

CBP P532 Land-Use

WIP Technical Series #1

January 25, 2013

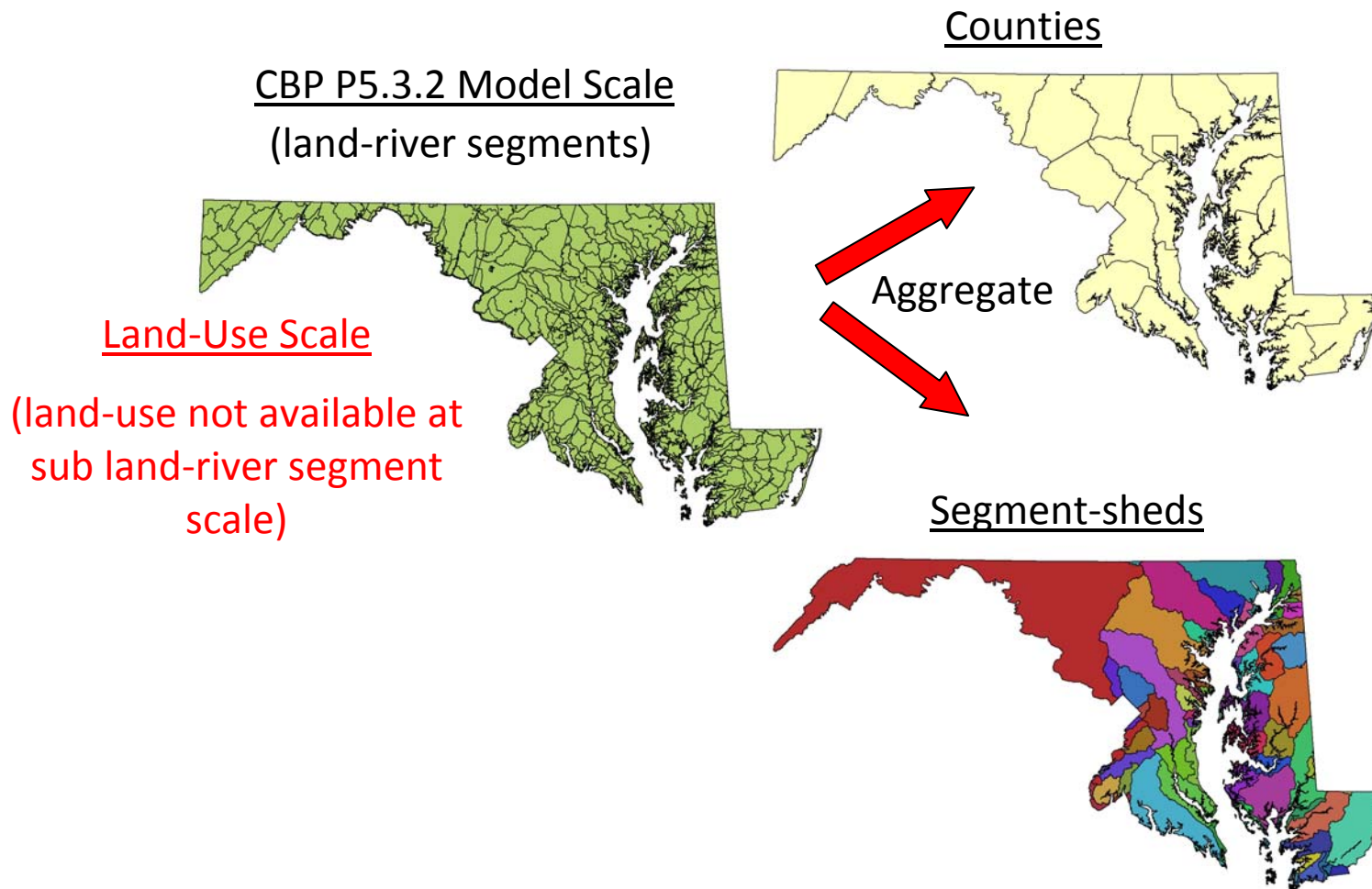
Presentation Overview

- What is the spatial scale of CBP P5.3.2 watershed model land-use?
- How did CBP develop the Phase 5.3.2 watershed model land-use?
- How did MDE refine the P5.3.2 land-use?
- How are CBP and MDE planning to improve watershed model land-use in the future?
 - Phase 6
 - Local input

Presentation Overview

- What is the spatial scale of CBP P5.3.2 watershed model land-use?

Geography Overview



Presentation Overview

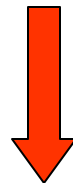
- How did CBP develop the Phase 5.3.2 watershed model land-use?

- Tabular data
 - 31 Classifications
 - 2 Forest
 - 17 Agricultural
 - 6 Urban
 - 2 Construction
 - 3 Extractive
 - 1 Water

- General Process
 - Apply agricultural census data
 - USDA dataset
 - Non-spatial dataset (tabular)
 - Incorporate extractive and construction land-use estimates
 - MDE permit data + USGS-CBPO methodologies
 - Incorporate urban land-use estimates
 - Impervious and pervious
 - USGS-CBPO methodologies
 - Forest = left-over

- Final tabular land use classifications
 - Crop
 - High till w/o manure
 - High till w/ manure
 - Low till w/ manure
 - Alfalfa
 - Hay w/o nutrients
 - Hay w/ nutrients
 - Nutrient management high till – w/o manure
 - Nutrient management high till – w/ manure
 - Nutrient management low till
 - Nutrient management alfalfa
 - Nutrient management hay
 - Pasture
 - Pasture
 - Nutrient management pasture
 - Trampled pasture
 - Nursery

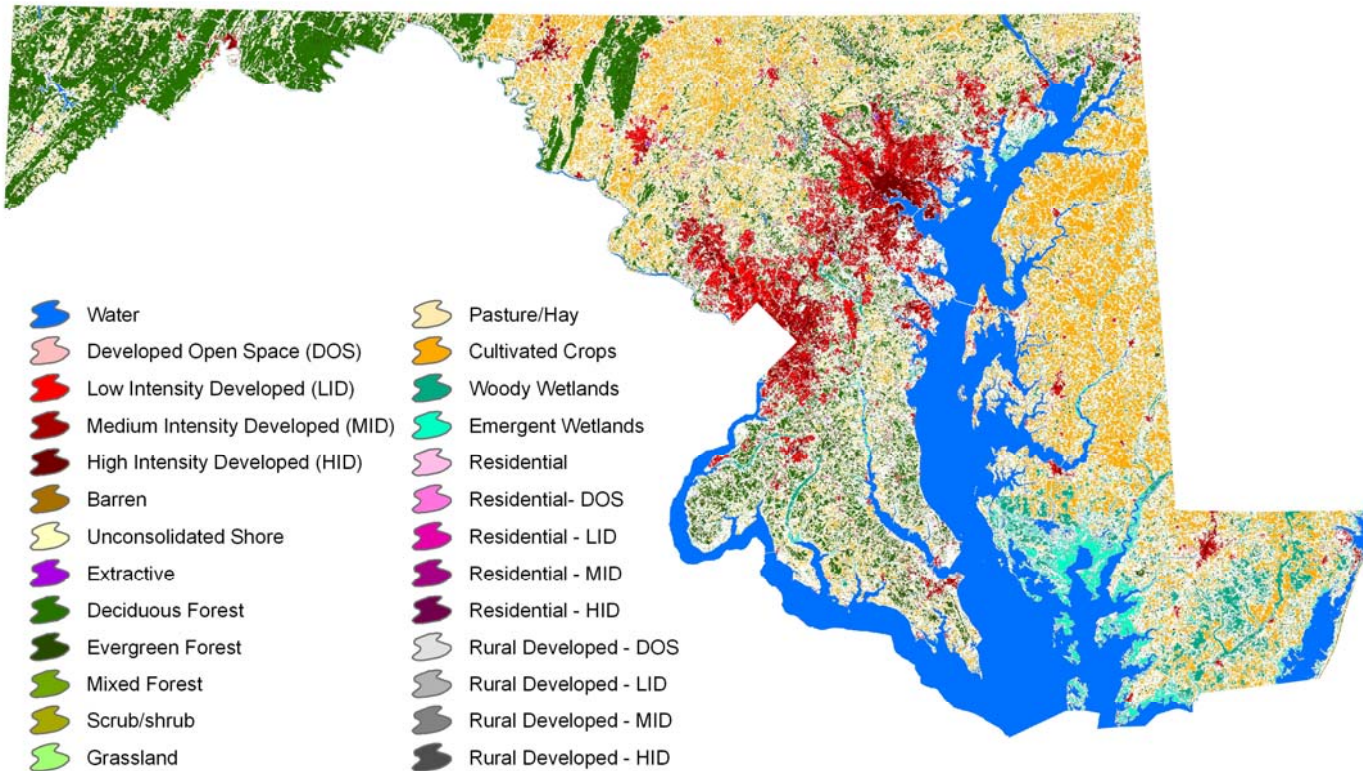
- Tabular land use development
 - Data Sources
 - USDA Agricultural Census data
 - 1982, 1987, 1992, 1997, 2002, and 2007
 - County scale
 - Distributed to land-river segments based on satellite data
 - » 2006 Landsat satellite imagery
 - » Used to create USGS 2006 Modified Chesapeake Bay Land-Cover Dataset (CBLCD)



