US EPA ARCHIVE DOCUMENT

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Environmental Monitoring and Assessment Program
Great River Ecosystems
Biological Indicators Workshop
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Landscape Approach for Great Rivers Assessment

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Approach

- Determine Areas of Potential Influence for River Sites

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- Determine Areas of Potential Influence for River Sites
- Calculate and Test Landscape Metrics

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- Calculate and Test Landscape Metrics
- Relate Landscape Metrics to
  - Stressors
  - Water Quality
  - Habitat Metrics
  - Biological Response Indicators

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- Calculate and Test Landscape Metrics
- Relate Landscape Metrics to
  - Stressors
  - Water Quality
  - Habitat Metrics
  - Biological Response Indicators

Approach

- Determine Areas of Potential Influence for River Sites at Several Scales

Whole Upstream Watershed

↓

Regional

↓

Local (near the River Sites)

Approach

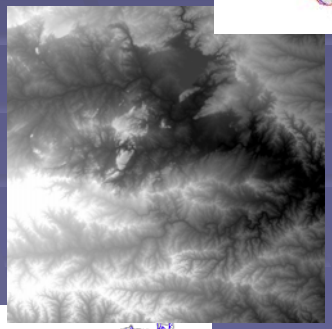
- We need a consistent approach.
- Comprehensive for the Missouri, Mississippi, and Ohio Rivers
- Accurate for the scale of each use and for our assessment purpose
- Automated in GIS for efficiency and for testing

Currently

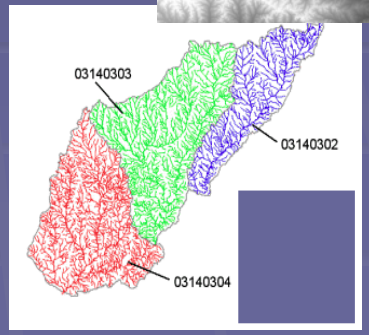
- We are testing the use of NHDPlus as primary data layer for the GRE landscape analysis.
- We have used 2 methods for obtaining whole upstream watershed areas.
- We are now testing various ways to determine local and regional areas of influence.

NHD Plus

National Hydrography Dataset (NHD)



National Elevation Dataset (NED)



Watershed Boundary Dataset (WBD)

- USEPA: Tommy Dewald
- USGS Water Resources Division
- Horizon Systems

NHD Plus
Catchments and Flowlines

A catchment is the portion of the land surface that drains to a network flowline.

NHDPlus identifies all upstream catchments from any point on a flowline.

NHD Plus
Has Other Data Incorporated

Value Added Attributes

Temperature & Precipitation

Land Cover (NLCD)

Flow Volume & Velocity

Approach

- Determine Areas of Potential Influence for River Sites at Several Scales

Whole Upstream Watershed

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Regional

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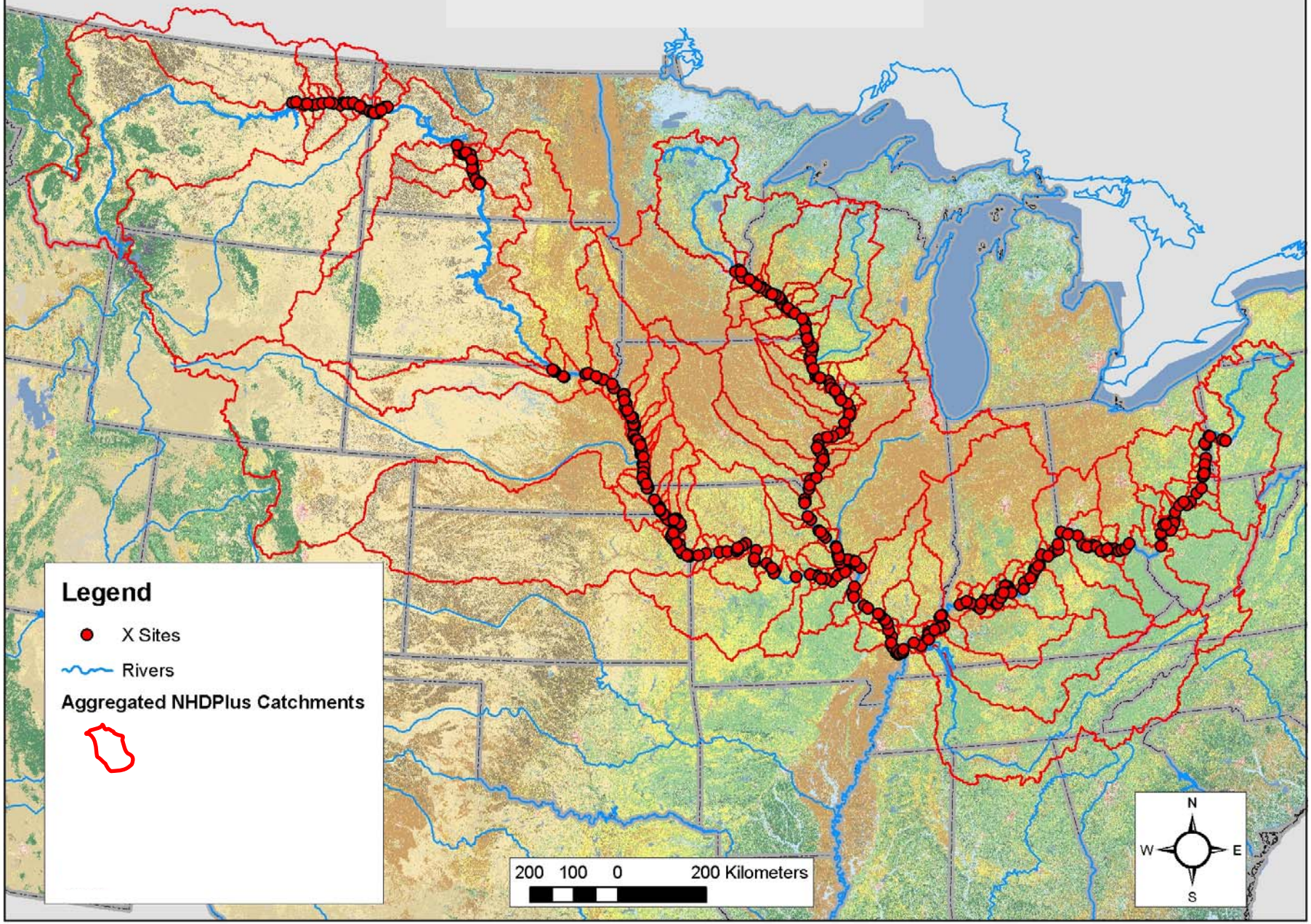
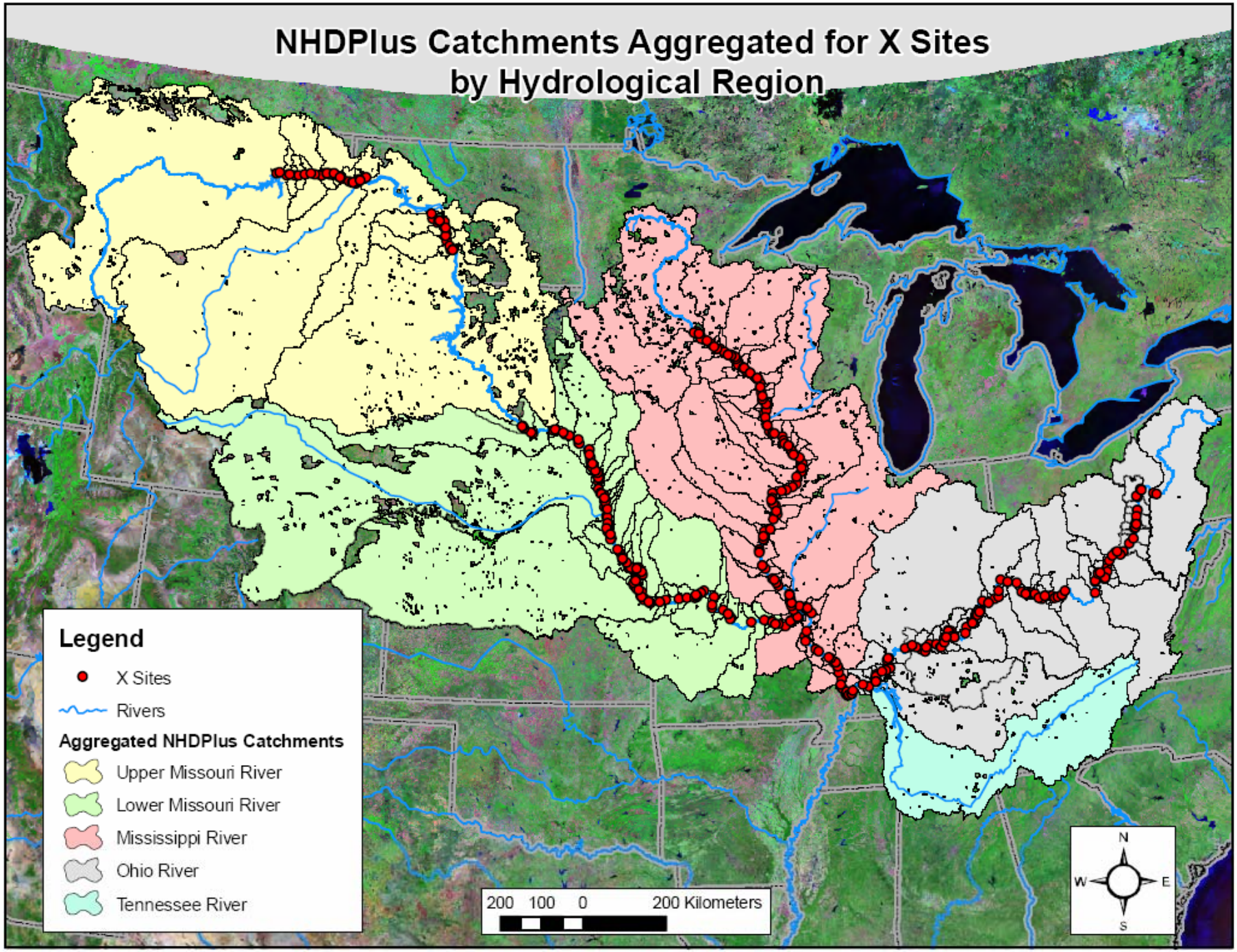
Local (near the River Sites)

Approach

- We are testing the use of NHDPlus as primary data layer for the GRE landscape analysis.
  - What is NHDPlus and what can it do for our GRE needs?
- We have used 2 methods for obtaining whole upstream watershed areas.
  - NHDPlus aggregation tools and ArcHydro
- We are testing various ways to determine local and regional areas of influence.

NHDPlus Catchments Aggregated for X Sites




NHDPlus Catchments Aggregated for X Sites
by Hydrological Region
Legend
X Sites
Rivers
Aggregated NHDPlus Catchments
Upper Missouri River
Lower Missouri River
Mississippi River
Ohio River
Tennessee River
200 100 0 200 Kilometers
N
W
E
S

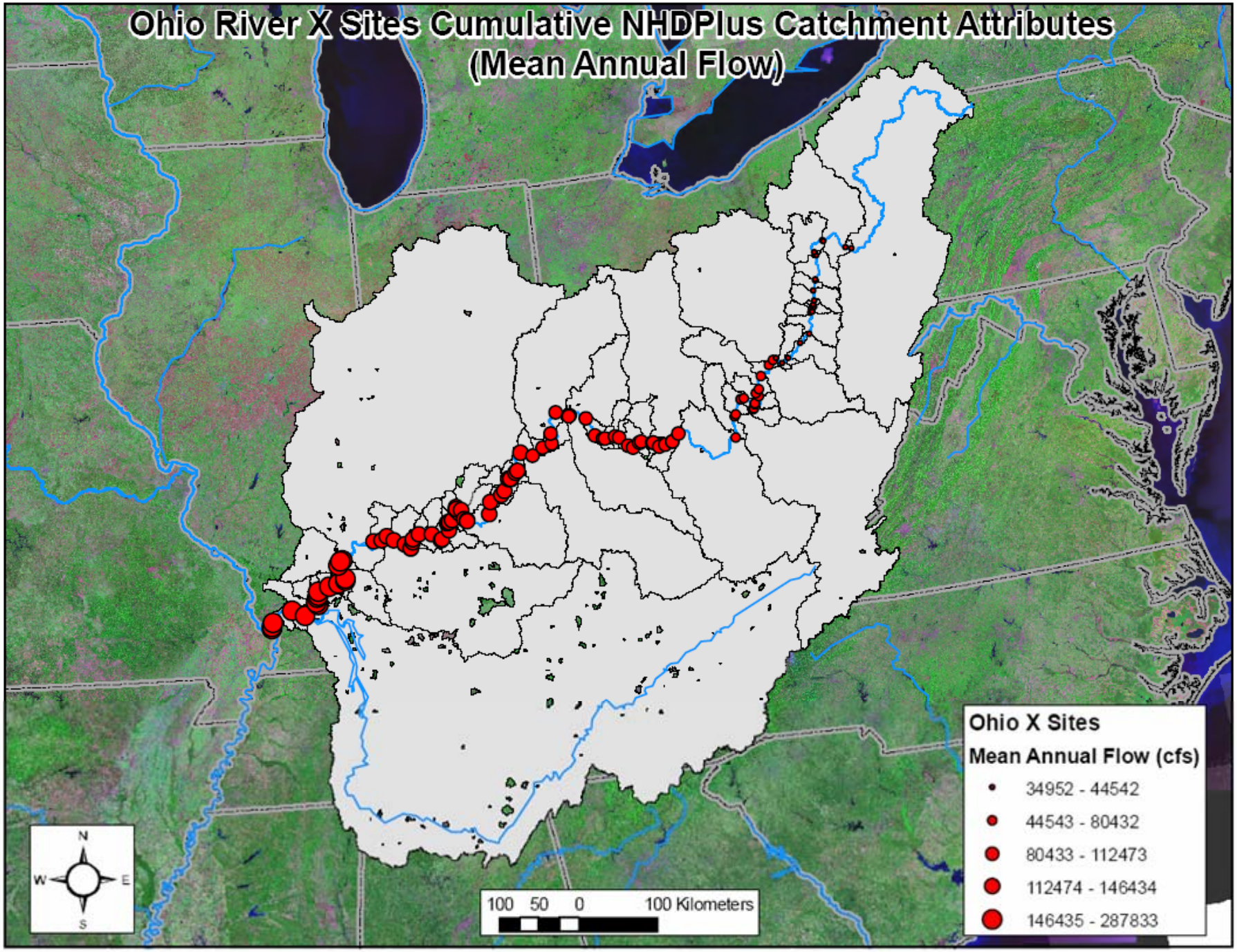
NHDPlus Cumulative Watershed Aggregation

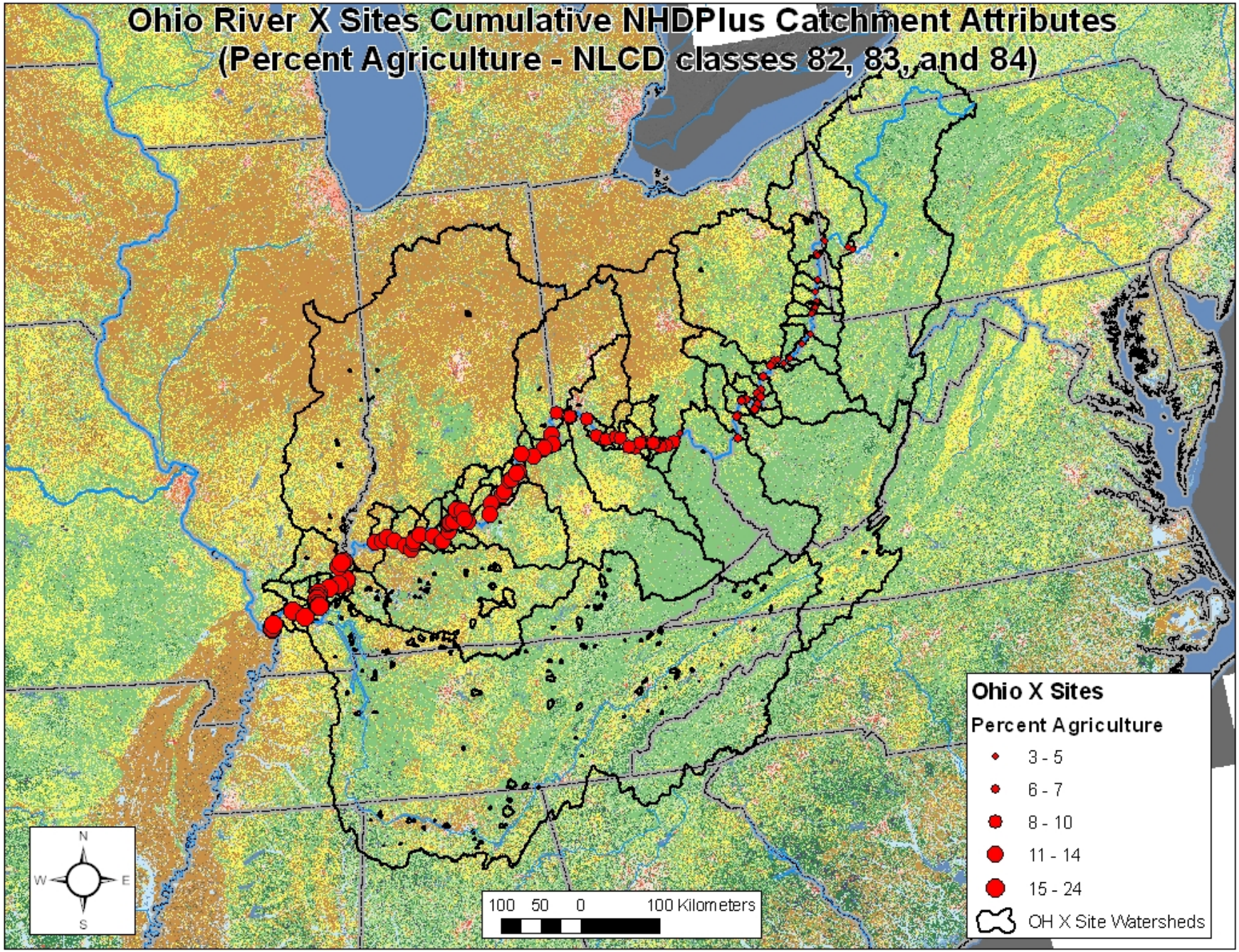
- NHDPlus schema has already summarized cumulative attributes for NLCD, temperature and precipitation, and flow.

- Aggregated watershed boundaries can be used for visualization and to summarize additional input datasets.

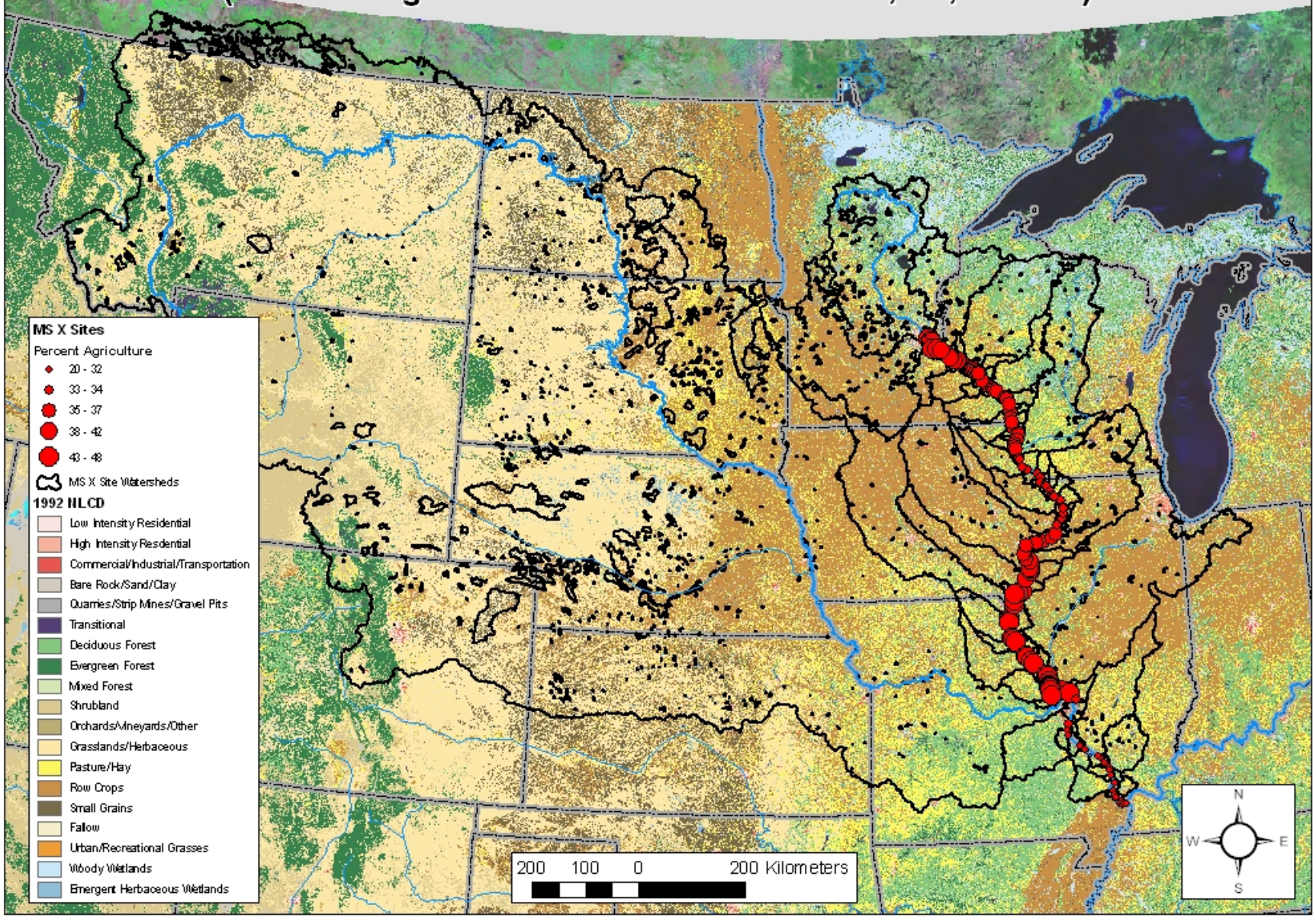
NHDPlus Cumulative Attributes

4	DUPLICATE	Value of 1 indicates that more than one x site occurs on the same NHDPlus flowline
5	COMID	Common identifier of an NHD Flowline
6	CumNLCD_11	% of cumulative drainage area classified as Open Water in NLCD
7	CumNLCD_12	% of cumulative drainage area classified as Perennial Ice/Snow in NLCD
8	CumNLCD_21	% of cumulative drainage area classified as Low Intensity Residential in NLCD
9	CumNLCD_22	% of cumulative drainage area classified as High Intensity Residential in NLCD
10	CumNLCD_23	% of cumulative drainage area classified as Commercial/ Industrial/Transportation in NLCD
11	CumNLCD_31	% of cumulative drainage area classified as Bare Rock/Sand/ Clay in NLCD
12	CumNLCD_32	% of cumulative drainage area classified as Quarries/Strip Mines/Gravel Pits in NLCD
13	CumNLCD_33	% of cumulative drainage area classified as Transitional in NLCD
14	CumNLCD_41	% of cumulative drainage area classified as Deciduous Forest in NLCDD
15	CumNLCD_42	% of cumulative drainage area classified as Evergreen Forest in NLCD
16	CumNLCD_43	% of cumulative drainage area classified as Mixed Forest in NLCD
17	CumNLCD_51	% of cumulative drainage area classified as Shrubland in NLCD
18	CumNLCD_61	% of cumulative drainage area classified as Orchards/Vineyards/ Other in NLCD
19	CumNLCD_71	% of cumulative drainage area classified as Grasslands/ Herbaceous in NLCD
20	CumNLCD_81	% of cumulative drainage area classified as Pasture/Hay in NLCD
21	CumNLCD_82	% of cumulative drainage area classified as Row Crops in NLCD
22	CumNLCD_83	% of cumulative drainage area classified as Small Grains in NLCD
23	CumNLCD_84	% of cumulative drainage area classified as Fallow in NLCD
24	CumNLCD_85	% of cumulative drainage area classified as Urban/Recreational Grasses in NLCD
25	CumNLCD_91	% of cumulative drainage area classified as Woody Wetlands in NLCD
26	CumNLCD_92	% of cumulative drainage area classified as Emergent Herbaceous Wetlands in NLCD
27	Cumpct_CN	% of cumulative drainage area in Canada and not classified in NLCD
28	Cumpct_MX	% of cumulative drainage area in Mexico and not classified in NLCD
29	AreaWtMAP	Area Weighted Mean Annual Precipitation at bottom of flowline in mm
30	AreaWtMAT	Area Weighted Mean Annual Temperature at bottom of flowline in degree C * 10
31	CumDrainag	Cumulative drainage area in square kilometers(sq km) at bottom of flowline
32	MAFlowU	Mean Annual Flow in cubic feet per second (cfs) at bottom of flowline as computed by Unit Runoff Method
33	MAFlowV	Mean Annual Flow (cfs) at bottom of flowline as computed by Vogel Method
34	MAVelU	Mean Annual Velocity (fps) at bottom of flowline as computed by Unit Runoff Method
35	MAVelV	Mean Annual Velocity (fps) at bottom of flowline as computed by Vogel Method
36	IncrFlowU	Incremental Flow (cfs) for Flowline as computed by the Unit Runoff Method
37	MaxElevRaw	Maximum elevation (unsmoothed) in meters
38	MinElevRaw	Minimum elevation (unsmoothed) in meters
39	MaxElevSmo	Maximum elevation (smoothed) in meters
40	MinElevSmo	Minimum elevation (smoothed) in meters
41	Slope	Slope of flowline (m/m)


