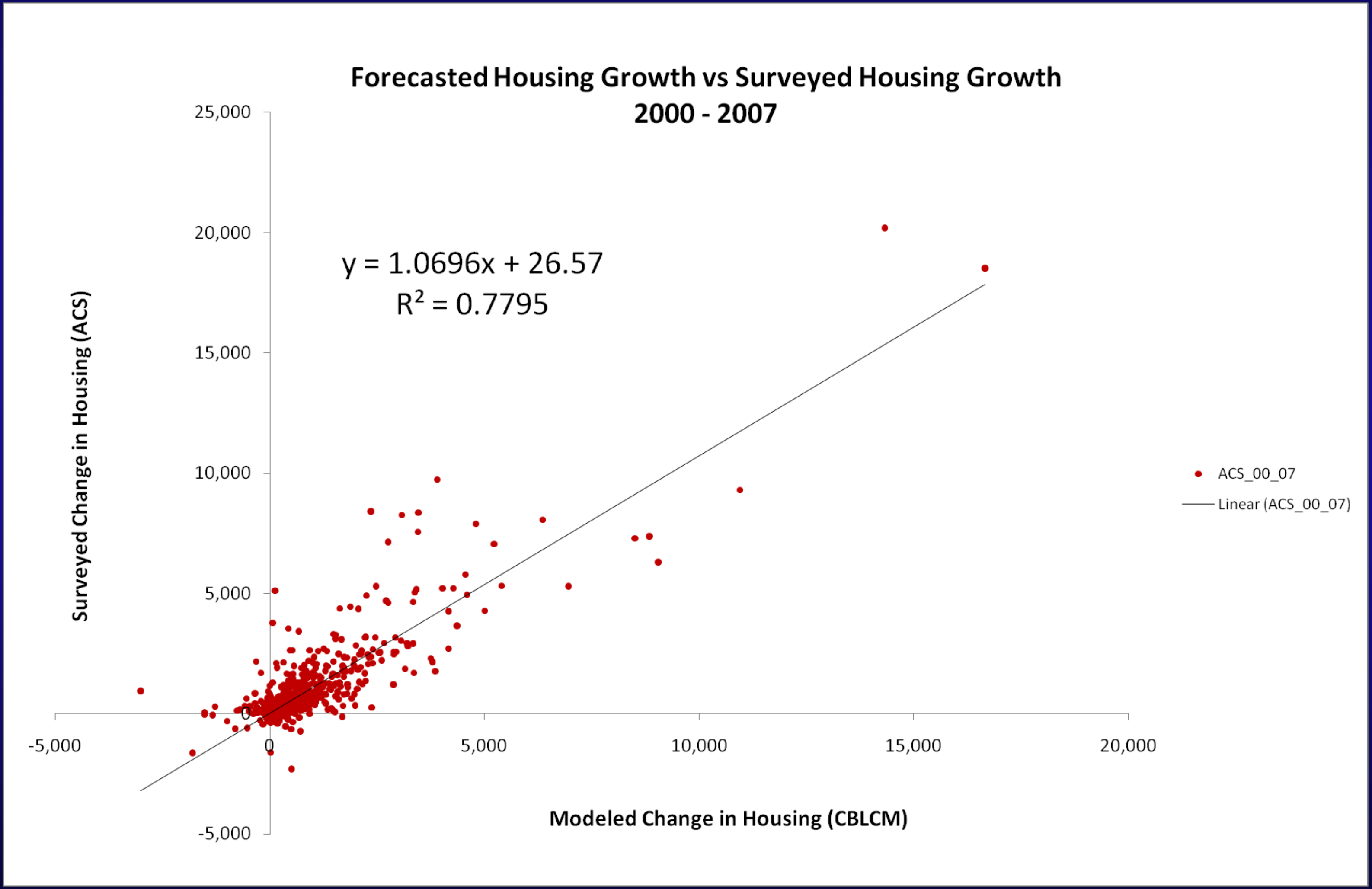
From 1984 to 2006, developed lands increased 33% (53,000 acres per year on average).

In 2000, there were 3.6 million people on septic and 12.1 million people on sewer.

By the year 2025:

- Developed lands may increase an additional 18% by the year 2025 (45,000 acres per year).
- Population on septic may increase 16% and the population on sewer may increase 27%.
- Approximately 400,000 acres of forests and 460,000 acres of farmland may be converted to development.
  - Note: The “Current Objectives” scenario in the Chesapeake Futures report estimated 900,000 of forests and farmlands lost to development by 2030.

Comparison of Modeled vs. Surveyed Growth



Phase 5.3.2 Improvements to the Land Use Dataset

1. Impervious surfaces associated with all rural roads, residences, and most commercial/industrial areas are represented.
2. Satellite data are used where they are most accurate (in dense urban areas).
3. Consistent methods are used to back-cast development (2006 to 1984) and to simulate future trends (2006 to 2025).
4. Recent housing unit estimates (published Dec 14, 2010) and updated population estimates, projections, and protected lands data are explicitly incorporated into the backcast and future scenario.
5. Road width and residential impervious surface coefficients were determined based on a literature review and sampling aerial imagery in PA, MD, and VA.
6. Sewer and septic forecasts are based on weight of evidence from trends in housing, land use, and the amount of remaining sewered land available for development.

STAC's major comments/ concerns about Phase 5.3.2 land use:

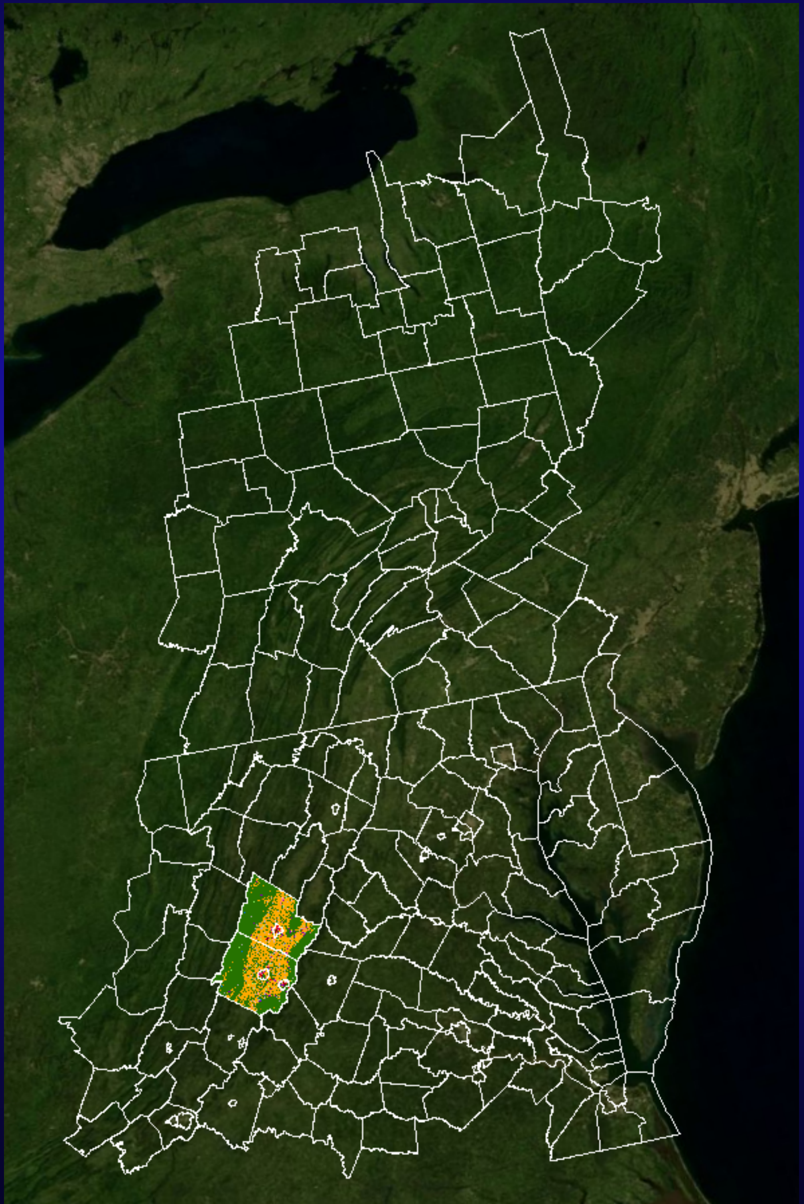
- Conduct a systematic sensitivity analysis
- Develop multiple plausible future scenarios, with explicit characterization of uncertainty.
- Incorporate a mechanistic understanding of land market dynamics (e.g.., housing for aging populations, excess housing stock, increases in urban amenities)
- Growth may be underestimated because not accounting for growth in employment.
- Explicitly address scale issues