See Next 2 Slides

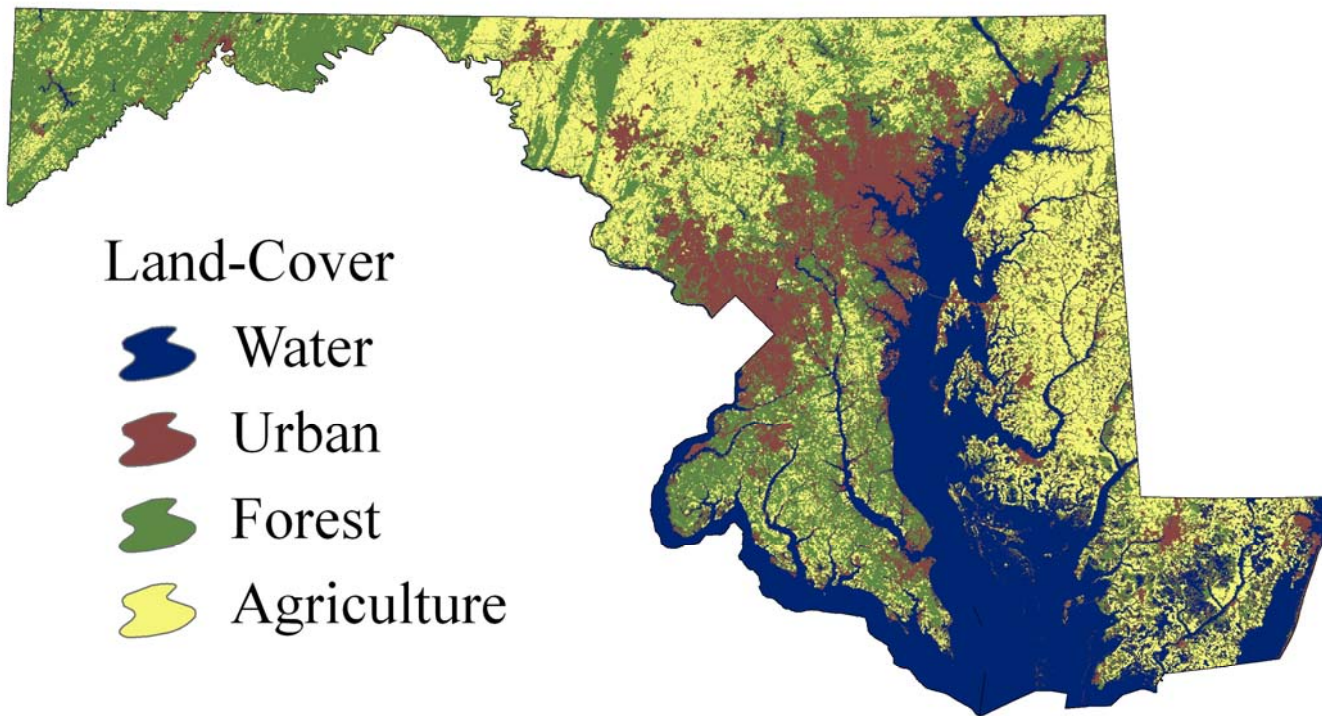
Agriculture

USGS 2006 Modified CBLCD (Detailed)



Agriculture

USGS 2006 Modified CBLCD (Reclassified)



Agriculture

Ag Census Apportionment

If Ag. Census data says:

-County High Till w/Manure = 200 acres

And if Land-Cover data says:

-Total County cropland = 100 acres

-Land River Segment X cropland = 20 acres

-Land River Segment Y cropland = 10 acres

Then, proportions are:

-Land River Segment X = 0.2

-Land River Segment Y = 0.1

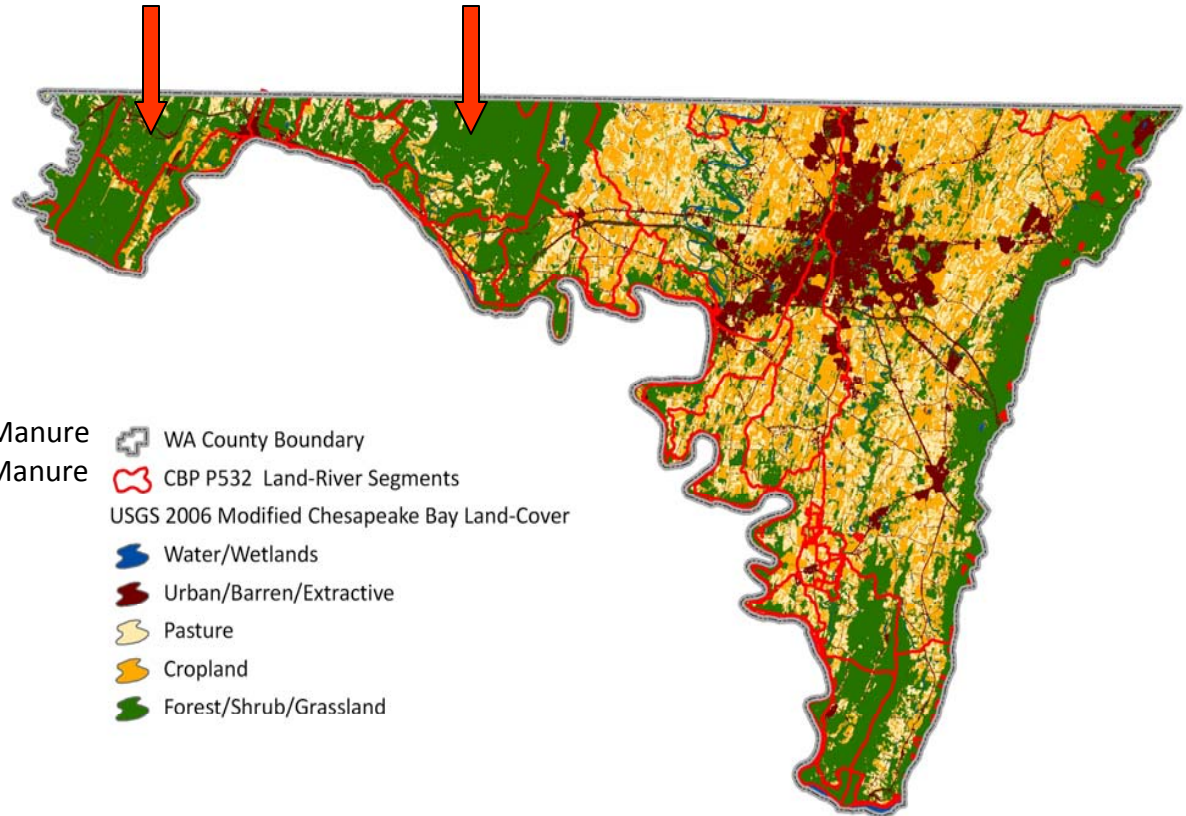
And, final acres are:

-Land River Segment X = 40 acres High Till w/Manure

-Land River Segment Y = 10 acres High Till w/Manure

Land-River Segment
Y = 10% of Total
County Cropland
(USGS Land-Cover)

Land-River Segment
X = 20% of Total
County Cropland
(USGS Land-Cover)

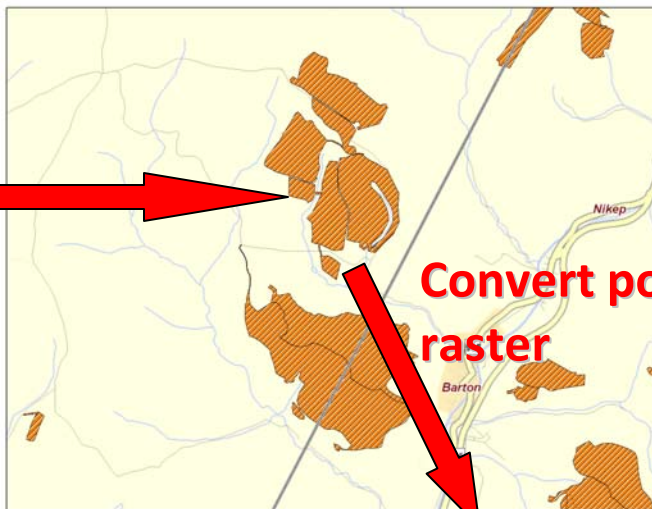
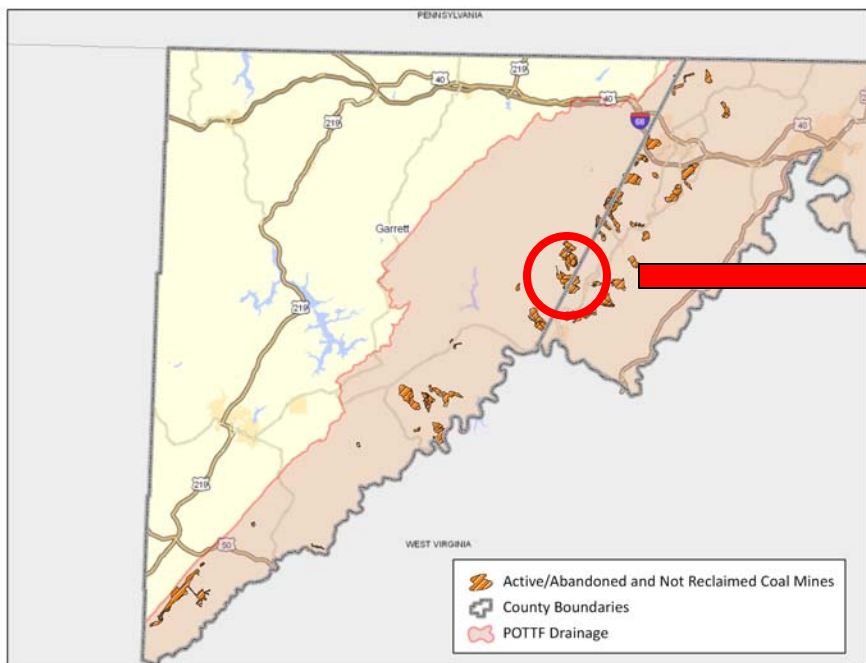


Segment Ag. LU acres = (Segment LC % of County Total) x (County Ag. Census LU acres)