Ohio River X Sites Cumulative NHDPlus Catchment Attributes
(Mean Annual Flow)
Ohio X Sites
Mean Annual Flow (cfs)
34952 - 44542
44543 - 80432
80433 - 112473
112474 - 146434
146435 - 287833
100 50 0 100 Kilometers
N
W
E
S

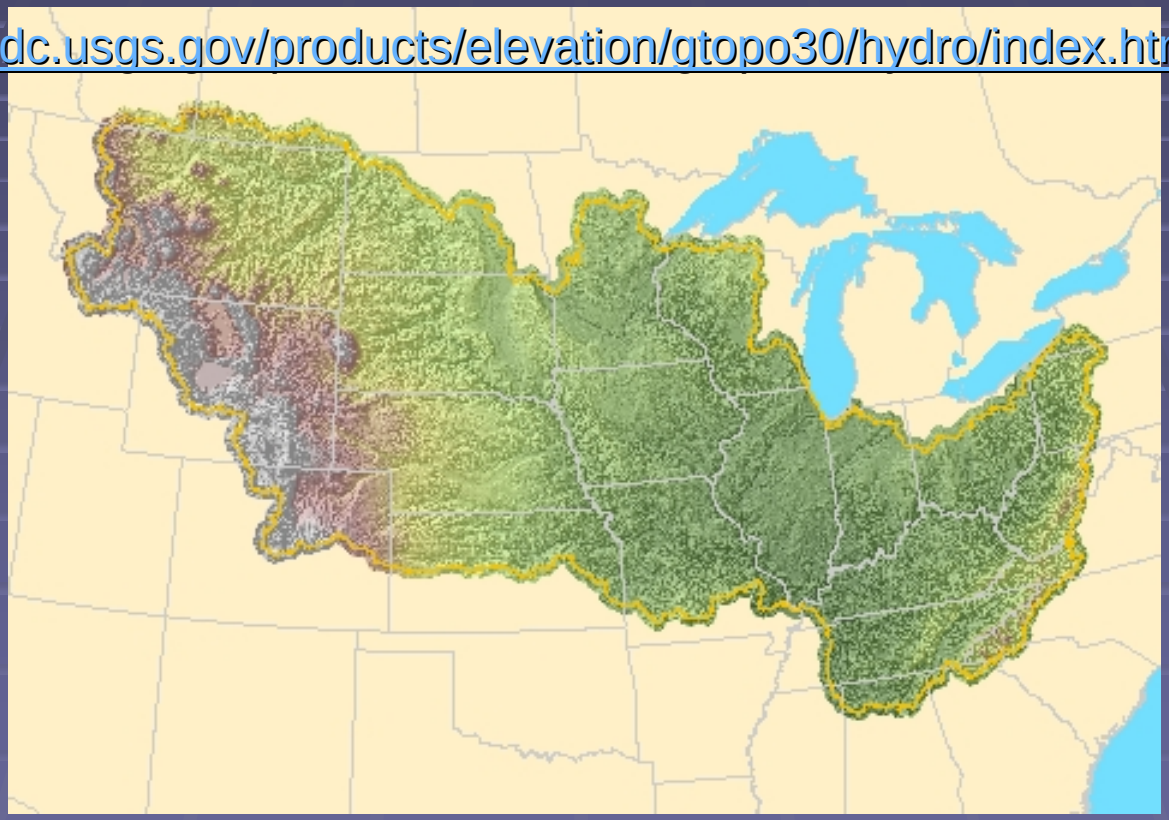

Ohio River X Sites Cumulative NHDPlus Catchment Attributes
(Percent Agriculture - NLCD classes 82, 83, and 84)
Ohio X Sites
Percent Agriculture
3 - 5
6 - 7
8 - 10
11 - 14
15 - 24
OH X Site Watersheds
100 50 0 100 Kilometers
N
W
E
S

Mississippi River X Sites Cumulative NHDPlus Catchment Attributes (Percent Agriculture - NLCD classes 82, 83, and 84)



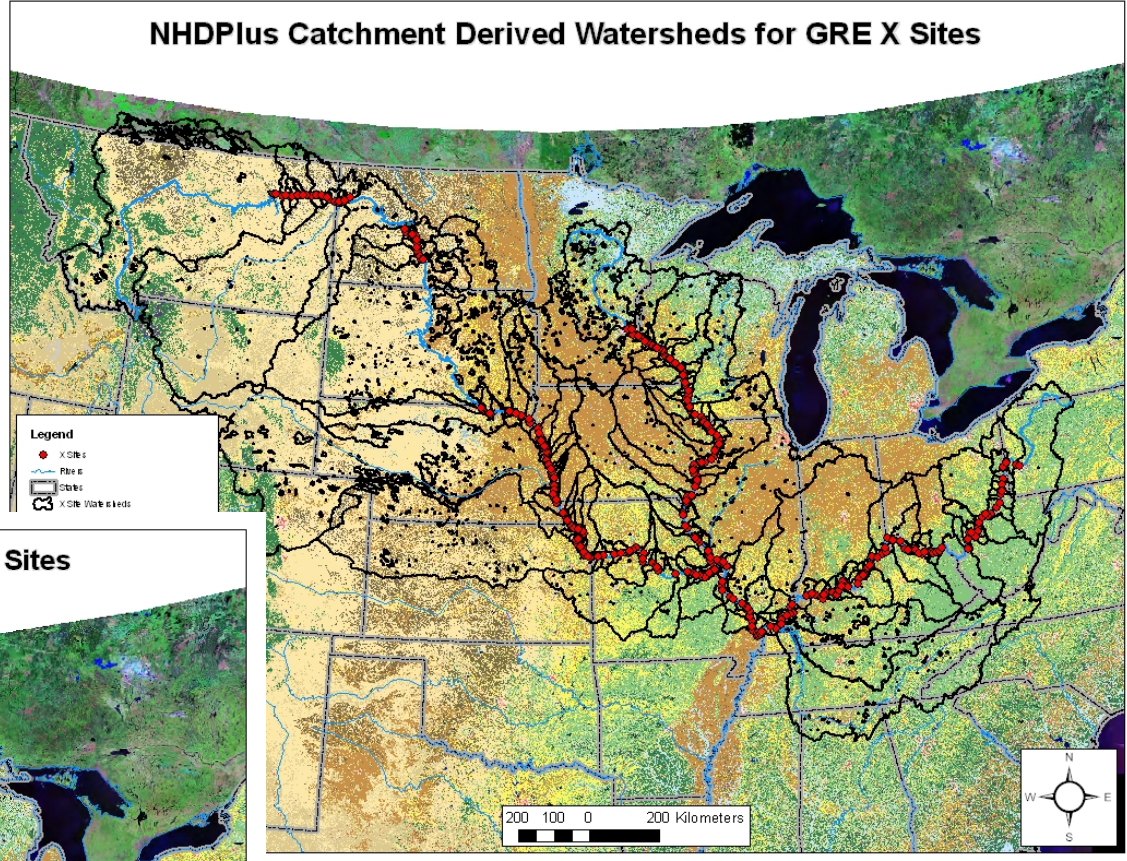
Using Archydro model and tools with Hydro1 data: 1km DEM with hydrology, flow accumulation and flow direction grids

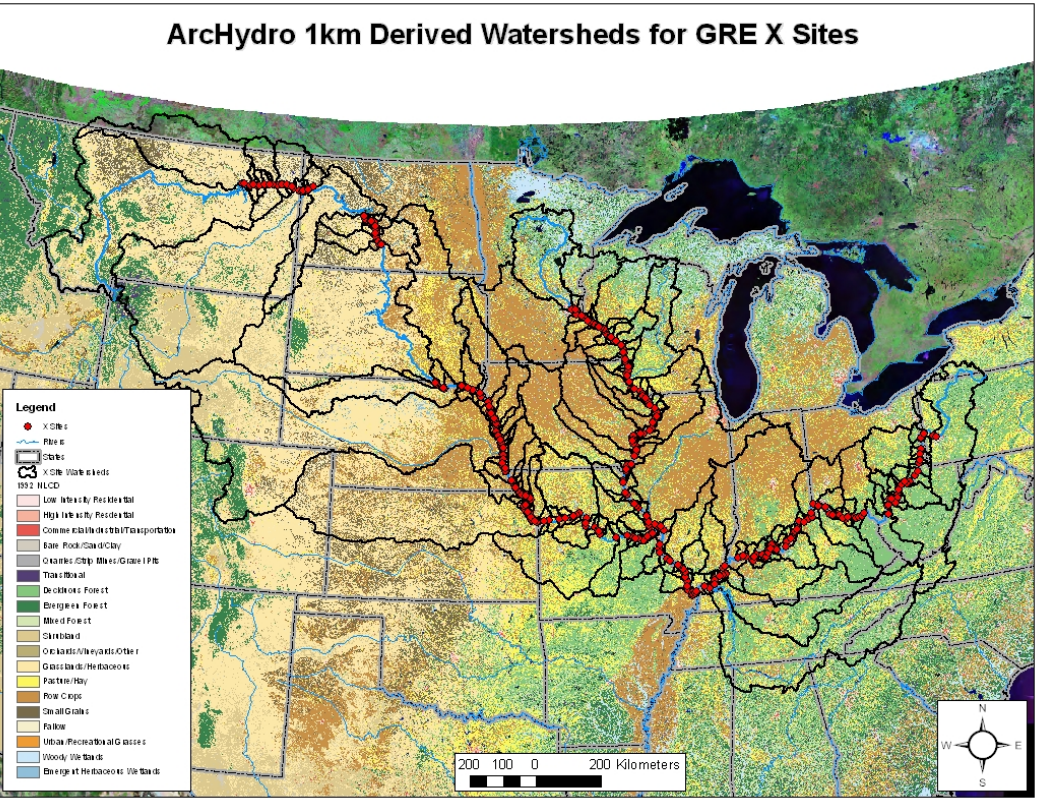
http://edc.usgs.gov/products/elevation/gtopo30/hydro/index.html



Extent of Hydro1 Data for the Missouri, Ohio, and Upper Mississippi Rivers

Upper Mississippi River X-sites and Upstream Watersheds





NHDPlus (at 30m)

ArcHydro and Hydro1km

Approach

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  - NHDPlus aggregation tools and ArcHydro
- We are testing various ways to determine local and regional areas of influence.

Approach

- Determine Areas of Potential Influence for River Sites at Several Scales

Whole Upstream Watershed

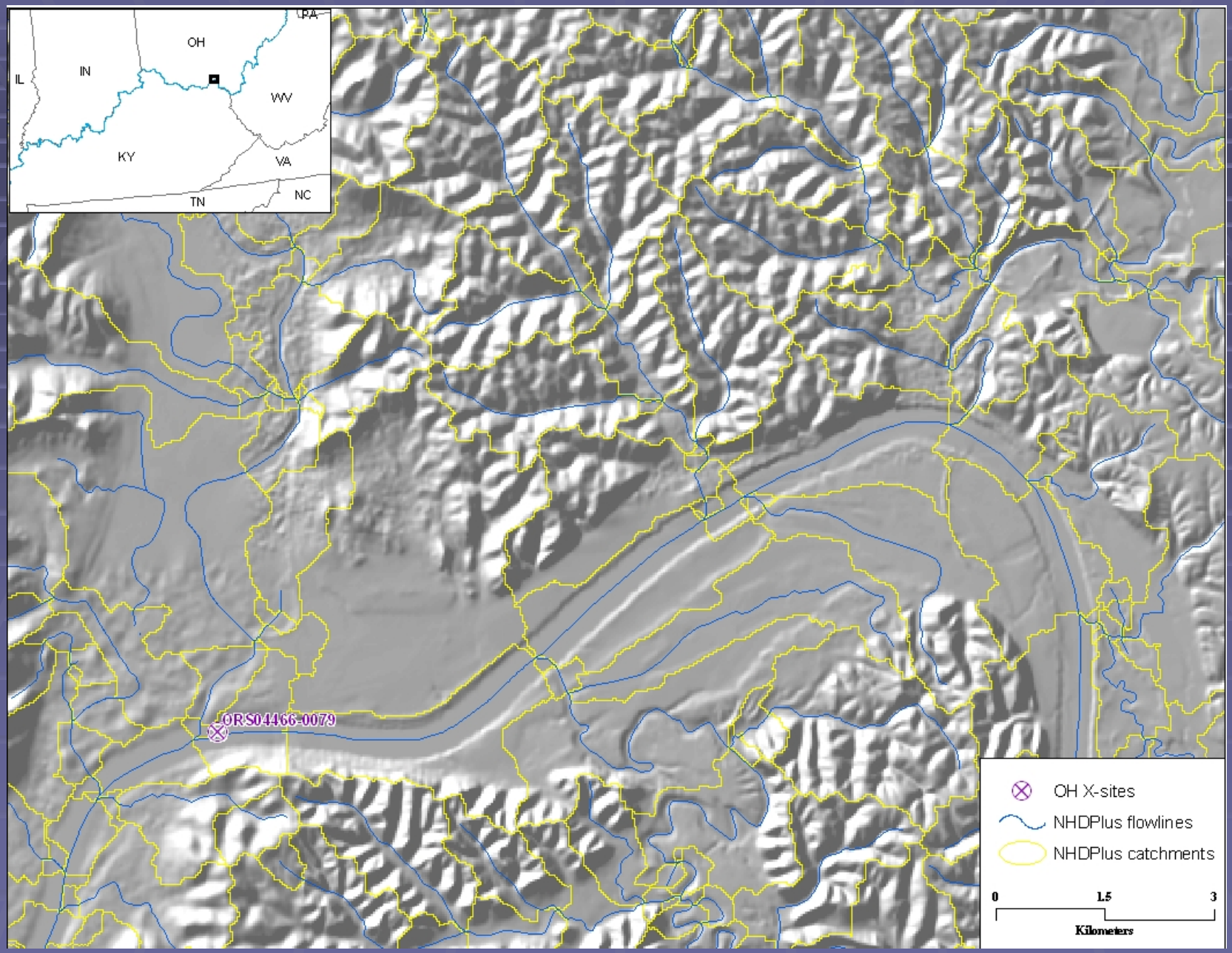
↓

Regional

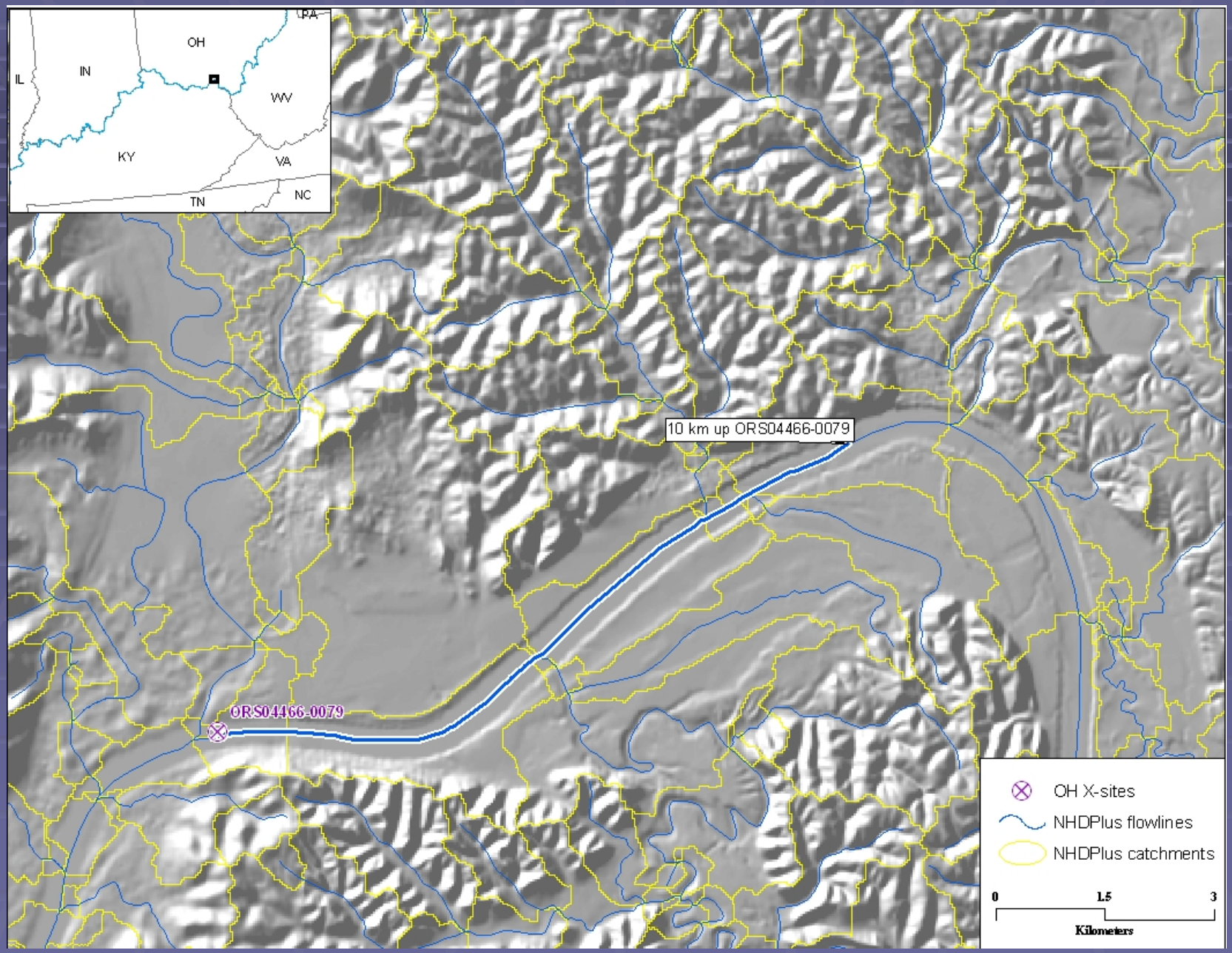
↓

Local (near the River Sites)

