Concepts for Ecohydrology:

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USDA United States Department of Agriculture

Concepts for Ecohydrology

Webinar outline

1. Ecohydrology Definition
2. Review of Current Technology & Methods
   - Simulation Models
   - Classification Systems
   - Geospatial Techniques
   - Data Sources
3. Testing Ecohydrology Methods
   - Method choice
   - Study area choice
   - Minimum delineation or raster patch size target
   - Map layer development for landscape screening
   - Evaluation of method in context of broader landscape
4. Example Ecohydrology Classifications – models of reality
5. Recommendations & Questions

Ecohydrology Definition

Many Currently available definitions……..

- Water moves through all landscapes
- Water movement influences the formation of soils and maintenance of soil functions
- The soil – water interaction largely drives ecological processes

Current Technology & Methods

- Simulation Models
  - Rangeland Hydrology and Erosion Model (RHEM), Soil, Plant, Atmosphere, Water (SPAW), DRAINMOD, etc.

- Classification Systems
  - Landscape
    - Hydrogeomorphic (HGM)
      http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_010784.pdf
    - Ecological Site Description (ESD) SSURGO components
      http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/ecoscience/desc/
    - Hydrosequences and Soil Systems
      http://www.asprs.org/a/publications/pers/.../PERS_April14_Flipping.pdf
      - Catenas (soil parent material/soil drainage class)
      - Soil Associations
      - Applied pedology
        - » Soil functions inherited from soil parent materials
        - » Geomorphic context of landforms

Current Technology & Methods

- Classification Systems (cont.)
  - Stream
    - Rangeland Hydrology
    - Stream Visual Assessment Protocol (SVAP)
    - Proper Functioning Condition (PFC)
    - Rosgen (1994)
- Geospatial Techniques
  - Data management
  - Overlay and acreage estimates
  - Terrain Derivatives
    - Analytical hillshade
    - Wetness index
  - Remote Sensing

Current Technology & Methods

- Data Sources
  - USDA Major Land Resource Areas (MLRA)
  - 12-digit Hydrologic Units (HUC12)
  - National Hydrology Database (NHD)
  - USDA SSURGO (current fiscal year publication)
  - USGS National Elevation Dataset (NEDS)
    - 10m and 30m
    - LiDAR (other high resolution sources)
  - National Land Cover Data (NLCD)
  - USDA-NASS National Crop Data Layer (CDL)
  - Other sources…

Hydrogeomorphic Classification (HGM)

US Army Corps of Engineers®
Engineer Research and Development Center

ERDC/EL

A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Riverine Floodplains in the Northern Rocky Mountains

August 2002

- Originally for Development of "Functional Assessment Models" for wetlands (Brinson, et. al.)
- Starts with 7 Wetland Classes
- Requires the Determination of a "*Reference Domain*" where a certain "subclass" exists
- Must make a decision between "lumping" and "splitting"

HGM – ESD Ecohydrology - Common Parameters

The Hydrogeomorphic (HGM) Classification System is based on 3 factors –

- Landscape Position
  - WHERE it is
- Dominant Water Source
  - Not the ONLY Source
- Hydrodynamics
  - The direction(s) of water movement in and out

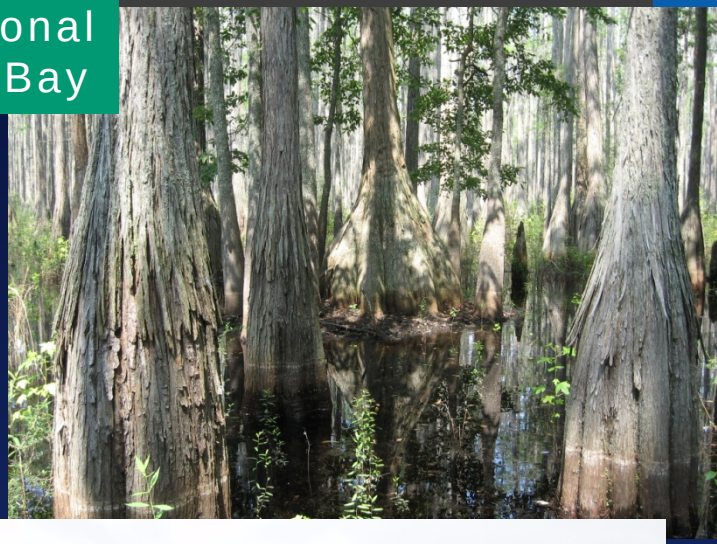
Three Factors that Define HGM Landscape Classes

- Landscape Position
- Dominant Water Source
- Hydrodynamics

The Seven HGM Classes

- RIVERINE
- SLOPE
- MINERAL SOIL FLAT
- ORGANIC SOIL FLAT
- ESTUARINE FRINGE
- LACUSTRINE FRINGE
- DEPRESSION

Depressional
Carolina Bay



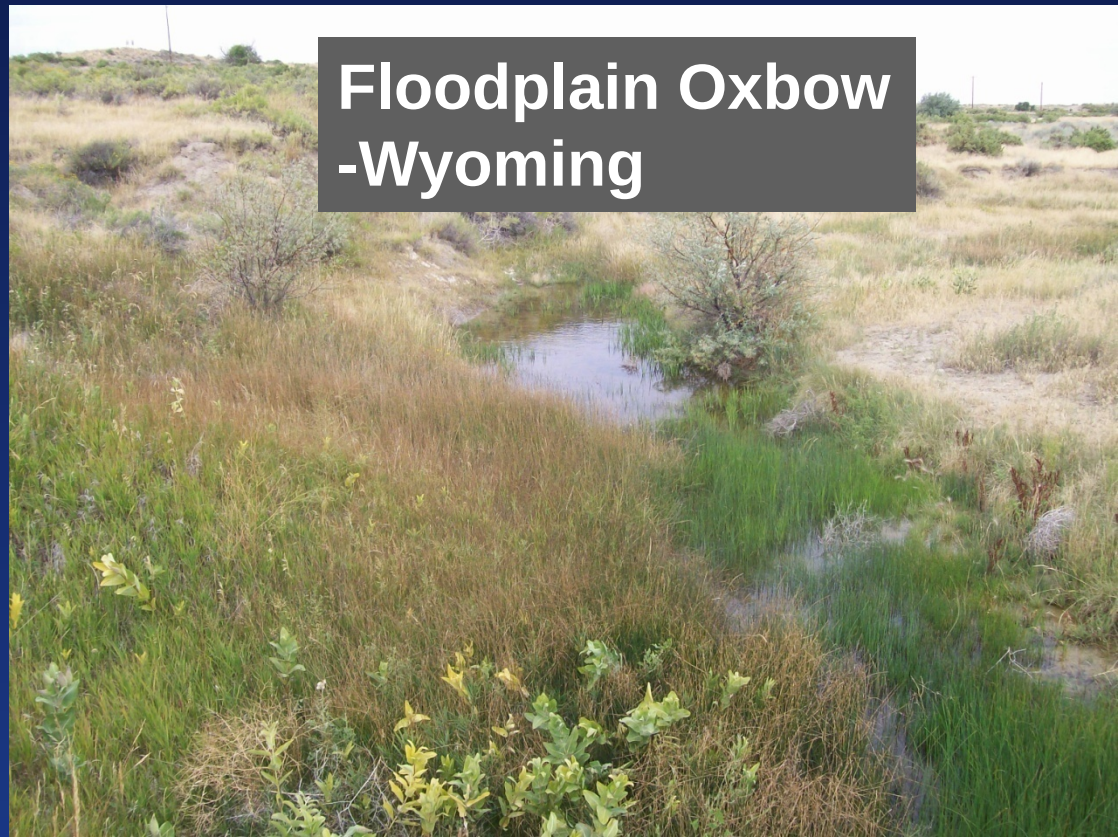
Estuarine Fringe
Oregon

Mineral Flats
Indiana Flatwoods

Slope
Puerto Rico

RIVERINE Wetlands

Landscape Position
Floodplains
Dominant Water Source
Surface Flooding AND/OR Groundwater Inputs
Hydrodynamics
Horizontal, Bi-Directional



Floodplain Oxbow -Wyoming

United States Department of Agriculture
Natural Resources Conservation Service

RIVERINE Wetlands

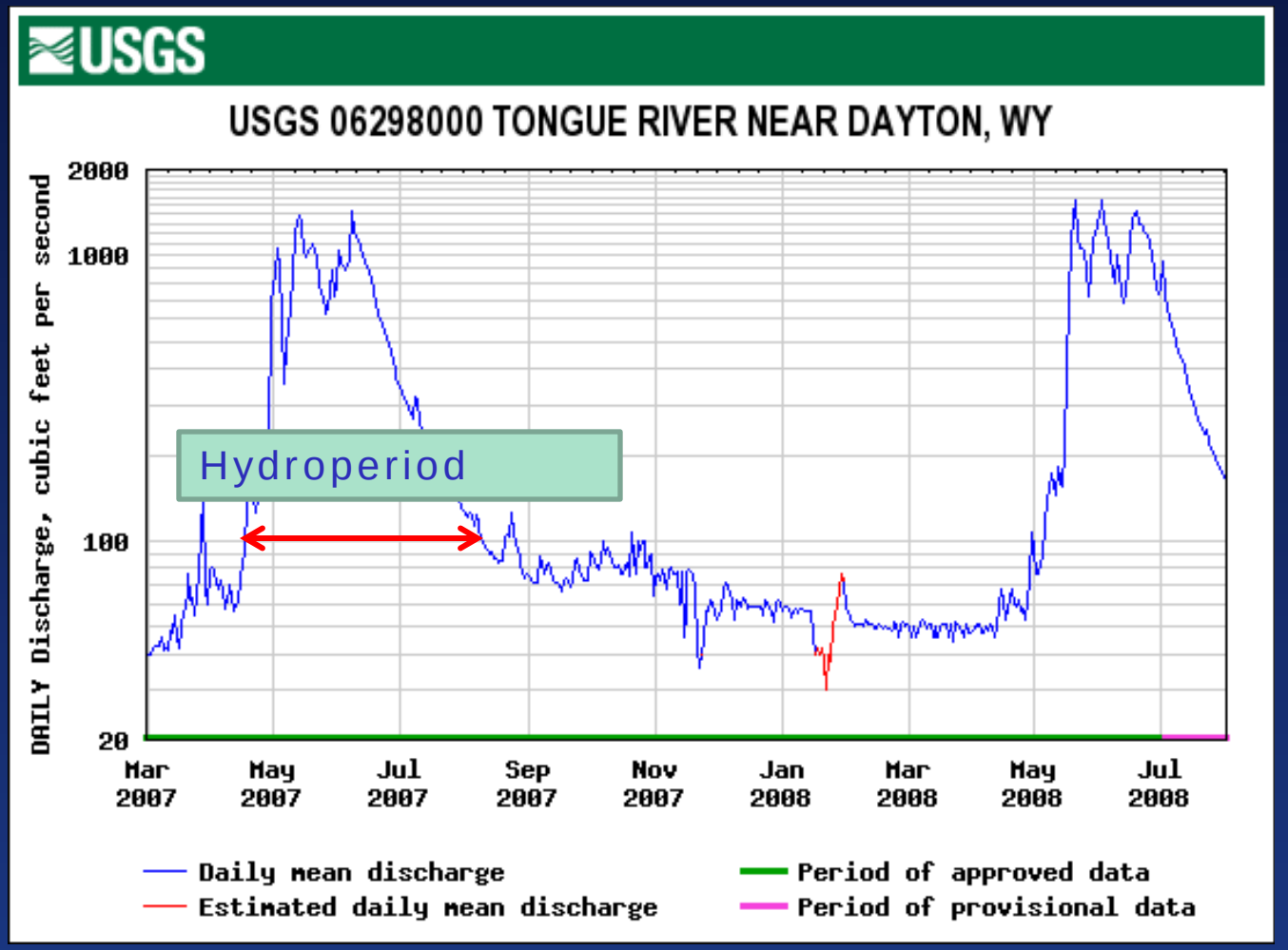
Landscape Position

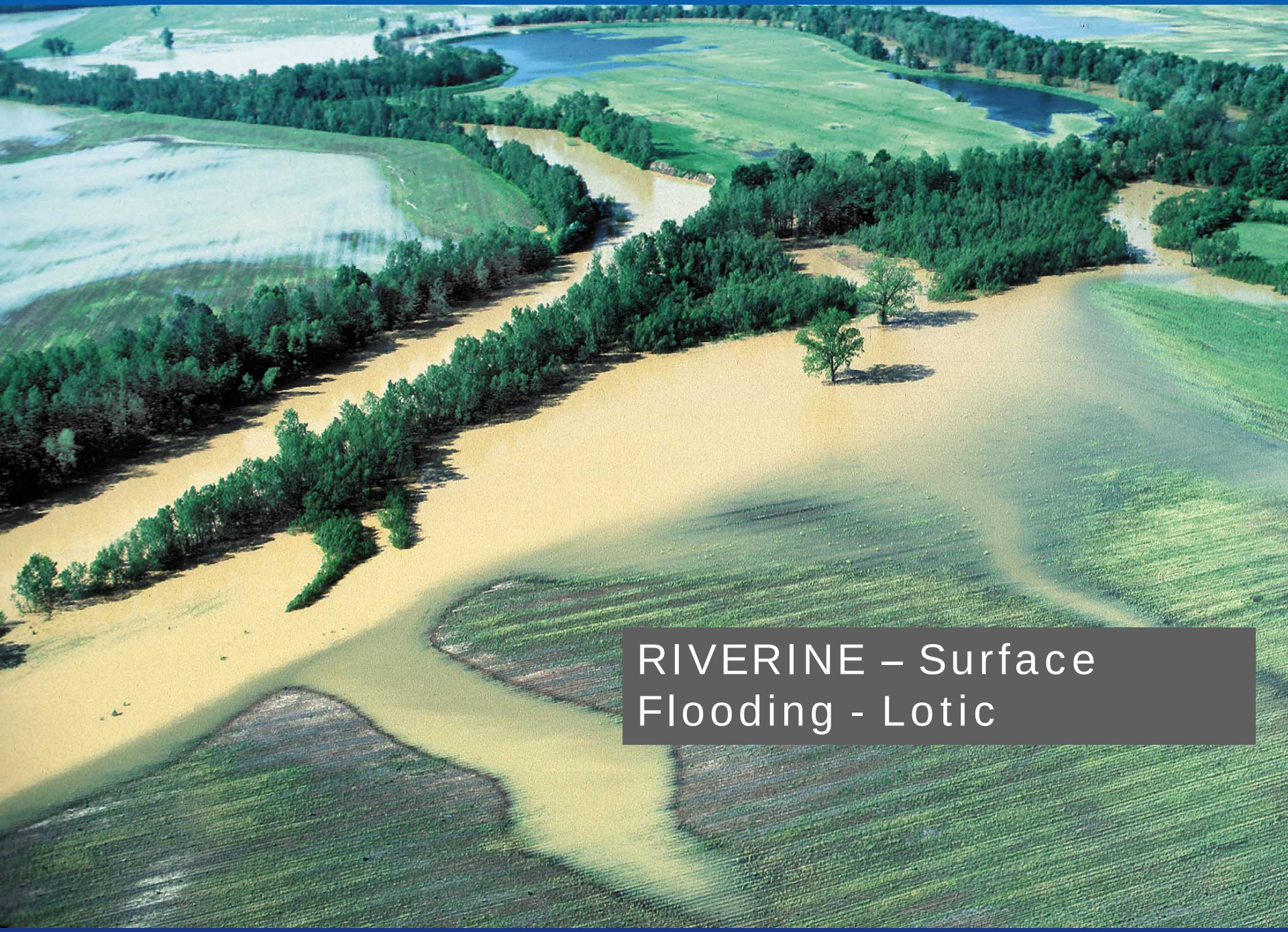
SSURGO “geomorph”: Floodplain

RIVERINE – Dominant Water Source – Stream Hydrograph

Hydrograph Effects on SSURGO Water Features

- **Flooding**
- **Ponding**
- **Groundwater**



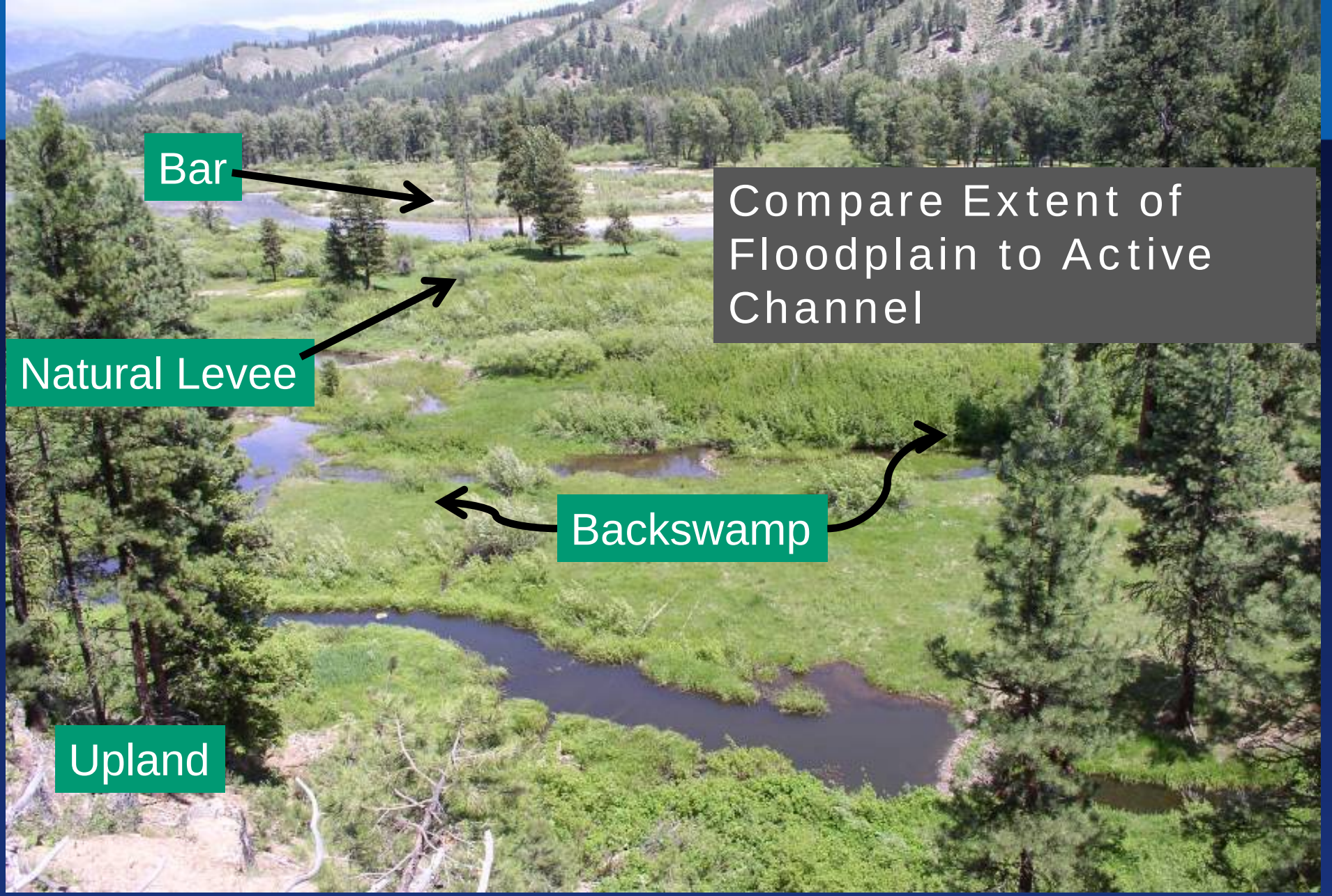

RIVERINE – Surface
Flooding - Lotic

RIVERINE – Surface Ponding - Lentic

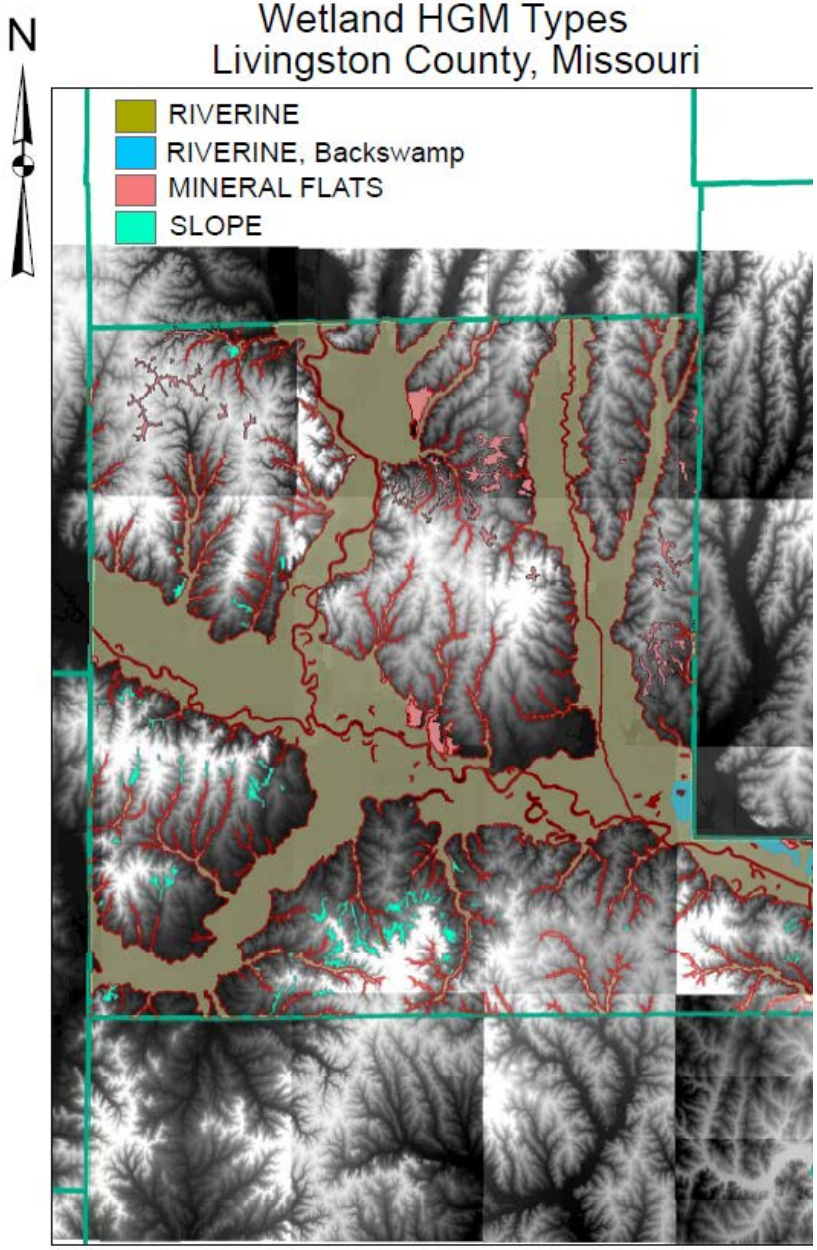
- Episaturated Condition
- Ponded Water Features in SSURGO

RIVERINE – Floodplain Groundwater

- Endosaturated Condition
- Groundwater Water Features in SSURGO



US COE – Regional Guidebook

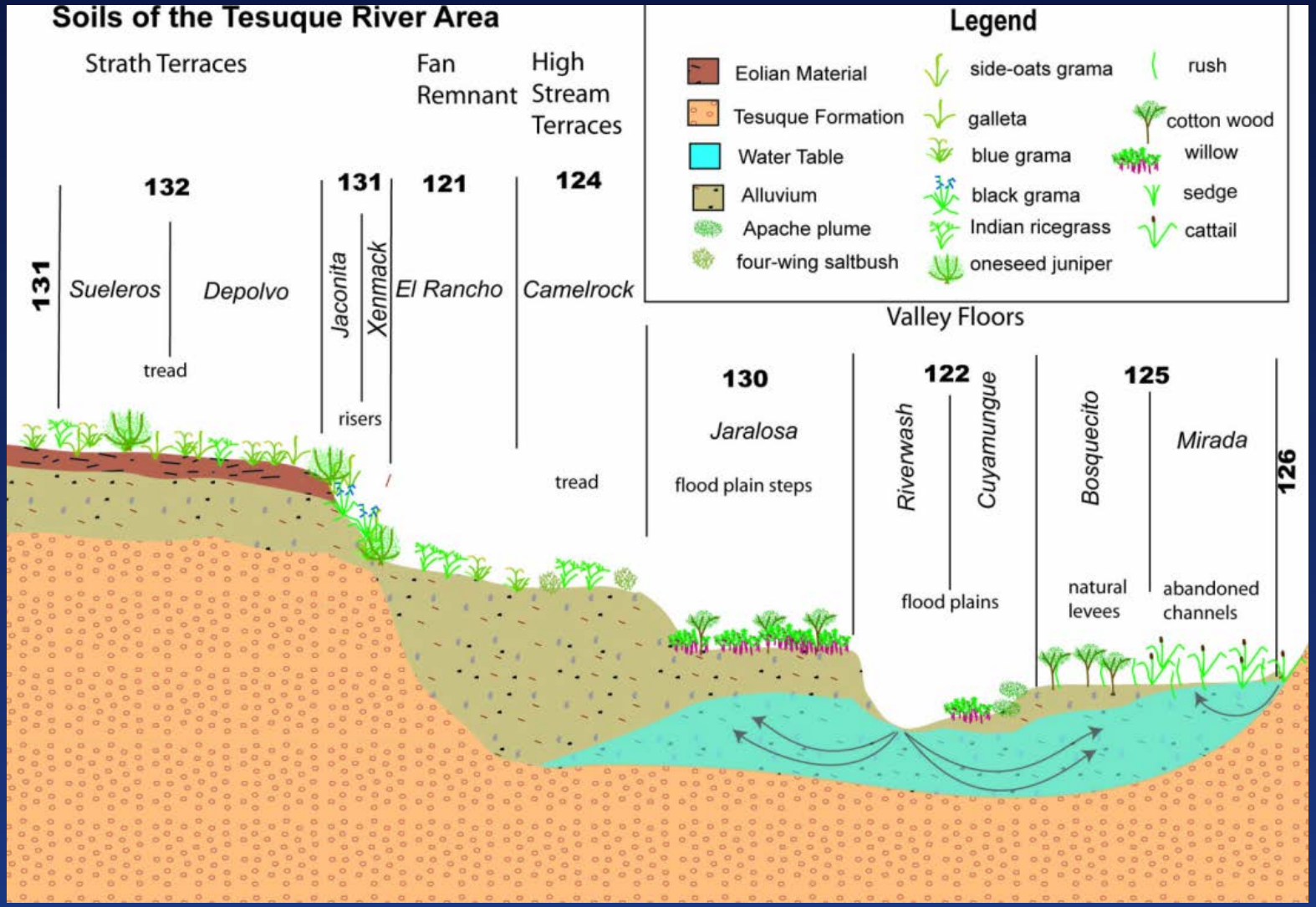


Floodplain Soils

compname	hydricrating	geomdesc	taxsubgrp
Tice	No	flood-plain steps on river valleys	Fluvaquentic Hapludolls
Nodaway	No	flood-plain steps, river valleys	Mollic Udifluvents
Zook	Yes	flood-plain steps, river valleys	Cumulic Vertic Endoaquolls
Portage	Yes	flood plains, river valleys	Vertic Endoaquolls
Wabash	Yes	flood-plain steps, river valleys	Cumulic Vertic Endoaquolls
Sandover	No	flood plains on river valleys	Aquic Udifluvents
Carlow	Yes	flood plains on river valleys	Vertic Endoaquolls
Tice	No	flood plains on river valleys	Fluvaquentic Hapludolls
Wabash	Yes	flood plains, river valleys	Cumulic Vertic Endoaquolls
Zook	Yes	flood plains on river valleys	Cumulic Vertic Endoaquolls
Vesser	Yes	flood-plain steps on river valleys	Argiaquic Argialbolls
Colo	Yes	flood-plain steps, river valleys	Cumulic Endoaquolls

RIVERINE Soil System

- One Complex Site?
- Several Simple Sites?
- Depends on the target spatial resolution...