Key model datasets and variables

Historic and Forecasted Developed Extent

- Magnitude and patterns of land cover and housing change
- Location and extent of sewer service areas
- Average household size
- Estimated and projected population (from Census & counties)
- Vacancy rate
- Housing density
- Road width (number of lanes, lane width, shoulder width)
- Impervious surface associated with suburban and rural residential lots
- Mean rural residential lot size (1.88 acres)
- Median urban lot size (0.24 acres)
- Impervious surface associated with developed land cover classes
- Rural residential land cover (lawns vs. forests)
- Proportions of forest and farmland loss

Pilot of 5.3.2 Land Use: Shenandoah Valley



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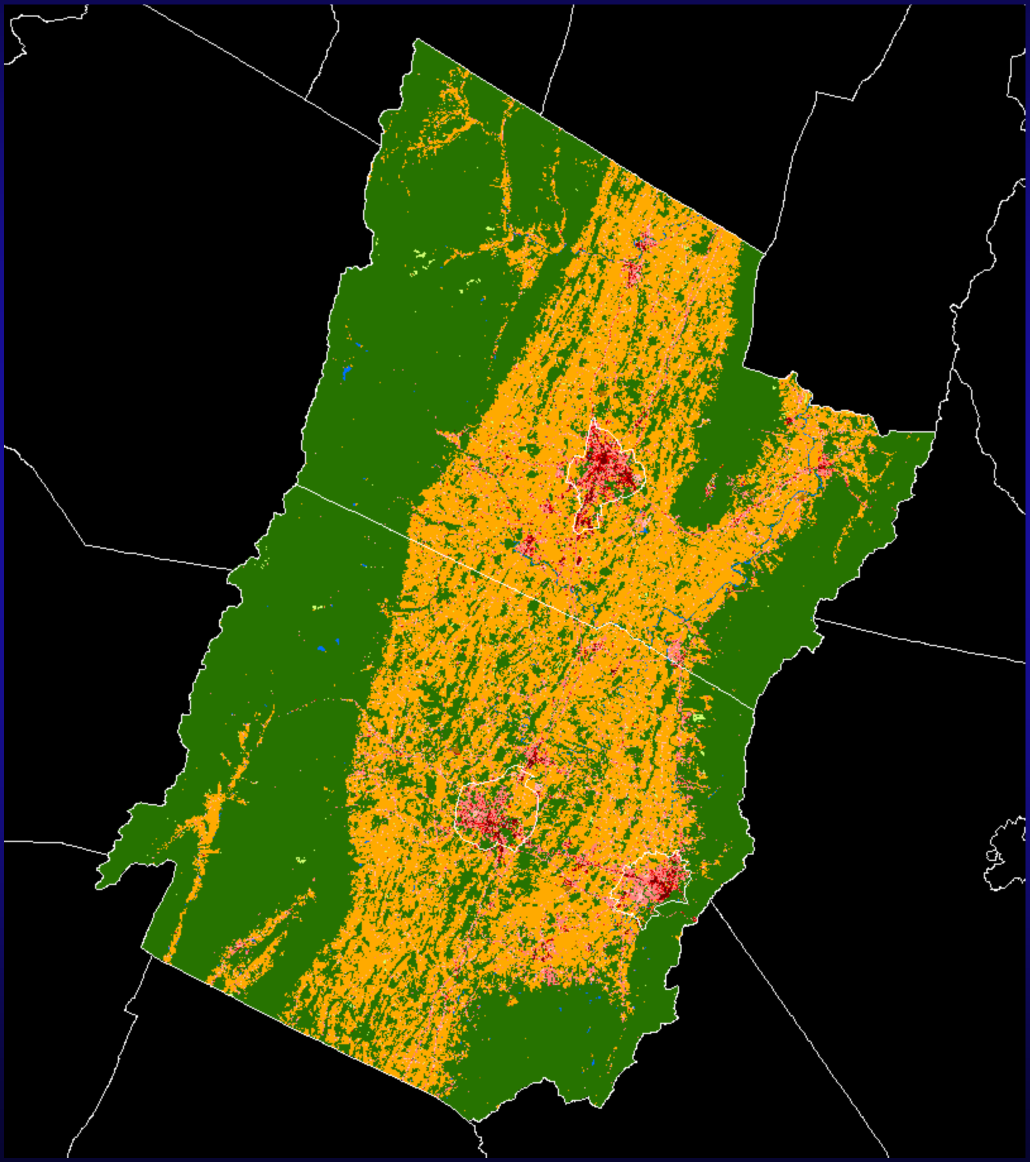
Pilot of 5.3.2 Land Use: Shenandoah Valley