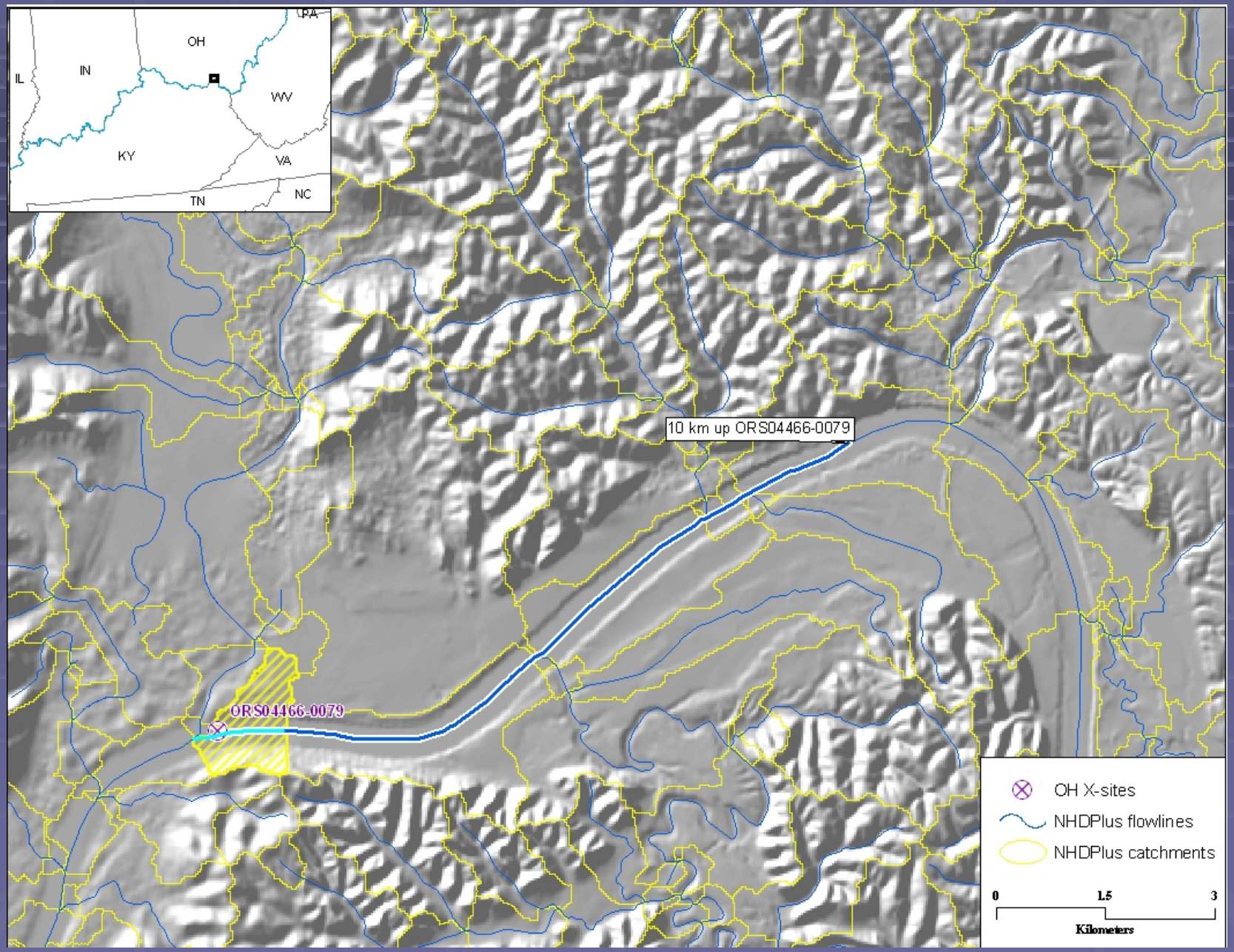
NHD Plus Input and GRE Sites



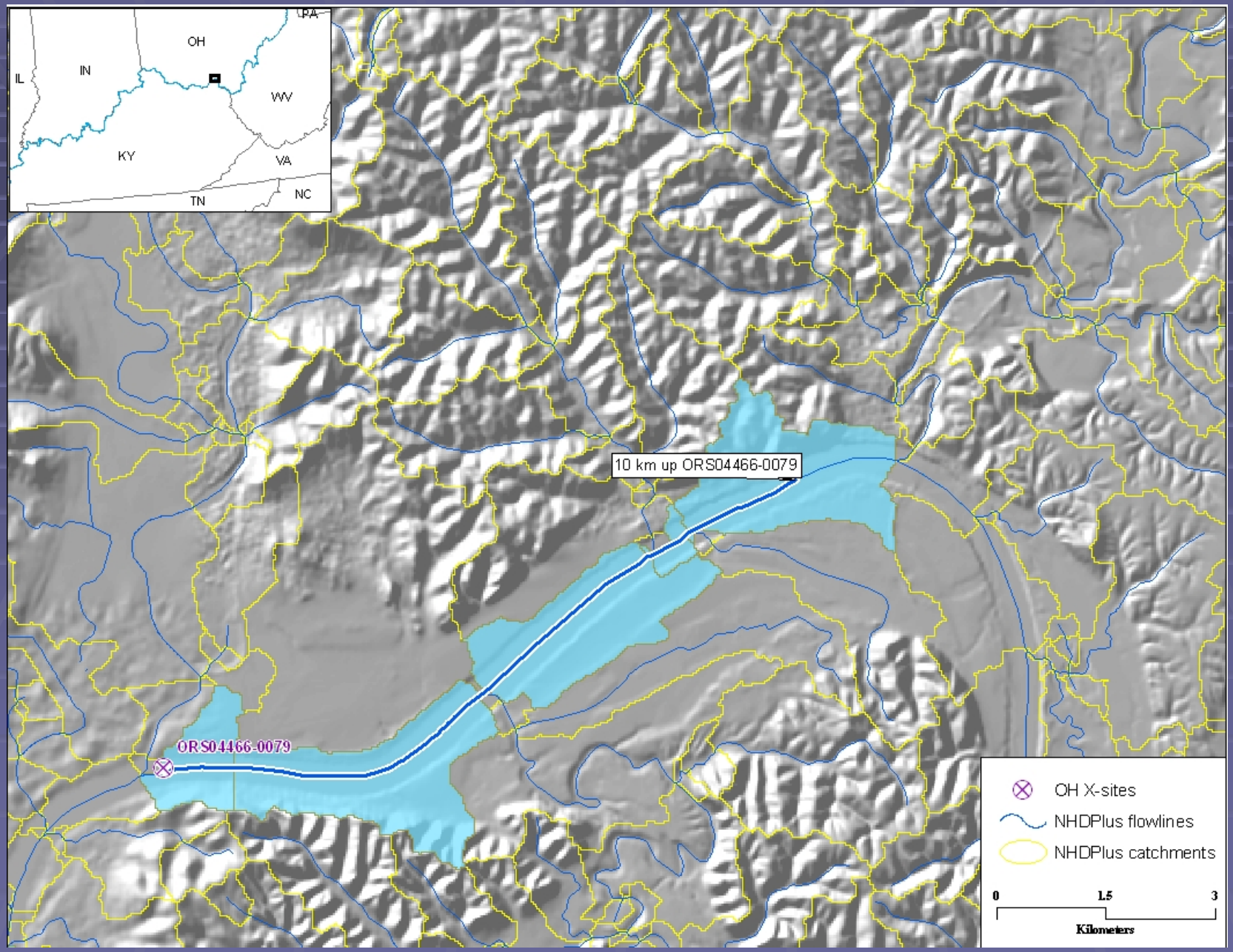
Define 10km Centerline Segments



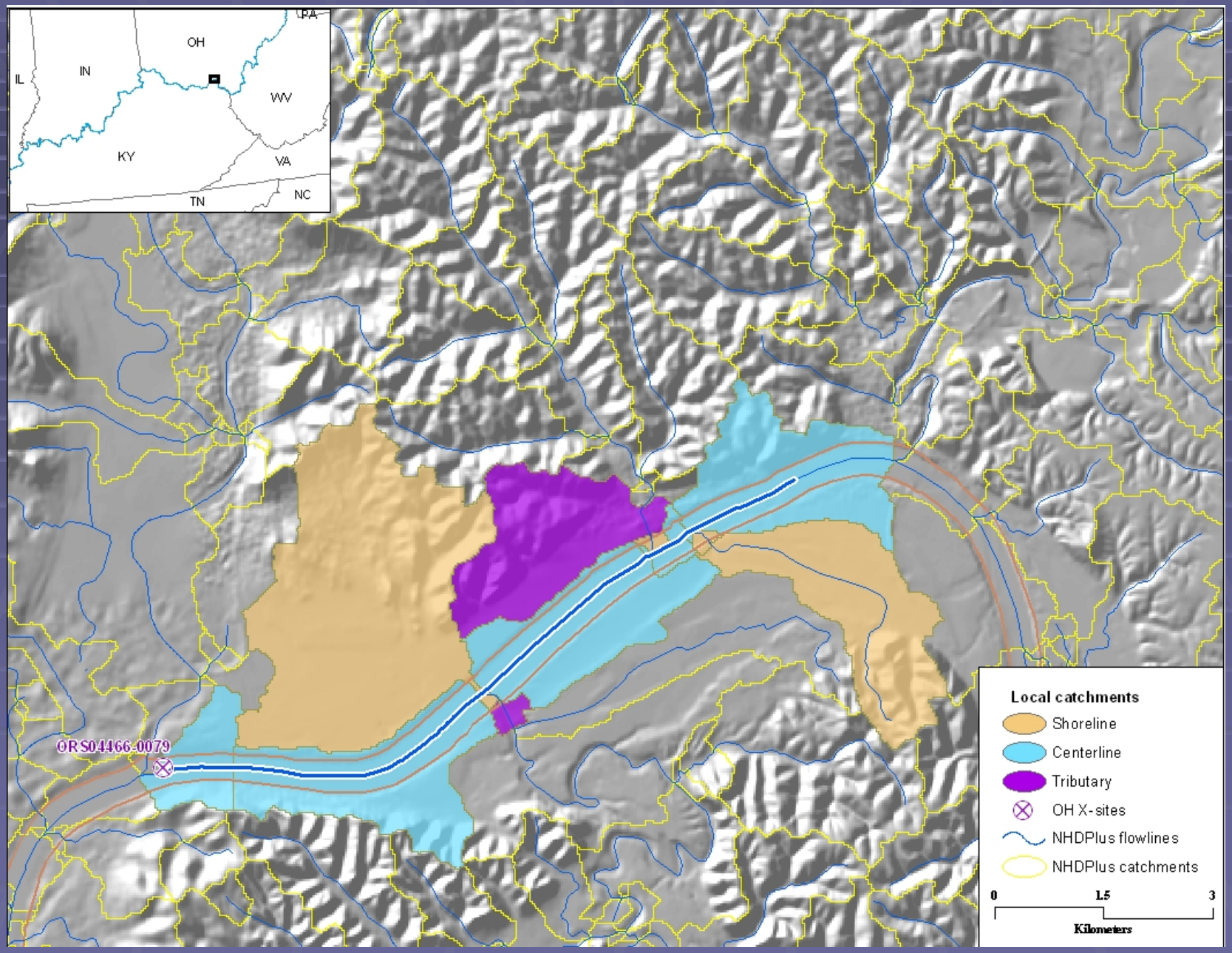
Identify X-reach Catchment



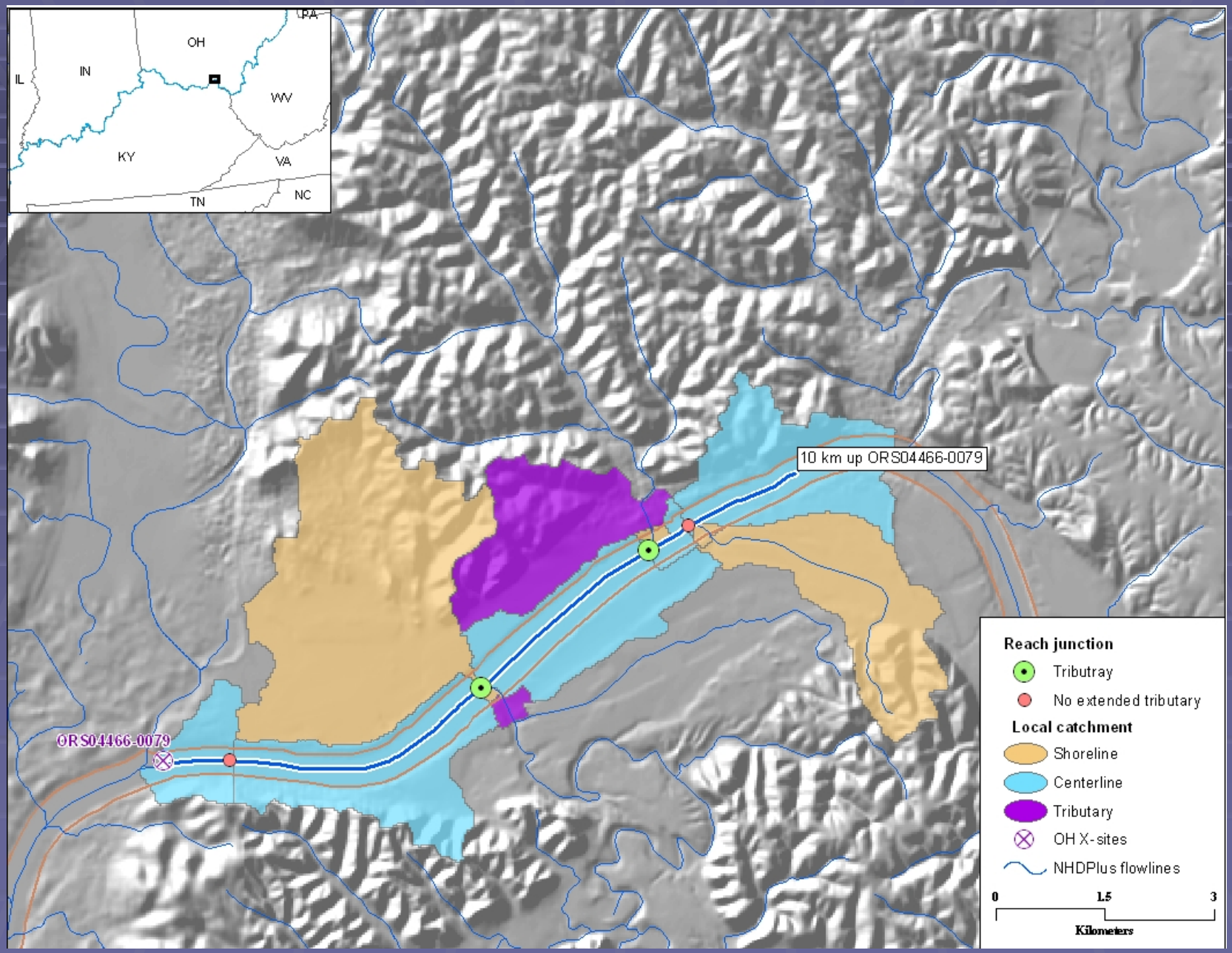
Identify 10km Centerline Catchments



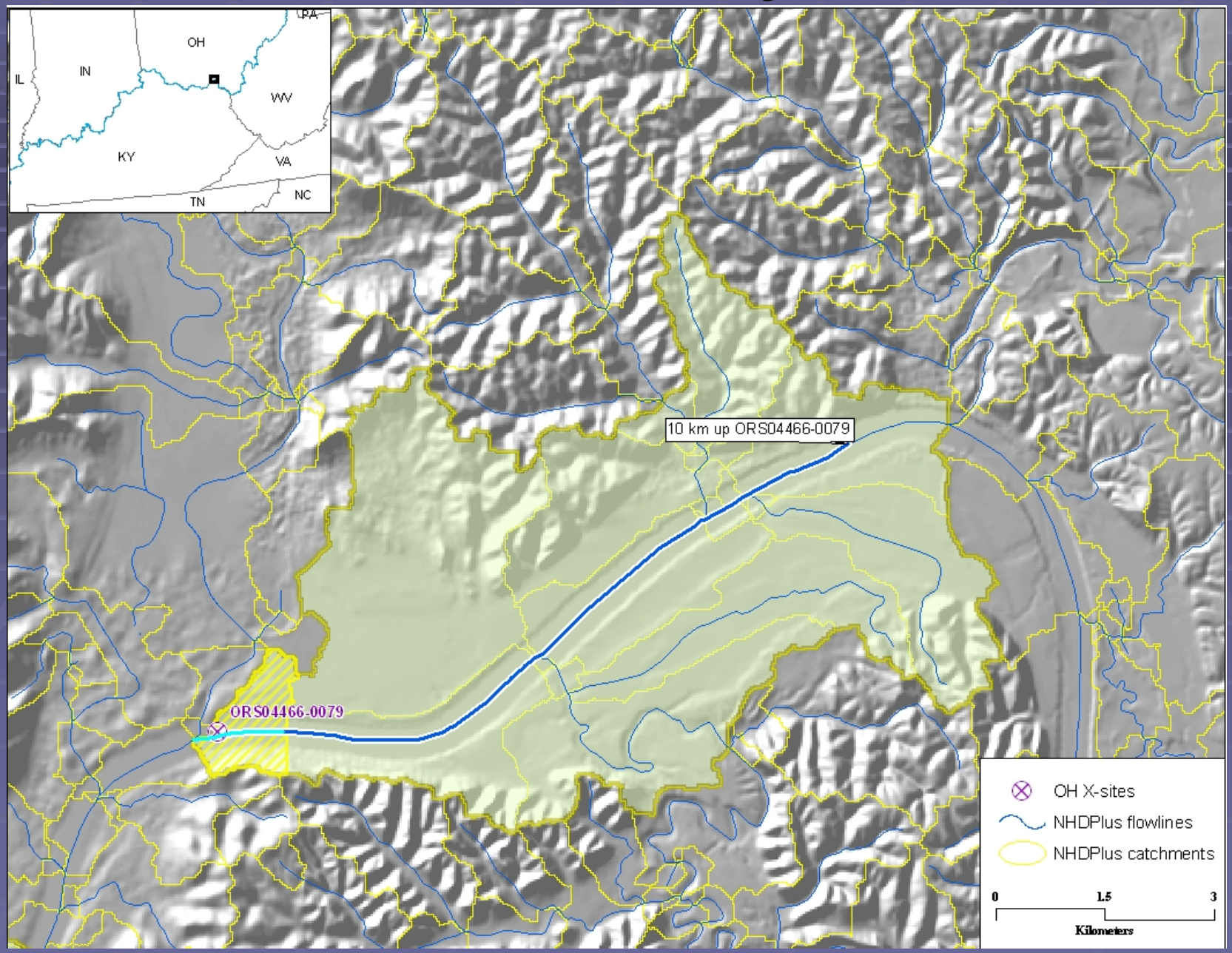
Classify 10km Shoreline Catchments



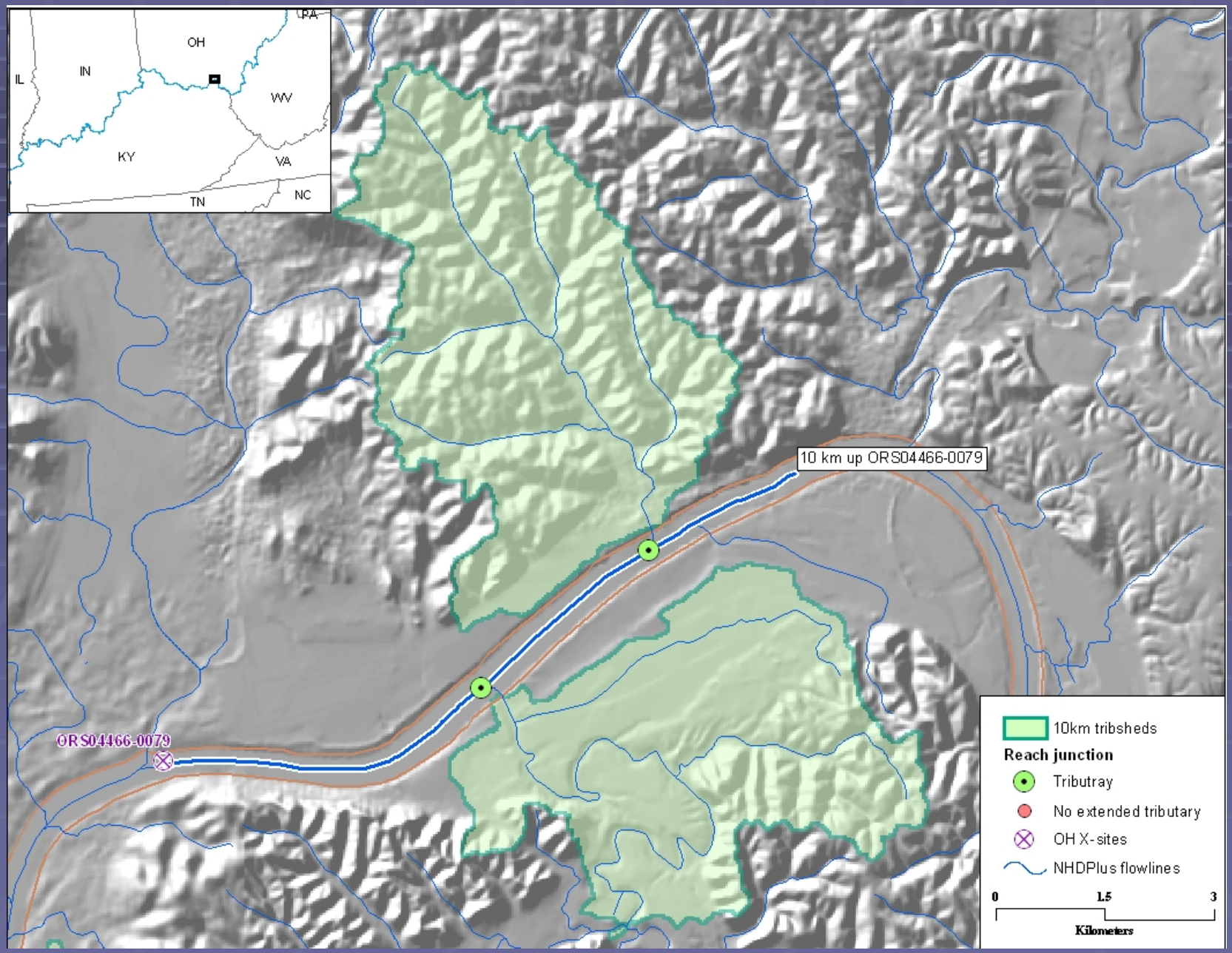
10km Other Mainstem Junction Catchments



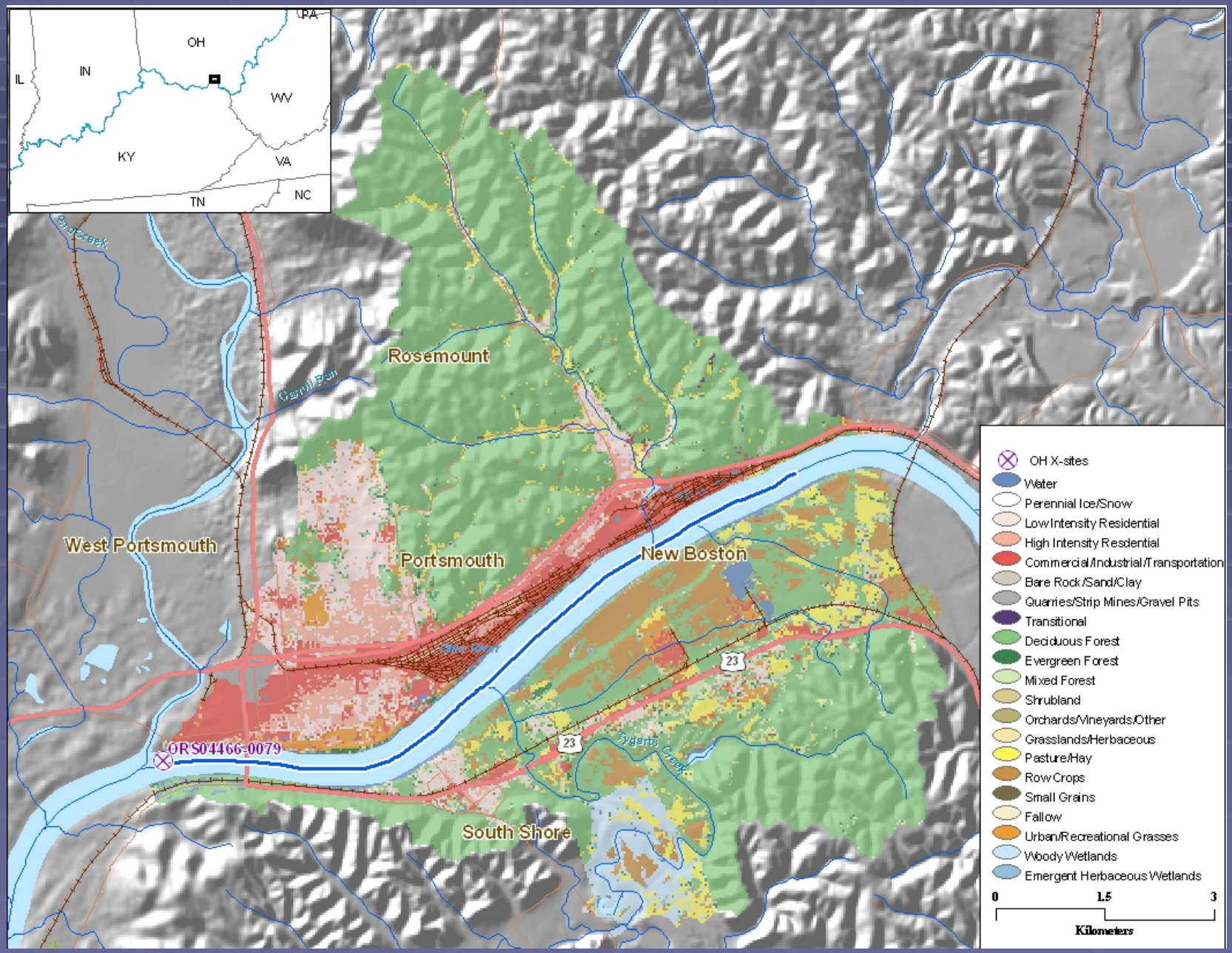
Add 1st Level Tributary Catchments



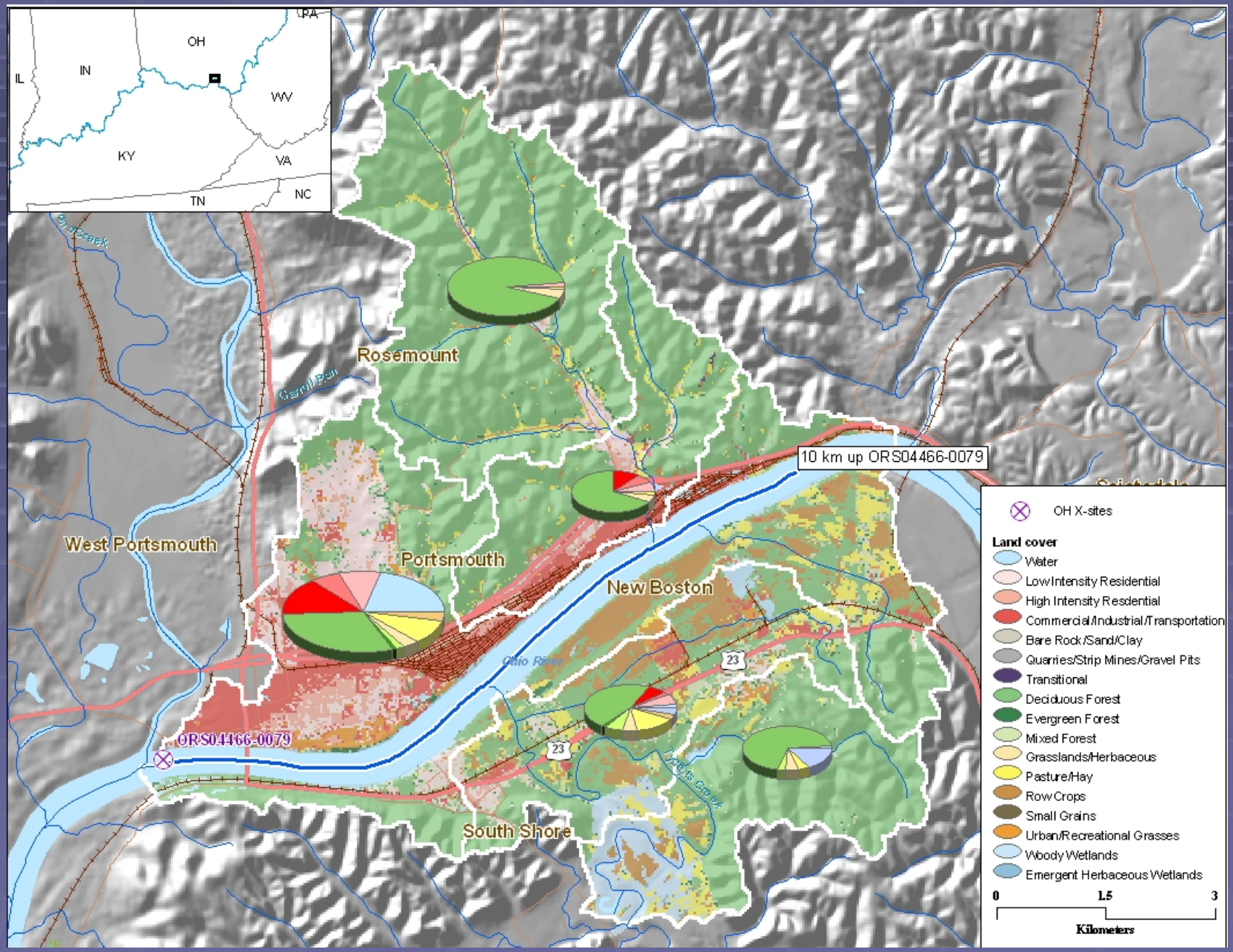
10km Tributary Catchments



Calculate 10km Local Land Cover Metrics



Proximity Analysis of Local Land Cover



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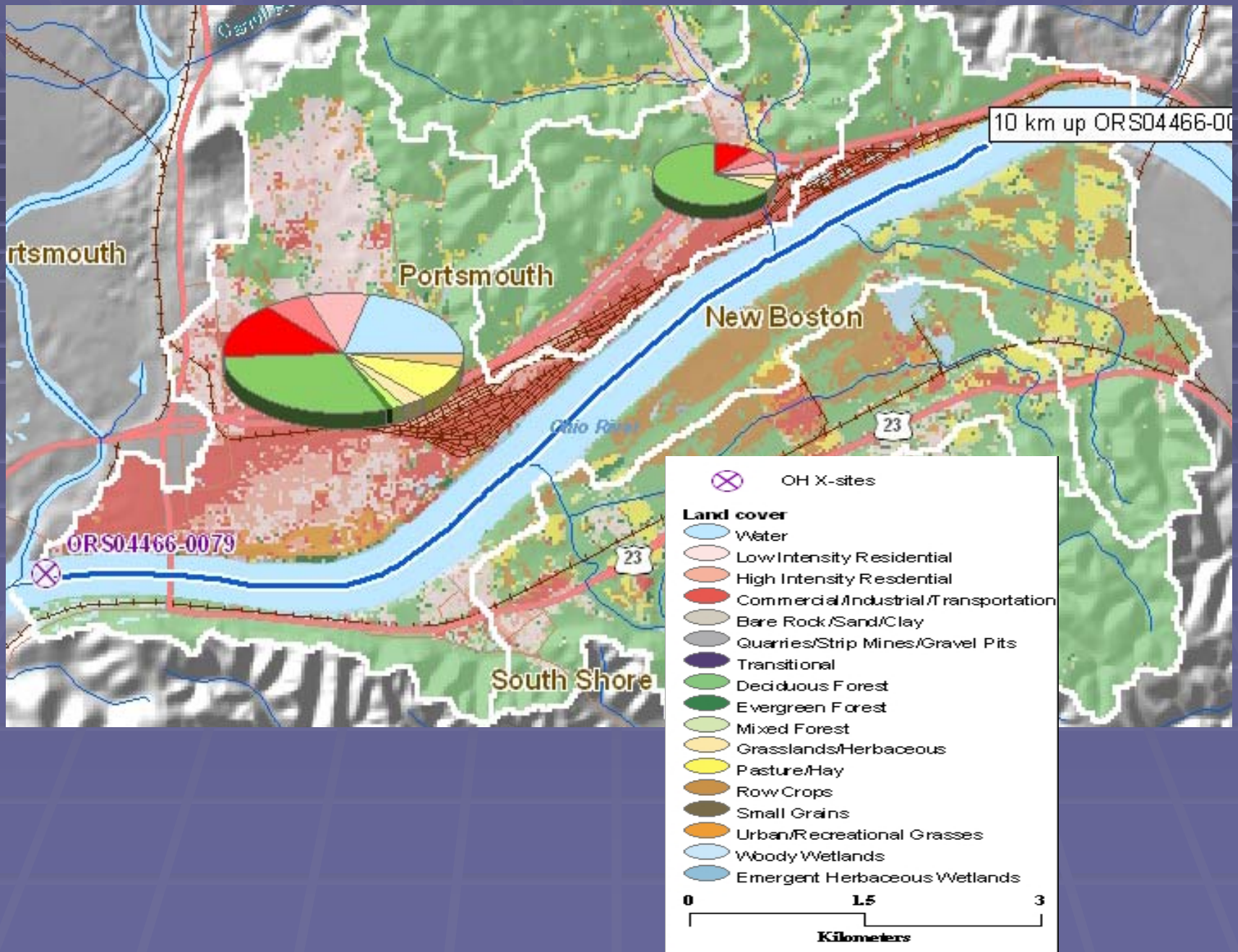
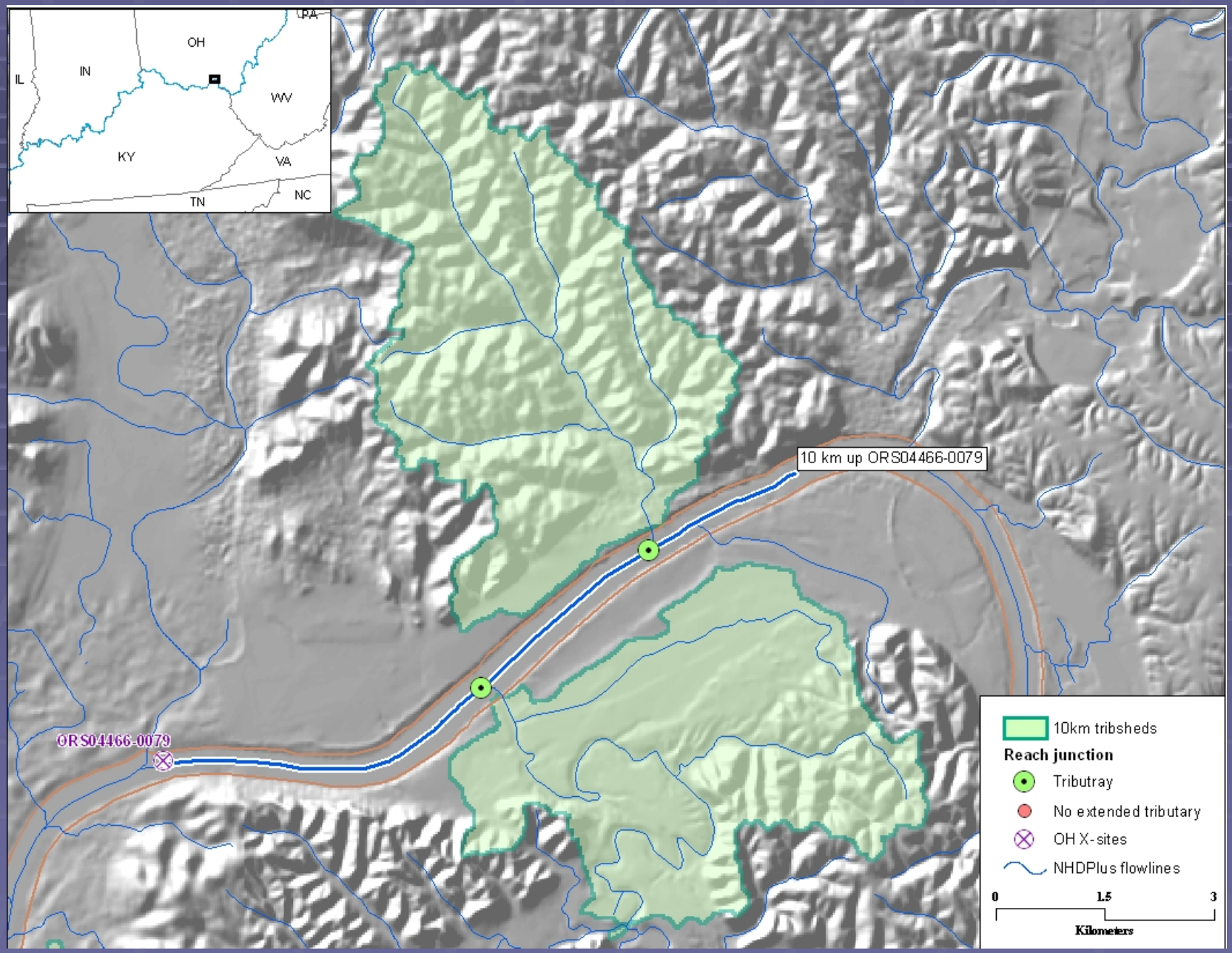


10km Tributary Catchments