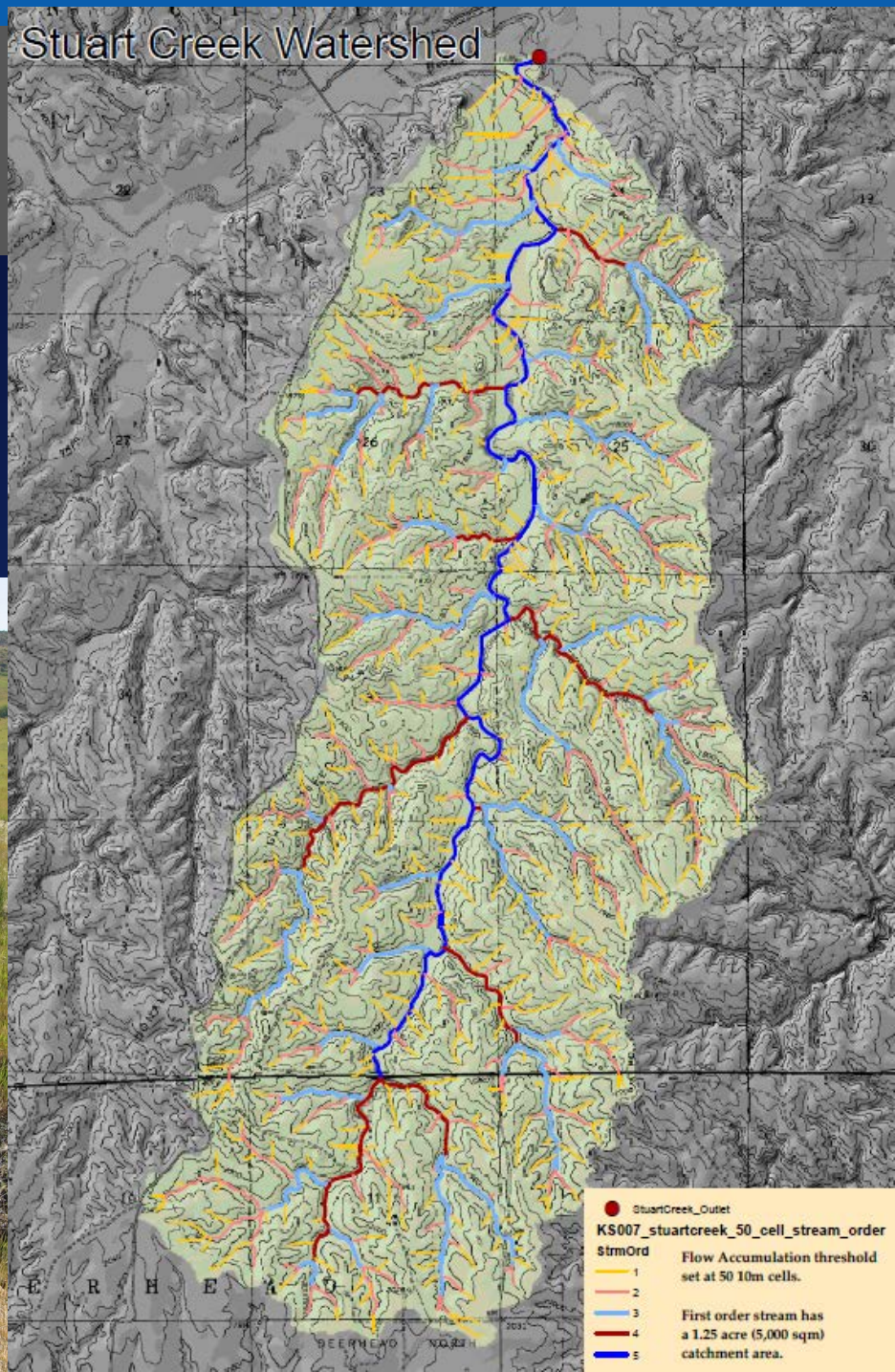
SLOPE – Low Order Reaches

Dominant Water Source - Groundwater

SLOPE

Landscape Position –

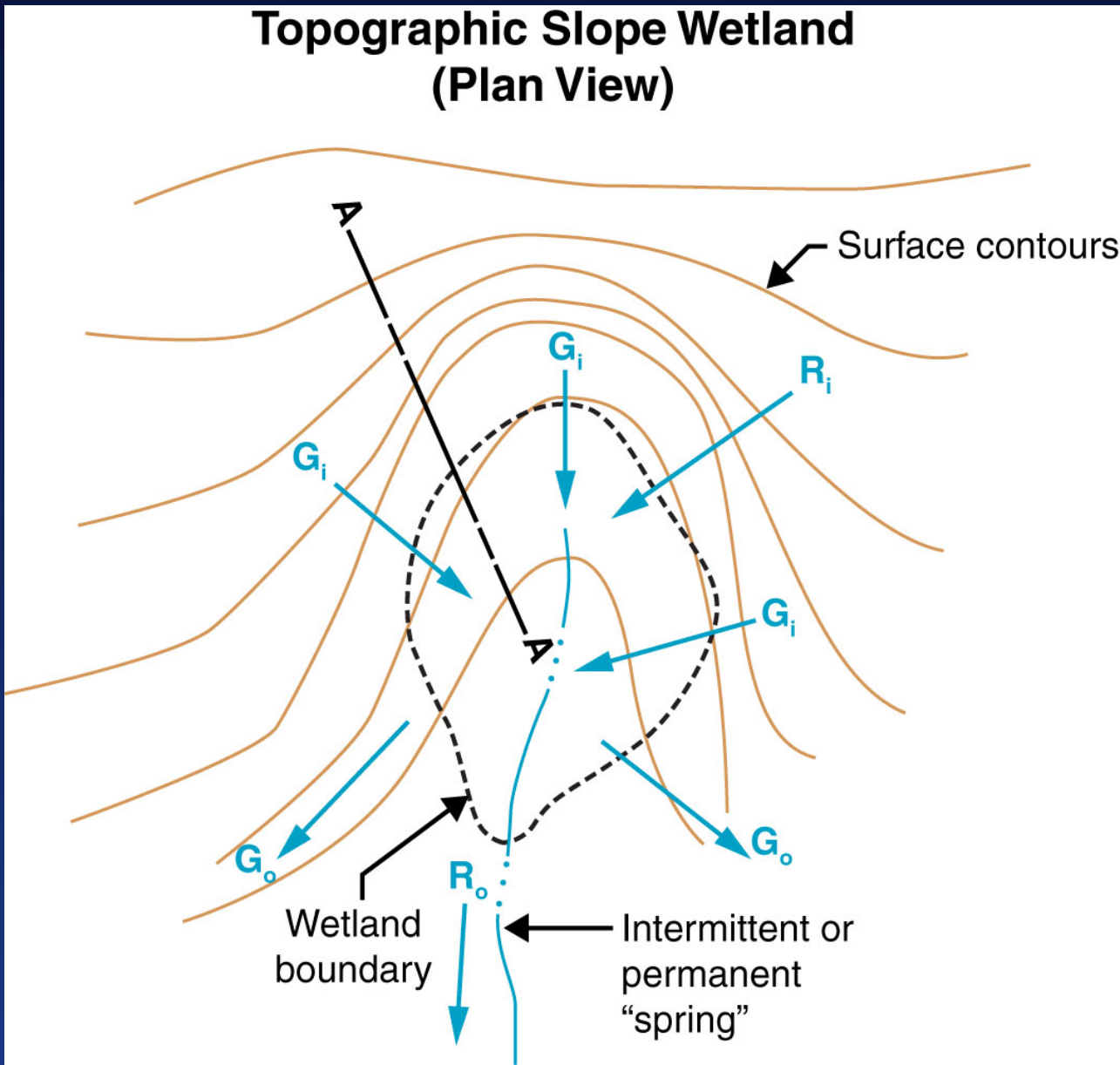
Concave Topographic positions, usually stream headwaters –



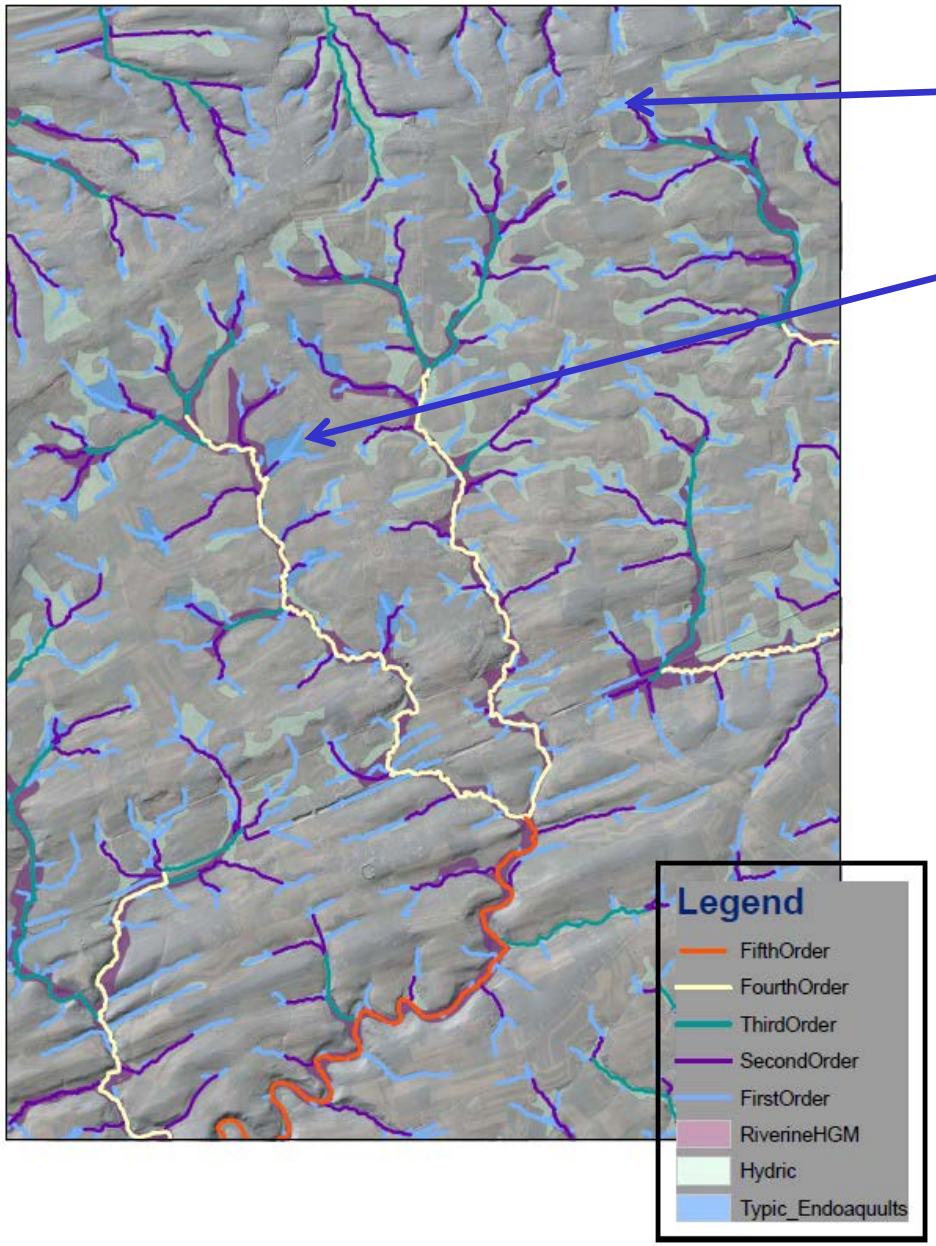
Topographic SLOPE Wetland Plan View

Concave Landscape Positions

Typical of Stream Headwaters



Lancaster County
HGM Class Map



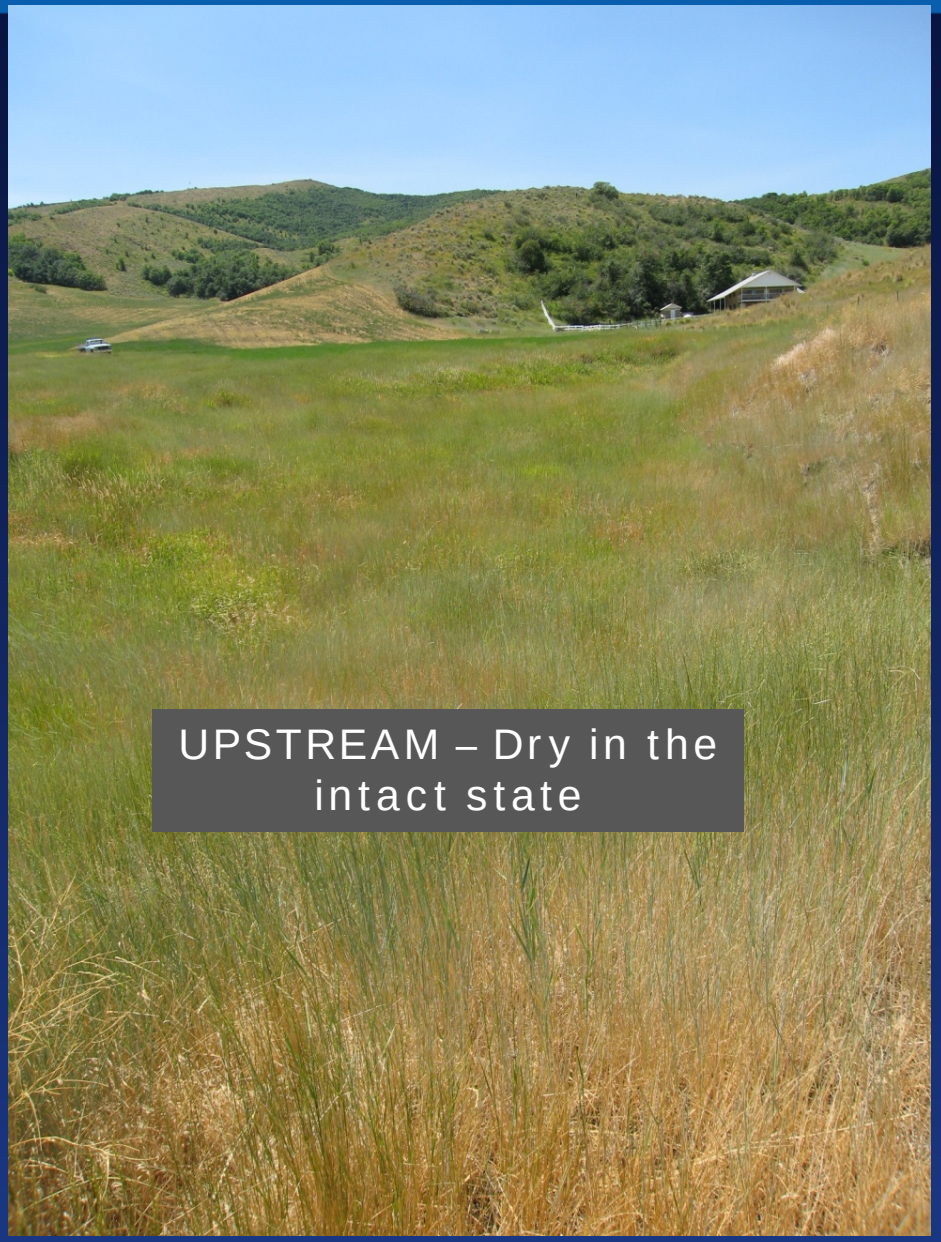
Potential Bog Turtle Habitat

“Typic Endoaquults

Groundwater Dominated Soils In Low Stream Order Landscapes

RIVERINE or SLOPE?

DOWNSTREAM – wet in the degraded state



UPSTREAM – Dry in the intact state

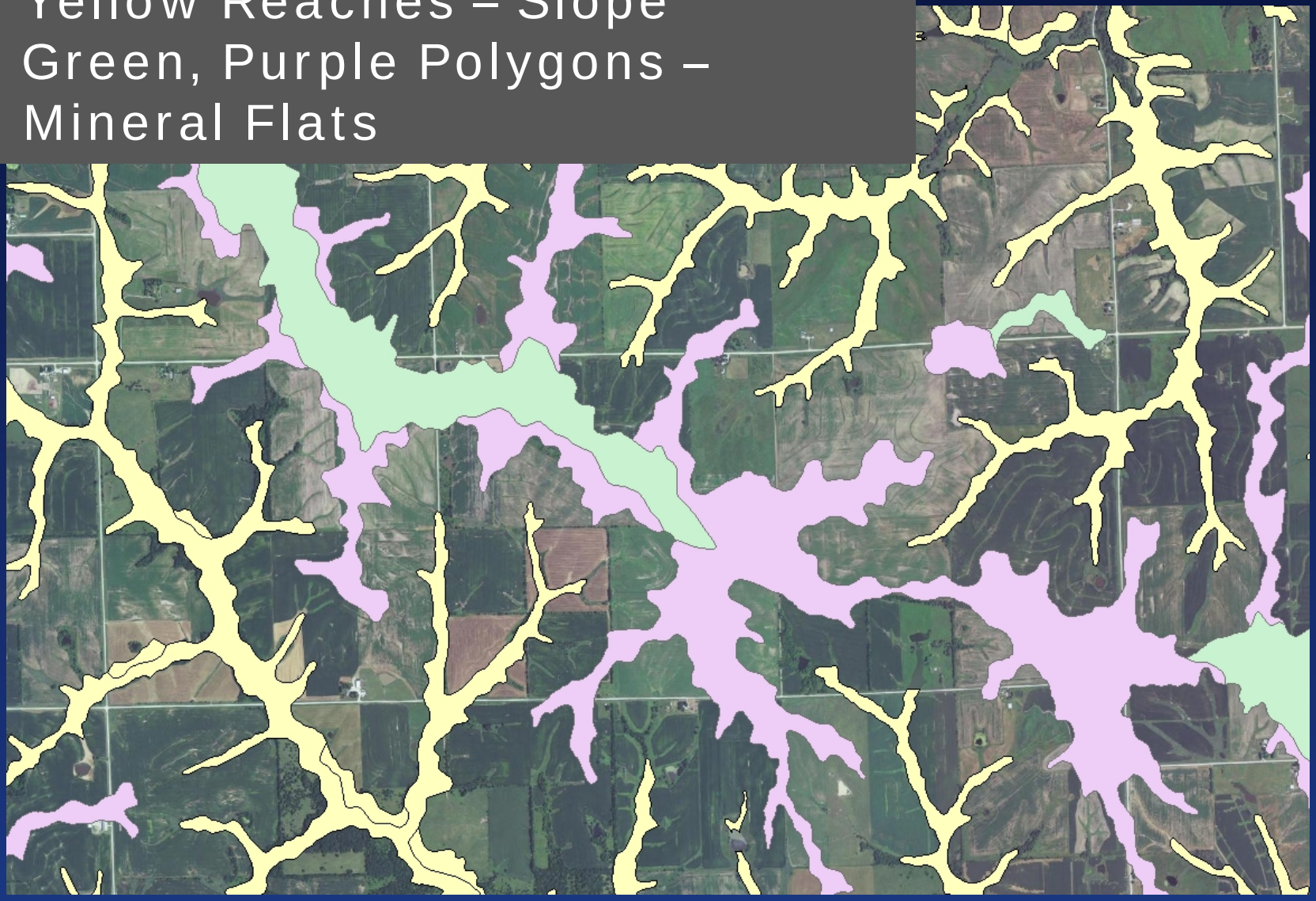
SLOPE Wetland Before "Restoration"

SLOPE Wetland After “Restoration”

Headwater SLOPE
Wayne County, Iowa

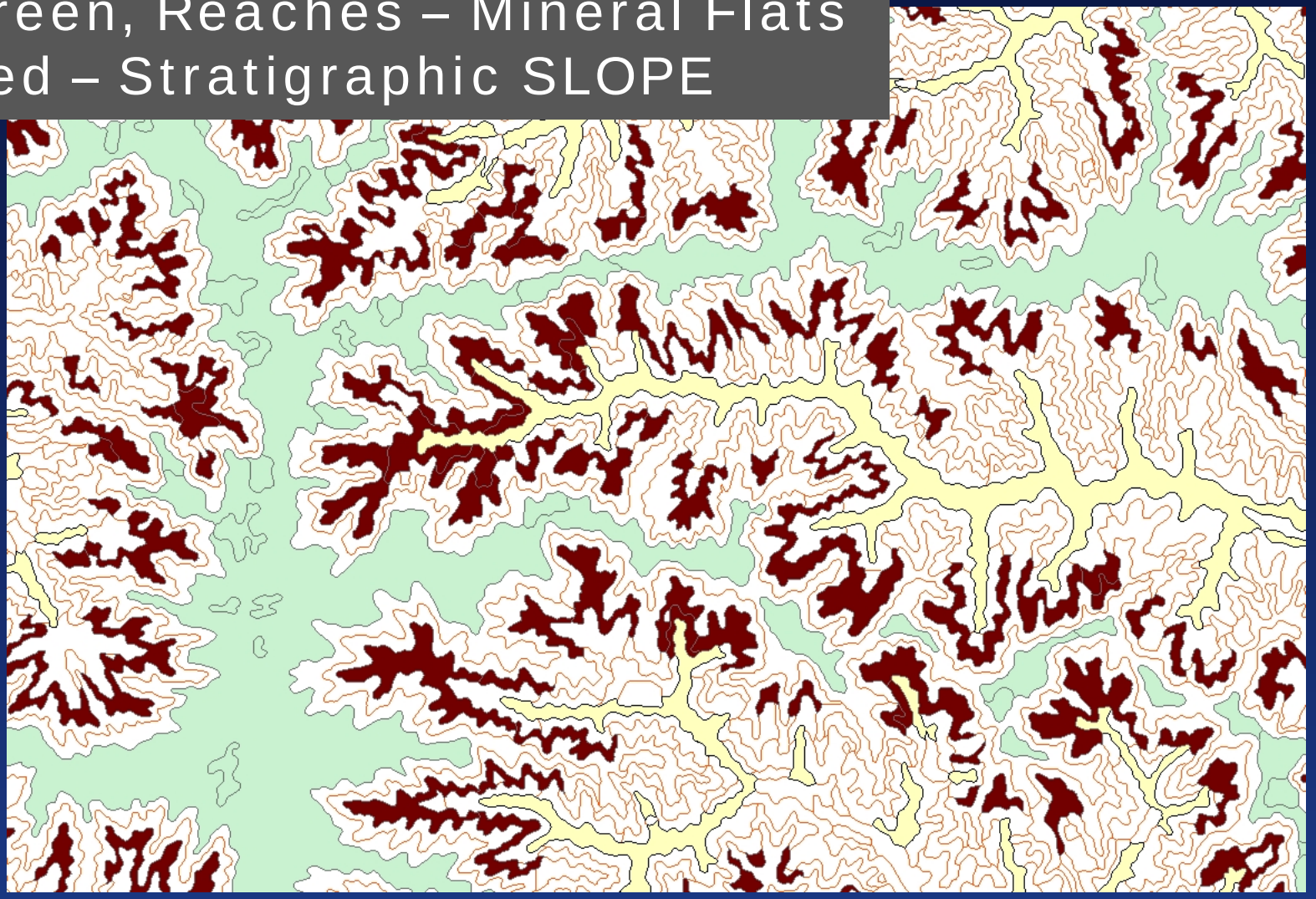
Yellow Reaches – Slope

Green, Purple Polygons – Mineral Flats



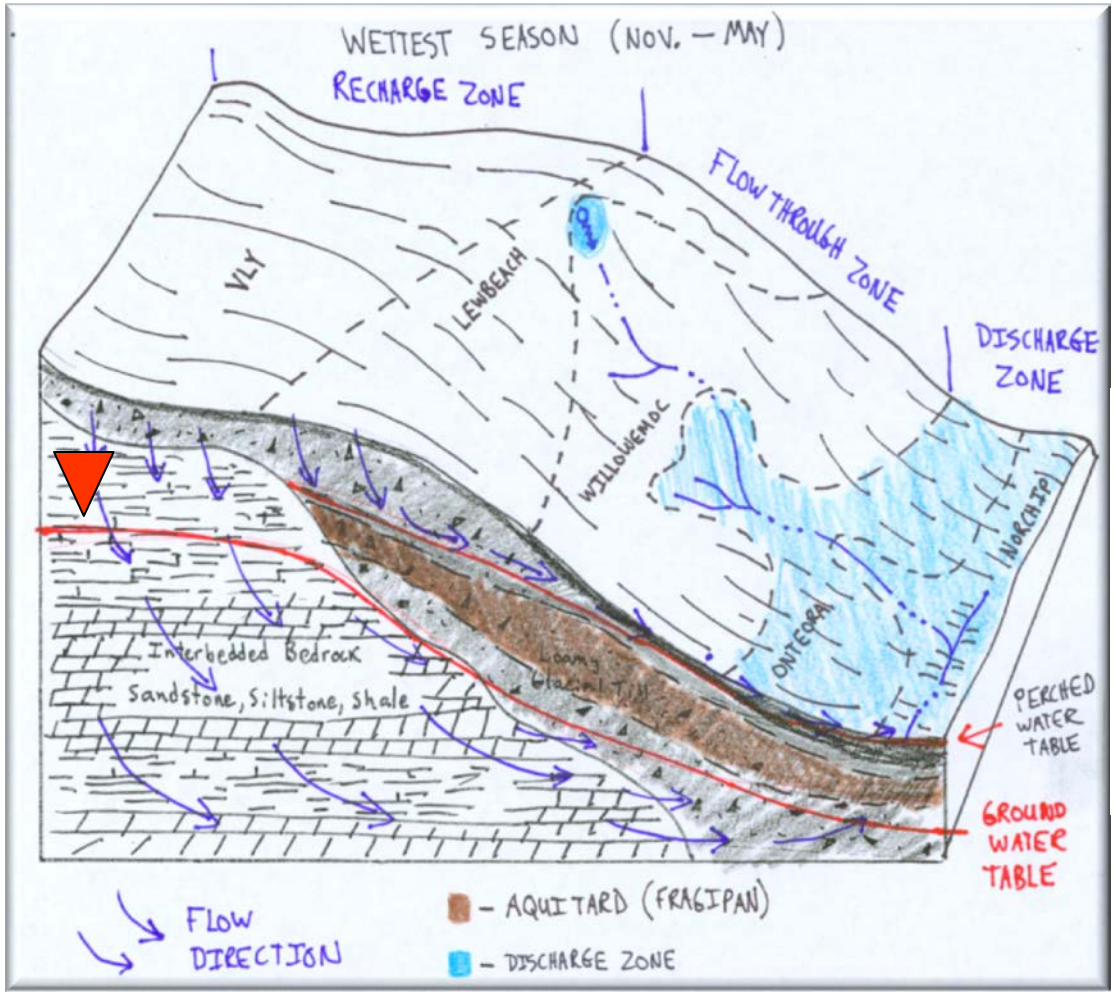
Stratigraphic SLOPE
Lucas County, Iowa

Yellow Reaches – Slope
Green, Reaches – Mineral Flats
Red – Stratigraphic SLOPE



Integrated Soil System →

Focuses on the SOIL SYSTEM behavior as a WHOLE



Source: Matt Havens, Catskills area, NY. (SGI, 2008)

<u>Conceptually</u> integrates:

- ***Geomorphology***
- ***Pedology***
- ***Stratigraphy*** *(pedo- & geo-)*
- ***Hydropedology***
- ***Climate*** *(e.g. seasonal)*

SLOPE Wetlands – Unique Functions

Kansas Headwater

Idaho Headwater Fen

New York Headwater Fen

- Aquifer Storage/groundwater discharge
- Sequestration of Organic Carbon
- Critical Upland Water Sources
- Downstream Baseflow Maintenance

