Virginia Land Cover Data

Hampton Roads, VA Methodology

Chesapeake Bay Program Land Use Workgroup Meeting

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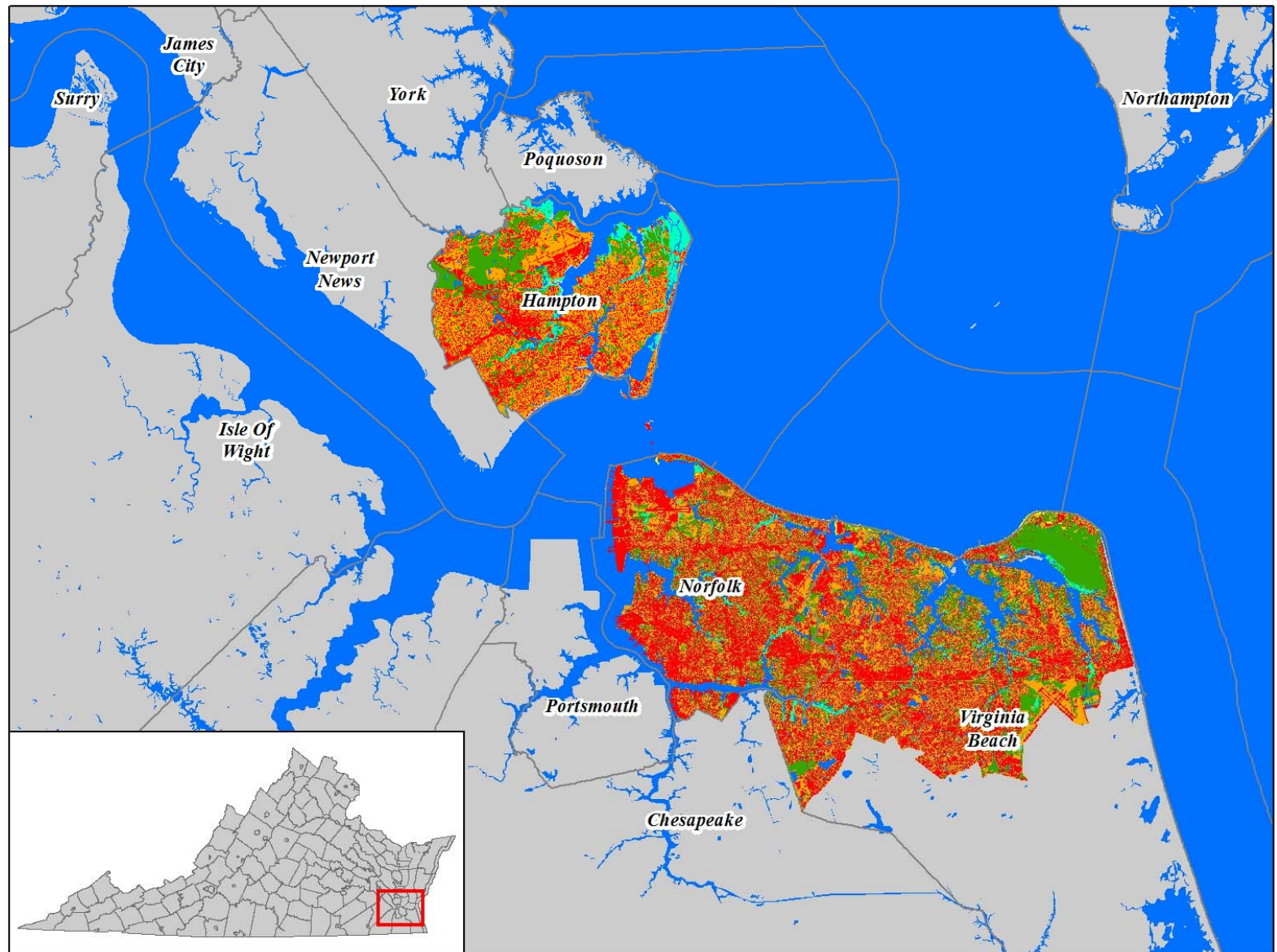Virginia Beach, VA
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Kimley-Horn and Associates, Inc.