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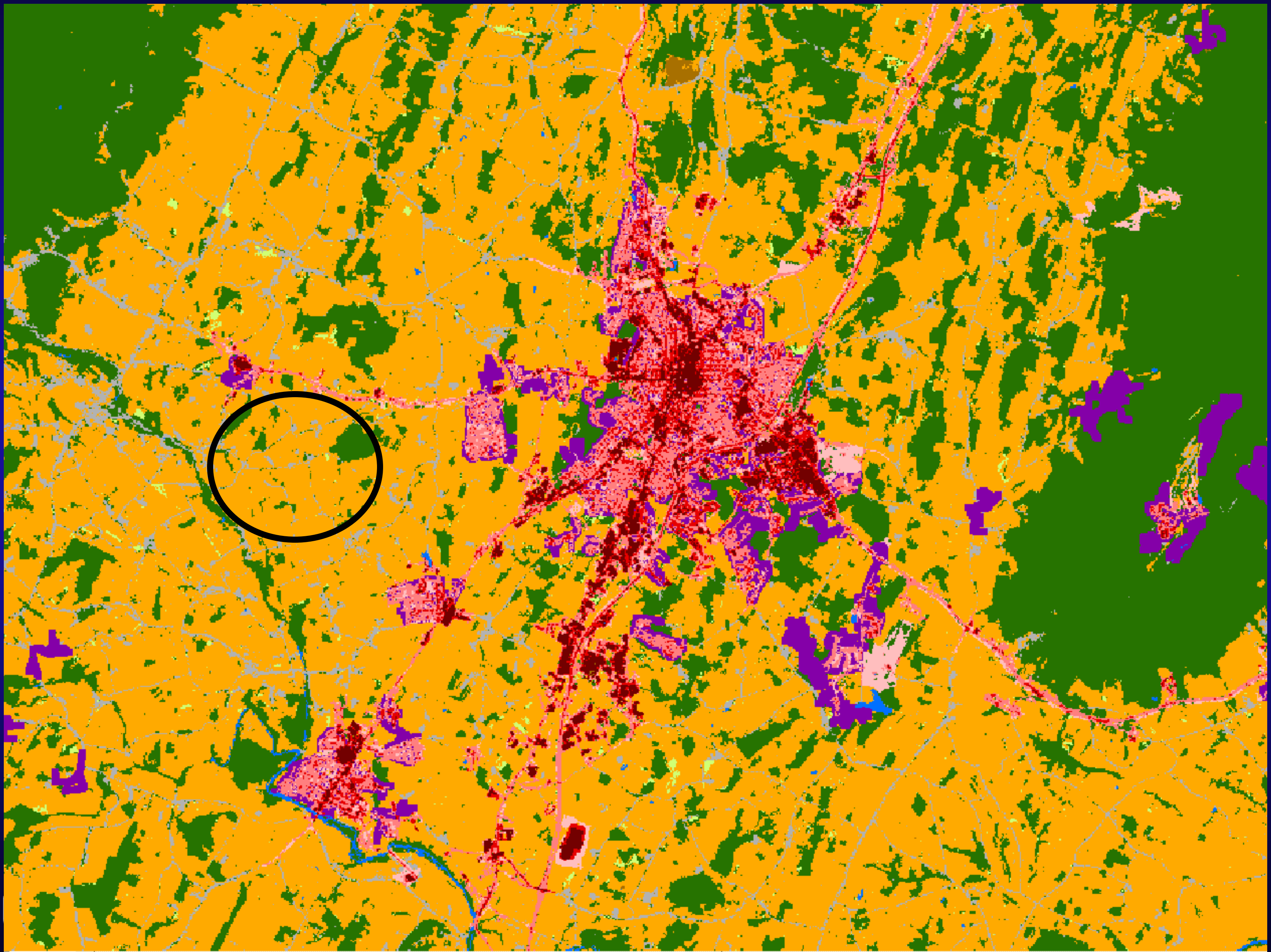
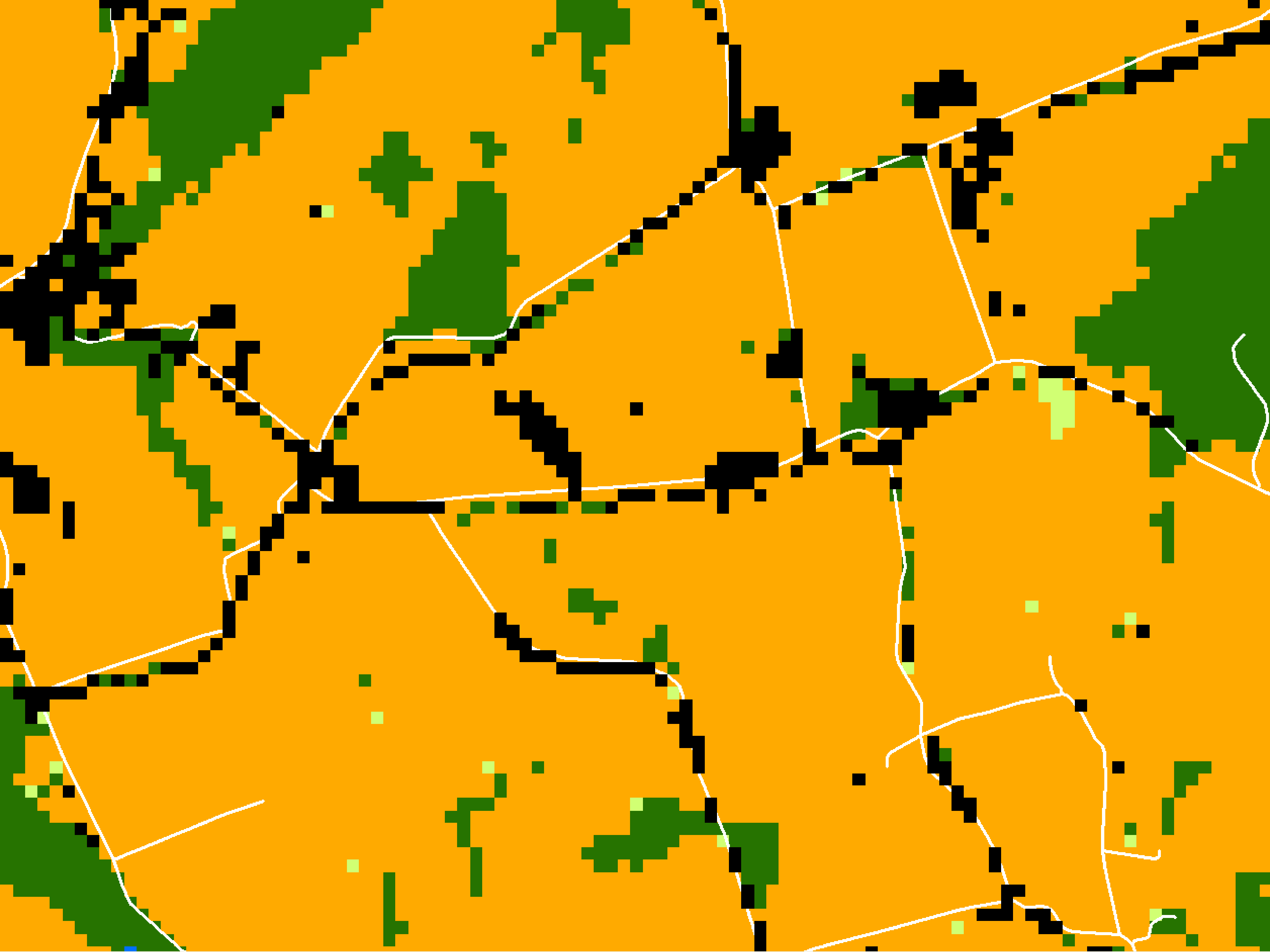
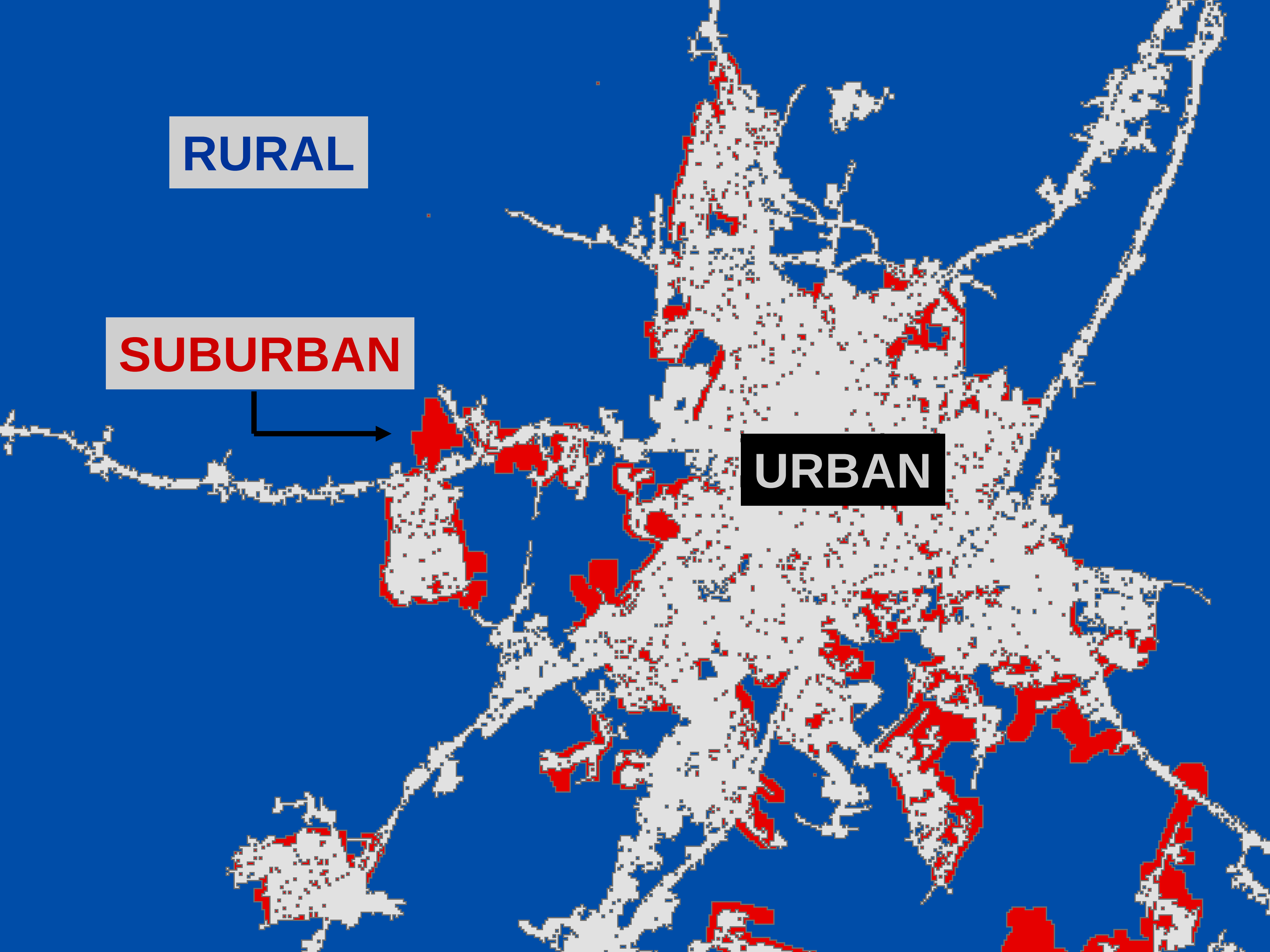
Pilot of 5.3.2 Land Use: Shenandoah Valley






