



**Department of the Environment**

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# Chesapeake Bay Phase 6 Watershed Model Land- Use

October 26, 2015

MDP and MDE – SSA

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**MDP**  
Maryland Department of Planning





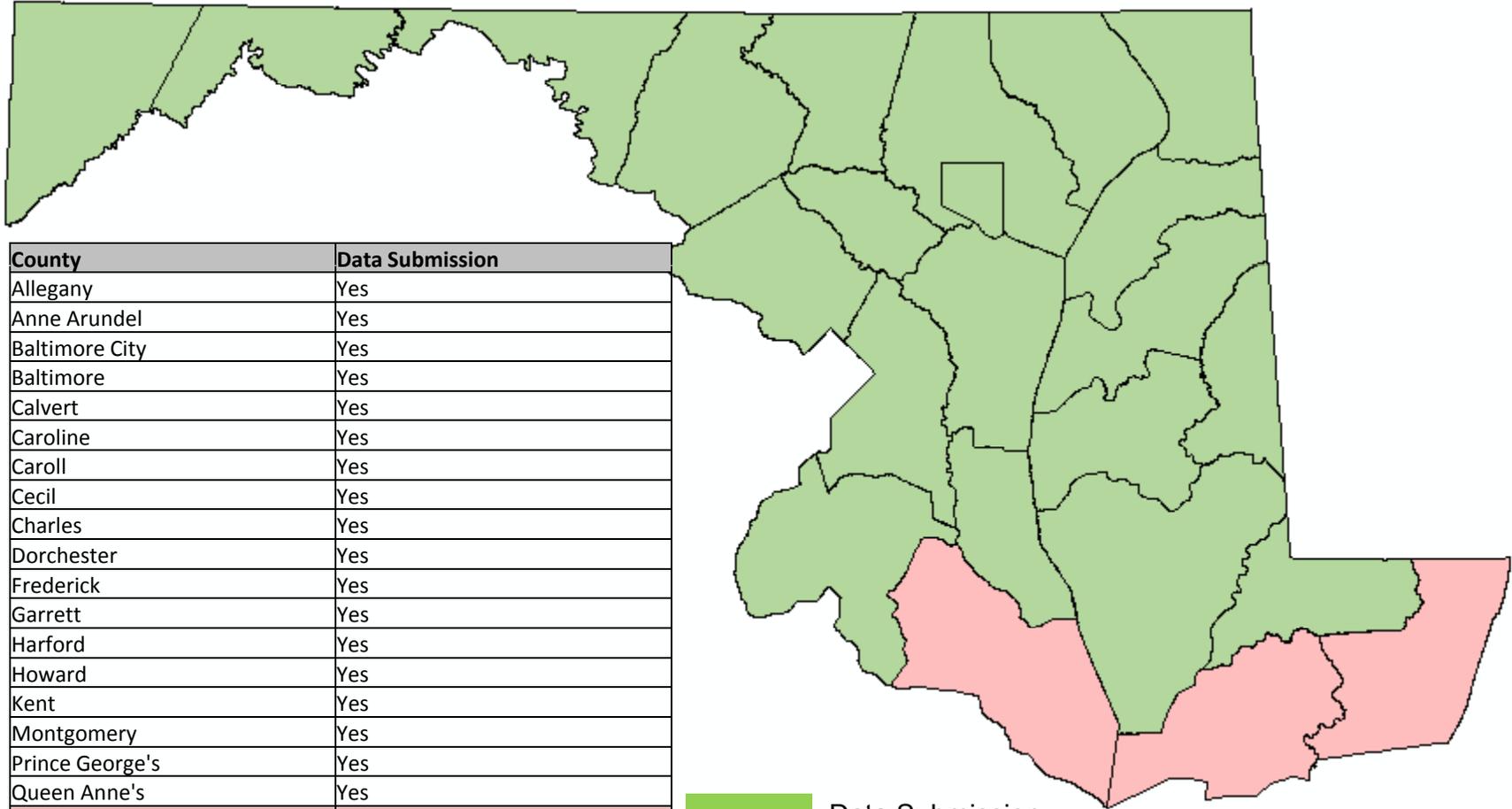
# P6 Model Schedule

- Land-Use Version 1 (Fall 2015)
- General Model Calibration (Winter 2016)
- Land-Use Version 2 (Fall 2016)
- Detailed Model Calibration (Winter 2017)
- Phase III WIPs (2018)

Local data  
updates to  
MDE/MDP  
(By March  
2016)



# Local Data Submission

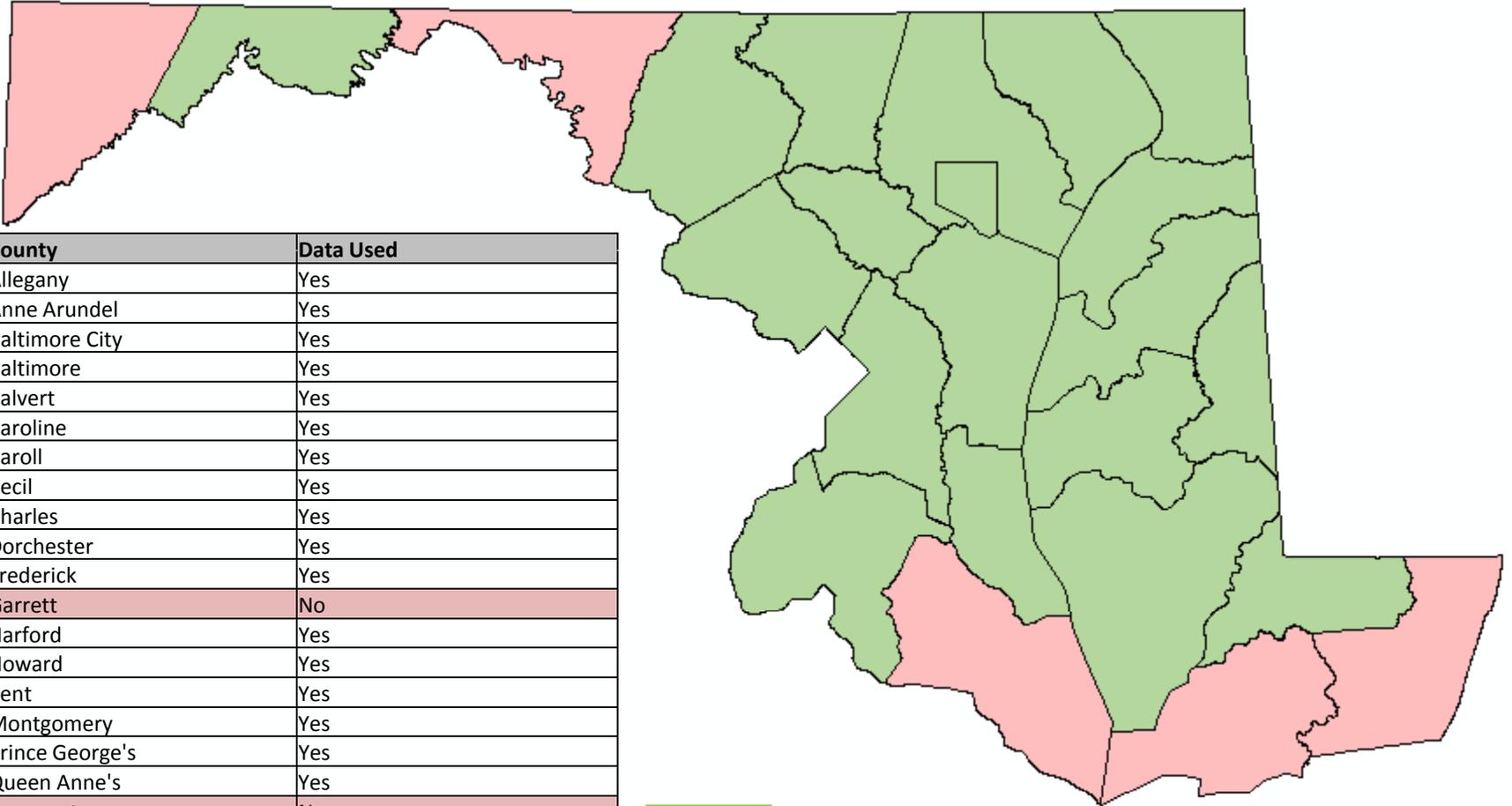


County	Data Submission
Allegany	Yes
Anne Arundel	Yes
Baltimore City	Yes
Baltimore	Yes
Calvert	Yes
Caroline	Yes
Caroll	Yes
Cecil	Yes
Charles	Yes
Dorchester	Yes
Frederick	Yes
Garrett	Yes
Harford	Yes
Howard	Yes
Kent	Yes
Montgomery	Yes
Prince George's	Yes
Queen Anne's	Yes
Somerset	No
St. Mary's	No
Talbot	Yes
Washington	Yes
Wicomico	Yes
Worcester	No

 Data Submission  
 No Data Submission



# Local Data Used



County	Data Used
Allegany	Yes
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Wicomico	Yes
Worcester	No

 Data Used  
 No Data Used



# MD P6 Model Webpage

- [http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/phase6\\_development.aspx](http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/phase6_development.aspx)

**Water Programs**

- MD's Blueprint for Bay Restoration
- TMDL Documents A-Z
- Draft TMDL for Public Comment
- TMDL Implementation
- TMDL Resource Links
- Signup to Receive TMDL Updates
- Approved Final TMDLs
- Water Quality Assessment Report
- Water Quality Standards
- TMDL Data Center
- TMDL Home

**Chesapeake Bay Phase 6 Watershed Model Development**

**Background**

The Chesapeake Bay Program (CBP), in conjunction with the Bay watershed states, has been working on the development of the Phase 6 version of the Chesapeake Bay Watershed Model (P6 Model). The P6 Model will be used in the development of the Phase III Chesapeake Bay Watershed Implementation Plan (WIP) and the development of the new model is available for download below. Currently, the only item for stakeholders to view is the first draft version (v1) of the P6 land-use. New items will be added to this page as they are made available by CBP and the State of Maryland.

