



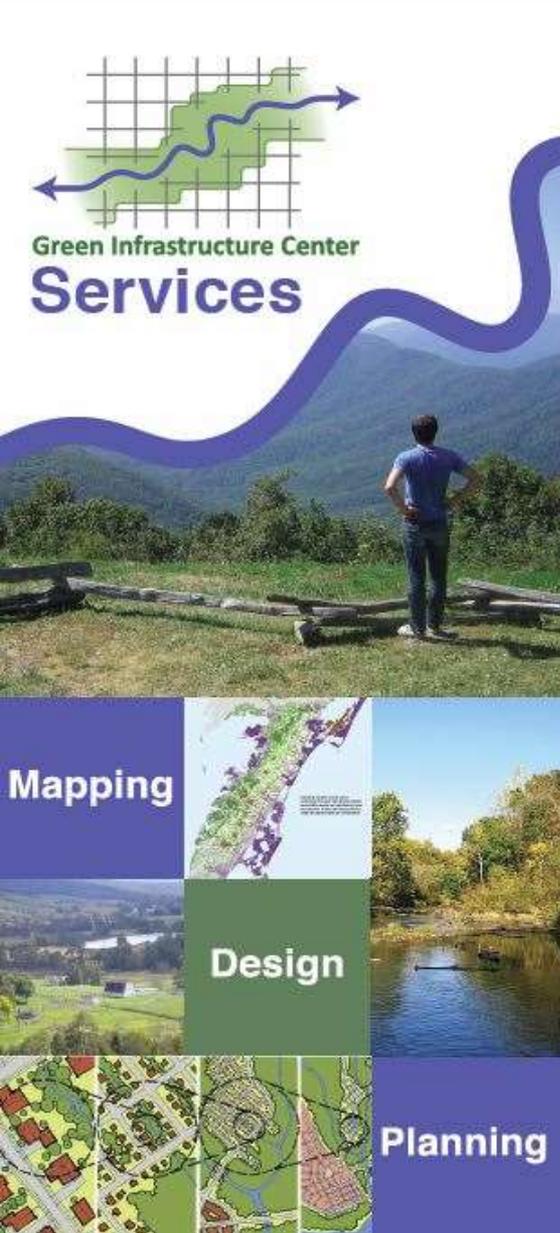
Green Infrastructure at Multiple Scales: How to Re-green and Re-link the Urban Landscape

by Karen Firehock, Executive Director,

the Green Infrastructure Center Inc.

The Potomac Watershed Partnership

© December 9, 2014



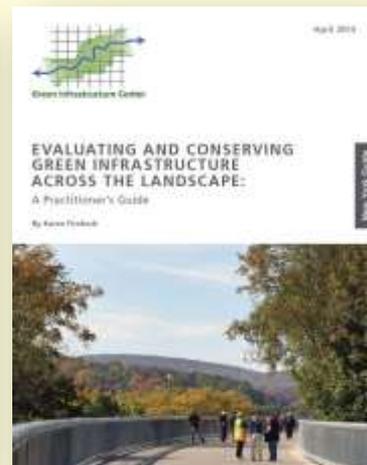
The Green Infrastructure Center's mission is to help communities evaluate their green assets and manage them to maximize ecological, economic and cultural returns.

We do this by:

- Technical and mapping consulting
- Teaching courses and workshops
- Research into new methodologies

Case Studies and Models

Launched in Virginia, the GIC has conducted 16 projects from multi-county regions, to counties, cities, towns and watersheds. We have also worked in New York, Arkansas, and North Carolina and are completing South Carolina. We can help create new state models or assist with local implementation. To view GIC's projects or order a guide visit: www.gicinc.org



Slide Show Topics



- ❑ Why We Need to Plan Better
- ❑ Natural Assets as Green Infrastructure
- ❑ Six Steps for Green Infrastructure Planning
- ❑ Case Examples: *County, Town/Watershed, Site*
- ❑ Making the Case to Decision Makers, Landowners and Managers

Impacts of poor/no planning on environment

Traffic congestion

Poor water quality

Bad air quality

Loss of critical habitat

Loss of working lands



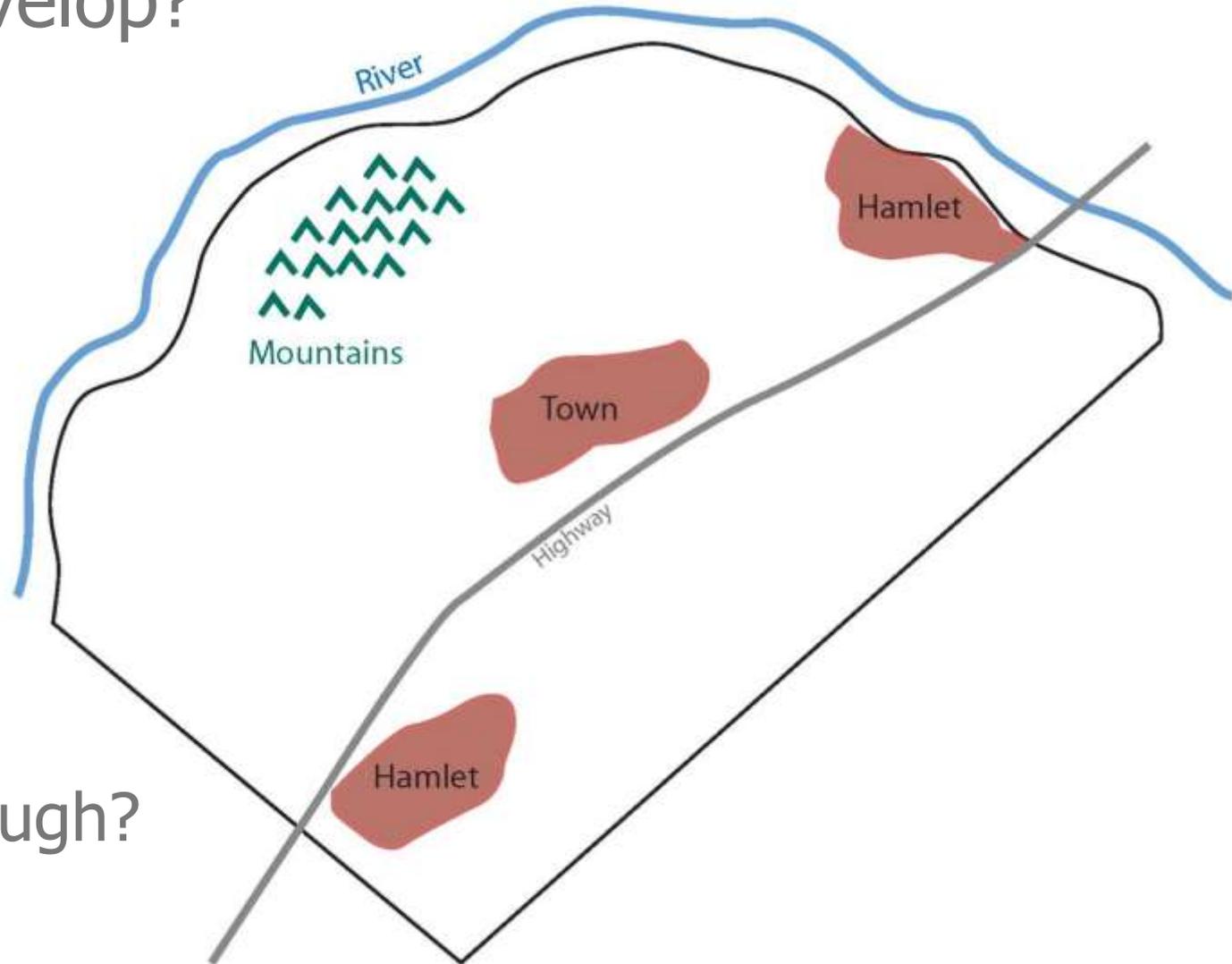
While you viewed this slide, America lost another 3 acres of open space

Where to develop?

Smart
Growth =

Using
Existing (grey)
Infrastructure

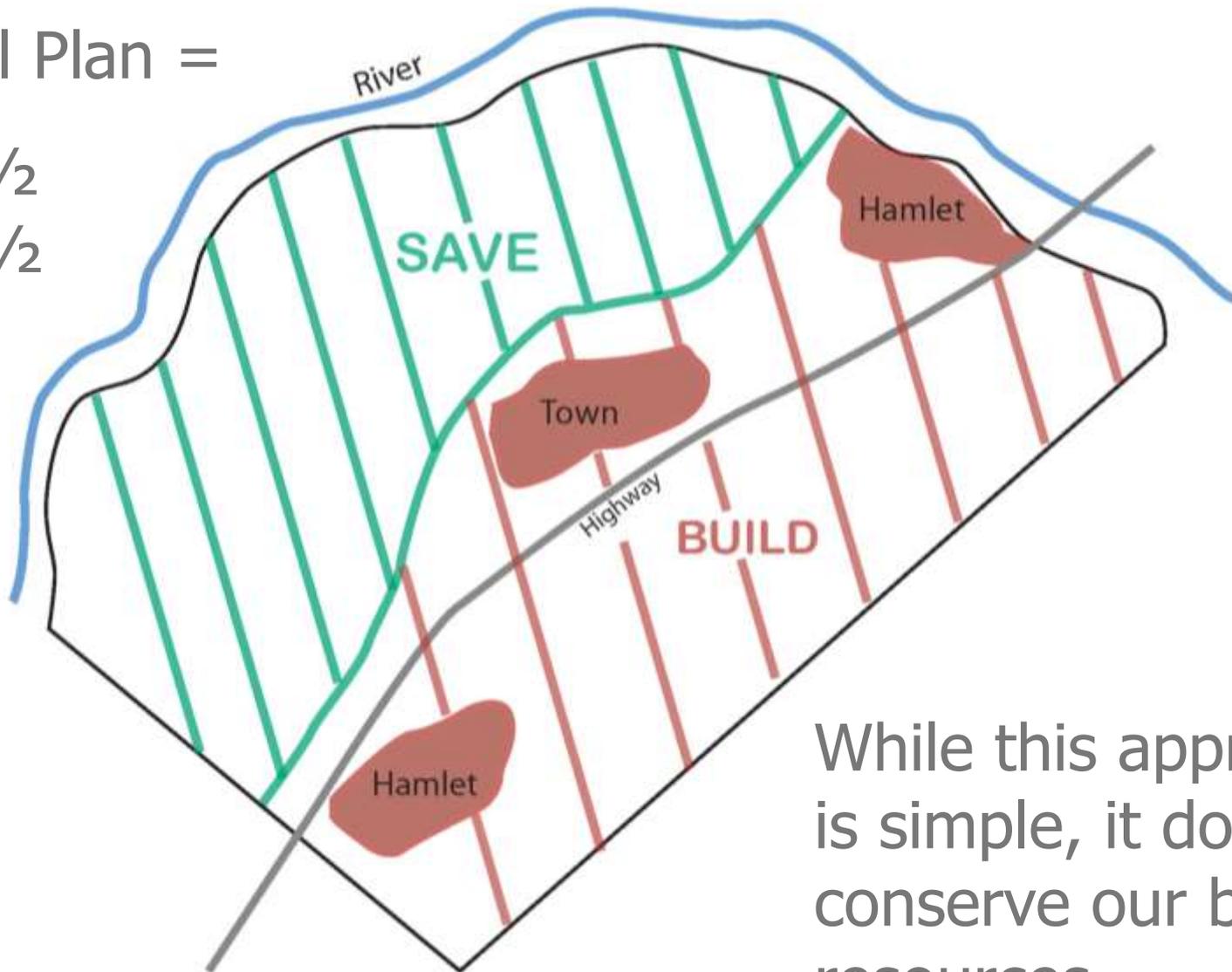
But is this enough?



Typical Plan =

Save $\frac{1}{2}$

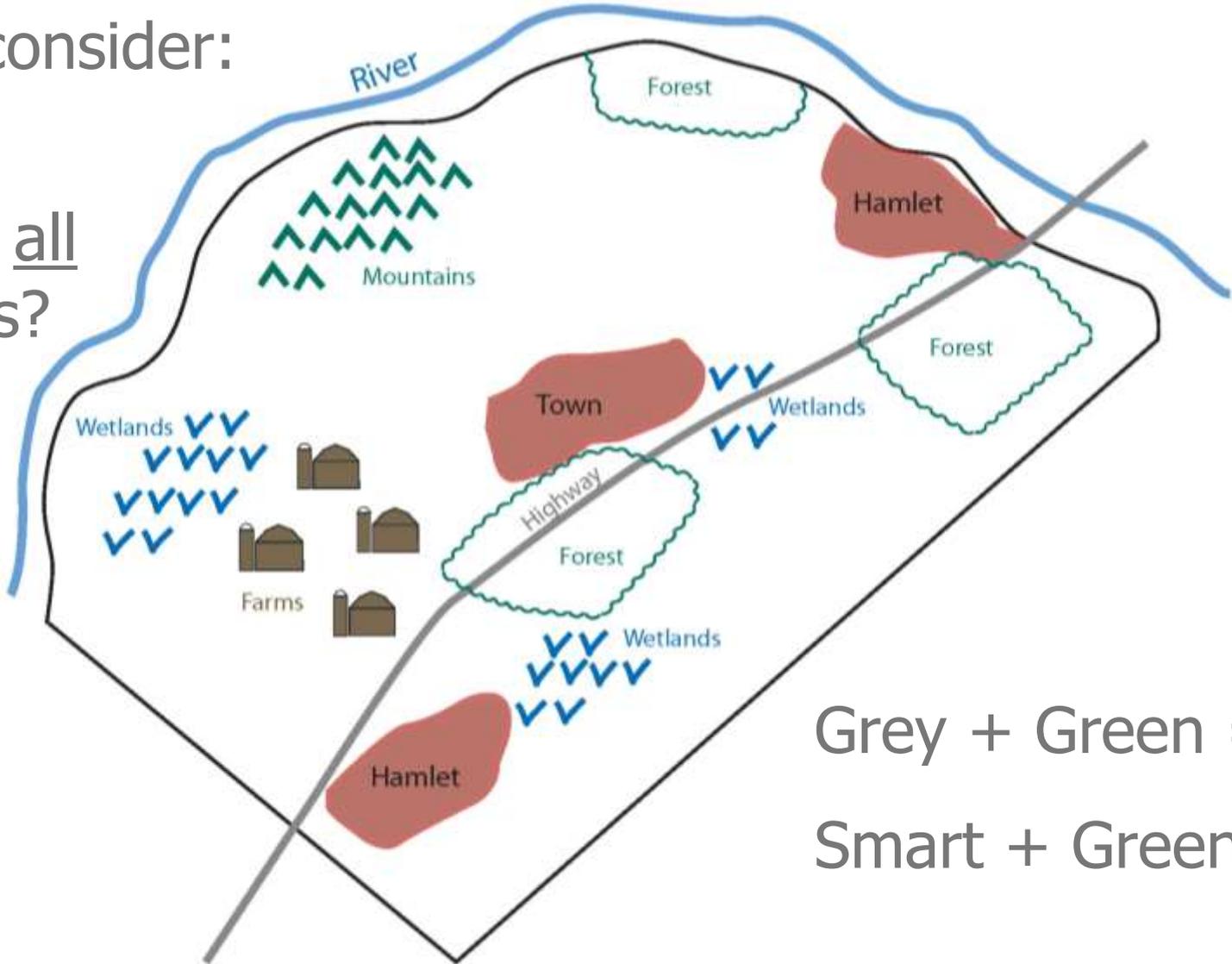
Build $\frac{1}{2}$



While this approach is simple, it does not conserve our best resources.

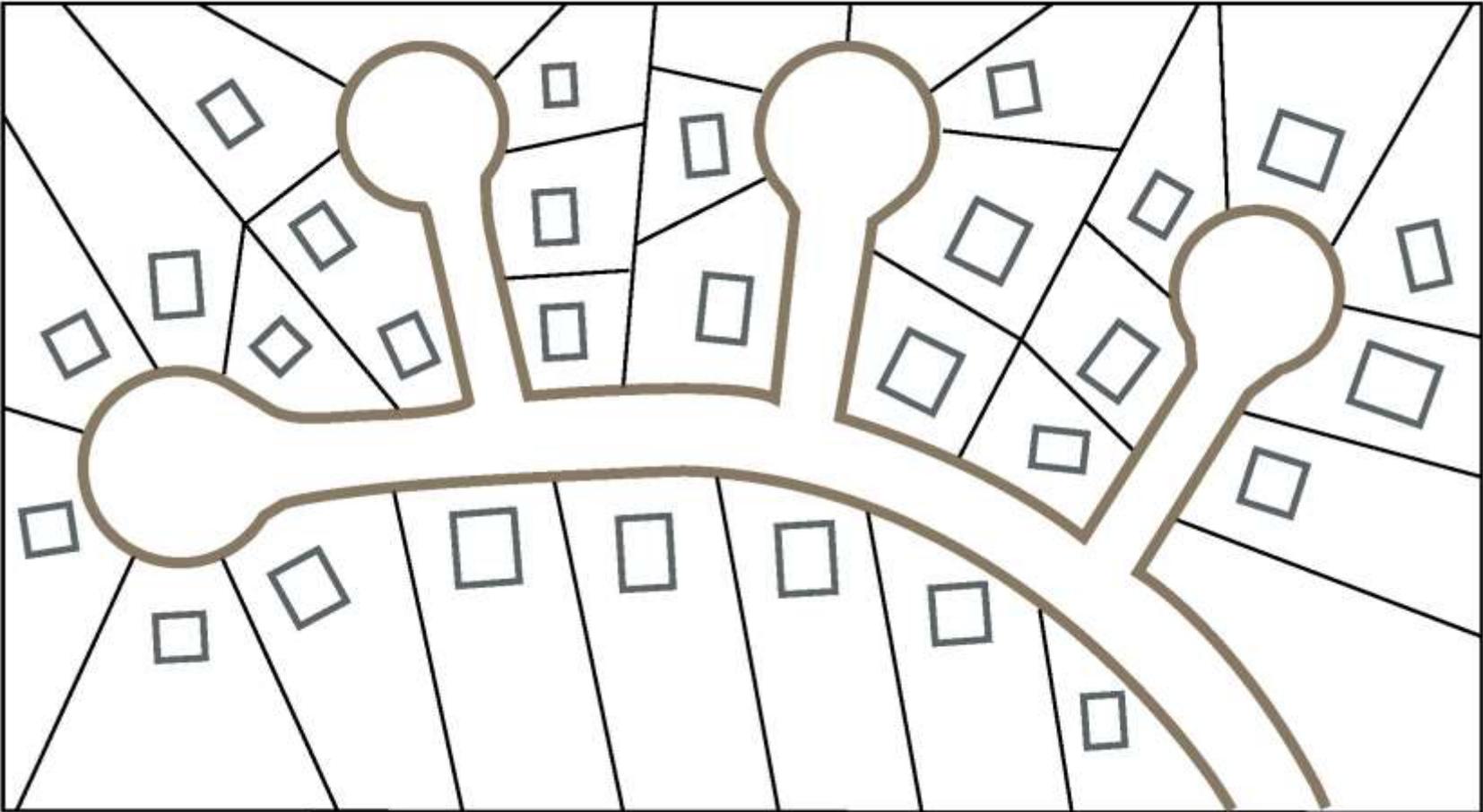
Need to consider:

What are all the assets?



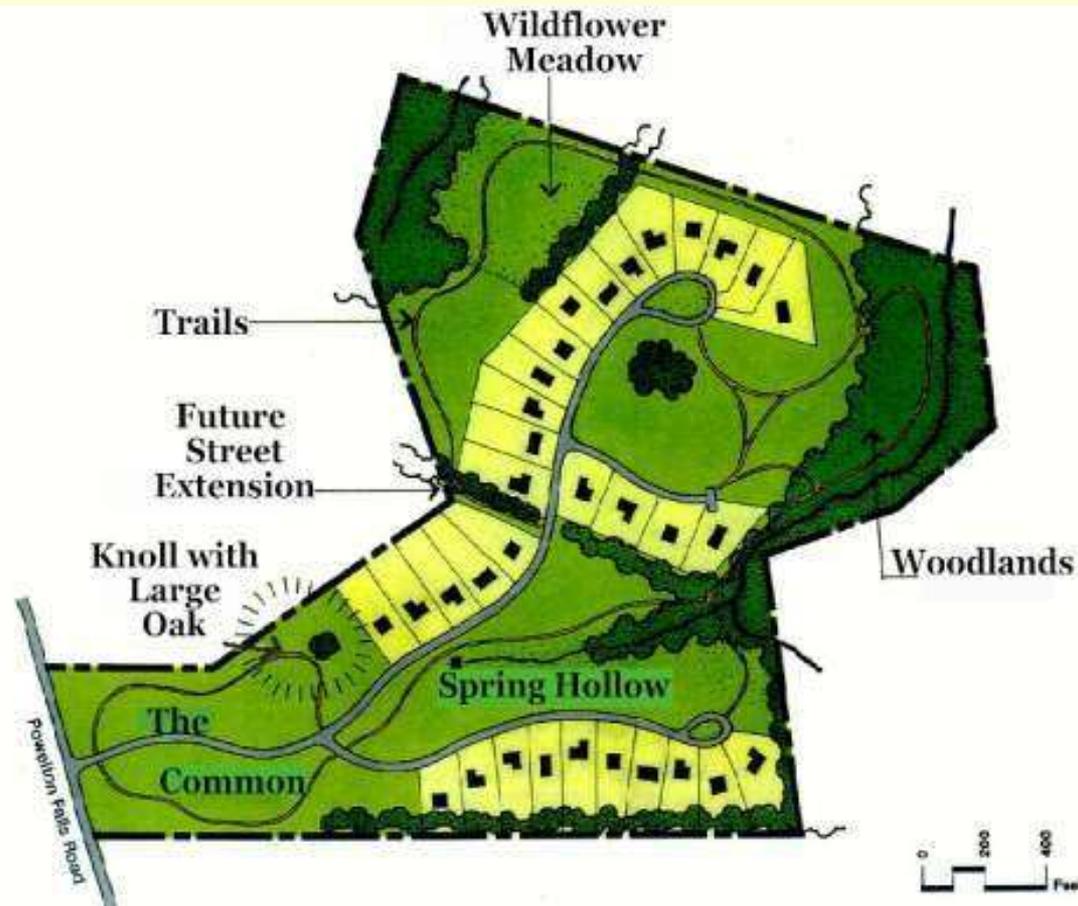
Grey + Green =
Smart + Green

Traditional Development

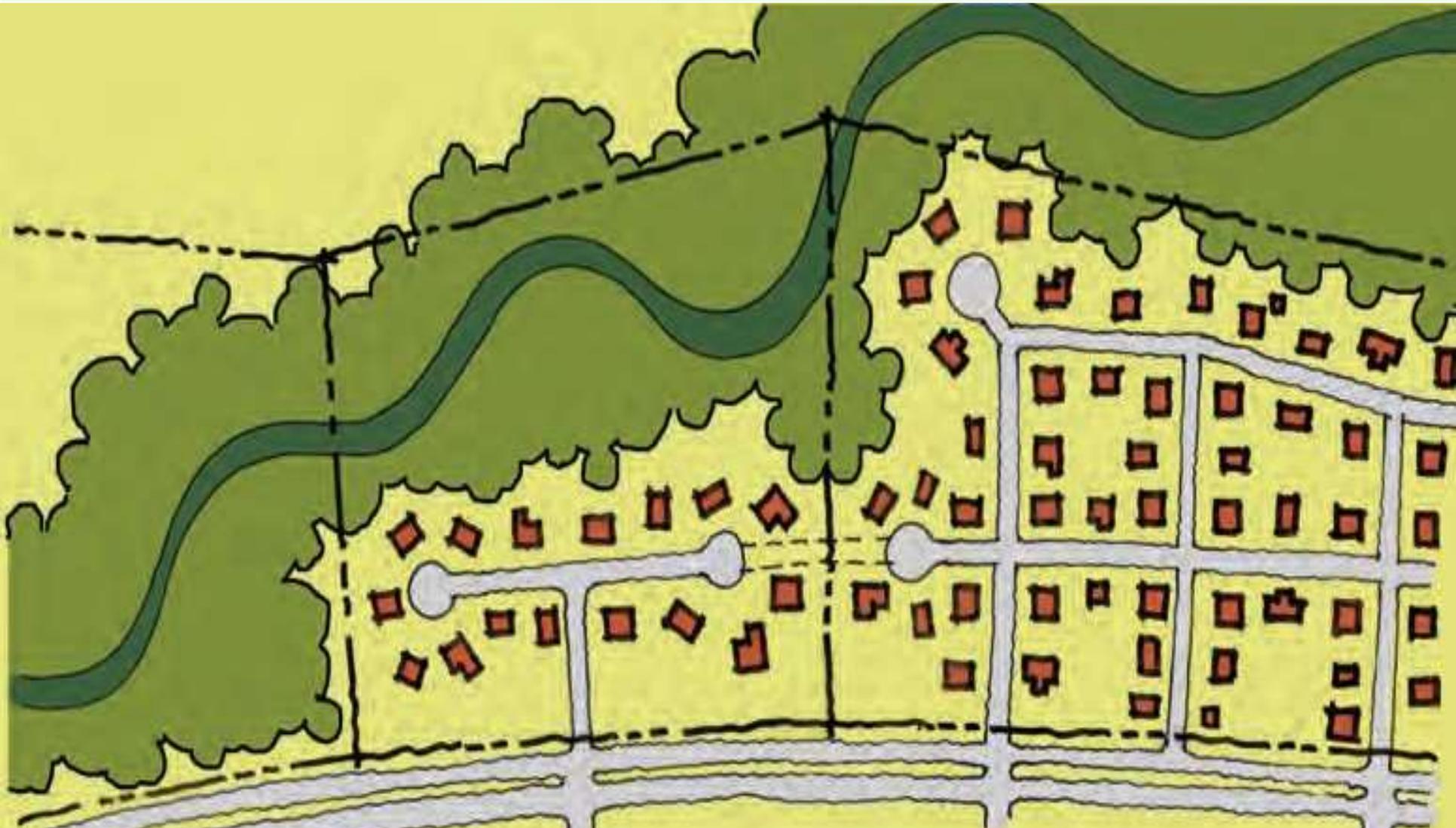


Clustering =
setting buildings
closer together
to conserve
green space

Within a subdivision,
clustering can add to open
spaces and provide an
amenity for wildlife and
recreation. But which land is
protected and how it is
connected are critical.