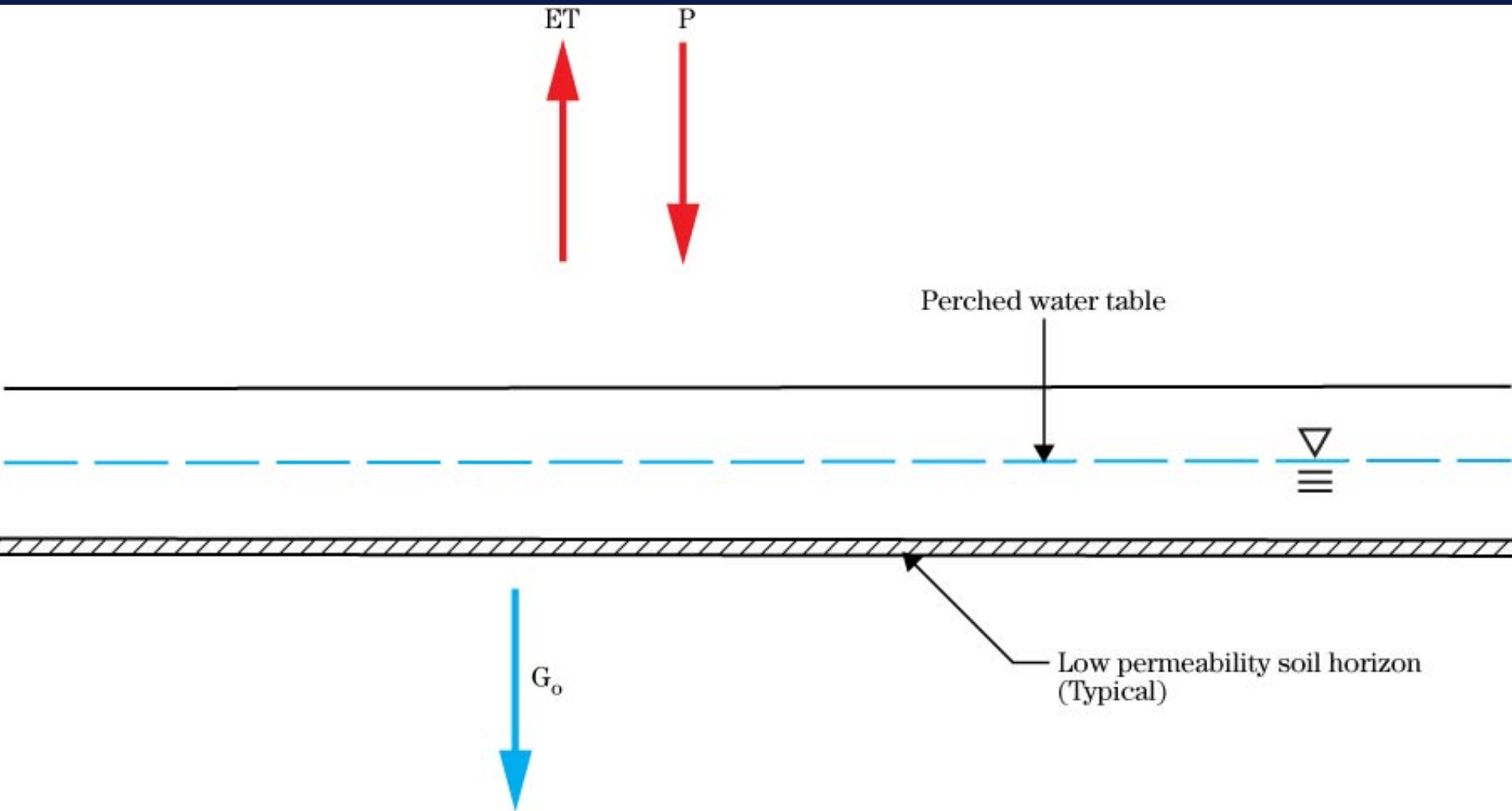
Slope HGM Class Wetland

Wyoming Sage Grouse Country

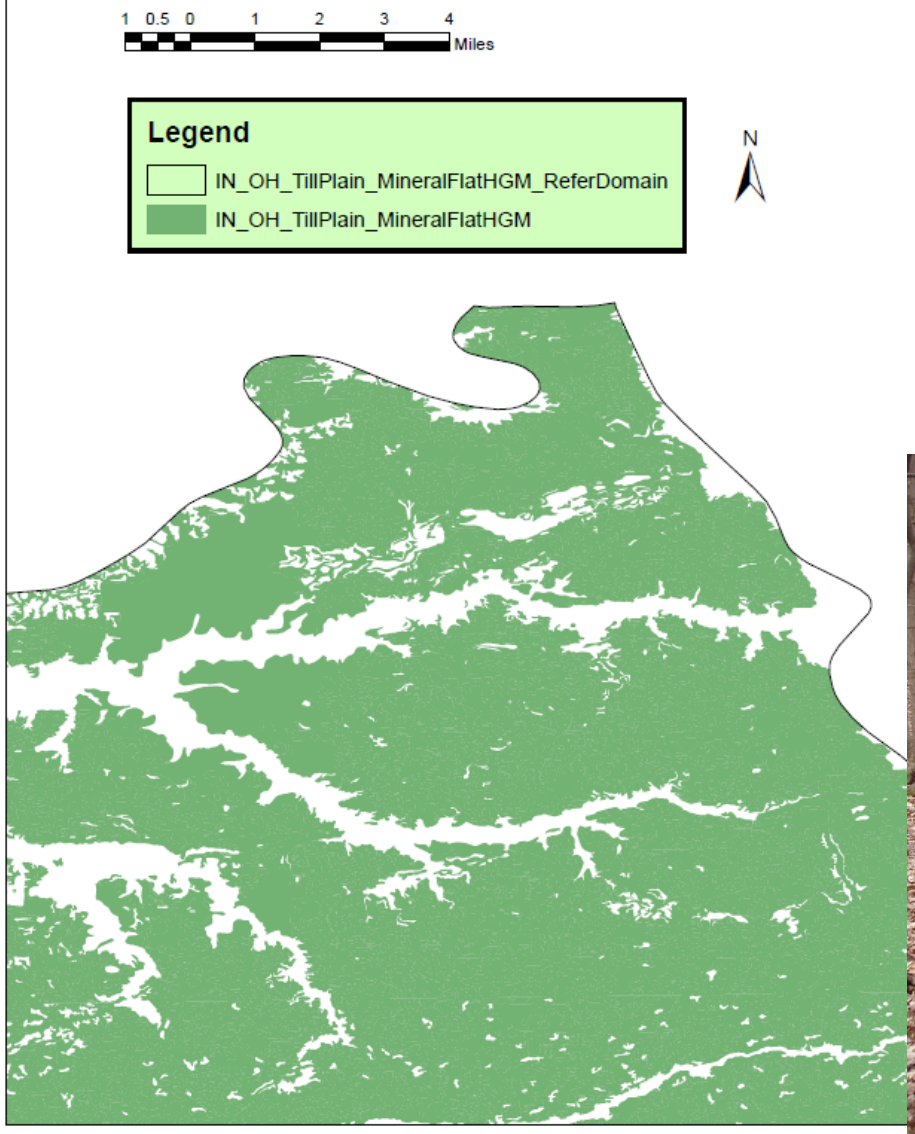
MINERAL SOIL FLAT Dominant Water Source- Direct Precipitation

MINERAL FLAT Wetland

Hydrodynamics and Water Budget



Landscape Mapping Mineral Flats



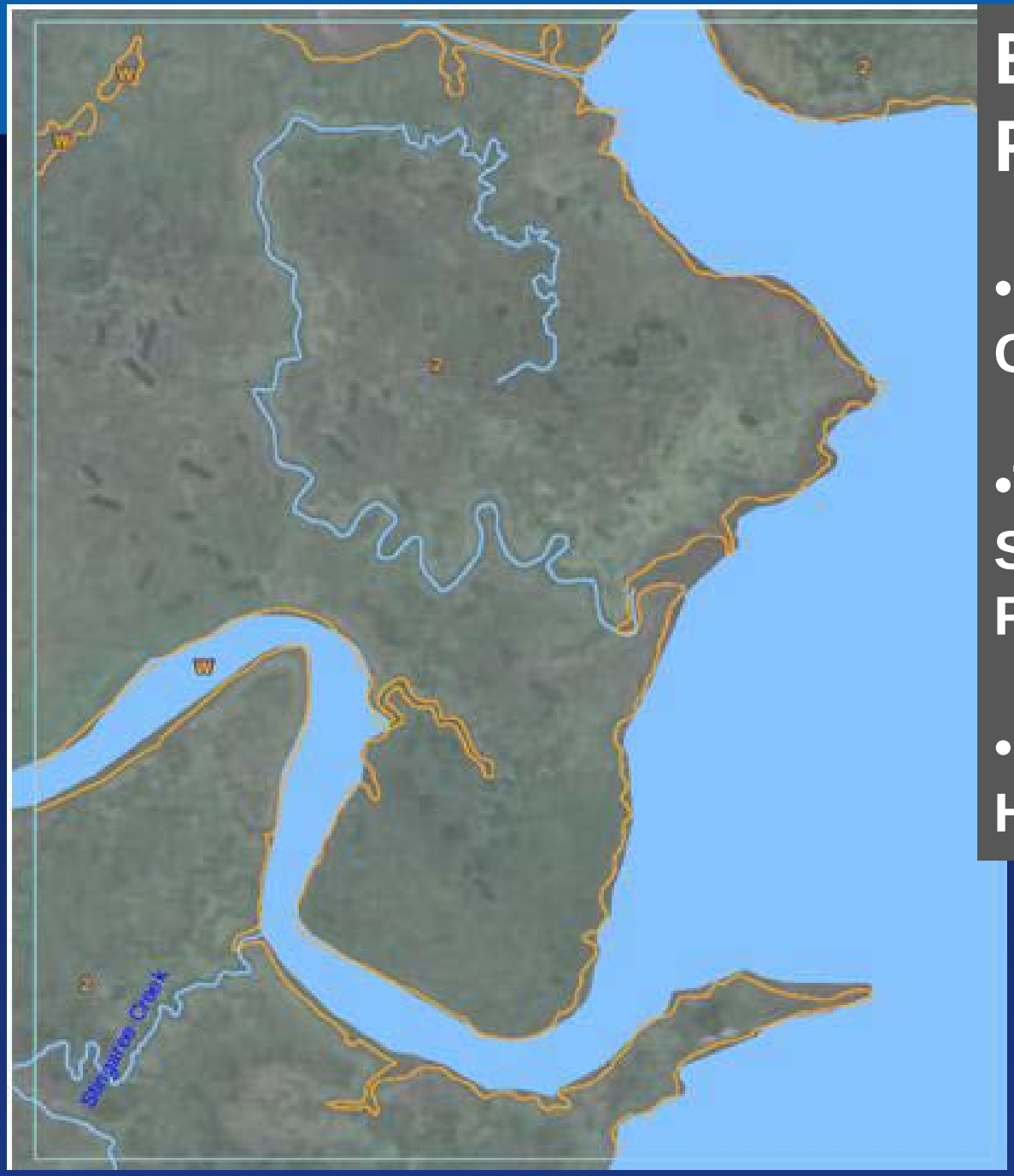
Current Efforts –

- ESD for site in Ohio and Indiana Till Plains
- HGM Mineral Flat Model
- Site mapping

ORGANIC SOIL FLAT
Dominant Water Source – Direct Precipitation

- Ombotrophic Bogs
- Extensive Lake Beds

ESTUARINE FRINGE
Dominant Water Source - Tides



Estuarine Fringe

- Organic Soils are Common
- Tidally Influenced Salt, Brackish, or Freshwater
- Adjoins Riverine HGM landscapes

ESTUARINE FRINGE – Tidal Inlet Channels

LACUSTRINE FRINGE
Dominant Water Source- Lake Fluctuations

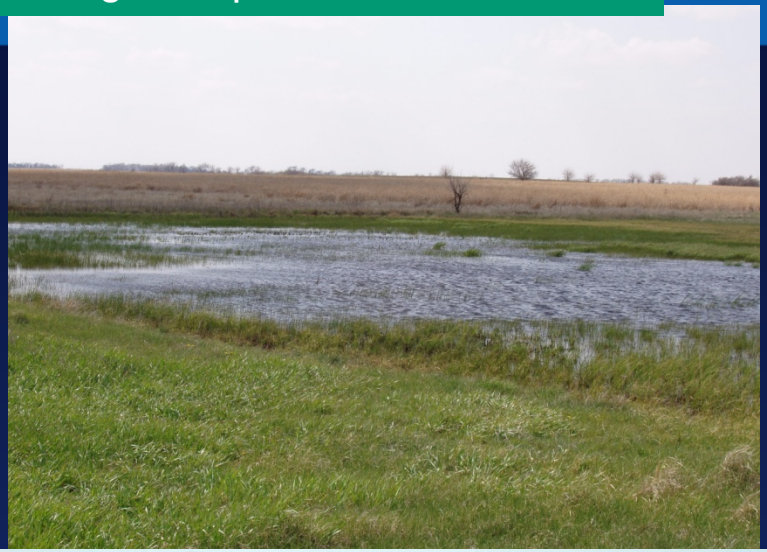
Yellowstone Lake

Jenny Lake - Tetons

DEPRESSIONAL

Wyoming – Recharge Depression, Gillette

Nebraska Rainwater Basin – Recharge Depression

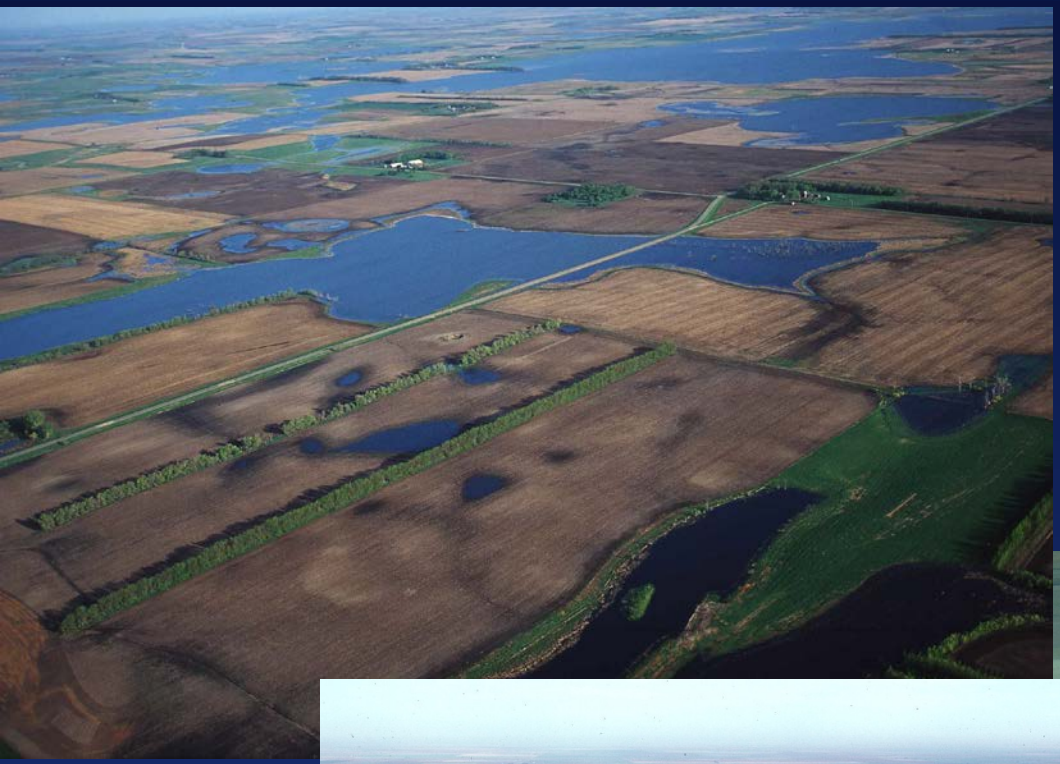


South Carolina – Carolina Bay

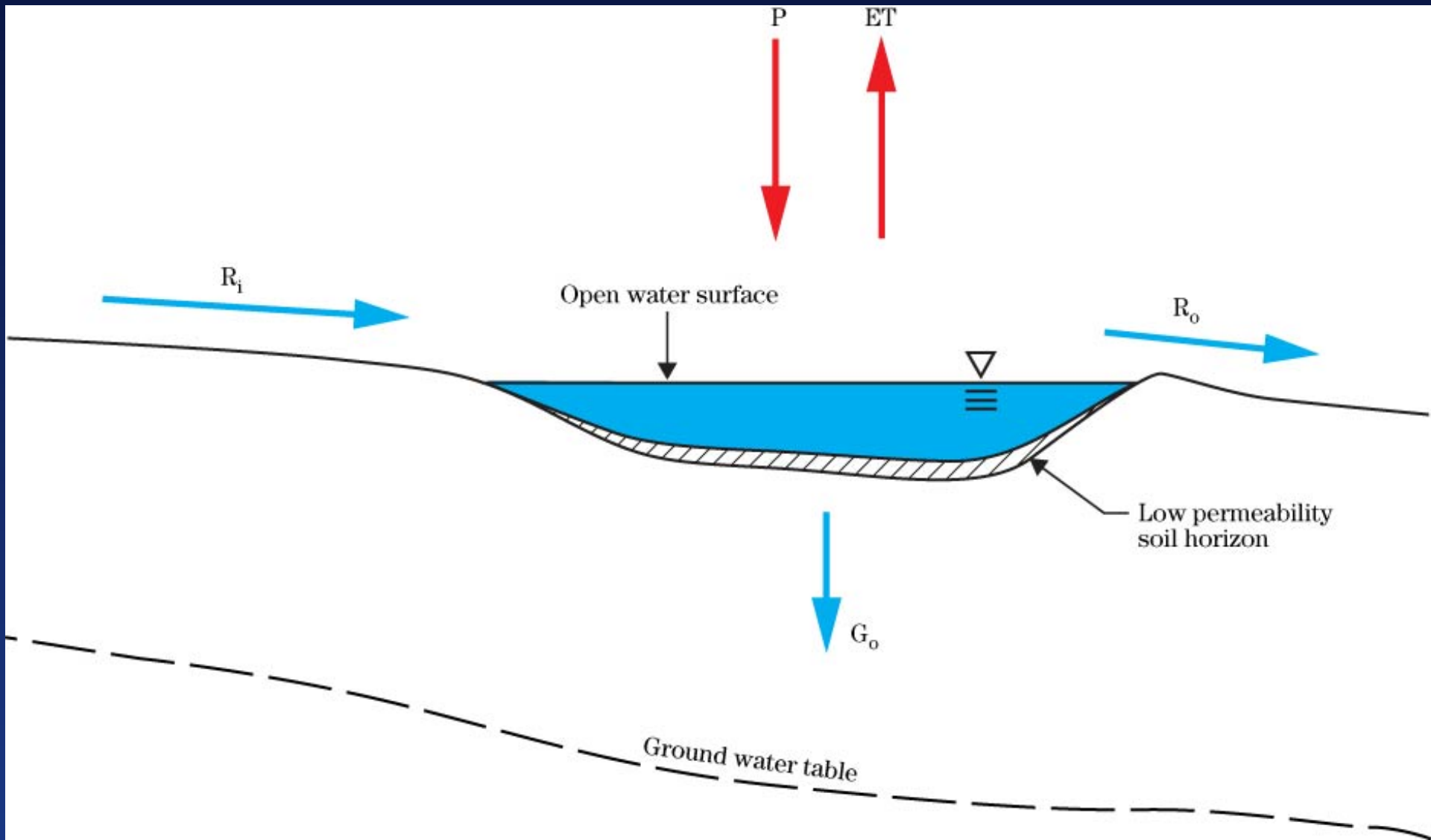
South Dakota Prairie Pothole

DEPRESSIONAL

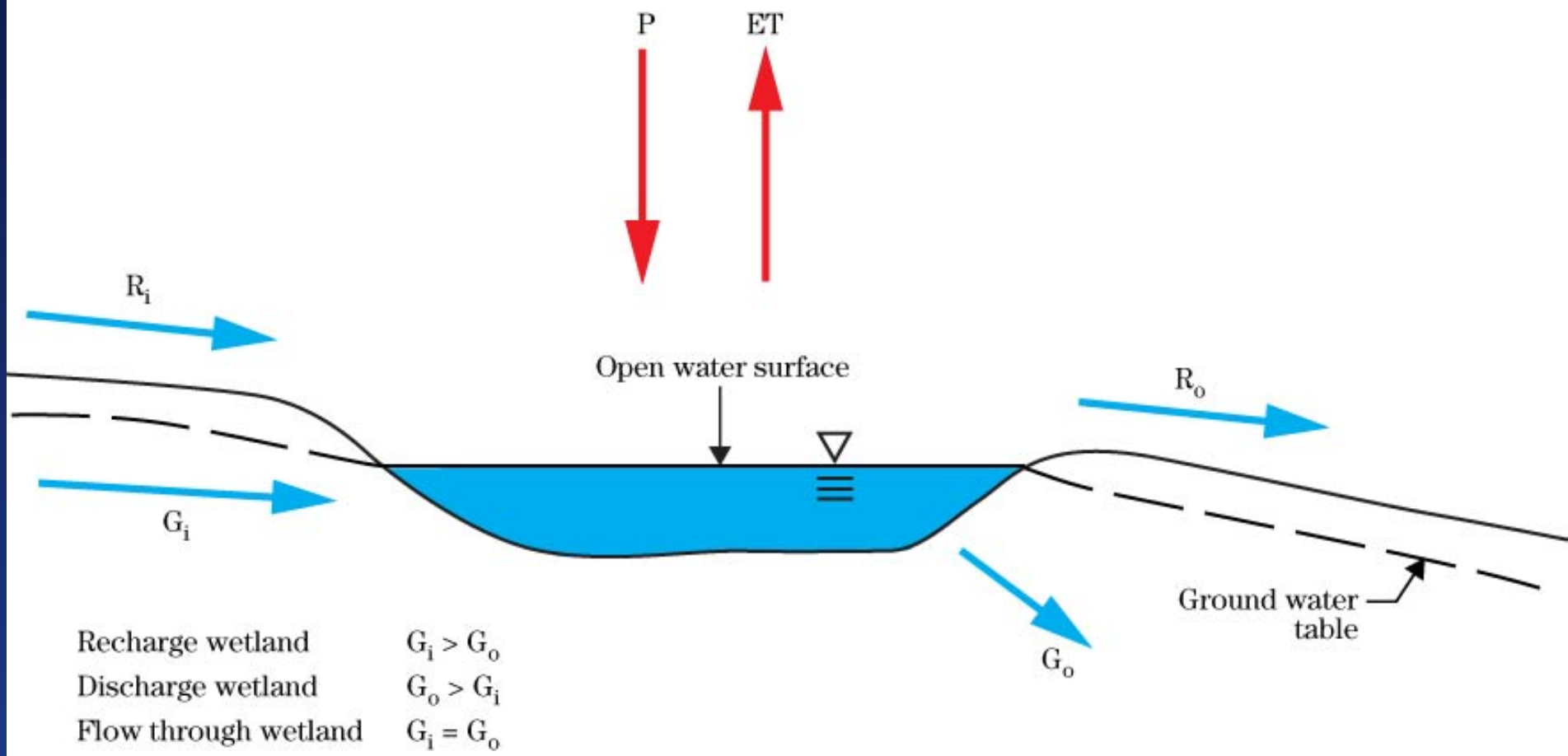
Dominant Water Source – Surface Runoff and/or Groundwater



Depressional - Recharge



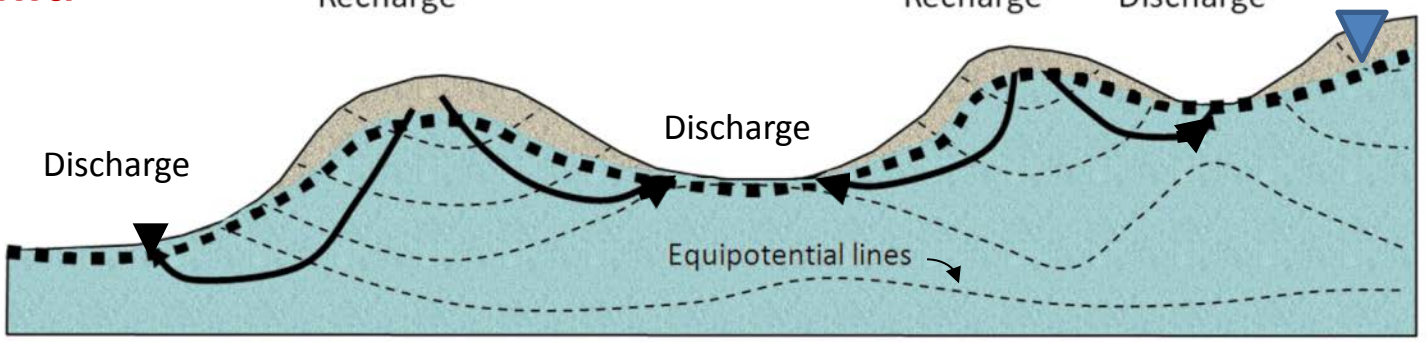
Depressional – Discharge or Flow Through



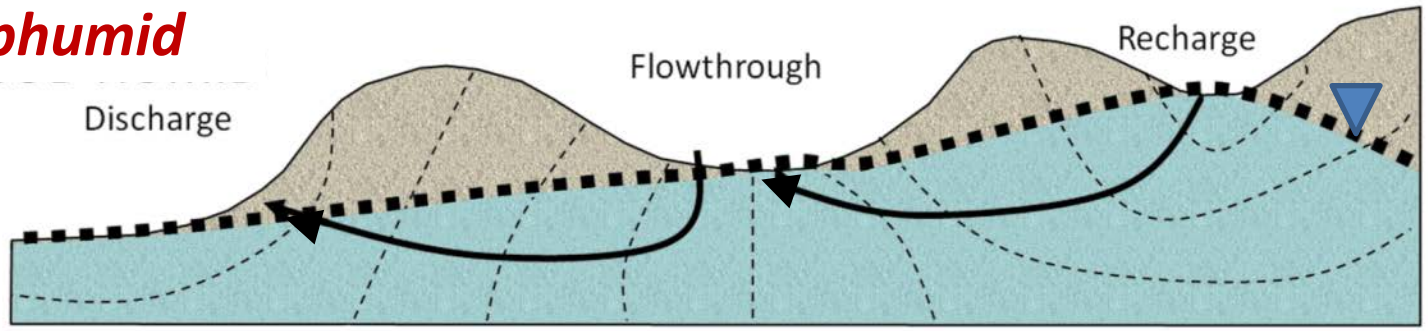
Soil Systems and Climate Uncertainty

(A way to bridge scales in climate prediction and response).

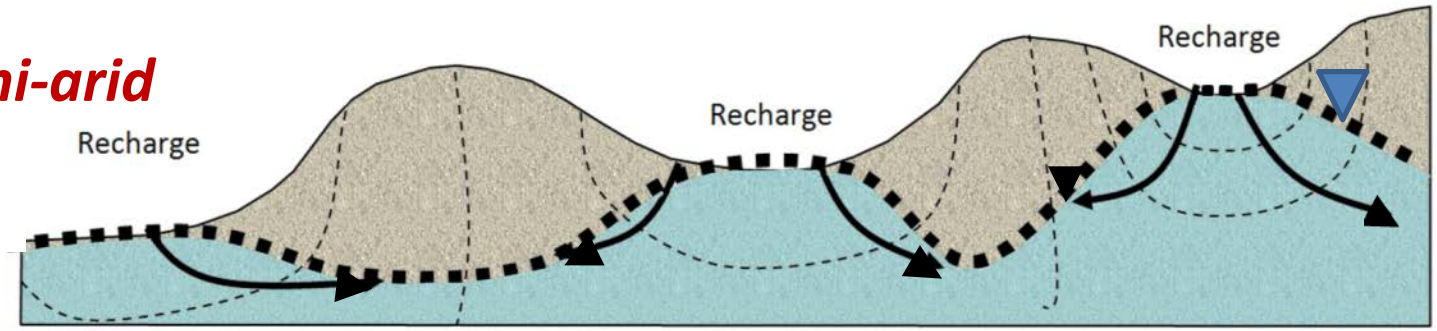
Humid



Subhumid



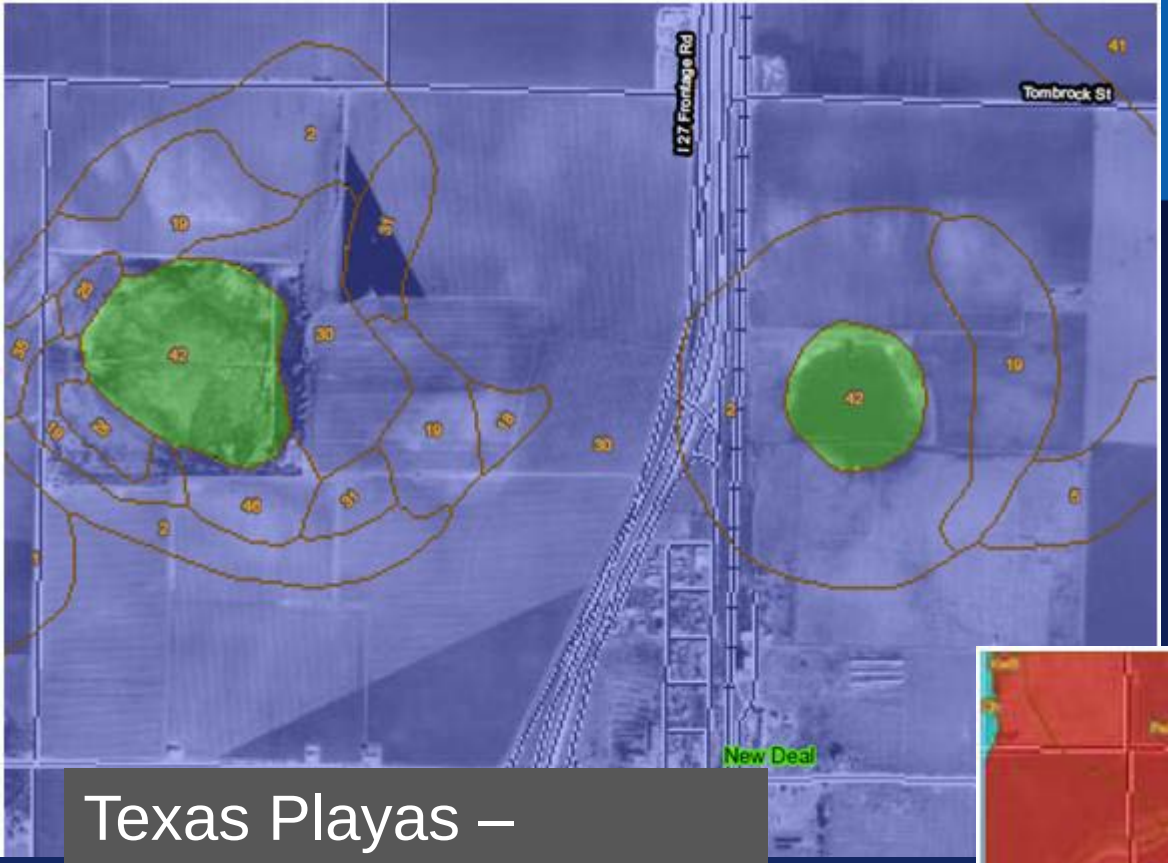
Semi-arid



Richardson et al. 1991

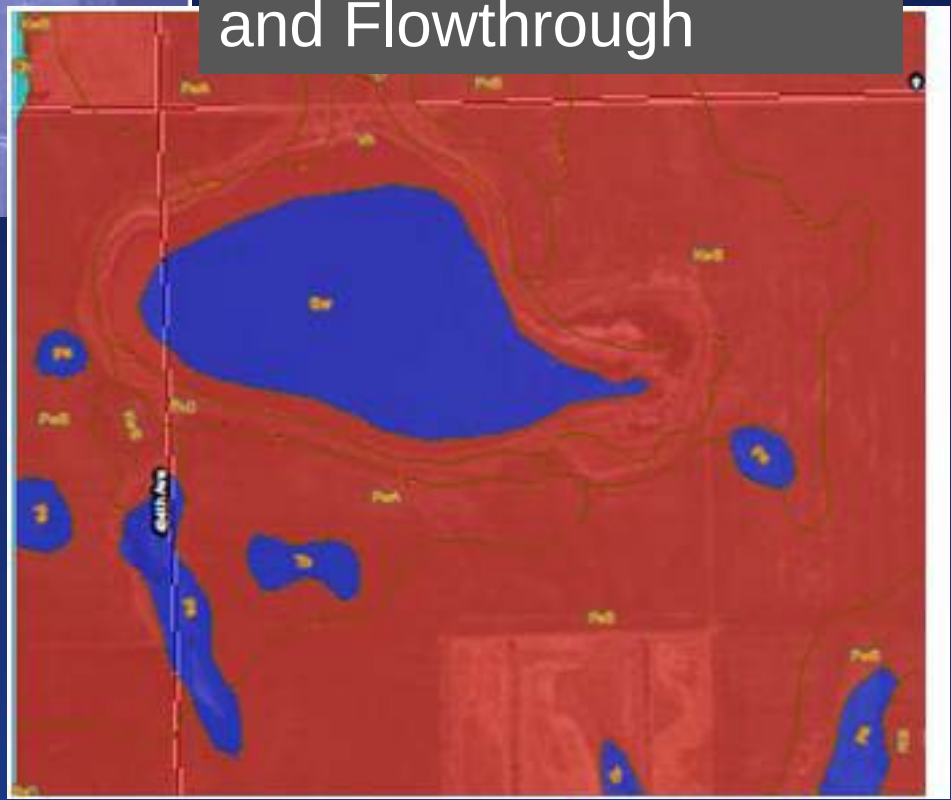
Depression Wetlands – Unique Functions

- Aquifer Recharge
- Critical Upland Water Sources
- Seasonal Aquatic Organism Habitat