**Model Land-Use (Draft, Version 1)**

Following the development of Maryland's Phase II WIP, MDE received comments from several local jurisdictions related to the model land-use estimates. In order to fully address these concerns, MDE and its partners, Maryland Department of Planning (MDP), Maryland Department of Natural Resources (MD DNR), and CBP, have made it a priority to collect and incorporate the most accurate local land-use/land-cover data into the P6 Model. For the majority of the State, this meant incorporating the planimetric datasets compiled by the counties. The land-use data sets provided below utilize and build off this data. MDE and its partner agencies are currently asking for the local jurisdictions to review the data and provide the State with feedback.

**Model Land-Use Methods**

The State has developed methodologies for incorporating impervious cover and high-resolution land-cover data from the local jurisdictions to estimate the areas of impervious surfaces per watershed model segment. For forest and other tree canopy land uses, the best available data is the University of Maryland's 1-meter resolution statewide tree canopy cover dataset. Maryland used this dataset to develop estimates for forest, tree canopy over impervious surfaces, tree canopy over turf grass, and tree canopy over open space. For wetlands, the best available data is the National Wetlands Inventory (NWI) coupled with MD DNR's mapping of wetlands.

The State has identified no spatial datasets for turf grass that conform to the quality standards of this project. This includes even high-resolution land-cover, since most remotely sensed imagery and LIDAR data cannot distinguish between turf grass, hay, pasture, and other low-lying vegetation. In response, the State has developed interim methods for estimating turf grass areas, and is currently working on methods that utilize a random sampling and statistical modeling approach based on parcel information. These methods are described in much further detail in the methodology documents available for download below.

These datasets represent the first draft (v1) of the new watershed model land-use, which will be used for the general calibration of the model. Version 2 of the model land-use will be finalized by September 2016 and the final calibration of the model will begin in October 2016. Updates to the model are planned for the subsequent versions of the land-use.

**County Summary Sheets**

<a href="#">Allegany</a>	<a href="#">Anne Arundel</a>	<a href="#">Baltimore County</a>	<a href="#">Baltimore City</a>
<a href="#">Calvert</a>	<a href="#">Caroline</a>	<a href="#">Carroll</a>	<a href="#">Cecil</a>
<a href="#">Charles</a>	<a href="#">Dorchester</a>	<a href="#">Frederick</a>	<a href="#">Garrett*</a>
<a href="#">Harford</a>	<a href="#">Howard</a>	<a href="#">Kent</a>	<a href="#">Montgomery</a>
<a href="#">Prince George's</a>	<a href="#">Queen Anne's</a>	<a href="#">Somerset†</a>	<a href="#">St. Mary's†</a>
<a href="#">Talbot</a>	<a href="#">Washington*</a>	<a href="#">Wicomico</a>	<a href="#">Worcester†</a>

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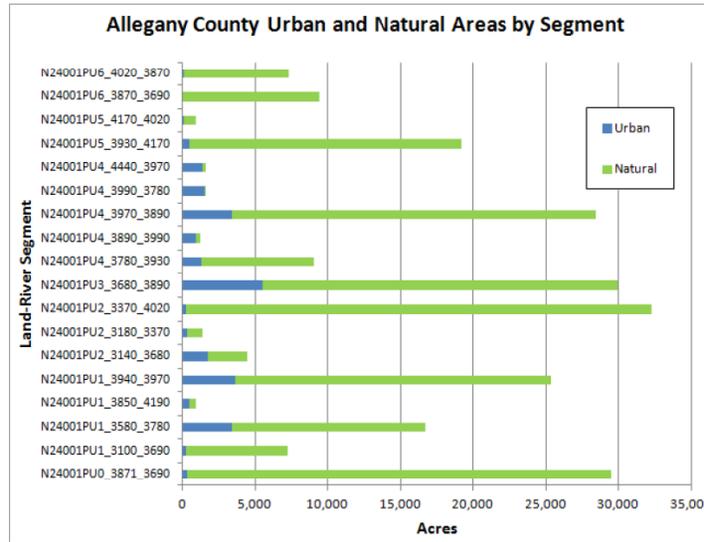
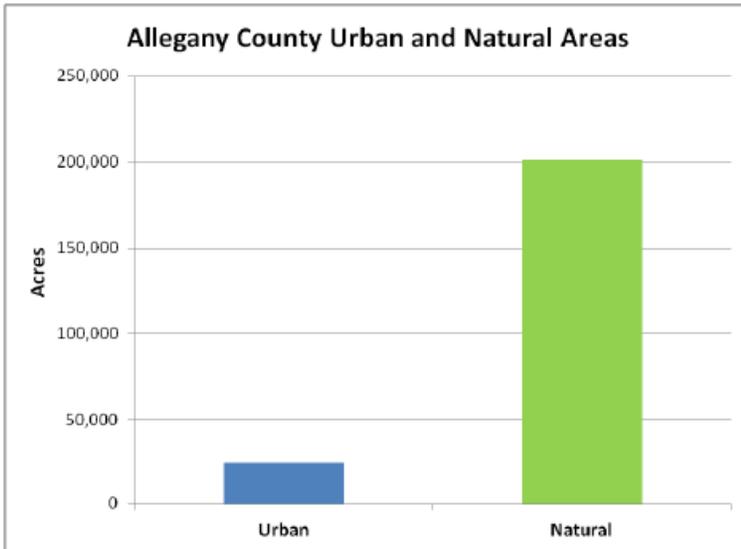
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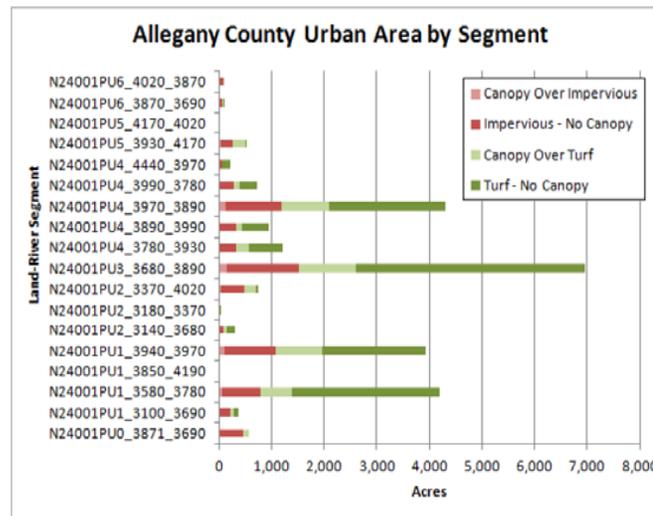
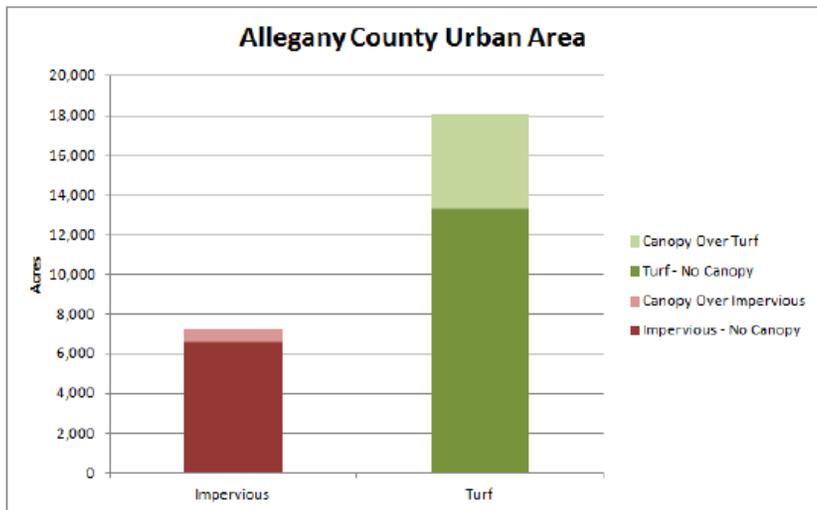
For information about the TMDL Data Center, please contact Greg Busch at 410-537-3901 or at [gregory.busch@maryland.gov](mailto:gregory.busch@maryland.gov).