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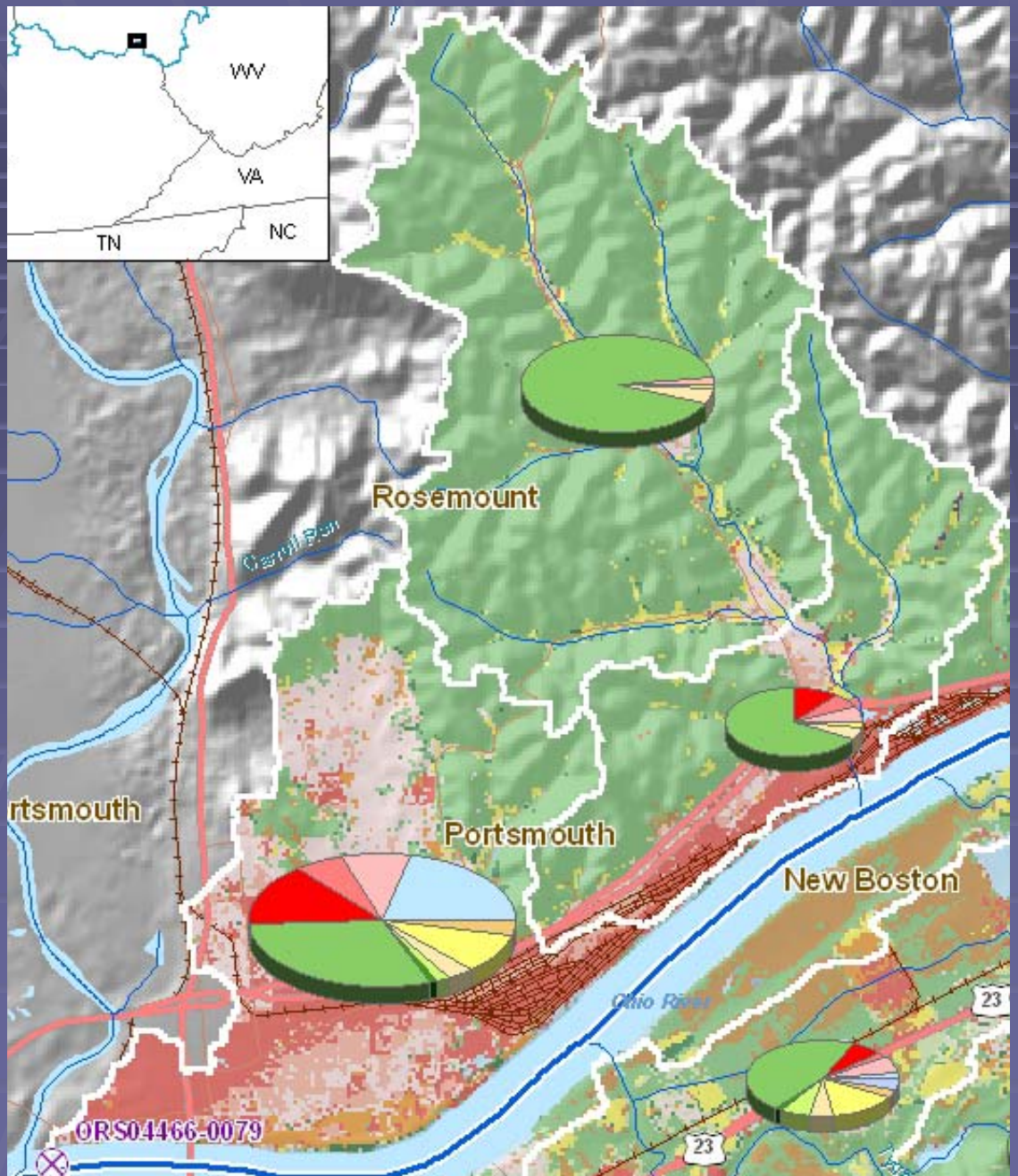


OH X-sites

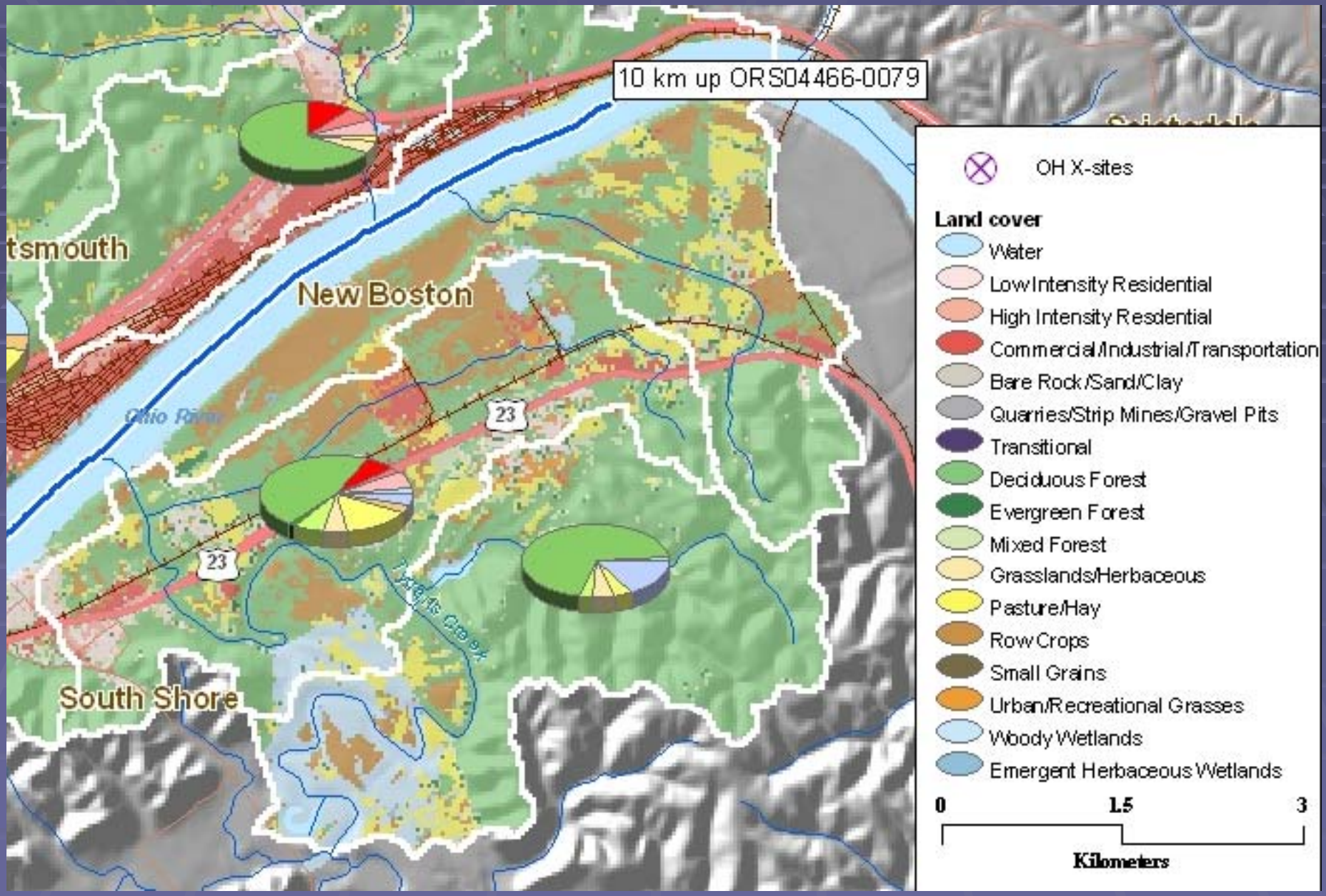
Land cover

- Water
- Low Intensity Residential
- High Intensity Resdential
- Commercial/Industrial/Transportation
- Bare Rock/Sand/Clay
- Quarries/Strip Mines/Gravel Pits
- Transitional
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Grasslands/Herbaceous
- Pasture/Hay
- Row Crops
- Small Grains
- Urban/Recreational Grasses
- Woody Wetlands
- Emergent Herbaceous Wetlands

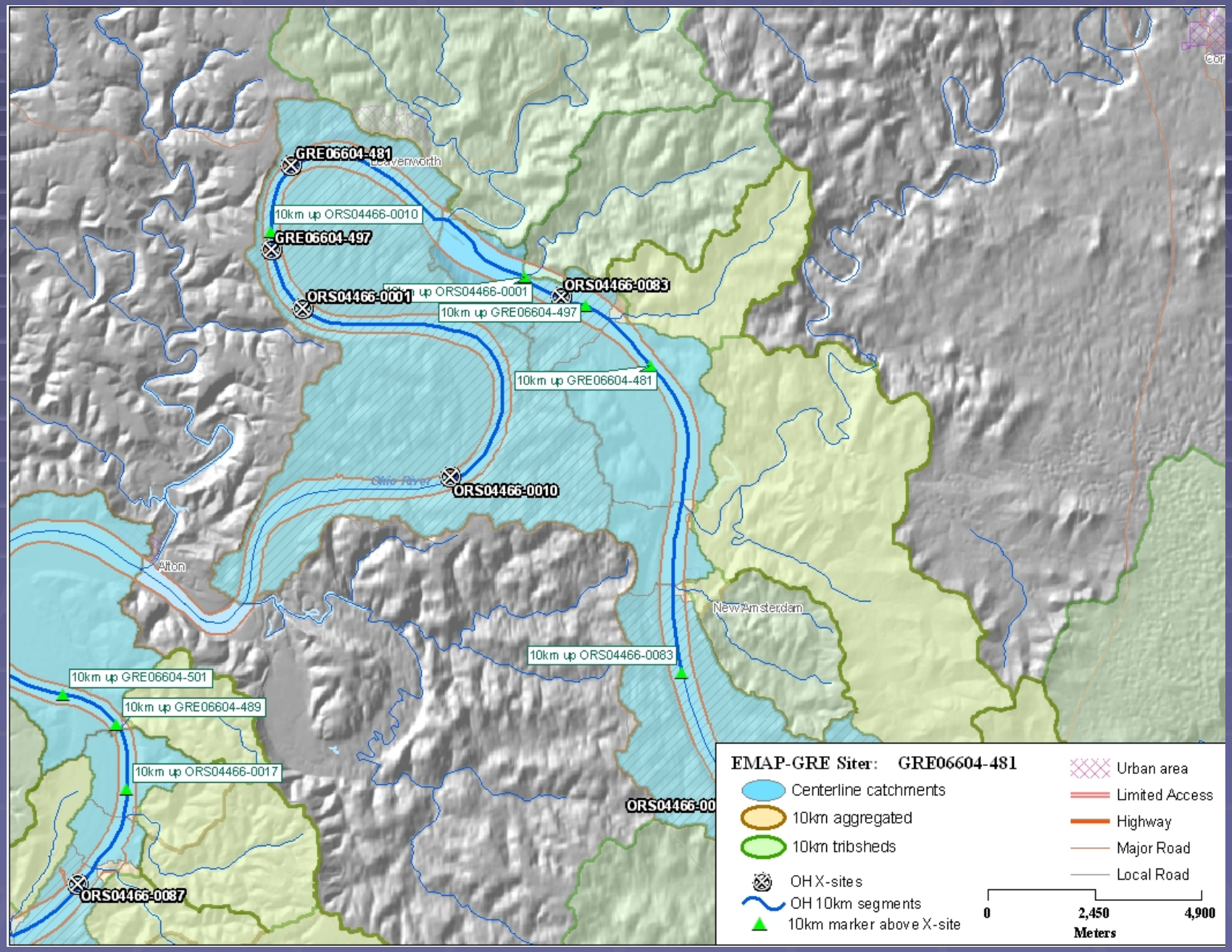
0 1.5 3

Kilometers

Proximity Analysis of Local Land Cover



10km Local Catchments: Ohio River



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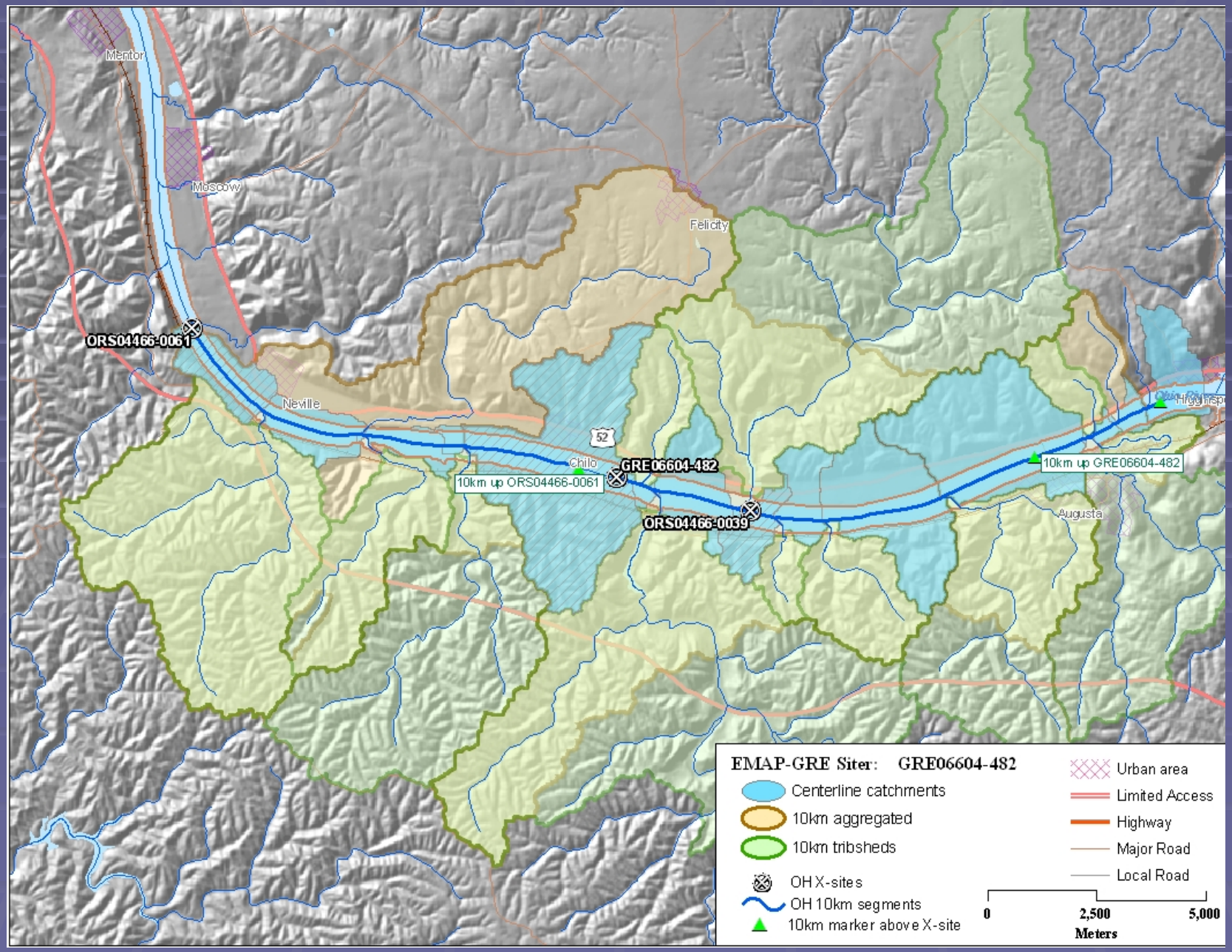

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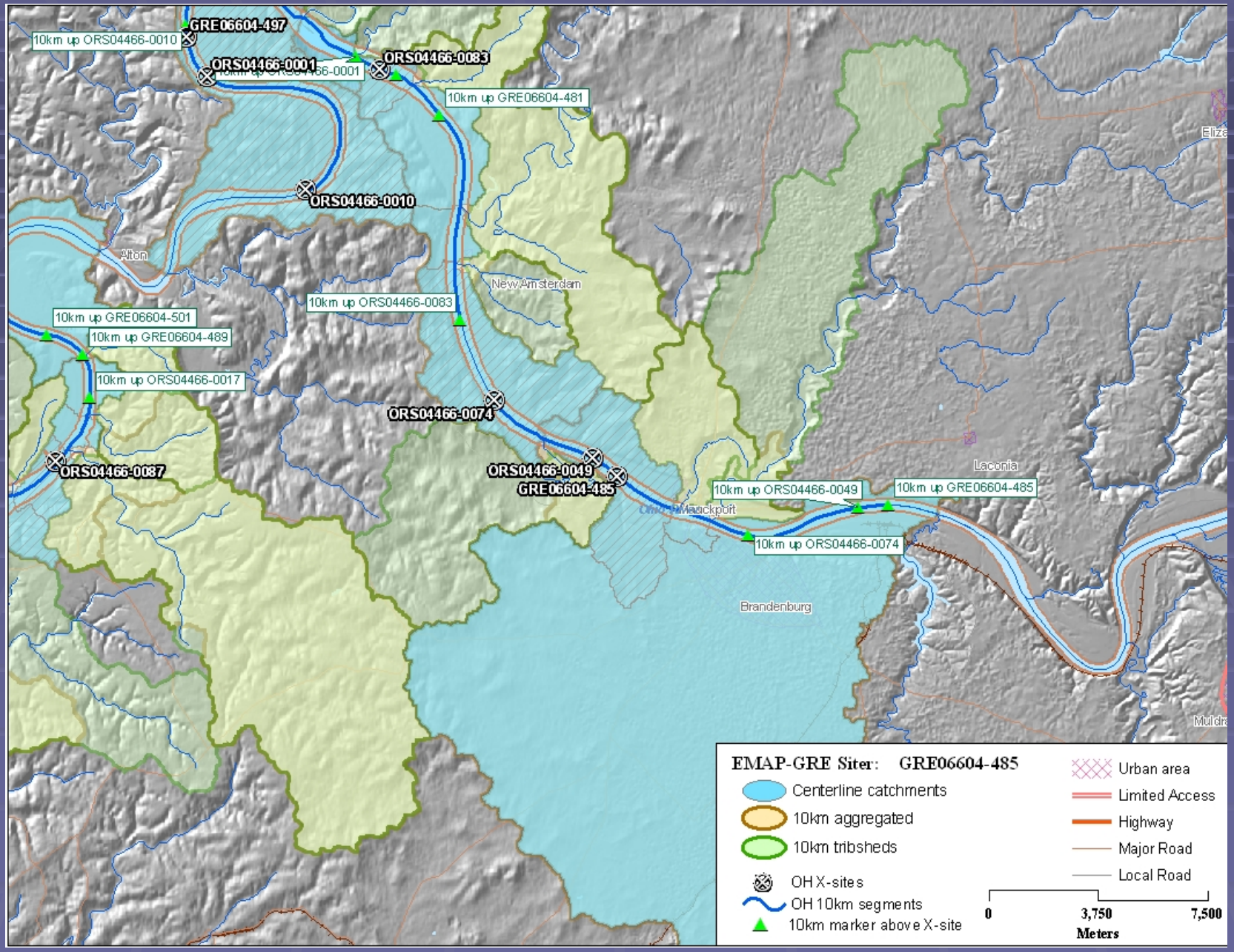
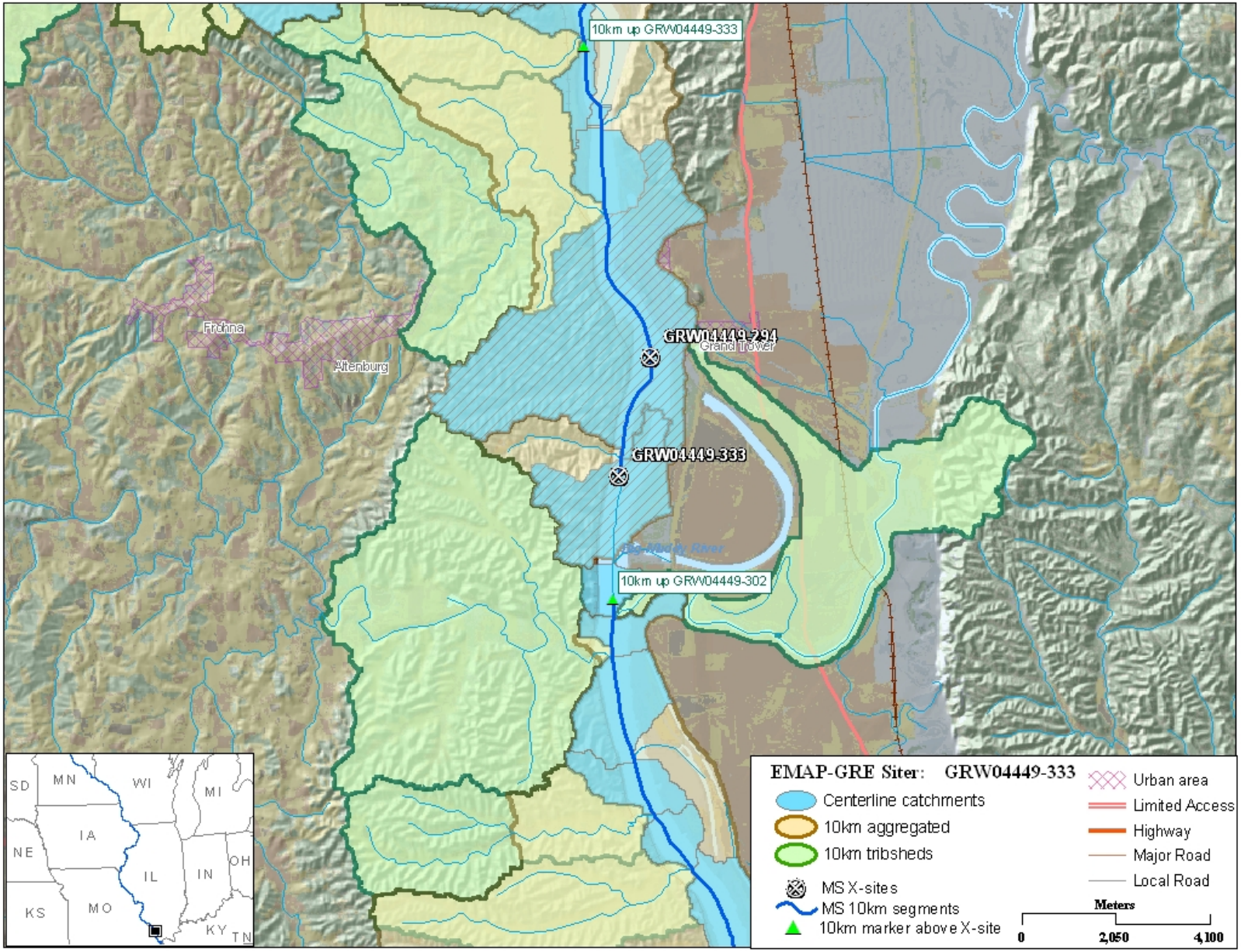