Land Cover Classification Goals

- Goals:
  - Use existing data
  - Compare Bay Model to actual land cover
  - Optimize resolution and accuracy
  - Create secondary products
    - Stormwater billing reconciliation
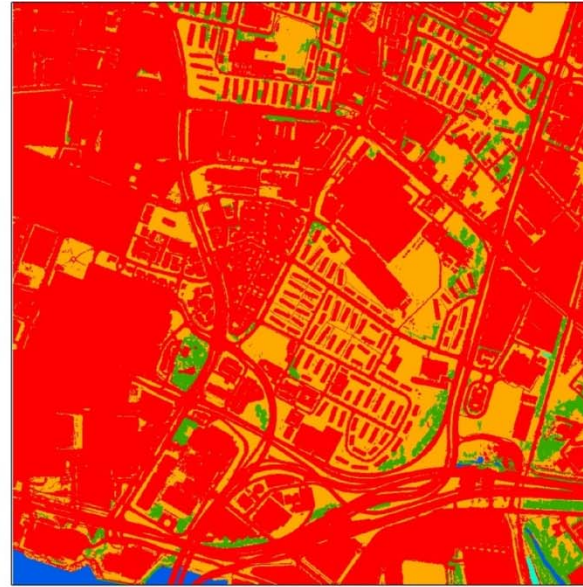   - Compatible with Virginia Runoff Reduction Method (VA RRM)

Where?

METHODOLOGY

Why Land Cover?

	Derived from 1' Land Cover (ac)	Estimated Land Cover by Parcel Use using CWP WTM (ac)
Impervious	397.82	339.79
Forest/Wooded	25.35	0.00
Managed Turf	132.76	181.96
Wetland	0.30	0.00
Water	4.44	0.00
Other	0.00	38.93

Data Sources

- 2009 4-band VBMP Aerial Photography – GeoTIFF
  - 1-foot pixel resolution
  - 4-bands (Red, Green, Blue, NIR)
  - Acquired during winter/spring 2009 in "leaf-off" conditions
- City Level Planimetric Data
  - Roads
  - Buildings
  - Parking Lots
  - Etc.

Data Sources (Cont.)

- Data acquired by the State of Virginia on a 2 to 4 year cycle

- Other States have similar programs
  - Examples:
    - Pennsylvania: PAMAP iCubed Imagery
    - Maryland: Dept. of IT Contracted Imagery

Process

- Obtain raw images in GeoTIFF format covering the study area (red, green, blue, NIR)

Image Classification

ERDAS Imagine used to perform Supervised Classification into 6 classes.

Land Cover Class	Land Cover Description
Impervious	Consists of features such as rooftops, pavement, packed hardened soil, sidewalks, driveways, etc.
Managed Turf	Contains features such as, or similar in nature to, lawns, golf courses, ball fields and manicured landscaping.
Forest / Wooded Land	Tree covered or other densely vegetated surface not falling into the managed turf surfaces category.
Wetland / Marsh	Areas that appear to be wetlands from the aerial photography. These are not field verified or official.
Open Water	Areas completely covered with water for the majority of the year. Examples are rivers, ponds, lakes and oceans.
Other/ Sand / Beach / Dunes	Large beach or dune areas. The sand category does not include recreational fields or small sandy areas in yards.

Automated Correction

- After automated classification
  - Additional refinement using planimetrics to derive obstructed features due to tree canopy or other phenomena.
    - Buildings
    - Road Areas
    - Water
    - Other planimetric features

- Planimetric data converted to Raster format and Raster Calculator used for optimized efficiency

Raw Classified Image

Anomalies Requiring Manual Correction

- Dormant Bermuda Grass
  - Golf Courses, Recreational Areas, Military bases
- Single Trees / Shrubs / Managed Turf
- Shadows
- Other Miscellaneous errors corrected
  - Extremely wet yards classified as wetlands
  - Image noise resulting in "grainy" classification