The problem of clusters that don't look beyond parcel boundaries



Infrastructure: What's in a name?

Infrastructure (n): the substructure or underlying foundation...on which the continuance and growth of a community or state depends.



What is Green Infrastructure?

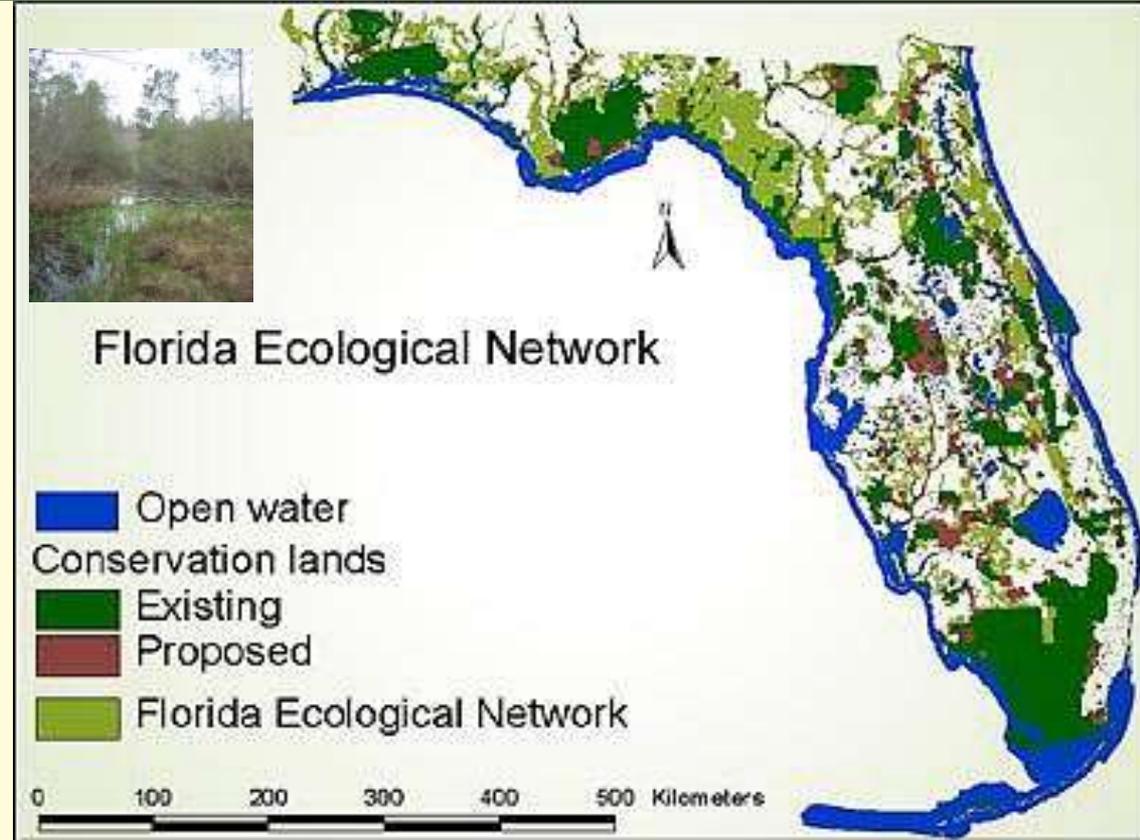


A planimetric map of a Washington DC neighborhood shows a neighborhood's gray infrastructure including buildings and roads (left). Classified high-resolution satellite imagery adds a green infrastructure data layer (trees and other vegetation) (right). [Source: American Forests](#)

Origin of the Term “Green Infrastructure”

Florida coined the term “Green Infrastructure.” in a 1994 report to the governor on land conservation strategies.

It was intended to reflect the notion that natural systems are important components of our “infrastructure.”



When Did GI Definition Expand to Include BMPs?

2006: the U.S. EPA begins calling integrated best management practices -- previously referred to as **Low Impact Development** strategies -- “Green Infrastructure.” This led to confusion!



Used in concert – best management practices such as biofilters, no mow zones, permeable pavers, filterra boxes, downspout protection and green roofs can significantly reduce urban runoff impacts.

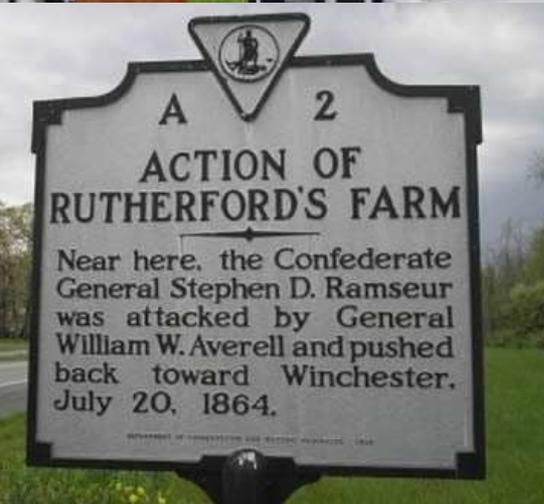
Natural Assets Are Green Infrastructure

Green infrastructure includes all landscape elements that support our existence.



Natural Assets Also Support Cultural Assets

Natural assets support the landscape context for historic and recreation features.



DUMFRIES

★ ★ ★
Love's Tavern

Dumfries, an important Potomac River port chartered in 1749, became strategically significant in the autumn of 1861 when Confederate forces built batteries along the Potomac River nearby to blockade Washington, D.C. Gen. William H.C. Whiting, commanding Confederate forces, established his headquarters here at Love's Tavern (Williams's Ordinary) while winter camps were erected around Dumfries. After the Confederates evacuated the town in March 1862, Col. Charles Casey's Federal troops moved in.

On December 27, 1862, Confederate Gen. J.E.B. Stuart and 1,500 cavalry troopers attacked the Federal garrisons at Dumfries and Occoquan. Part of Stuart's command, led by Gens. Pittsburgh Lee and W.H.F. Rooney Lee, assaulted Dumfries from the north and south. Stuart's Horse Artillery bombarded the town, destroying many buildings, but Casey's Federals repulsed numerous attacks. The losses on both sides were relatively light.

The Confederates stalled the town until dark and the next morning moved north to join their comrades then riding into Fairfax County, where Stuart engaged the Union garrison at Occoquan and captured supplies at Burke Station. Dumfries remained under Federal control for the rest of the war, but various Confederate partisan bands launched attacks periodically until the close of the war.



"Gen. Johnston arrived here (Dumfries) this evening, and is now staying at Gen. Whiting's head quarters. He will remain here a day or two inspecting the army and then return to Centreville. His arrival has been a course of much rejoicing, and hundreds have been in town today, to get a glimpse of their Chief. They will have an opportunity tomorrow." - Times dispatch, November 27, 1861



Gen. W.H.F. Whiting
General of Virginia



Gen. Charles Casey
General of Virginia



Gen. Pittsburgh Lee
General of Virginia



Gen. W.H.F. Rooney Lee
General of Virginia



GREEN INFRASTRUCTURE CENTER



Benefits of Conserving Green Infrastructure

- ❑ Conserving working lands such as farms and forests, that contribute to the economy.
- ❑ Protecting and preserving water quality and supply.
- ❑ Providing cost-effective stormwater management and hazard mitigation.
- ❑ Preserving biodiversity and wildlife habitat.
- ❑ Improving public health, quality of life and recreation networks.



How to think strategically about Green Infrastructure

For new development:

- 1) Is this the right site to develop?
- 2) If yes, how do natural features connect to other sites?
- 3) How can I minimize my site impacts (smaller footprint...) AND keep connections?
- 4) Once I have the right site, have maximized its connections and protected sensitive landscape features, *then and only then* can I ask, how to mitigate the impacts (hint: use LID approaches with a decentralized, small footprint, integrated approach)! Also consider restoring the site's natural features!

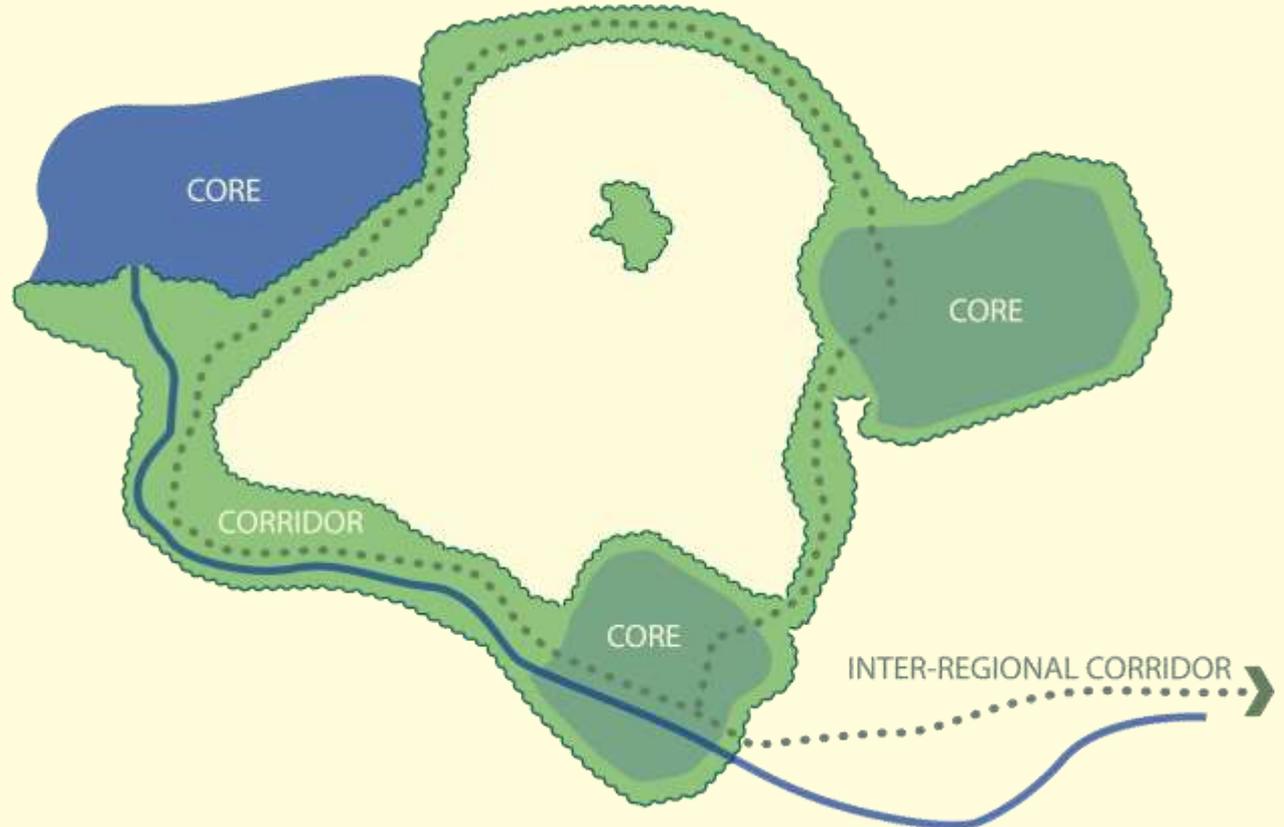
In summary, first ask, how can we avoid disturbing natural resources, then second, if we must disturb some area, how can we minimize impacts and lastly, how can we mitigate the harm caused. **So first, *conservation* and then, *mitigation* with LID.**



Green Infrastructure Planning For A Connected Landscape

It's about connecting the landscape!

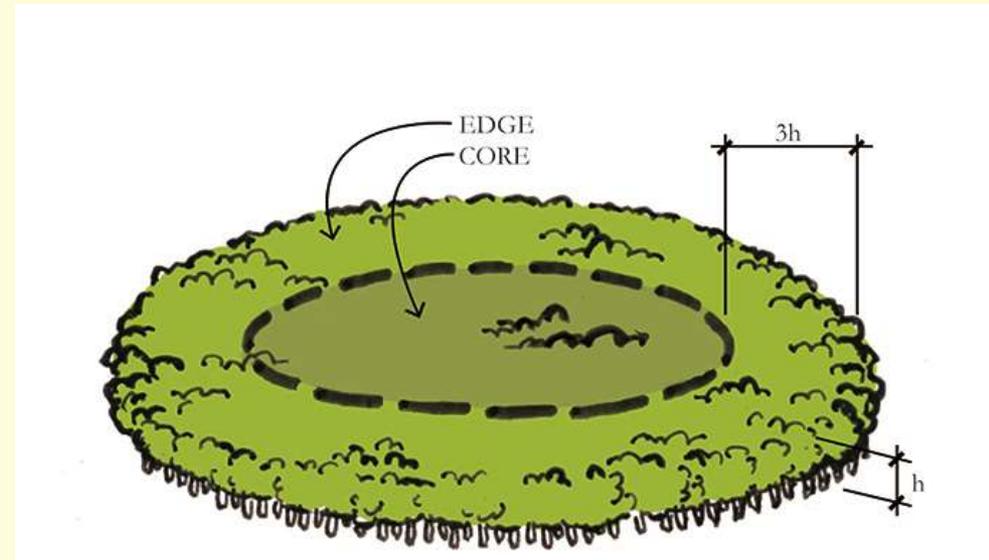
Not just key habitats but how we connect them!



How to Calculate Interior Habitat

Take the average tree height for @ 100 feet and multiply by 3 to get edge. Subtract that to learn what remains and whether there is enough area to constitute a core. If smaller, it may still be a key “patch” or “site.”

$$\text{Interior} = \text{Total Area} - 3(h)$$



Who Prefers Interior Forest Cores?

Birds, e.g. cerulean warbler,
Scarlet tanager



Mammals, e.g. black bear,
bobcat, n. flying squirrel

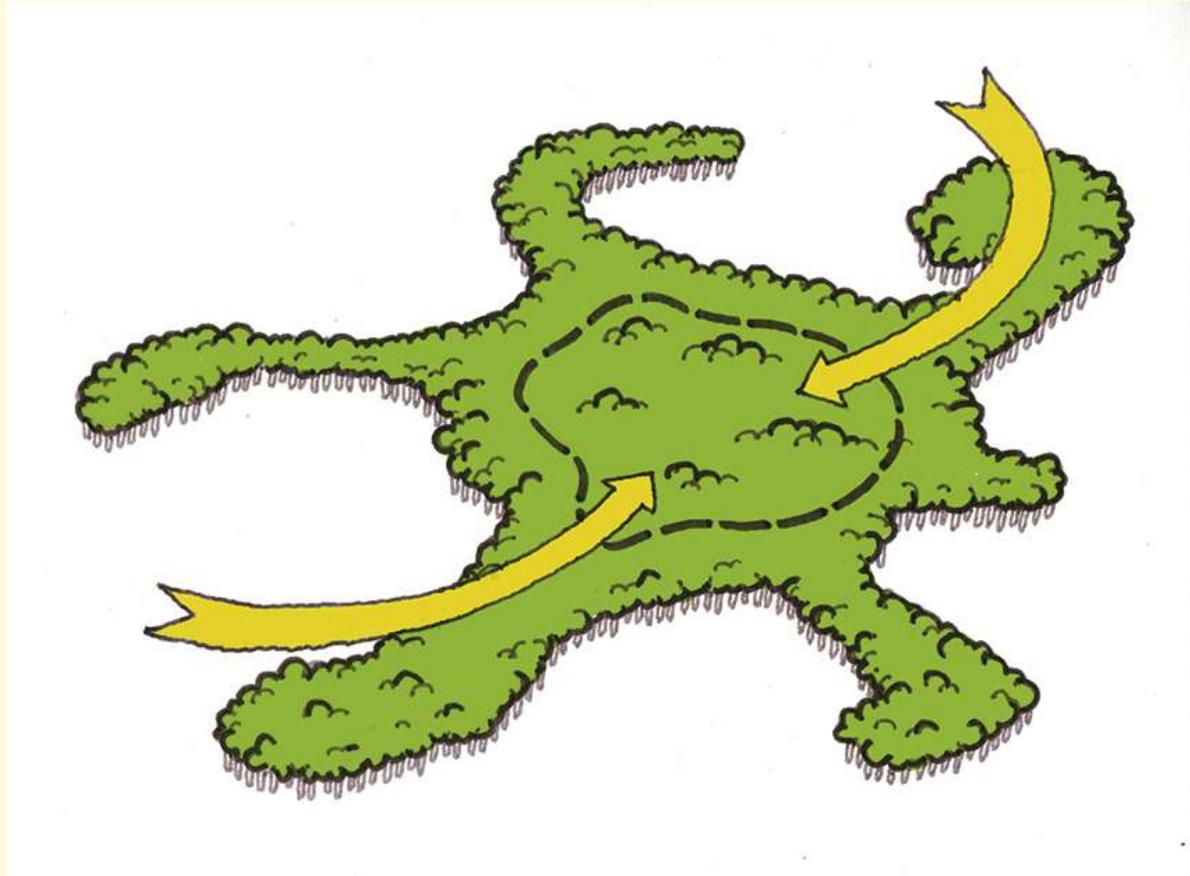


Amphibians, e.g. spotted
salamander

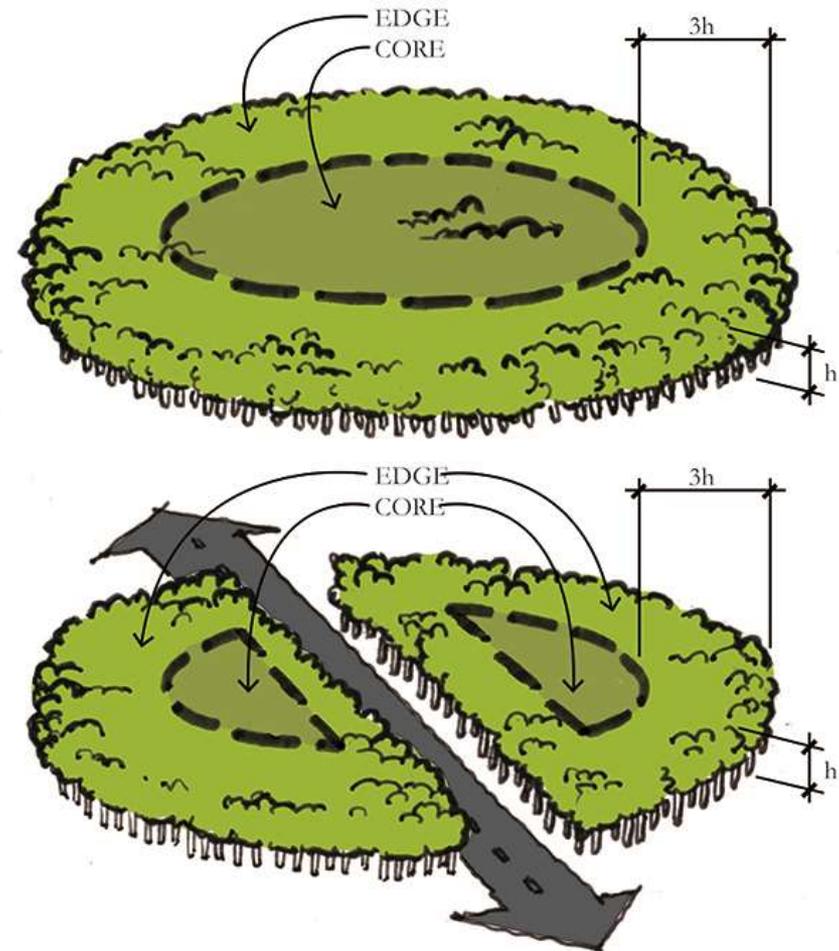


Core Shape Matters

In nature, cores are not usually round. Fingers of green help animals move into and out of cores.