10km Local Catchments: Upper Mississippi River



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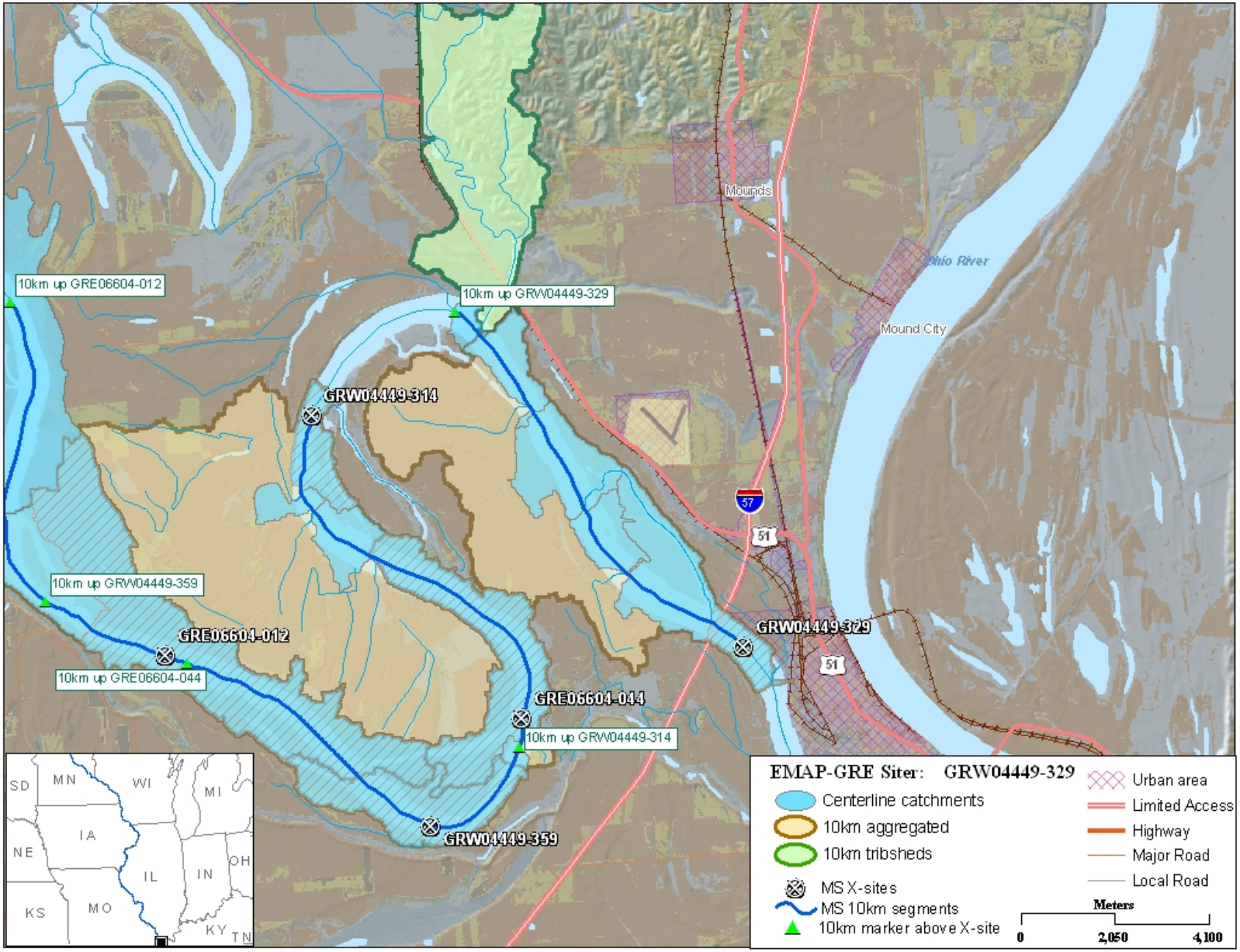

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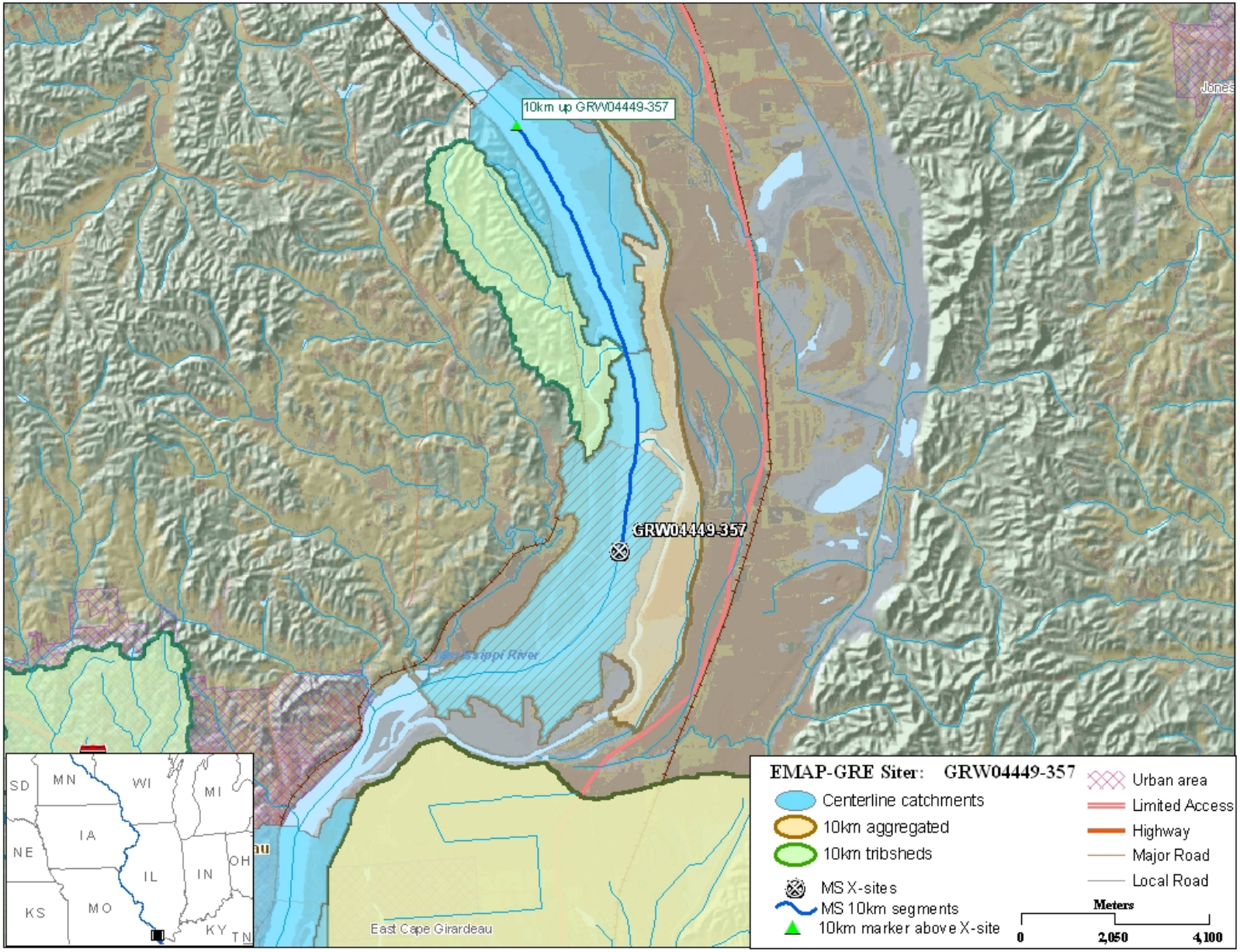

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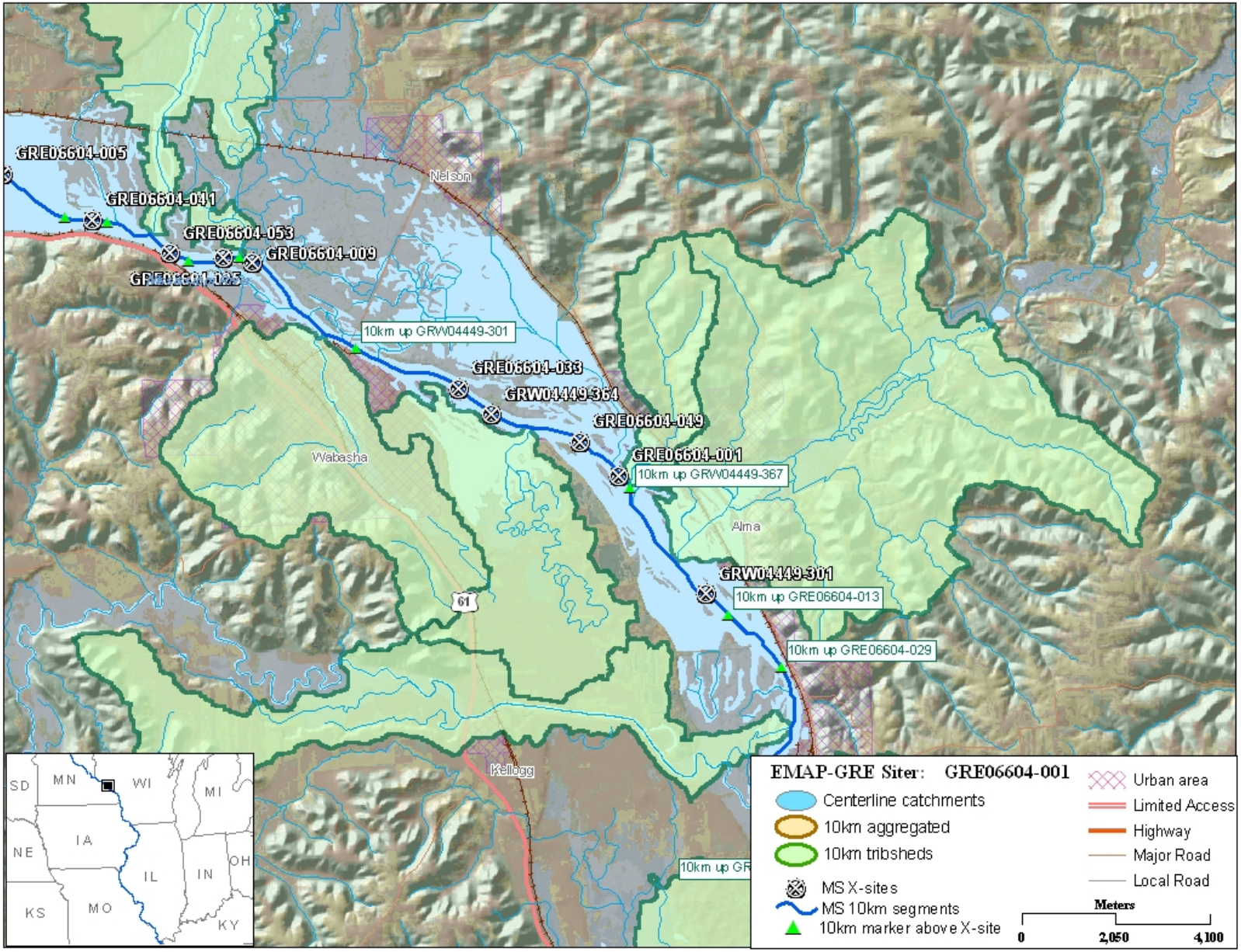

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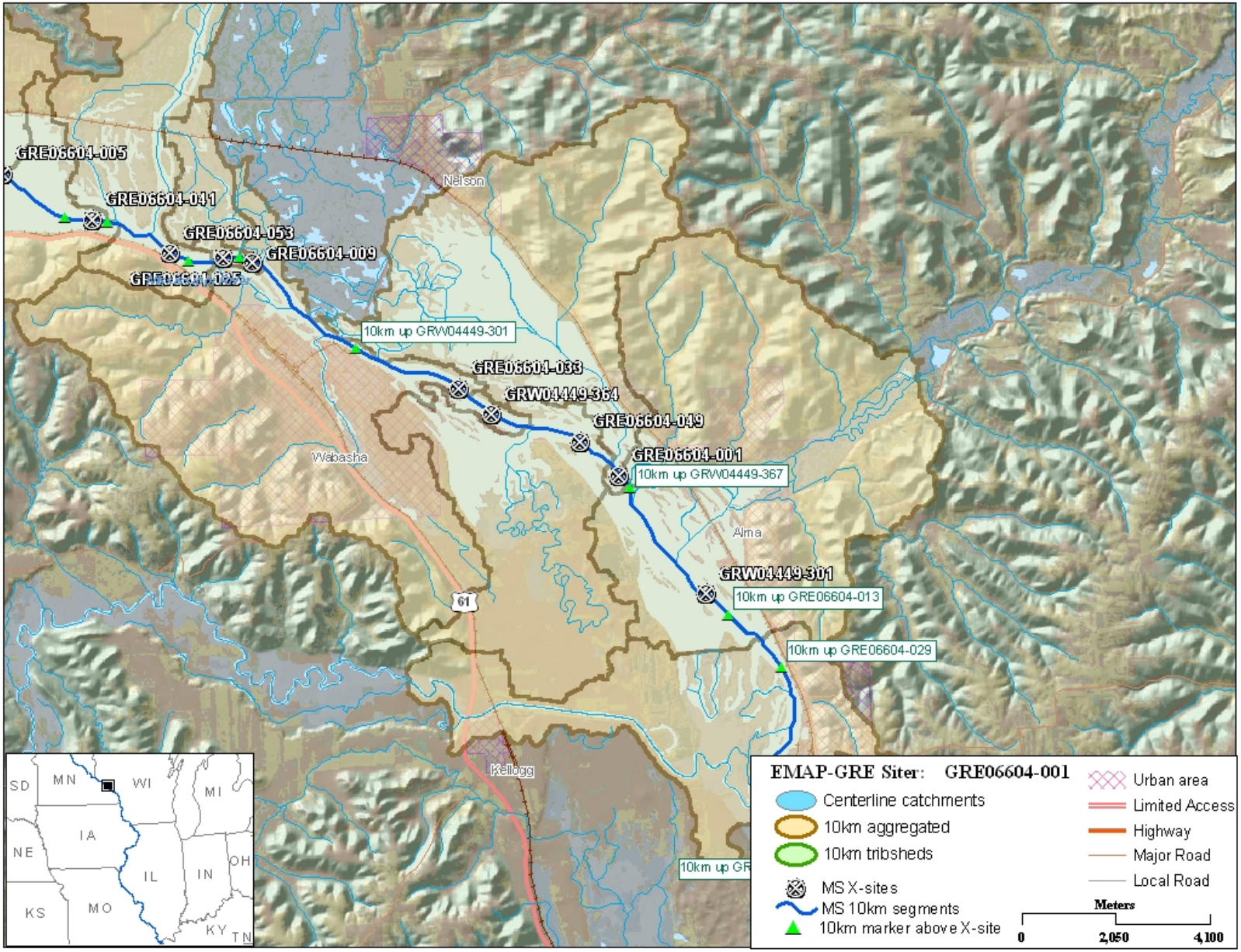

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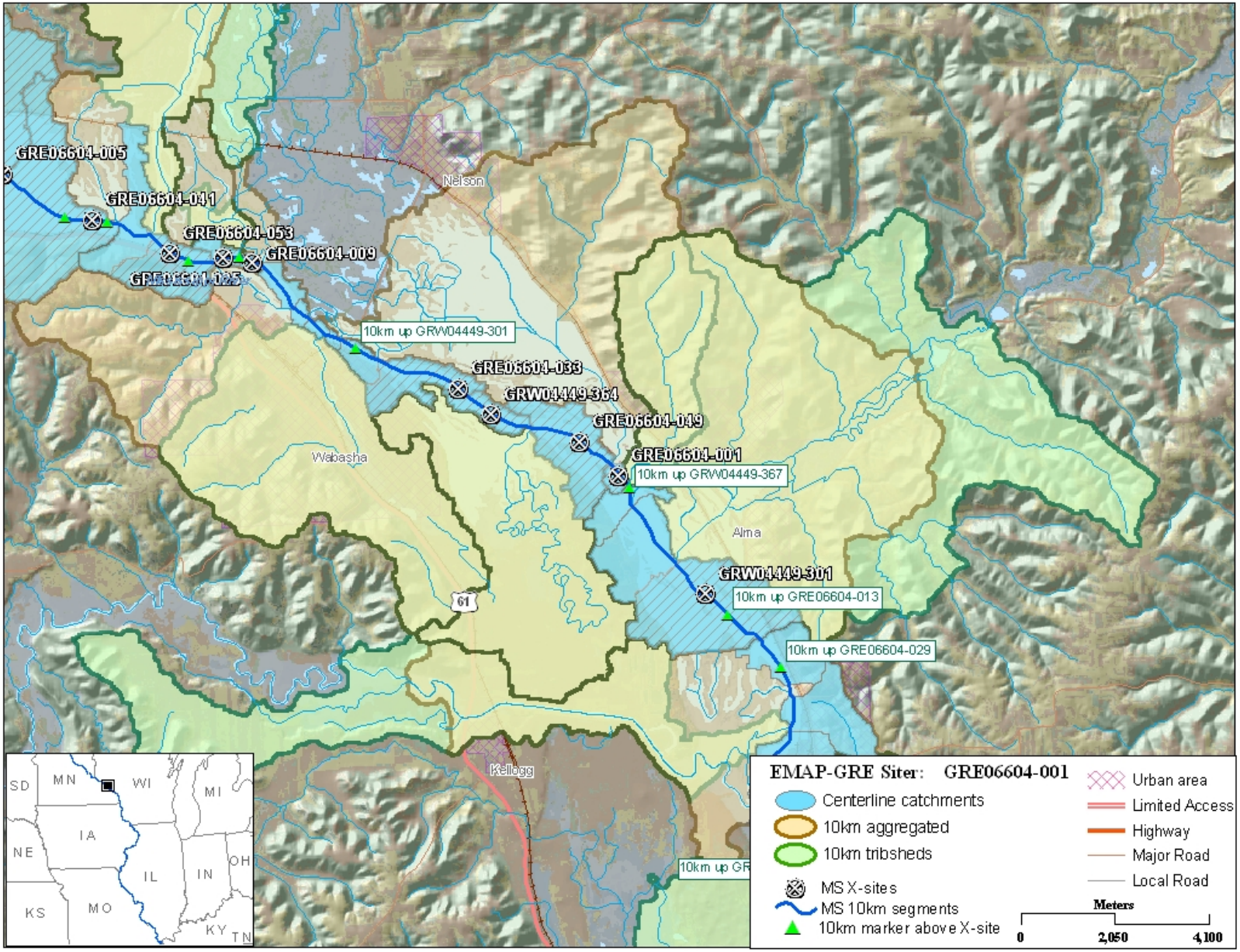

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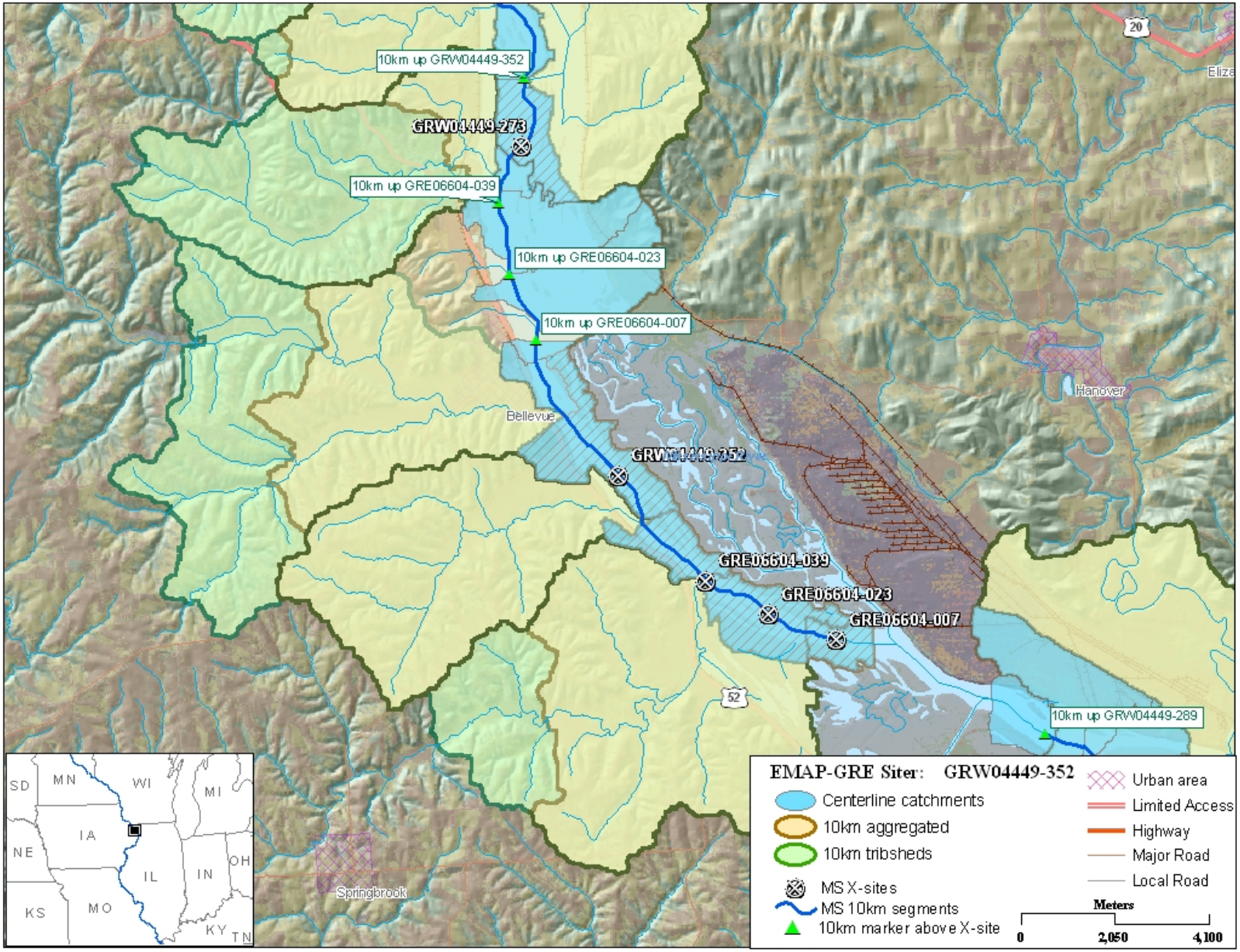

Lansing
Ferryville
10km up GRE06604-002
GRW04449-342
GRE06604-002
10km up GRW04449-349
10km up GRE06604-022
Lynxville
Mississippi River
GRW04449-349
Harpers Ferry
MN
WI
MI
IA
IL
IN
OH
MO
EMAP-GRE Siter: GRE06604-002
Centerline catchments
10km aggregated
10km tribsheds
MS X-sites
MS 10km segments
Urban area
Limited Ac
Highway
Major Roa
Local Roa
Meters

Lansing
Ferryville
10km up GRE06604-002
GRW04449-342
GRE06604-002
10km up GRW04449-349
10km up GRE06604-022
Lynxville
Mississippi River
GRW04449-349
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Local Roa
Meters

Approach

- Determine Areas of Potential Influence for River Sites at Several Scales

Whole Upstream Watershed

↓

Regional

↓

Local (near the River Sites)