RURAL
SUBURBAN
URBAN

Phase 5.2

NLCD Impervious Coefficients

Land Cover Class	Sample Land Use Associated with comparable Imp. Surface (%)	Impervious Surface (%)	Pervious Surface (%)
Developed Open Space (DOS)	Ball fields and Parks	5.82	94.18
Low Intensity Developed (LID)	½ acre lot residential areas	20.18	79.82
Medium Intensity Developed (MID)	Multifamily residential areas, townhomes/rowhomes (attached)	44.60	55.40
High Intensity Developed (HID)	Commercial areas	71.04	28.96

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Phase 5.3.0

NLCD Impervious Coefficients

Developed Land Cover Classes	Bay watershed	DC	DE	MD	NY	VA	WVA
Developed Open Space	5.82%	8.35%	9.98%	6.26%	6.27%	6.21%	1.53%
Low-intensity Developed	20.18%	30.32%	24.39%	22.74%	18.04%	16.08%	9.55%
Medium-intensity Developed	44.60%	61.40%	53.89%	52.46%	48.79%	48.04%	35.84%
High-intensity Developed	71.04%	86.99%	82.52%	82.57%	73.49%	75.97%	61.08%

Phase 5.3.2

NLCD Impervious Coefficients (County Ranges)

Developed Land Cover Classes	County Min	County Mean	County Max
Developed Open Space	2.1 %	6.6%	19.2%
Low-intensity Developed	11.4%	19.3%	37.1%
Medium-intensity Developed	32.4%	43.4%	68.7%
High-intensity Developed	53.0%	66.9%	90.8%

Due to potential error at the low-end of the range, the coefficients are not allowed to be less than the 1st quartile value in range of county coefficients for each state.

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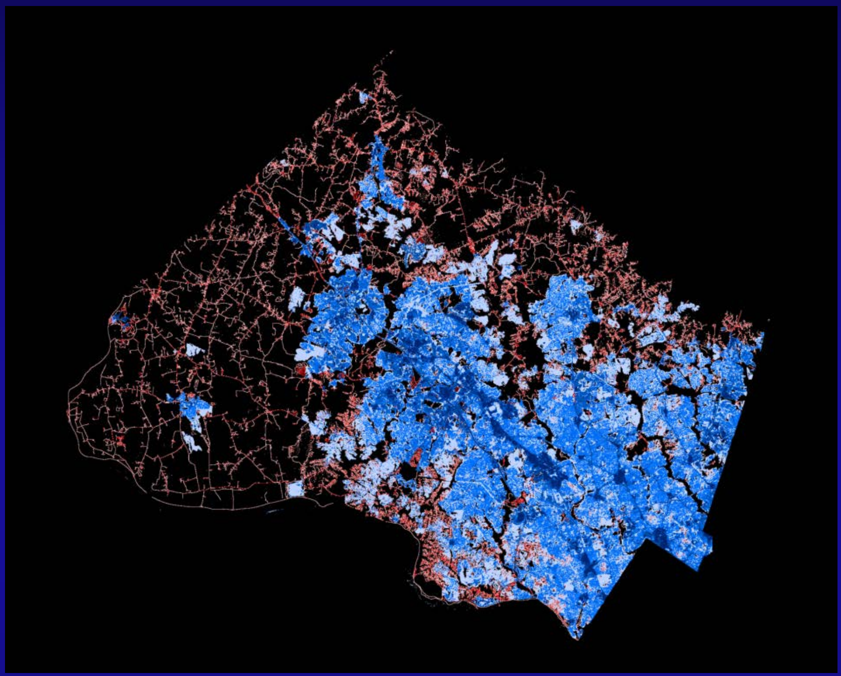
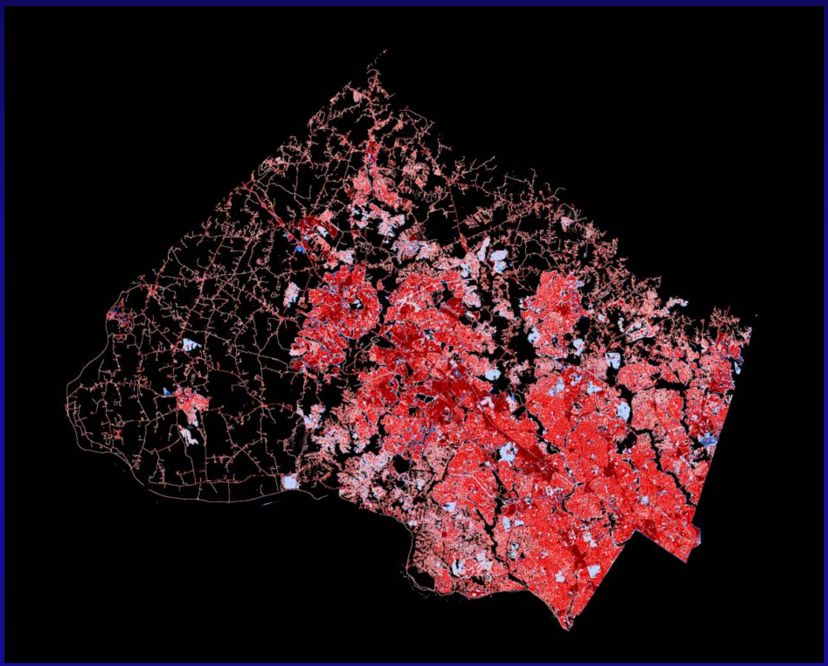
Comparison with Local Data (Montgomery County, MD)

Spatial omission errors (red)



Spatial commission errors (blue)



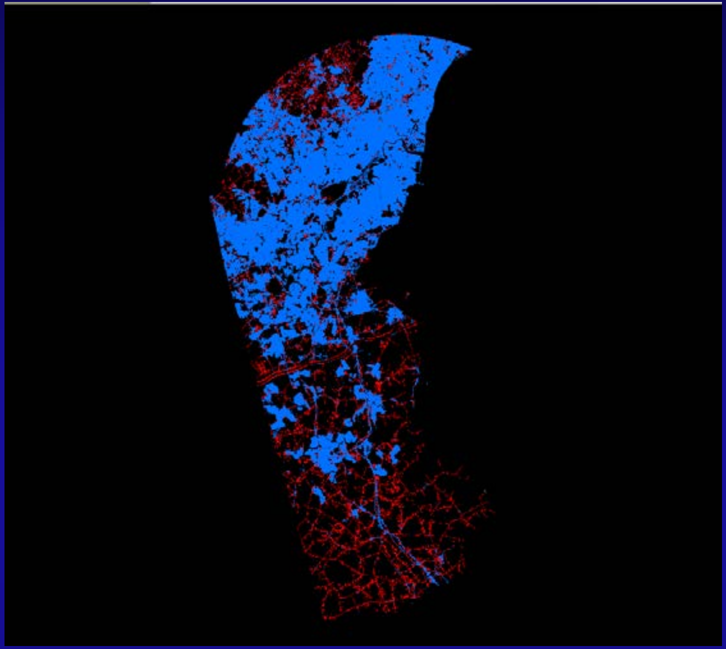
County planimetric data = 37,600 acres impervious