# County Summary Sheets



- Urban/Natural area summaries
- Urban Breakdown
  - Impervious
  - Turf
- Natural Breakdown
  - Forest
  - Open Space
  - Wetland





# Data

## Data

The following data files are available for download:

- 1) [The actual Phase 6 land-use dataset that was submitted to CBP by the State of Maryland MD Phase 6 Land-Use Data](#)
- 2) [A document containing Maryland's primary QA/QC on the data provided to CBP MD Phase 6 Land-Use QA/QC](#)
- 3) [The P6 watershed model segments MD Phase 6 Watershed Model Segments](#)

## Methodology Documents

- [Impervious Surface Methodology Document](#)
- [Turf Grass Methodology Document](#)
- [Forest and Tree Canopy Methodology Document](#)
- [Wetlands Methodology Document](#)

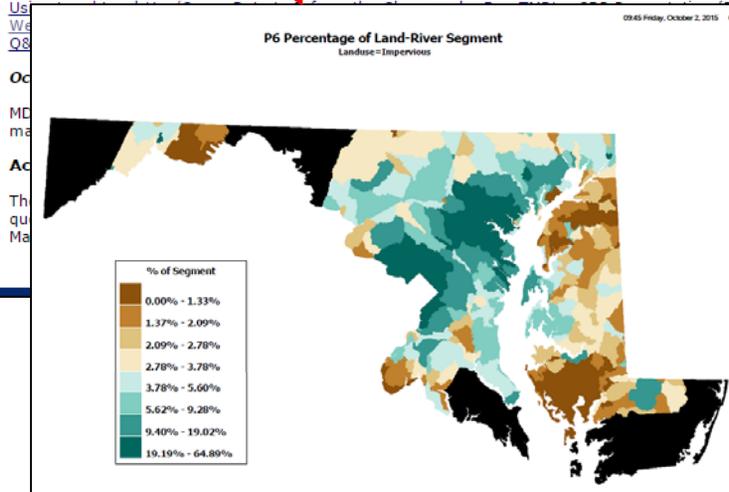
## Outreach Materials

[April 28, 2015 - Chesapeake Bay Phase 6 Watershed Model Land-Use Development Webinar](#)

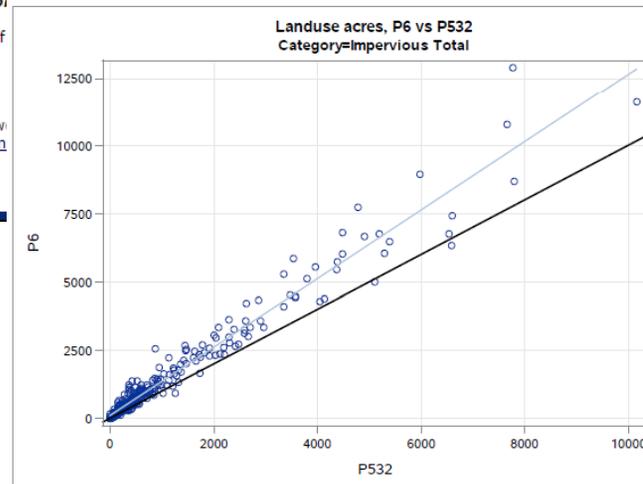
MDE and MDP hosted a webinar that discussed the development of the Chesapeake Bay Program's Phase 6 watershed model land-use for Maryland. The Phase 6 modeling tools are being developed to inform the Phase III WIPs. MDE, MDP, and USGS presented on the Land-Use Classifications, Incorporation of Local Jurisdiction Data, and Maryland Specific Methodologies.

[Chesapeake Bay Phase 6 Watershed Model Land-Use - MDE/MDP Presentation \(PDF\)](#)

FIPS	CNTYNAME	LndRvrSeg	Seg_Acres	INR	IR	INRF	IRF
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24001	ALLEGANY	N24001PU1_3100_3690	10110.98575000	57.12581797	150.7326801	1.12E-10	0.164830645
24001	ALLEGANY	N24001PU1_3580_3780	19980.78215200	364.4389043	425.7282123	0	0
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24001	ALLEGANY	N24001PU1_3940_3970	35959.38730600	576.8051942	508.9619059	0	0
24001	ALLEGANY	N24001PU2_3140_3680	3487.41928470	45.15616146	28.96371291	0	0
24001	ALLEGANY	N24001PU2_3180_3370	1424.91158680	2.434890235	6.316431103	0	0
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24001	ALLEGANY	N24001PU3_3680_3890	35397.67877600	946.6232757	563.2590189	0.007094567	0
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24001	ALLEGANY	N24001PU4_3890_3990	1262.71221710	1262.71221710	211.7832211	0.053594587	1.335364416
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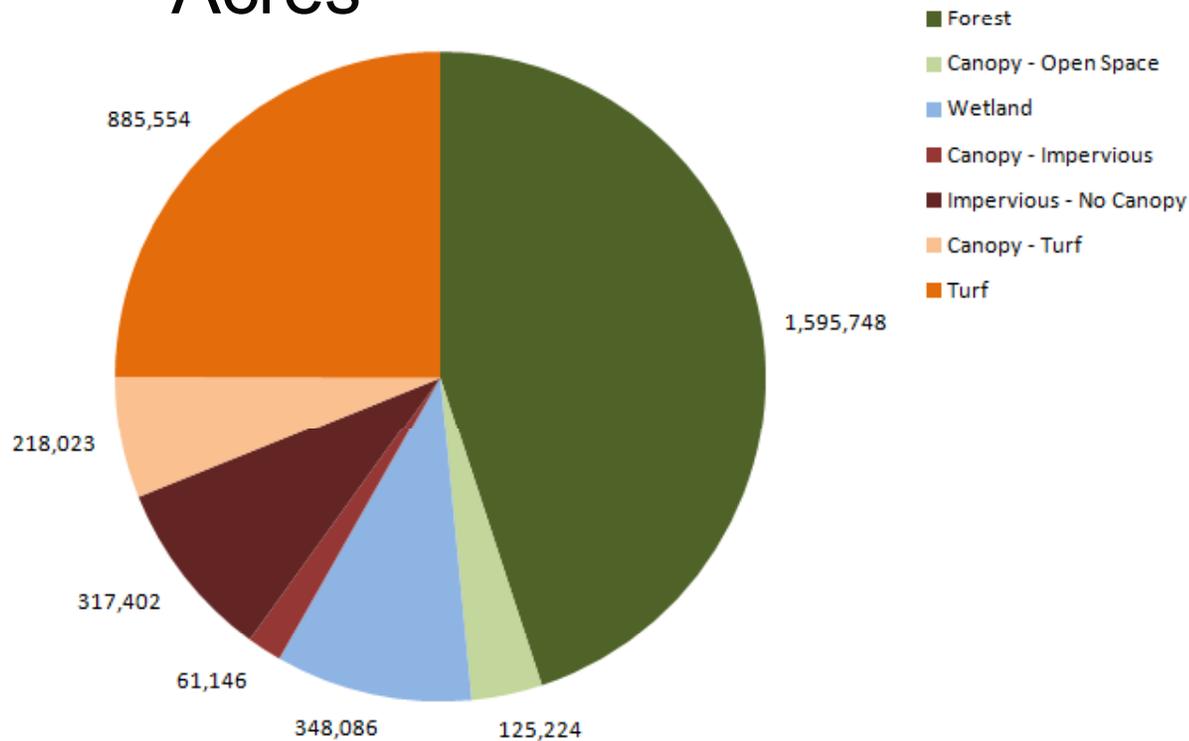
# P6 Webpage Improvements

- Link to CBP P6 land-use webpage
  - Actual model land-use
  - Viewer for regional data used to develop land-use for counties that did not submit data
- Final model data summaries
- Original Data Links
  - County impervious cover data
  - UMD tree canopy data
  - NWI + MD DNR wetlands data



# MD P6 Land-Use Summary

Acres



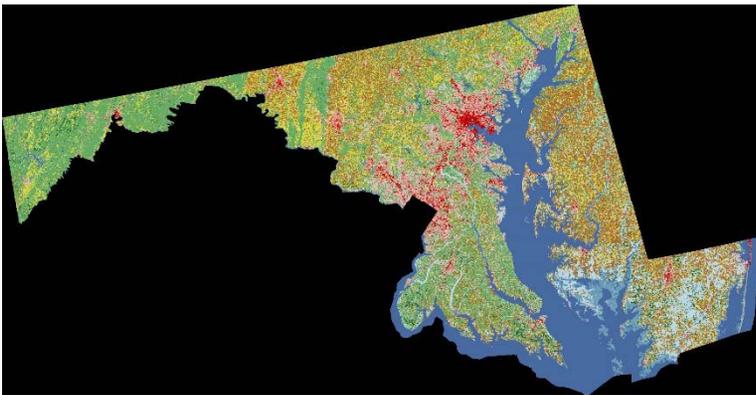
- No open space, agriculture, or open water
  - CBP estimates
  - Open space = left-over
  - Ag = agricultural census
  - MD data not better for open water
- Turf acres = “interim”
  - Very rough estimates
  - Significant accuracy improvement for Version 2
- Impervious surface + forest/canopy estimates
  - Accurate
  - Derived from local planimetric data and 1 m tree canopy cover data

- Wetland acres do not include tidal wetlands
- Tidal wetlands removed from watershed model

- Urban = Impervious - No Canopy + Canopy over Impervious + Turf - No Canopy + Canopy Over Turf
- Natural = Forest + Canopy Over Open Space

# Methods: Impervious Surfaces

NLCD 30m pixels



MD 6-in pixel imagery





# Impervious Surface Data

- Data similarities among jurisdictions
  - Complete planimetric data
  - planimetric data with missing features only
  - planimetric data with missing features + high res land-cover