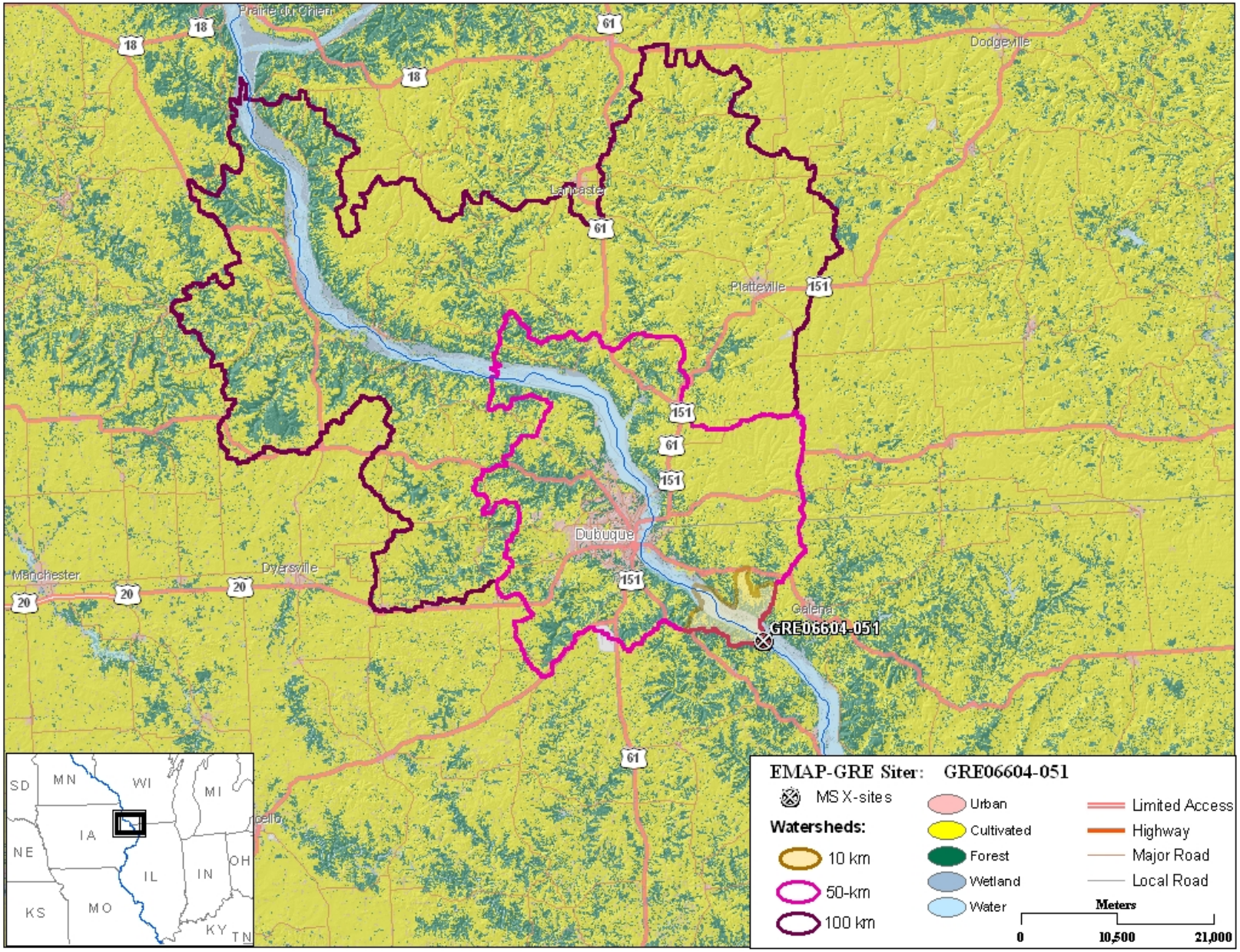
Approach

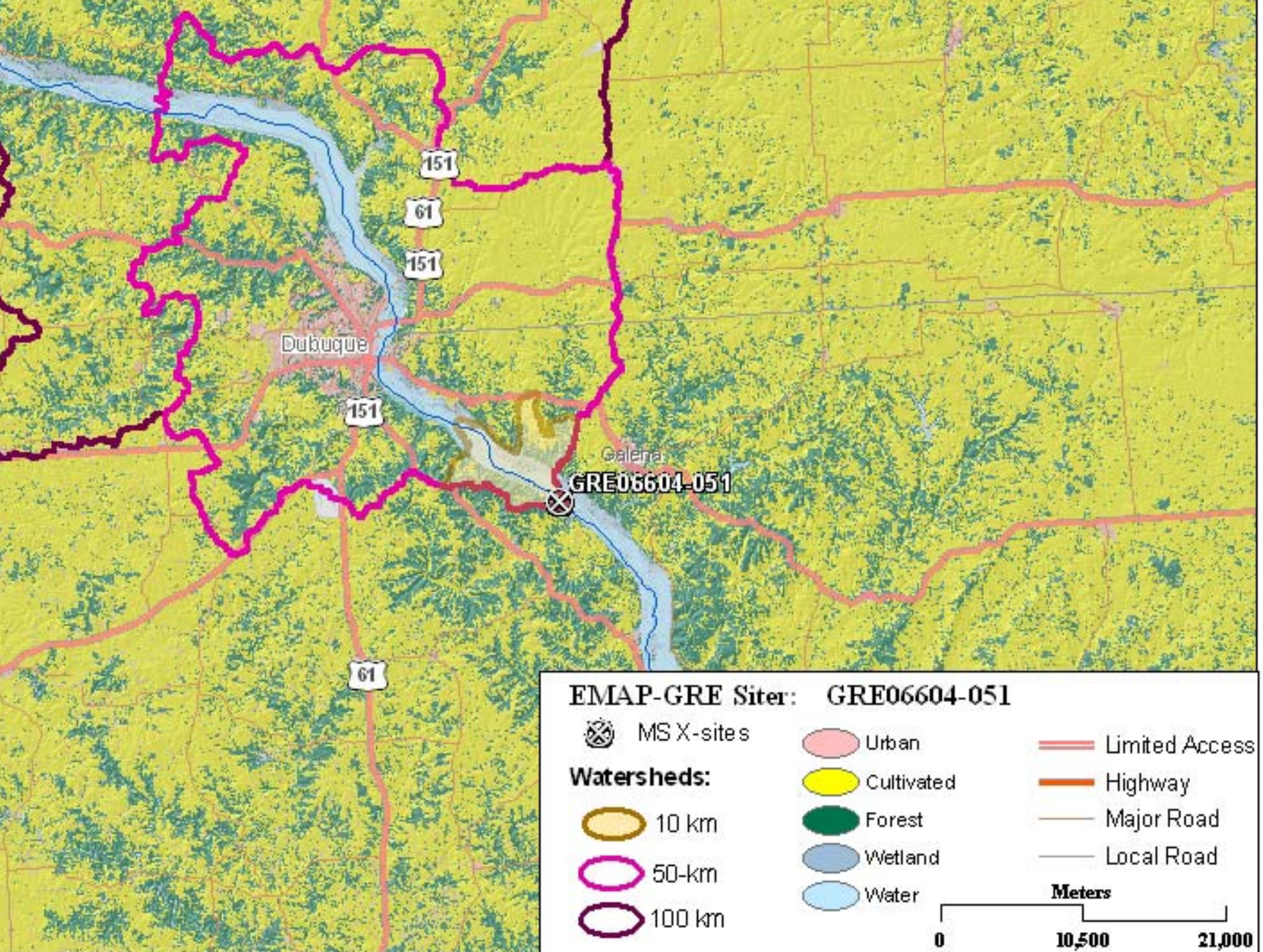
- Regional Scale Area of Influence for River Sites
  - What should this be?
  - How can we produce this in GIS?

Upstream Watershed = Aggregated Upstream Catchments

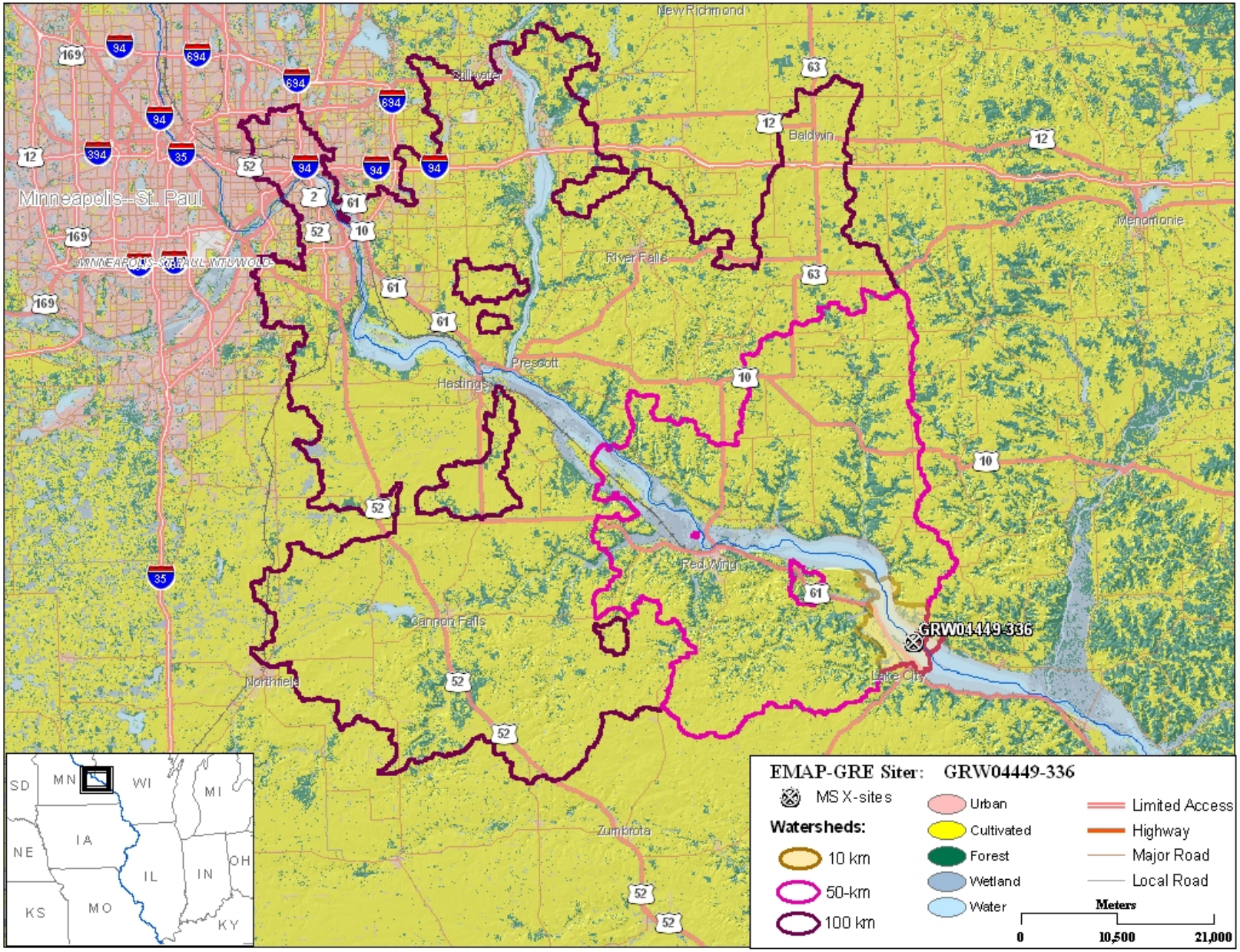
- Delimiter: 50km and 100km Distance from Site by Flowlines

50km and 100km Upstream Watersheds

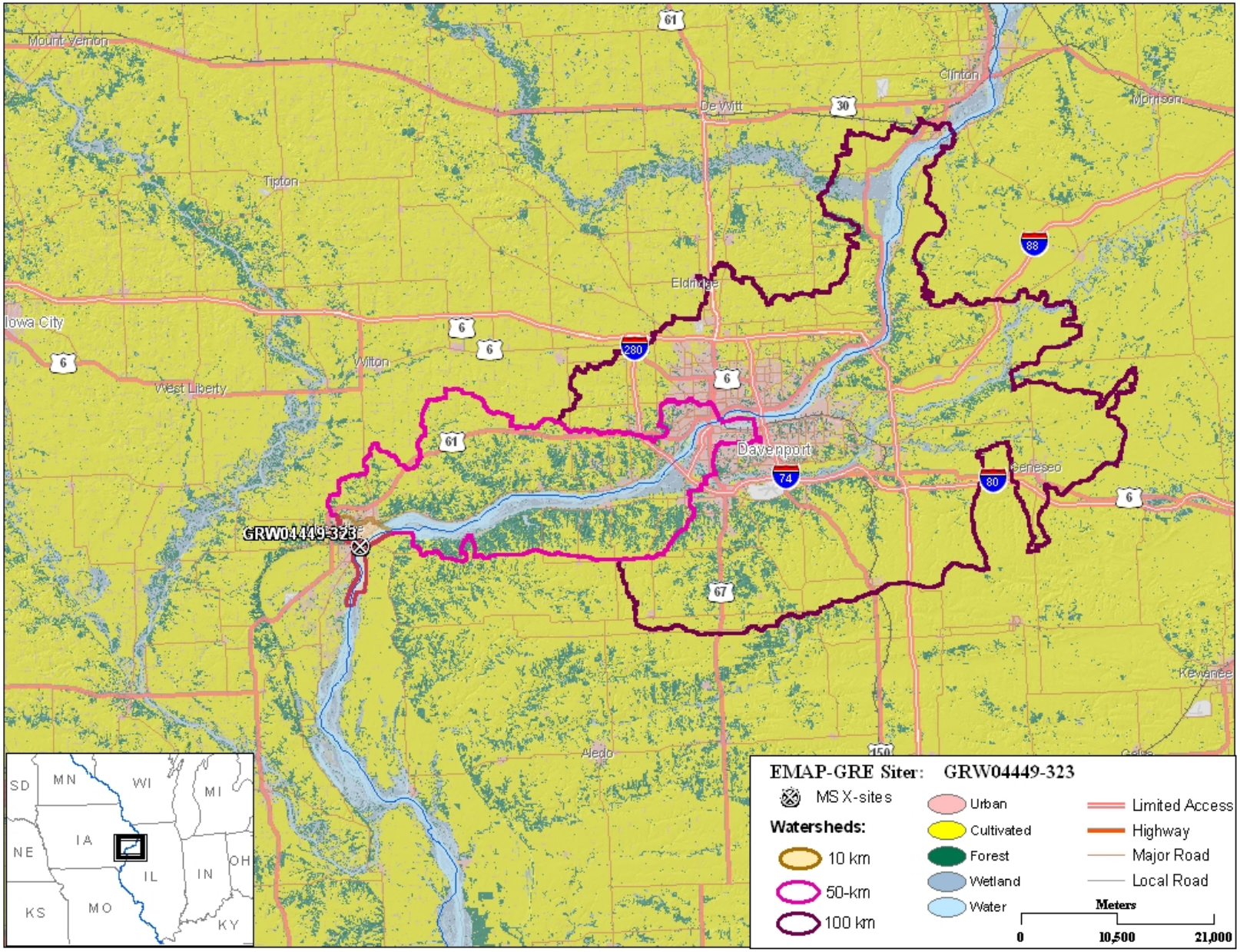


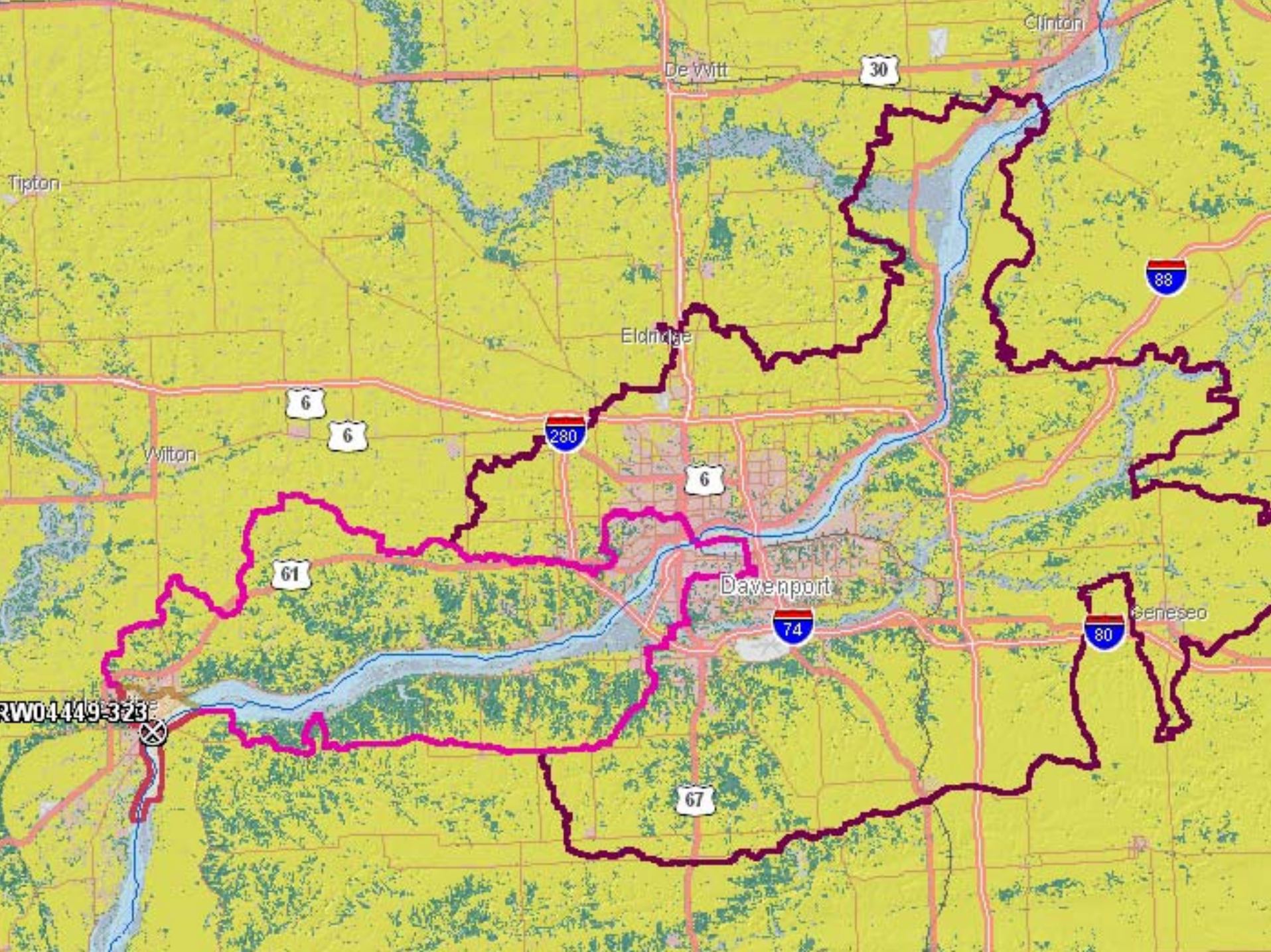

151
61
151
Dubuque
151
Galena
GRE06604-051
61
EMAP-GRE Siter: GRE06604-051
MS X-sites
Watersheds:
10 km
50-km
100 km
Urban
Cultivated
Forest
Wetland
Water
Limited Access
Highway
Major Road
Local Road
Meters
0
10,500
21,000

50km and 100km Upstream Watersheds

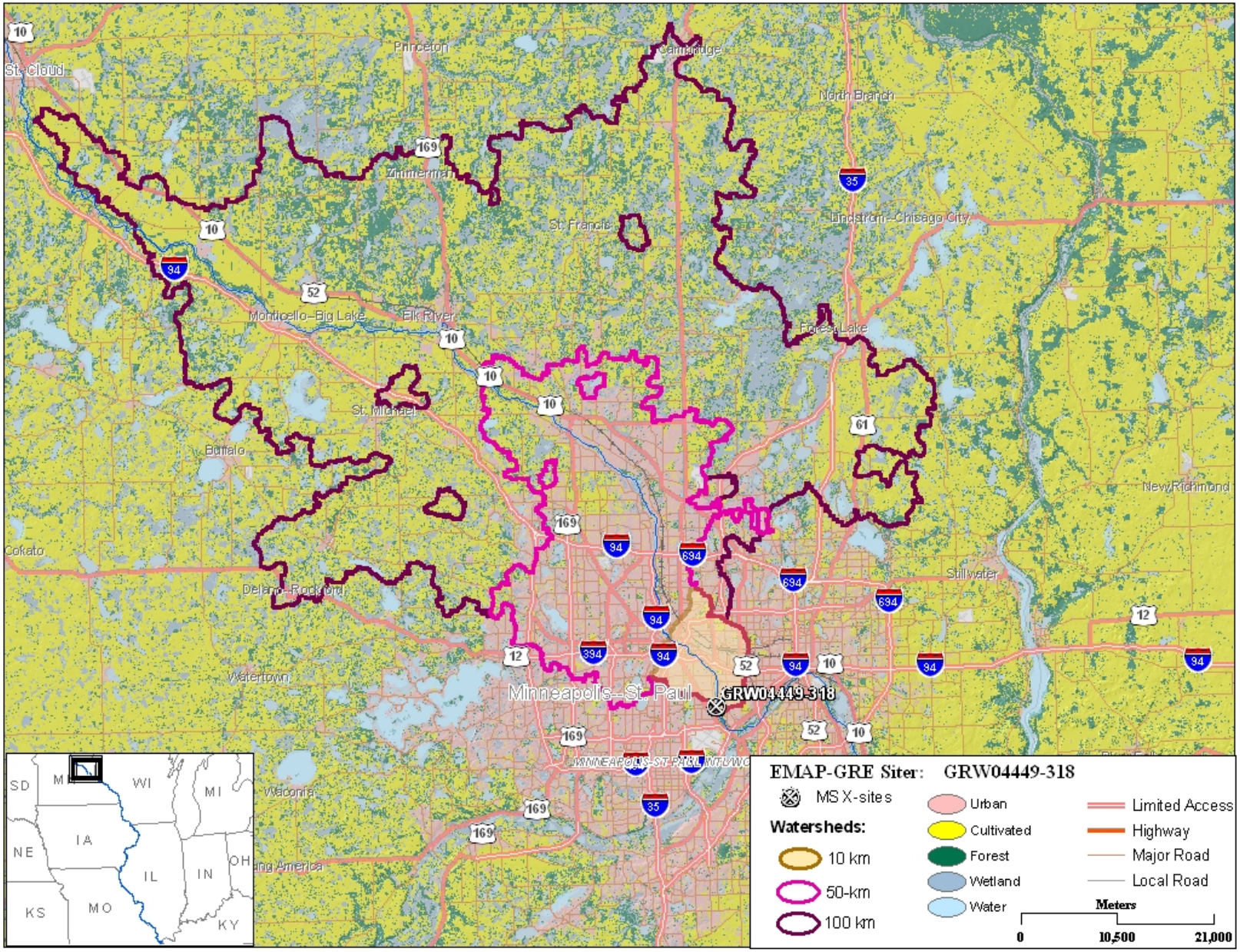


50km and 100km Upstream Watersheds

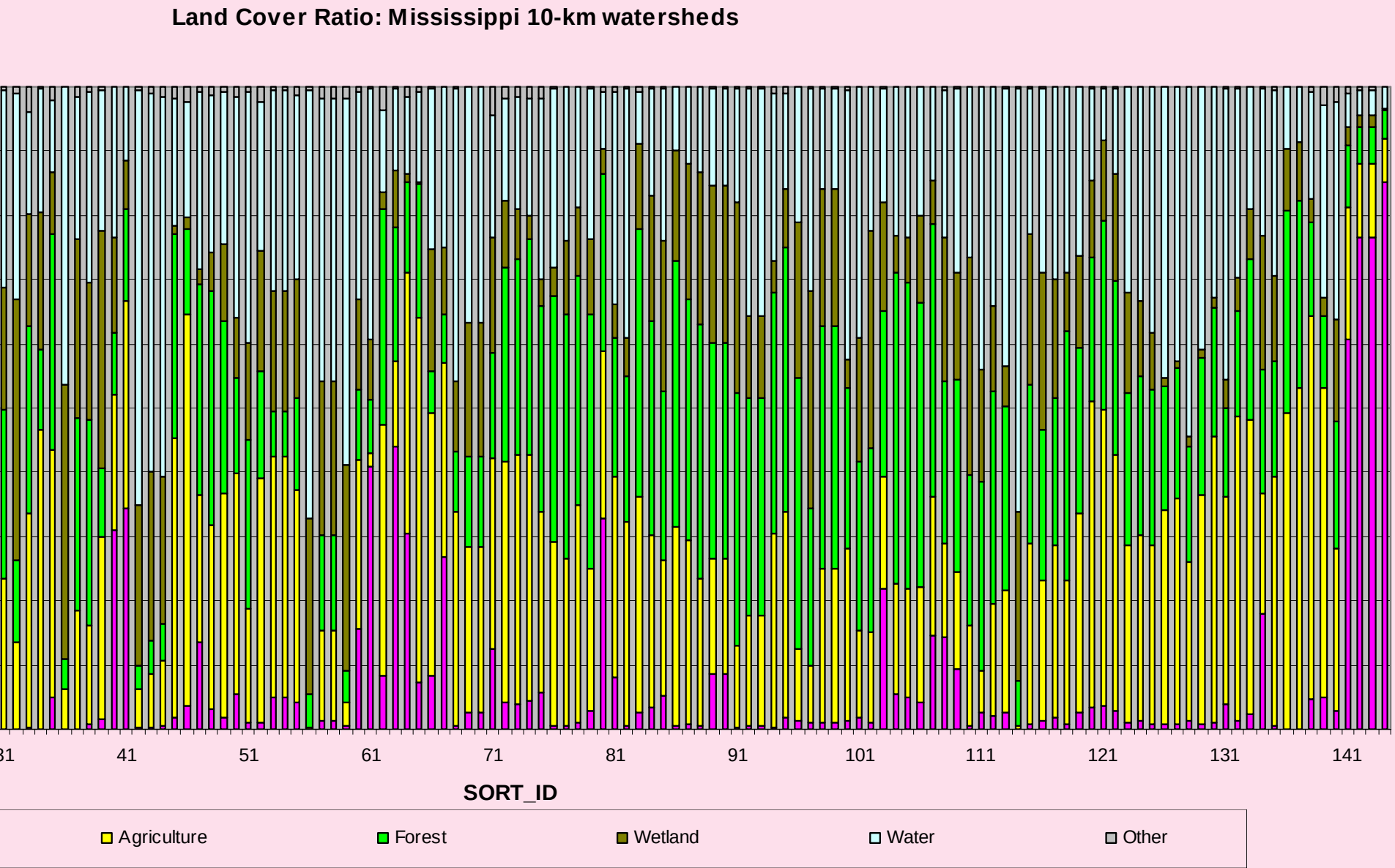



Clinton
De Witt
30
Tipton
88
Eldridge
6
6
280
Wilton
6
61
Davenport
74
Geneseo
80
RW04449-3235
67