Dividing a large core into two smaller cores = less interior habitat

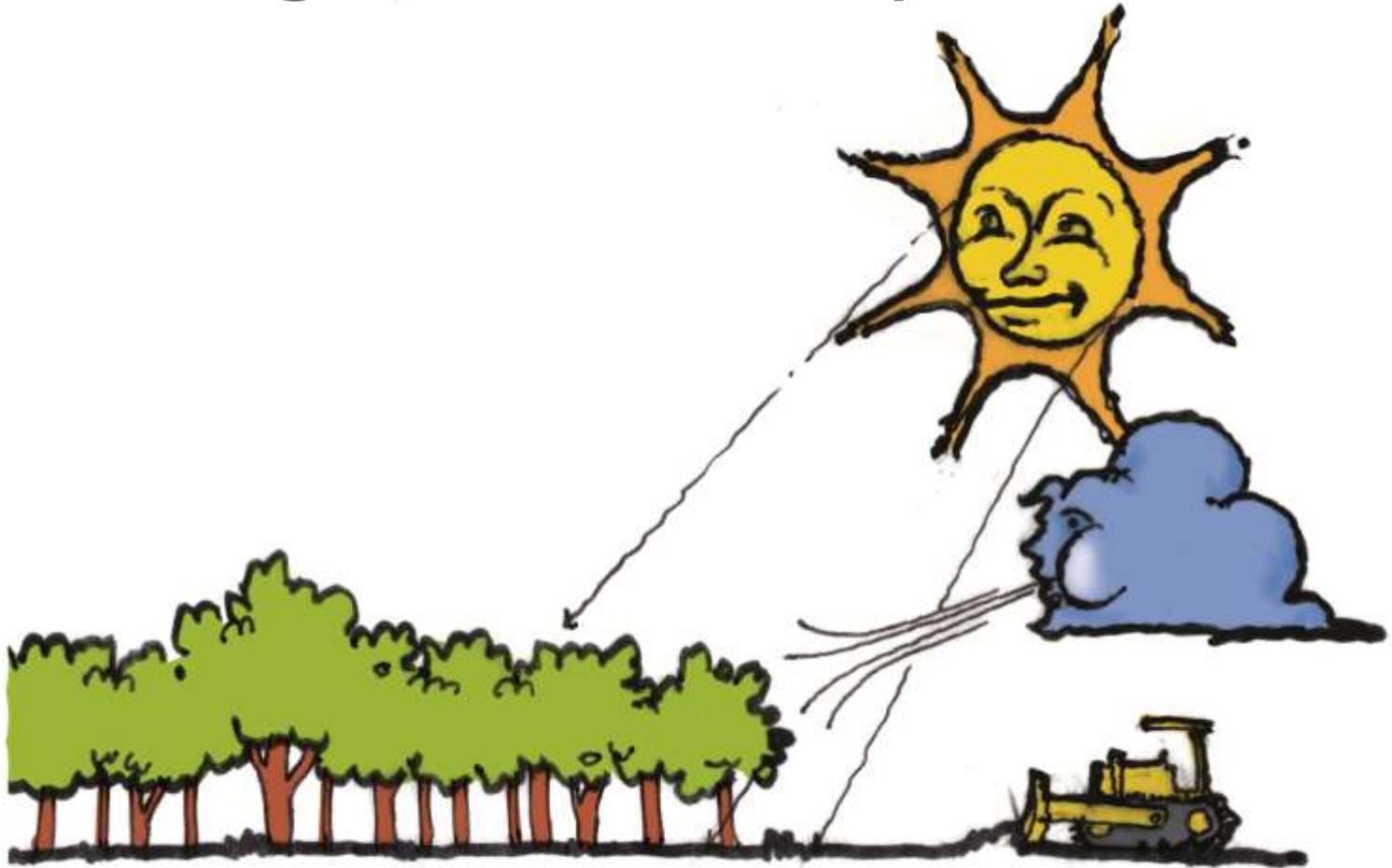


Edge area = Average tree height (h) X 3

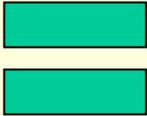
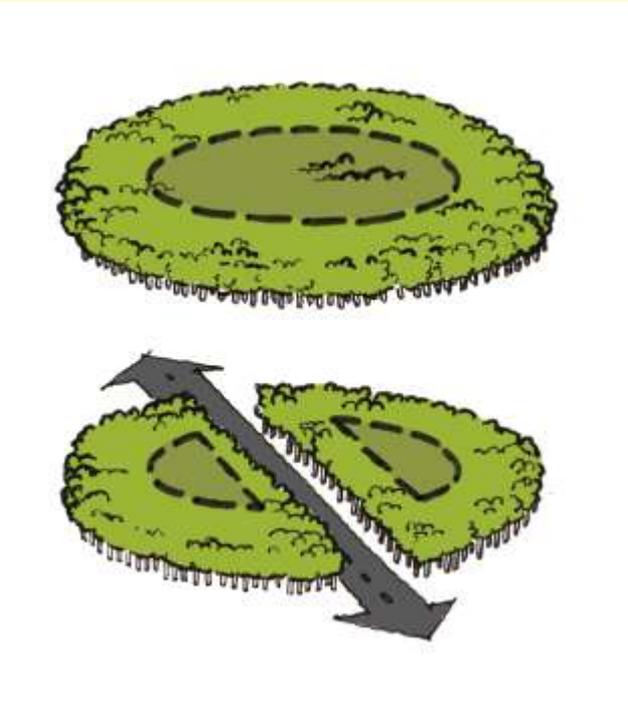
Core = Total area - Edge area

Ideally, Core \geq 100 acres

More Edge = More Impact Zones

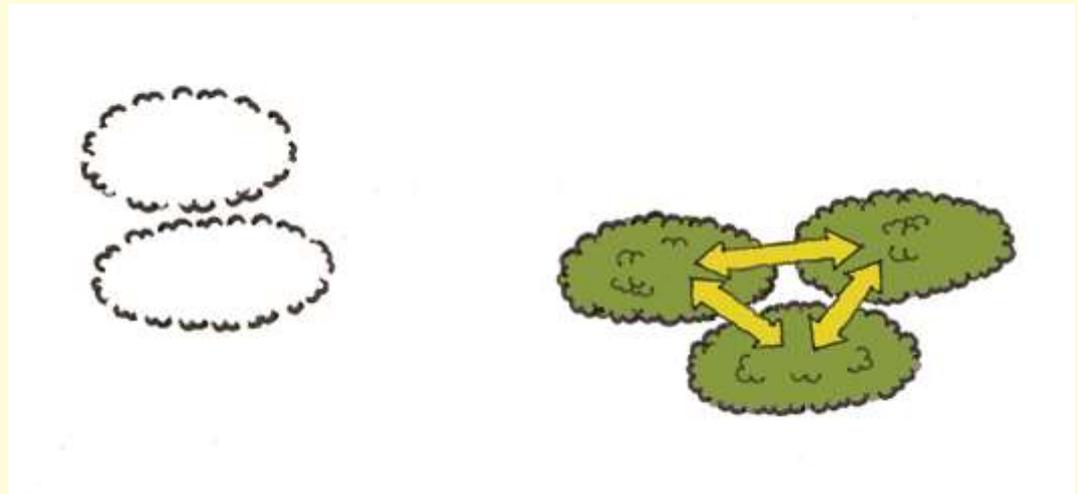
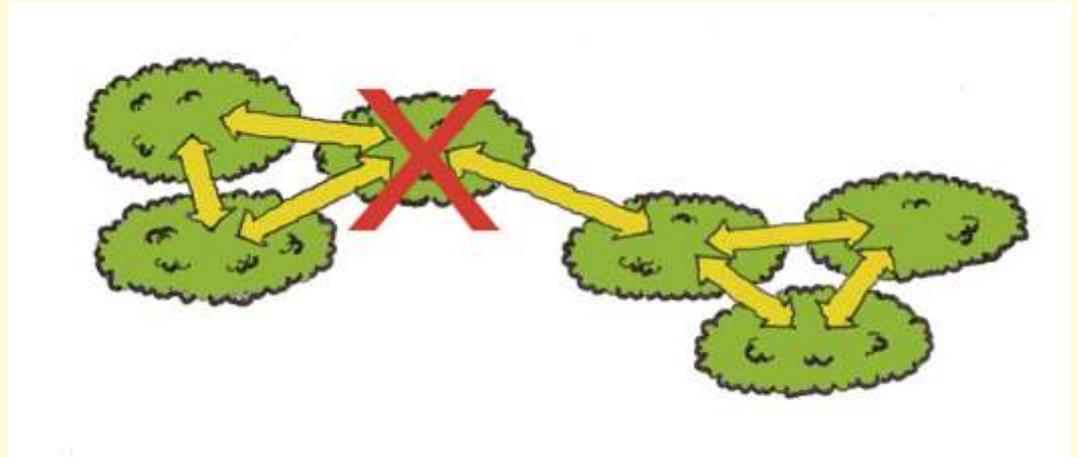


Some Species Take Advantage of the Edge



When Cores Are Lost, Species May Decline

If cores or patches are too far apart, or if a core is lost, species may become isolated and decline over time.



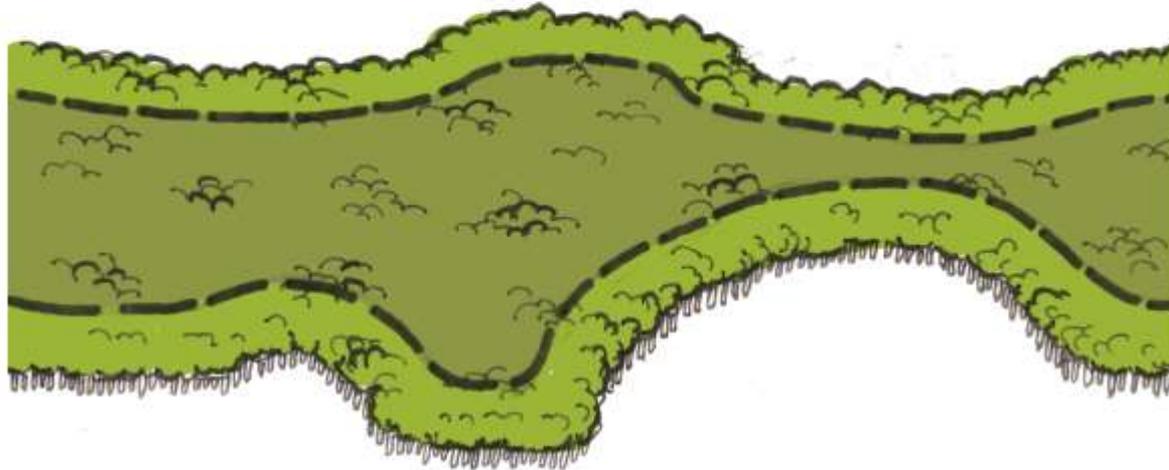
Who Can Use the Corridors? (300 meters is ideal...)



Corridors May Not Be Uniform.

The ideal is 100 meters of safe space in the middle
and 100 meters of edge.

minimum width = 300 meters wide

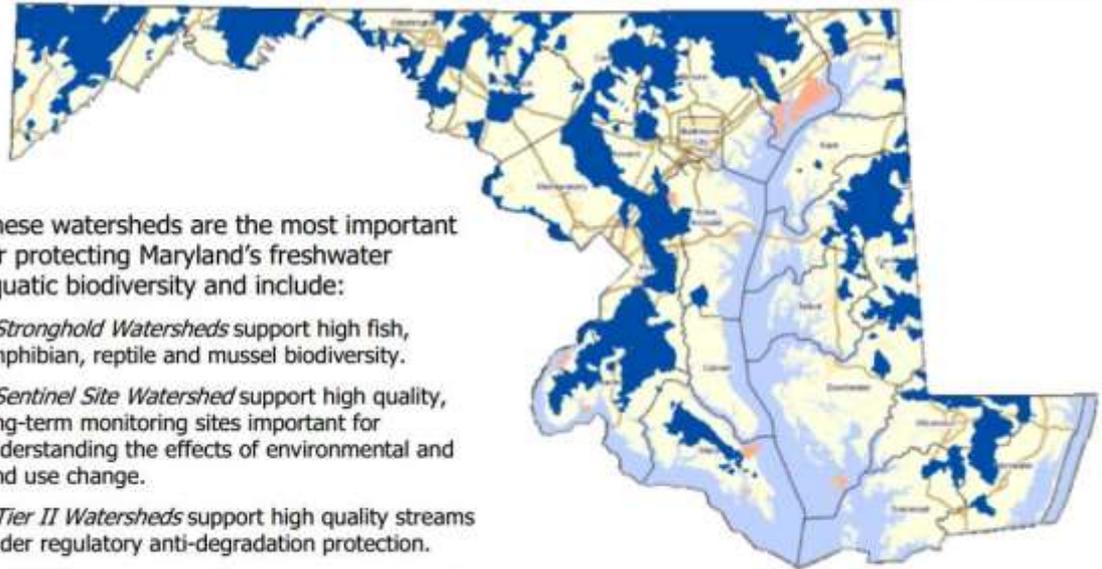
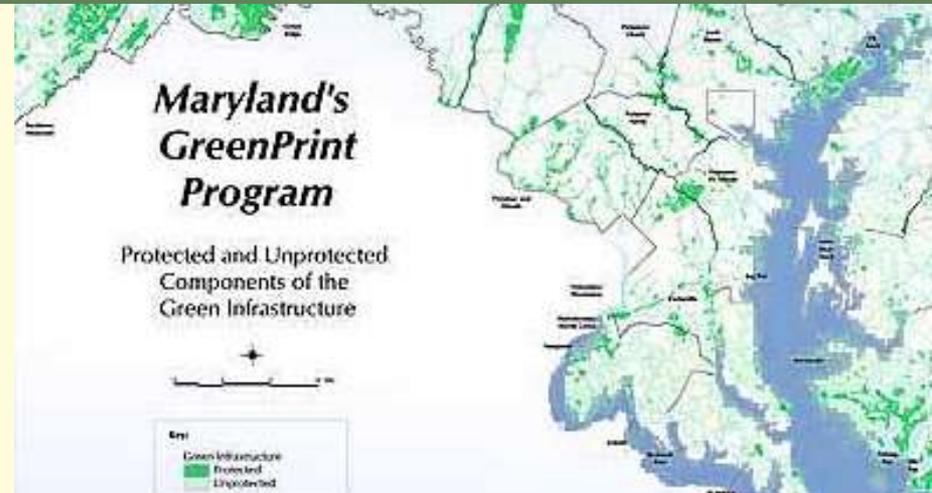


Maryland Greenways
Commission est. 1991

Statewide green
infrastructure
assessment, mid-1990s

GreenPrint Program
2001, Manual 2003

Prince George's
County has a great
local implementation.



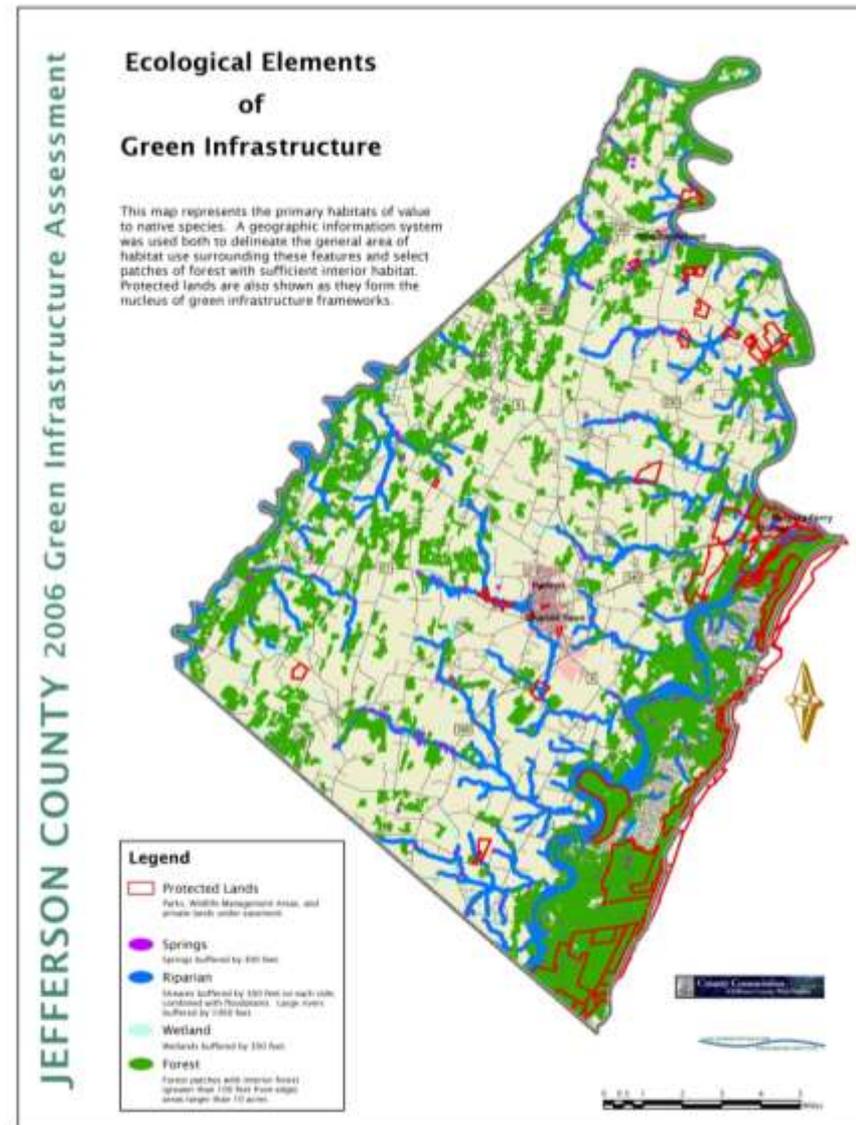
WV Environmental Data

Rare species data:

<http://www.wvdnr.gov/Wildlife/Data.shtm>



No state data: but Jefferson County did a plan



Disclaimer:

While reasonable efforts have been made to enhance the accuracy of this map, the information provided may be inaccurate, outdated or incomplete. The Conservation Fund will not be held liable for any damage, loss, or liability, whether in tort or contract, direct, indirect, or consequential, that arises or may arise from use of graphical representations.

PA Environmental Data

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

WAVE
Water Viewer for the Enterprise

Subject Area Legend Metadata Links

- Water Withdrawal/Use/Discharge
- Water Quality Assessment
- Complaints Custom US EPA Permanent Layers
- Geopolitical and Floodplains
- Habitat/Recreation Use Land/Soil Related

Permanent Layers

Subject Area Layers

- Approved Trout Waterbodies
- Approved Trout Waters
- Coop Fish Nurseries
- Fish and Game
- Managed Land
- PA Gamelands
- PFBC Recognized Fishing and Boating Access
- Scenic Rivers
- State Fish Hatcheries
- Stations
- Trout Natural Reproduction
- Trout Stocked Streams
- Wetlands
- Wilderness Trout Streams

Refresh Map

Map Search

Identify

All Visible Layers All Visible Subject Layers Select Layer

Click on map to identify all visible subject layers.

Current Tool: Identify

ESRI Street and Imagery Topo

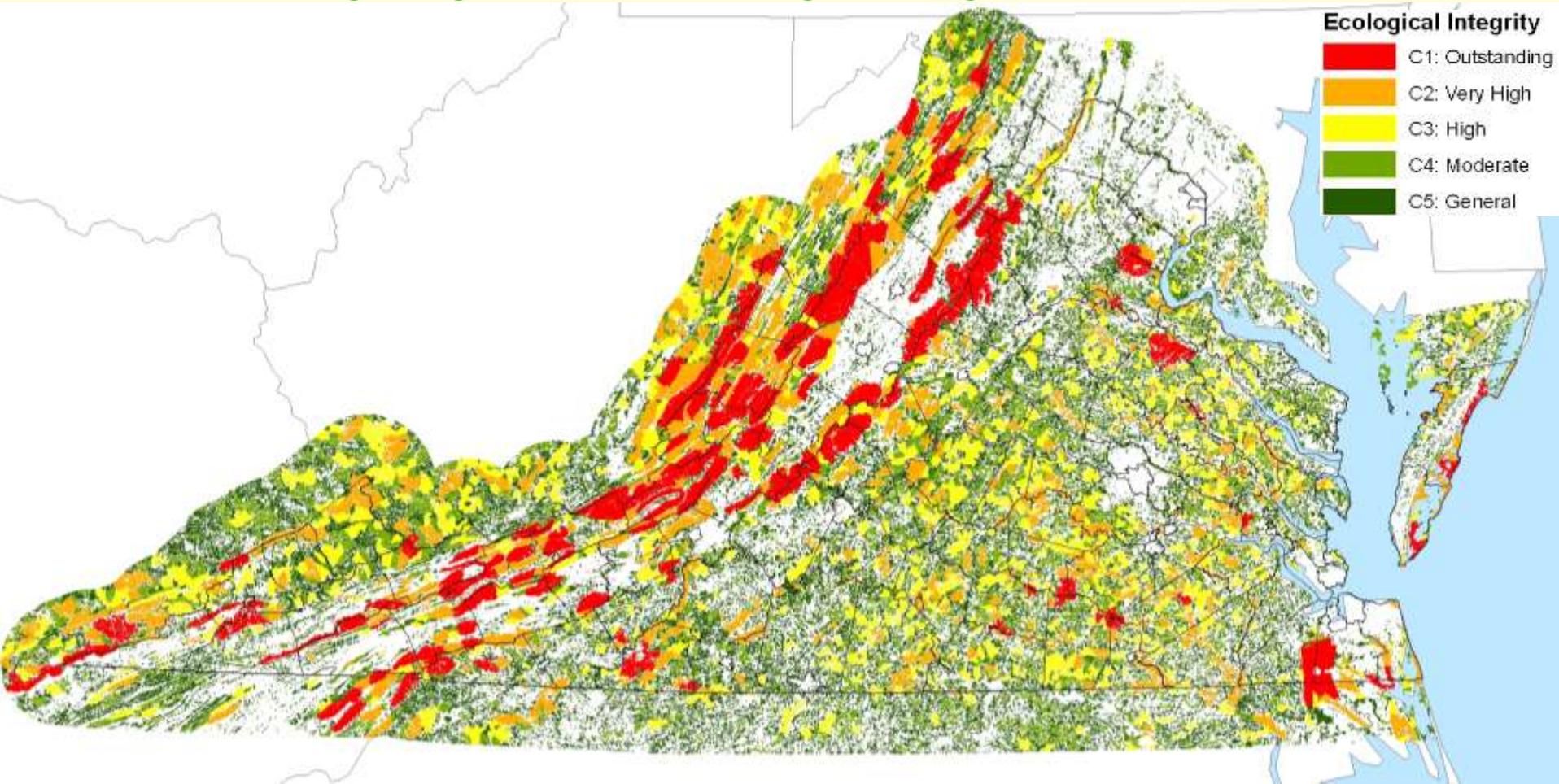
ESRI Streets ESRI Imagery

Map showing environmental data layers (green and pink) overlaid on a topographic map. The map includes roads, water bodies, and various land use features. The region shown is near Luzerne, PA.

Virginia Natural Landscape Assessment

a landscape-scale GIS analysis for identifying, prioritizing, and linking natural habitats in Virginia