# Scenario 1: Complete Planimetric data







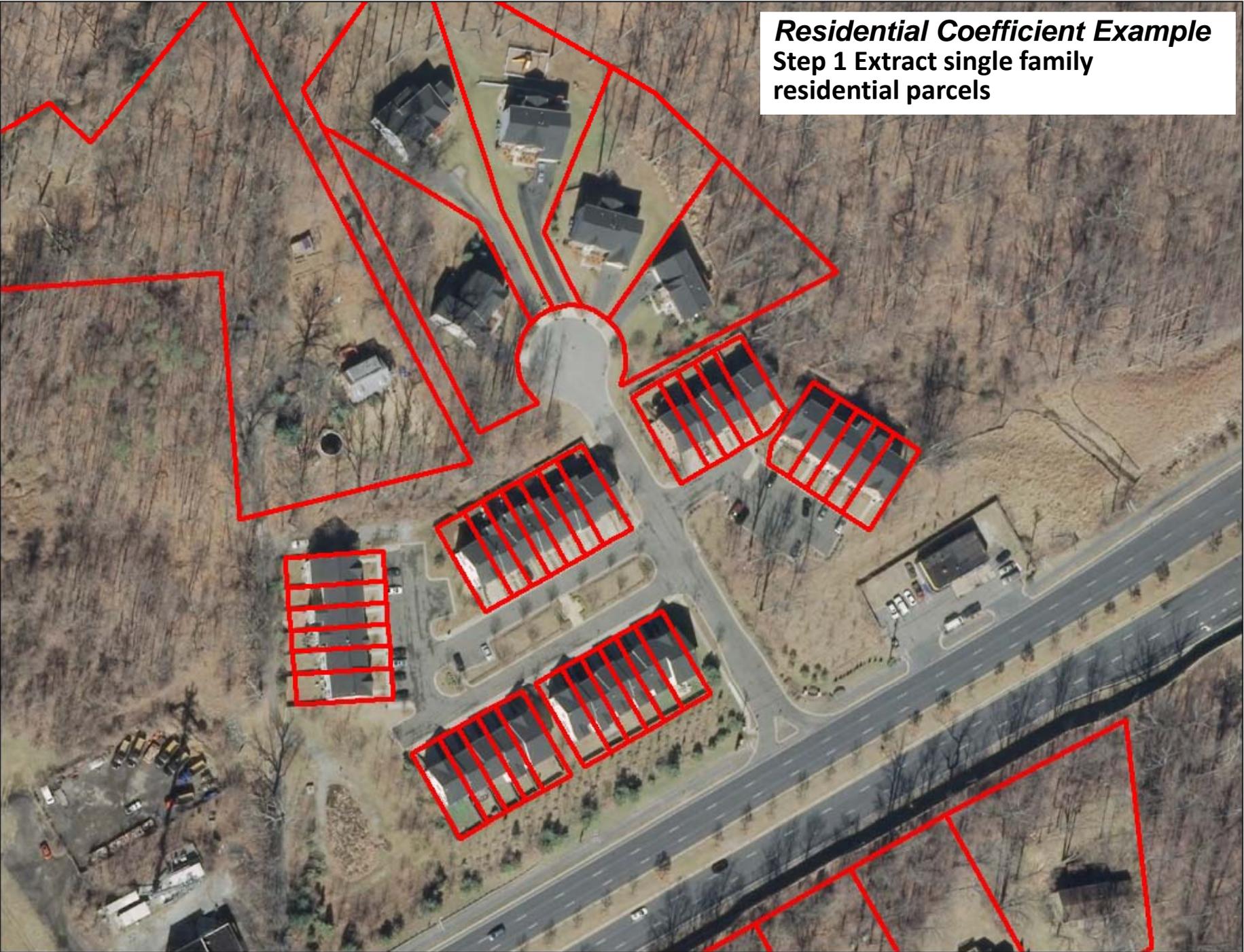
**-Imagery year = 2010**  
**-Phase 6 baseline = 2012**



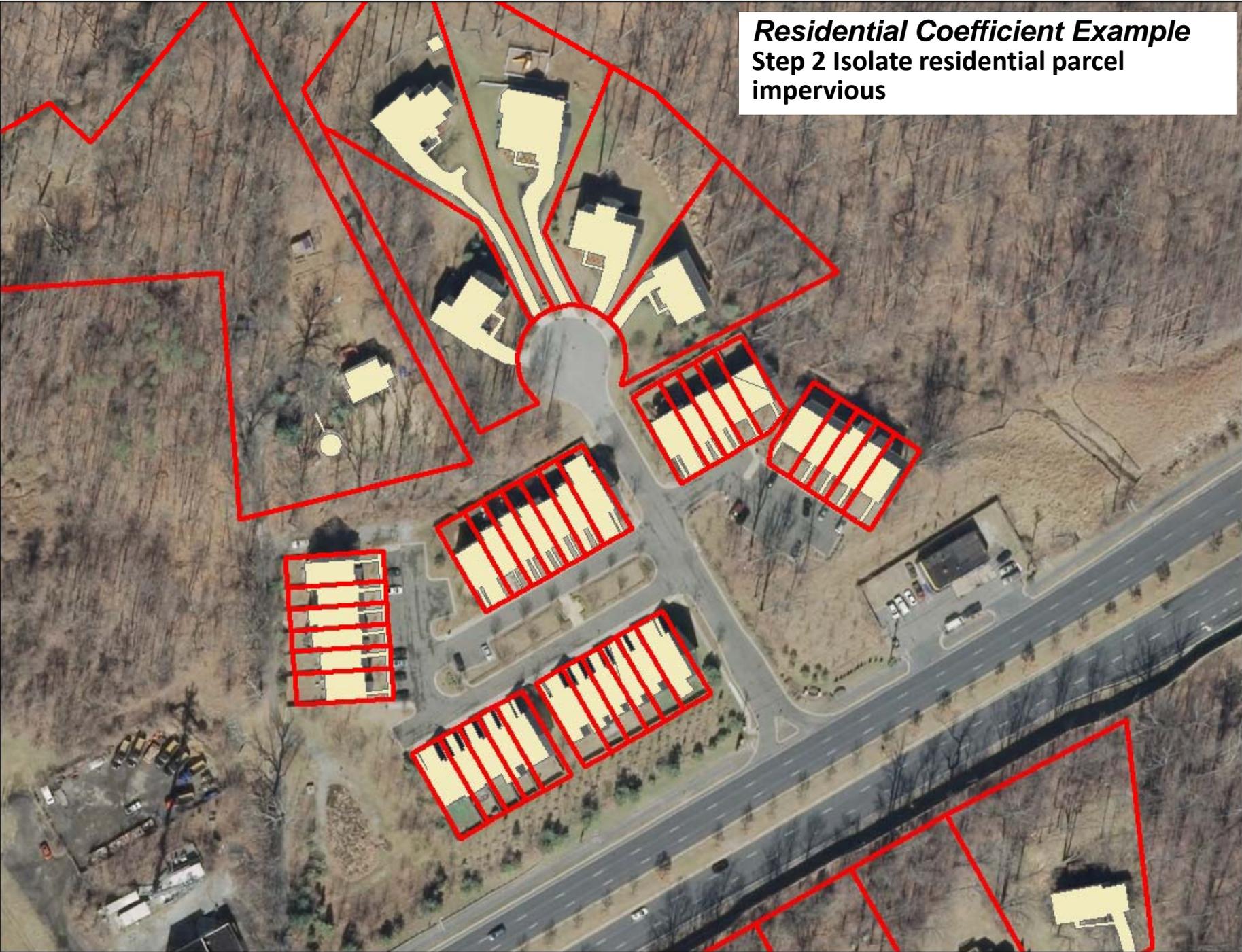
# Project to Baseline Conditions

- Planimetric data – vary from 2005 - 2011
- How to project to 2012?
  - Example - Imagery = Winter/Spring 2011
    - Reflects 2010 conditions
  - Best available data
    - MDP - MD Propertyview database
      - Parcels developed in 2011 and 2012
- Method
  - Calculate impervious coefficients for developed parcels through 2010 (planimetric data conditions)
  - Use coefficient and apply to parcels built since the planimetric data year (2011-2012)
  - Separate methods for residential and non-residential parcels

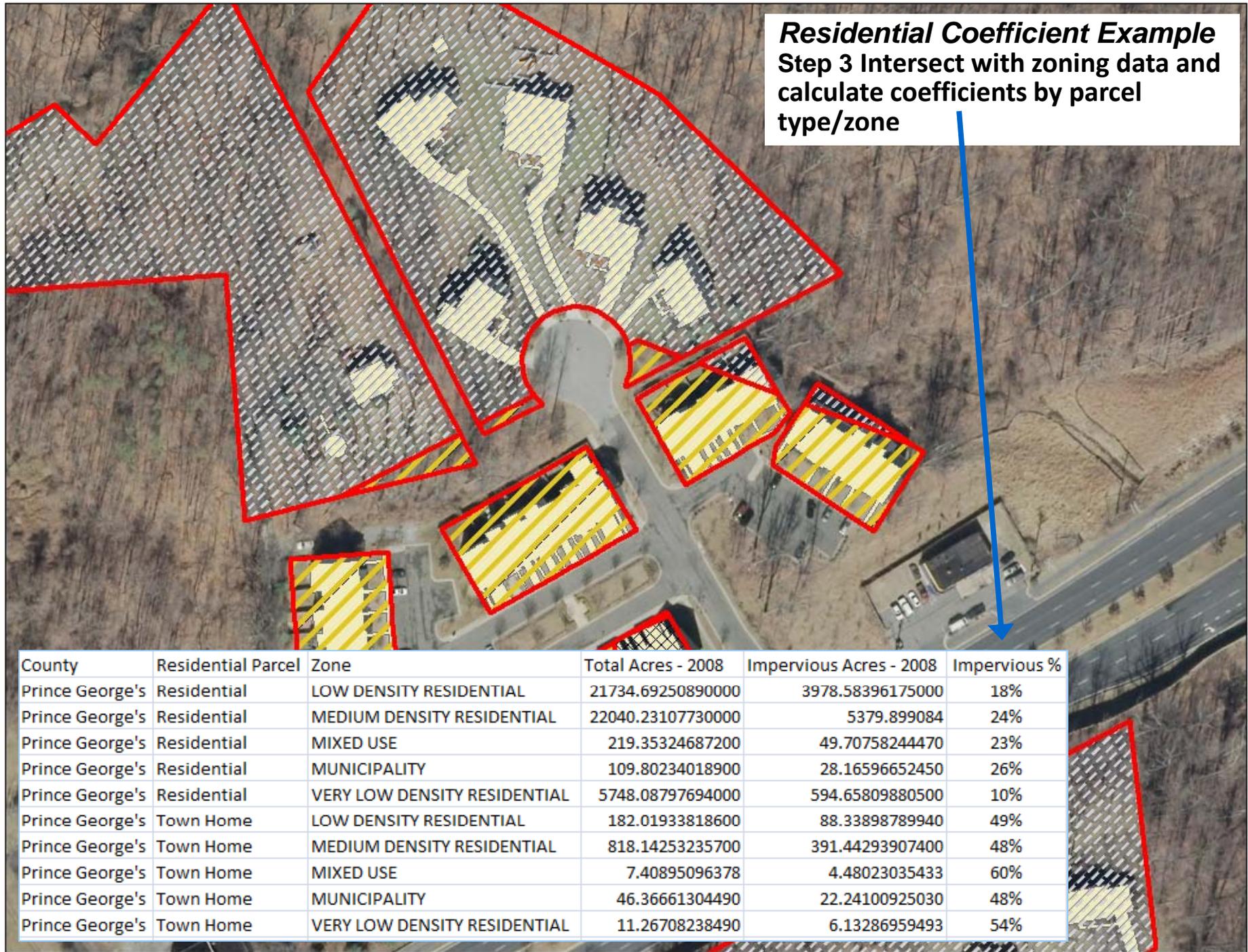
**Residential Coefficient Example**  
**Step 1 Extract single family**  
**residential parcels**