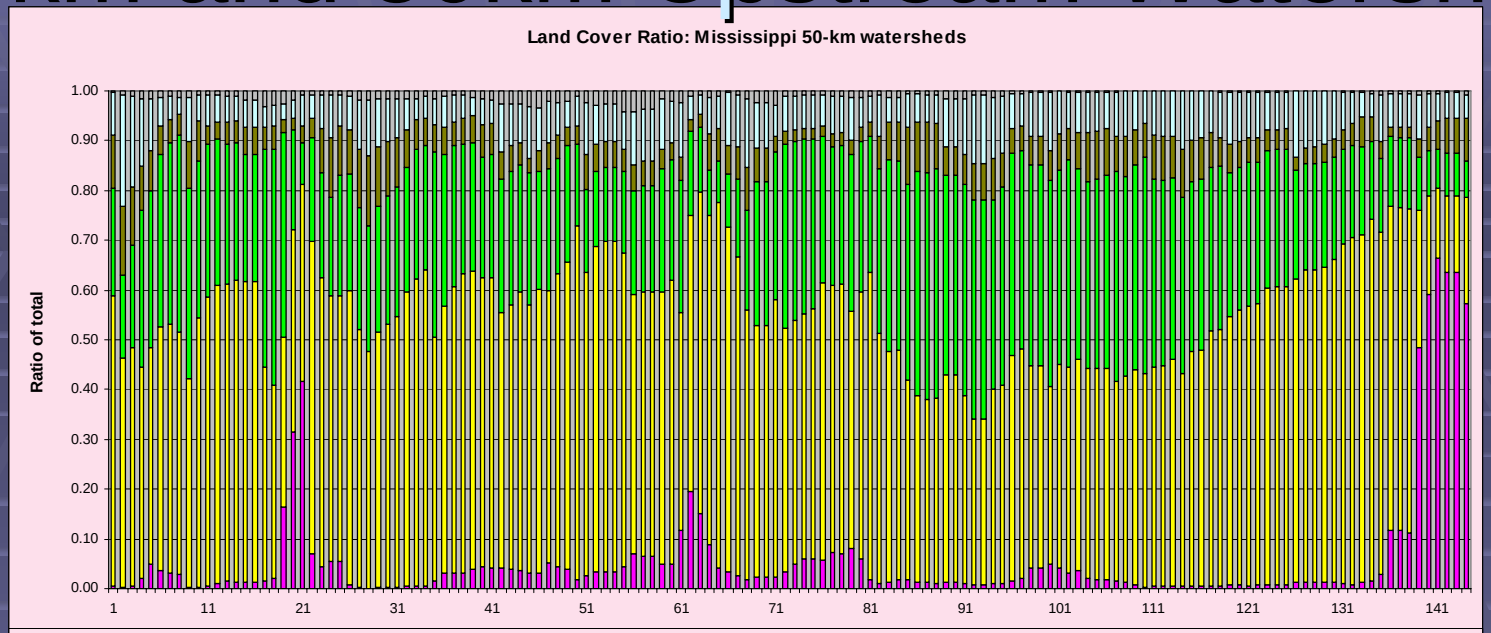
50km and 100km Upstream Watersheds

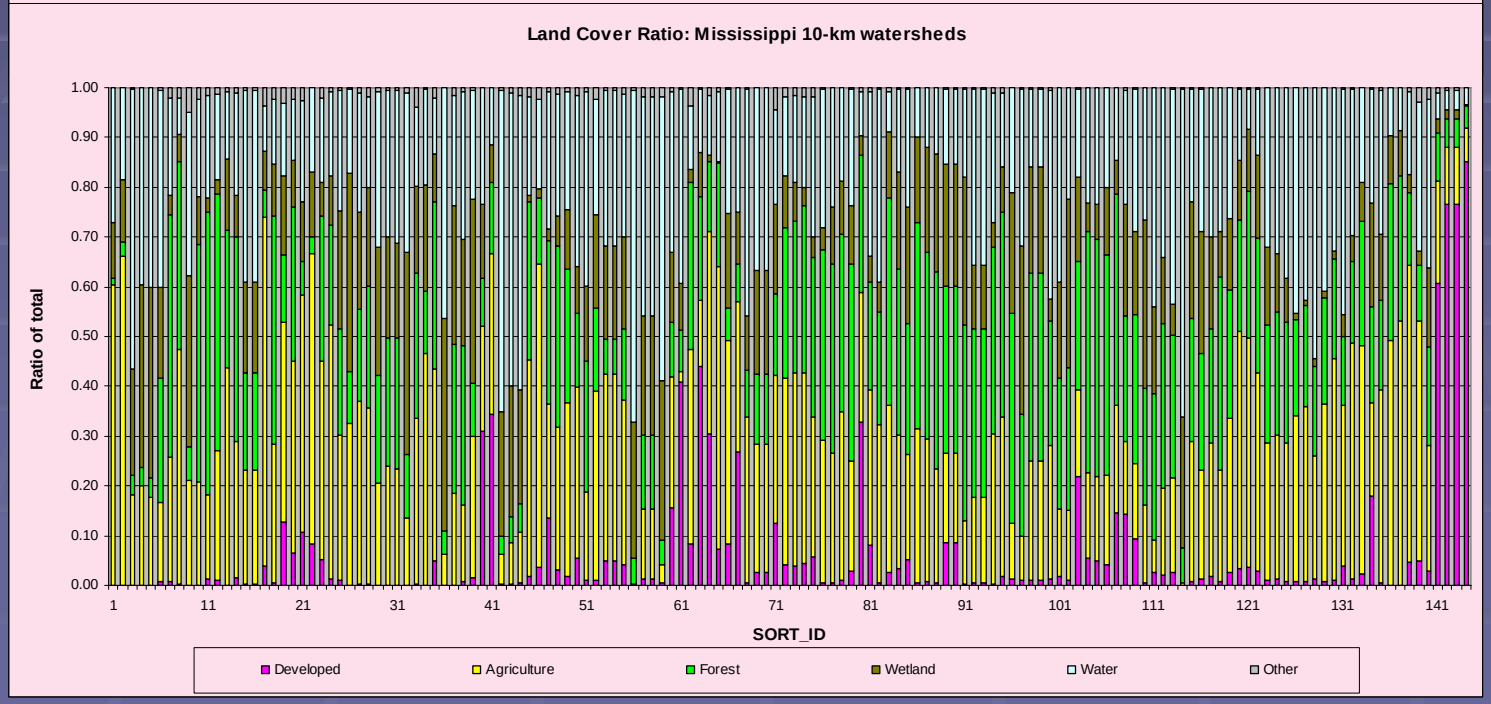


10km Local Watershed Land Cover

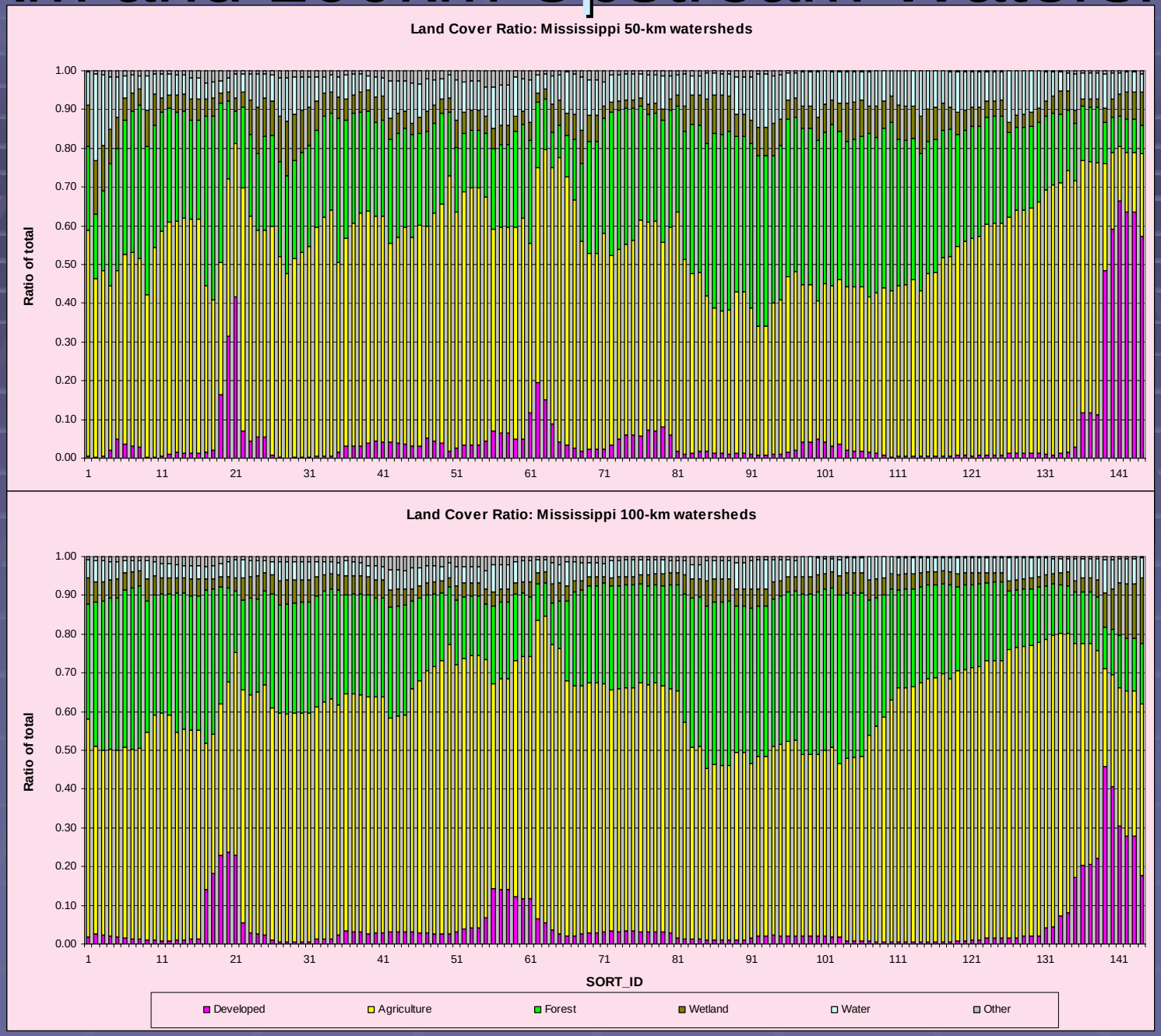


10km and 50km Upstream Watersheds



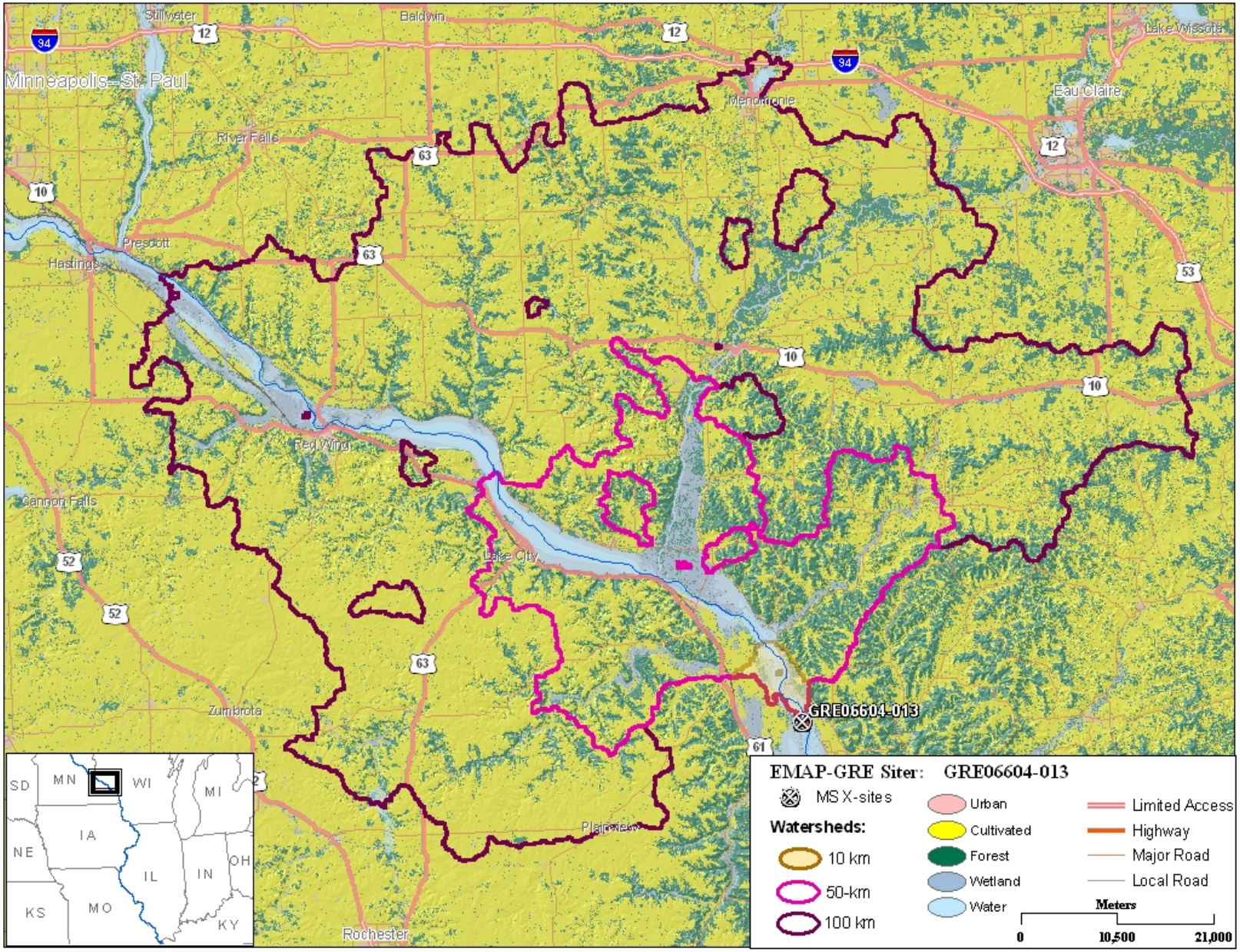


50km and 100km Upstream Watersheds

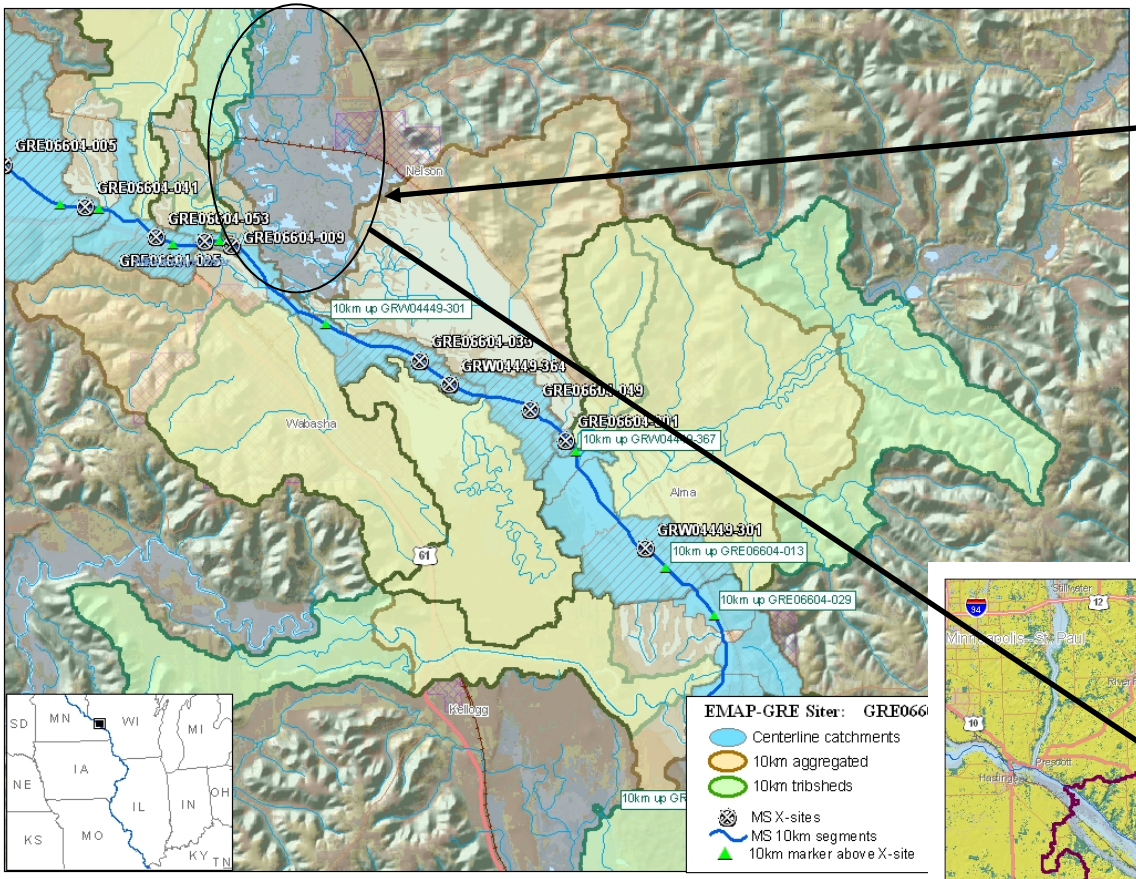


NHD Plus: Problems to resolve

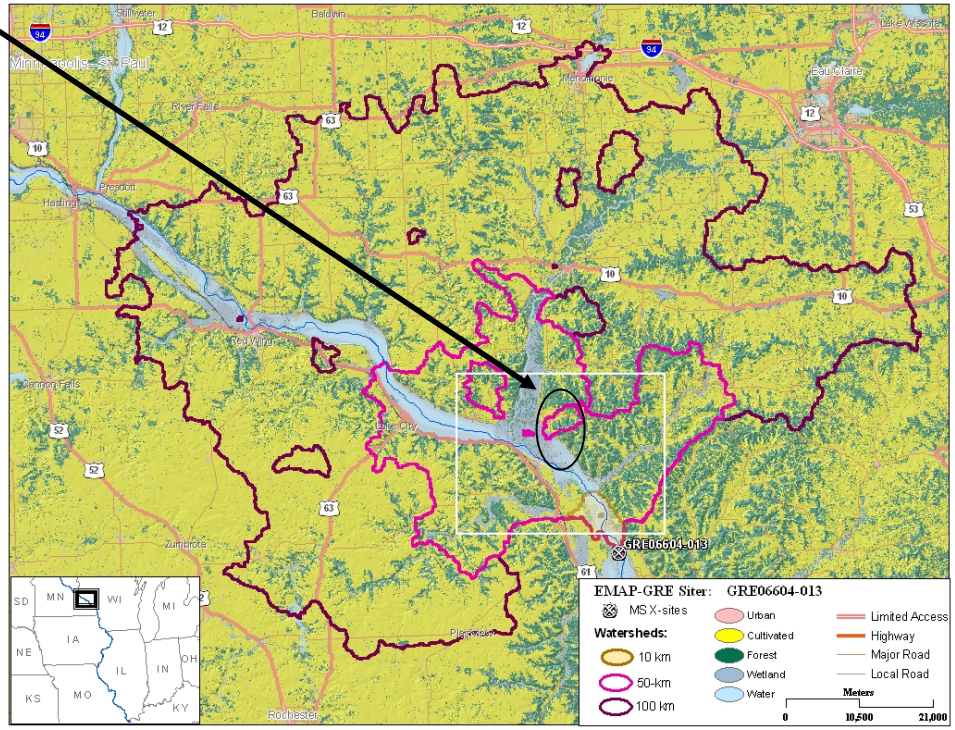
50km and 100km Upstream Watersheds



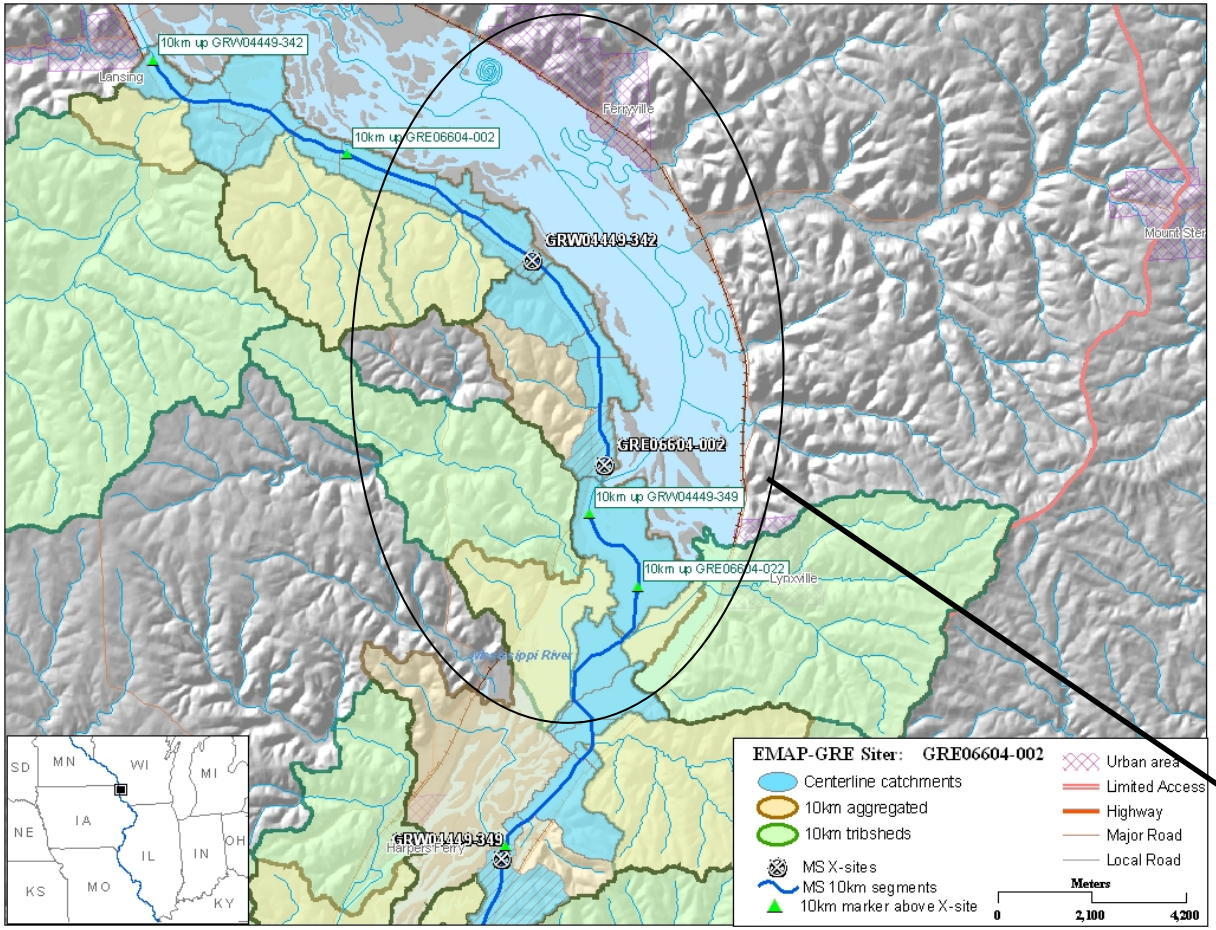
Flowlines not Connected

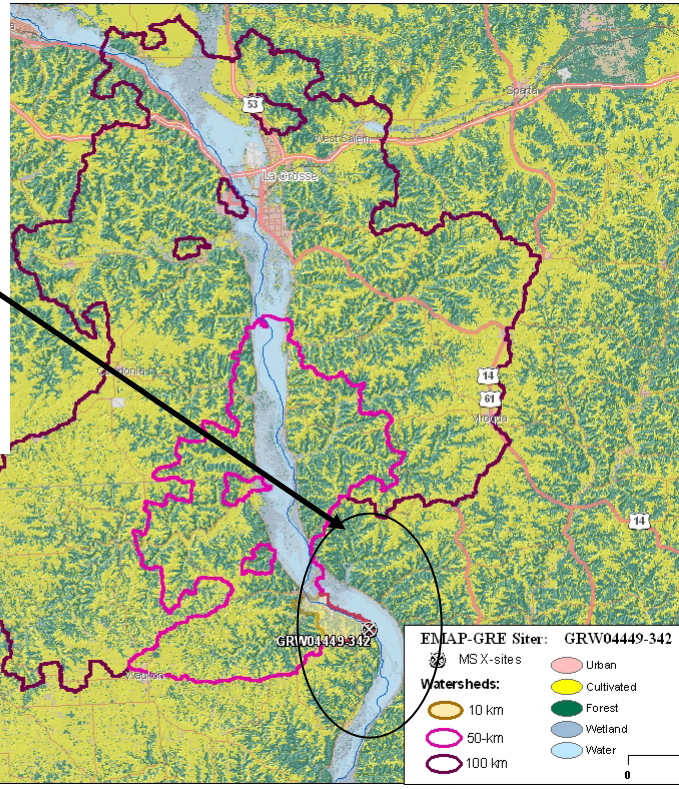


Catchments Excluded



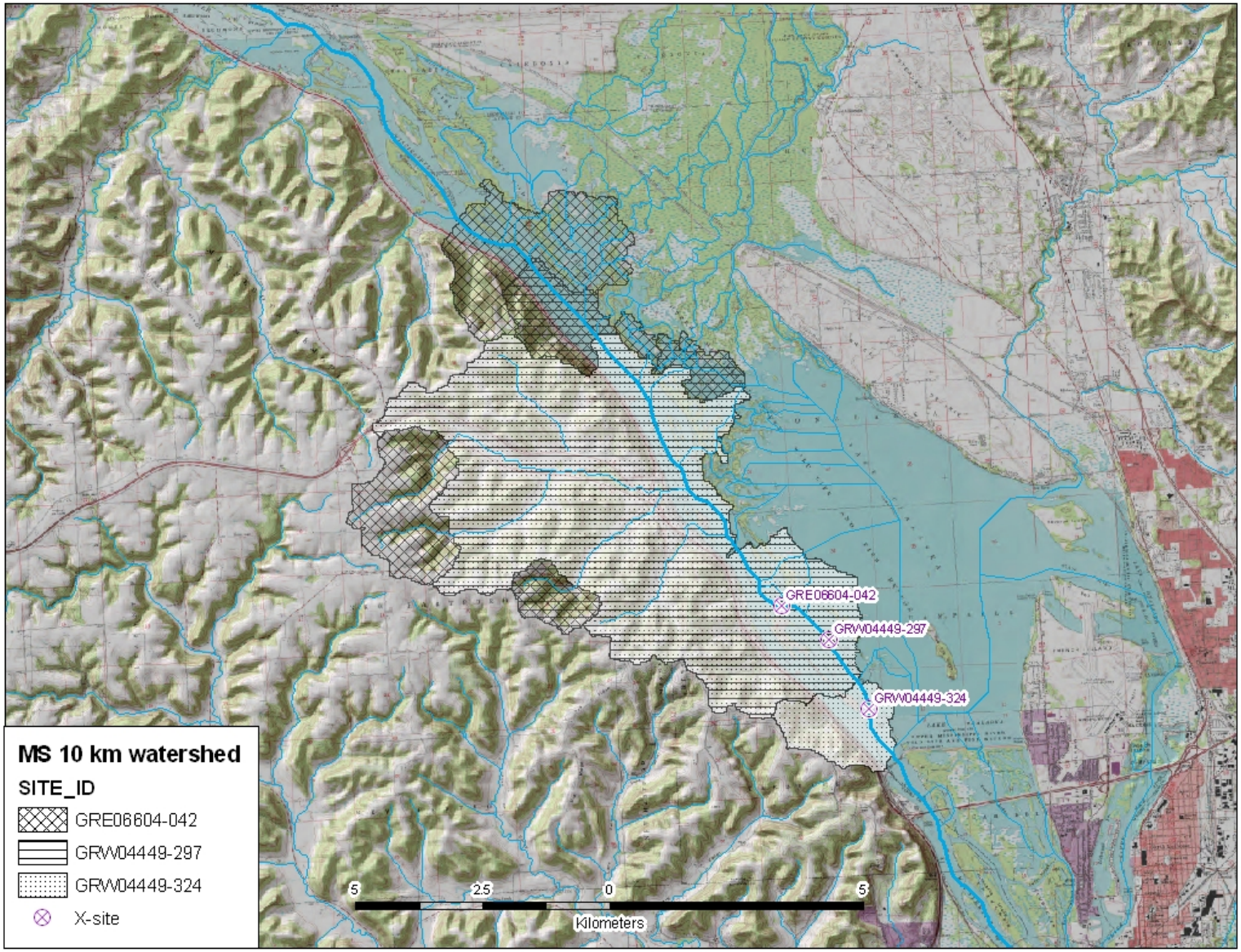
Flowlines not Connected





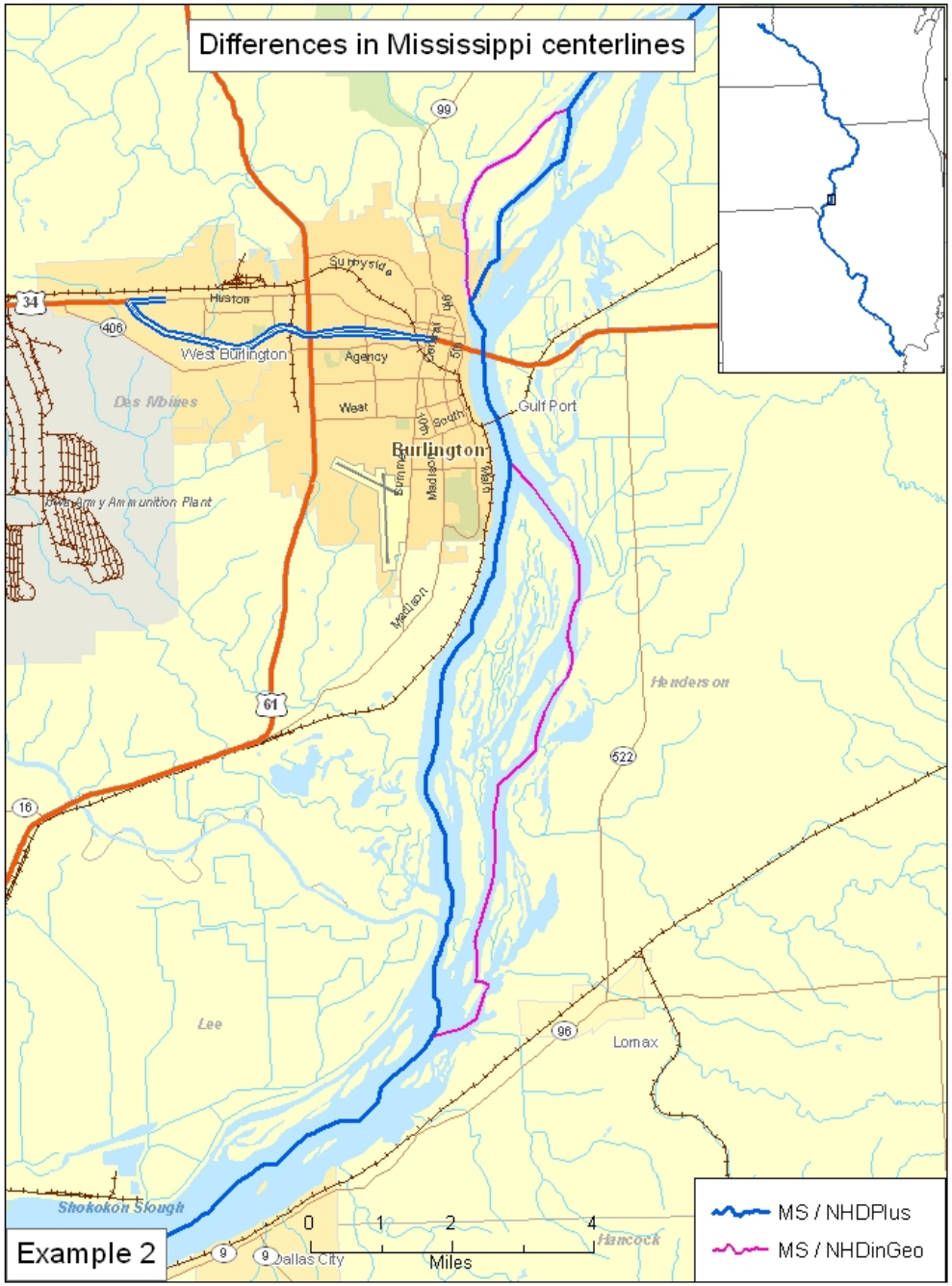
Catchments Excluded

How to Identify and Separate Local Watersheds in Highly Braided Areas?



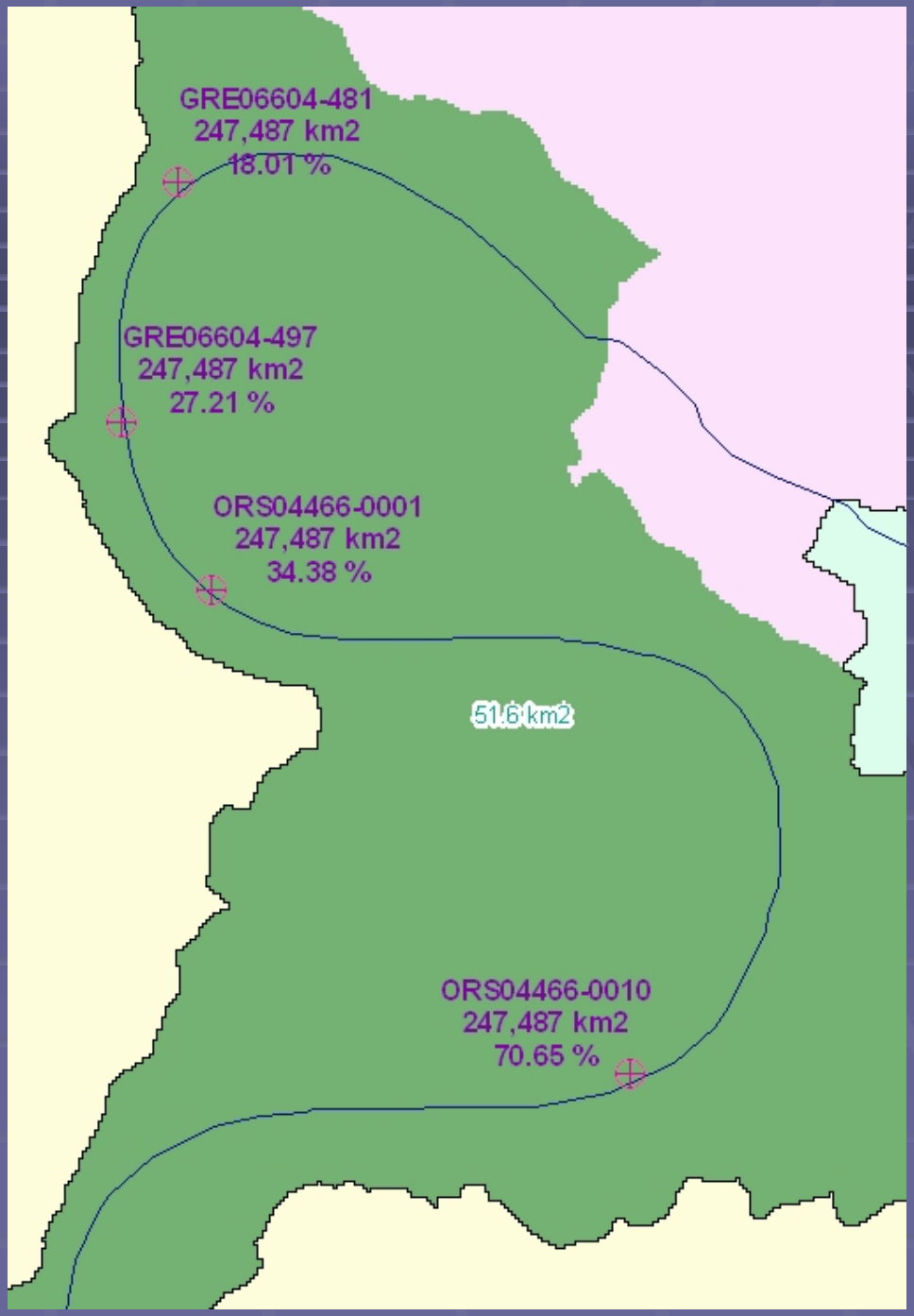
Centerline Differences NHDPlus vs NHDinGeo

(used for the reference site selection process)



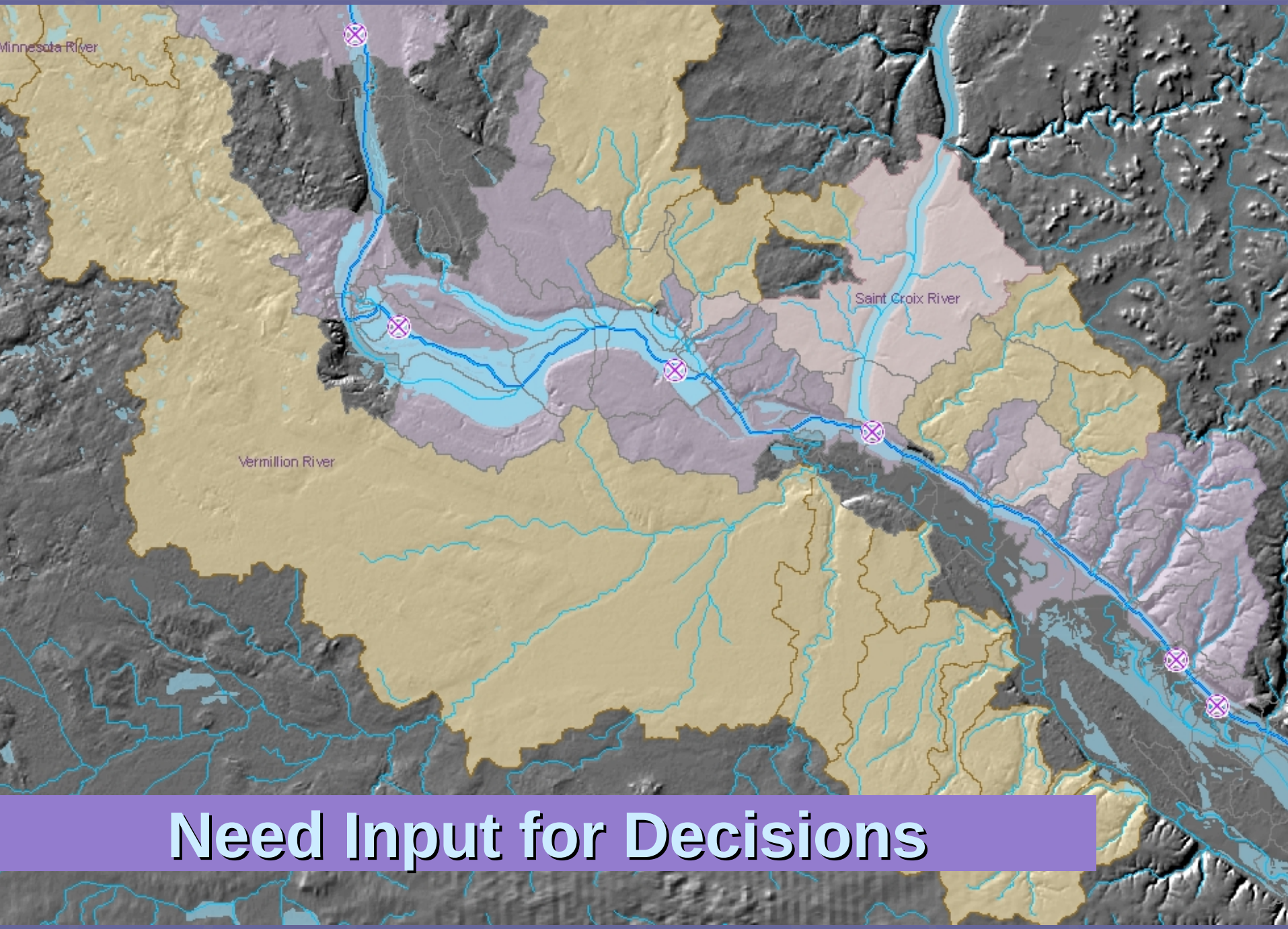
NHD Plus Local Catchment Area with Several GRE Sites

- Areal (km^2) estimates were divided as percentage of reach length.
- But, how do we divide the catchment geometry?



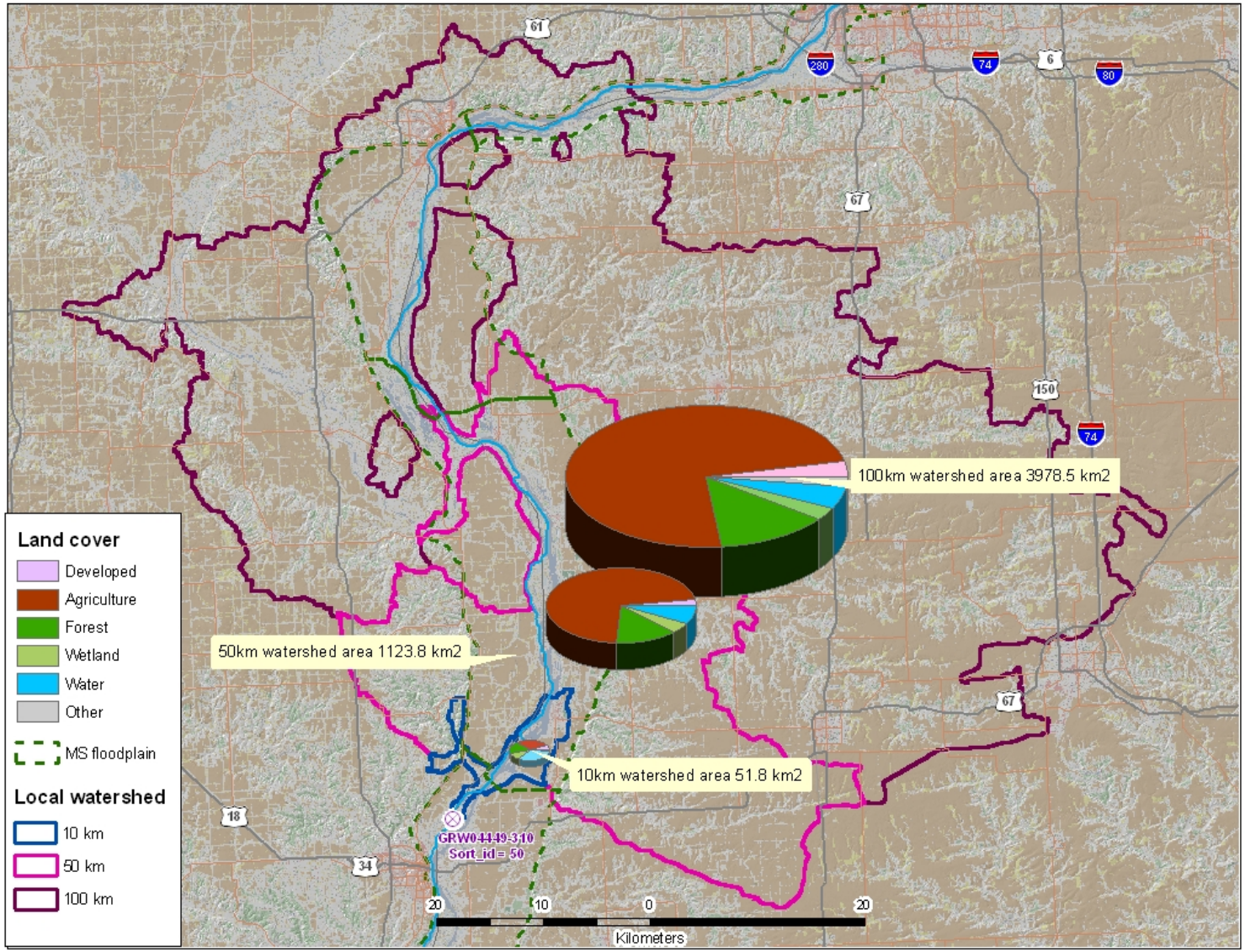
- Local watersheds may require adjustments to incorporate regional differences in river width and floodplain configuration.

- Automated GIS methods are preferred, but manual inspection for making these decisions will be necessary.



Need Input for Decisions

Goal Remains:
to link geometry to landscape



Currently

- Determining Areas of Potential Influence for River Sites