Depressional- Default if not found on other HGM class

South Dakota Prairie Potholes – Recharge, Discharge, and Flowthrough

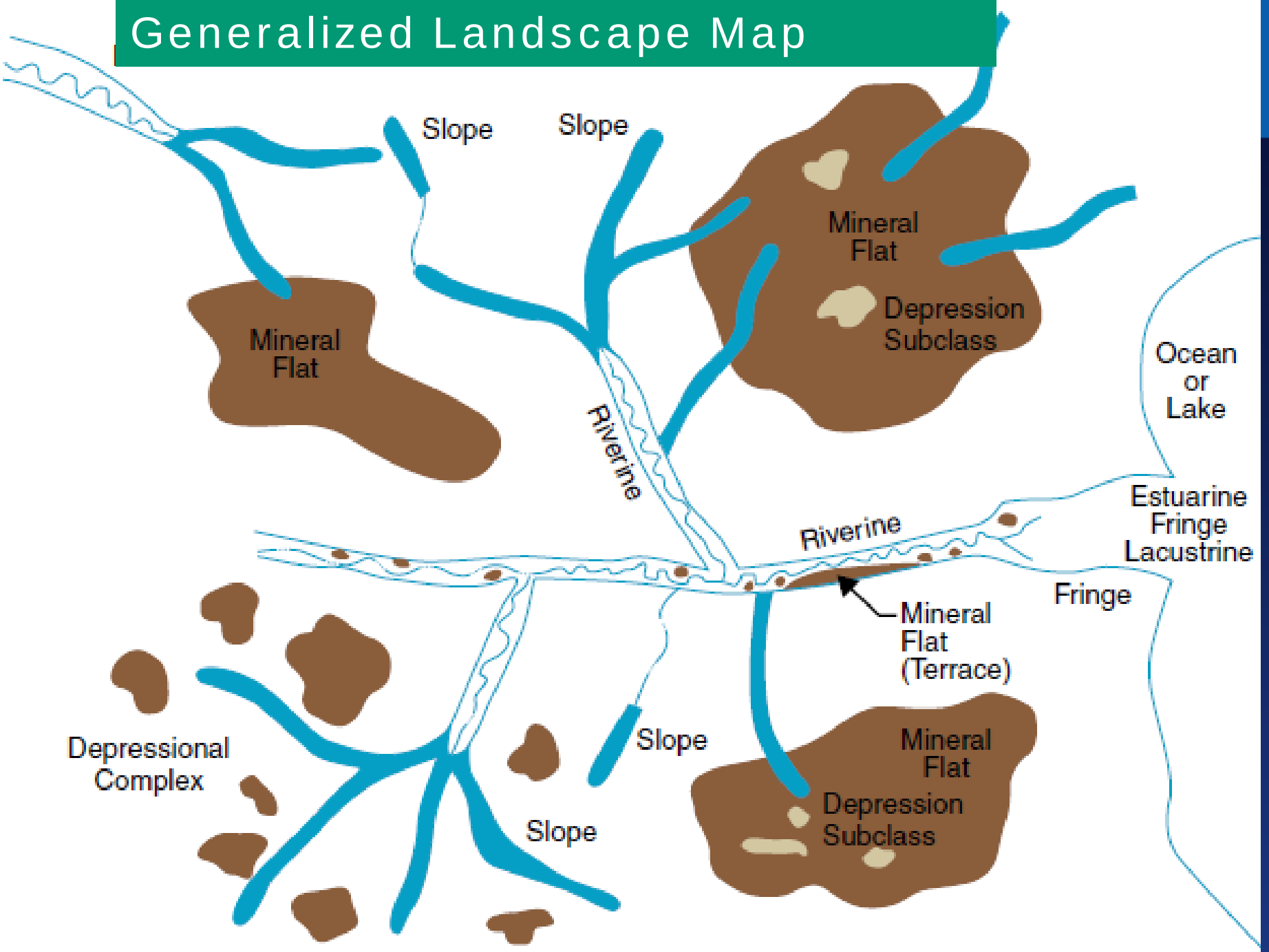


Texas Playas – Recharge

Randall Clay

Highly affected by higher Ecological Sites

Generalized Landscape Map



HGM – ESD Ecohydrology -Common Parameters

The Hydrogeomorphic (HGM) Classification System is based on 3 factors –

- Landscape Position
  - WHERE it is
- Dominant Water Source
  - Not the ONLY Source
- Hydrodynamics
  - The direction(s) of water movement in and out

“Influencing Water Features” -Discussion

- Do influencing water features capture site to site connections?
- Do they allow the construction of watershed with sites?
- Are they tied to soil hydrodynamic properties?
- Do ALL sites have a hydrologic influence within their watershed? (ans. YES)

Recommendations:

- Integrate Hydrosequence and Soil System concepts into all ESDs in an equitable fashion by targeting:
  - similar spatial resolution
  - similar climate record
  - similar data sources
  - similar methods
  - geomorphic landscape context
  - a soil data model that can be upscaled or downscaled
- Use HGM parameters to build sites containing streams, floodplains, stream corridors, and wetlands

Recommendations:

- Screen ecological site concepts using spatial mapping or simulation model techniques – beginning with MLRA and 12-digit HUC's, SSURGO and Digital Elevation Models and other relevant sources

- *Coordinate with HGM practitioners – they are a primary customer.*

Concepts for Ecohydrology

Webinar Review

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   - Data Sources
3. Testing Ecohydrology Methods
   - Method choice
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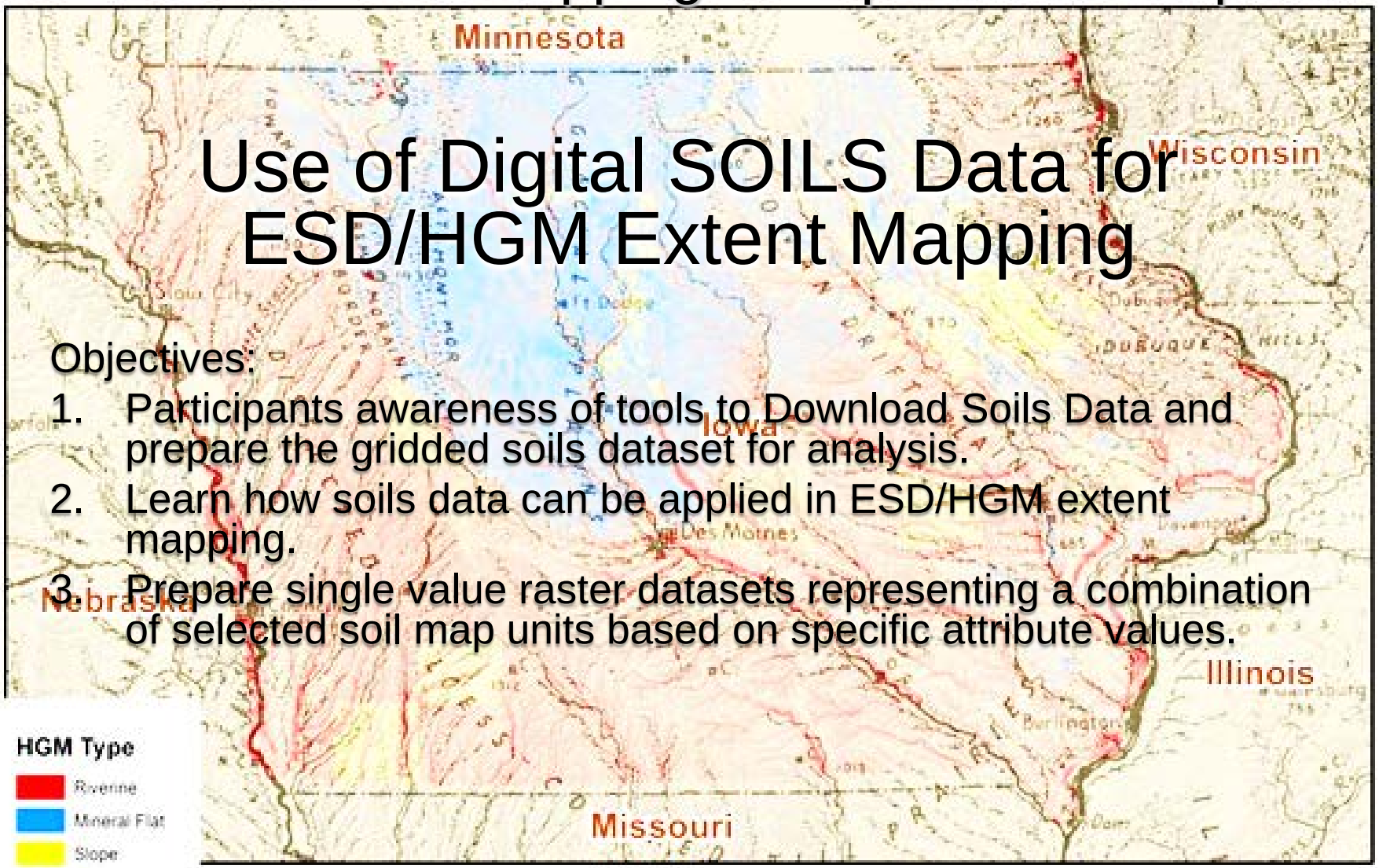
   - Map layer development for landscape screening
   - Evaluation of method in context of broader landscape
4. Example Ecohydrology Classifications – models of reality
5. Recommendations & Questions

ESD/HGM Extent Mapping Geospatial Techniques

Use of Digital SOILS Data for ESD/HGM Extent Mapping

Objectives:

1. Participants awareness of tools to Download Soils Data and prepare the gridded soils dataset for analysis.
2. Learn how soils data can be applied in ESD/HGM extent mapping.
3. Prepare single value raster datasets representing a combination of selected soil map units based on specific attribute values.

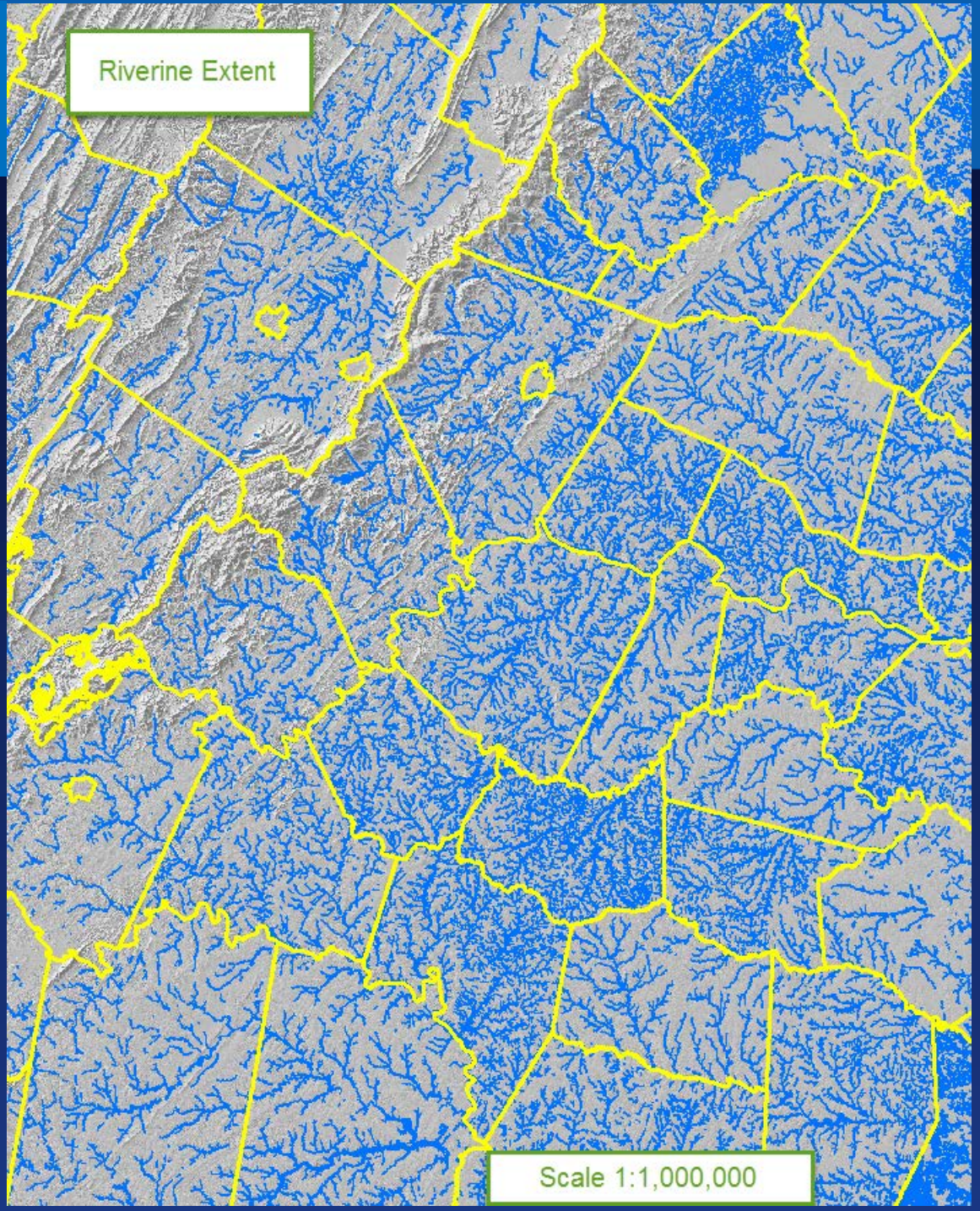


Soils Data Preparation

- Steve Peaslee, NSSC GIS Specialist, and Sharon Waltman, NSSC-GRU Soil Scientist, presented a webinar titled, "Working With The New FY2015 SSURGO and gSSURGO Soil Databases" October 28th.
- The PowerPoint and webinar recording are available on the NSSC Videos and Webinars page, or access the recording directly on the National Soil Survey Center YouTube channel, http://www.youtube.com/user/nrcsnssc
- SSURGO Download tools are available at the NRCS GIS Sharepoint site: https://ems-team.usda.gov/sites/NRCS_SSRA/gis/Shared .
- Additional assistance for soil data preparation for participants can be provided as requested.

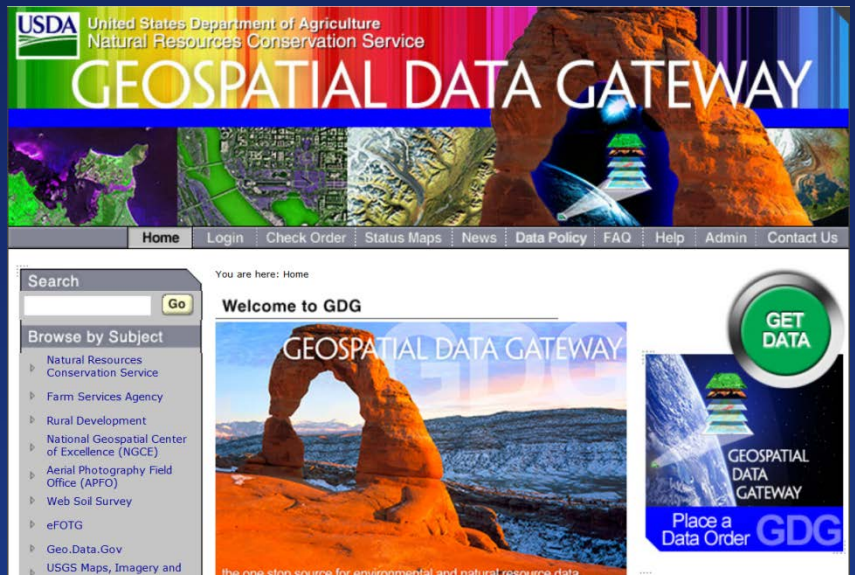
Soils Data Preparation

- Tools can prepare large extent datasets.
- Both Vector and Raster format.
- Can be used for multi-SSA analysis at watershed or MLRA extents.



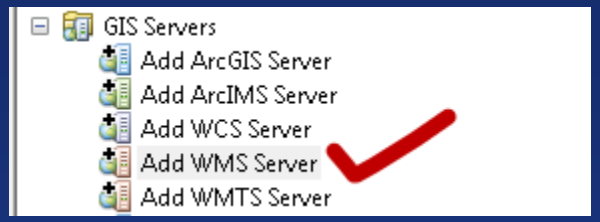
Acquisition of Other Datasets

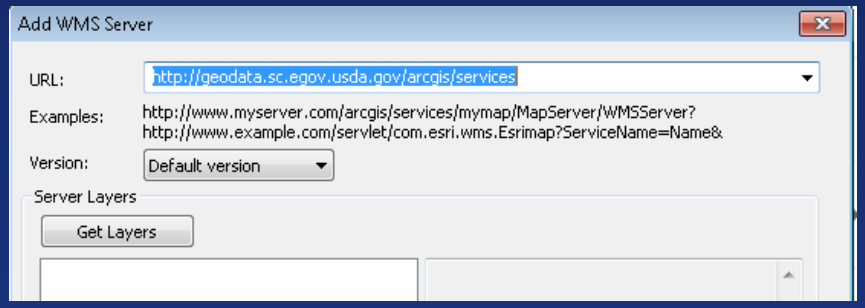
- ESD/HGM Analysis will be performed on an extent to be determined.
- If available it is recommended to have a GIS specialist provide the geospatial data for the project.
- Base datasets can be acquired at the Geospatial Data Gateway. http://datagateway.nrcs.usda.gov/GDGHome.aspx
- Base Datasets that may be required:
  - Common Resource Area
  - Major Land Resource Area
  - 12 Digit Hydrologic Units
  - States and Counties polygon feature class

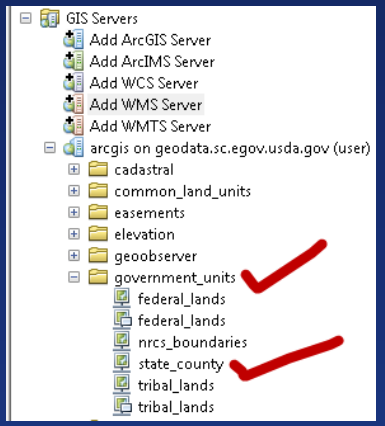


Prepare the Map Document

- After the Soil Dataset has been prepared then other datasets are needed in the ArcMap Document.
- Another useful dataset will be the State boundary. Since this will not be used for analysis, a Web Map Service can be used.
- ArcCatalog is used to make a connection to the NRCS datasets provided.
- Aerial Photography and Topographic Map images can also be accessed using the WMS.
- Requires a Network Connection.

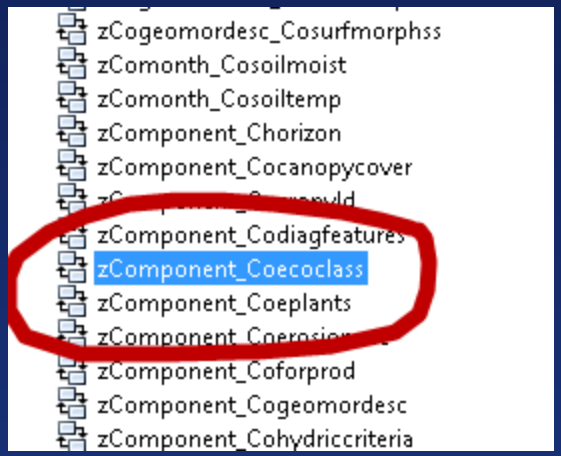


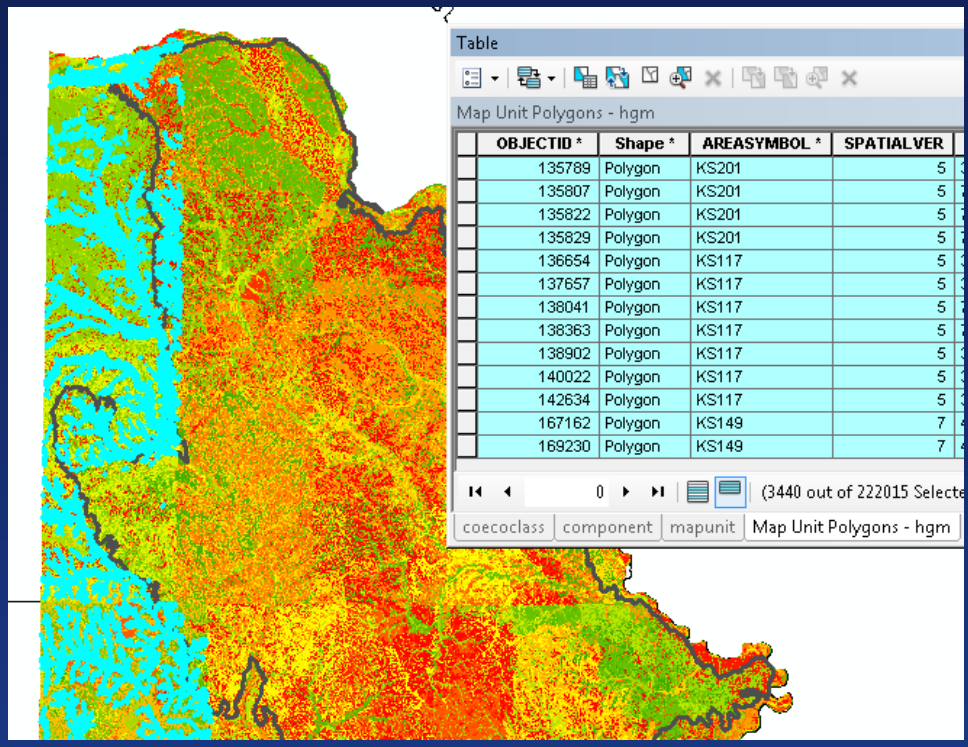




Analysis of Soil Vector Data

- Scripts automatically create the table relate objects in the file geodatabase.
- Example of a sequence of relates from the Component Ecoclass table to the MUPOLYGON feature class for the RX075XY013KS Loamy Lowland (PE 25-34) ESD for MLRA 106.

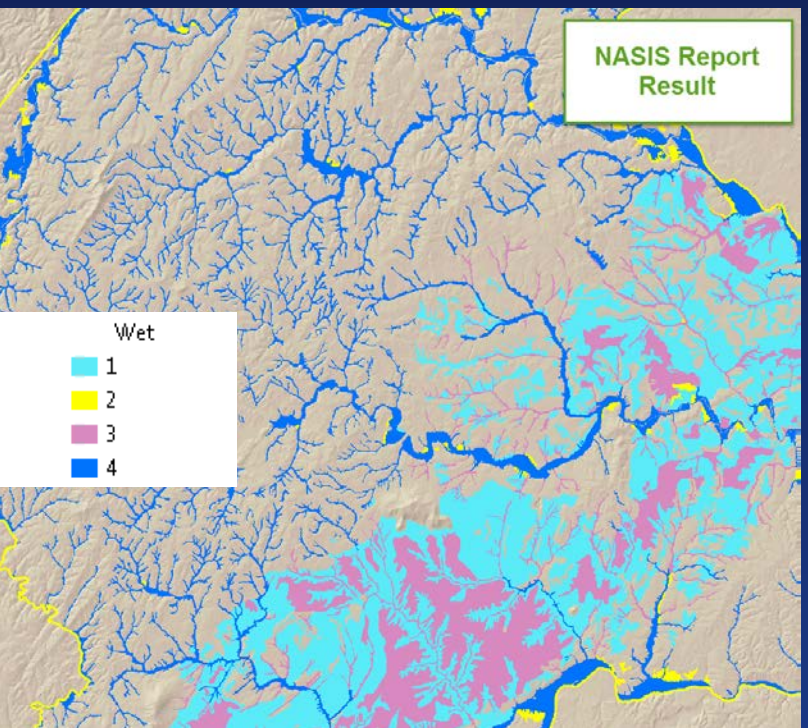




Create Soils Database Script

- Optimum method for database query is a Soil Data Access or NASIS report.
- Prepared by a Soil Scientist to extract specific soil properties

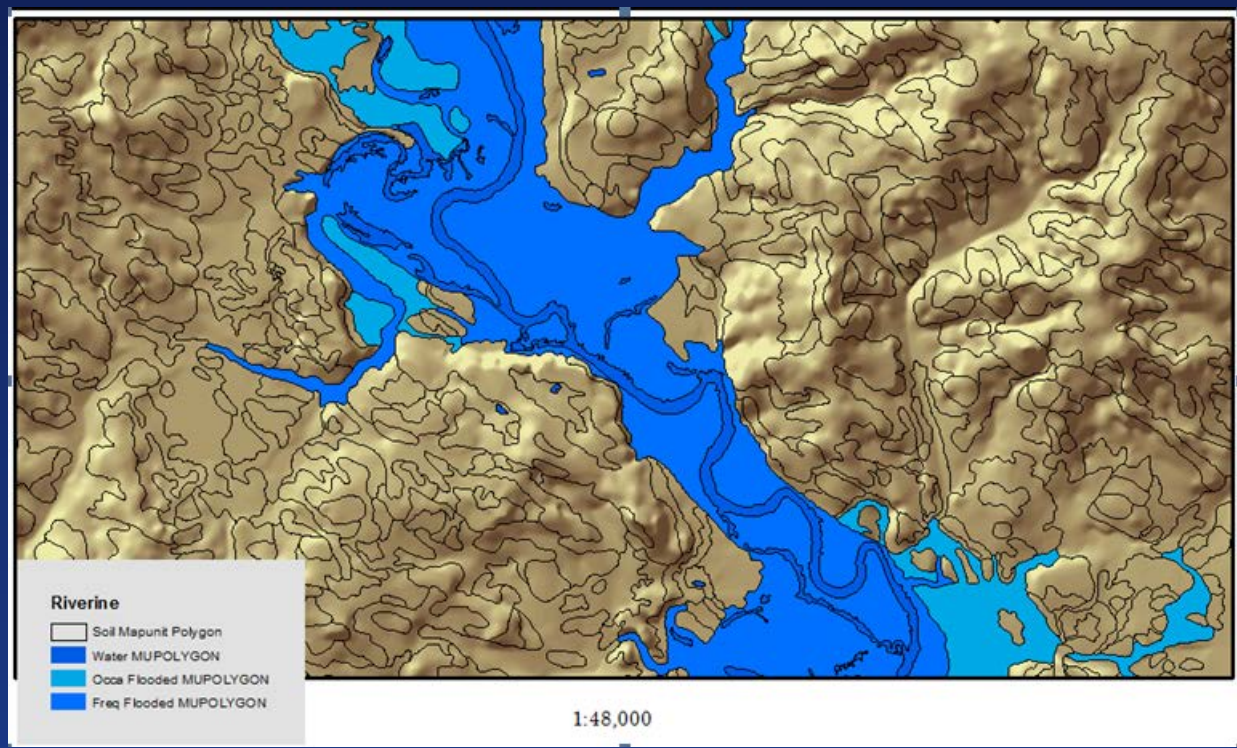
```
select LEFT((areasymbol), 2) as state,  l.areasymbol, l.areaname, mu.mukey, mu.musym, mu.muname, mu
(select CASE when min(soimoistdept_r) is null then '200' else (min(soimoistdept_r) ) END
          from component left outer join comonth left outer join cosoilmoist
            on comonth.comonthkey = cosoilmoist.comonthkey
            on comonth.cokey = component.cokey
         where component.cokey = c.cokey
           and soimoiststat = 'Wet'
and ((taxtempregime in ('Cryic', 'Pergelic') and comonth.month in ('July', 'August'))
or (taxtempregime in ('Frigid', 'Mesic', 'Isofrigid') and comonth.month in ('May', 'June',  'July'
or (taxtempregime in ('Thermic', 'Hyperthermic') and comonth.month in ('April', 'May', 'June',  'Ju
or (taxtempregime in ('Isothermic', 'Isohyperthermic', 'Isomesic') and comonth.month in ('March',
            ) as mingswatertable_r,
(select CASE when max(soimoistdept_r) is null then '200' else (max(soimoistdept_r)) END
          from component left outer join comonth left outer join cosoilmoist
            on comonth.comonthkey = cosoilmoist.comonthkey
            on comonth.cokey = component.cokey
         where component.cokey = c.cokey
           and soimoiststat = 'Wet'
and ((taxtempregime in ('Cryic', 'Pergelic') and comonth.month in ('July', 'August'))
or (taxtempregime in ('Frigid', 'Mesic', 'Isofrigid') and comonth.month in ('May', 'June',  'July'
or (taxtempregime in ('Thermic', 'Hyperthermic') and comonth.month in ('April', 'May', 'June',  'Ju
or (taxtempregime in ('Isothermic', 'Isohyperthermic', 'Isomesic') and comonth.month in ('March',
            ) as maxgswatertable_r,
(select top 1 floddurcl from comonth, MetadataDomainMaster dm, MetadataDomainDetail dd where comont
INTO #jerry
FROM legend l INNER JOIN mapunit mu ON mu.lkey = l.lkey
LEFT OUTER JOIN component c ON c.mukey = mu.mukey
LEFT OUTER JOIN chorizon ch ON ch.cokey = c.cokey
LEFT OUTER JOIN chtexturegrp ct ON ch.chkey=ct.chkey
WHERE c.majcompflag = 'yes' and ct.rvindicator = 'yes' and hzdept_r = 0 and slope_r < 1.1  and nir
LEFT ((areasymbol), 2) IN ('IL', 'IN', 'IA', 'MI', 'MO', 'MN', 'SD', 'WI', 'OH', 'ND')
ORDER by l.areasymbol, mu.musym

select state,  areasymbol, areaname, mukey, musym, muname, muacres, majcompflag, comppct_r, compnar
FROM #jerry
Where mingswatertable_r < 61 and floddur is null or (floddur <> 'long' and floddur <> 'very long')
```



- Output can be joined or related to either vector or raster soil spatial data.
- Soil Scientist extracted properties into 4 categories that can be analyzed for specific HGM class.