Phase 5.3.0 = 27,700 acres impervious (state coefficients)
Phase 5.3.0 = 29,900 acres impervious (county coefficients)

Phase 5.3.2.= 35,362 acres impervious

Comparison with Local Data
(New Castle, Kent, Sussex (DE) and Lancaster, PA)

Spatial omission errors (red)



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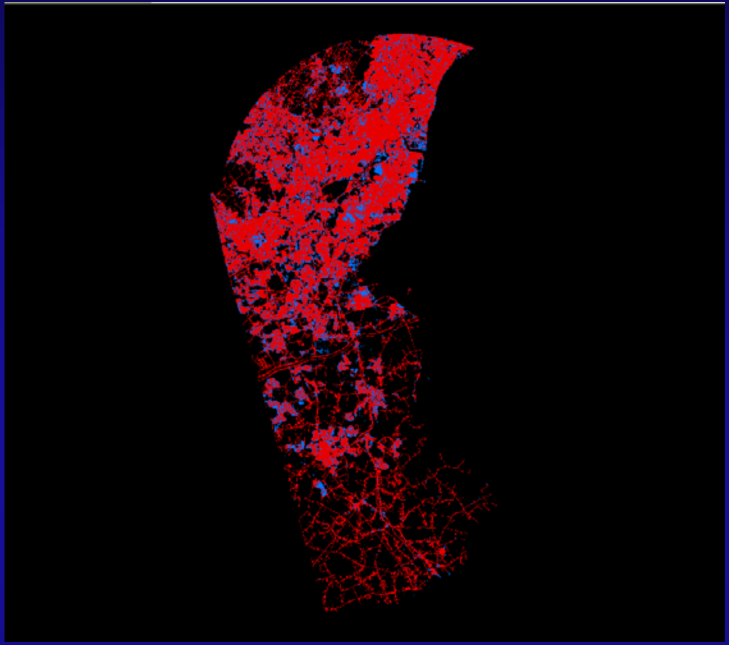

	Local Impervious	P532 Impervious
	(acres)	(acres)
Lancaster, PA	37,383	34,880
New Castle, DE	43,911	32,888
Kent, DC	20,148	13,646
Sussex, DE	32,400	21,969

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Comparison with Local Data
(New Castle, Kent, Sussex, DE and Lancaster, PA)

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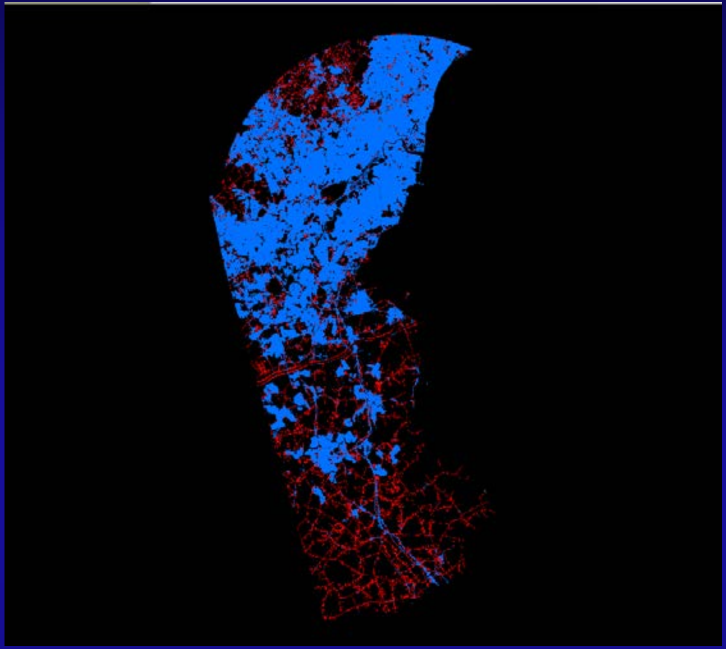
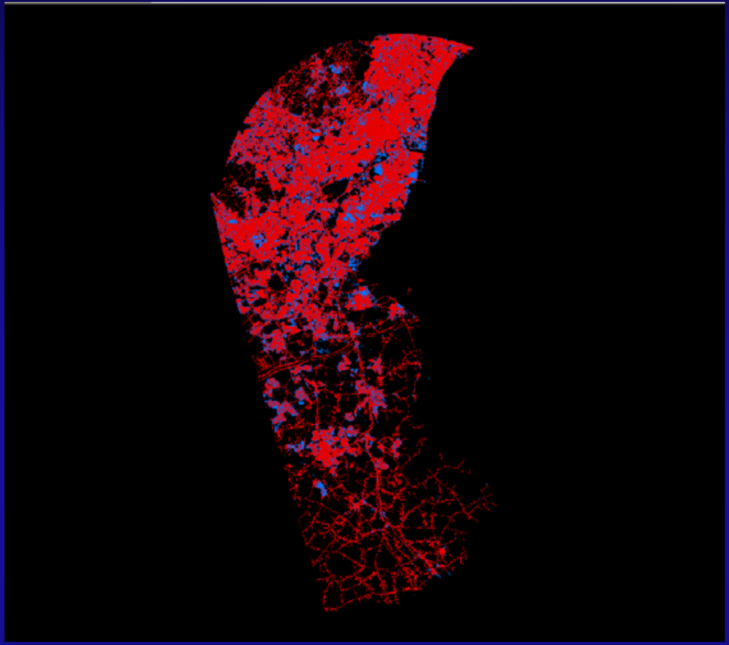


Spatial commission errors (blue)



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Lancaster, PA	37,383	34,880
New Castle, DE	43,911	32,888
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Sussex, DE	32,400	21,969

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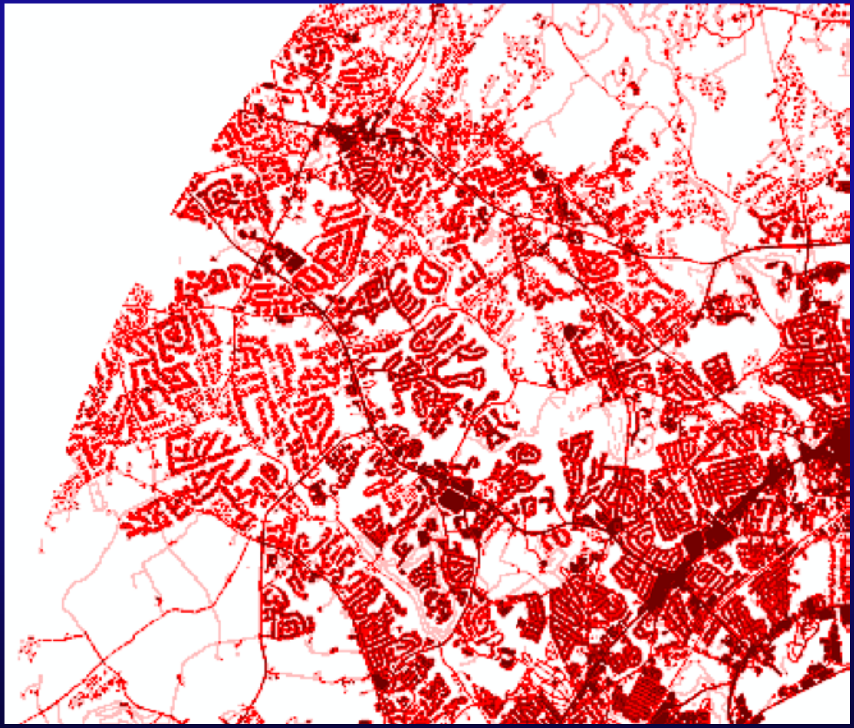
Why the large underestimate in Delaware?

