Chesapeake Bay Phase 6
Watershed Model Land-Use

October 26, 2015
MDP and MDE – SSA
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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 Submission

<table>
<thead>
<tr>
<th>County</th>
<th>Data Submission</th>
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<tbody>
<tr>
<td>Allegany</td>
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<tr>
<td>Anne Arundel</td>
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<tr>
<td>Baltimore City</td>
<td>Yes</td>
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<tr>
<td>Baltimore</td>
<td>Yes</td>
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<tr>
<td>Calvert</td>
<td>Yes</td>
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<tr>
<td>Caroline</td>
<td>Yes</td>
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<td>Carroll</td>
<td>Yes</td>
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<tr>
<td>Cecil</td>
<td>Yes</td>
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<tr>
<td>Charles</td>
<td>Yes</td>
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<td>Dorchester</td>
<td>Yes</td>
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<td>Frederick</td>
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<td>Garrett</td>
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<td>Harford</td>
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<td>Howard</td>
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<td>Kent</td>
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<td>Queen Anne's</td>
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## Local Data Used

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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)

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Maryland TMDL Data Center

- **TMDL Search**: Search for approved TMDLs by county, watershed, or for the entire state.
- **WQA Search**: Find the watershed or wastewater allocations for an NPS DS permit.
- **TMDL Maps**: View the geographic extents of existing TMDLs and download EPS files.
- **Stormwater Toolkit**: Tools to assist in applying stormwater WQAs to regulated stormwater systems.
- **Stormwater Documents**: Guidance documents to assist stormwater permittees in implementing TMDLs.
- **P6 Bay Model Development**: 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 Watershed Model. The development of the model is focused on improving the spatial and temporal accuracy of the model outputs, which are used to develop water quality improvement strategies. The new model is available for download below.

Model Lead-Use (Draft, Version 1)

The model has been developed for use in conjunction with the existing WPS model. The model is designed to provide estimates of water quality improvements for the Phase 6 watershed. The model is designed to be used to inform state and local governments about the potential impacts of land use changes.

Model Lead-Use Methods

The model has been developed using a combination of land use information and water quality data. The model is designed to be used to inform state and local governments about the potential impacts of land use changes. The model is designed to be used to inform state and local governments about the potential impacts of land use changes.

County Summary Sheets

- Anne Arundel
- Baltimore City
- Baltimore County
- Carroll
- Charles
- Dorchester
- Frederick
- Garrett
- Harford
- Howard
- Kent
- Montgomery
- Prince George’s
- Queen Anne’s
- Somerset
- St. Mary’s
- Talbot
- Washington
- Worcester
County Summary Sheets

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

The following data files are available for download:
1. The Final Phase 6 Modeling dataset that was submitted to CBP by the State of Maryland.
2. Document containing Maryland's primary QA/QC on the data provided to CBP.
3. The P6 watershed model segments.

Methodology Documents:
- Impervious surface methodology document
- Forest and Tree cover methodology document
- Wetlands methodology document

Meetings:
April 28, 2015 - Chesapeake Bay Phase 6 Watershed Model Land-Use Development Webinar

MD2 and MD3 hosted a webinar that discussed the development of the Chesapeake Bay Program Phase 6 Watershed model Land-Use Development for Maryland. The Phase 6 modeling tools are being developed to inform the Phase III WTPs, MD2, MD3, and USGS presented on the Land-Use Classification, Incorporation of Local Jurisdiction Data, and Maryland Specific Methodologies.
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

- 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
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

<table>
<thead>
<tr>
<th>Parcel</th>
<th>LndRvrSeg</th>
<th>coefficient</th>
<th>coefficient predicted impervious area increase</th>
<th>correction factor</th>
<th>Overall impervious increase</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1_A24003XU2_4270_4650</td>
<td>0.675352131</td>
<td>25.77921508</td>
<td>1.5</td>
<td>24.27921508</td>
<td>No change - impervious increase</td>
<td></td>
</tr>
</tbody>
</table>
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

Legend:
- County Planimetric Roads
- NAVTEQ Buffered Segments already captured
- NAVTEQ Segments
Example 2 – Roads not captured by planimetric data – missing or “new”
Road vs. non-road impervious

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

### Residential Parcels

<table>
<thead>
<tr>
<th>County</th>
<th>Total Impervious ac</th>
<th>Sidewalks ac</th>
<th>Sidewalks RATIO</th>
<th>Patios ac</th>
<th>Patios RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anne Arundel</td>
<td>12,067</td>
<td>430</td>
<td>4%</td>
<td>1,048</td>
<td>9%</td>
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<tr>
<td>Calvert</td>
<td>3,814</td>
<td>119</td>
<td>3%</td>
<td>267</td>
<td>7%</td>
</tr>
<tr>
<td>Prince Georges</td>
<td>12,710</td>
<td>NA</td>
<td>NA</td>
<td>583</td>
<td>5%</td>
</tr>
<tr>
<td>State Coefficient Avg</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td>7%</td>
</tr>
</tbody>
</table>

### Non-Residential Parcels

<table>
<thead>
<tr>
<th>County</th>
<th>Total Impervious ac</th>
<th>Sidewalks ac</th>
<th>Sidewalks RATIO</th>
<th>Patios ac</th>
<th>Patios RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anne Arundel</td>
<td>8,731</td>
<td>323</td>
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<td>35</td>
<td>0%</td>
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<td>Calvert</td>
<td>870</td>
<td>39</td>
<td>4%</td>
<td>8</td>
<td>1%</td>
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<td>Prince Georges</td>
<td>7,552</td>
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<td>10</td>
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<td>State Coefficient Avg</td>
<td>4%</td>
<td></td>
<td></td>
<td></td>
<td>0.5%</td>
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</tbody>
</table>
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

\[ TG_i = [Imp_i \times P532\text{Ratio}_i] - TCOT_i \]

Where:

- \( TG \) = Acres of turf grass in segment \( i \)
- \( Imp \) = Acres of impervious surface in segment \( i \)
- \( P532\text{Ratio} \) = 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
  – DFIRM

• 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 (DFIRM)
    • 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

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

NonTurf = -1.196 + 0.995512(TotalP) – 1.905(STRU)
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 sewered
- 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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