Analysis of Soil Vector Data

- Soil data tables with the appropriate one-to-one or many-to-one relationship can be joined to Soil Map Unit polygon feature class. Also table relates can be used to access values in other tables.
- Specific attribute values can be used to select and build HGM extent maps.



Adding Attributes to the Soil Raster Data

- Prior to the Clip of the MLRA Soil Raster dataset to the MLRA boundary.
- Use of custom table created for soil property query and analysis.
  - MUAGGATT or MAPUNIT table.
  - Join table to MLRA soil raster dataset using MUKEY

	mukey	musym	muname	cokey	majcompflag	comppct_r	compname	drainagecl
1	50226	101	Benka silt loam, 0 to 3 percent slopes	979953	Yes	90	Benka	Well drained
2	50227	102	Benka silt loam, sloping and moderately steep	979954	Yes	60	Benka	Well drained
3	50229	103	Benka silt loam, undulating	979954	Yes	90	Benka	Well drained
4	50231	104	Benka-Liten complex, nearly level and moderately steep	979955	Yes	65	Benka	Well drained
5	50233	105	Bodenburg silt loam, 0 to 3 percent slopes	979955	Yes	90	Bodenburg	Well drained
6	50234	106	Bodenburg silt loam, sloping and moderately steep	979956	Yes	60	Bodenburg	Well drained
7	50235	107	Bodenburg silt loam, steep and sloping	979956	Yes	65	Bodenburg	Well drained
8	50236	108	Bodenburg silt loam, undulating	979957	Yes	90	Bodenburg	Well drained
9	50237	109	Bodenburg silt loam, silty substratum, 0 to 3 percent slopes	979957	Yes	90	Bodenburg	Well drained
10	50239	110	Bodenburg silt loam, silty substratum, sloping and moderately steep	979958	Yes	60	Bodenburg	Well drained
11	50240	111	Bodenburg silt loam, silty substratum, undulating	979958	Yes	85	Bodenburg	Well drained
12	50241	112	Bodenburg-Jim complex, steep and sloping	979959	Yes	50	Bodenburg	Well drained

0 (0 out of 285547 Selected)

MapunitRaster_soil_10m_clip106bnd

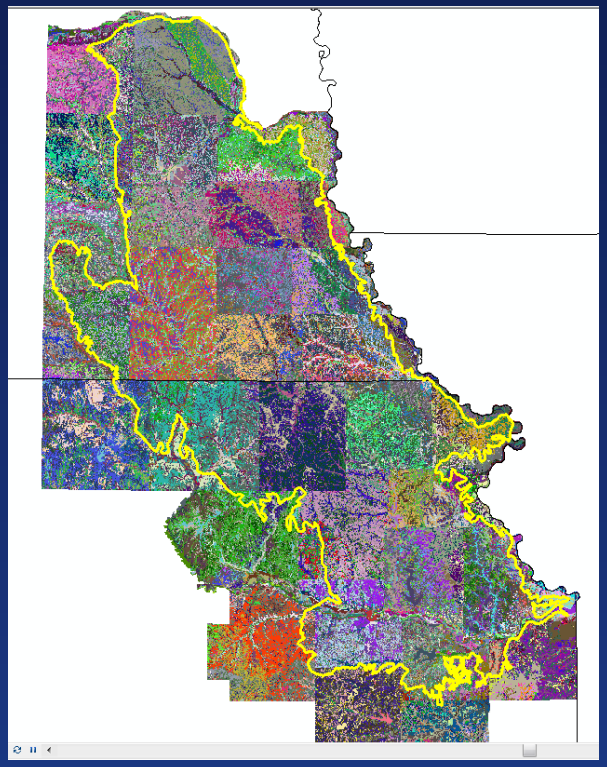
majcompflag	comppct_r	compname	compkind	drainagecl	hydgrp	ecositeID	
Yes	85	Albaton	Series	Poorly drained	D	R107XY004K	Clay Lov
Yes	85	Armster	Series	Moderately well drained	C	R106XY007K	Clay Upl
Yes	55	Bendena	Series	Somewhat excessively drained	D	R106XY028K	Shallow
Yes	55	Bendena	Series	Somewhat excessively drained	D	R106XY028K	Shallow
Yes	65	Contrary	Series	Well drained	B	R106XY015K	Loamy L
Yes	65	Contrary	Series	Well drained	B	R106XY015K	Loamy L
Yes	85	Hamburg	Series	Somewhat excessively drained	B	R107XY012K	Limy Upl
Yes	95	Haynie	Series	Well drained	B	R107XY013K	Loamy L
Yes	60	Haynie	Series	Well drained	B	R107XY013K	Loamy L
Yes	95	Judson	Series	Well drained	B	R106XY013K	Loamy L
Yes	85	Kennebec	Series	Moderately well drained	B	R106XY013K	Loamy L
Yes	90	Knox	Series	Well drained	B	R107XY015K	Loamy L

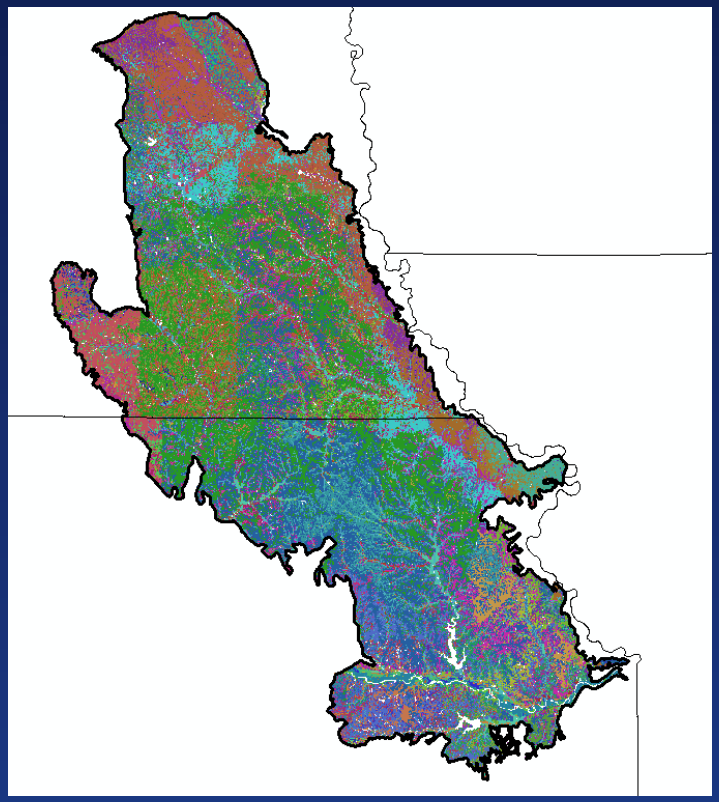
1 (0 out of 1703 Selected)

- Number of rows in the table after the clip to the MLRA boundary.
- Over 285,000 rows reduced to 1,703.

Analysis of Soil Raster Data
Extract by Mask

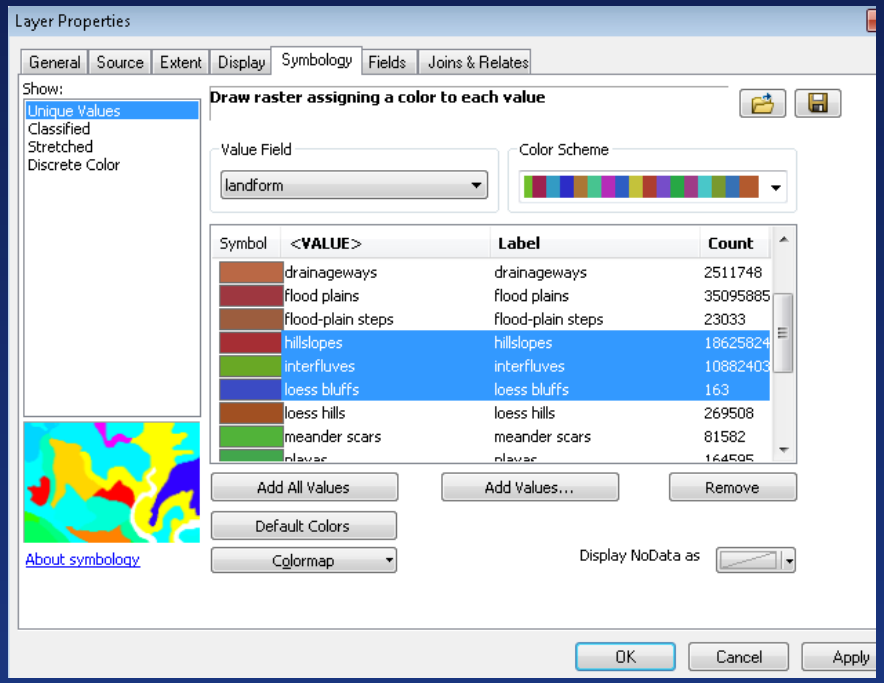
- Original Raster dataset extends beyond the MLRA boundary.
- Clipped Raster dataset can be used for area calculations.

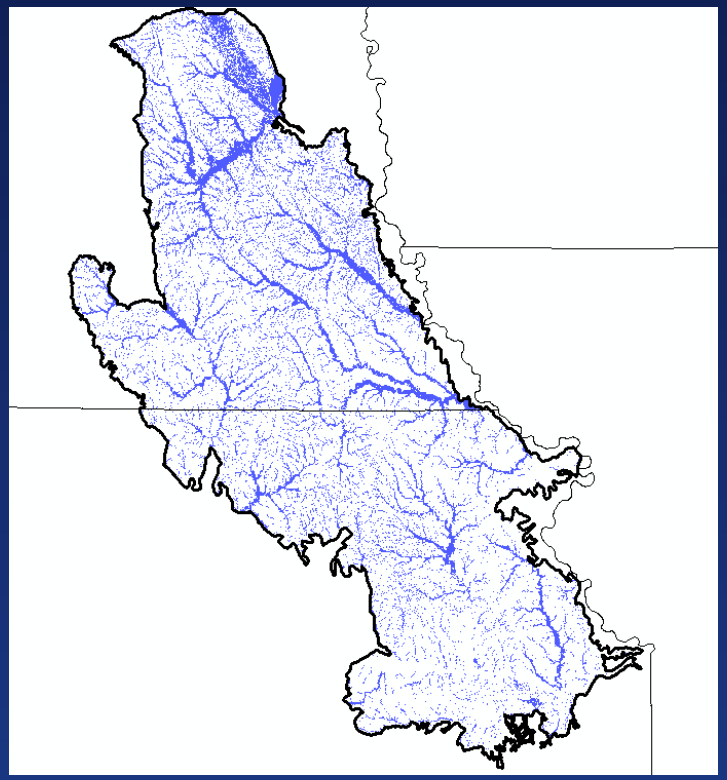




Analysis of Soil Raster Data

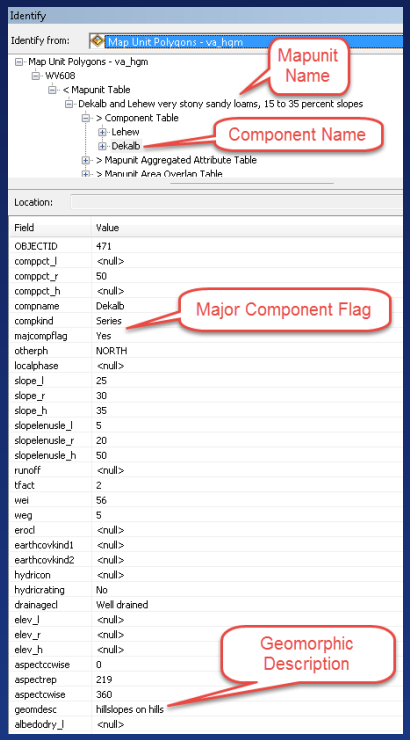
- Query of soil mapunit properties is now available with the additional attributes included in the clipped raster soil dataset.
- Use of Symbology of the Raster Soils Dataset as a Preview
- Example of Selecting Landforms related to Hydrology.

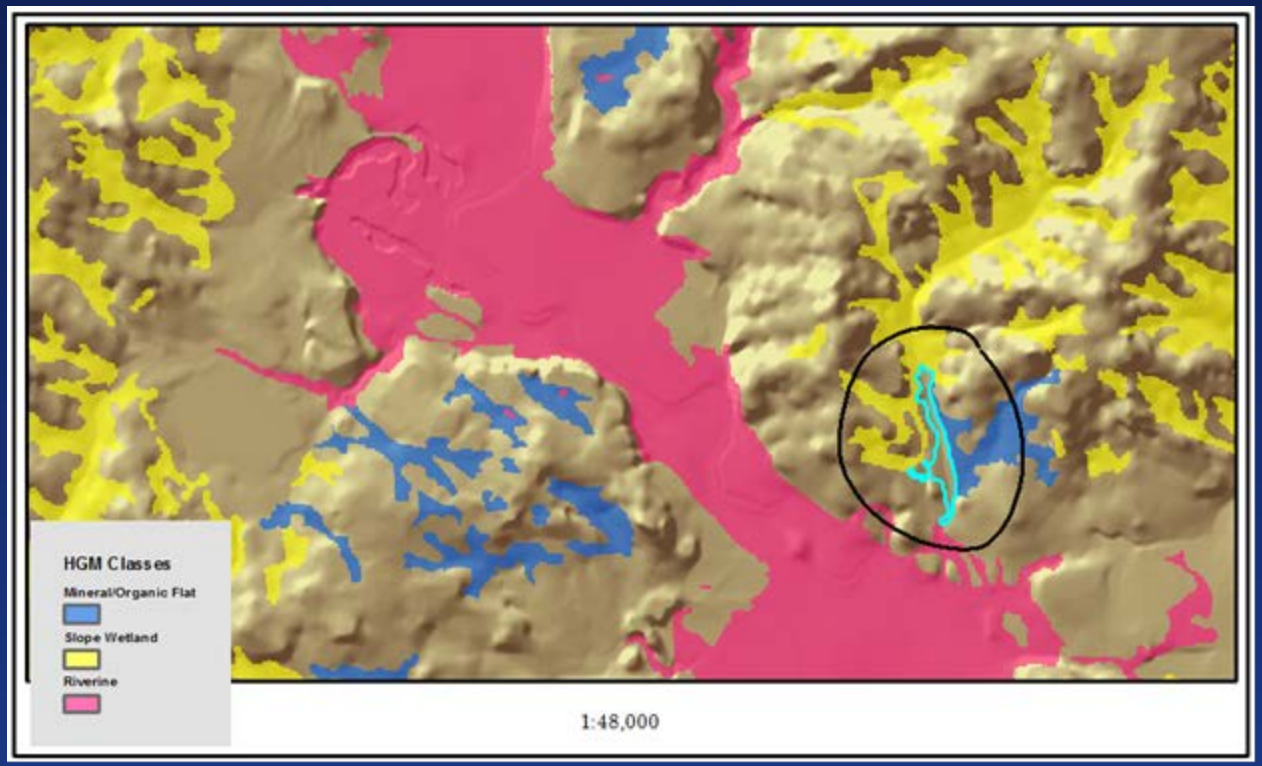




Analyzing the Result

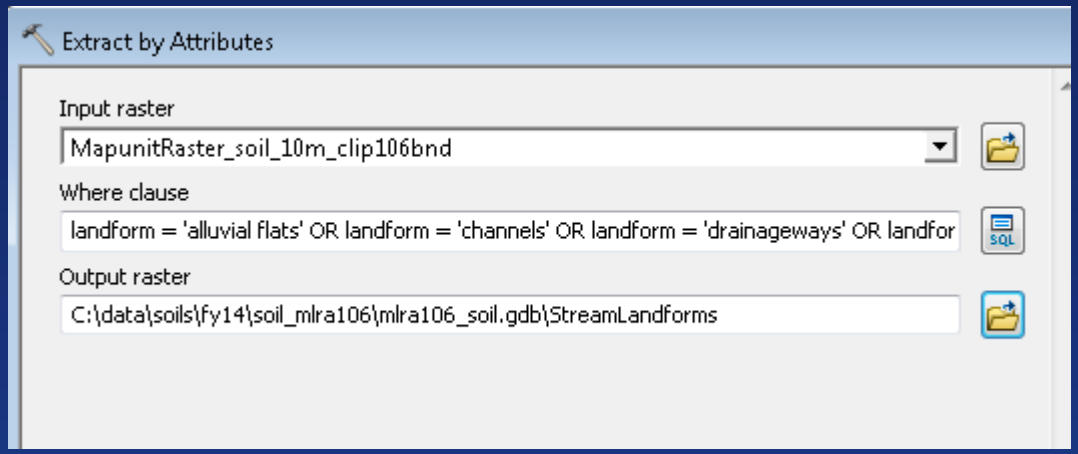
- Symbology Results used to identify areas that need additional examination.
- Multiple Queries may be needed to added to include additional areas.
- Use the ID Tool with the original soil map unit polygon feature class to examine the attributes in related tables.

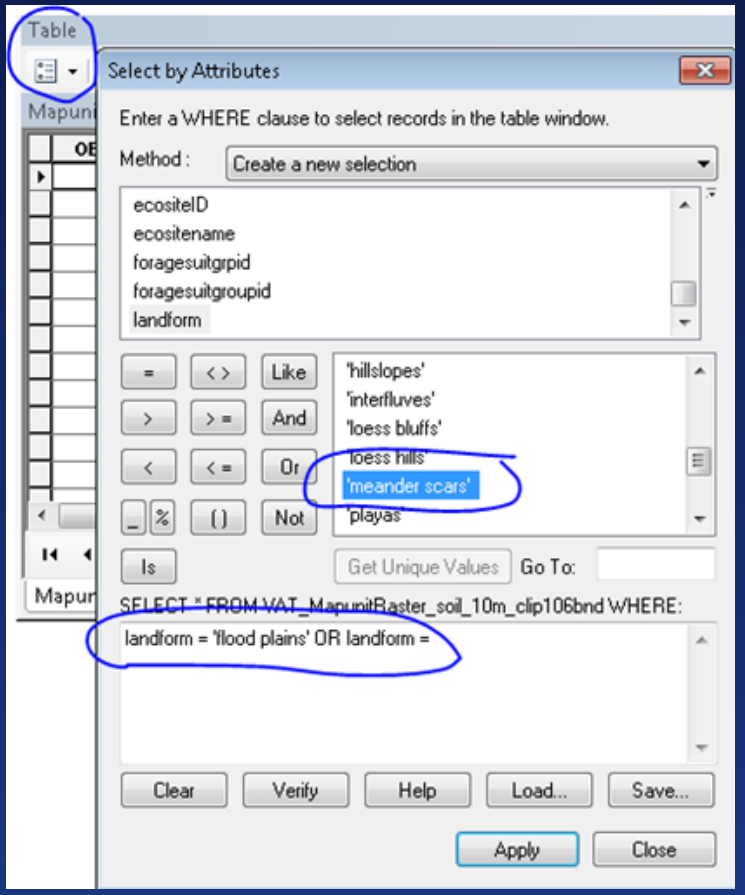




Create a Single Value Raster Dataset

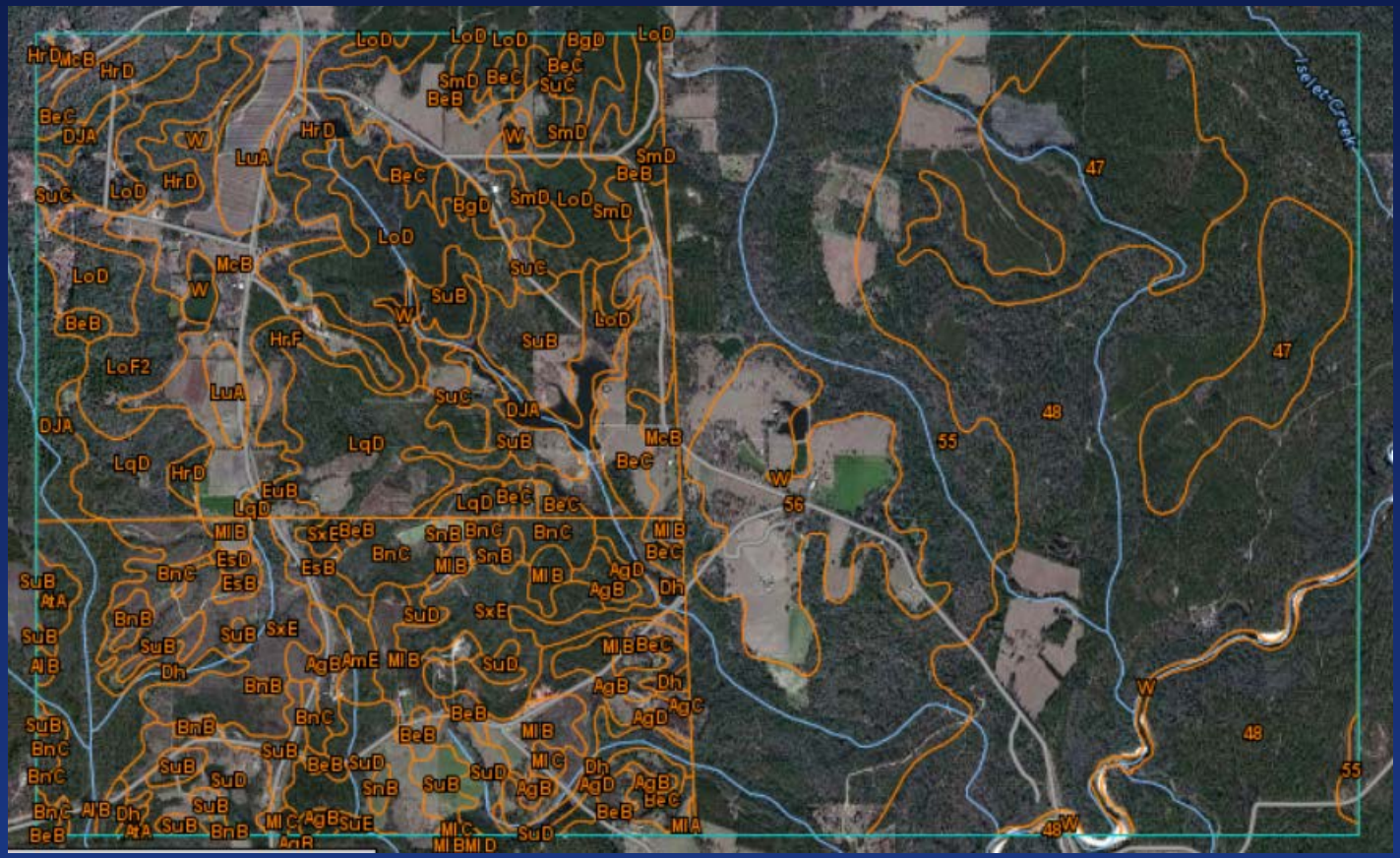
- A single value raster dataset can be used in analysis with other datasets for ESD and HGM analysis purposes.
- After a preview to know what values to use in a selection, use the Table Select by Attributes to build the Query.
- In this case the hydrology related values from the landform attribute are used to build the query
- The completed query can be saved for use with Extract by Attributes tool.





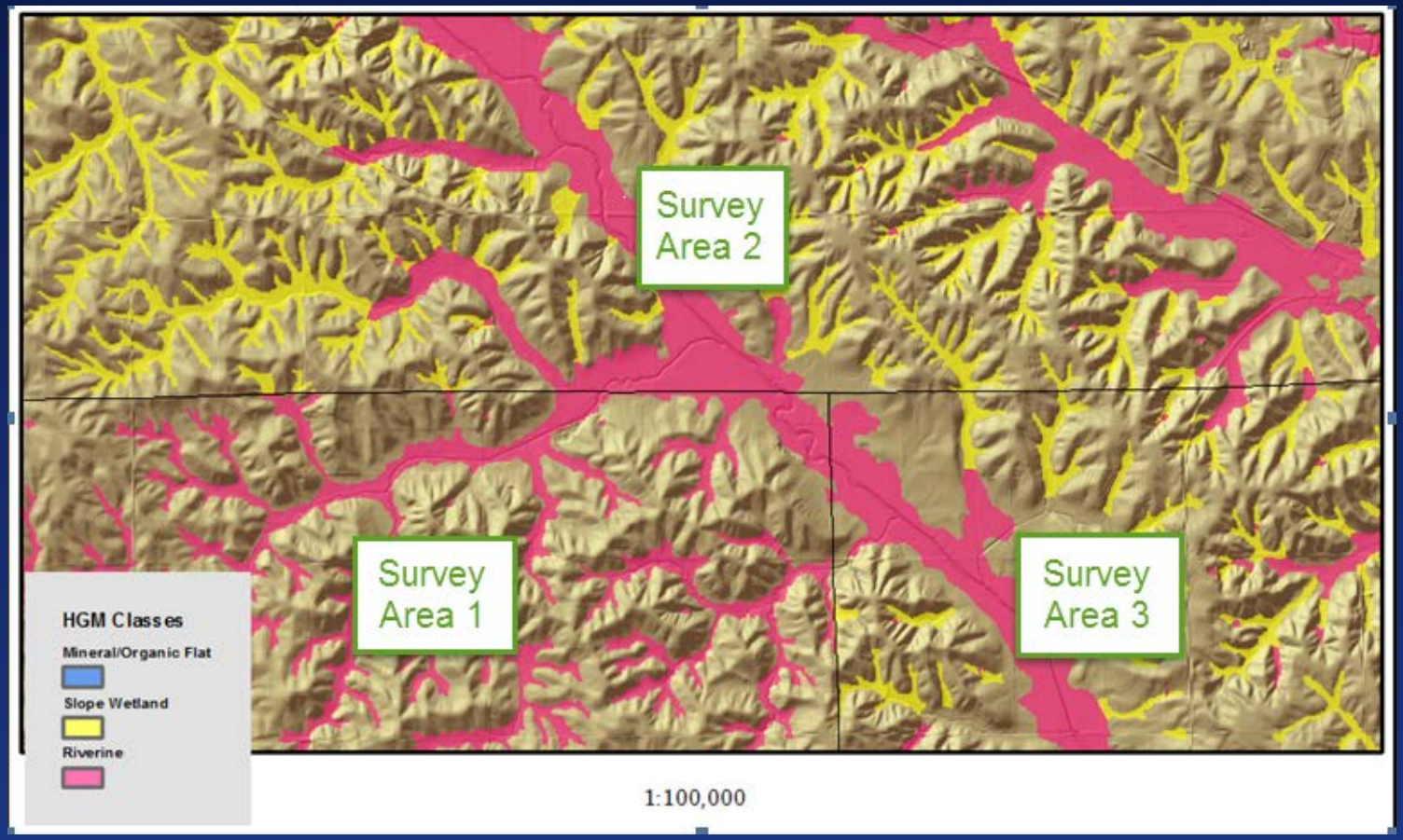
Soil Data Application for HGM Analysis

- Example of 3 adjacent Soil Survey Areas differences in level of detail
- Screen Capture from Web Soil Survey Displayed at 1:24,000.