www.dcr.virginia.gov/natural_heritage/vcInagr.html



VCLNA Fragmentation Layer

Legend

- Pipeline
- Power Line
- Rail
- Road

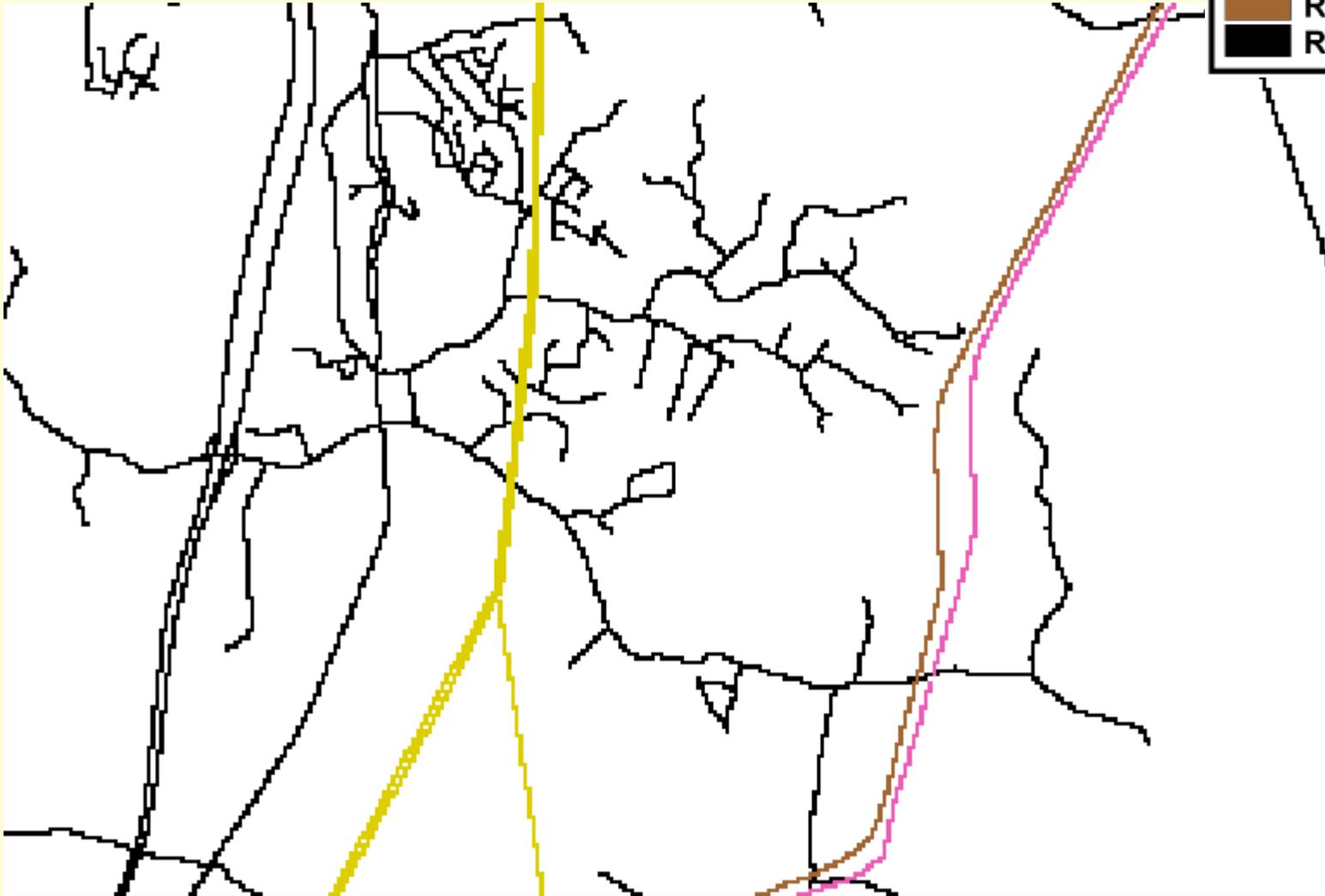
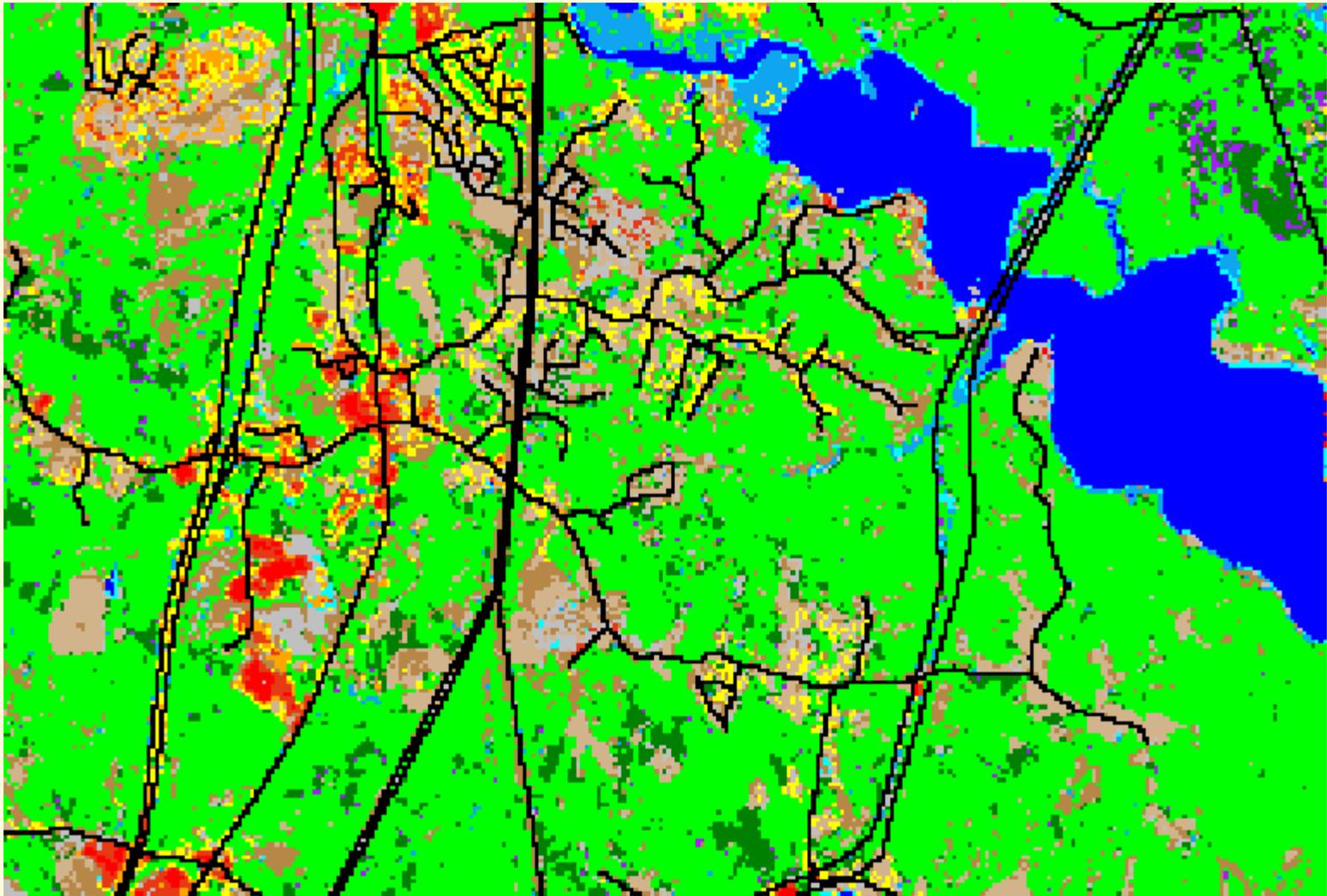
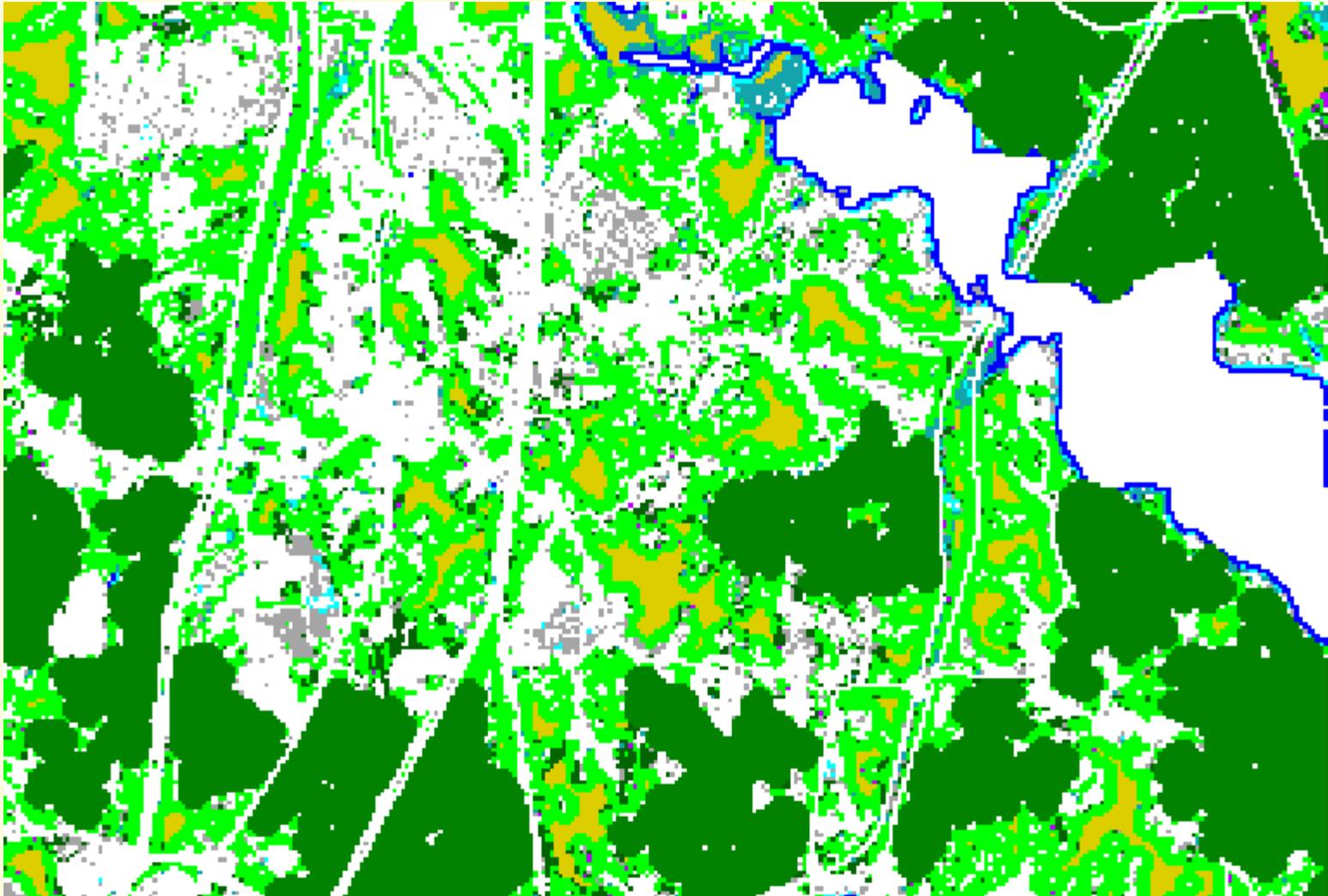


Image: VA Dept. of Conservation and Recreation

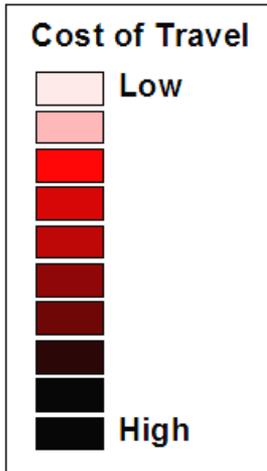
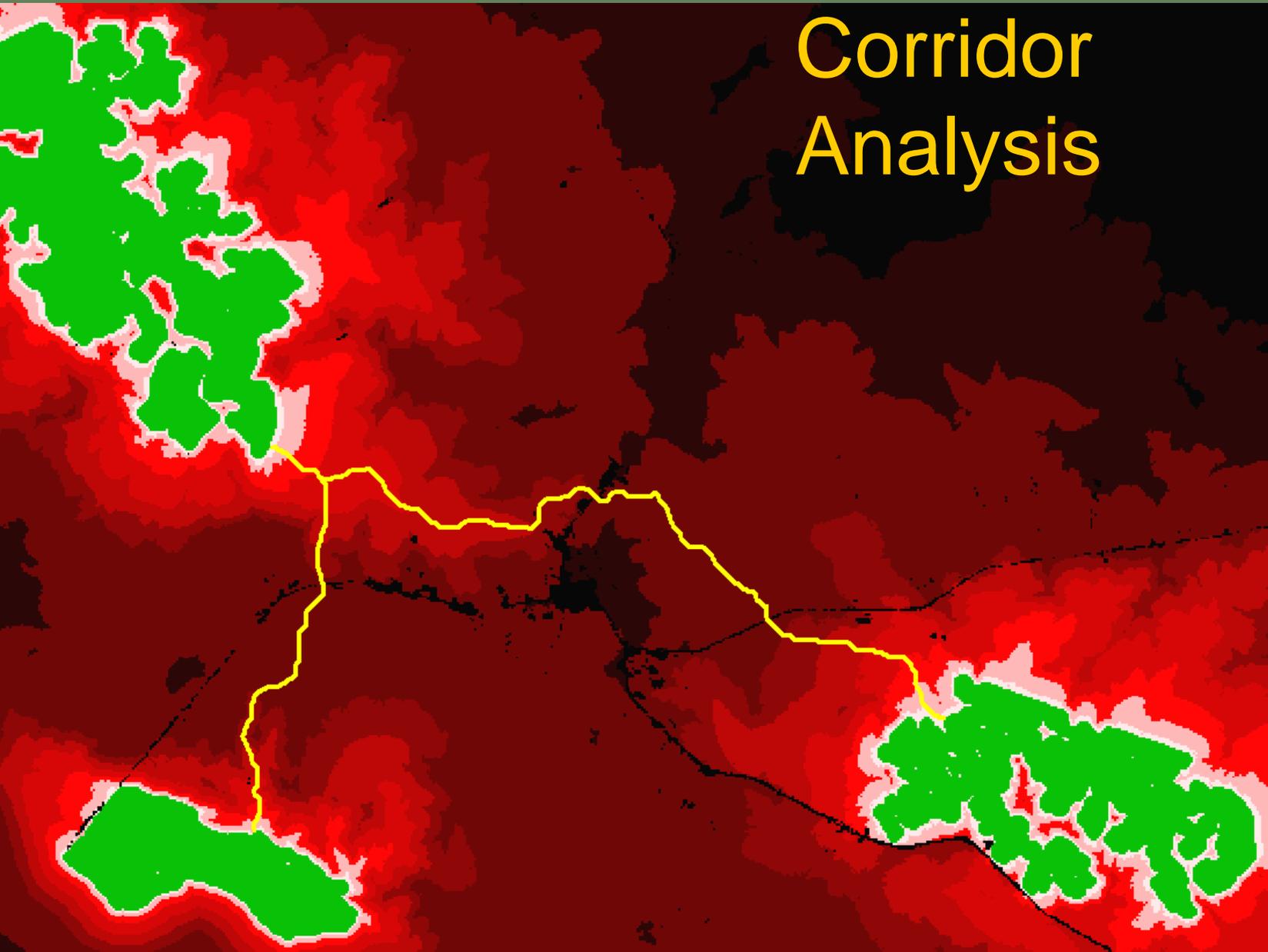
Fragmented Land Cover Image

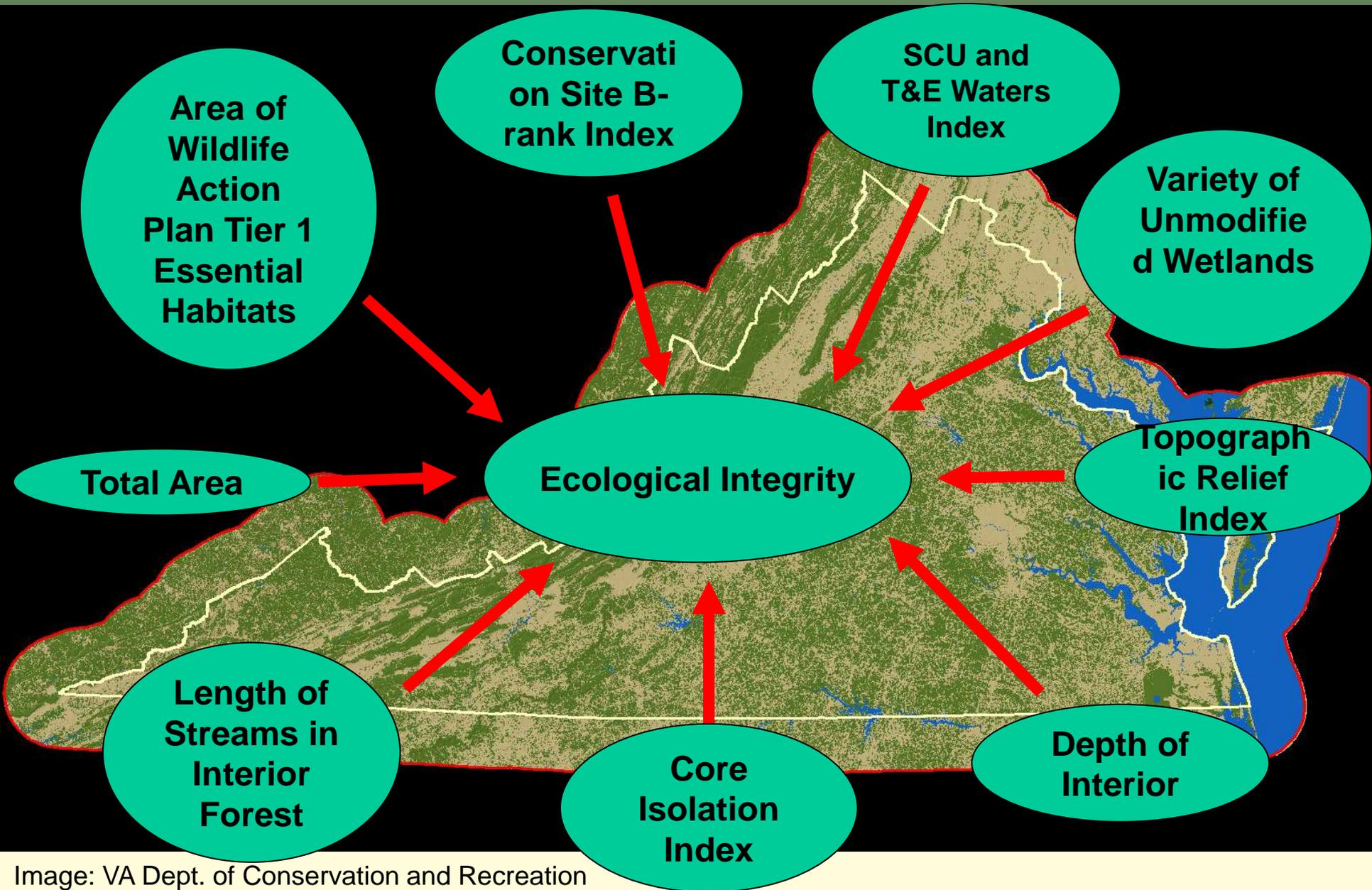


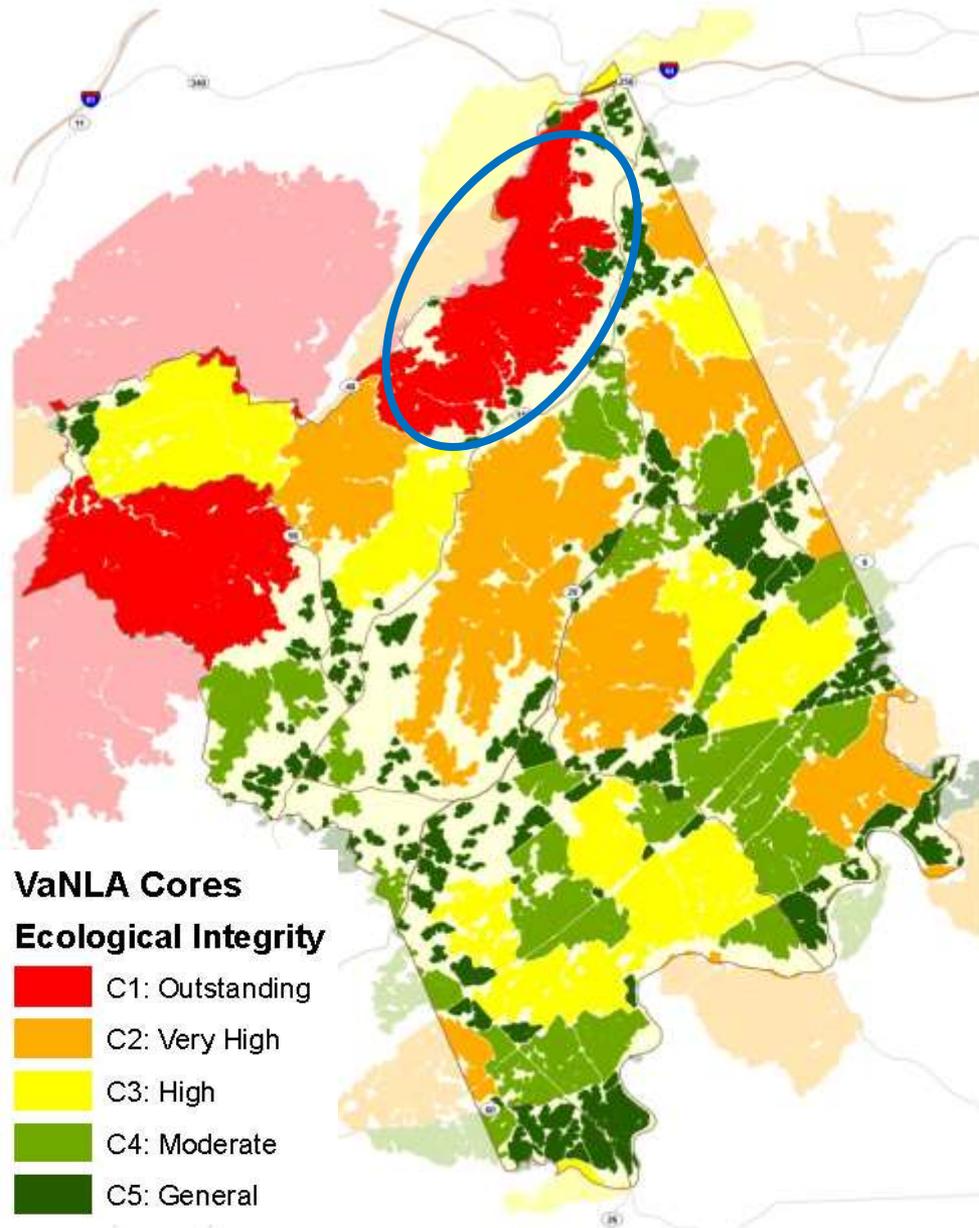
Cores



Corridor Analysis







Nelson County Example:
Use the data table for
each core. ⓘ tool

311,784 acres of habitat cores

249,274 acres are outstanding
(red) to very high quality (orange).

See example core at left (red
core) has:

✓ 20,406 acres

✓ 14 element occurrences

✓ 5,523 drinking water acreage

Six Steps for Green Infrastructure Planning

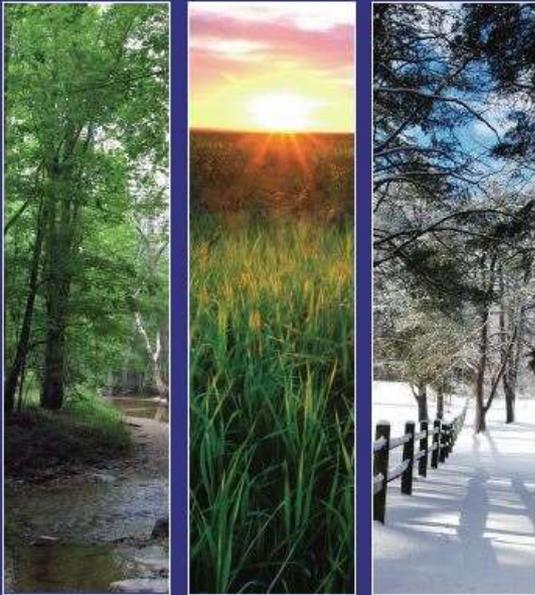


- 1) **Set Your Goals:** What does your community/organization value?
- 2) **Review Data** – What do we know or need to know, to map identified values?
- 3) **Map Your Community’s Ecological and Cultural Assets** – Based on the goals established in Step One and data from Step Two.
- 4) **Risk Assessment** – What assets are most at risk and what could be lost if no action is taken?
- 5) **Rank Your Assets and Determine Opportunities** – Based on those assets and risks you have identified, which ones should be restored or improved?
- 6) **Implement Opportunities** – Include natural asset maps in both daily and long-range planning (park planning, comp plans, zoning, tourism and economic development, seeking easements etc)

Application Examples at Multiple Scales



CONSERVATION CORRIDOR PLANNING



Northern Virginia
Regional Commission



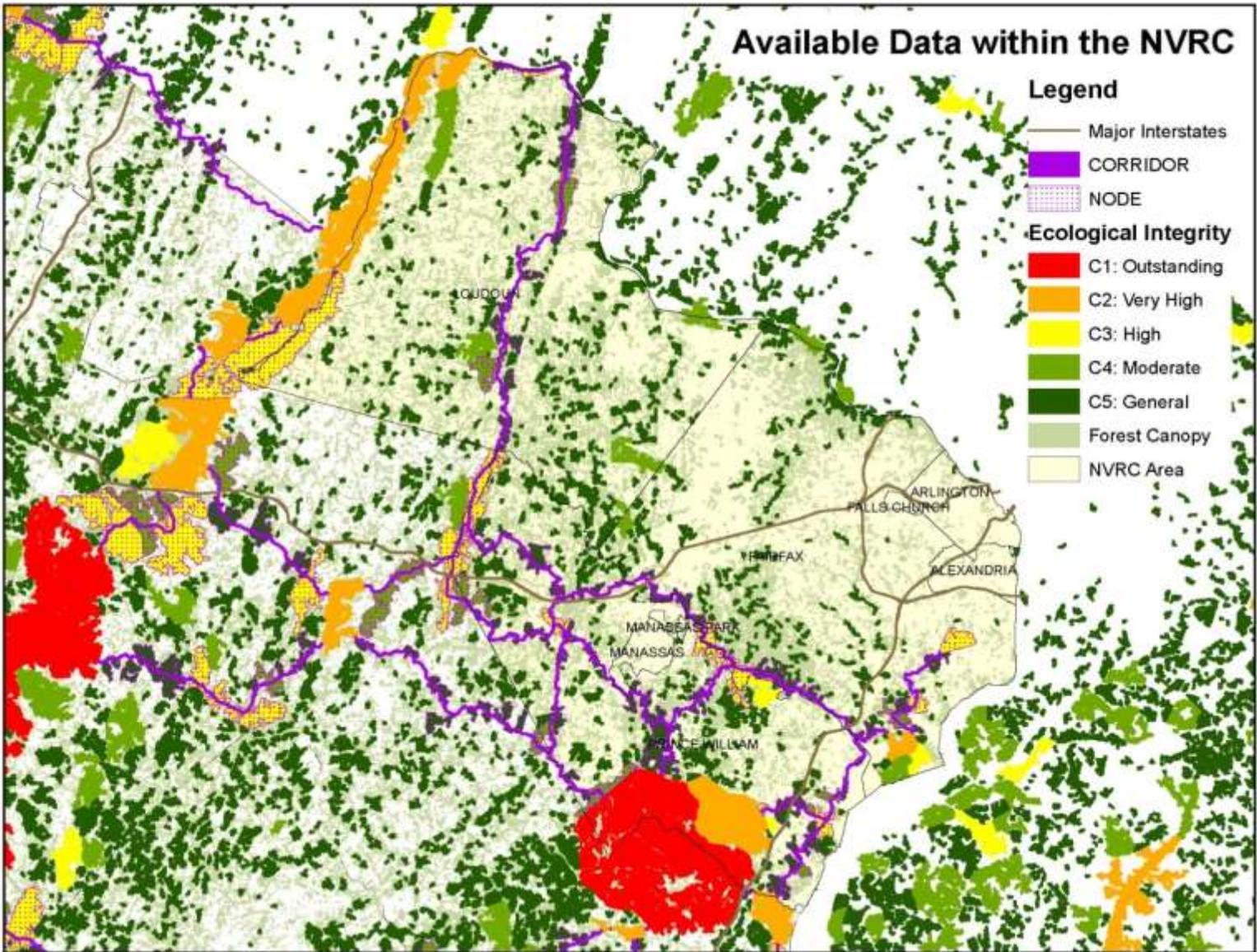
January 2012

GIC helped NVRC create regional map series to:

- Refine state analyses using local data and priorities.
- Identify & map high value cores and corridors across the region.
- Highlight opportunities for regional connections.
- Quantify benefits of these areas.
- Create themed overlay maps to highlight relationship of green infrastructure and uses

<http://www.novaregion.org/index.aspx?NID=1102>

VNLA



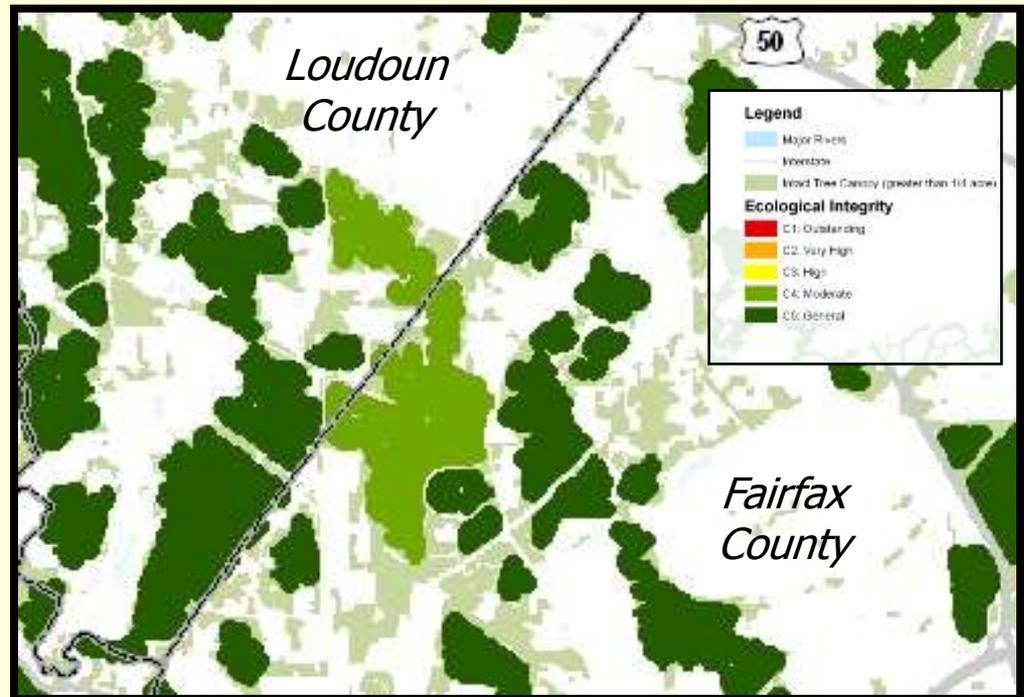
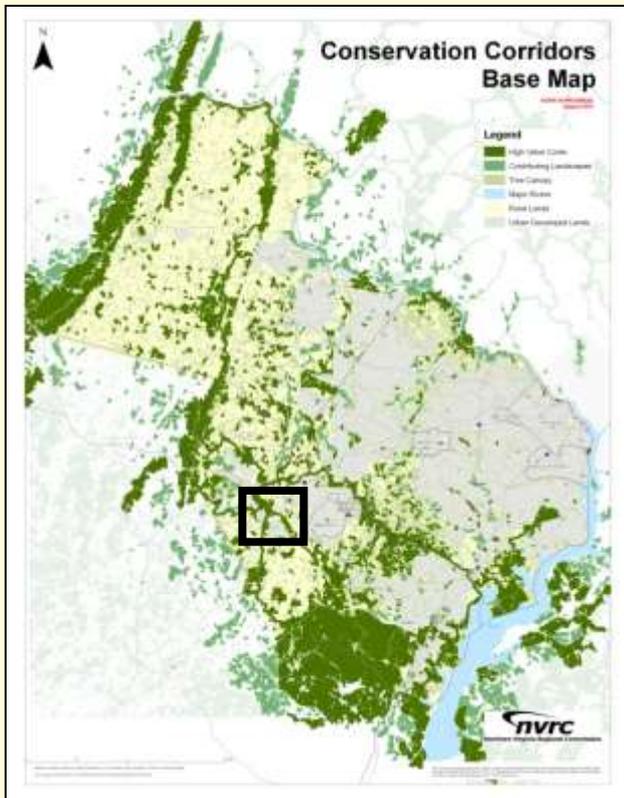
An example
of a cross-
county
opportunity



845 acres

206.2 acres of Tier 1 Habitat

4 Elements of Occurrence



% Tree Canopy

87.4 percent
(738.8 acres)

Lbs of Air Pollutants removed

74,416
(\$199,246)

Tons of Carbon Stored

31,790

Tons of Carbon Sequestered

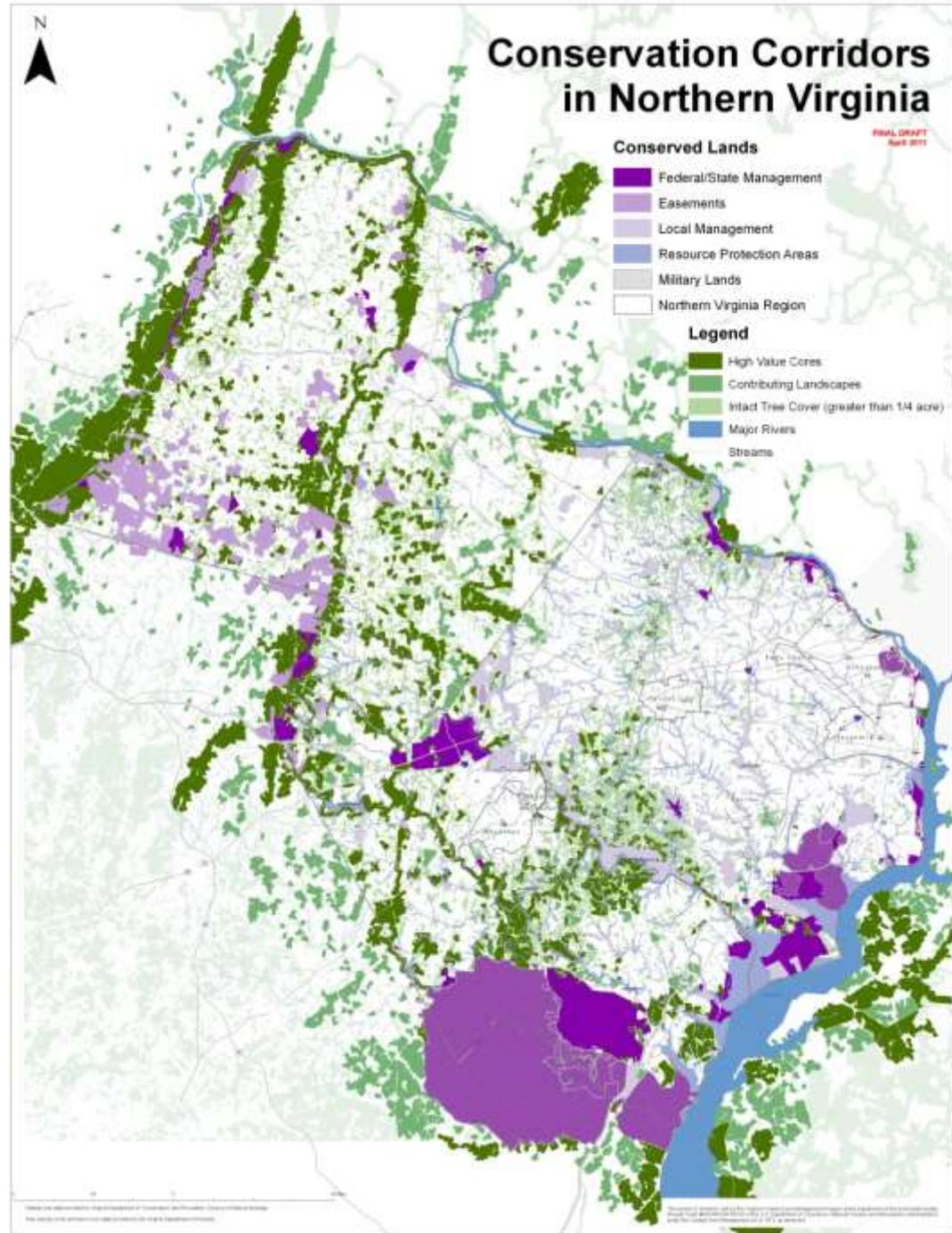
247

Cu. Ft of Stormwater Retained (estimated)

4,832,337 cu. ft
(\$28,994,024)

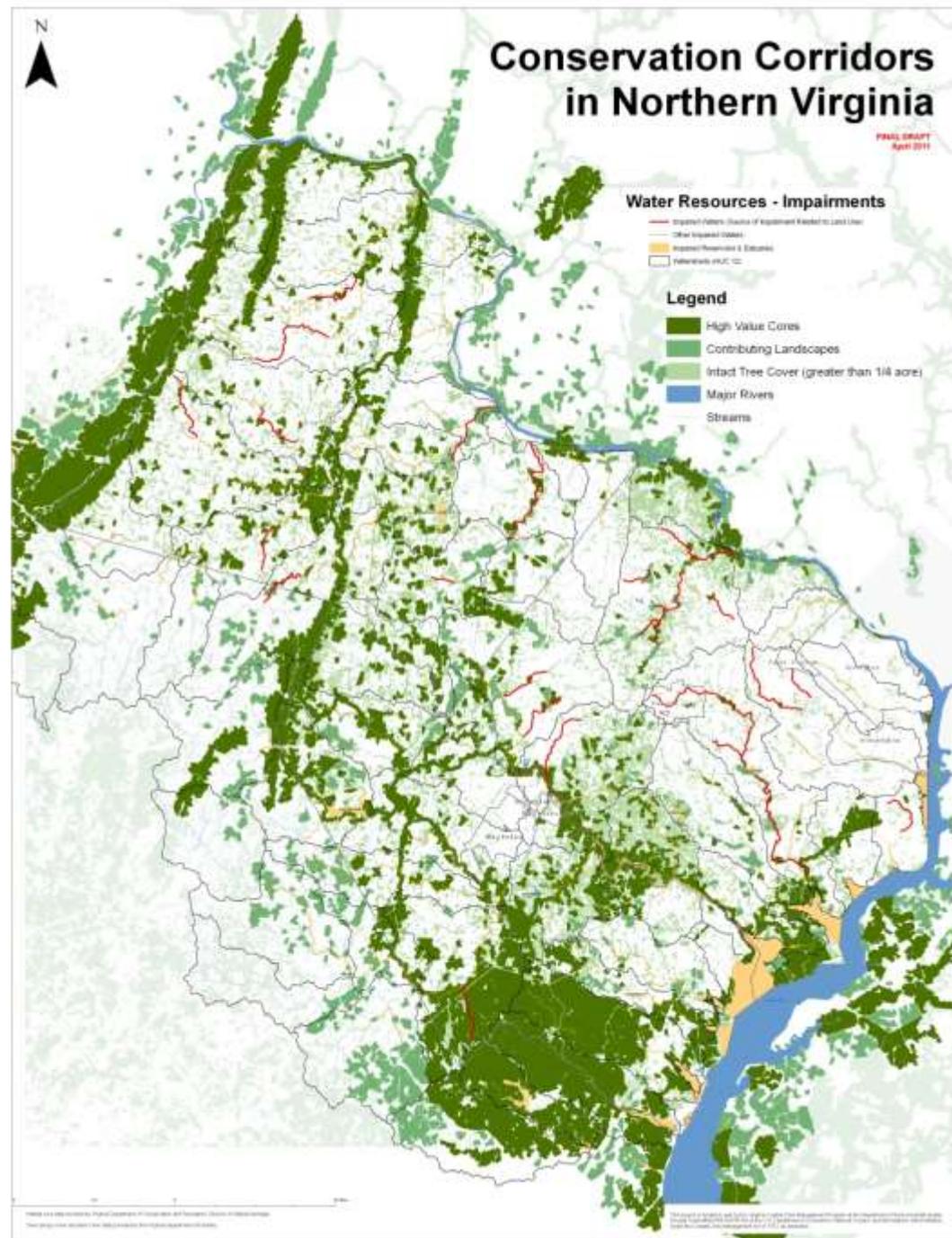
Opportunities -- What is conserved?

The Northern VA Conservation Trust uses these maps to help set their priorities.

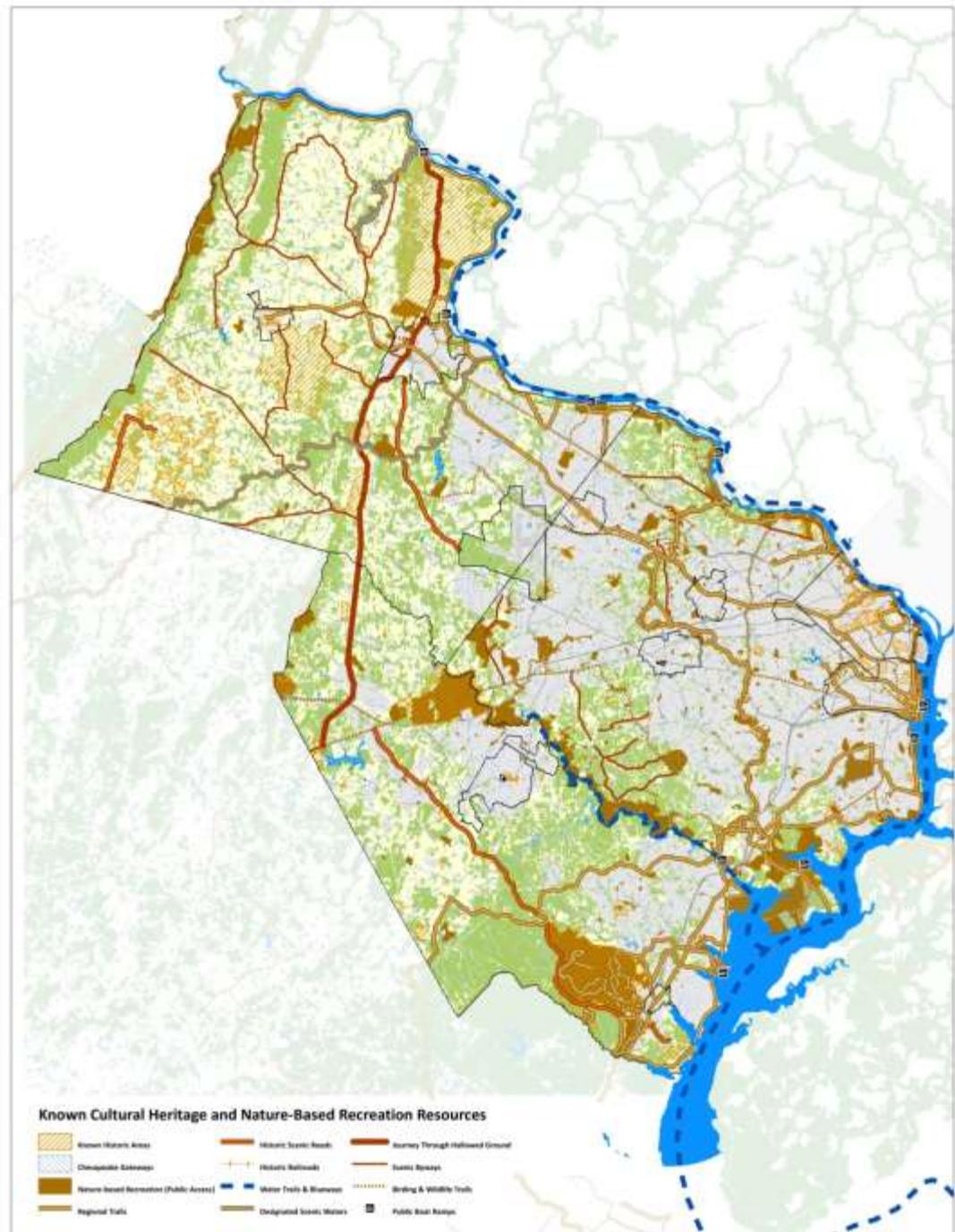


Opportunities –
Where are key
water resources
that support
drinking water?

Opportunities –
Which areas are
impaired –
needing
restoration?

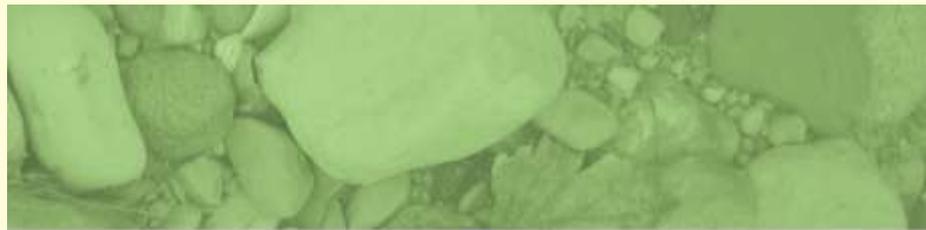


How does the network support regional cultural resources?



Now to
See All
Scales

First:
Region



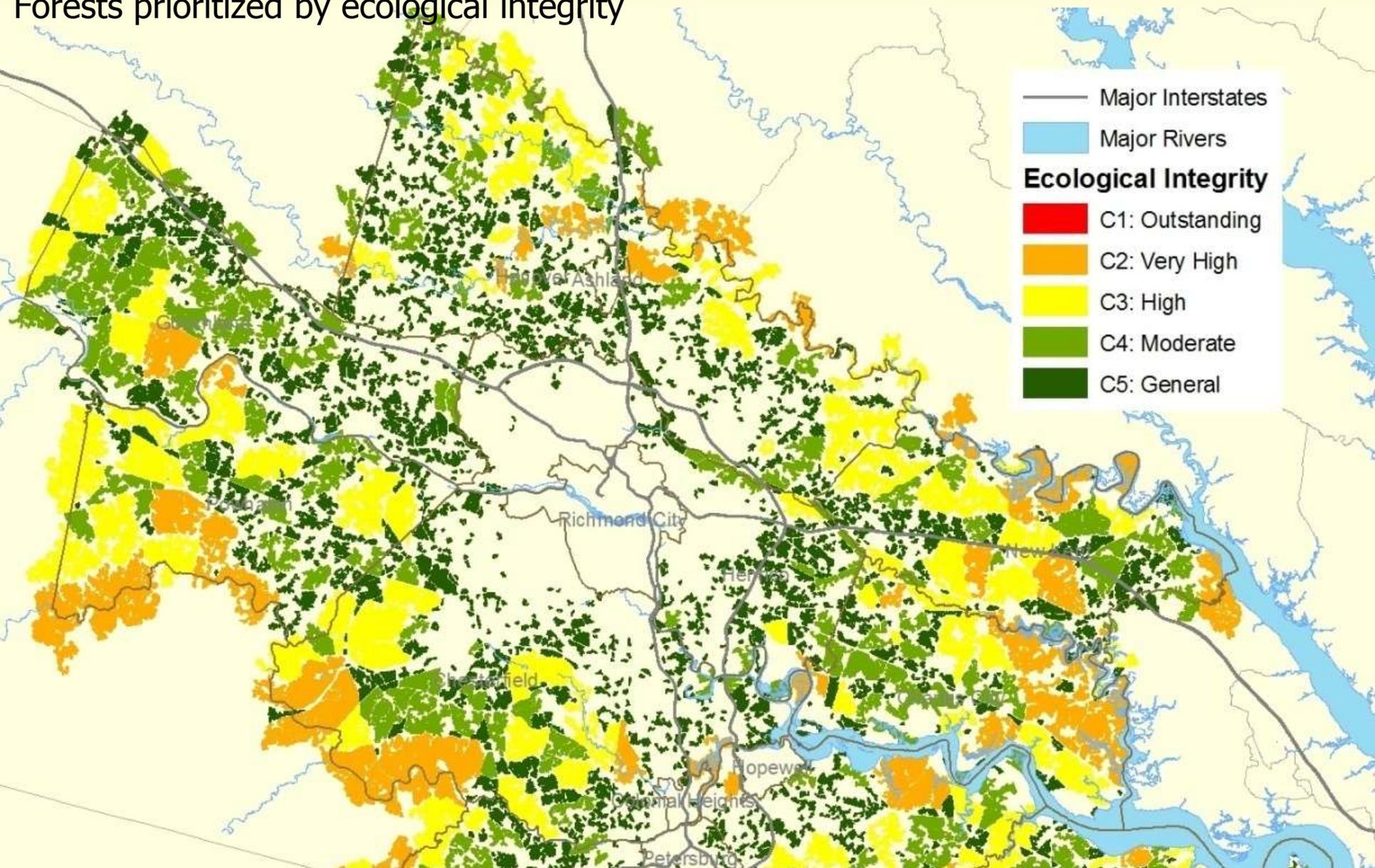
THE RICHMOND REGION
GREEN INFRASTRUCTURE PROJECT



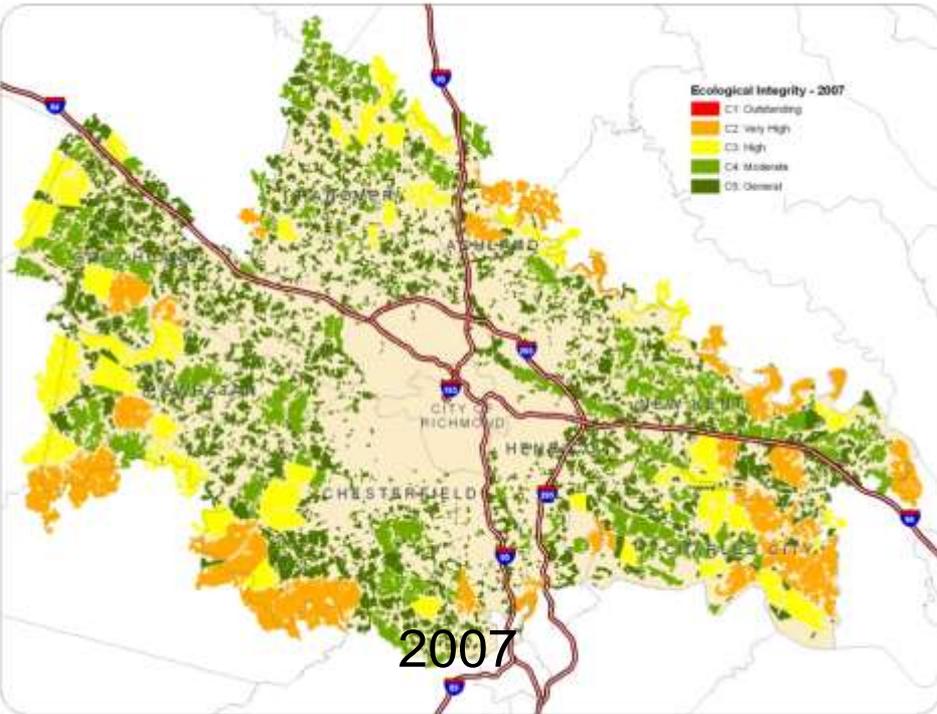
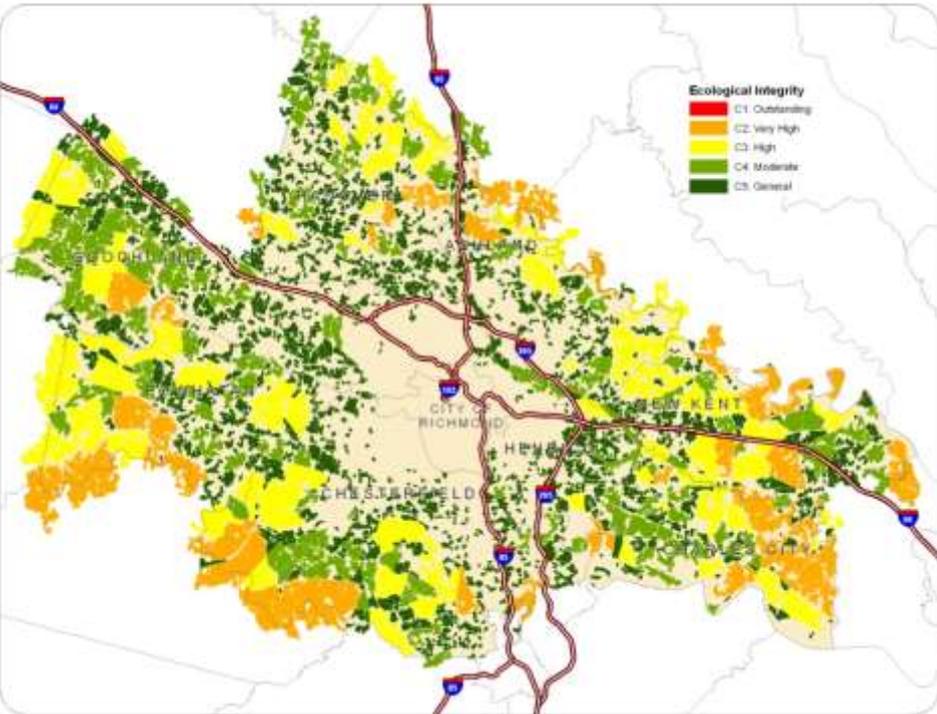
*Building a regional
green infrastructure network
for our communities*