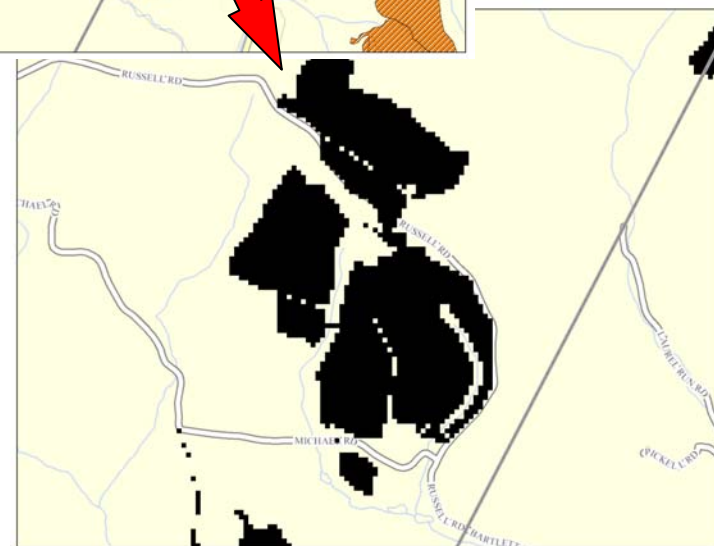
Extractive

- Tabular land-use acres based off permitted mining data provided by MDE
 - Coal Mines
 - MDE provided polygons of disturbed areas to CBP
 - MDE Bureau of Mines
 - » Garrett and Allegany Counties
 - » Upper North Branch Potomac River
 - » Georges Creek
 - CBP rasterized polygons and acres were subsequently incorporated into tabular land-use
 - Mineral Mines
 - MDE provided point data of permitted mining locations
 - Acres in attribute table of point shapefile represent total permitted acres
 - CBP developed regression between permitted and disturbed acres using VA data
 - Apply regression to MD data
 - Incorporate estimated disturbed acres into tabular land-use
 - Buffer points based on estimated disturbed acres
 - Reclassify urban land-cover pixels
 - Overlay rasterized coal mine polygons and buffered mineral mine points with USGS 2006 CBLCD
 - Reclassify underlying urban pixels (represent misclassification) as extractive
 - Removes previously classified urban pixels from final tabular land-use calculations (i.e., avoids double counting urban)

Extractive



Convert polygons to raster



1. Calculate area of raster cells
2. Calculate acres
3. Incorporate into tabular data

Extractive

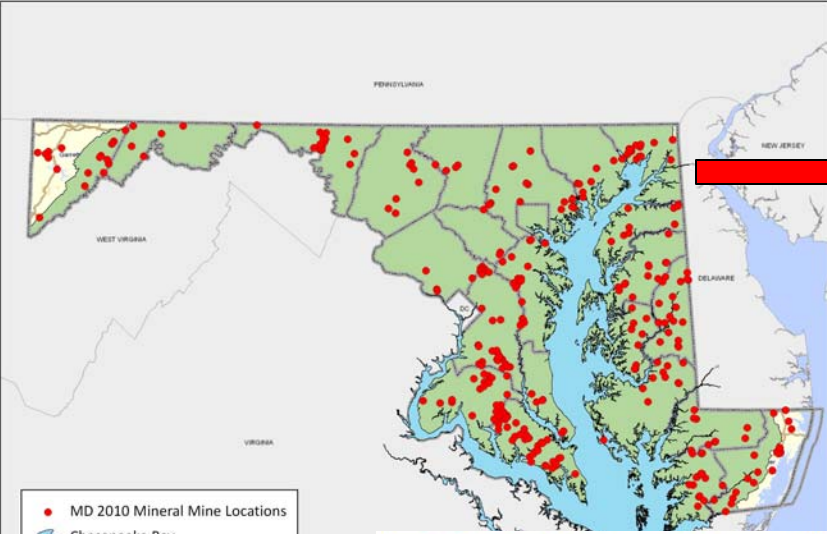
Calculate Disturbed Area:

$$DA = 0.4725(PA) + 1.8224$$

Where:

DA = Disturbed acres

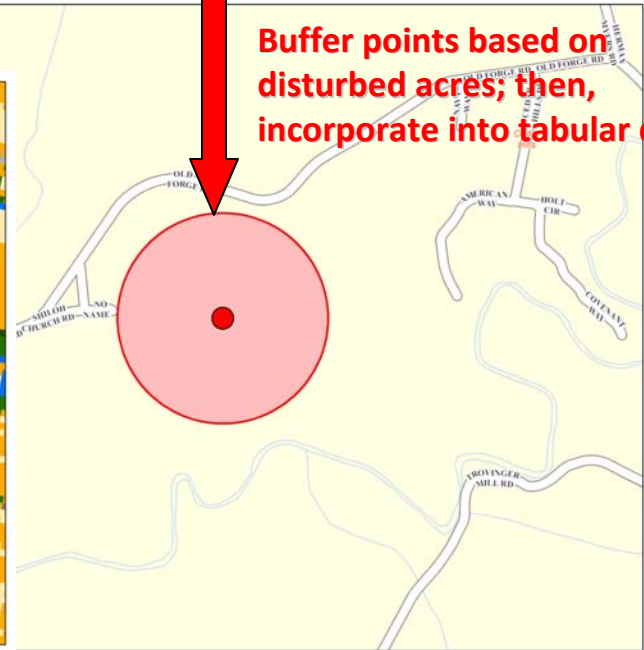
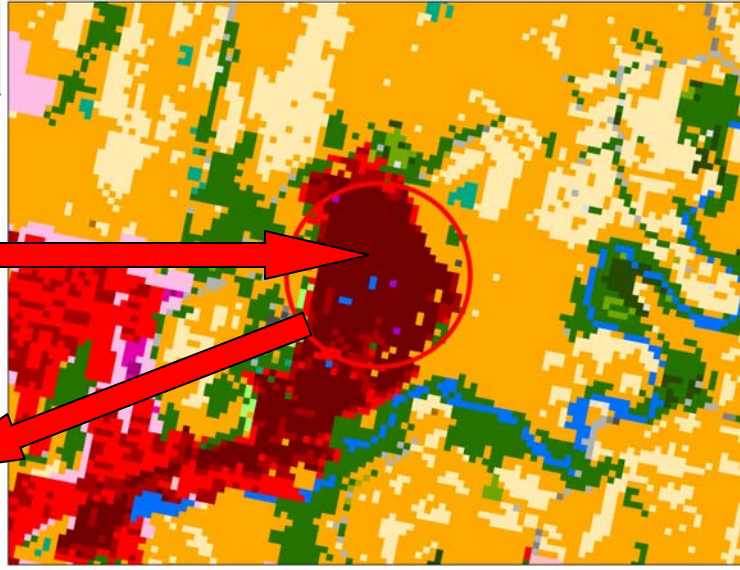
PA = Permitted acres



- MD 2010 Mineral Mine Locations
- Chesapeake Bay
- MD County Boundaries
- MD Chesapeake Bay Watershed

Reclassify underlying urban in USGS 2006 CBLCD to extractive so as to not double count

Extractive in USGS 2006 Modified CBLCD



Buffer points based on disturbed acres, then, incorporate into tabular data.

Construction

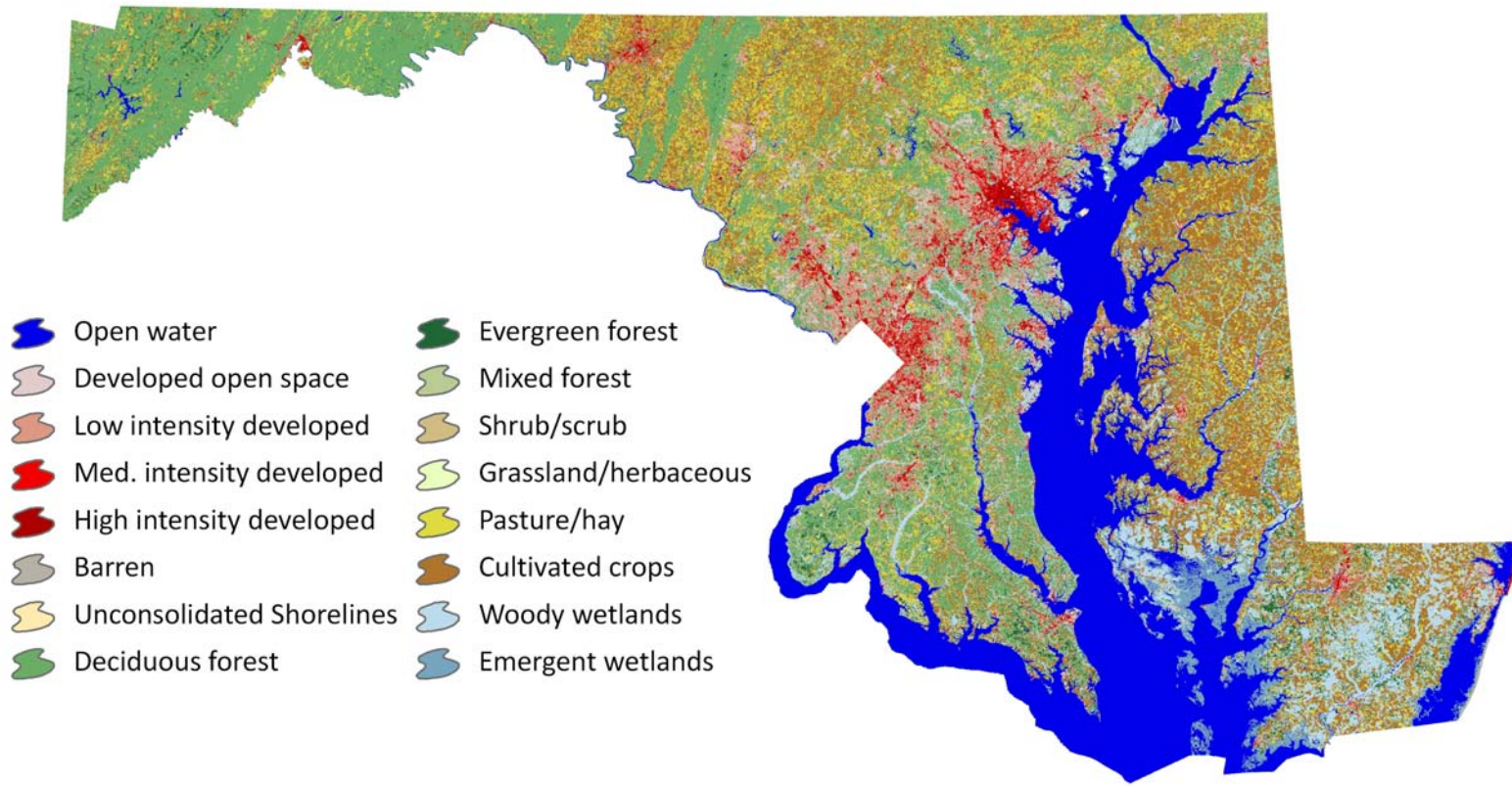
- Construction land-use acres calculated based on MD permitted construction site data
 - What is construction land-use?
 - Disturbed area of construction site only
 - Land requiring E&S controls
 - MDE sent Construction NOIs to CBP
 - CBP Methods
 - From MDE NOIs, calculate ratio between disturbed acres and acres of impervious generated
 - County scale
 - Impervious acres generated: disturbed acres
 - » Unique ratio per MD county
 - Apply ratio to CBP P532 model annual change in impervious acres
 - Per land-river segment
 - » Year A Construction Acres = (Year A impervious acres – Year B impervious acres) x (impervious - disturbed ratio)