Recent residential development, long driveways, agricultural buildings (silos, barns, chicken houses), dispersed commercial and industrial development…. and

Underestimation of the intensity of impervious surface in urban areas.



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Measuring Impervious Surface Associated with Roads

Road Type	% of Rd Miles	Literature Range	Sample Range	Sample Mean	Selected Width
2-lanes (2-way)	88.8%	22 – 36	13 – 50	23- 25	22 (rural) 26 (urban)
4-6 lanes (2-way)	2.4%	42 – 84	26 – 104	72	26, 36, and 72
8 + lanes (2-way) (controlled access)	2.9%	116 - 120	70 - 222	120	116

Within the Bay watershed, there are 331,860 acres of impervious surfaces associated with rural roads composing about 26% of all impervious surfaces. Eighty-nine percent of the roads have 2 lanes and most likely range from 22' – 26' resulting in an impervious surface range of +/- 70,000 acres in the Bay watershed.

Note: Lane width= 10' - 12'. Shoulder width= 2' - 12' (2 – 6 lanes) or 10' – 12' (controlled access highway).

This analysis does not take into account sidewalks or parking lanes.

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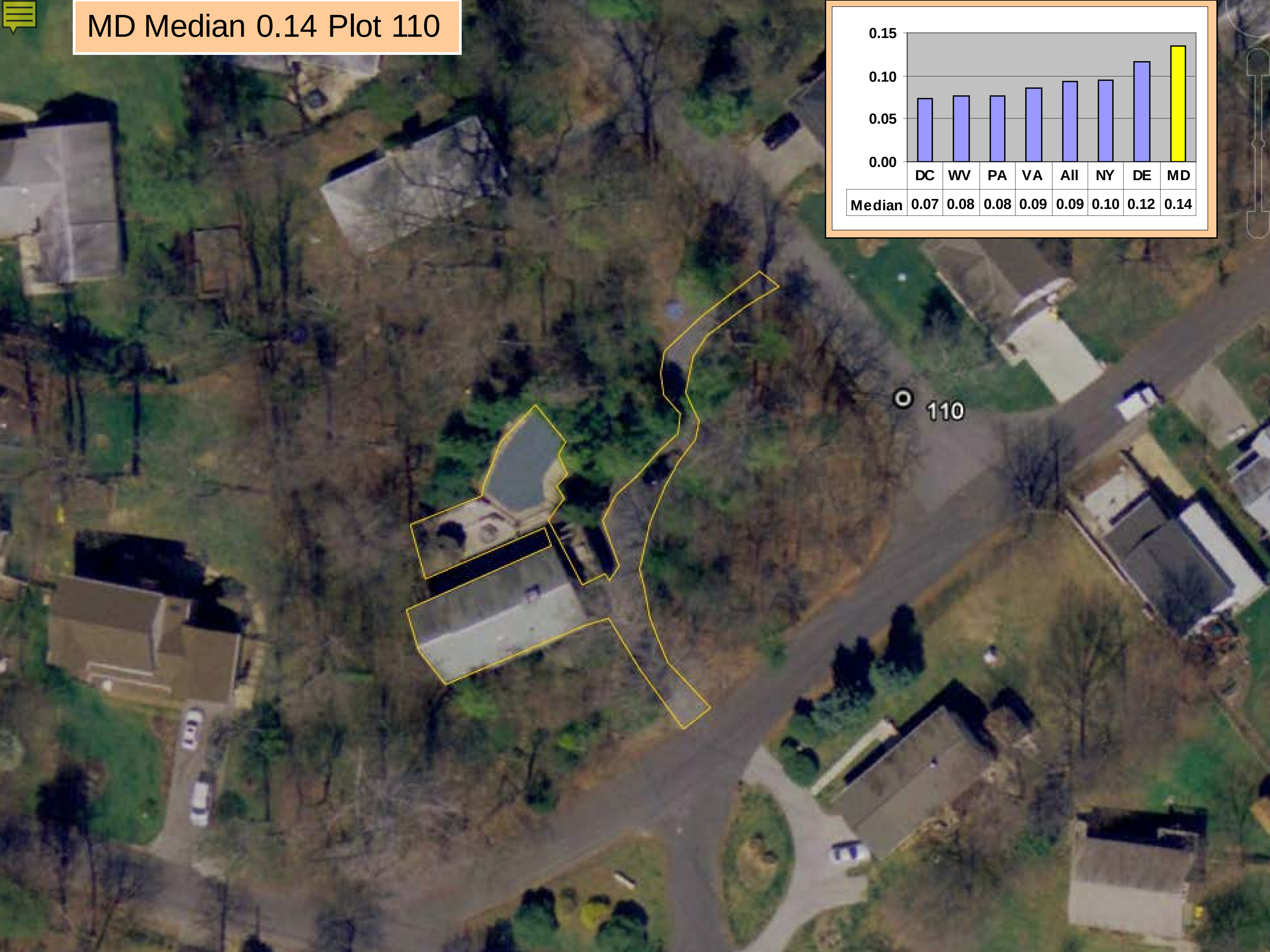
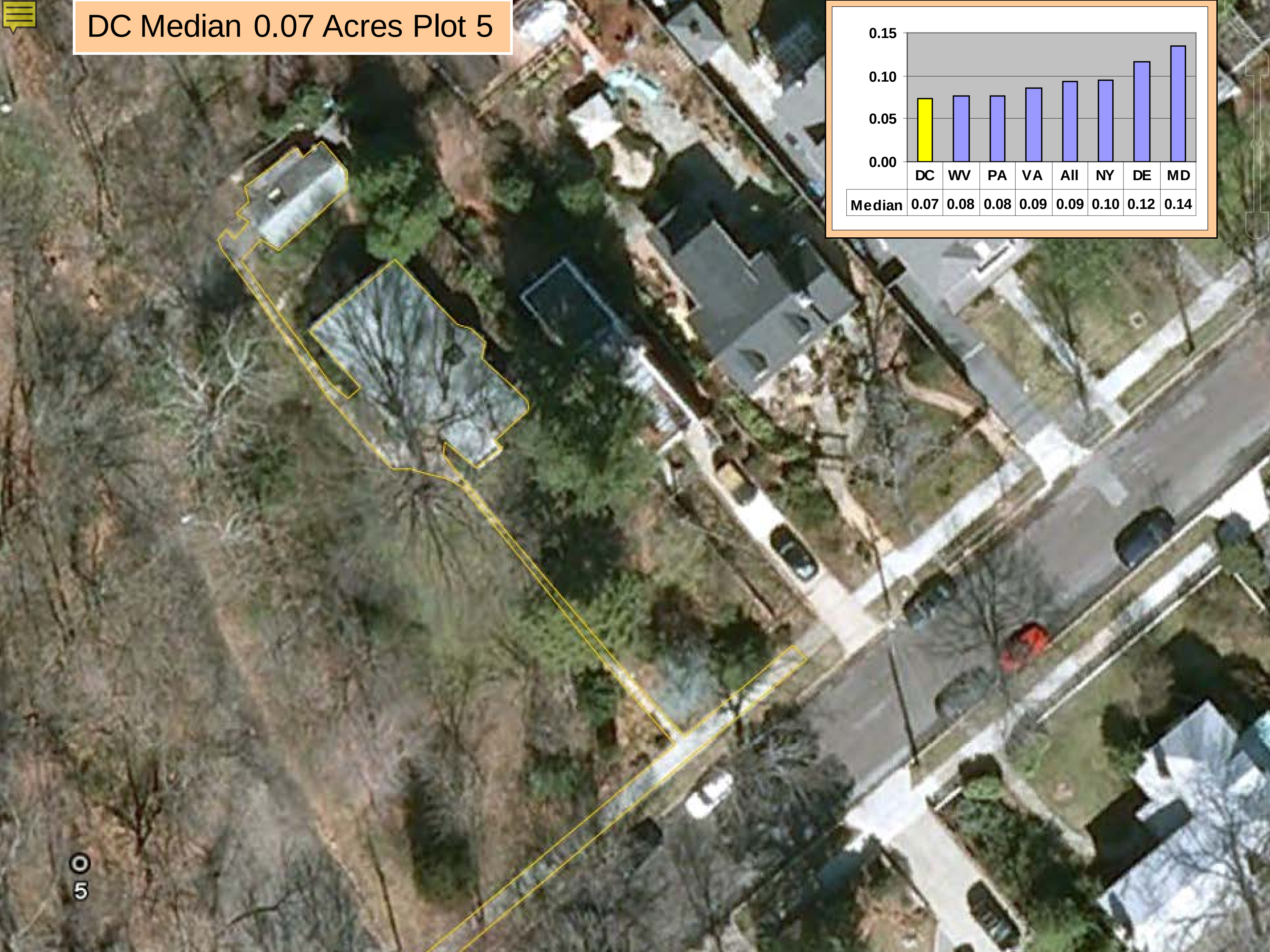
MD Median 0.14 Acres Plot 138