Manual correction process:

- Patch polygons created in large areas of errors (image noise)

- Converted to raster and "burned" into classified land cover

- ESRI ArcGIS Raster Calculator used in this process. Simple "IF… Then" statement

Changes after Manual Correction
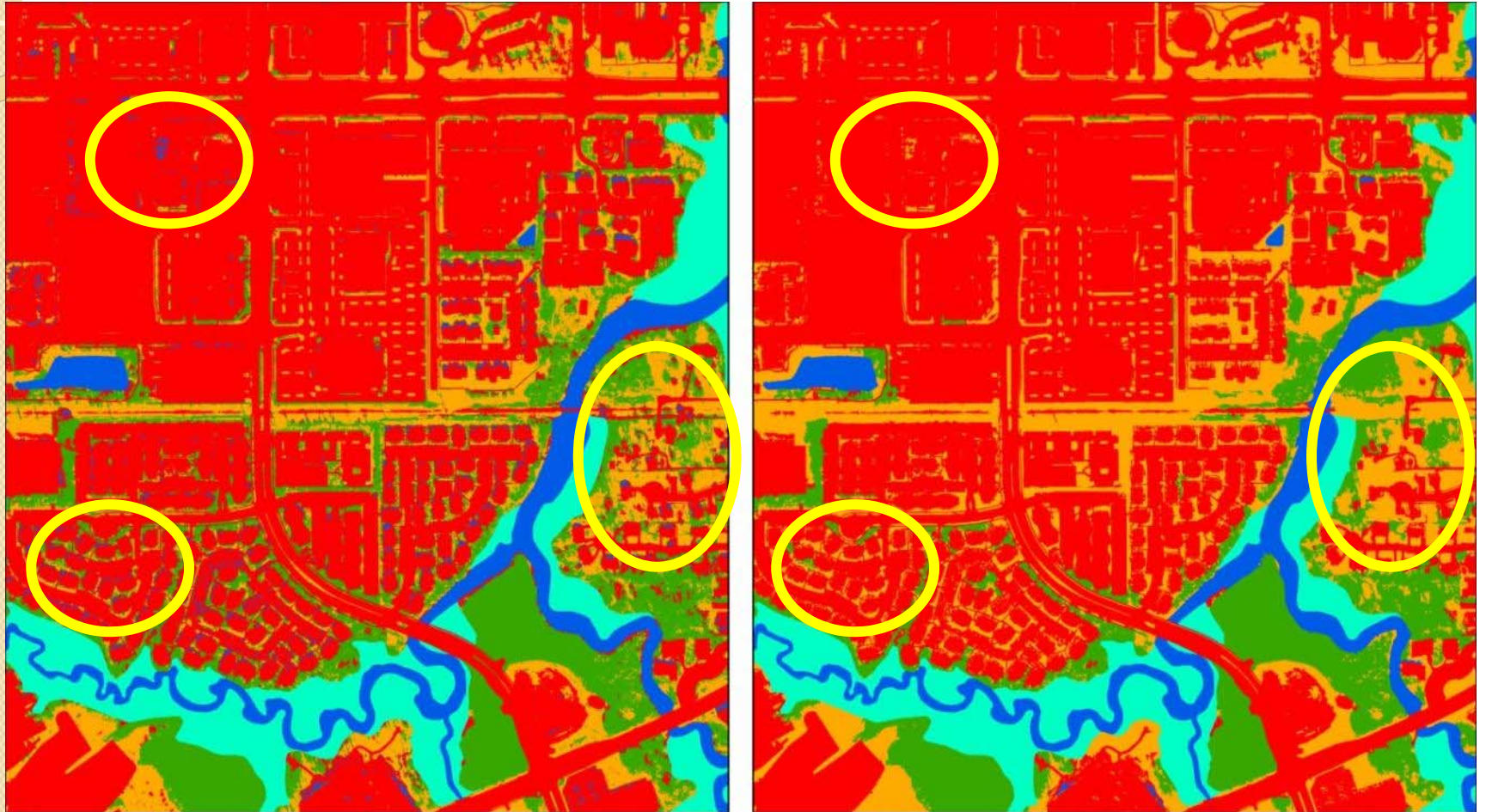
Additional Cleanup