- Final tabular land use classifications
 - NPDES Regulated
 - Impervious
 - Pervious
 - Non-regulated
 - Impervious
 - Pervious
 - Note: all pervious urban assumed to be turf grass

- Final tabular land use development
 - Data Sources
 - Satellite data - 2006 Landsat imagery (USGS 2006 NLCD)
 - USGS 2006 CBLCD
 - USGS 2006 Modified CBLCD
 - Institutions - NAVTEQ
 - Roads - NAVTEQ
 - Road widths
 - Single detached housing units - US Census Bureau
 - Rural lot sizes (acres) - MDP Propertyview
 - Impervious coefficients
 - Regional Earth Sciences Applications Center (RESAC) impervious grid
 - Residential lot analysis
 - Turf grass coefficients
 - Land cover proportions within buffered rural roads
 - NPDES Regulated vs. Non-regulated
 - Mask land cover data with Maryland's urban stormwater source sector delineation

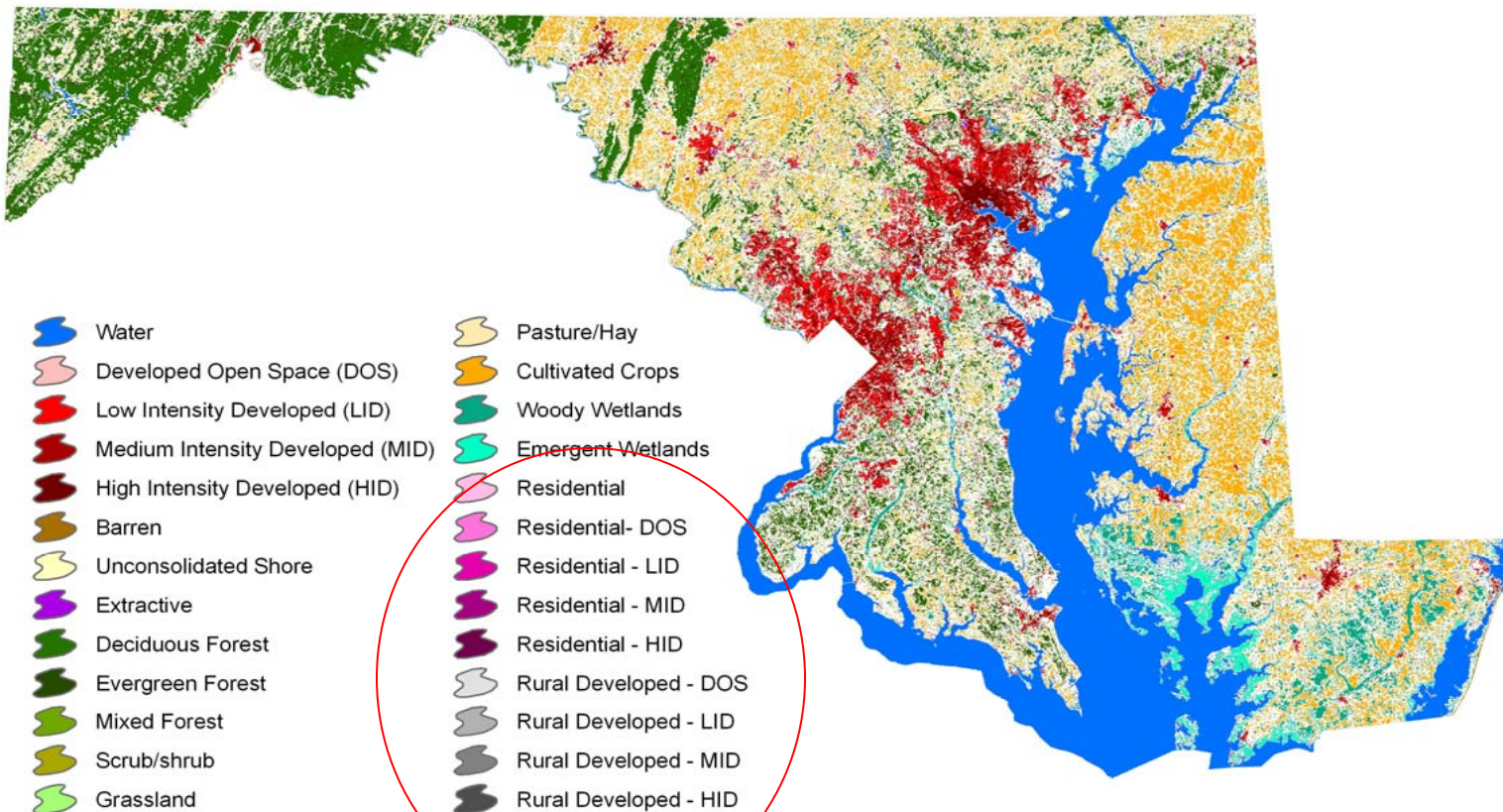
Urban

- USGS 2006 CBLCD
 - Serves as basis for urban impervious and pervious estimates
 - Derived from USGS 2006 NLCD



Urban

- USGS 2006 Modified CBLCD
 - Reclassified USGS 2006 CBLCD
 - Expanded urban footprint based on reclassification of non-urban areas
 - More detailed urban classification



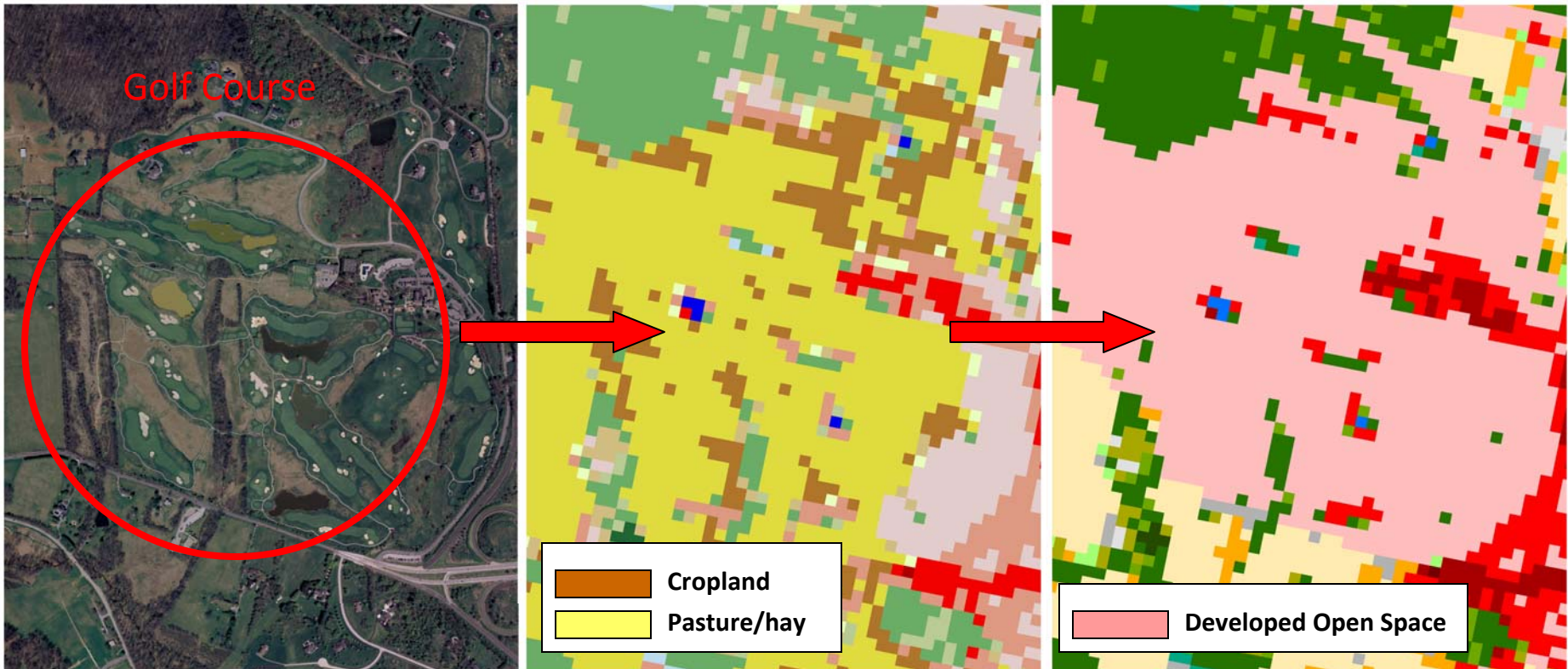
- USGS 2006 Modified CBLCD
 - Reclassification
 - Expanded urban footprint
 - Reclassify based on overlay with NAVTEQ institutional areas
 - Apply 500 meter filter to developed pixels
 - Secondary road/developed area density reclassification
 - More detailed classification
 - Development Zones
 - » Different methods used to estimate urban impervious and pervious acres in each zone
 - » Urban
 - » Suburban
 - » Rural

Urban

- Reclassify CBLCD barren, scrub/shrub, grassland, pasture/hay, and cropland areas to developed open space based on overlay with NAVTEQ institutional area polygons
 - Military bases, golf courses, universities, hospitals, etc.