SPRING 2009

Forests prioritized by ecological integrity

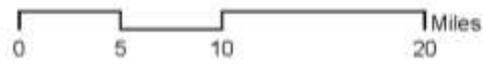
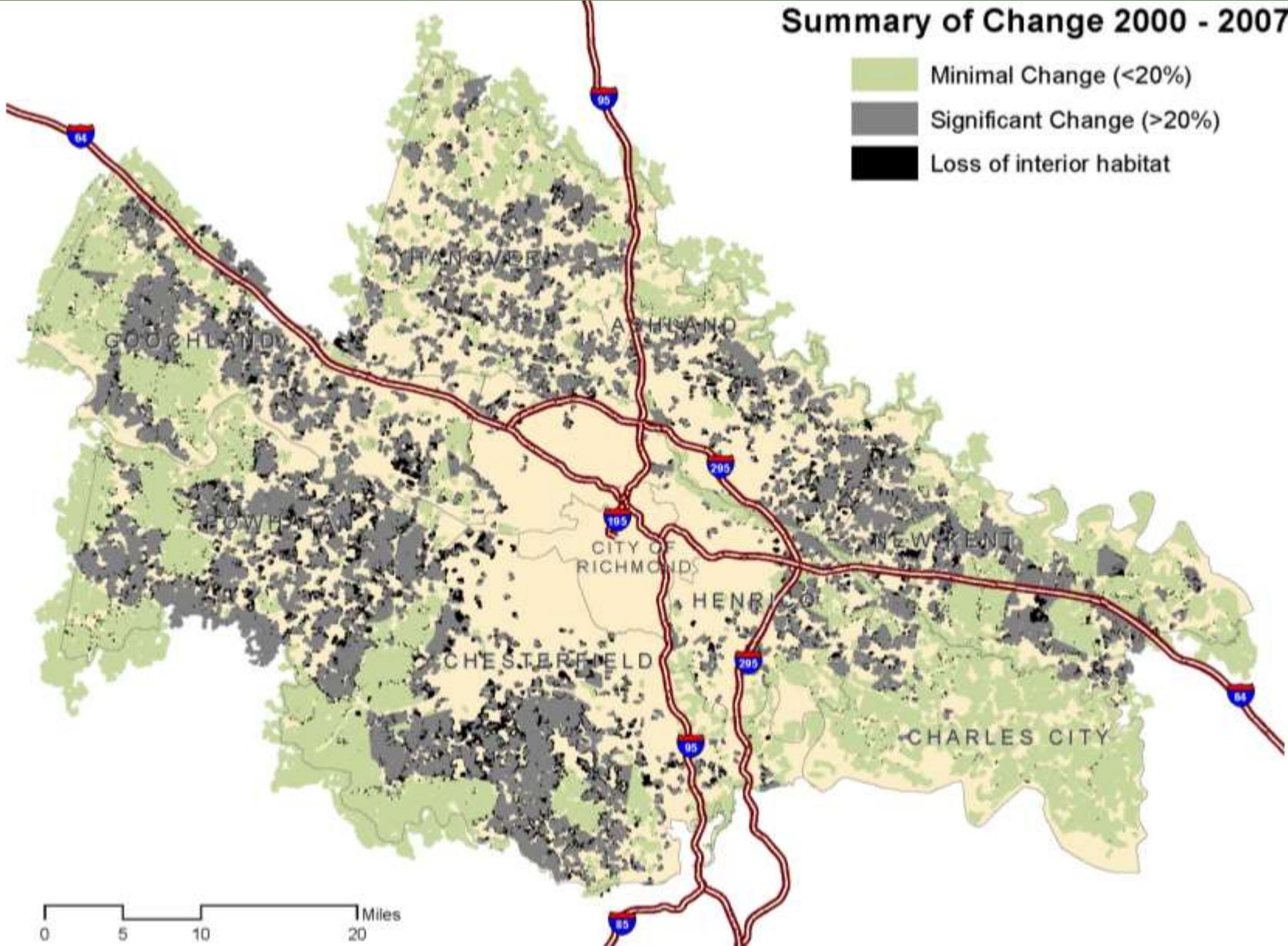


Identify Trends & Priorities

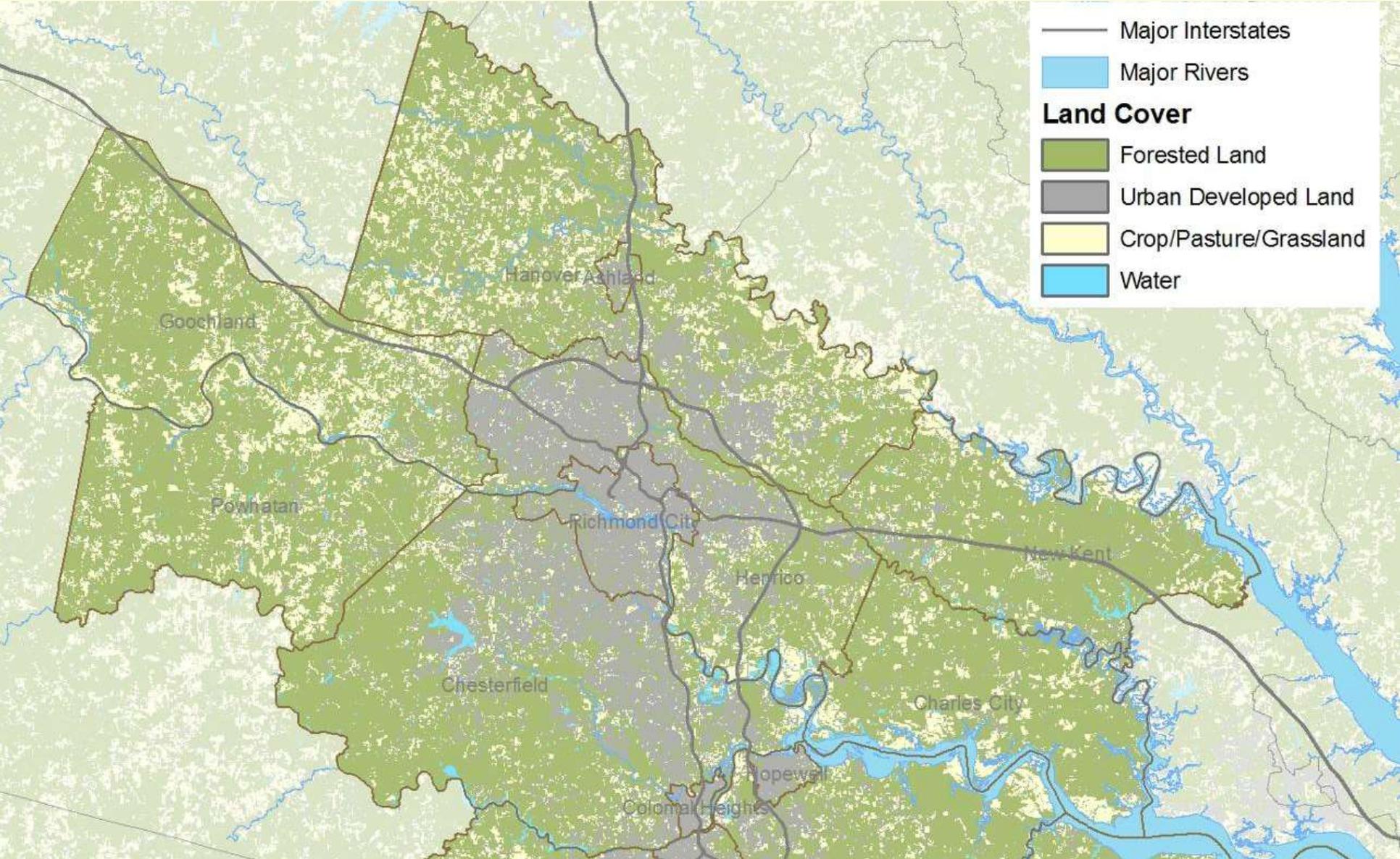


Summary of Change 2000 - 2007

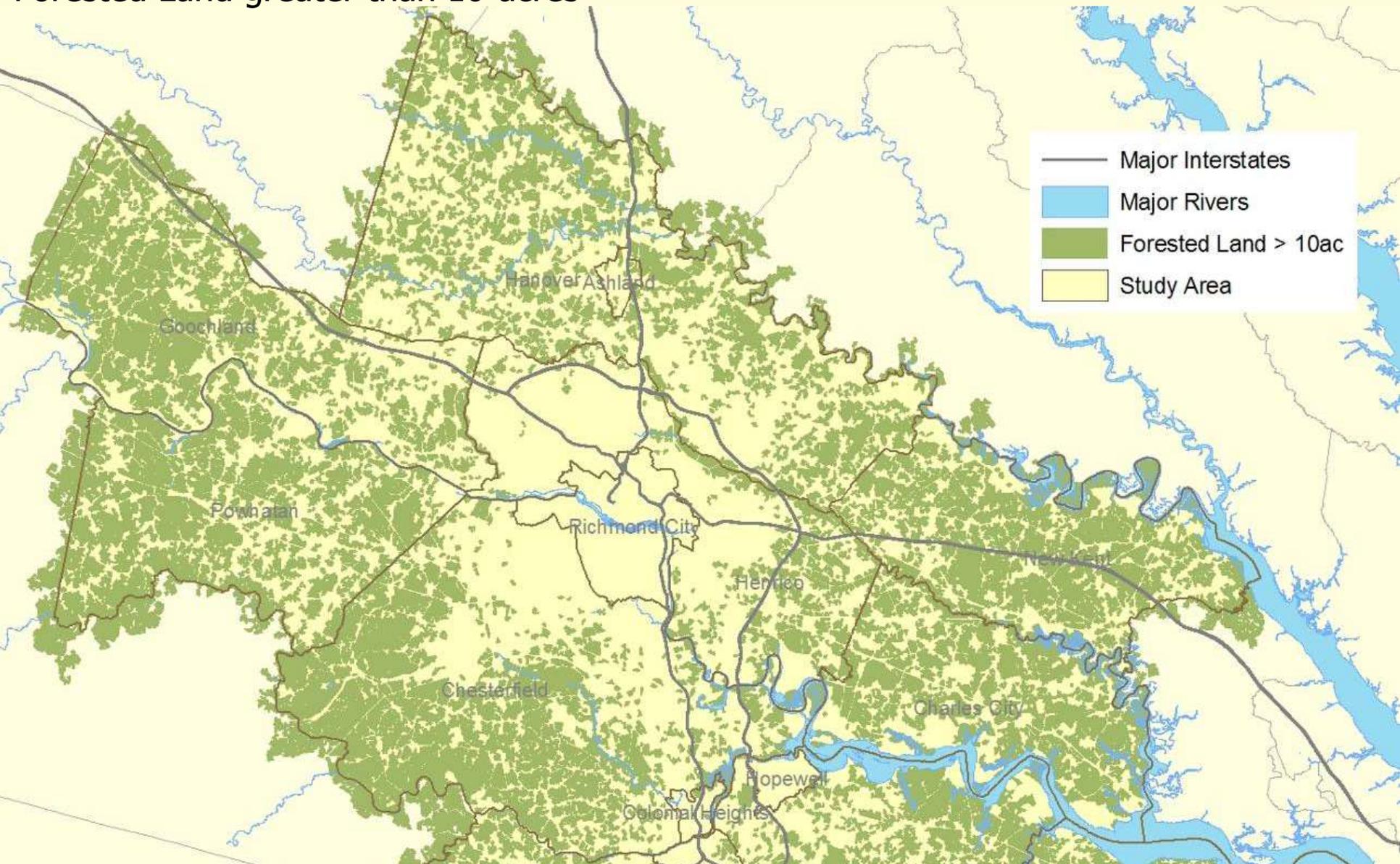
- Minimal Change (<20%)
- Significant Change (>20%)
- Loss of interior habitat



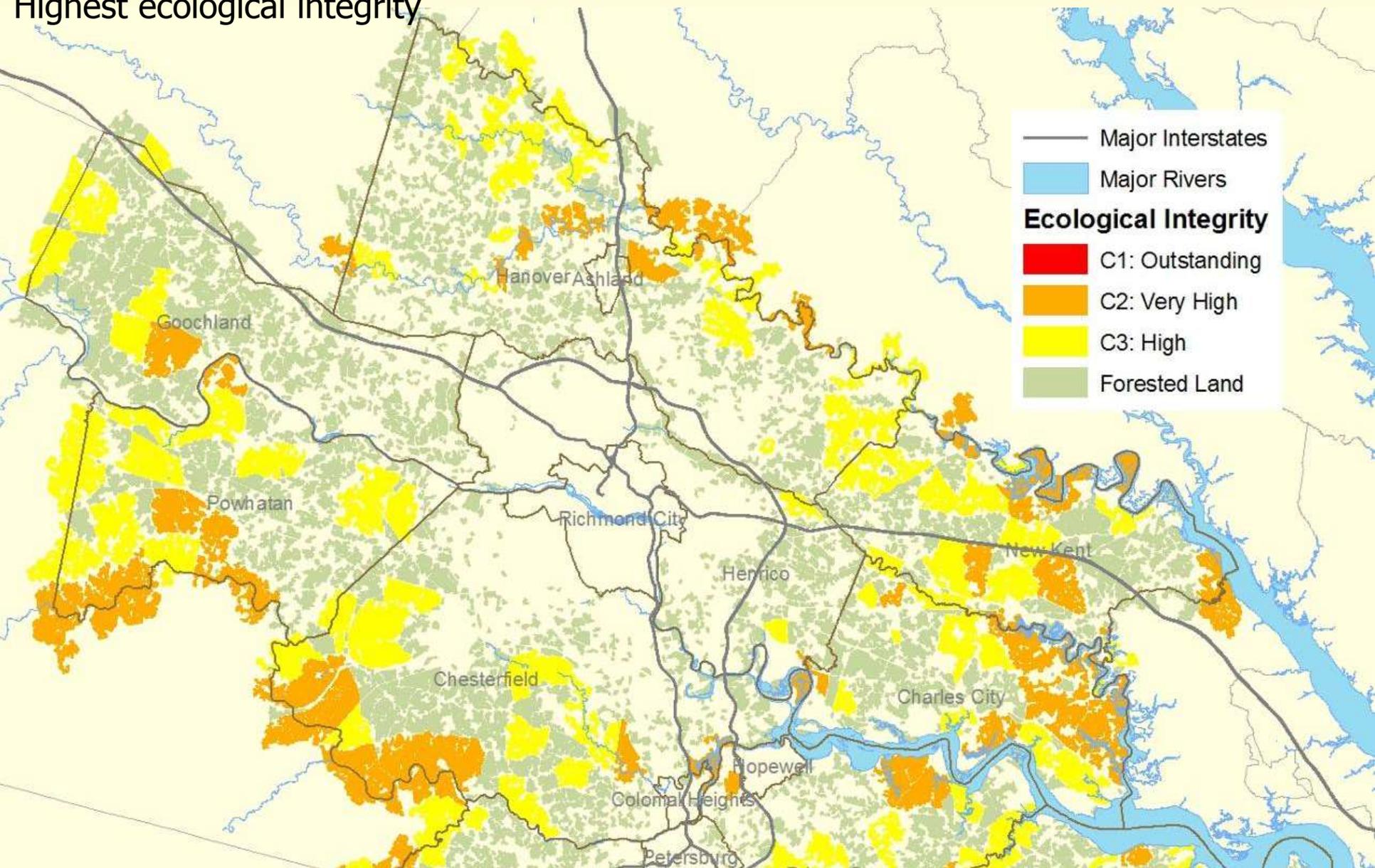
Land Cover



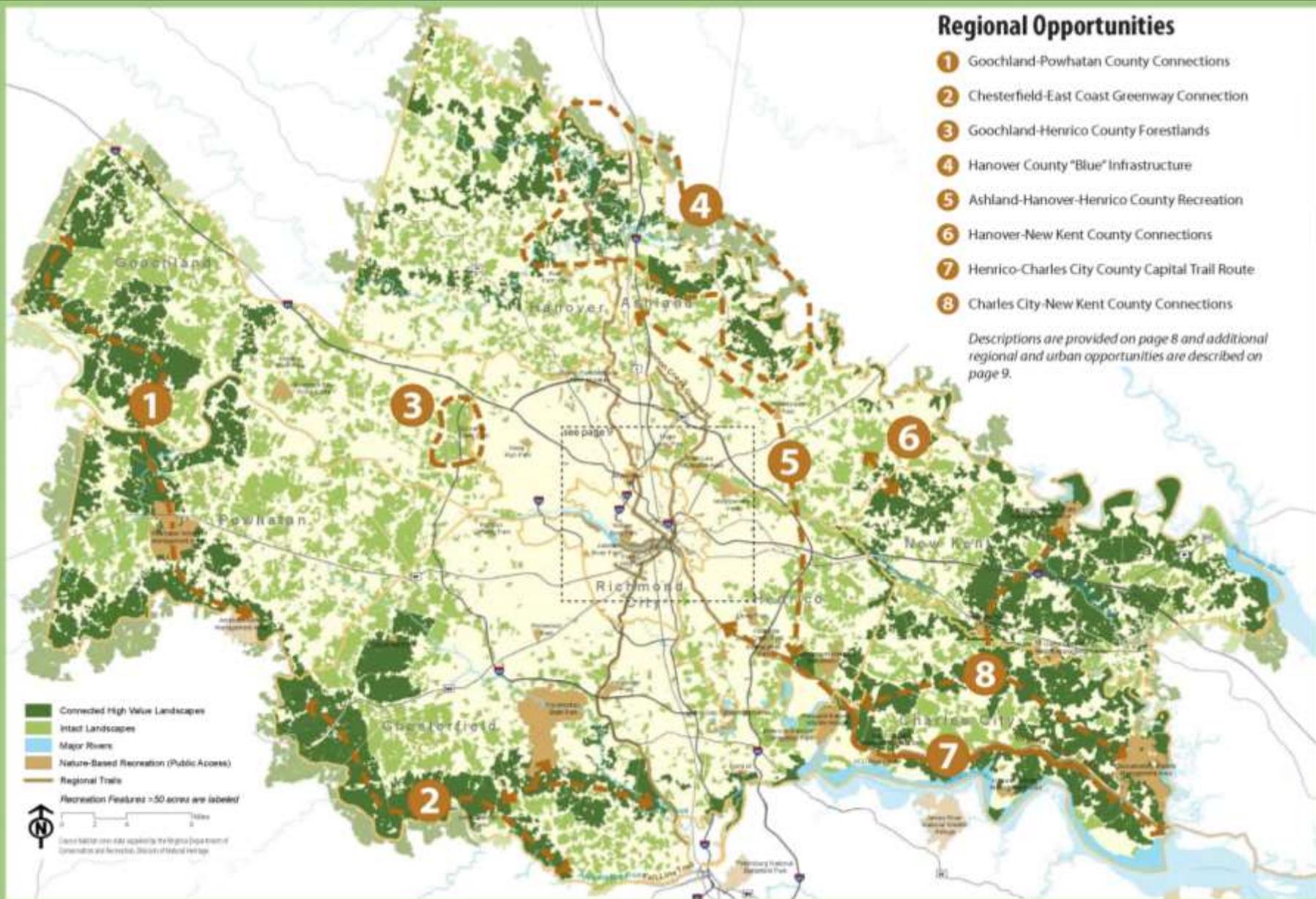
Forested Land greater than 10-acres



Highest ecological integrity



STRATEGIC GREEN INFRASTRUCTURE a base map for regional planning



Example County Map Links Culture and Recreation to Network

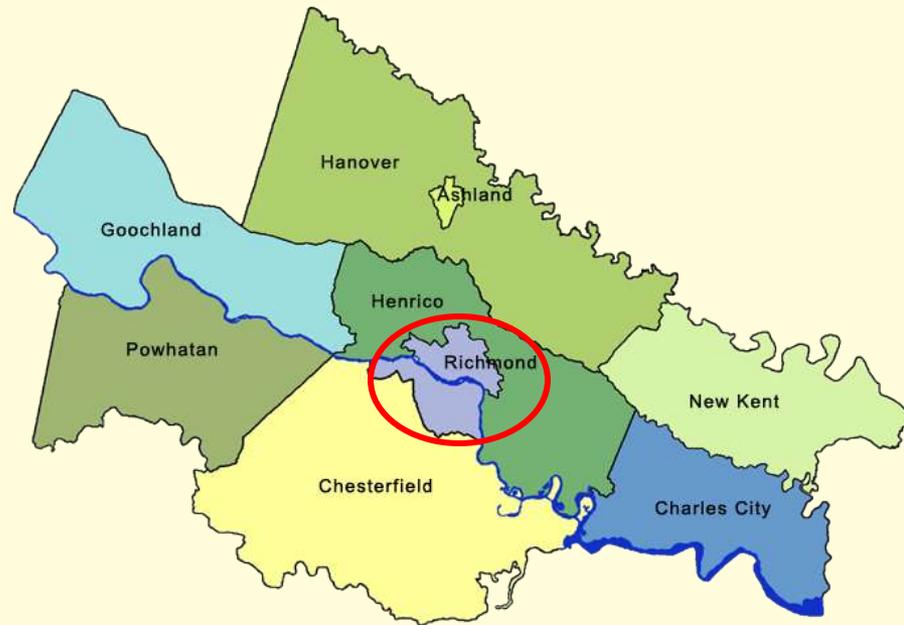


HERITAGE AND NATURAL RESOURCES



Scaling down to the city ...

Richmond City Green Infrastructure Assessment



Smaller scales ...

Trees and woodlots

Habitat patches

Streams and wetlands

Trails and smaller parks

Still can connect to larger networks ...