MD Median 0.14 Plot 110



	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14

DC Median 0.07 Acres Plot 5

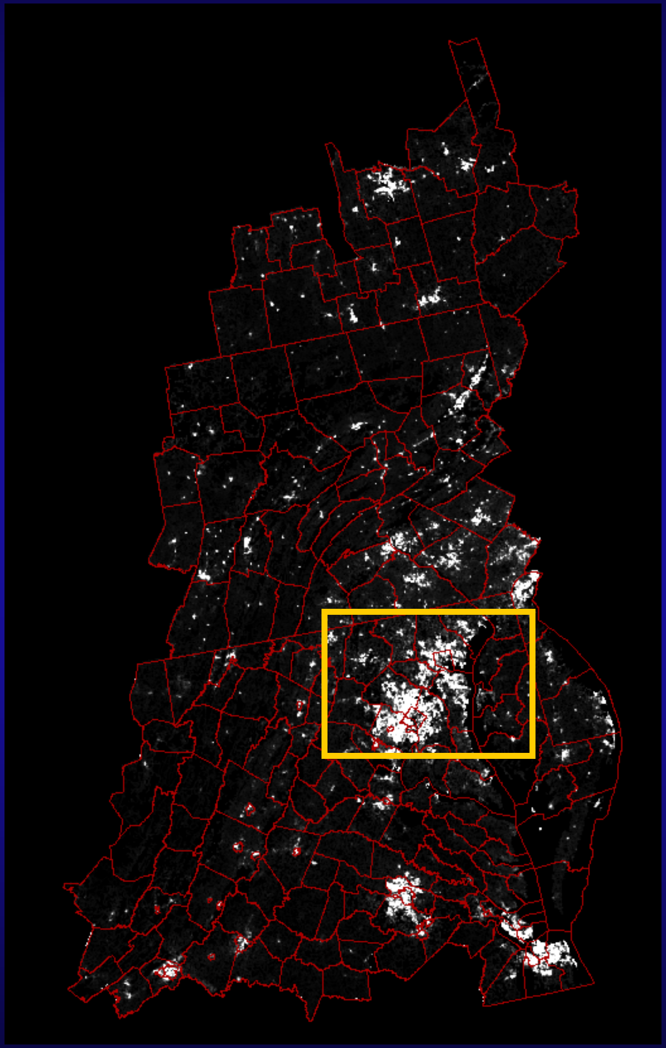


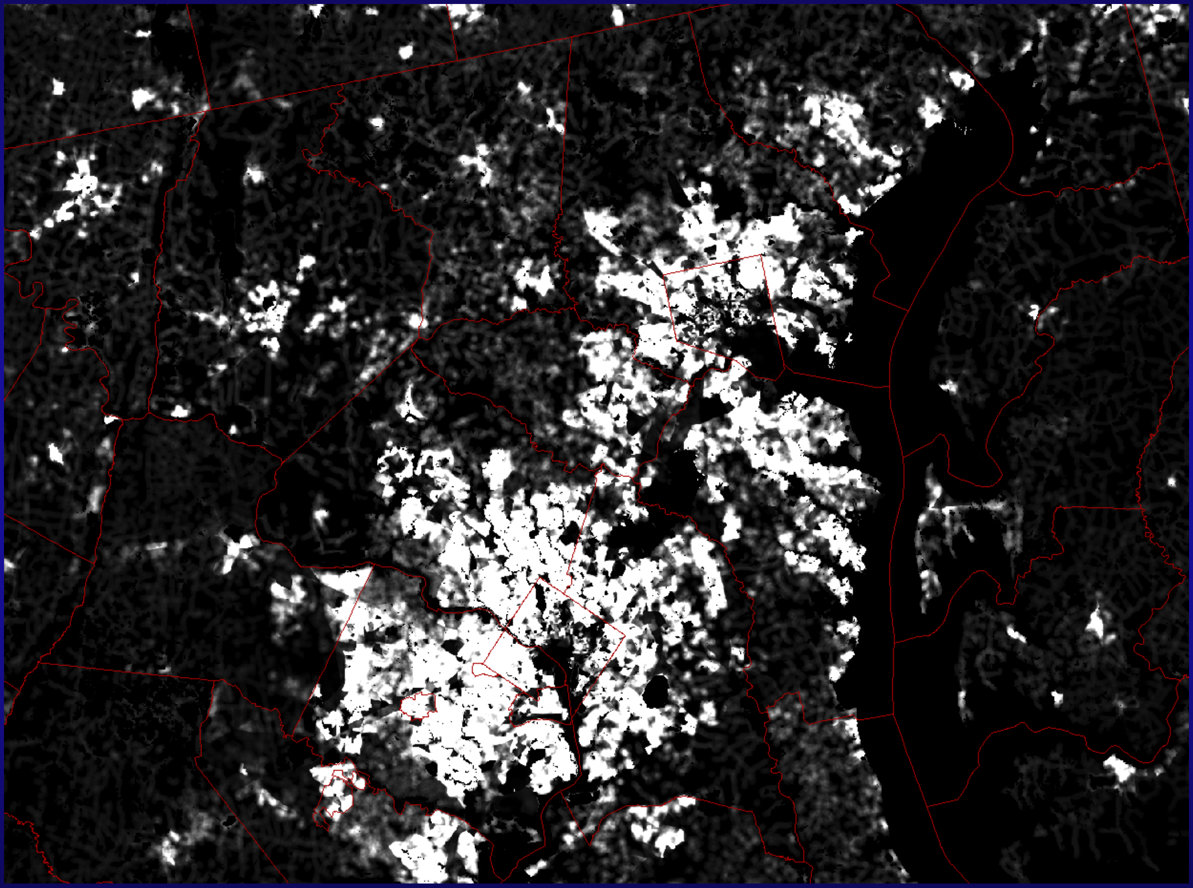
	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14