CBLCD

Modified CBLCD

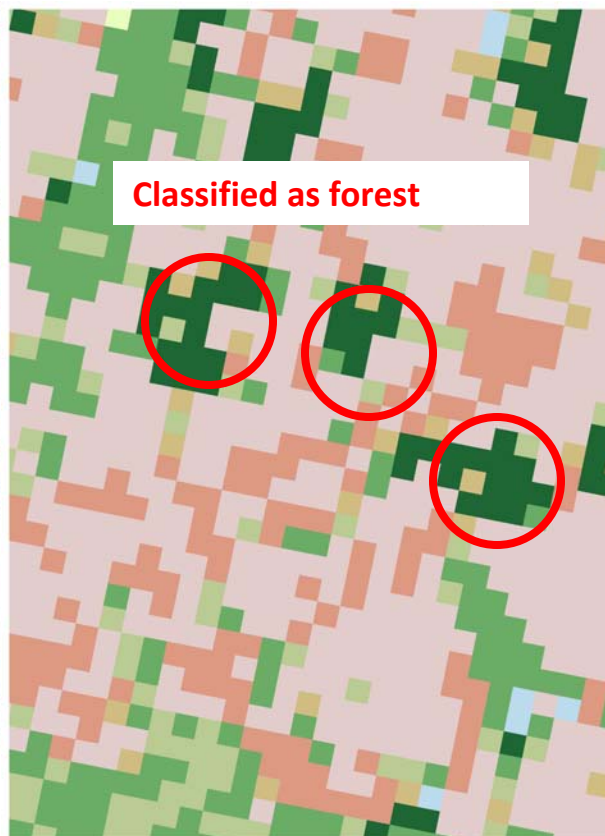
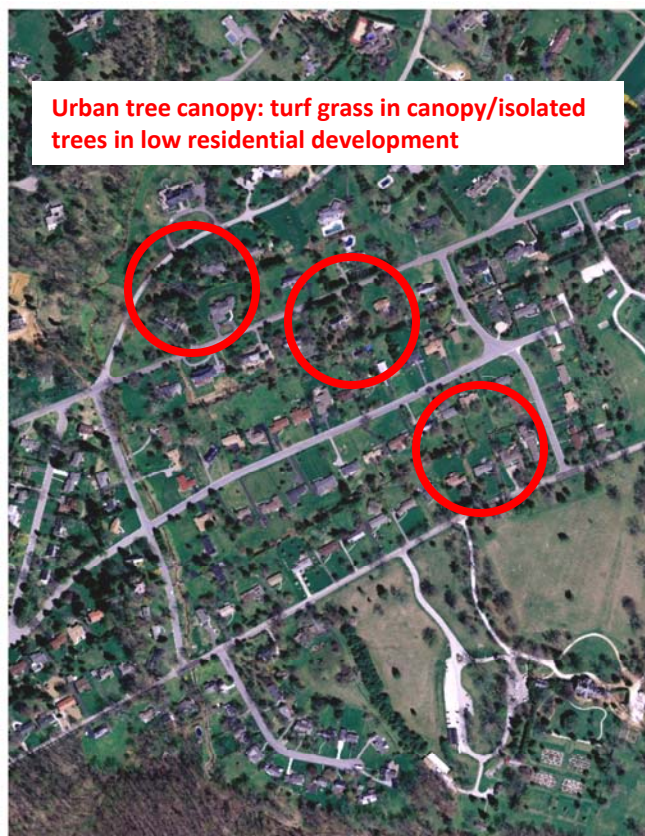


Urban

- Apply 500 meter filter to developed pixels
 - Reclassifies all non-developed pixels within dense urban clusters as developed

CBLCD

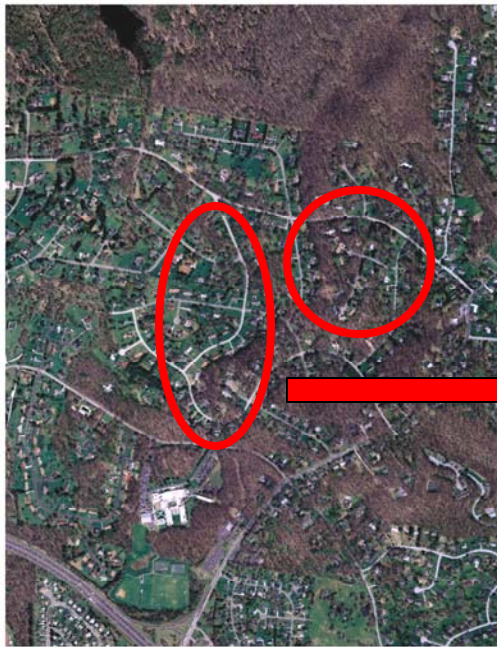
Modified CBLCD



Urban

- Reclassify secondary roads and adjacent areas based on *secondary road/developed area density raster* thresholds
 - Development of density raster
 - Rasterize secondary road network
 - Merge secondary road raster polygon with CBLCD developed pixels
 - Calculate density (road pixels + developed pixels) using 500 meter filter
 - Covert pixel values in resultant raster to integers
 - Calculate threshold density values
 - Calculate mean and median values in previously mapped low-density residential areas. BPJ for final threshold values
 - Buffer secondary roads within density raster thresholds
 - 2 pixels (197 ft.)
 - Density thresholds vary per urban and rural area demarcations
 - Urban vs. rural - US Census urbanized areas
 - Urban
 - » Density threshold: 4.5
 - Rural
 - » Density threshold: 5.0
 - Reclassify underlying pixels as developed (low-density residential), except for open water, unconsolidated shore, wetlands, and areas > 21% slope

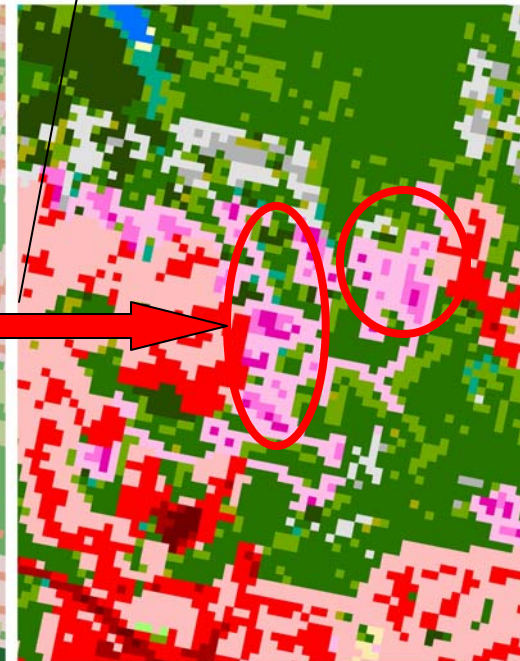
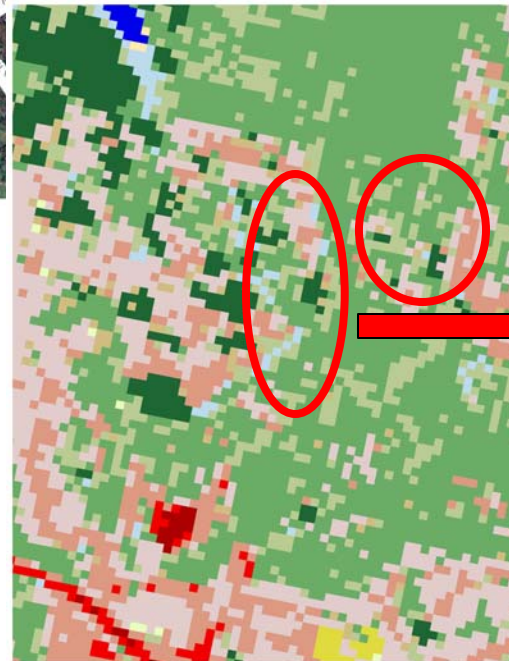
Urban



Bring in secondary road network

Dense secondary road network

Non-developed pixels reclassified

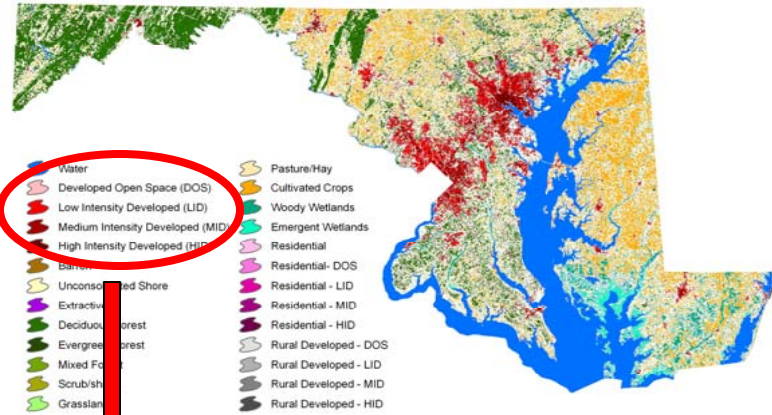


- Estimating impervious surfaces
 - Methods vary per development zone
 - Urban
 - Suburban
 - Rural
 - Delineated by USGS-CBP
 - Differentiate between intensity and type of development

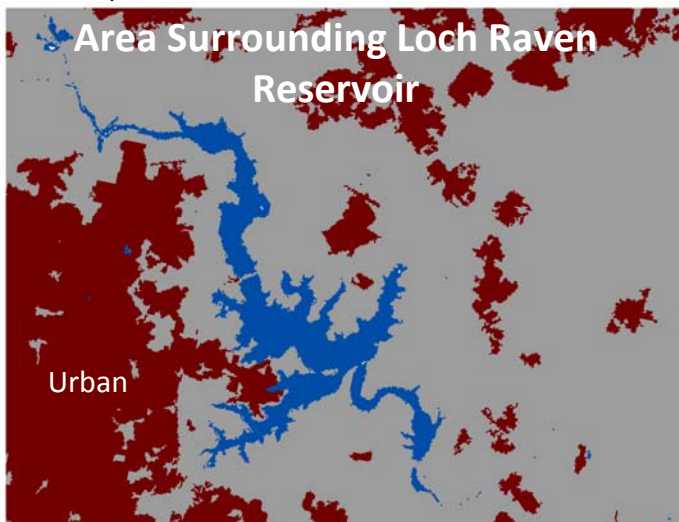
- Urban Zone
 - Original CBLCD urban + filter reclassification + NAVTEQ institutional reclassification
 - Represents core urban areas/greater intensity of development
 - Estimating impervious surfaces
 - Impervious surface coefficients
 - State specific
 - 2001 RESAC impervious surface grid
 - » 30 meter pixels
 - » Percentage of pixel covered by impervious surfaces