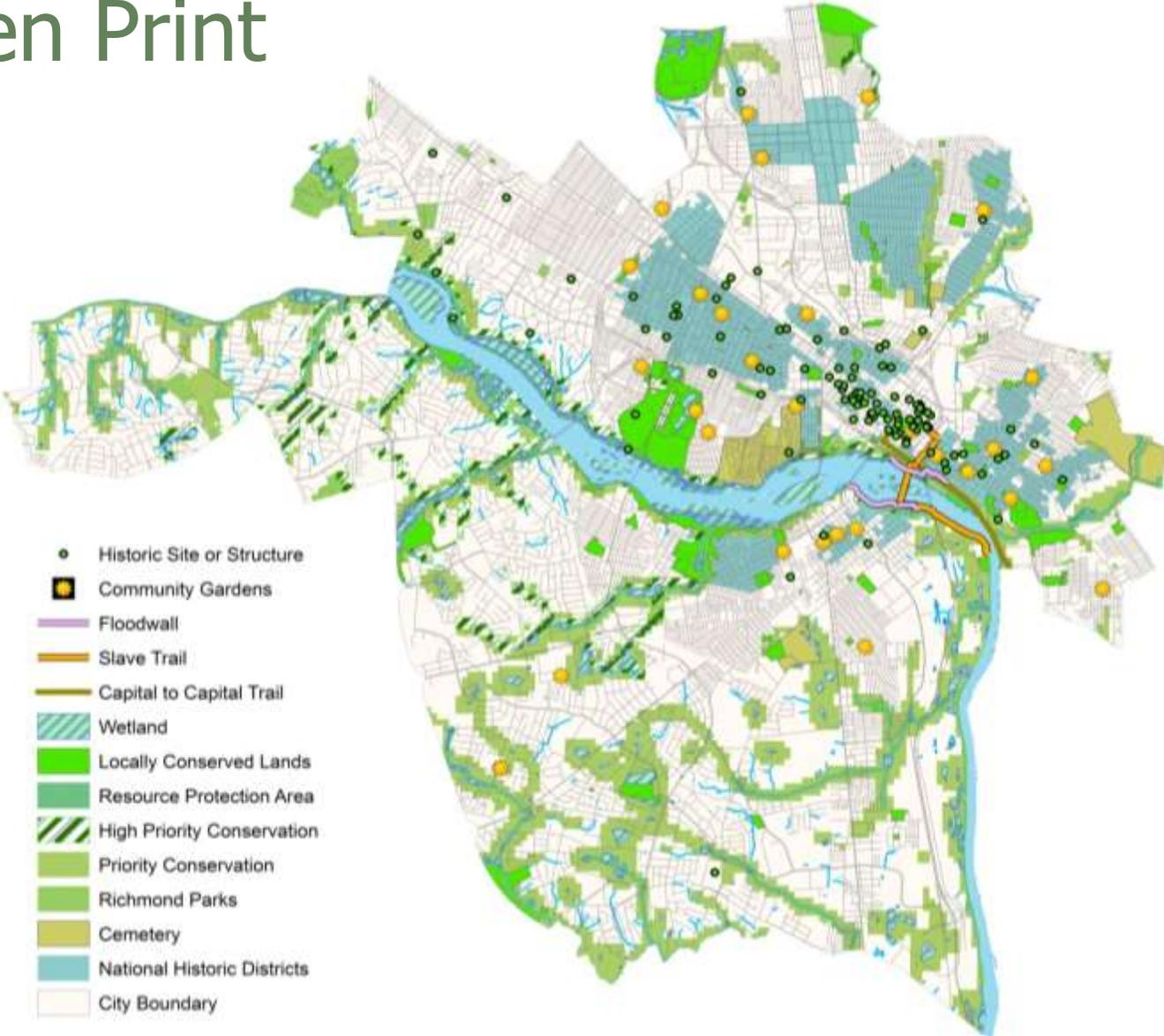


First: Richmond Regional Planning District Commission maps city green assets = city green print



Green Infrastructure Assessment
Phase 1: A Green Print Pilot Program for Richmond
October 2010

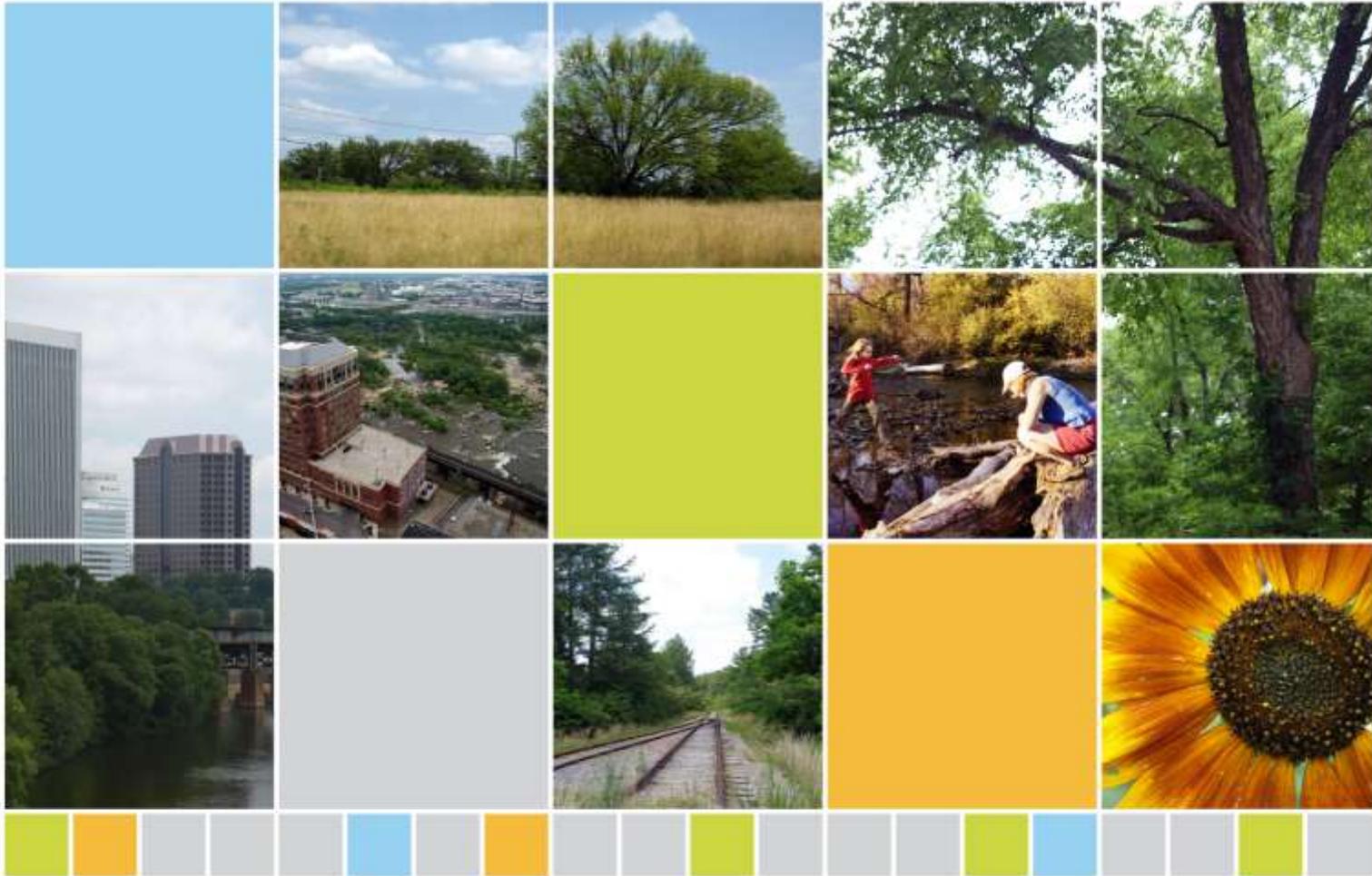
City Green Print



What are opportunities to re-green Richmond?

- The 2009 regional green infrastructure assessment revealed a significant decline of green infrastructure over the last decade due to sprawling development outside the city.
- The City of Richmond includes over 9,000 vacant parcels.
- Many of these sites can become a resource for expanding the green infrastructure network and enhancing neighborhoods.





Richmond Green Infrastructure Assessment

Produced by the Green Infrastructure Center and E² Inc. for the City of Richmond, Virginia
December 2010

Implementation Approach: Planning Across Scales

City: Develop citywide green infrastructure network based on suitability of vacant parcels.

Planning District: Create interactive database to evaluate suitability of vacant parcels for various goals.

Neighborhood: Develop concept plans and prototypes to connect neighborhoods to the city's green infrastructure network.

Project: Provide case studies and strategies that can be implemented to enhance Richmond's green infrastructure network.



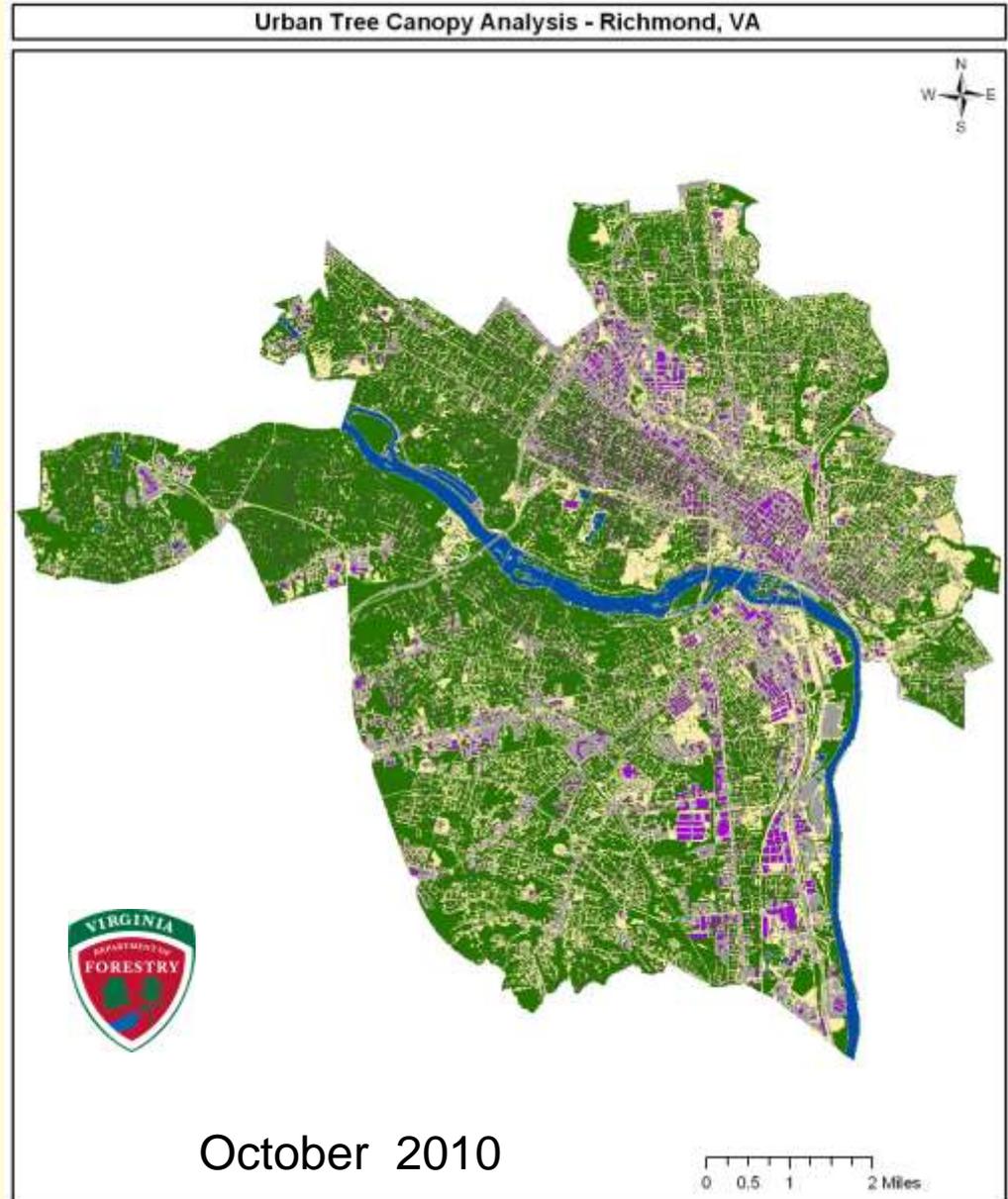
City Land Cover:

42% Tree Canopy

23% Other Vegetation

24% Non-Building
Impervious

11% Building
Impervious

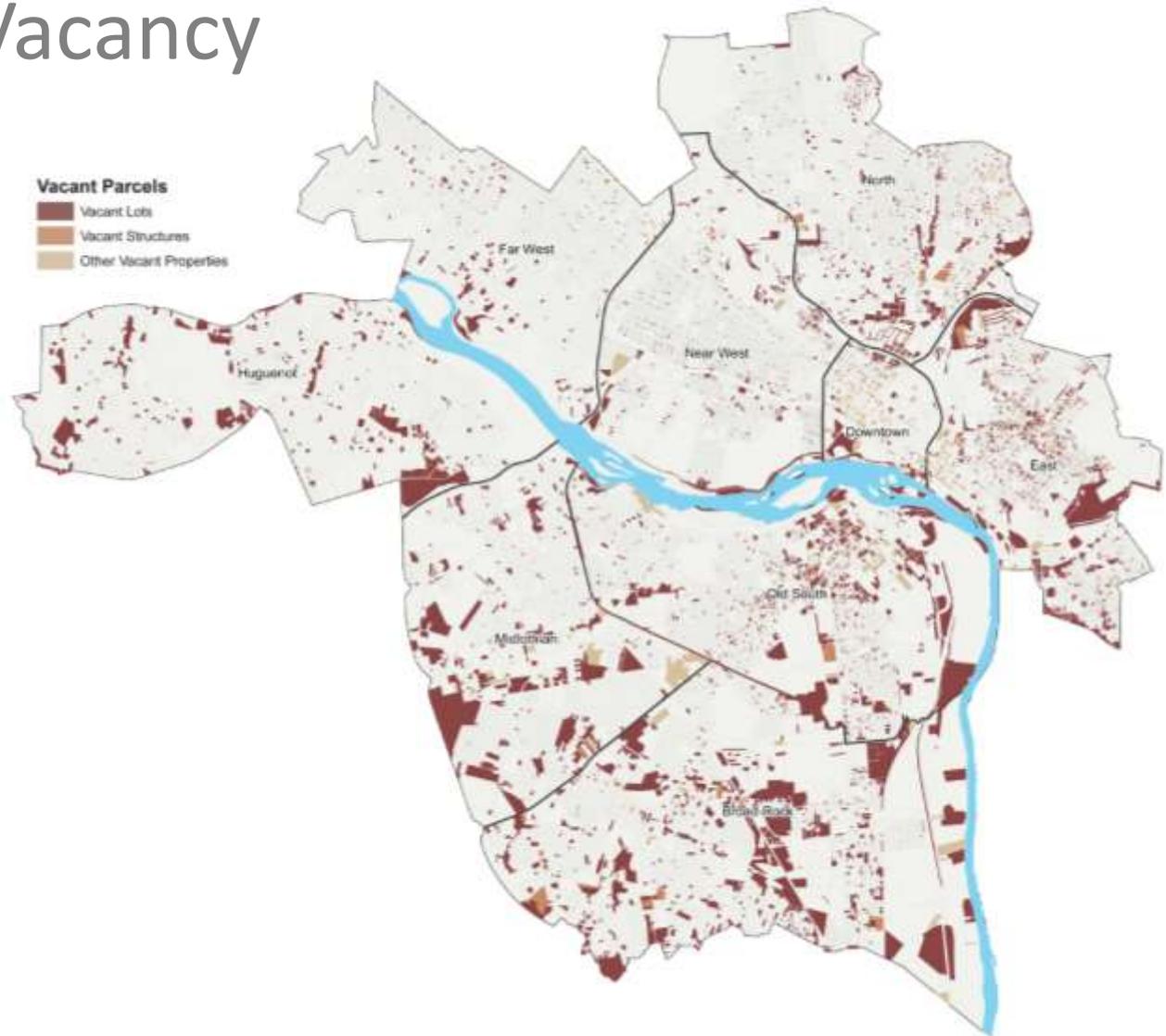


City: Citywide Vacancy

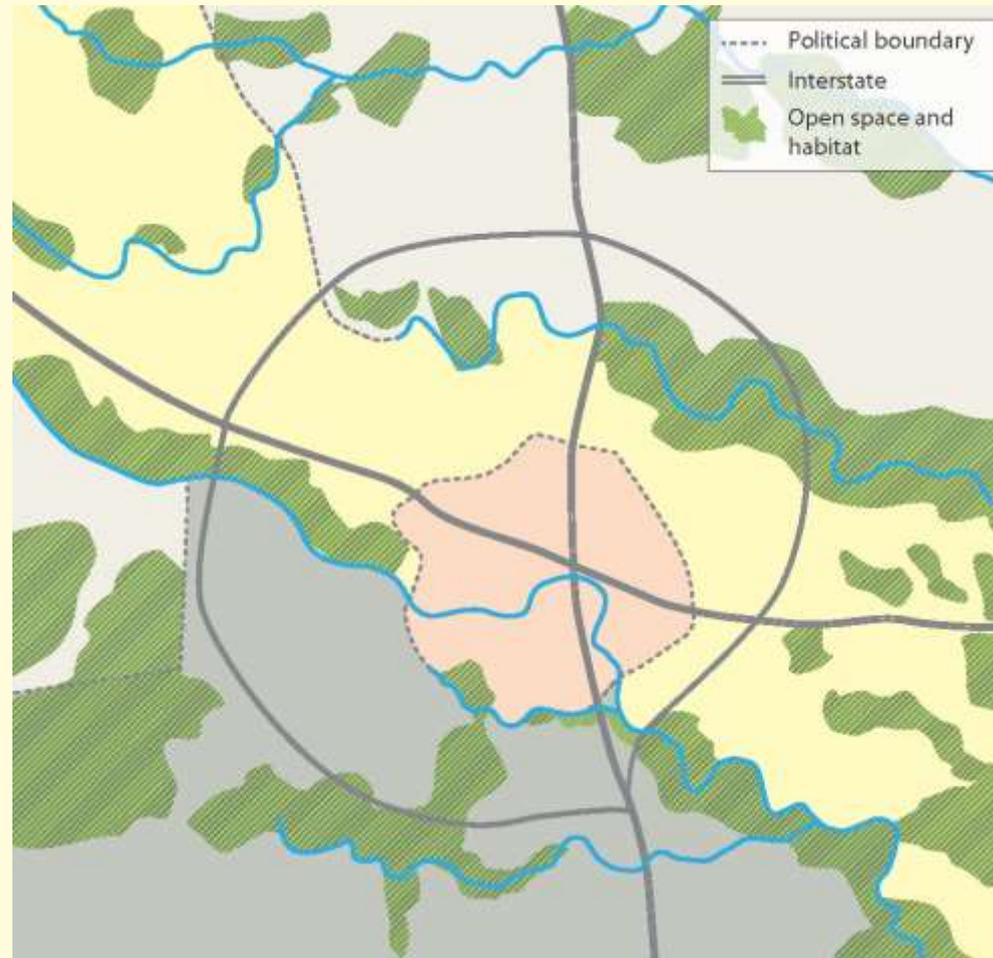
Vacant parcel inventory,
grouped by:

- vacant lots
- vacant structures
- vacant properties
(parcels that have
unknown status)

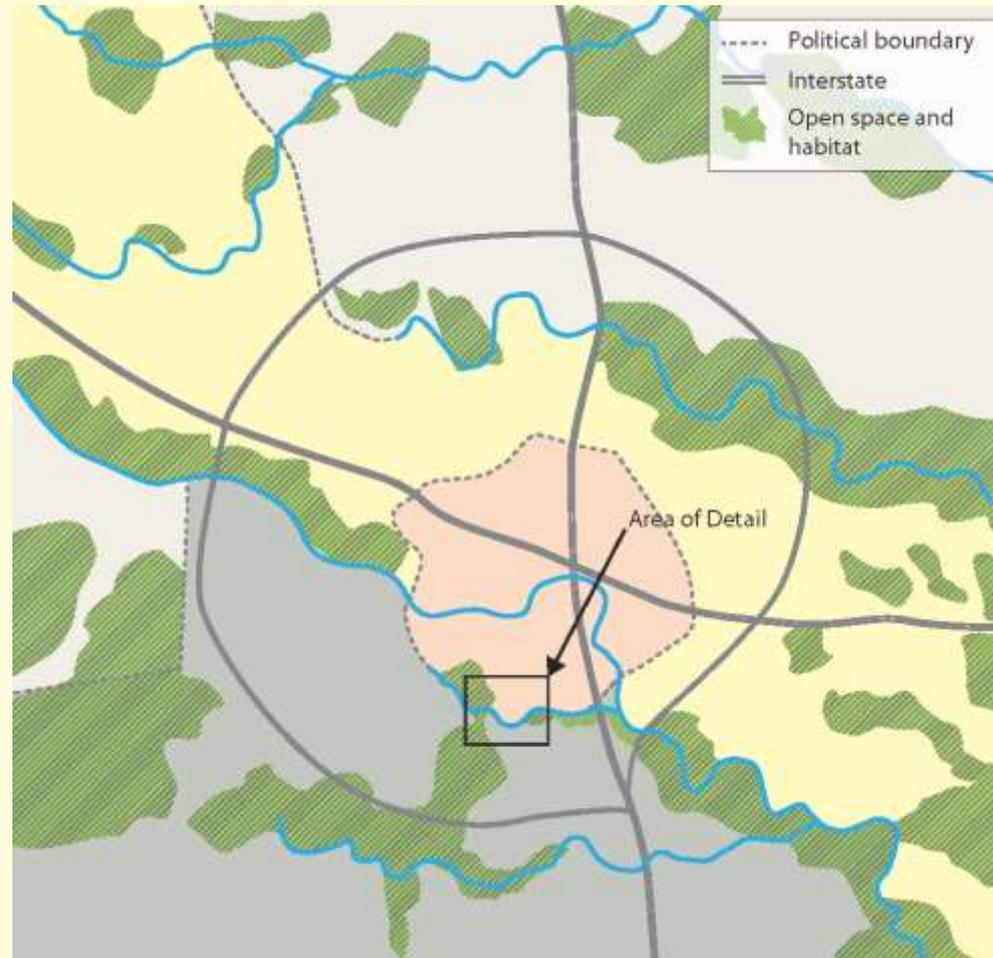
= 9000 vacant parcels



How can we link regional green infrastructure to local projects?



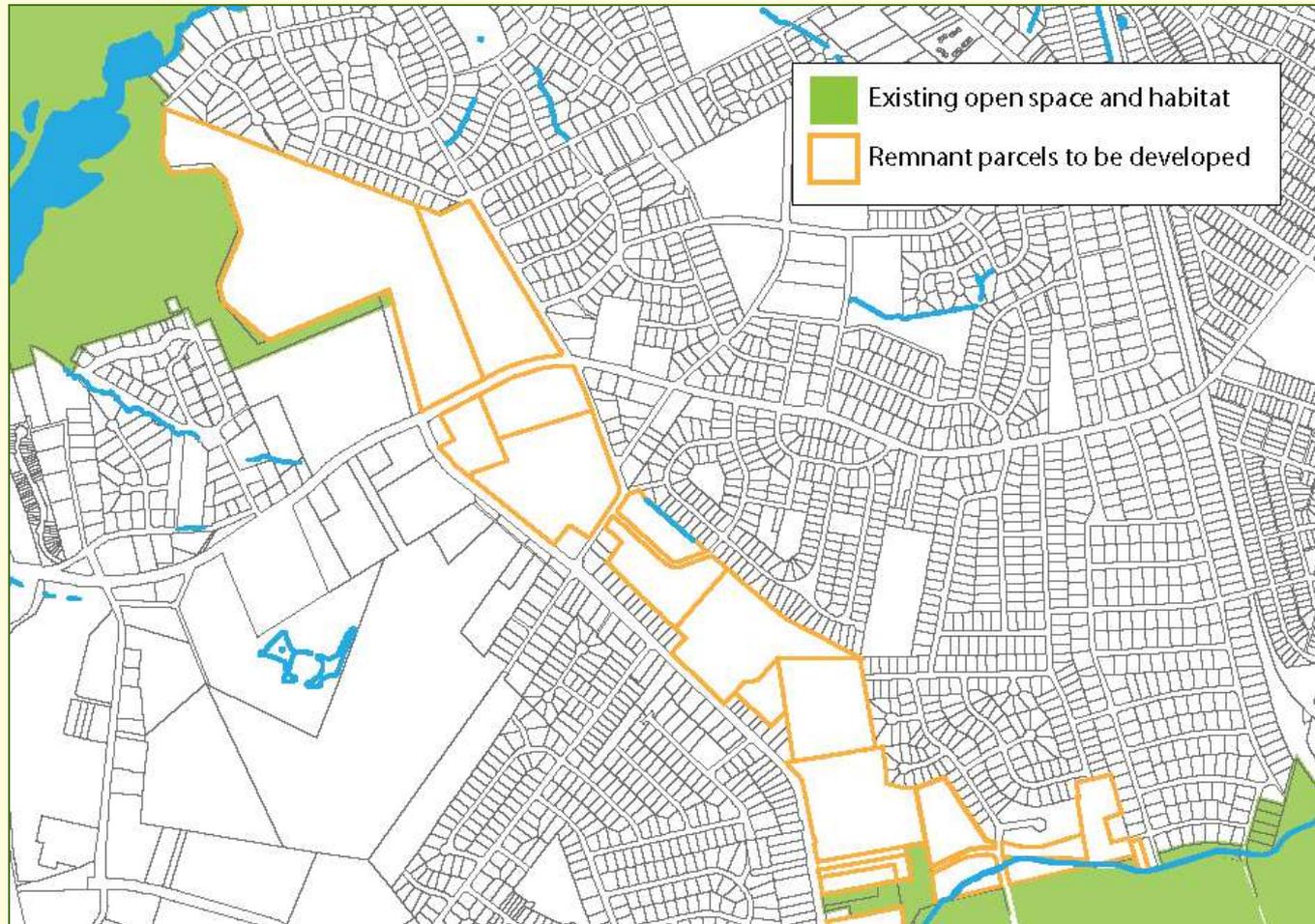
How can we link regional green infrastructure to local projects?