Followed by…

Approach

- Determine Areas of Potential Influence for River Sites
- **Calculate and Test Landscape Metrics**
- Relate Landscape Metrics to
  - Stressors
  - Water Quality
  - Habitat Metrics
  - Biological Response Indicators

Landscape Metric Approach

- Areal Extent and Spatial Pattern (complexity, fragmentation, shape)

Landscape Metrics Possibilities

- Areal Extent and Spatial Pattern (complexity, fragmentation, shape)
- Watershed/Catchment Attributes
  - Drainage Character/Topography
    - Soil character, slope
  - Mainstem and watershed flow (annual cfs)
    - Channel gradient (m/km)
  - Watershed Storage in Wetlands and Lakes
  - Floodplain metrics

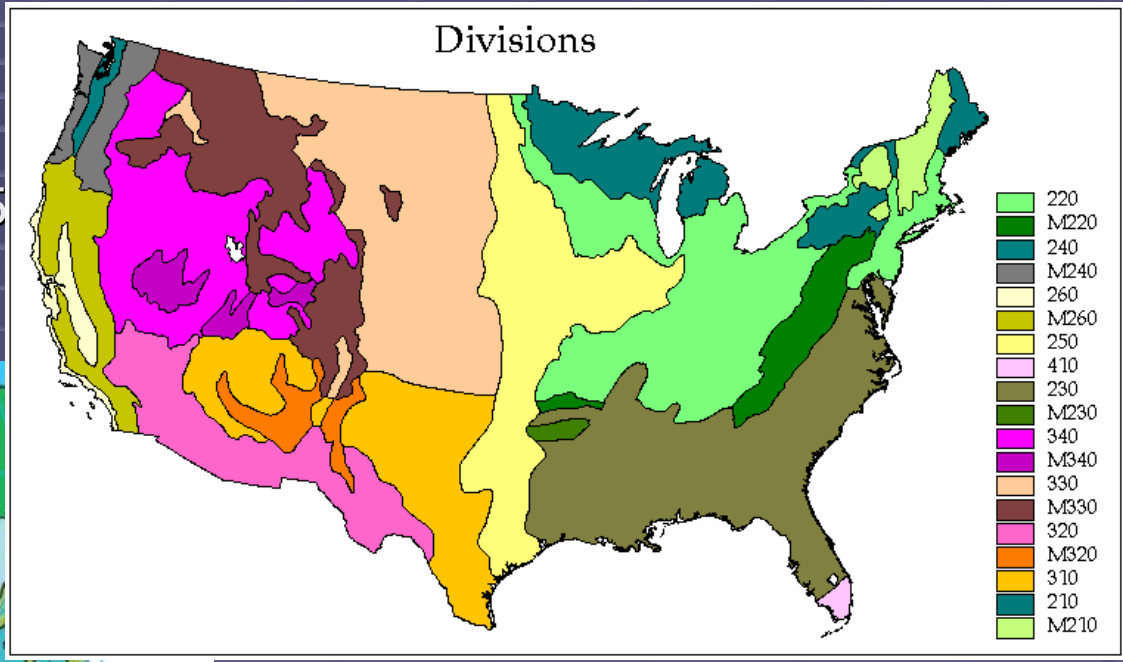
Landscape Metrics Possibilities

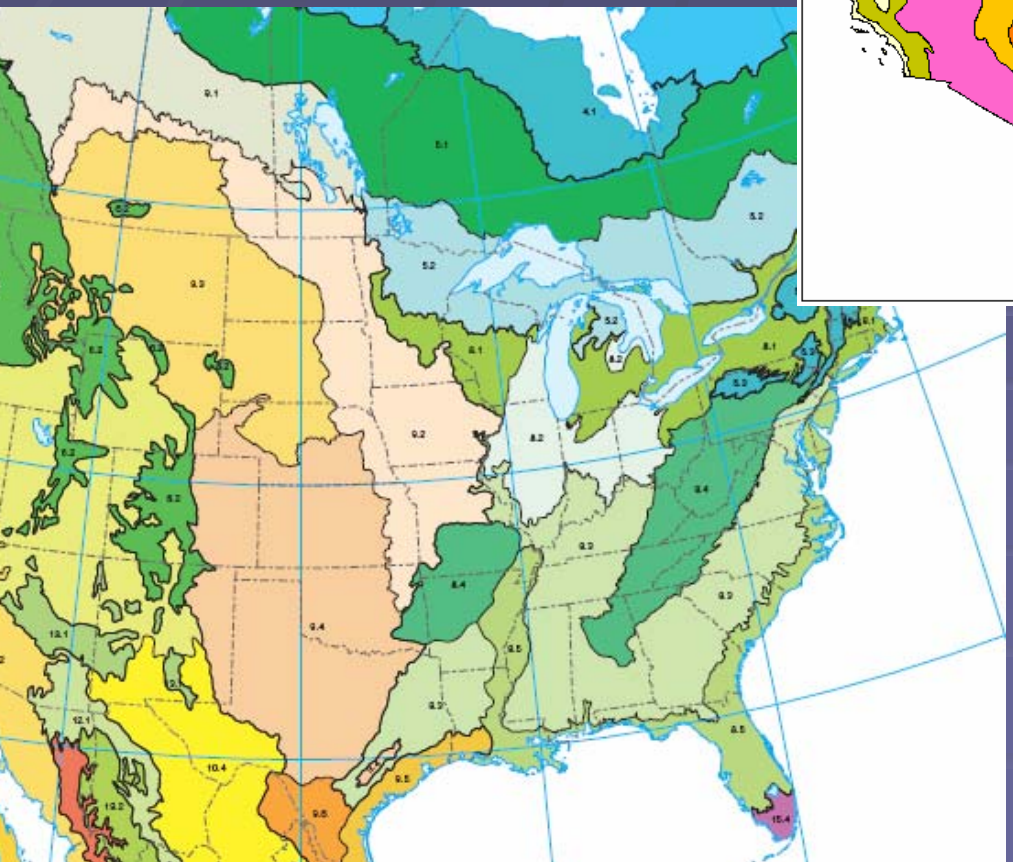
- Regional Classification Factors
  - Climate, Geology, Ecoregions
  - Rivers (Ohio,MO,Miss)
  - Dams, reservoirs

Possible Regional Classification

8 USEPA Ecoregions Level II

8.1, 8.2, 8.3, 8.4, 9.2, 9.3, 9.4,9.5





3 USFS Climate Divisions

330 = Temperate Steppe

250 = Prairie Division

220 = Hot Continental

Landscape Metrics Possibilities

- Anthropogenic Impacts/Stressors
  - Land Cover (NLCD)
  - NPDES dischargers
  - Road density
  - Population Density
  - Others

Landscape Approach for GRE

- Determine Areas of Potential Influence for River Sites (Input is still needed)
- Calculate and Test Landscape Metrics
- Relate Landscape Metrics to
  - Stressors
  - Water Quality
  - Habitat Metrics
  - Biological Response Indicators