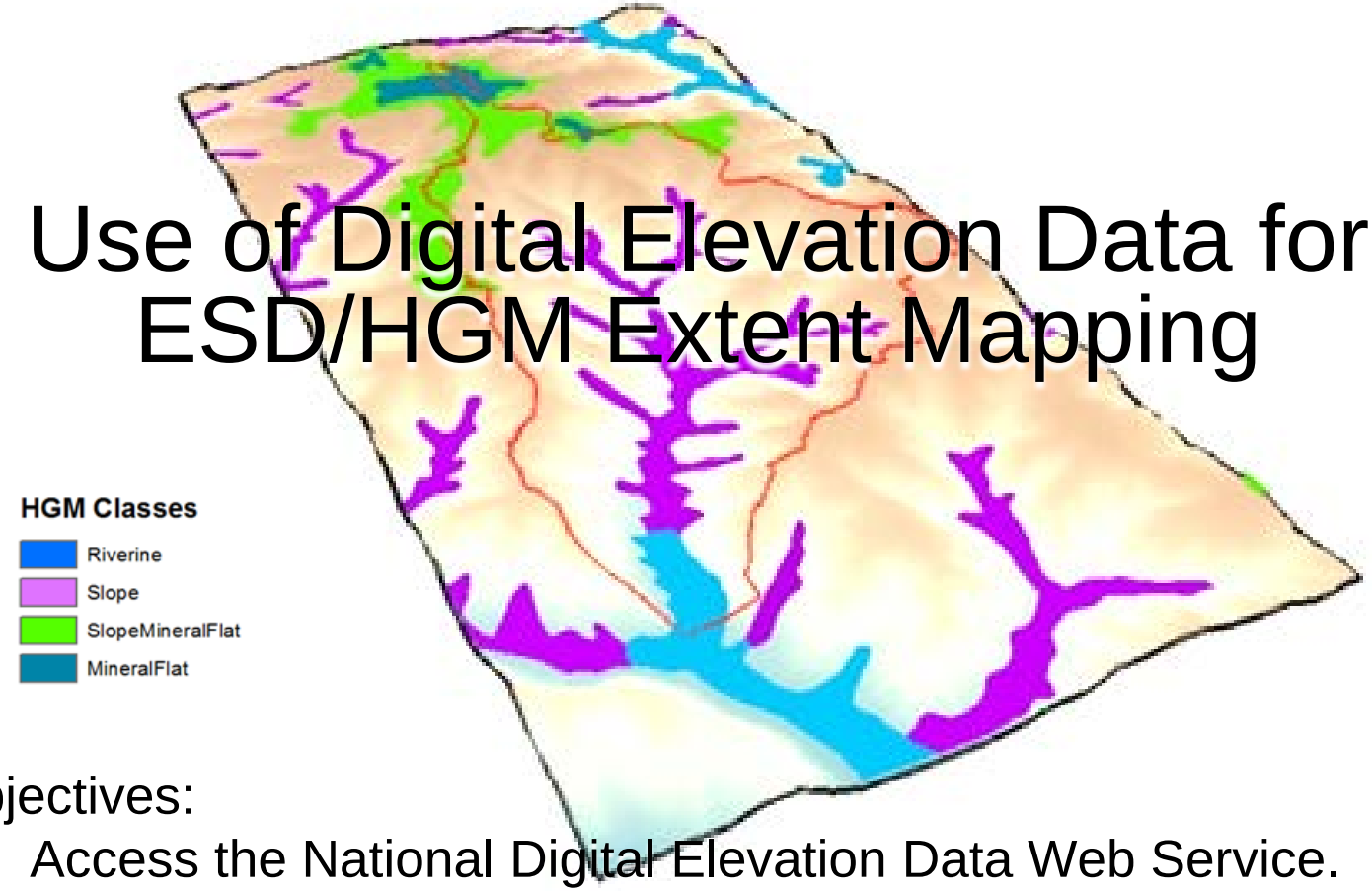


Soil Attribute Differences

- Soil map unit delineations are very consistent across survey area boundaries.
- Soil Attribute values are different.



ESD/HGM Extent Mapping Geospatial Techniques



Use of Digital Elevation Data for ESD/HGM Extent Mapping

Objectives:

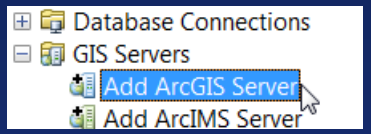
1. Access the National Digital Elevation Data Web Service.
2. Prepare terrain and hydrology datasets derived from 10m digital elevation data for ESD/HGM extent mapping.

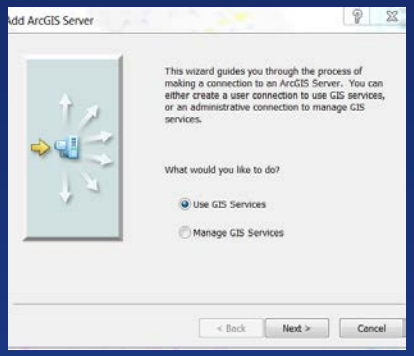
National Elevation Data Web Service

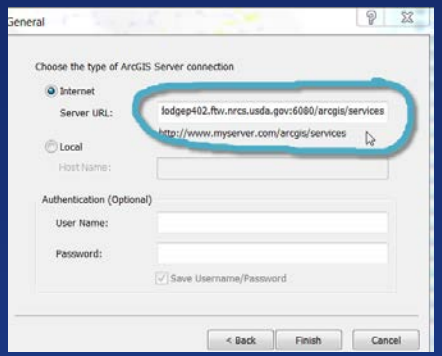
Access to NED, LiDAR, IFSAR elevation data holdings.

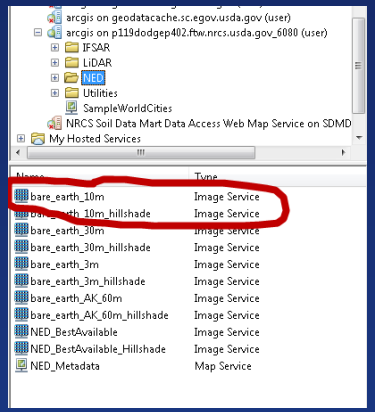
http://p119dodgep402.ftw.nrcs.usda.gov:6080/arcgis/services

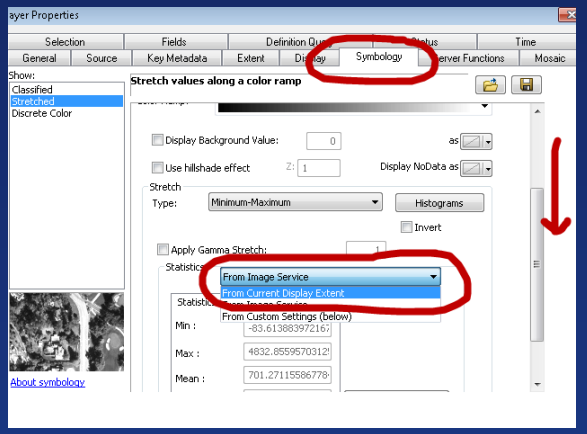
Connection made using ArcCatalog – Add ArcGIS Server dialog.
NED consists of 3, 10, or 30m resolution DED.











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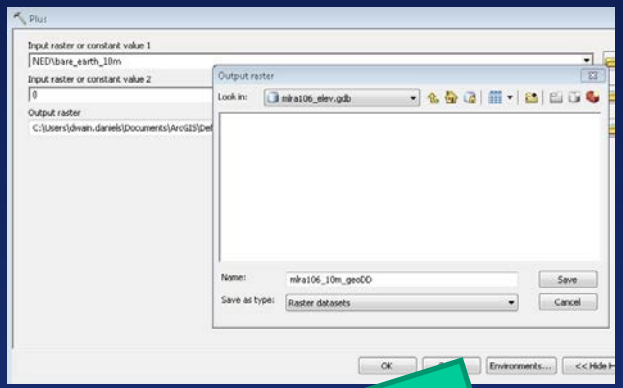
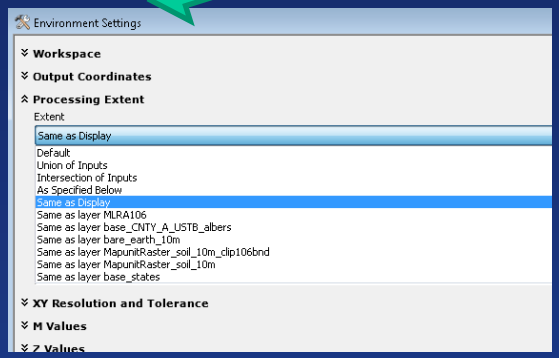
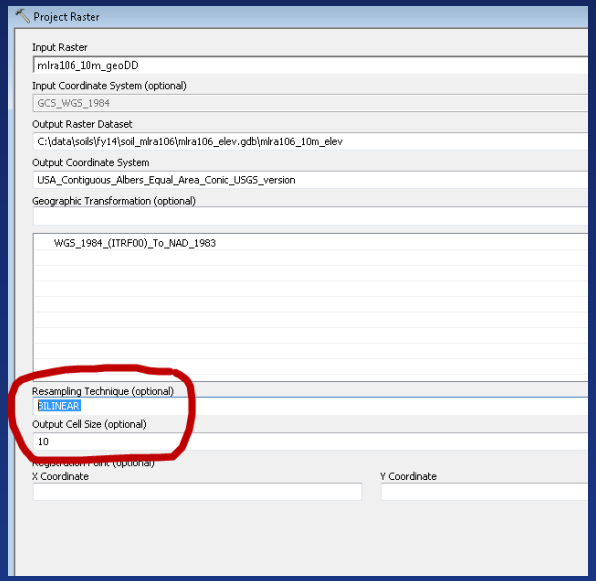
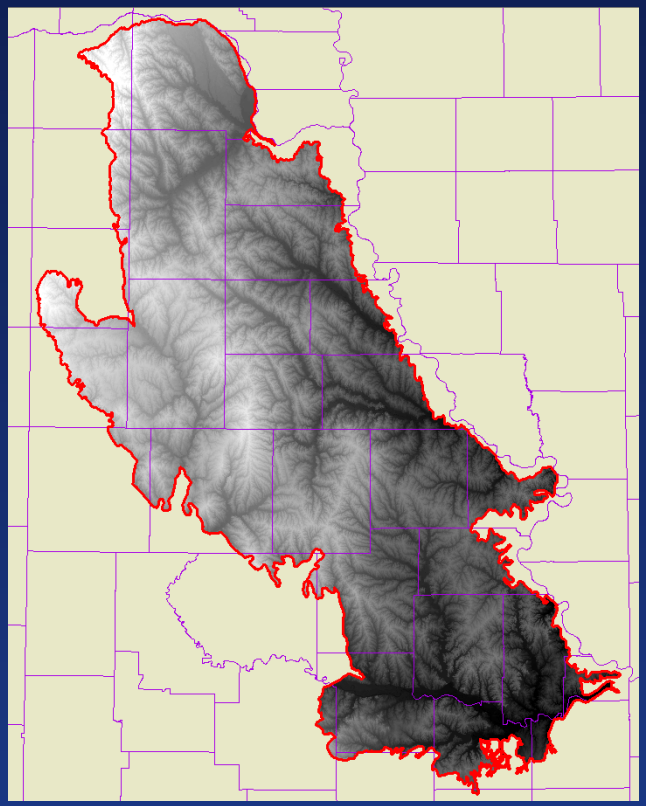
National Elevation Data Web Service

Extract the Digital Elevation Data for the Area of Interest (MLRA extent)
Project and Extract by Mask using the MLRA boundary feature.









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Creation of Terrain Derivatives

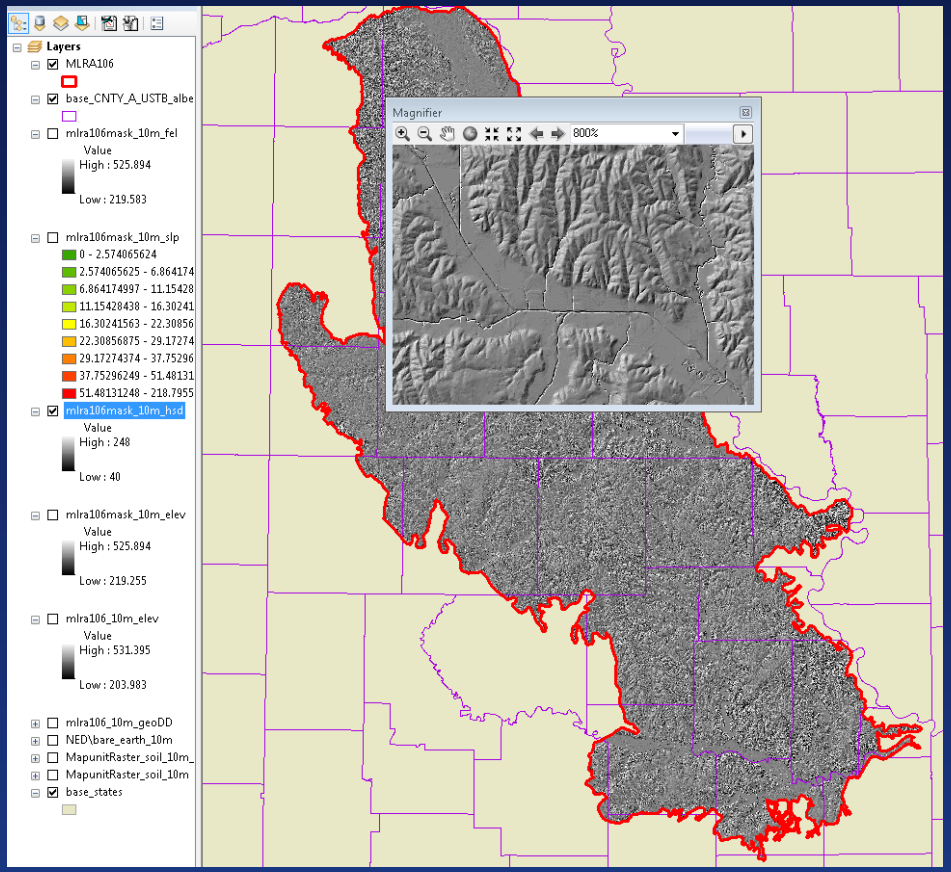
After extraction of the elevation dataset, Terrain derivatives can be created. There are many automated tools and scripts available to create different terrain derivatives.

Primary and Secondary Terrain Derivatives can be used in conjunction with Soil Map Units to locate specific combinations of soil and landscape conditions.

The HILLSHADE image product is very useful to visually evaluate the results of soil map unit queries.

Primary terrain derivatives such as SLOPE (gradient) and ASPECT are commonly used.

Secondary derivatives such as wetness index are also used.



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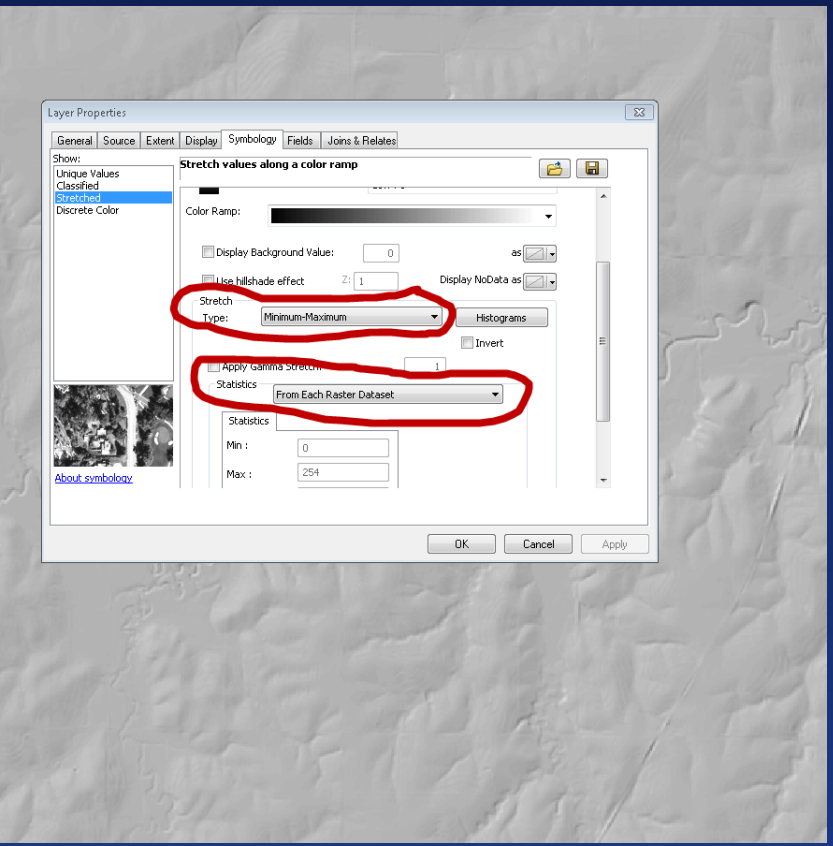
Natural Resources Conservation Service

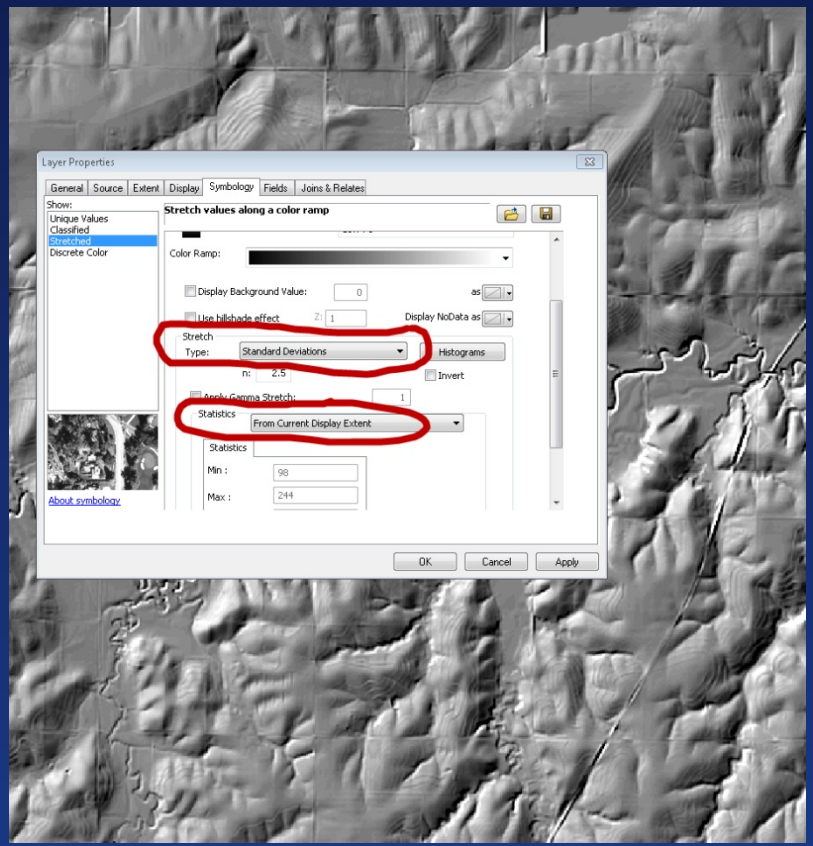
Symbolization of Terrain Derivatives

Symbolization of Terrain derivatives is needed for those datasets that will be used for visual comparison with other data subjects. Symbolization is a Layer Property that can greatly improve the usefulness of the dataset for visualization.

Default Symbology

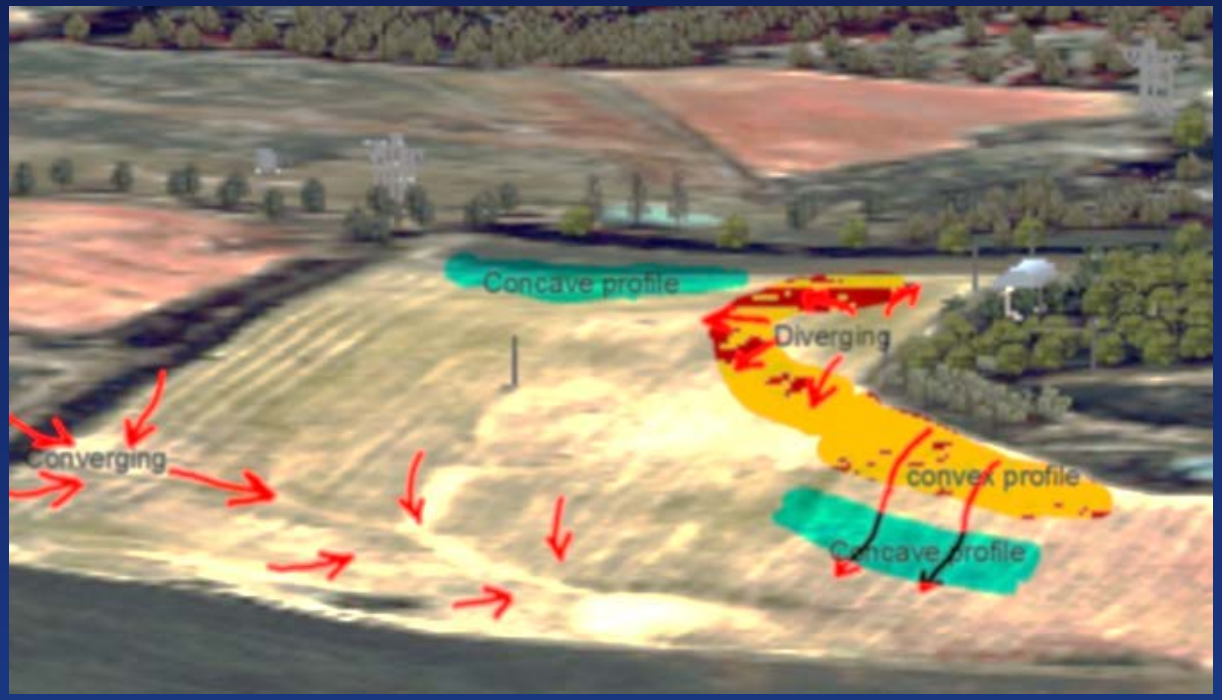


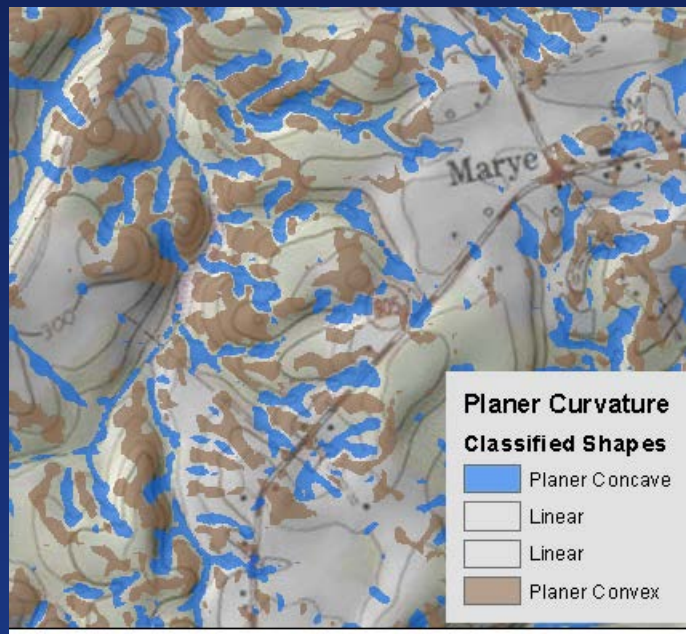
Modified Symbology



Curvature Analysis

- The areas where surface water collects across the landscape can be assessed with the planer curvature raster.
- The areas where surface water movement may accelerate and slow down may be assessed with the profile curvature raster.





1:12,000

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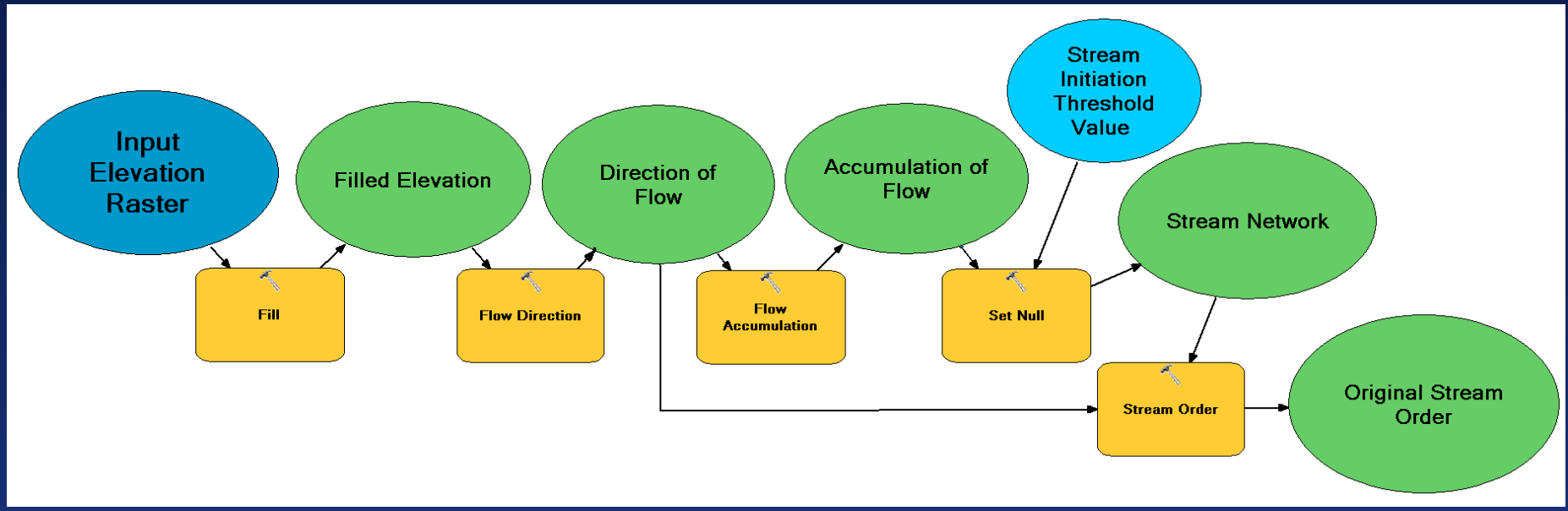
Creation of Hydrology Derivatives

The Stream Order Hydrology Derivative is useful for ESD/HGM extent mapping.
The workflow process to create the Stream Order raster dataset is illustrated in this ArcGIS model diagram.



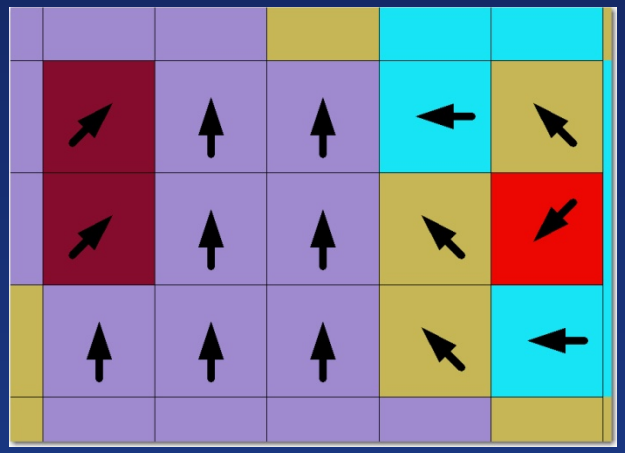
There are Five geoprocessing functions (yellow rectangles) performed on the original elevation dataset (dark blue ellipsoid). The Stream Initiation Threshold (light blue ellipsoid) is a user entered parameter that sets the amount of area (pixel/cell count) that runoff will collect and concentrated stream flow is expected to start .