**Residential Coefficient Example**  
**Step 2 Isolate residential parcel**  
**impervious**



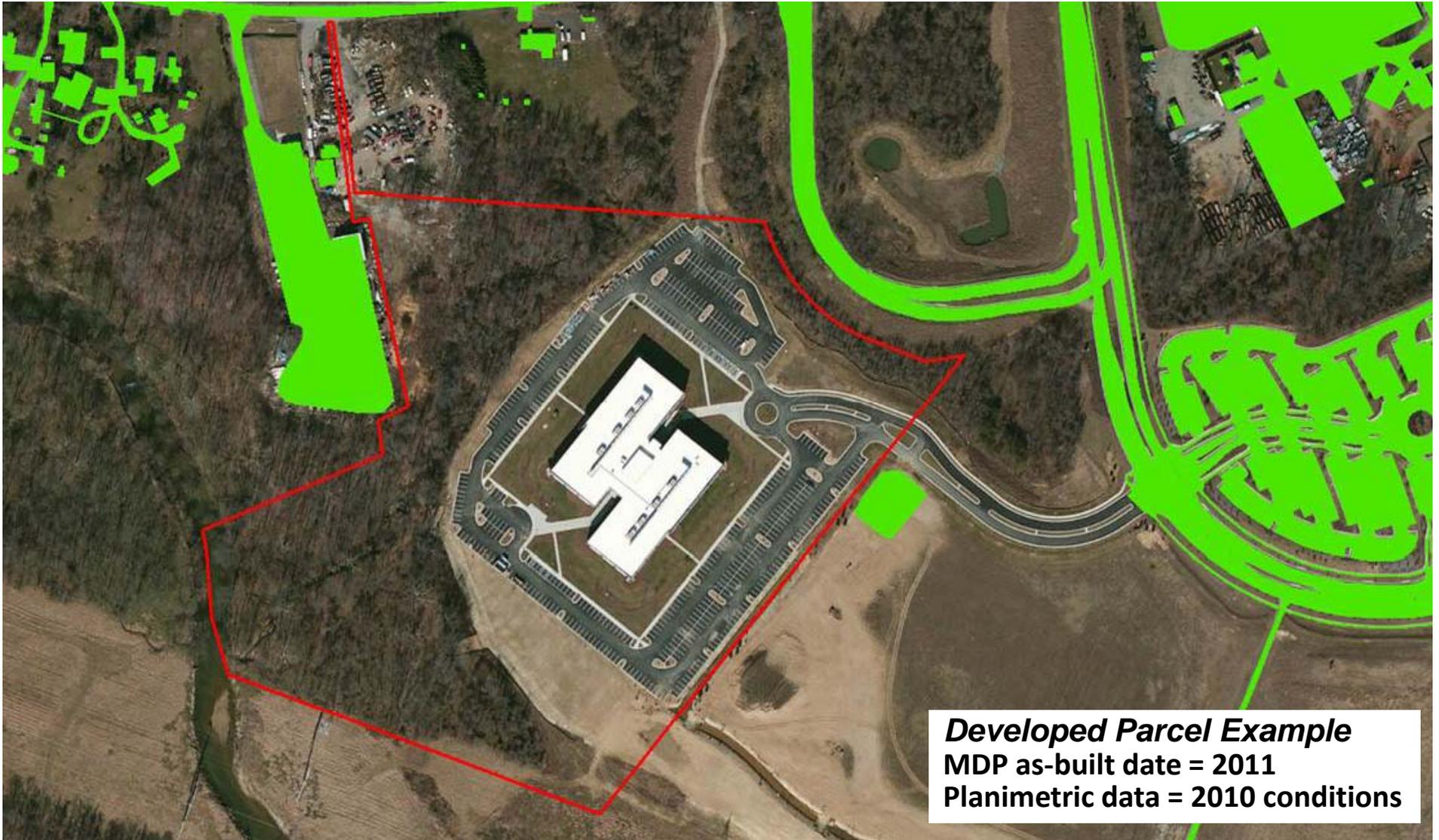
**Residential Coefficient Example**  
**Step 3 Intersect with zoning data and**  
**calculate coefficients by parcel**  
**type/zone**



County	Residential Parcel	Zone	Total Acres - 2008	Impervious Acres - 2008	Impervious %
Prince George's	Residential	LOW DENSITY RESIDENTIAL	21734.69250890000	3978.58396175000	18%
Prince George's	Residential	MEDIUM DENSITY RESIDENTIAL	22040.23107730000	5379.899084	24%
Prince George's	Residential	MIXED USE	219.35324687200	49.70758244470	23%
Prince George's	Residential	MUNICIPALITY	109.80234018900	28.16596652450	26%
Prince George's	Residential	VERY LOW DENSITY RESIDENTIAL	5748.08797694000	594.65809880500	10%
Prince George's	Town Home	LOW DENSITY RESIDENTIAL	182.01933818600	88.33898789940	49%
Prince George's	Town Home	MEDIUM DENSITY RESIDENTIAL	818.14253235700	391.44293907400	48%
Prince George's	Town Home	MIXED USE	7.40895096378	4.48023035433	60%
Prince George's	Town Home	MUNICIPALITY	46.36661304490	22.24100925030	48%
Prince George's	Town Home	VERY LOW DENSITY RESIDENTIAL	11.26708238490	6.13286959493	54%

# Impervious 2012

- 2012 Impervious (ac) = 2010 Impervious (ac) + [2011-2012 developed parcels (ac) x Coefficient]
- For residential and non-residential parcels
  - Residential = coefficients by parcel type and zone
    - Zoning data: MDP generalized zoning
  - Non-residential = coefficients by CIUSE
- QA/QC
  - Correction Factor
  - Visual QA of top area nonresidential parcels



***Developed Parcel Example***  
MDP as-built date = 2011  
Planimetric data = 2010 conditions



## QA/QC

- Correction Factor
- Visual QA of top area nonresidential parcels

### **Correction Factor Example**

Coefficient-predicted area -  
Planimetric parcel impervious  
area = overall increase

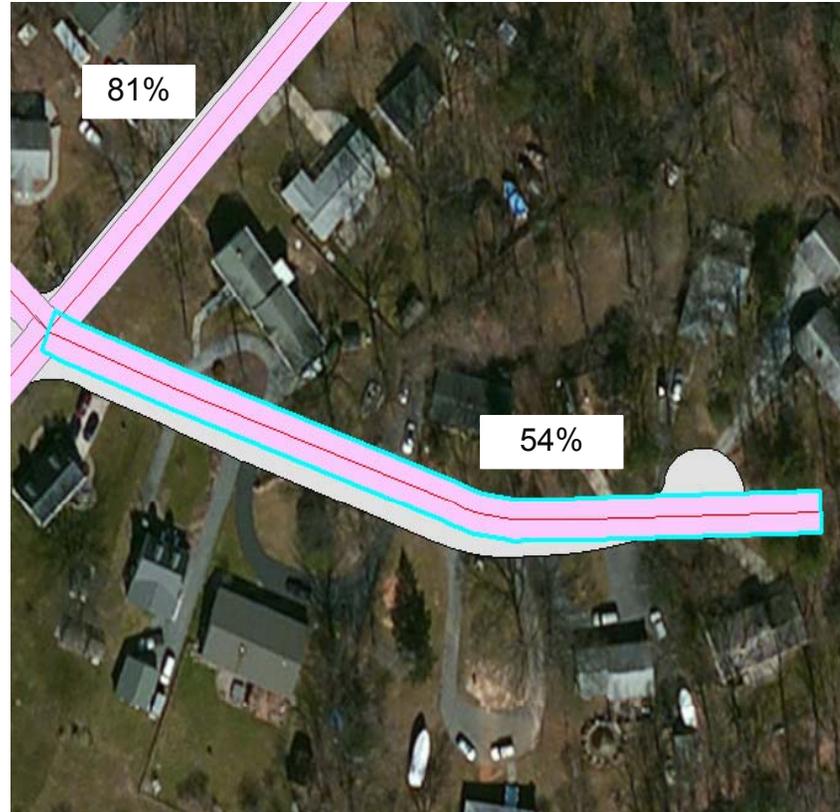
**Visual QA**

Parcel	LndRvrSeg	coefficient	coefficient predicted impervious area increase	correction factor (estimate)	Overall impervious increase	Action
1	A24003XU2_4270_4650	0.675352131	25.77921508	1.5	24.27921508	No change - impervious increase