Urban

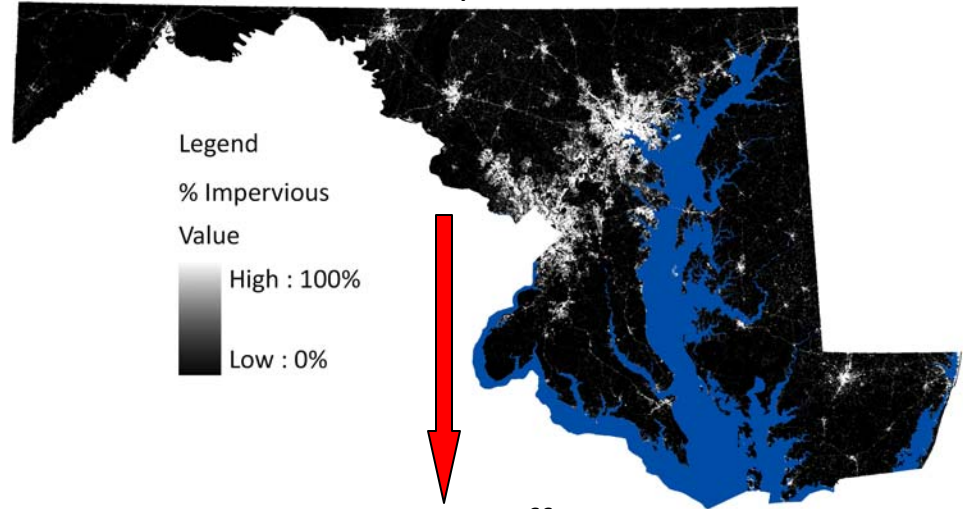
USGS 2006 Modified CBLCD (Detailed)



Urban Zone



RESAC 2001 Impervious Grid



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%

State specific coefficients used in analysis

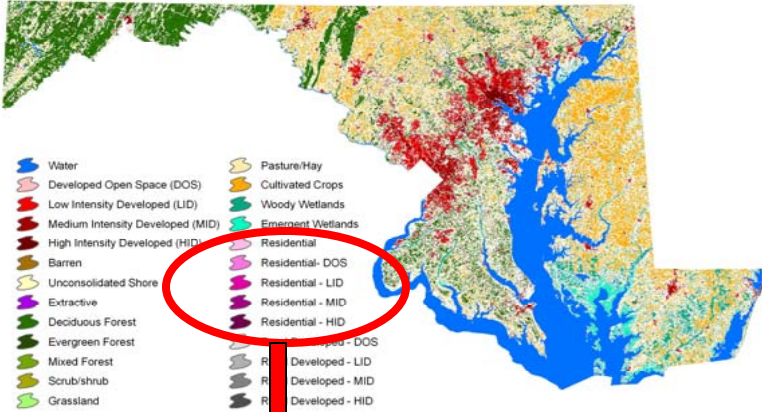
$$\text{Impervious Acres} = (\text{Developed LC Class Acres}) \times (\text{Impervious Coefficient})$$

Remainder = pervious urban; all pervious urban = turf grass

- Suburban Zone
 - Secondary road density reclassification
 - Represents suburban sub-divisions
 - Medium to low density residential (single detached homes)
 - Estimating impervious surfaces
 - 50 randomly selected points
 - Overlay with aerial photography
 - Digitize impervious surfaces within closest residential parcel to random point
 - Calculate median impervious acres
 - Multiply median acres by number of single detached housing units (US Census Data) within the suburban zone
 - Done per land-river segment
 - Roads
 - NAVTEQ data includes # lanes, direction of travel, and whether or not controlled access
 - USGS-CBP assumed:
 - » Lane width = 12 ft.
 - » Shoulder width = 12 ft (24 ft. for controlled access roads)

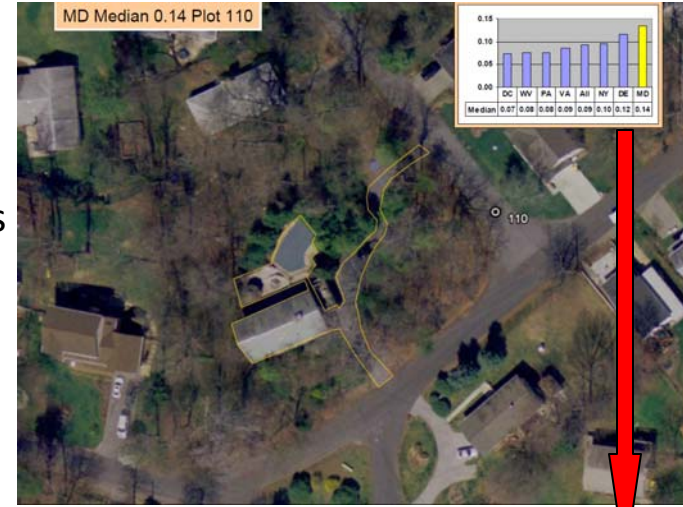
Urban

USGS 2006 Modified CBLCD (Detailed)



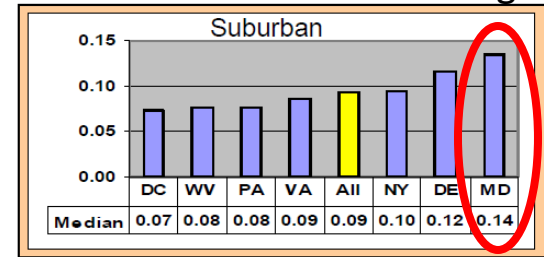
Sub-urban Zone

Digitize Impervious surfaces

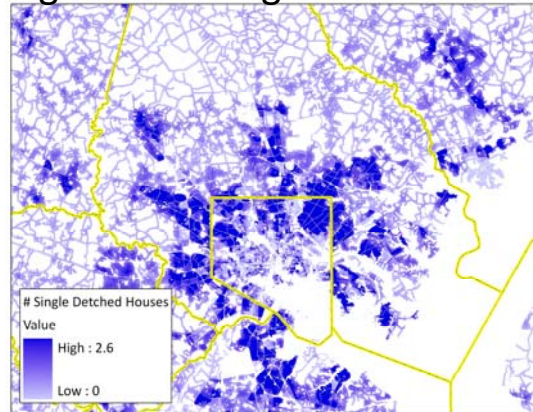


Mapping the # of single detached houses

Calculate median acreage



State specific median applied in analysis



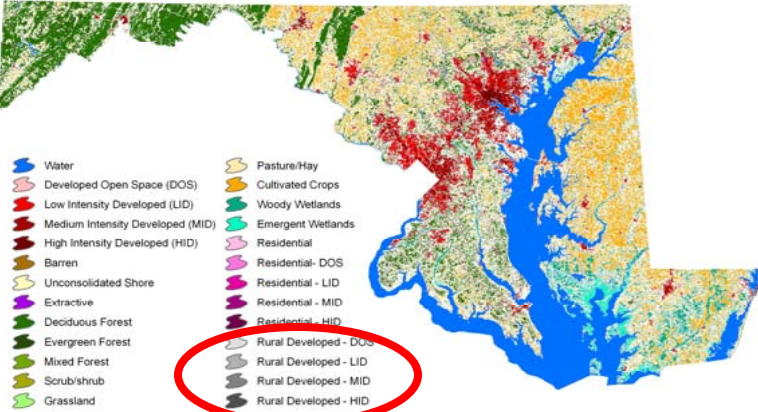
Impervious Acres = ((# single detached houses) x (0.14)) + (road impervious surfaces)
Pervious Acres = original LC class barren, grassland, scrub/shrub, cropland, and pasture cells

- Rural Zone
 - All areas that are not classified as “urban” or “suburban”
 - Includes all Modified CBLCD classifications outside of urban/suburban areas
 - Modified CBLCD urban classifications in the “Rural Zone”:
 - “Rural Developed”
 - Original CBLCD developed classifications that are reclassified to non-developed once 500 meter filter applied
 - » i.e., not part of dense urban clusters
 - Not actually used to inform any urban acre calculations in the tabular CBP P532 land-use

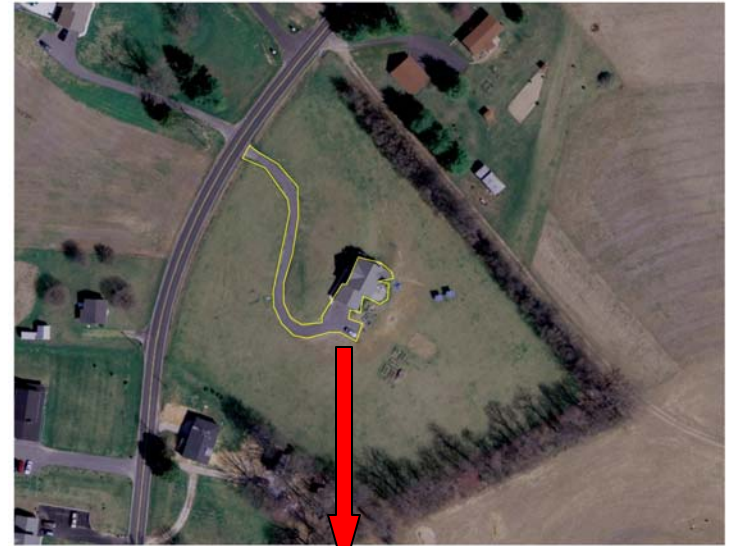
- Rural Zone
 - Estimating impervious surfaces
 - Similar methodology as applied for sub-urban areas
 - i.e., digitized impervious area for random sample of properties using aerial photography and applied US census data on single detached houses
 - Variation: Total property size key to calculation
 - Median property size = 1.86 acres (MDP Propertyview)
 - Median impervious surface acres = 0.14 (watershed); 0.18 (MD)
 - » Coefficients = 7.5% (watershed); 9.7% (MD)
 - » Applied state specific coefficients
 - Impervious Acres = (# single detached housing units) x (1.86) x (0.097)
 - » Done per land-river segment
 - Roads
 - Same exact methodology as applied for sub-urban areas
 - Estimating pervious urban area (i.e., turf grass)
 - Calculate turf grass coefficient
 - Apply 300 ft. buffer to roads
 - Overlay with Modified CBLCD
 - Calculate proportion of barren, grassland, scrub/shrub, cropland, and pasture cells to forest cells within buffer
 - Represents ratio of turf grass to wooded on rural residential properties
 - » Underlying assumption: all residential houses are located next to existing roads
 - Apply coefficient to total property size (1.86 acres)
 - Pervious Urban Acres = (# single detached housing units) x (1.86) x (turf grass coefficient)

Urban

USGS 2006 Modified CBLCD (Detailed)