- Data converted to Vector

- Small areas, < 20ft^2 "dissolved" into surrounding areas

- Tile groupings were edge matched to ensure continuity between them

Final Land Cover data

Cover Type	Area (Sq Feet)	Area (Acres)	Area (Percent)
Impervious	775,620,368	17,805.79	42%
Managed Turf	430,776,060	9,889.26	23%
Forest	249,361,409	5,724.55	13%
Marsh/Wetland	29,571,323	678.86	2%
Sand/Beach/Dune	9,678,307	222.18	1%
Water	362,561,527	8,323.27	20%
ALL	1,857,568,993	42,644	100%
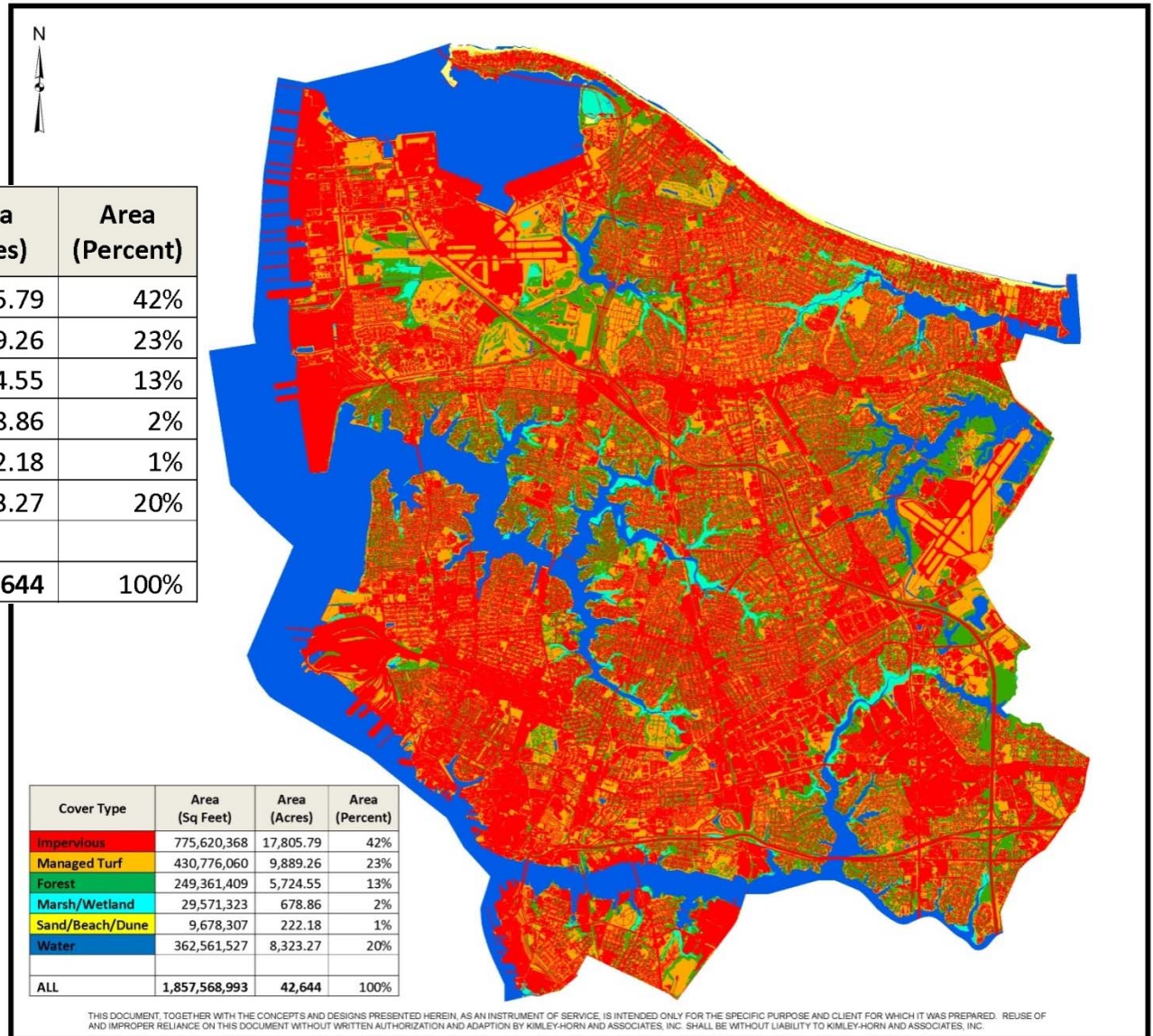
ACCURACY