DE Median 0.12 Acres Plot 53

	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14

Dasymetric Mapping of Single-detached Housing Units





Correlation with Census Block data at Modeling Segment Scale = 0.80

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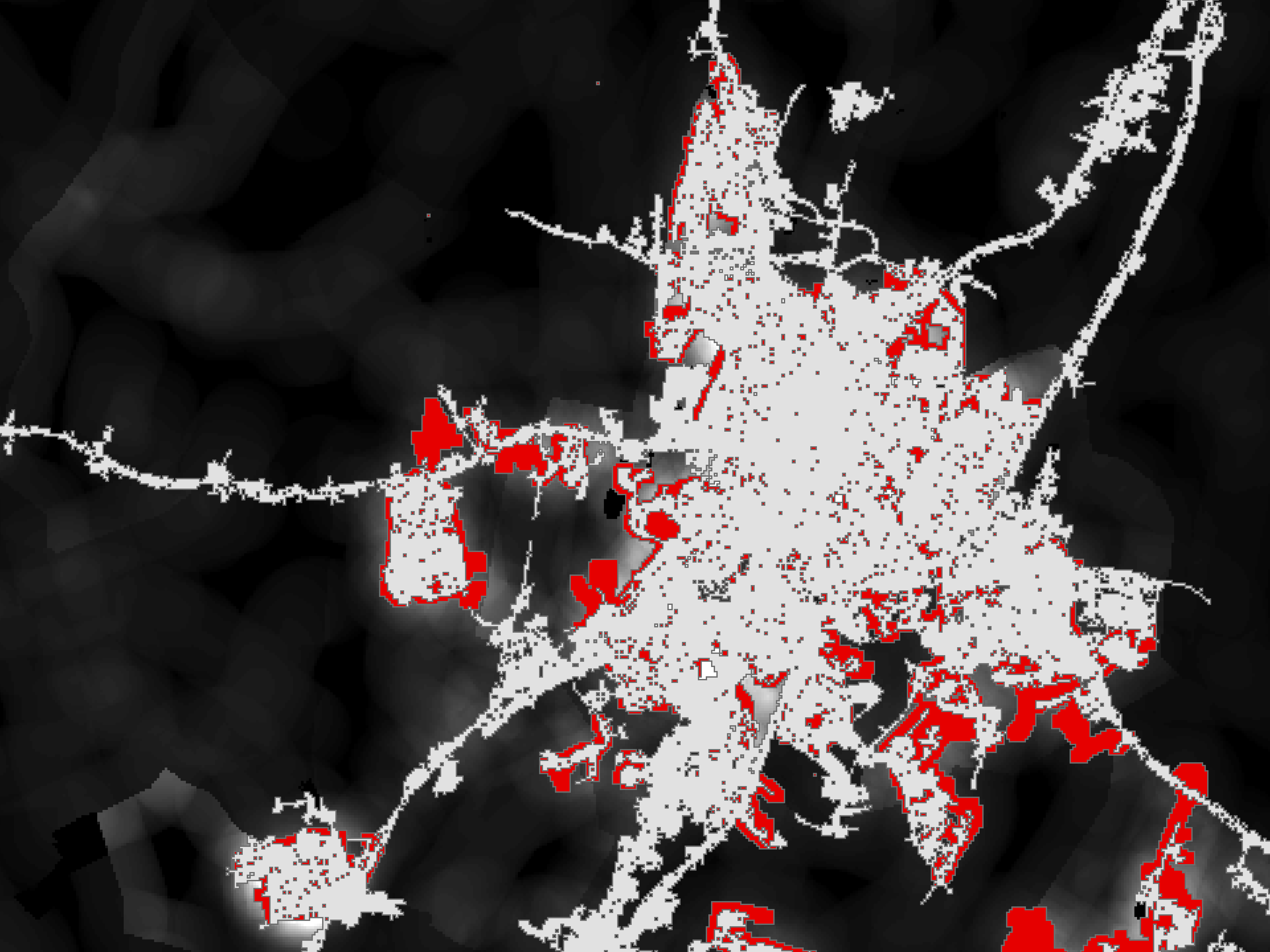
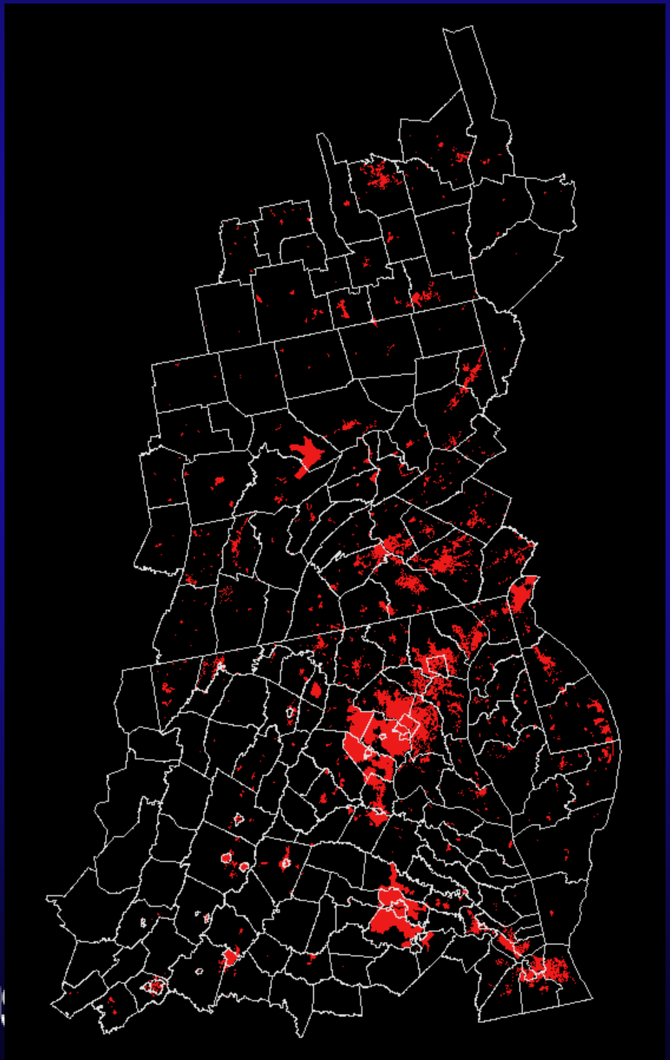


Estimating Population on Sewer

Sewer Service Areas



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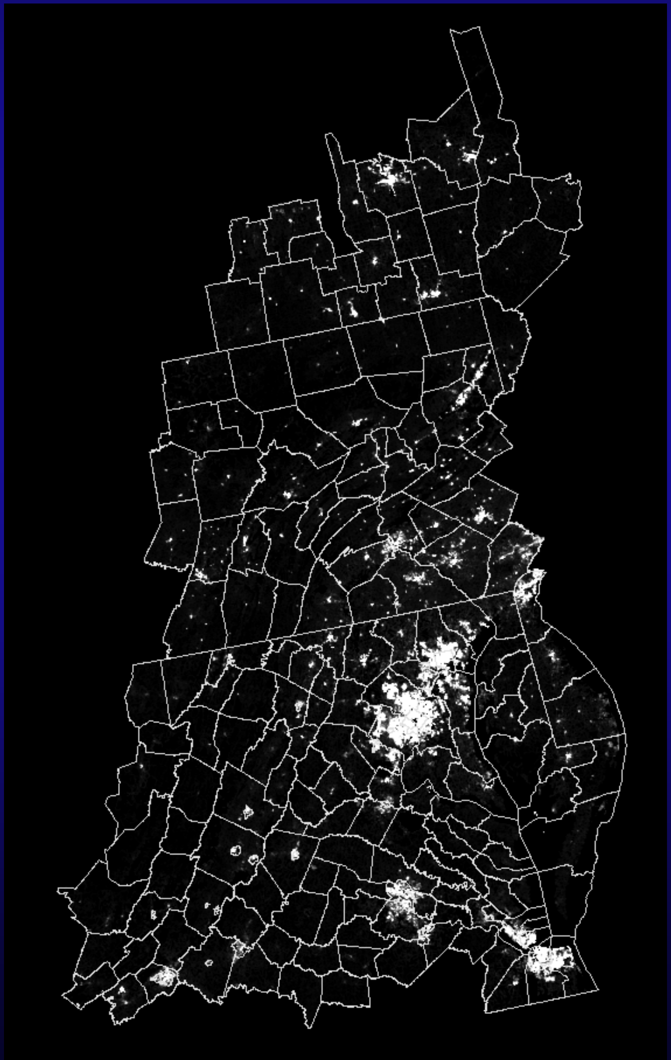
Population Distribution (yr. 2000)



Alternative Future Scenarios

Final Steps

- Distribute data to CBP Partners for review.
- Deliver written response to STAC review comments
- Complete USGS peer review and publish methods

Contact Information:

Peter Claggett

Research Geographer

U.S. Geological Survey

pclaggett@usgs.gov

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