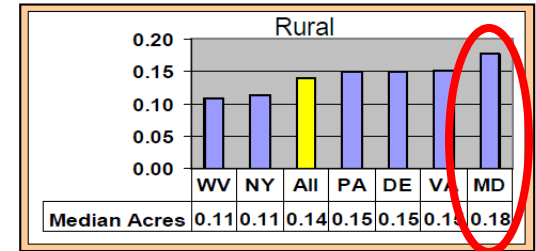
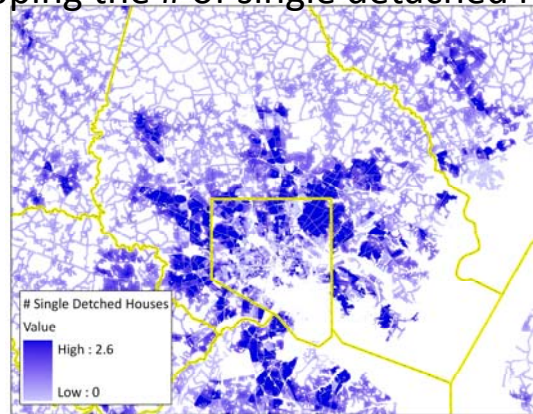
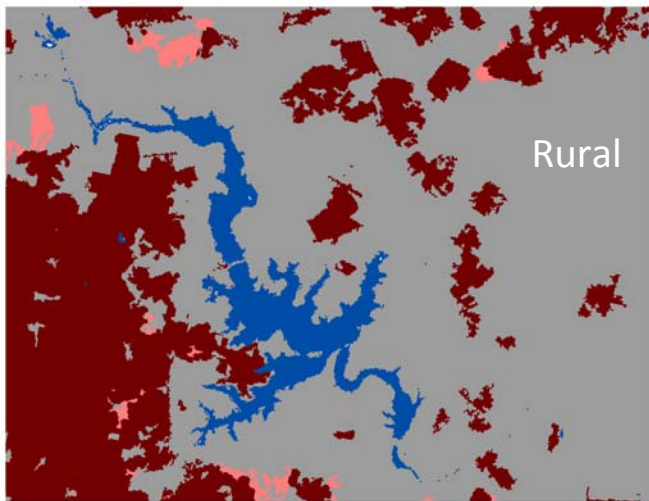
Digitize
Impervious
surfaces



Rural Zone

Mapping the # of single detached houses

Calculate median acreage



State specific median applied in analysis

$$\text{Impervious Acres} = ((\# \text{ single detached houses}) \times (1.86) \times (0.097)) + (\text{road impervious surfaces})$$

$$\text{Pervious Urban Acres} = (\# \text{ single detached houses}) \times (1.86) \times (\text{turf grass coefficient})$$

- Back-casting
 - 2006 base year
 - Methods discussed thus far reflective of 2006 conditions
 - Satellite imagery + NAVTEQ roads
 - High and medium intensity developed land estimates based on satellite imagery for 1984, 1992, and 2001
 - Apply housing data to back-cast low intensity residential developed lands to 1984, 1992, and 2001
 - Suburban and Rural Zones
 - Summarize total and single detached housing units in 1990 and 2000 (30 meter raster grid)
 - Extrapolated to 1992 and 2001 based on changes in county-level population estimates
 - Use GAME model to back-cast housing units to 1984 and 2006 based
 - » Translates county population estimates into housing units
 - Develop regression equation between housing units and low intensity residential developed lands
 - » Use equation to estimate low intensity residential developed lands in 1984, 1992, and 2001
 - **Linear interpolation to model years in between**
- Forecast to model years beyond 2006
 - Linear interpolation

Progress Scenario Land-Use

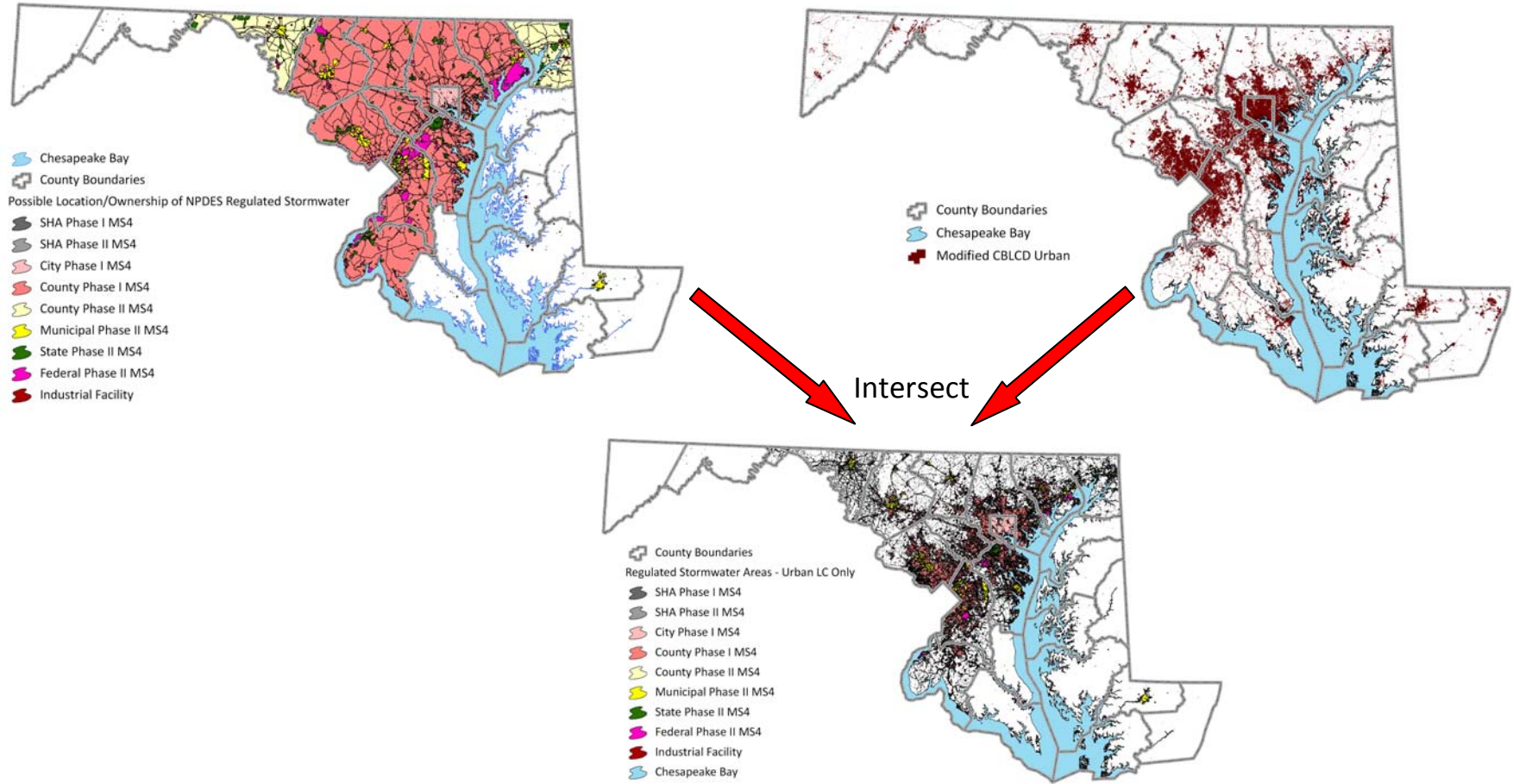
- CBP P532 progress scenario land-use adjustments
 - Urban impervious and pervious acres developed based on previously discussed methods
 - Ag. acres based on ag. census data and extrapolation to non ag. census years
 - Forest = leftover
 - Total land-river segment acres – (urban acres + ag. acres) = forest acres
 - If forest is negative, then ag. acres decreased proportionally
 - If there are still negative acres, non-regulated pervious and impervious acres reduced proportionally
 - If still negative acres, regulated impervious and pervious acres reduced proportionally
 - Land-use change BMPs applied

Presentation Overview

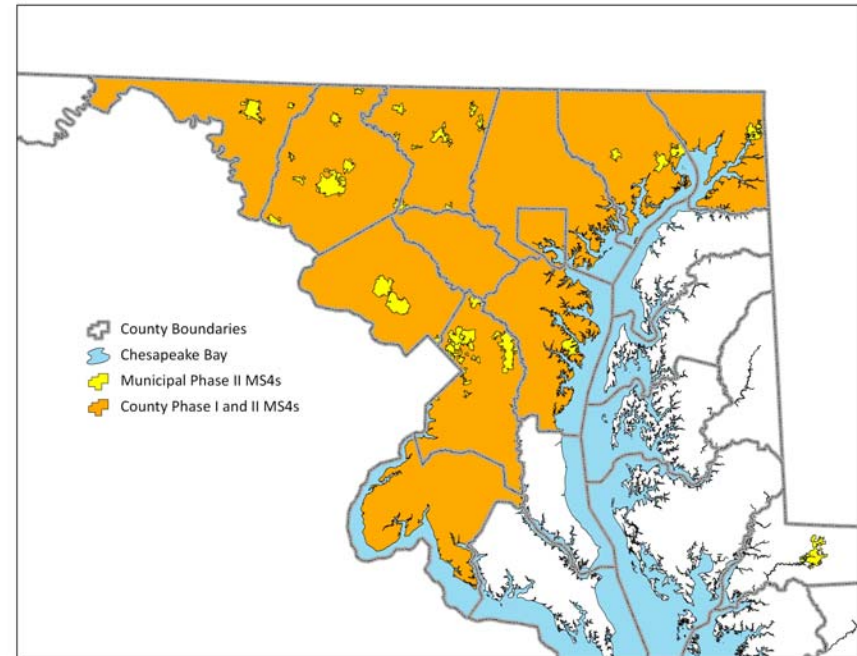
- How did MDE refine the P5.3.2 land-use?