Issues and Questions that arose

- Land Cover data are only as good as the source images
- Detail is good, but can be detrimental to classification process
  - One pixel of concrete in an open field, do we care?
- Distinguishing the forest from the trees…
  - What counts as forested land?
  - The process currently allows for "forested lots"
  - Forested areas must be greater than 2,500 ft2

Accuracy Statistics

Class name	Reference Totals	Classified Totals	Number Correct	Producer's Accuracy	User's Accuracy	Kappa
Impervious	101	100	96	95.05%	96.00%	0.9483
Forest	94	100	89	94.68%	89.00%	0.8607
Managed Turf	110	100	93	84.55%	93.00%	0.9072
Marsh/Wetland	22	23	20	90.91%	86.96%	0.8628
Water	97	100	97	100.00%	97.00%	0.9617
Sand/Beach/Dune	22	24	22	100.00%	91.67%	0.9124
Totals	**447**	**447**	**417**	**N/A**	**93.29%**	**0.915**

Minimum Mapping Units

- Smallest Impervious Feature
  - 20 ft^2 (10'x10')

- Smallest Forested Feature
  - 2,500 ft^2
  - **<u>Single Trees assigned to Managed Turf</u>**

- Other Features
  - 20 ft^2 (10'x10' – Same as impervious)

Class Omissions

- Current methodology is best suited to urban (MS4) areas
  - Very little Ag in study areas

- Classes could be added to aid in non-urban classification
  - Ex: Agricultural acreage could be defined
    - Crop type/ratios would still be determined by USDA Farm Service Administration statistics

RELATIONSHIP TO BAY MODEL CLASSIFICATION

Class mappings to 5.3.2

Norfolk Land Cover Class	Bay Model 5.3.2 Land Cover Class
Impervious	Urban Impervious
Managed Turf	Urban Pervious
Forest	Forest
Non-Tidal Wetland	Forest
Sand, Beach, or Dune	Urban Pervious
Open Water	N/A

Pollutant Loading Comparison

	TP (lb/yr)	TN (lb/yr	TSS (lb/yr)
2009 Existing Load per Virginia WIP 1 Bay Model V5.3	53,613	274,039	10,610,608
2009 EPA Load per Model 5.3.2	34,879	311,734	10,211,933
VA RRM (2009 Norfolk Land Cover)	51,010	365,753	10,791,619
EPA Interpolated (2009 Norfolk Land Cover Data)	33,241	272,155	10,423,180
CWP WTM (2009 Parcel Land Use Data)	59,014	358,074	12,286,601

Explanation of EPA Interpolated

- Calculated amount of TP, TN, and TSS per acre for each land cover type at the land river segment level

- Calculations based on EPA loading spreadsheets from 5.3.2 for VA

- Input local land cover acreages to derive final pollutant loading numbers for scenario

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Unanswered Questions

- How to account for "better site design" in Land Use
  - Average cover/use prior to/post a date?
- Availability of planimetric data outside of urban areas
  - Account for impervious cover under trees
- Can progress be tracked through Land Cover?

Summary

- 5.3.2 Land Cover appears consistent in SE VA
- Land Use derived cover inconsistent
- High resolution aerial photography available in most locations
- Ideal for urban areas
- Can be customized for non-urban areas

QUESTIONS?