# What about roads?

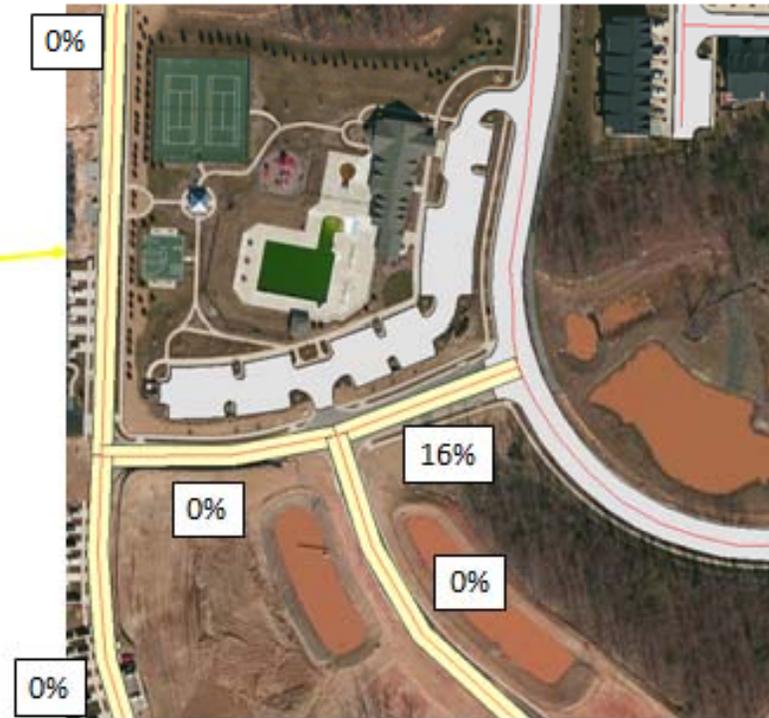
- Existing Roads
  - County planimetric separate road designation
  - NAVTEQ
    - Best available data (2012 conditions)
    - Buffer centerlines
    - Use to apportion county data between road and non-road impervious, if county does specifically designate roads
- New Roads
  - New roads not accounted for in county data, if imagery year prior to 2012
    - Apply NAVTEQ
    - Issue: Road centerlines do not align well spatially with county impervious data
    - Solution: Intersect area threshold

### Example 1 – Roads already captured by planimetric data



-  County Planimetric Roads
-  NAVTEQ Buffered Segments already captured
-  NAVTEQ Segments

### Example 2 – Roads not captured by planimetric data – missing or “new”



-  County Planimetric Roads
-  NAVTEQ Buffered Segments designated as “New” roads
-  NAVTEQ Segments

# Road vs. non-road impervious

- $INR = I_{Total} - IR,$ 
  - Where,
    - $IR = \text{Impervious Road}$ 
      - (Baseline Roads) + (New Roads)
    - $I_{Total} = \text{Total Impervious}$ 
      - (Baseline Total) + (Missing Feature Estimates) + (Res/Non-res Projection to 2012) + (New Roads)
    - $INR = \text{Impervious Non-road}$



# Scenario 2: Planimetric Data with Missing Features







# Missing Feature Coefficients

- Account for impervious features missing from data using coefficients
- Method:
  - Use counties with complete planimetric data
  - Calculate coefficients for residential and non-residential parcels
  - Apply coefficients to counties with missing data

# Estimate IC Feature Area

<b>Residential Parcels</b>					
County	Total Impervious	Sidewalks		Patios	
	ac	ac	RATIO	ac	RATIO
Anne Arundel	12,067	430	4%	1,048	9%
Calvert	3,814	119	3%	267	7%
Prince Georges	12,710	NA	NA	583	5%
State Coefficient Avg			3%		7%
<b>Non-Residential Parcels</b>					
County	Total Impervious	Sidewalks		Patios	
	ac	ac	RATIO	ac	RATIO
Anne Arundel	8,731	323	4%	35	0%
Calvert	870	39	4%	8	1%
Prince Georges	7,552	NA	NA	10	0%
State Coefficient Avg			4%		0.5%



# Scenario 3: Planimetric Data with Missing Features + High- Resolution Land-Cover









**-Burn planimetric data into high-res LC**

# QAQC

- Comparison of methods (coefficient + high res) to DNR data: Baltimore + Montgomery counties
- DNR digitized all impervious surface for select watersheds (MBSS watersheds)
- Findings
  - For data missing small number of features, coefficient method more accurate
  - For data missing larger number of features, high-res method more accurate
    - Not spatially accurate, but estimated acres close to true acreage



# Turf Grass



# Turf Analysis – Interim Method

1. Calculate Pervious-to-Impervious ratio from Phase 5.3.2
  - 2006 No Action Scenario
  - Per model segment
2. Match P532 segments to P6 modeling segments
3. Calculate turf by applying ratios to MDE's 2012 impervious estimates

$$TG_i = [Imp_i * P532 Ratio_i] - TCOT_i$$

Where:

TG = Acres of turf grass in segment i

Imp = Acres of impervious surface in segment i

P532 Ratio = Phase 5.3.2 watershed model urban pervious to impervious ratio in segment i

TCOT = Tree canopy over turf in segment i



# Forest and Tree Canopy



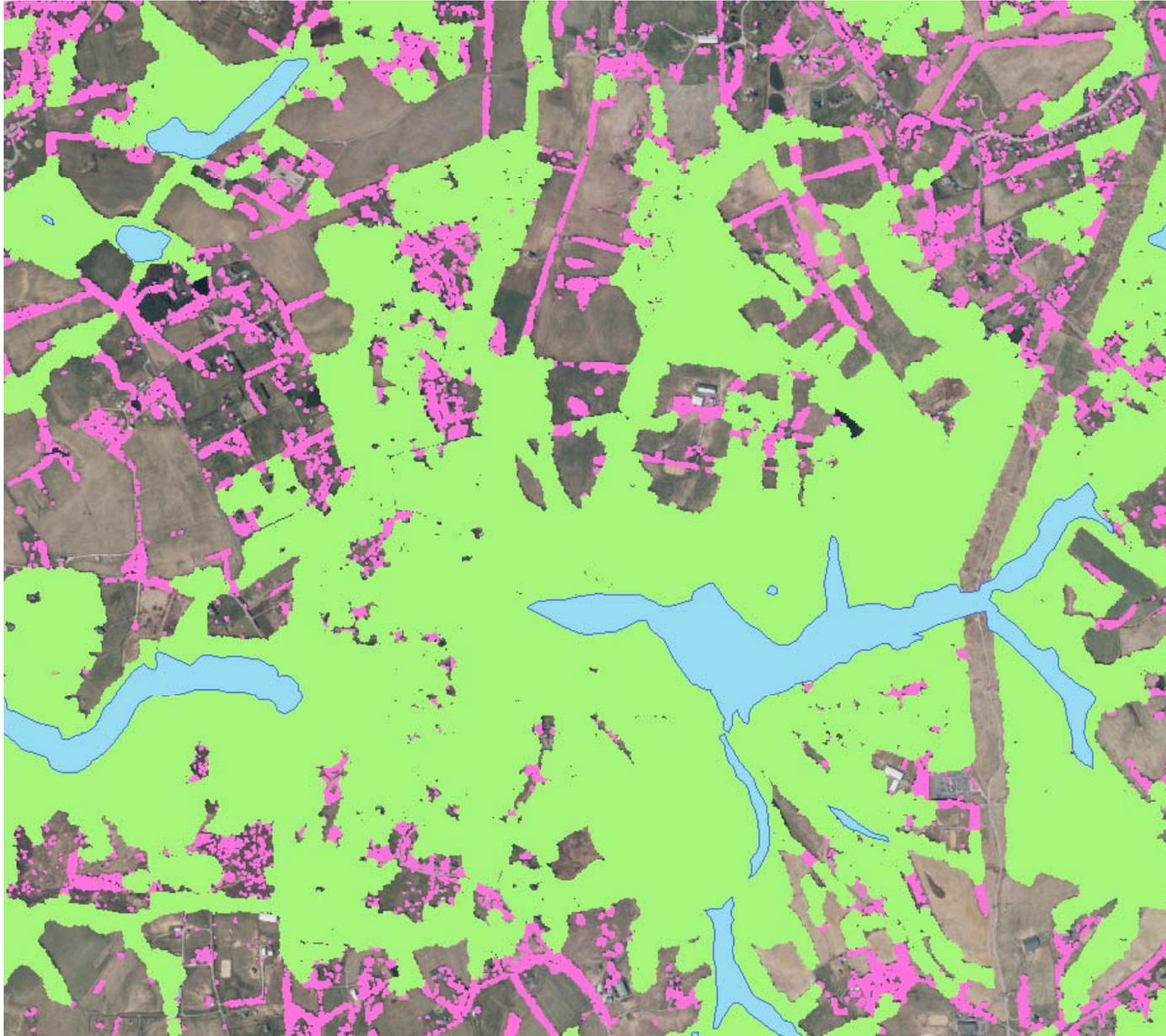
# Forest and Tree Canopy

- Best available data
  - UMD statewide 1 m canopy cover
- Forest vs. tree canopy
  - MD DNR modeling
    - Use statewide 1 m canopy data
    - Remove wetlands
    - Applies US Forest Service definitions for forest
      - Total size = 1 acre
      - Width = 120 ft.
    - Leftover canopy = tree canopy