How can we link regional green infrastructure to local projects?



Vacant parcels can provide corridor opportunities to re-green and reconnect the urban landscape.



If each parcel leaves or replants a green strip, they can be connected for form a corridor – urban greenway trails can be created within an urban fabric.



Look for other ways for existing parcels to link to greenways.



Green Infrastructure Toolkit: what to do at the site scale



Urban Water

- Vegetated swales/bioswales
- Rain gardens/bioretention areas
- Vegetated filter strips
- Stormwater wetland



Community Spaces

- Pocket park
- Informal recreation
- Meadow/native habitat
- Outdoor classroom
- Community garden



Site Planning

- Green street design
- Reducing impervious surfaces
- Vegetated landscaping
- Urban forestry
- Urban stream restoration
- Riparian buffers

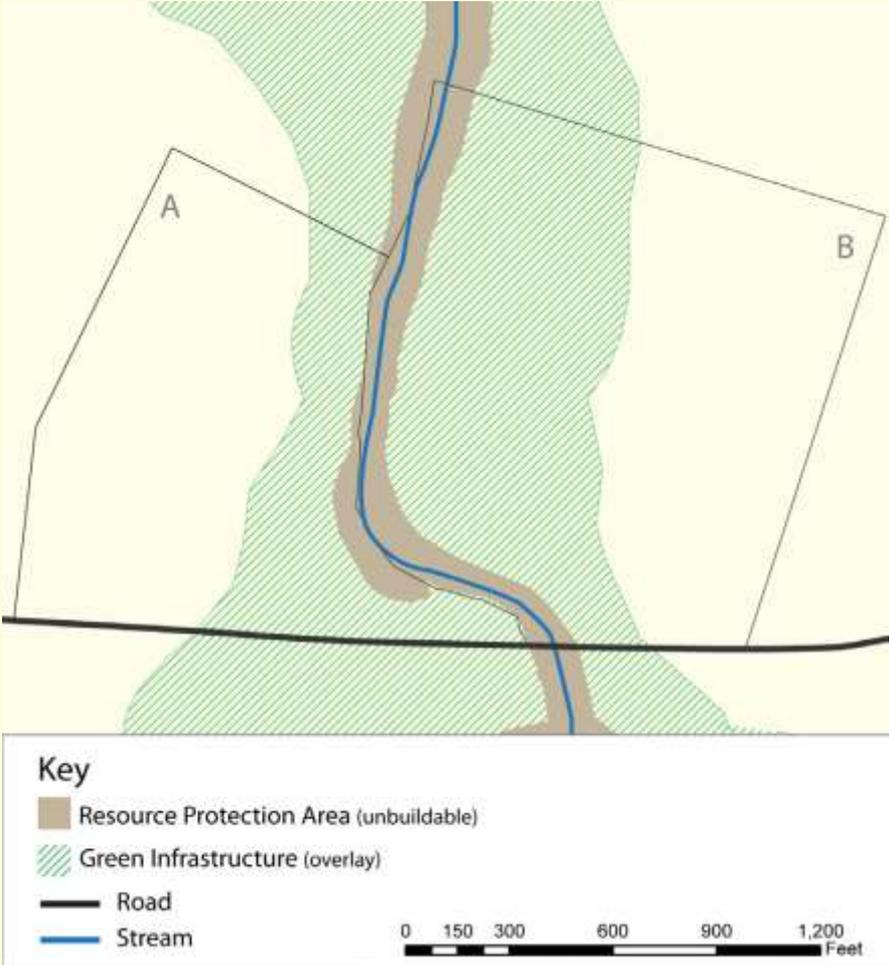


Community Stewardship

- Green space grant programs
- Land banking
- Mow-to-own
- Adopt-a-block

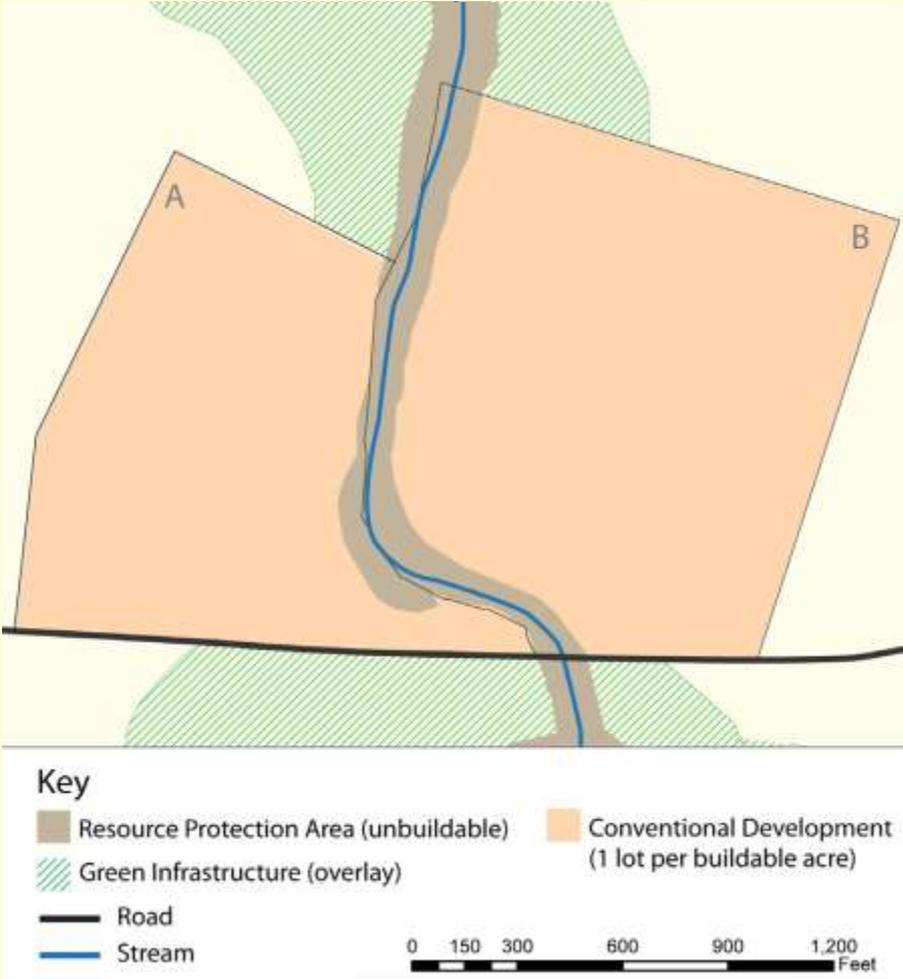
Example Parcel Strategy: strategic conservation

Existing
riparian
buffer



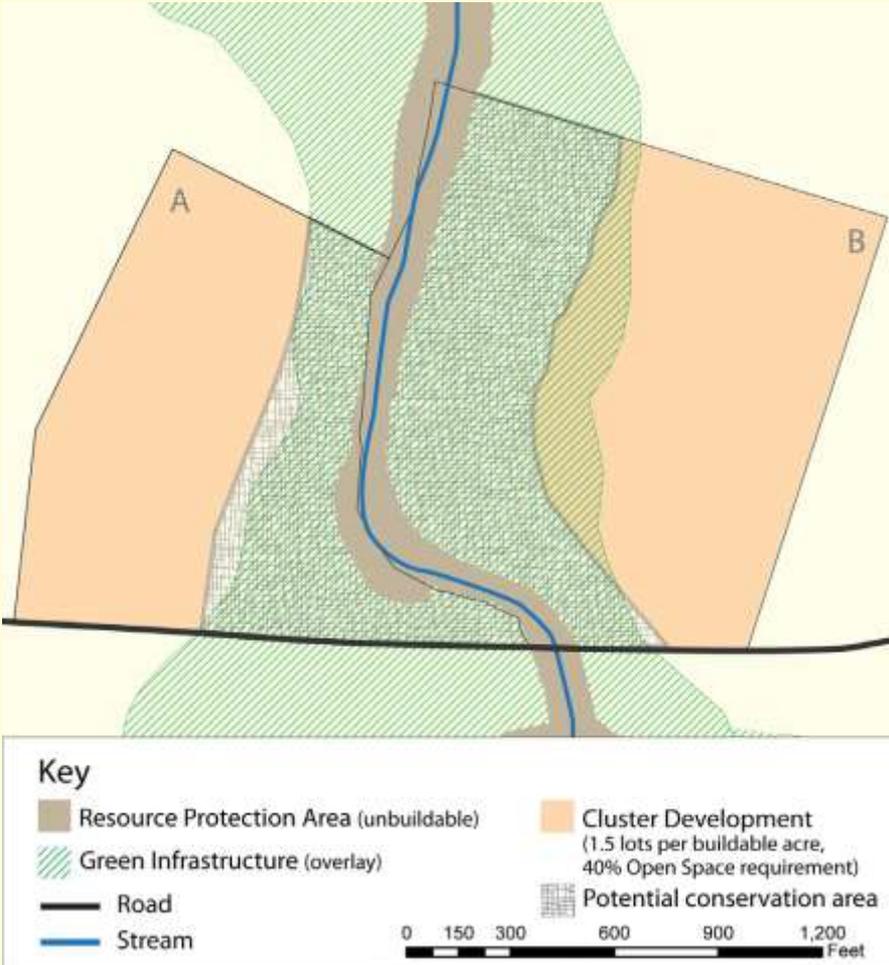
Parcel Strategy: strategic conservation

Conventional Development

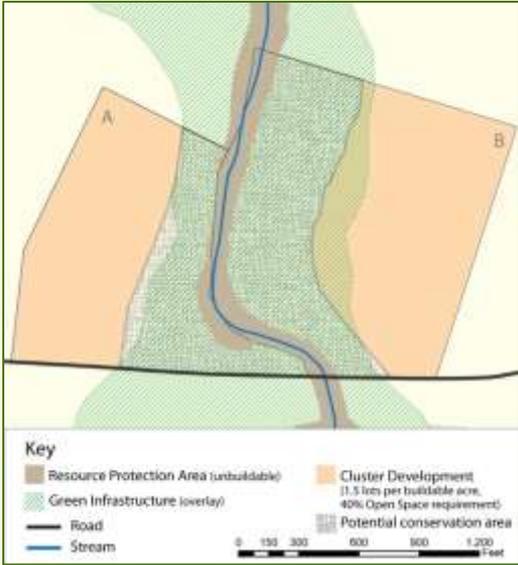
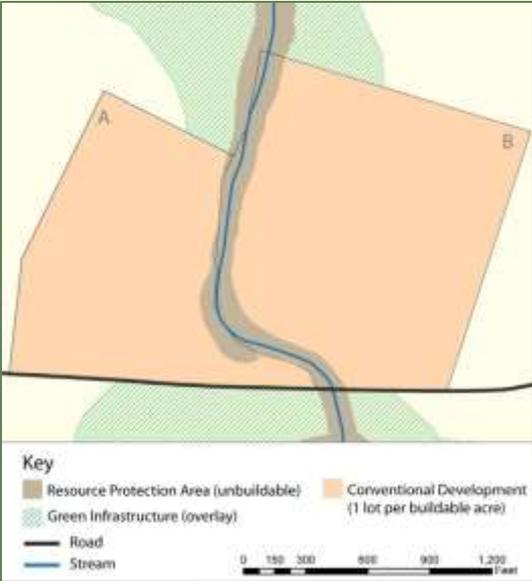


Parcel Strategy Ex: strategically conserving green infrastructure

Existing riparian buffer preserved by clustering development

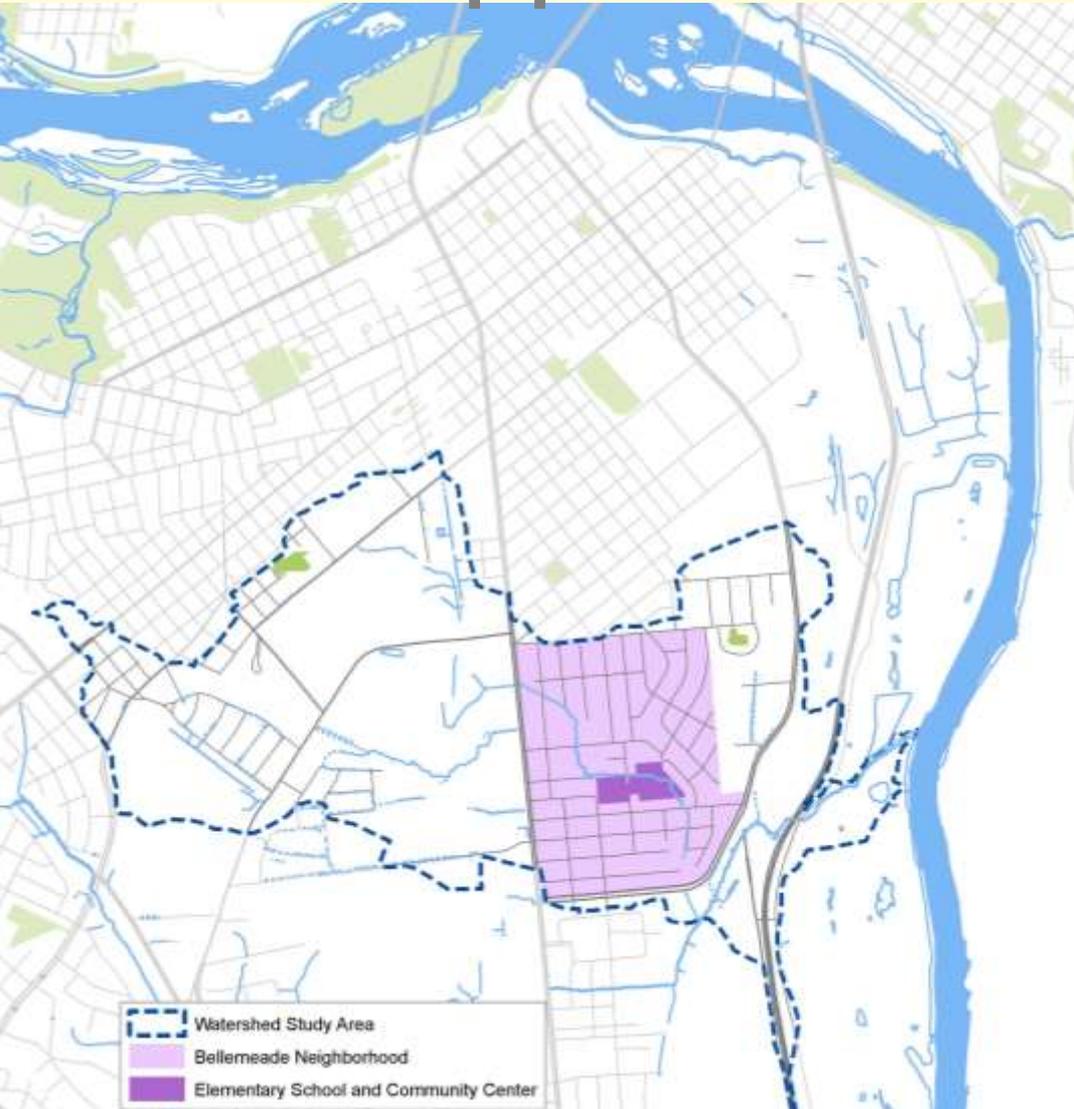


Parcel Strategy: Comparison



	# of Lots	
Parcel (acres)	Conventional Development (1 lot/acre)	Clustered Development (1.5 lots acre)
A (32)	26	39
B (38)	30	45
Total	56	84

Upper Goode's Watershed



Watershed (dashed boundary) shows the land that drains upper Goode's Creek

Goode's Creek drains into the James River

Model for other city watersheds

Neighborhood Bellemeade Creek Corridor



Vacant Parcels with Ecological Value



Vacant Parcels with Urban Tree Canopy

City Owned Land Adjacent to A New Green School Can we restore the site to meet ecological and recreational needs?



GREEN INFRASTRUCTURE CENTER

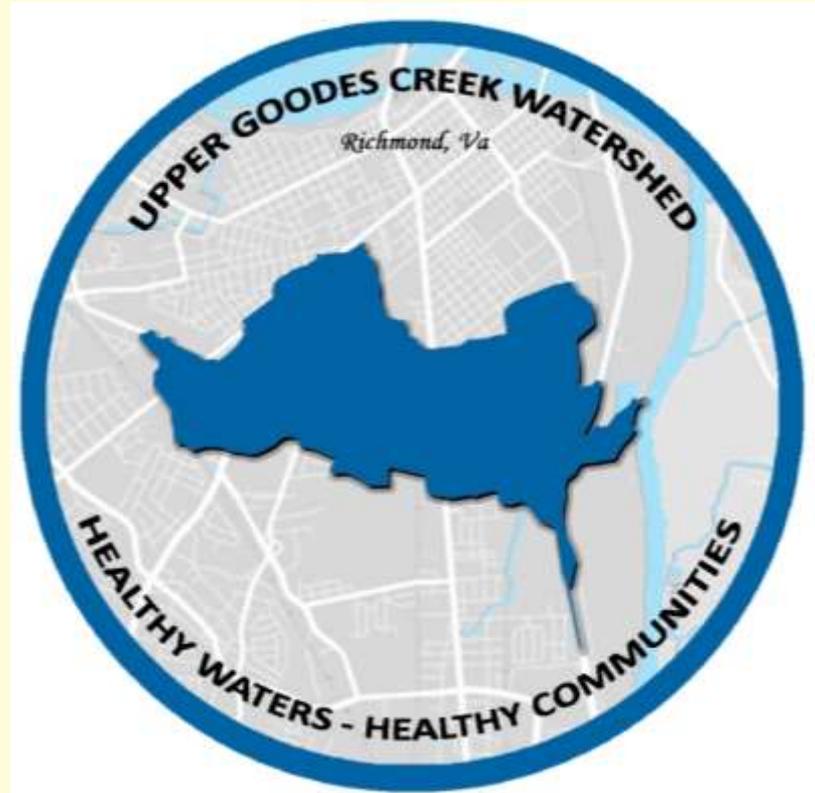


Park Concept Plan
Bellemeade Neighborhood - Richmond, VA



Partnerships Are Key

- Richmond government can not take on and solve watershed problems alone.
- Partnerships with nonprofit groups, businesses and community members are key to achieving goals to clean our waters.
- We formed a Watershed Coalition to make partnerships work!



Watershed Coalition Focused On:



Clean Environment
and Healthy Waters



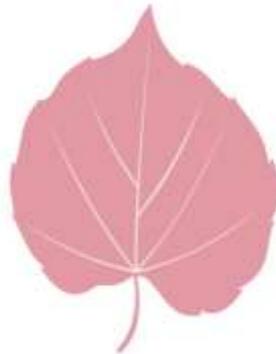
Green Streets



Safe Walkable Communities



Blight to Beautification



Parks and Green Spaces

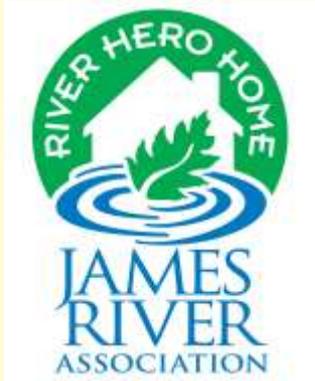


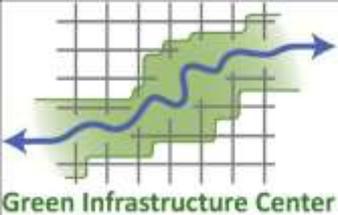
Urban Forest

Trash Cleanups



Storm Drain Labeling & Rainbarrels





Community Tree Planting



GIC Coordinated building the nature trail, replanting buffers



Making the Case

How to sell the importance of natural asset mapping and conservation.

Social Marketing

Social marketing arose as a discipline in the 1970s, when Philip Kotler and Gerald Zaltman applied the same marketing principles used to sell products to consumers to now *sell ideas, attitudes and behaviors*. Social marketing seeks to influence social behaviors to benefit the target audience and the general society.

Adapted from "What is Social Marketing", by Nedra Kline Weinreich, <http://www.social-marketing.com/Whatis.html>



Positive Messages

Positive messages sell while negatives do not.

So if you want to help the Potomac River, it would be more effective to say,

“Conserve large connected forests, especially along streams to ensure the best possible water quality and wildlife habitat.”

rather than saying,

“Don’t fragment the forest.” or “Stop polluting the river.”

Make it relevant....

Link efforts to existing initiatives and concerns: For example, if the county needs to address sedimentation of the reservoir link the project to preventing runoff pollution...

“Protecting surface water sources and aquifer recharge zones with forest cover reduces the cost of drinking water treatment. A survey by the American Water Works Association found that a 10% increase in forest cover reduced chemical and treatment costs of drinking water by 20%.” (Ernst et al. 2004)

Green Assets = Real Estate \$\$\$

\$ Having a park within 1,500 feet of a home increased its sale price between \$845 - \$2,262

(in 2000 dollars). Economic Benefits of Recreation, Open Space, Recreation Facilities and Walkable Community Design, 2010

\$ The larger the park, the more significant the property value increase. (ibid)

Key message: Parks = better tax base = \$!

\$ Large natural forest areas have a greater positive impact on nearby property prices than smaller urban parks or developed parks such as playgrounds, skate parks or golf courses.

Bigger intact forests/natural areas = more \$!



Trees: for Health

- ❑ Access to fitness opportunities. (addresses obesity, nature deficit disorders)
- ❑ Clean air – trees absorb pollutants, VOCs, filter runoff, cool the city. (combat asthma)
- ❑ Well being and mental health - -people heal faster when they can see or access green. (hospitals need this for patients, reduces absenteeism of workers)
- ❑ Less crime occurs near trees. (issue especially for downtowns and public housing areas)
- ❑ Employees will exercise if they can access green where they work and on the way to work. (addresses employee health)



Key Message: Treed areas = healthy safer communities!

Meet or Avoid Regulations

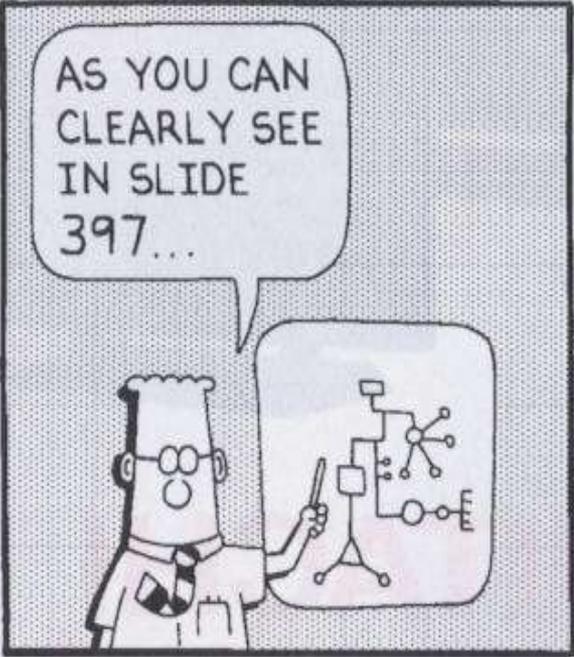
TMDLs: Identify areas that may be subject to impairment and protect them to prevent future TMDL's. Use your natural assets maps to indentify areas to restore to mitigate the pollution loadings. Choose practices that will affect runoff such as retain or restore forested stream buffers etc.

Stormwater Programs: Prevent new stormwater problems and erosion by identifying sensitive landscapes, steep slopes as well as natural assets to retain on site.

WIP: Identify landscape conservation practices that will create a connected natural asset network while also reducing runoff to meet WIP goals for reducing nitrogen, sediment and phosphorus.

How are we doing?

DILBERT



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If you enjoyed learning about these ideas, attend one of our workshops next year!

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