- Disaggregate urban land use into source sectors
 - NPDES Regulated
 - County Phase I and II MS4s
 - Municipal Phase II MS4s
 - SHA Phase I and II MS4
 - State Phase II MS4
 - Federal Phase II MS4
 - Industrial
 - Non-regulated
 - Non-MS4 jurisdictions (counties and municipalities)
 - State owned development in non-MS4 counties
 - Federally owned development in non-MS4 counties
 - SHA owned roads in non-MS4 counties
 - How?
 - Intersect urban land-cover (Modified CBLCD) with urban stormwater source sector delineations to produce urban area per regulated urban sector + non-regulated
 - Can calculate proportion of urban land-cover area per sector
 - Can apply proportions to tabular land-use data

MAST Urban Source Sectors



- County and Municipal Phase I and II MS4s
 - Jurisdictional boundaries
 - County
 - P5.3.2 land segments
 - Municipal
 - MDP Propertyview Data



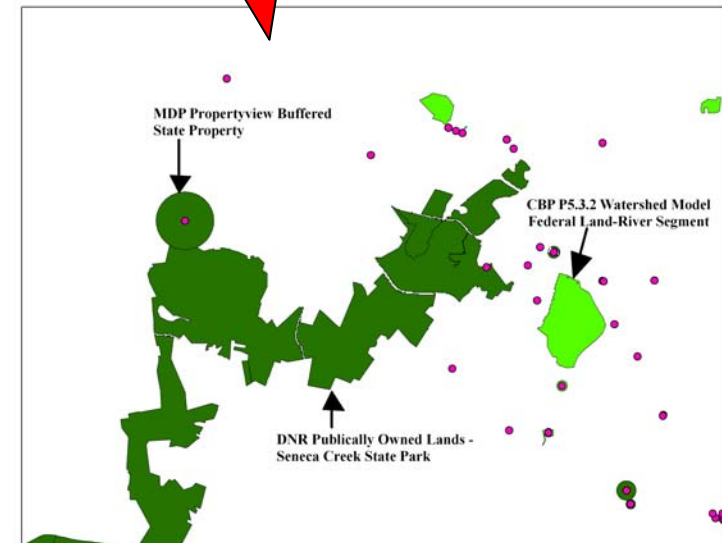
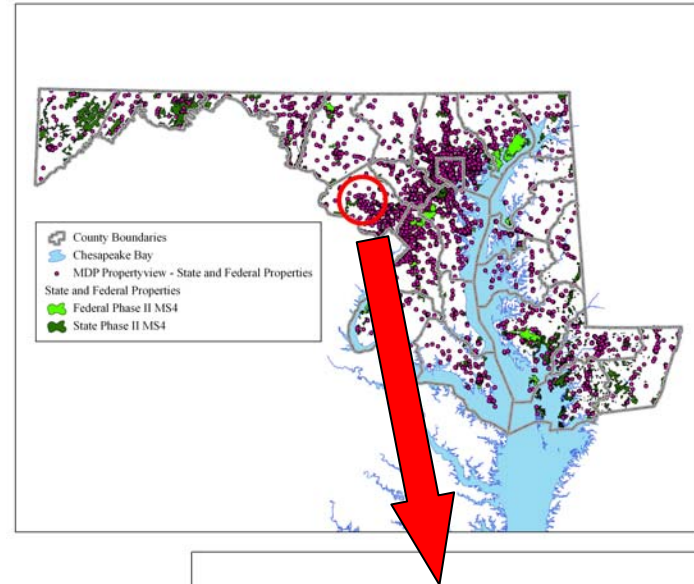
MAST Urban Source Sectors

- SHA
 - Phase I MS4
 - SHA Phase I MS4 impervious cover delineation
 - Right-of-way estimate
 - 75 m buffer to impervious cover
 - Intersect with RESAC transportation land-use
 - Phase II MS4 and Non-regulated
 - MDP Propertyview - road data
 - Impervious area estimate
 - » Interstates and state roads
 - » Assumed number of lanes
 - » Lane widths (SHA design manual)
 - Right-of-way estimate
 - » 75 m buffer to impervious estimate
 - » Intersect with RESAC transportation land-use



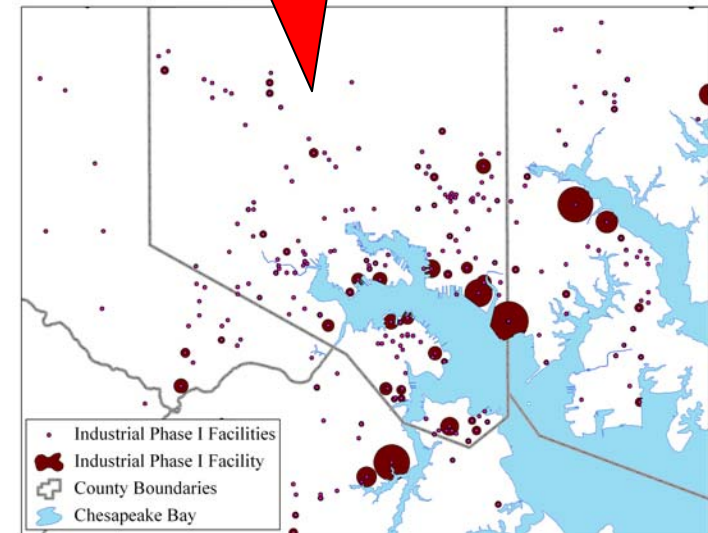
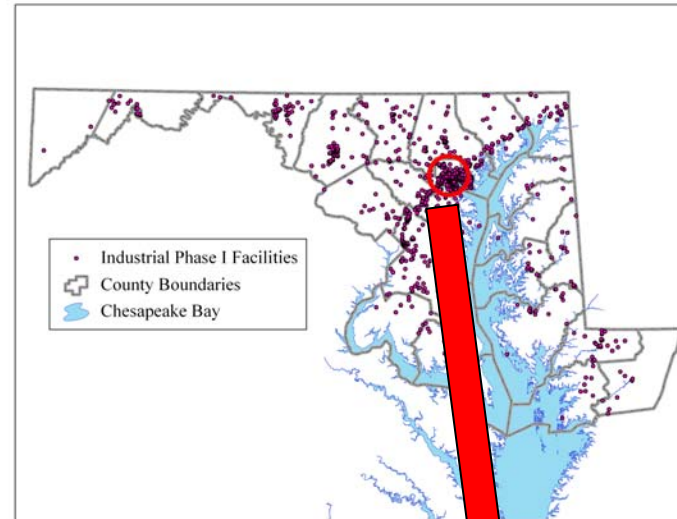
MAST Urban Source Sectors

- State Phase II MS4
 - DNR Public Properties data layer
 - Extract state owned lands
 - MDP Propertyview
 - Point data
 - Extract state owned exempt properties
 - Buffer (individual acreages)
- Federal Phase II MS4
 - CBP P532 federal land-river segments
 - DNR Public Properties data layer
 - Extract federally owned lands
 - MDP Propertyview
 - Point Data
 - Extract federally owned exempt properties
 - Buffer (individual acreages)
- Non-regulated state and federal
 - Within non-MS4 counties
 - Same methods



MAST Urban Source Sectors

- Industrial
 - General industrial stormwater permits
 - Process water permits with stormwater requirements
 - MDE permit applications
 - Geographic coordinates
 - Acres
 - » Create point shapefile
 - » Apply individual buffer



Presentation Overview

- How are CBP and MDE planning to improve watershed model land-use in the future?

CBP P6 Land-Use

- How does CBP plan to improve model land-use data?
 - Formation of CBP Land-Use Workgroup
 - Goals
 - To the extent feasible, incorporate as much local data into the Bay model land-use
 - Improve the spatial, temporal, and categorical representation of urban, agricultural, federal, and natural land uses through geospatial and statistical analyses applied to remotely sensed data, local data, and a large suite of other relevant geospatial datasets.

CBP P6 Local Data Needs

- How are MDE and CBP going to incorporate local data into CBP P6 land-use?
 - Acquire, inventory, analyze, and incorporate
 - Acquiring local data
 - MDE will be asking local jurisdictions to provide any “readily available” datasets that may be useful in developing the CBP P6 land-use dataset
 - The Department will be getting in touch with WIP team leaders and other applicable county and municipal staff in order to acquire this data
 - Target date for starting this process: **February 4th**
 - Target date for local jurisdictions to provide the data to MDE: **May 31st**

CBP P6 Local Data Needs

- Types of datasets MDE is looking for to characterize current and historic (1980+) LULC conditions
 - Land-Use/Land-Cover
 - Impervious surfaces
 - Other land cover (e.g., imagery derived tree canopy, turf grass, herbaceous vegetation)
 - Extractive areas (e.g., quarries, active and reclaimed surface mines, shale gas pads and related pipelines and roads)
 - Sewer service areas
 - Septic system locations
 - MS4/CSS stormwater regulated areas (latest version as defined by each state and/or locality)
 - Stormwater conveyance systems (drainage areas, pipes, outfalls, etc.)
 - Any other potential dataset that could inform current or historic land use
 - All applicable metadata files and methodology documentations

CBP P6 Local Data Needs

- Types of datasets MDE is looking for to characterize future LULC conditions
 - Zoning (consistent with latest comprehensive plan) with keys to interpret codes
 - Protected lands (including parks, recreation areas, and other county owned lands unavailable for future development)
 - Priority reinvestment/growth areas, designated growth areas, urban renewal/reinvestment zones, etc.
 - Actively planned and/or permitted developments (excluding approved but expired permits)
 - Proposed sewer service areas
 - Special environmental protection areas* (i.e., Critical Areas, Chesapeake Bay Preservation Areas, riparian buffers, erosion prone soils, flood zones, habitat protection areas)
 - Passenger rail transit stations (current and proposed)
 - Conservation priority areas (i.e., agricultural districts, green infrastructure hubs and/or corridors, rural legacy areas)
 - Planned transportation improvements
 - Any other potential dataset that could inform future land use
 - All applicable metadata files and methodology documentations

Summary

- CBP P532 model land-use does not exist in a spatial, GIS context
 - Why?
 - Incorporation of agricultural census data
 - Urban methodologies
 - Most are spatial in nature, but some result in output datasets that are not spatially explicit
- Developed at the model land-river segment scale
 - Land-use acres not available at a finer scale (such as for Hagerstown)
- Accuracy increases as spatial scale increases
 - Land-river segment, county, segment-shed, major basin, state, etc.
- Process for Incorporation into final tabular dataset
 - Incorporate agricultural census data
 - Incorporate urban estimates (adjust if need be)
 - Forest = leftover
- MDE refinement of urban data by regulated sector
- Opportunity for local jurisdictions to help MDE and CBP improve Phase 6 model land-use
 - Providing data

Summary

Questions?