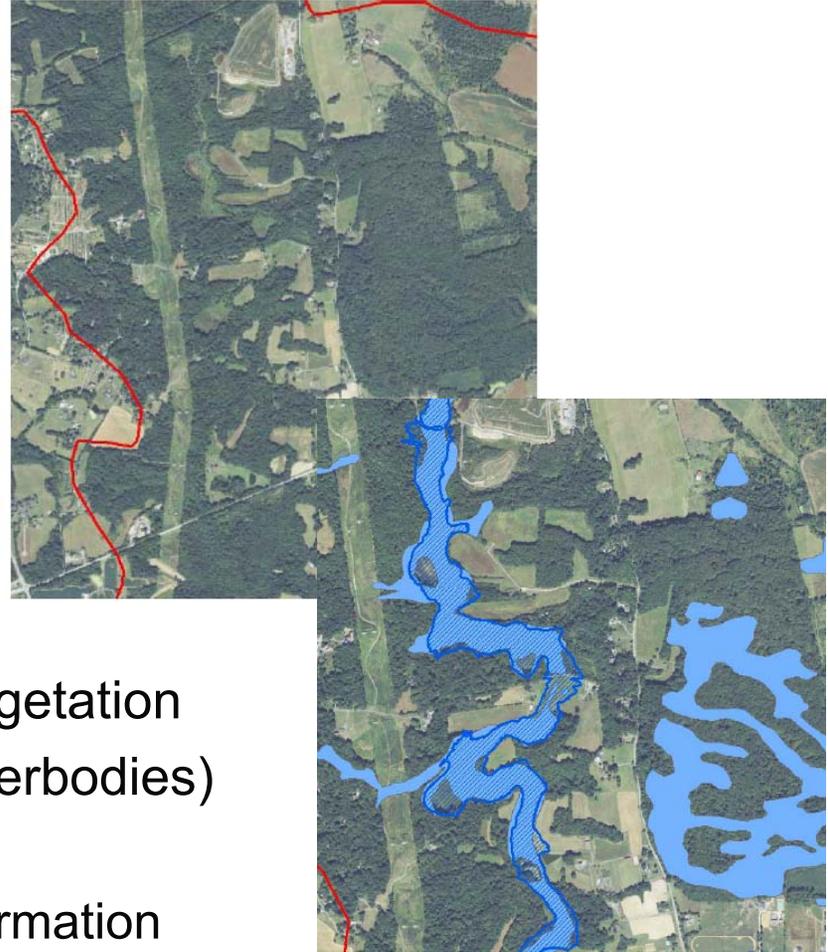


# Forest and Tree Canopy

- Tree canopy sub-classification
  - Canopy over impervious
    - Intersect with county impervious data
    - Adjust estimates if county impervious surface data missing features
      - Based on % impervious covered by canopy
  - Canopy over turf (urban)
    - Apply urban mask
      - Parcels > \$10,000 Improvement value
      - All commercial, industrial, and exempt parcels
      - Residential parcels < 20 acres
      - P532 urban and suburban zones
      - Buffered roads
  - Canopy over open space (natural)
    - Remainder

# Wetlands

- Data
  - NWI data
  - MD DNR data
  - DFIRMs
- Method
  - Union NWI + DNR polygons
  - Extract wetlands with emergent vegetation
  - Erase open water areas (NHD waterbodies)
  - Divide into sub-classifications
    - Tidal = NWI + DNR attribute information
    - Floodplain = intersection with 100 year floodplains (DFIRMs)
    - Headwater = Leftover





# Additional LULCs

- Agriculture
  - Set by agricultural census
- Open space
  - Left-over area
- Extractive
  - Currently modeled as open space in P6
- Open Water
  - CBP data
  - MD does not have higher-resolution data
- Construction
  - Phase 5.3.2 methods



# Summer 2016 Model Calibration

- Land-Use Improvements
  - MD Methods
    - Impervious Surfaces
    - Turf Grass
    - Forest/Tree Canopy
    - Wetlands
  - Chesapeake Conservancy high-resolution land-cover data
    - Fill in data gaps





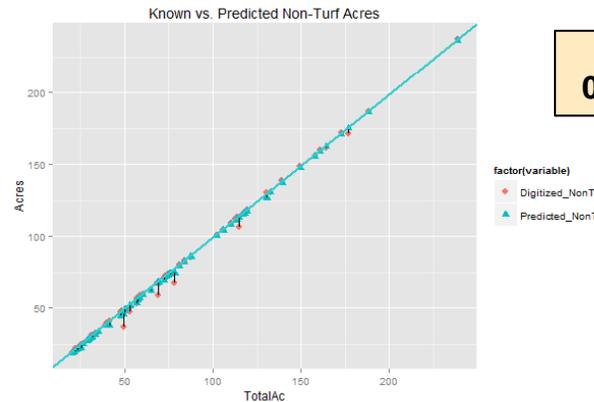
# Summer 2016 – Impervious Surface

- Suggested methodology revisions from counties
- Planimetric data updates from counties
  - Many jurisdictions are currently finalizing updates to their planimetric data using 2013/2014 imagery
  - Process with new imagery
  - Interpolate between imagery years
- Chesapeake Conservancy high-resolution land-cover data
  - For counties with significant number of features missing from data use Baltimore County methods
    - Burn planimetrics into high-resolution data

# Summer 2016 – Turf Grass

## 1. Group parcels:

- MS4
- Land Use type
- Parcel Size



$$\text{NonTurf} = -1.196 + 0.995512(\text{TotalP}) - 1.905(\text{STRU})$$

## 2. Develop statistical model for turf

- Aggregate & individual scales
- Random sampling/digitize turf
- Model turf acres
  - Propertyview + other data sources
  - Key variables
    - Parcel size, Building present/absent, CIUSE/EXCLASS, and Development zone



Digitized Turf



# Summer 2016 - Forest

- Imagery change detection updates
- Imagery years for UMD canopy cover data for some counties pre-2011/2012
- MD DNR use imagery change detection to map loss/gain for forest to update county forest delineation to 2011/2012 conditions



# Summer 2016 – UTC vs. RTC

- Urban tree canopy vs. rural tree canopy
  - Canopy over turf vs. canopy over open space
- Large lot parcels
  - Currently, all canopy considered to be over open space
    - Distinguish between canopy over turf and canopy over open space
      - Include canopy sampling with turf sampling to develop ratio between turf and canopy and large lot parcels



# Summer 2016 – Wetlands

- Incorporate NWI + Data
  - Improved delineation of wetland landscape position
- Use soil conditions to delineate additional wetland areas missing from current estimates
  - Upland reduction efficiencies for wetlands?



# Septic Systems





# Septic Systems - Model Estimates

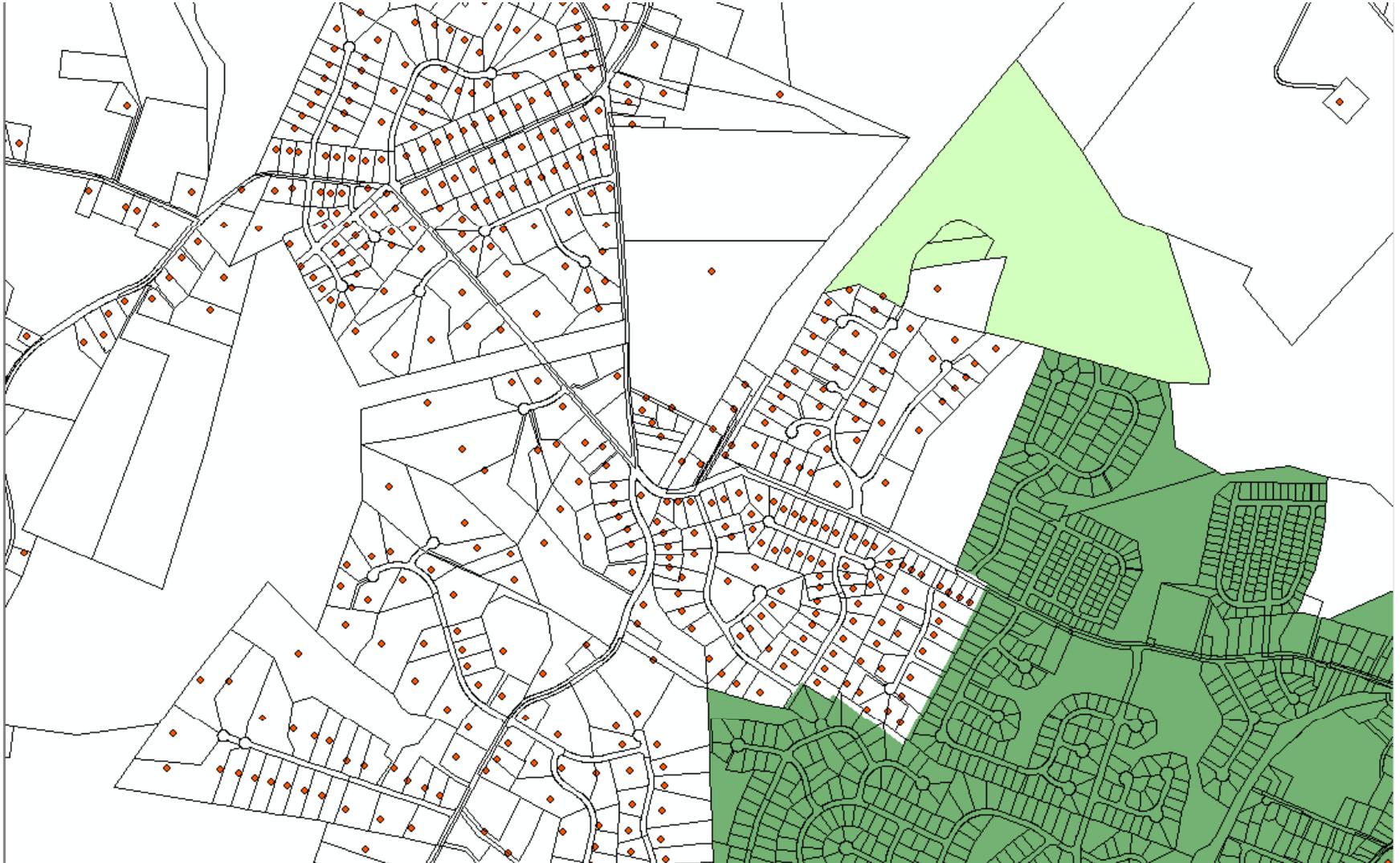
- Current calibration
  - CBP estimates for 2012 used
  - QAQC and back-cast to 2010 using MDP estimates
- Summer 2016
  - MDP 2012 estimates and local data