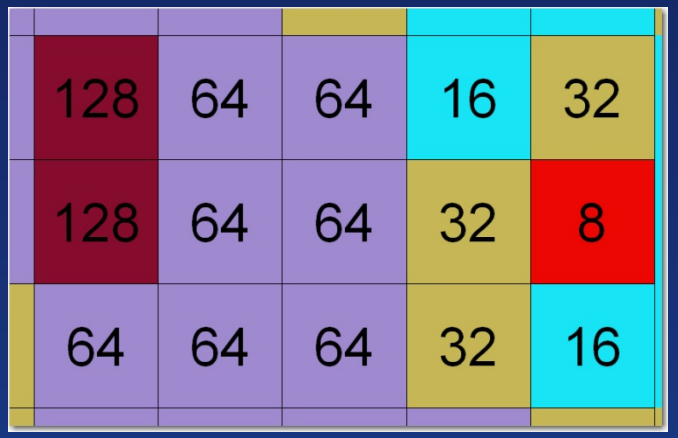
FILL Function

- Necessary preparation for hydrology analysis.
- The FILL function is a tool that performs a hydro-conditioning process on an elevation surface in order to have water flow continuously across the surface.
- Can identify true SINKS in the surface
- Can enter a threshold level that limits the amount of filling of depressions in the surface.

FLOW DIRECTION Function

- Initial primary derivative for hydrology analysis.
- Requires a hydro-conditioned surface.
- The Flow Direction output has values of 1, 2, 4, 8, 16, 32, 64, 128 indicating what direction has the steepest drop in the surrounding 8 cells.

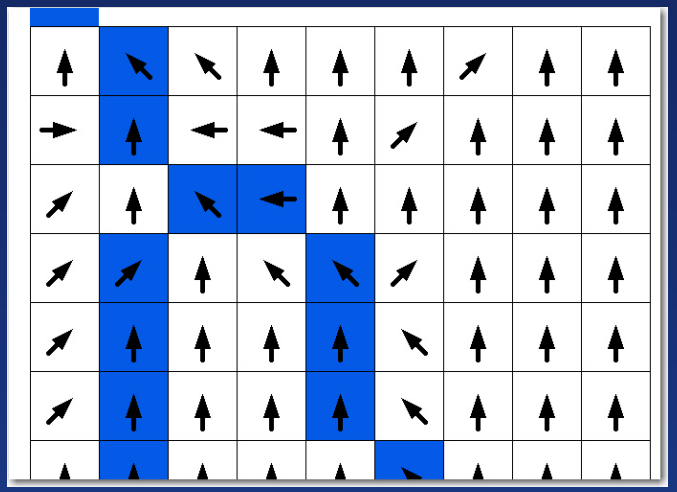




FLOW ACCUMULATION Function

- A secondary derivative for hydrology analysis.
- Requires the Flow Direction surface.
- The Flow Accumulation output has values of the number of cells flowing into the cell. Value of zero indicates no flow into that cell.
- An optional parameter is a weight raster that models the cells surface intake rate.
- Very useful for creating stream networks and calculation of runoff volume.

16	543	0	0	2	0	9
0	542	1	0	1	1	6
0	1	535	349	0	0	5
0	151	16	15	348	0	3
0	149	15	14	346	0	2
1	146	14	13	344	0	1



STREAM NETWORK - SETNULL Function

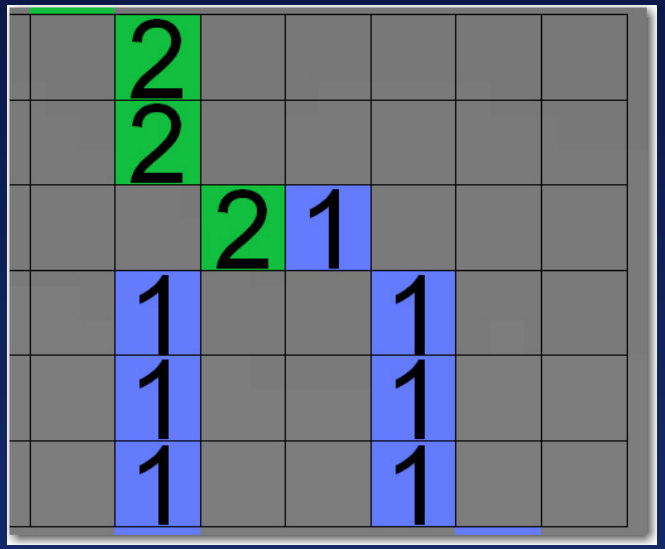
- Setnull is used to create a stream network
- The condition is entered that all flow accumulation values below a threshold level selected by the user will be converted to NULL (NoData).
- The value of the cells that do not meet this condition can be assigned a constant value or values from an existing raster.
- These cells are those in the areas where concentrated water flow occurs across the terrain surface.

16	543	0	0	2	0	9
0	542	1	0	1	1	6
0	1	535	349	0	0	5
0	151	16	15	348	0	3
0	149	15	14	346	0	2
1	146	14	13	344	0	1

	543					
	542					
		535	349			
	151			348		
	149			346		
	146			344		

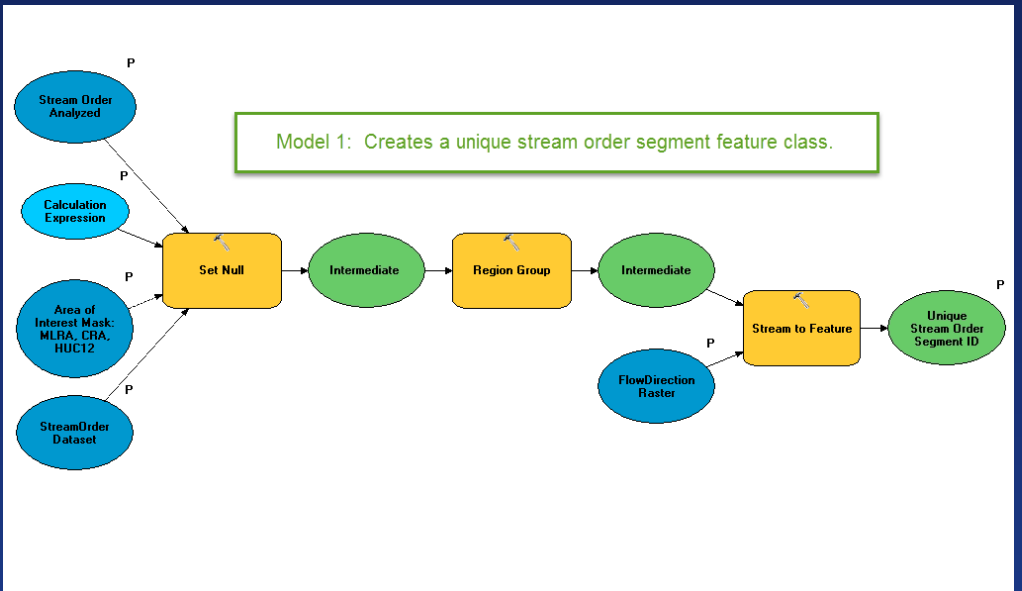
STREAM ORDER Function

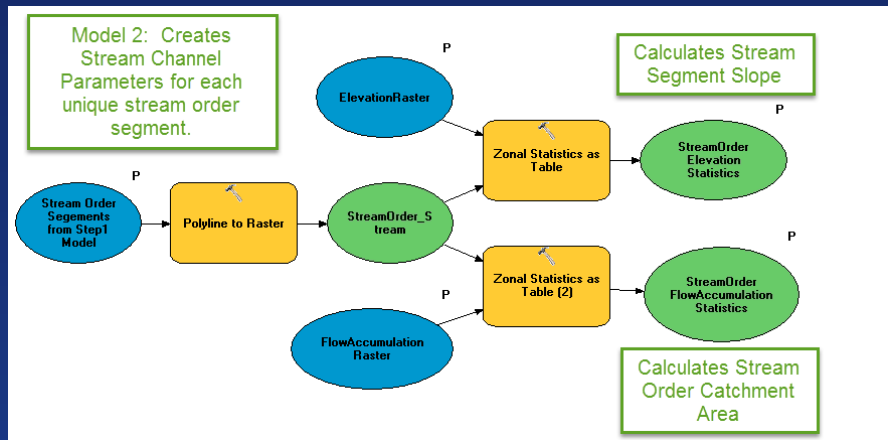
- STREAMORDER assigns values based upon how many stream junctions occur above the cell.
- There are 2 classification systems available as optional input parameters in the function: STRAHLER and SHREVE.
- Useful for targeting specific wet areas resulting from surface runoff is some landscapes.
- Will be used in conjunction with soils data analysis results



Stream Morphology Parameters

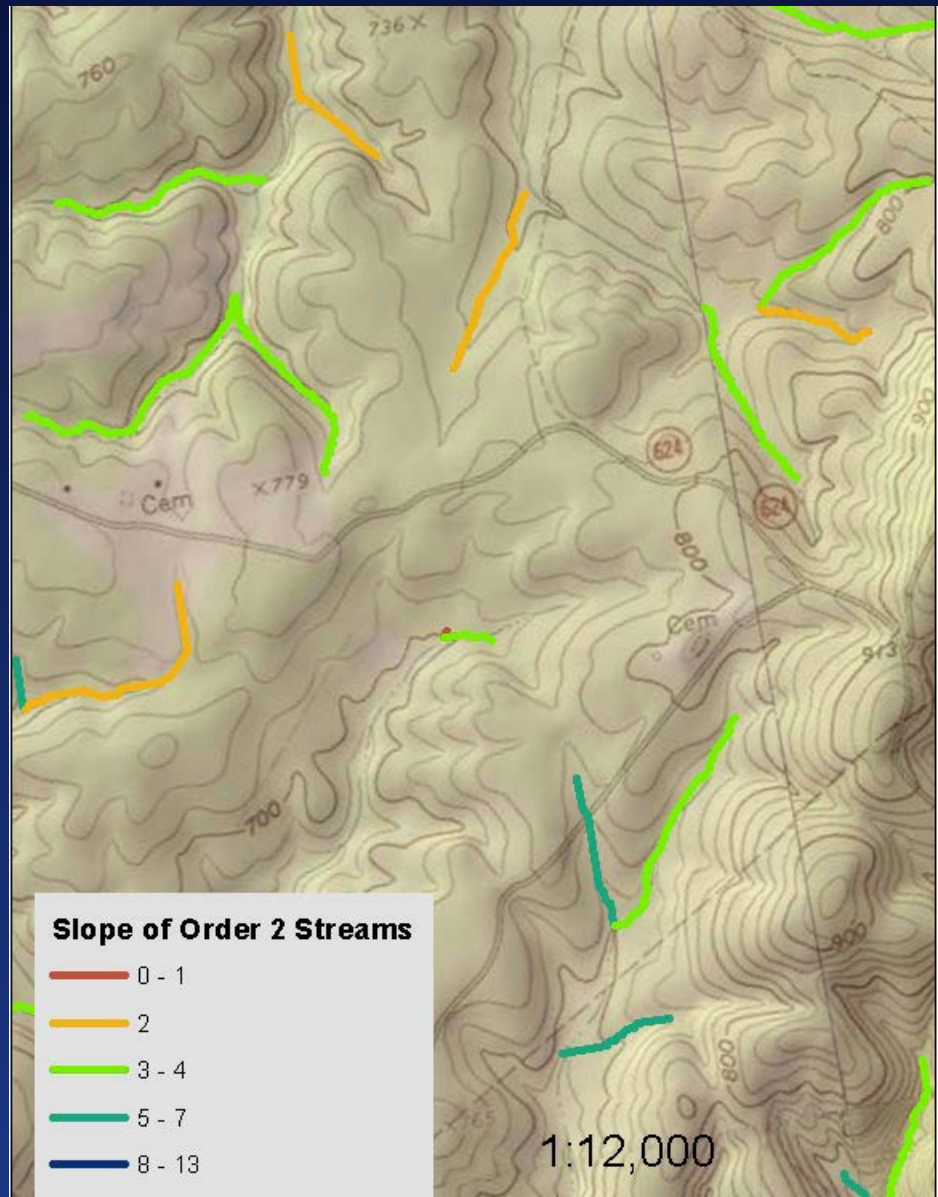
- A workflow process is available to extract specific stream orders within a geographic extent and calculate elevation, slope, catchment area values for each individual stream segment.
- Stream morphology parameters can be assessed over different extents MLRA, CRA, or watershed.





Extraction of Stream Channel Segments

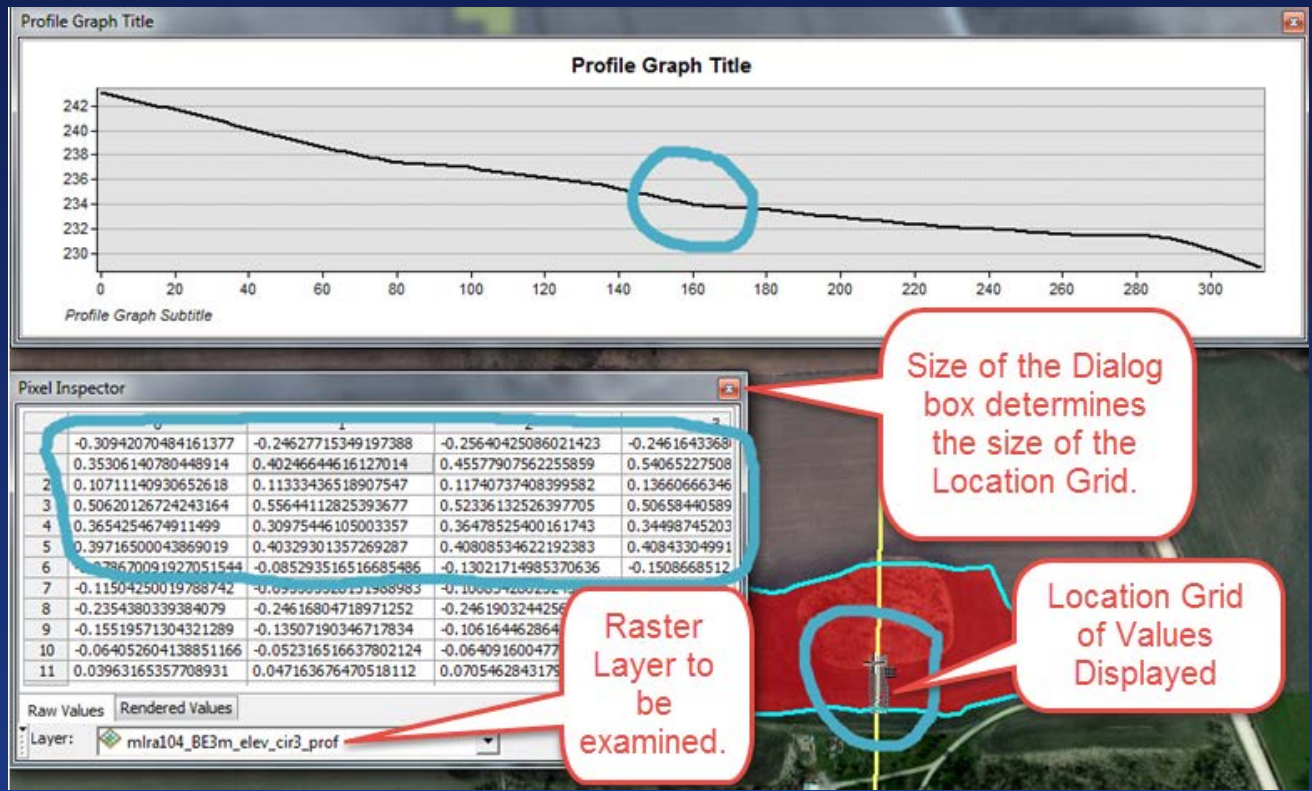
- Example of the different slope gradients within order 2 streams
- Used with other datasets to determine the hydrologic conditions across the area of interest.



Pixel Inspector Tool

- This tool is used to examine the values of raster datasets in the map document.
- It is very useful for answering questions necessary for determining reclassification thresholds and examination of questionable areas.

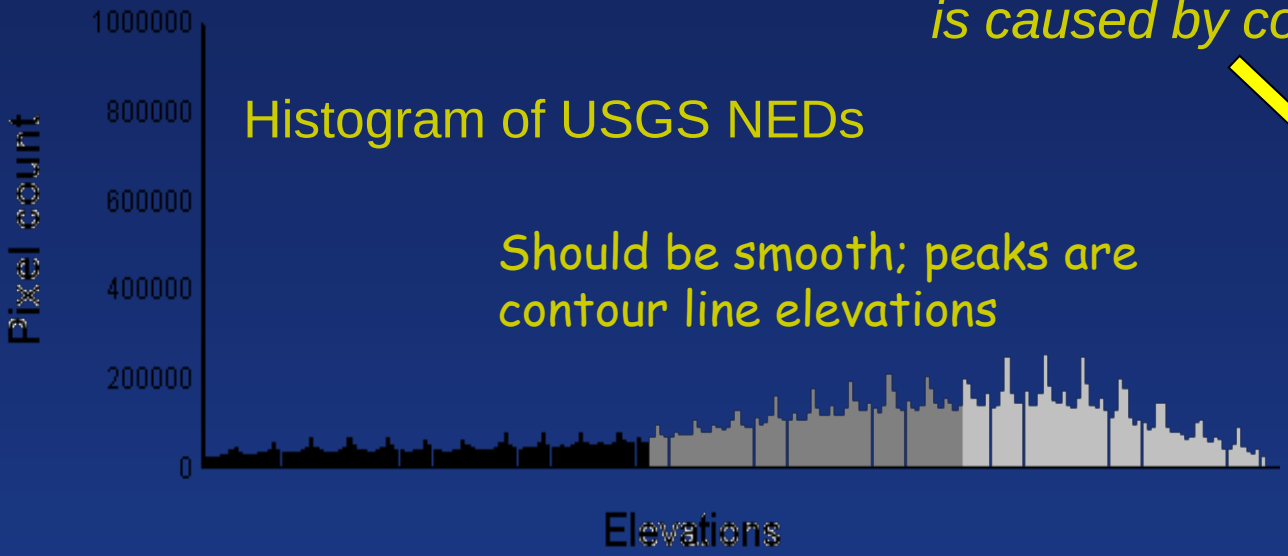
- This example displays the pixel inspector examining the profile curvature values in a concave section of a cross-section.

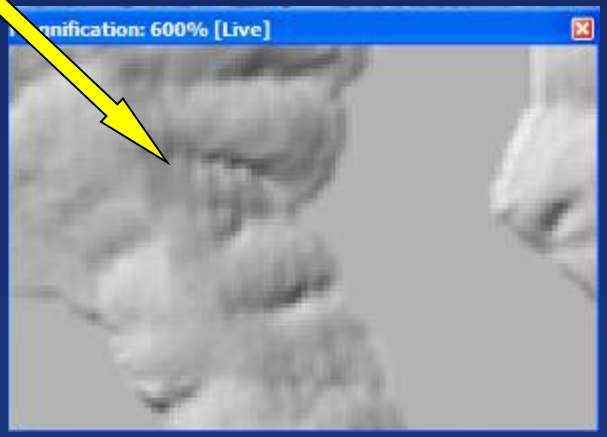


Hypsography-Characteristics

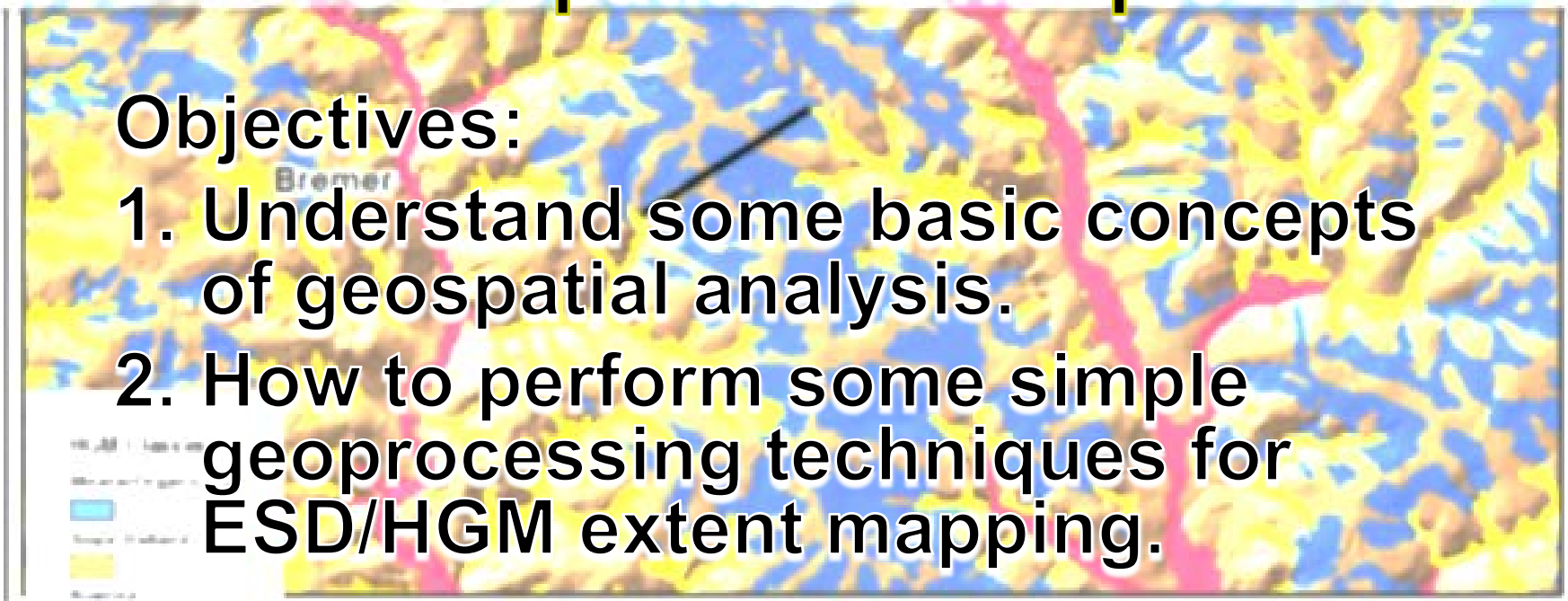
Hypsography derived surface – Cell values populated by interpolation between contour lines along with point features.

The "rice paddy" effect on this hillslope is caused by contour line bias.





ESD/HGM Extent Mapping Geospatial Techniques



Objectives:

1. Understand some basic concepts of geospatial analysis.
2. How to perform some simple geoprocessing techniques for ESD/HGM extent mapping.

Review Geospatial Analysis Concepts

Models are a bridge between the real world and how we think the world looks.

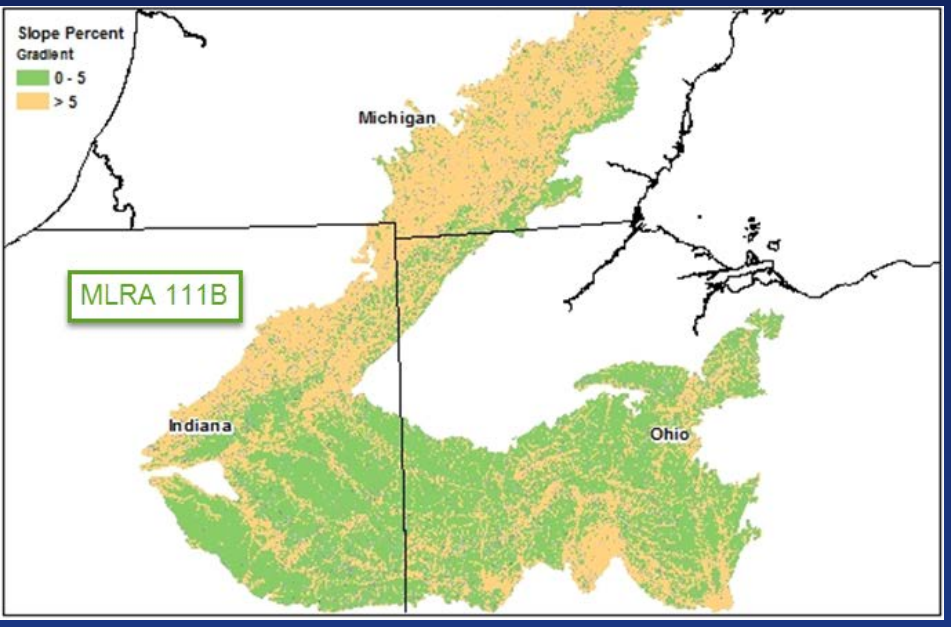
Models provide a simplification or abstraction that makes communication of ideas easier.

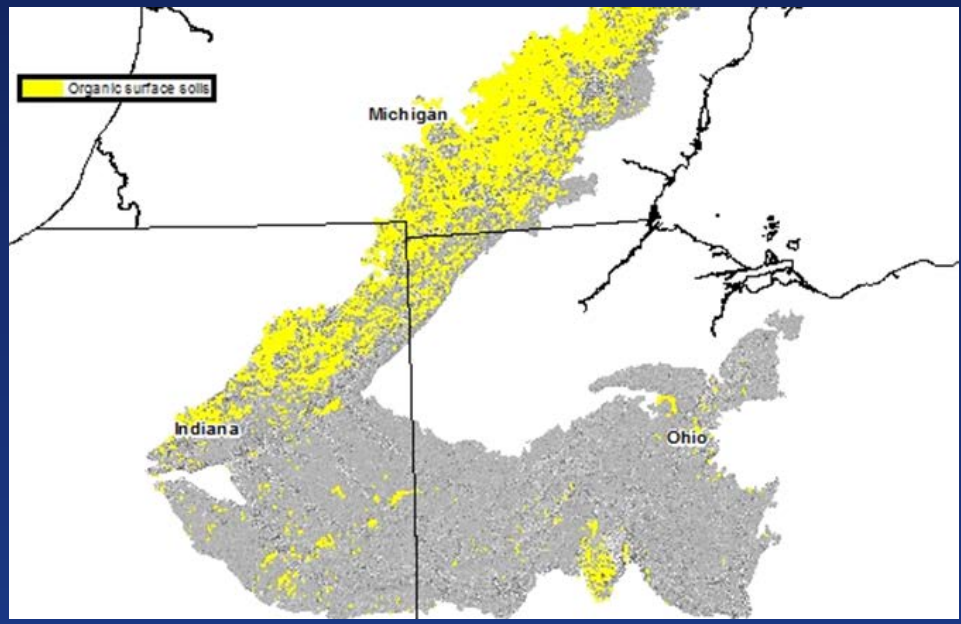
Modules 2 and 3 described 2 representation Geospatial models chosen to attempt mapping the extent of Hydrogeomorphic Classes.

This module will look at evaluating their combination and some simple geoprocessing functions.

Define the Question – Can the reference domain of HGM classes inside an Area of Interest be mapped?

Define the area of extent to be evaluated: MLRA, LRU/CRA, HUC.
Will the functional assessment parameters be the same?
Will the categorical wetland functions be the same?





Develop Sub-Models

Build the analysis in stages.

Requires knowledge of:

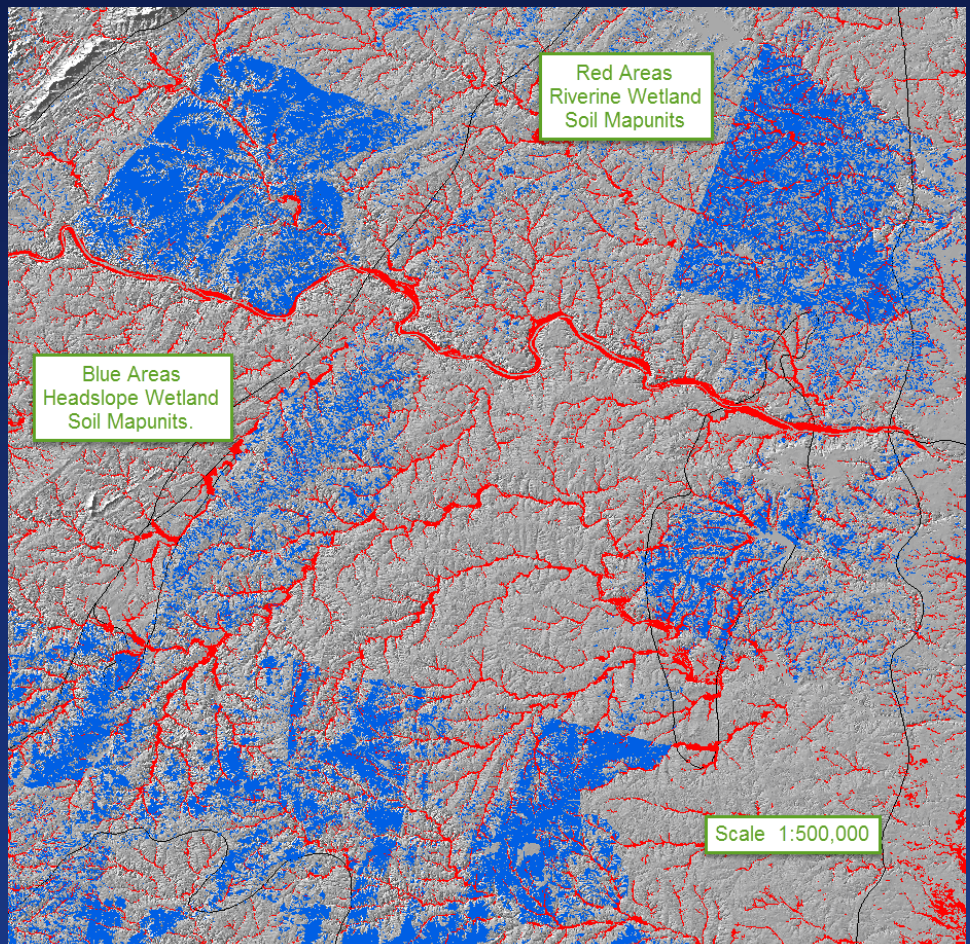
The phenomena being characterized

GIS software capability

Availability of suitable geospatial data.