# Estimating Residential Septic Systems (MDP)

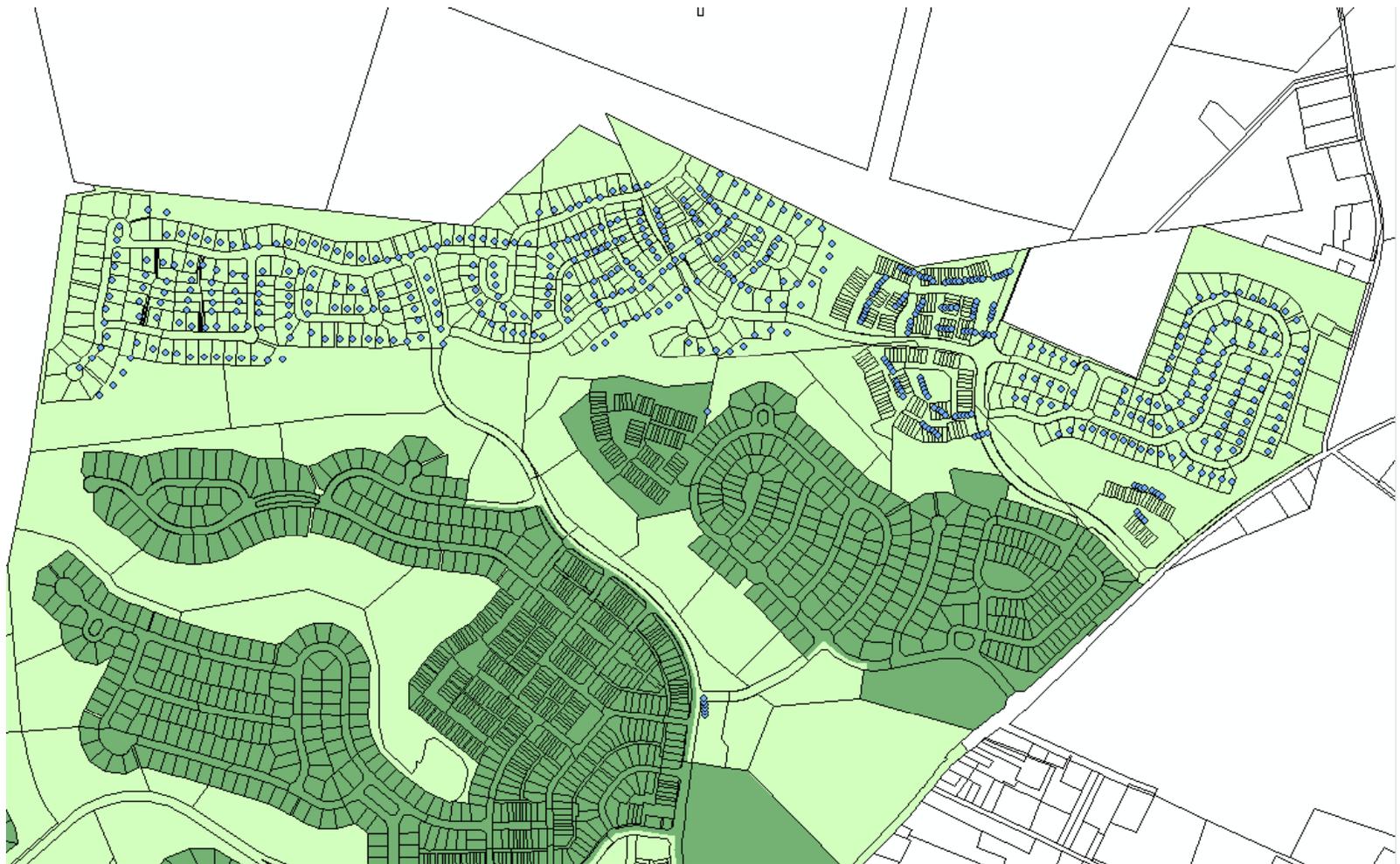
- MdProperty View parcel point data
- Sewer service area data from local governments
- Query improved residential parcels outside of existing (S1) areas
- Adjust for areas in “planned” service areas that are actually sewerred
- Compare with local estimates

# Residential Parcels on Septic

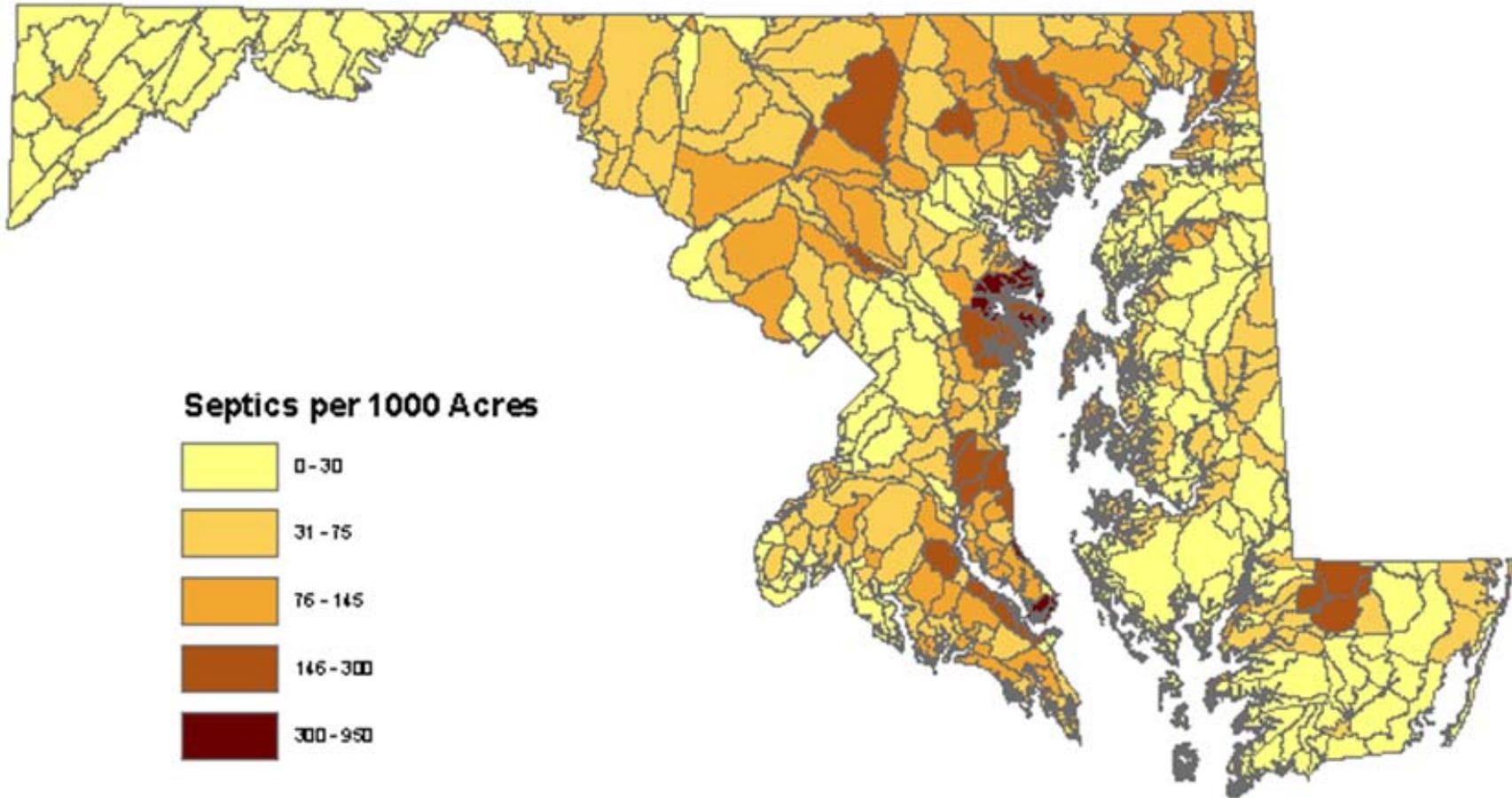




# Adjustments for Recent Development in Planned Service Areas



# Residential Parcels on Septic Per 1,000 Acres





# Questions?

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