Determine geospatial data availability.

- Is the data suitable for the analysis?
- Soil data query results considered to be suitable for one HGM class.
- Results need to be validated.

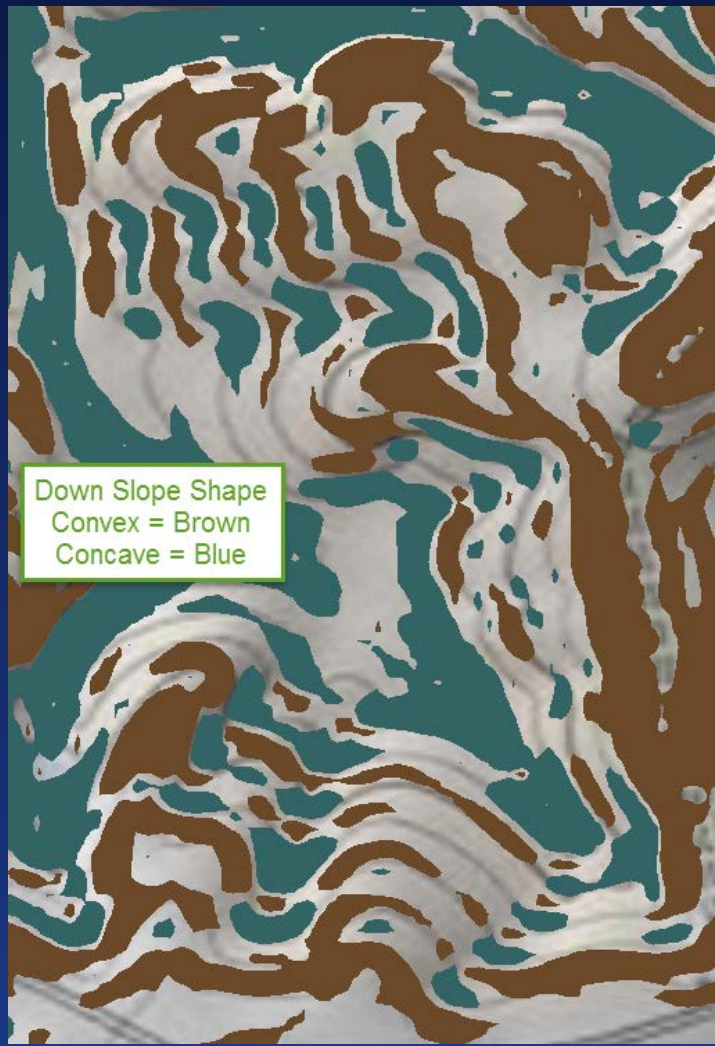


Determine geospatial data availability.

Ten meter digital elevation data generated from hypsography.

In this example the Profile curvature contains many contour line artifacts.

In this case the data was considered not suitable for analysis.

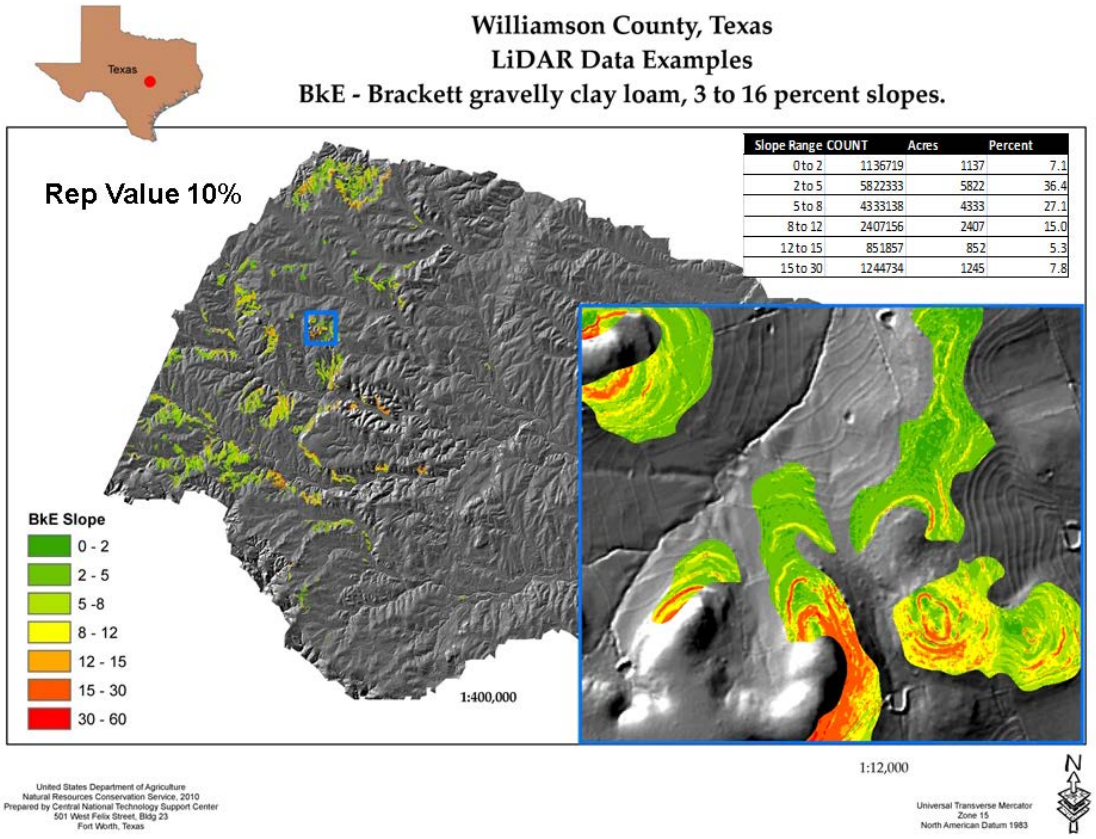


United States Department of Agriculture
Natural Resources Conservation Service

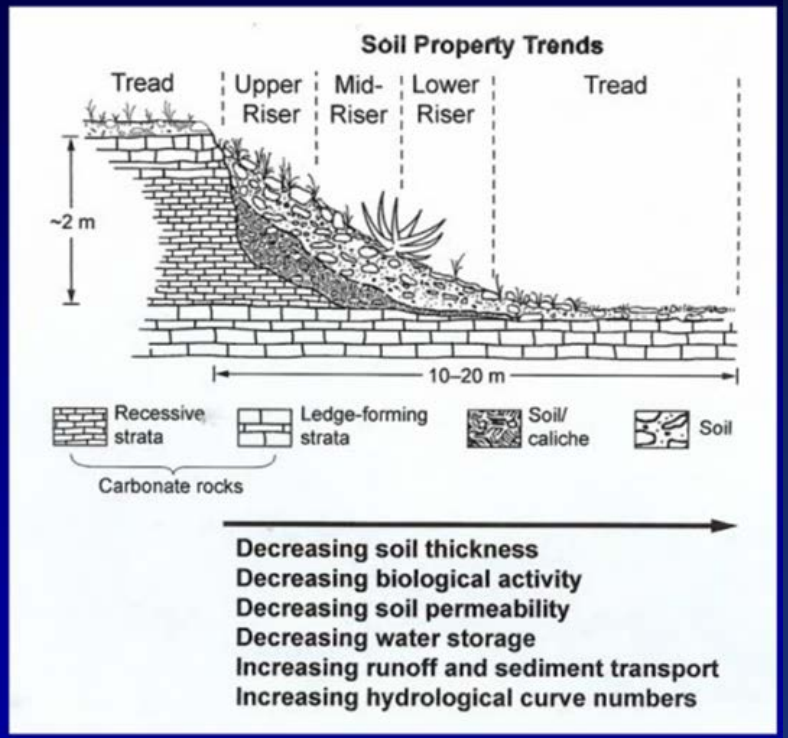
USDA NRCS

Integration of Soils and Elevation Derivatives

Example of soil research findings to improve soil map unit interpretation. Quantify the extent of different soil properties within map unit delineations.



Step Soil Property Trends



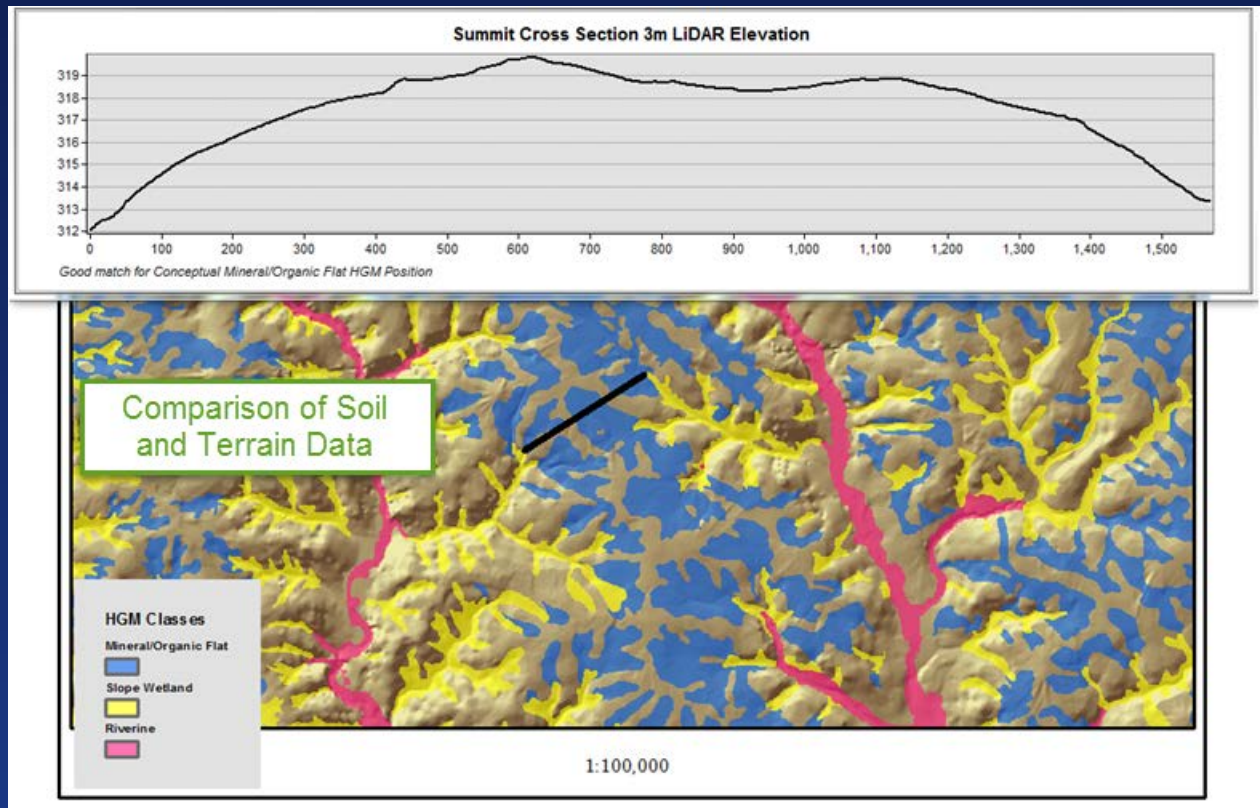
Unique Soil and Landform Features on the Edwards Plateau in Central Texas. 2011. L.P. Wilding. SSSA International Annual Conference Proceedings.

Simple Overlay Analysis

Stacking 2 or more datasets to enable visual comparison.

Identify areas to be examined more closely.

In this example, Visual Comparison of Soil Attributes and Elevation Terrain Surface have good agreement for conceptual HGM classes.

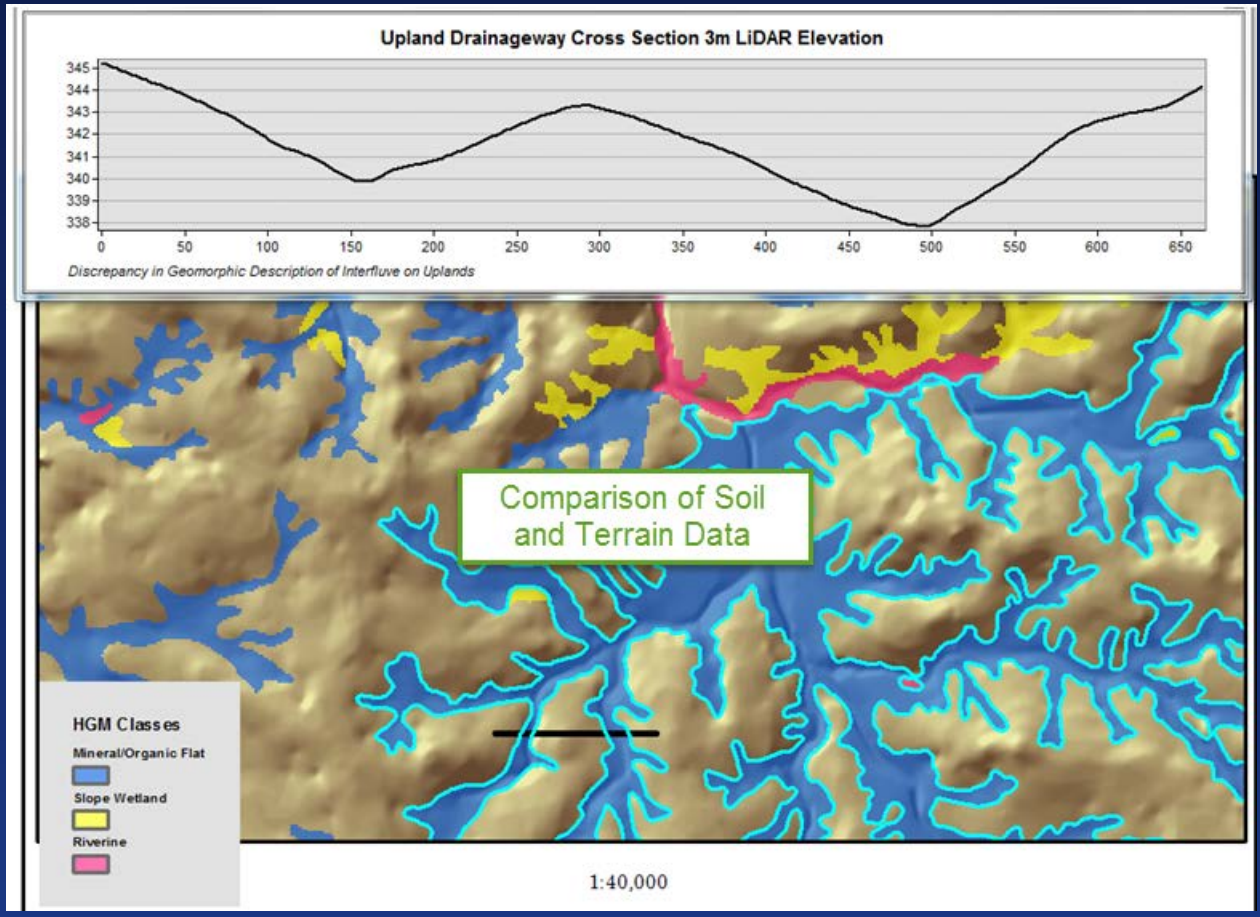


Simple Overlay Analysis

Stacking 2 or more datasets to enable visual comparison.

Soil query result not a good fit for the HGM class.

In this example, Visual Comparison of Soil Attributes and Elevation Terrain Surface have poor agreement for conceptual HGM class. Discrepancy in Geomorphic Description.

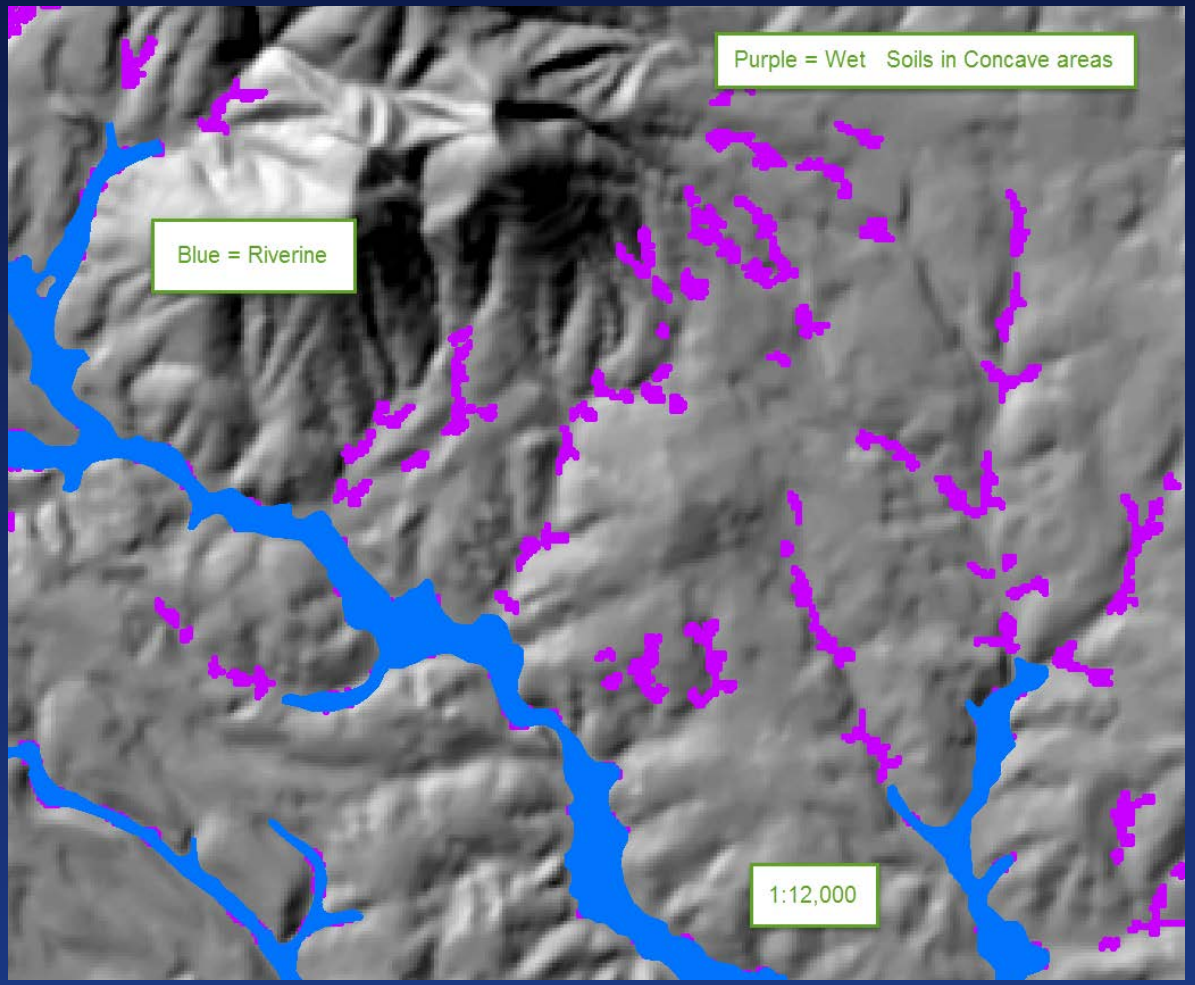


CONDITIONAL ANALYSIS

- Use the SETNULL function to extract potential Headslope wetland areas.
  - Select a threshold value for concave areas in the planer shape raster.
  - Use the threshold value in the expression as the null condition, all cells that meet the conditions of the expression will be set to a NULL value.
  - Populate the cells that do not meet the expression with the MUKEY values of the gSSURGO raster.
- Join the output raster to the MUAGGATT table.
- Use the Raster to Polygon function to create a polygon feature class.
- Select the polygons that exceed pre-determined minimum size area. Export these polygons to a separate feature class.
- Use the attribute to select and extract soil map units with wet soil components.

Intersect Analysis

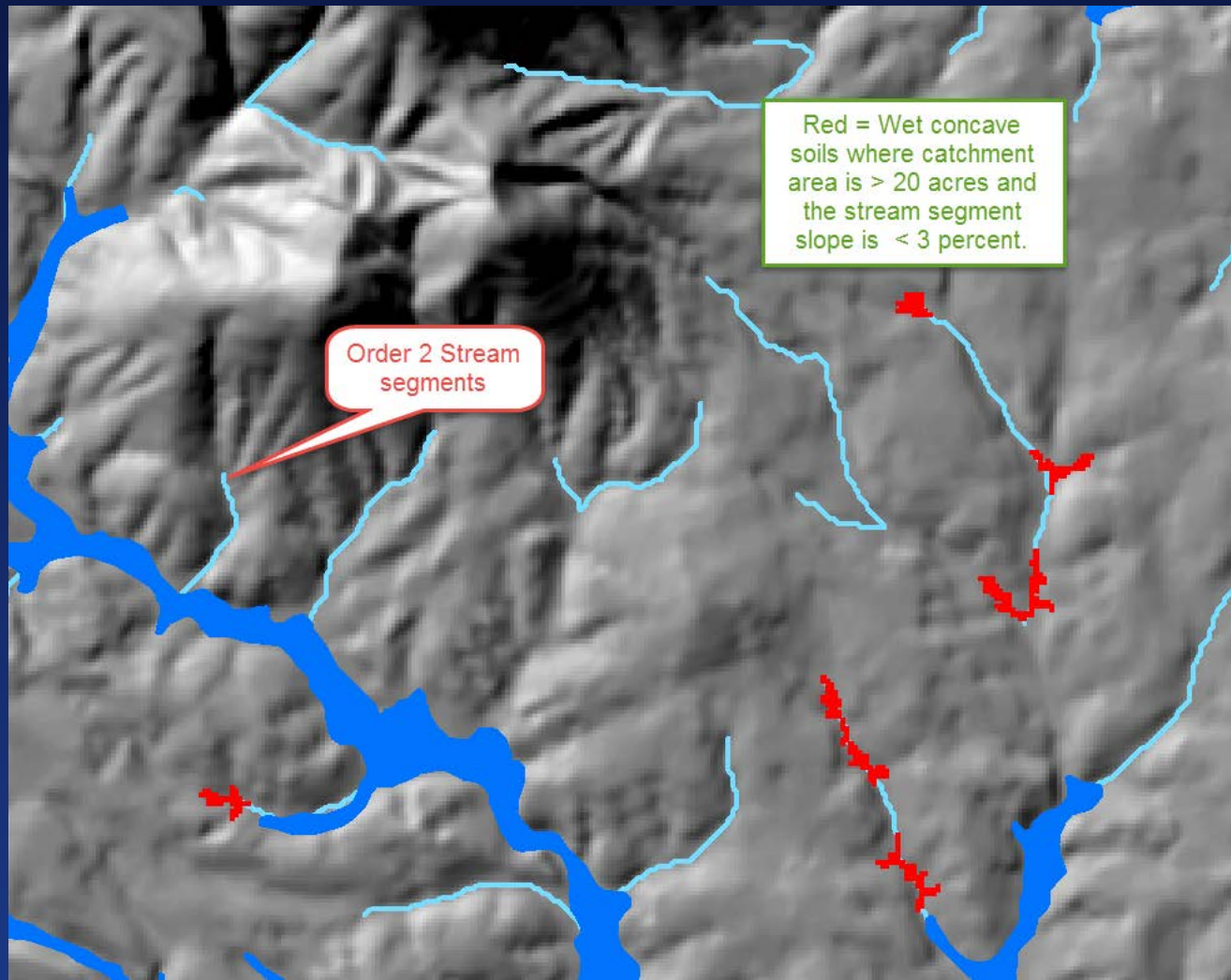
- Remove the wet soil concave areas that intersect the Riverine wetlands.
- Result will be potential sites of Headslope wetland areas that are a function of surface terrain and hydrology. Will not work where subsurface aquitards are present unless these are characterized by the soil components.



Intersect Analysis

Continued analysis with Stream morphology criteria.

Select the Wet soils in concave shaped areas that intersect order 2 stream segments that exceed a 20 acre catchment area and where the slope of the stream segment is < 3 percent.



Field Evaluation

- Field Observations to test results.
- Examination of threshold values that can be used to categorize continuous data.

Area with Riverine HGM class has a high stream order and large catchment area.

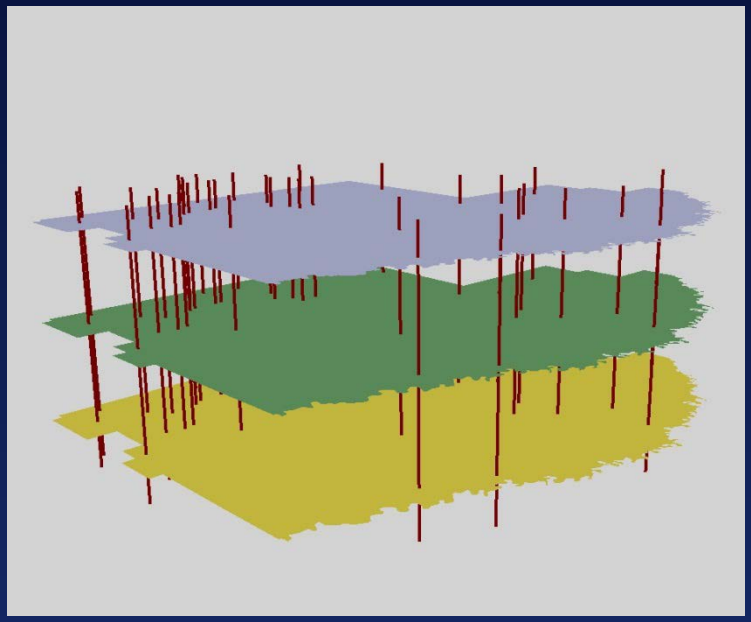
Low stream order and small catchment area-Riverine or Slope Wetland?

Is the channel natural or man-made?

What do the soil properties tell us?

Sample Function

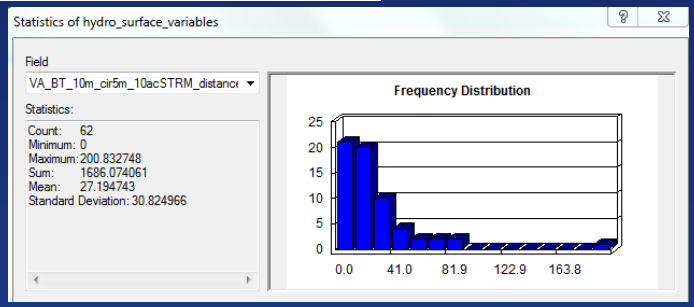
- Georeferenced field observations used to determine parameters for continuous data.
  - Distance to streams
  - Terrain derivatives



hydro_surface_variables

OBJECTID *	x	y	VA_BT_10m_cir5m_elev	VA_BT_10m_cir5m_slp	VA_BT_10m_cir5m_asp	VA_BT_10m_cir5m_prof	VA_BT_10m_cir5m_plan	VA_BT_10m_cir5m_cwi	VA_BT_10m_cir5m_10acSTRM_distance
1	561715	4077816	793.223999	4.36513	27.880705	0.201408	-0.001076	9.481701	17.608059
2	563485	4080272	743.321045	4.221605	233.40506	0.104267	-0.001483	9.209216	30.200628
3	562750	4078689	780.026917	5.835299	94.399521	0.189827	-0.046884	9.638313	25.700146
4	532010	4060093	783.226685	3.759391	322.375183	-0.005256	-0.258256	11.886502	0.073923
5	540031	4077753	779.059204	6.515594	53.976292	0.219286	0.00698	10.283484	31.805761
6	552761	4067365	865.345825	0.754292	232.365891	-0.033439	-0.134197	18.785349	0.368277
7	535590	4057623	810.152466	9.348001	287.049164	0.08586	-0.116379	10.795218	78.493279
8	562810	4081206	727.514099	2.900998	324.82309	-0.004969	-0.092234	11.783449	1.663623
9	563789	4080478	755.759583	7.401372	80.757767	0.440693	0.002175	12.712563	5.017433

0 (0 out of 62 Selected)



- Output table and statistics of some of the potential factors represented.

Additional Steps

This was a very brief introduction to a extensive subject matter.

Other tools that are available:

ArcSIE (Soil Inference Engine) for terrain anaylsis.
TAUDEM for hydrology analysis.

A few other types of analysis that are available :
Proximity is a type of analysis that compares and quantifies what features are near by.
Distance functions are the raster equivalent to vector proximity analysis.
Density functions determine the concentration of point and line features.
Fuzzy classification provides a way to work with data where the thresholds between categories are not clear or crisp.