

Arc Soil Inference Engine (ArcSIE) and
Digital Soil Mapping in
MLRA SSA 12-5:

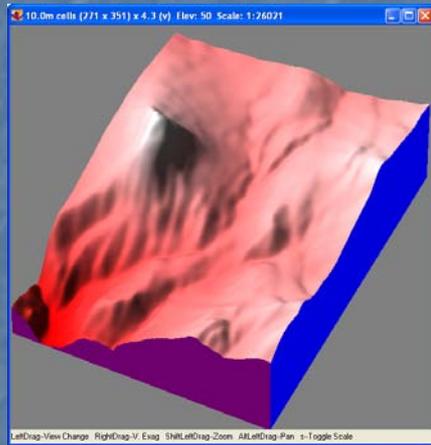
A SSURGO Success Story

Asheville, NC

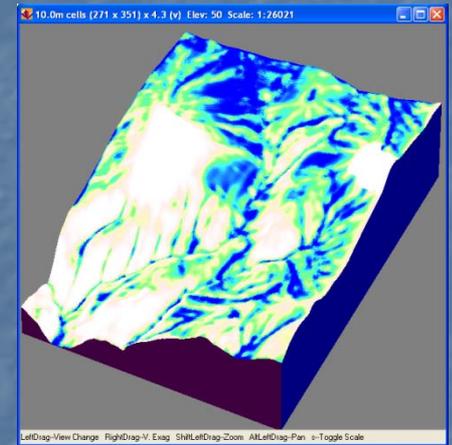
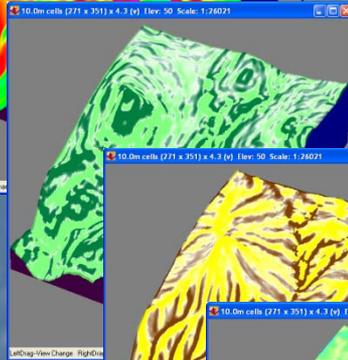
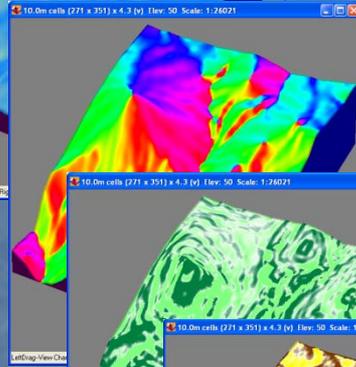
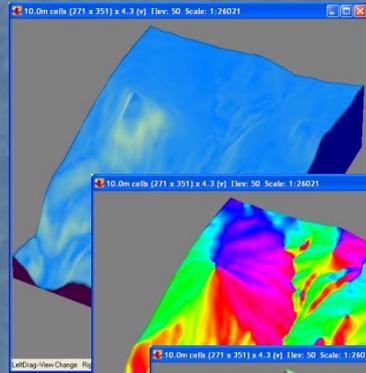
5/26/2011

ArcSIE is a proven tool, designed for *field soil scientists* to implement knowledge-based raster soil mapping.

Raster Soil Mapping



DEM

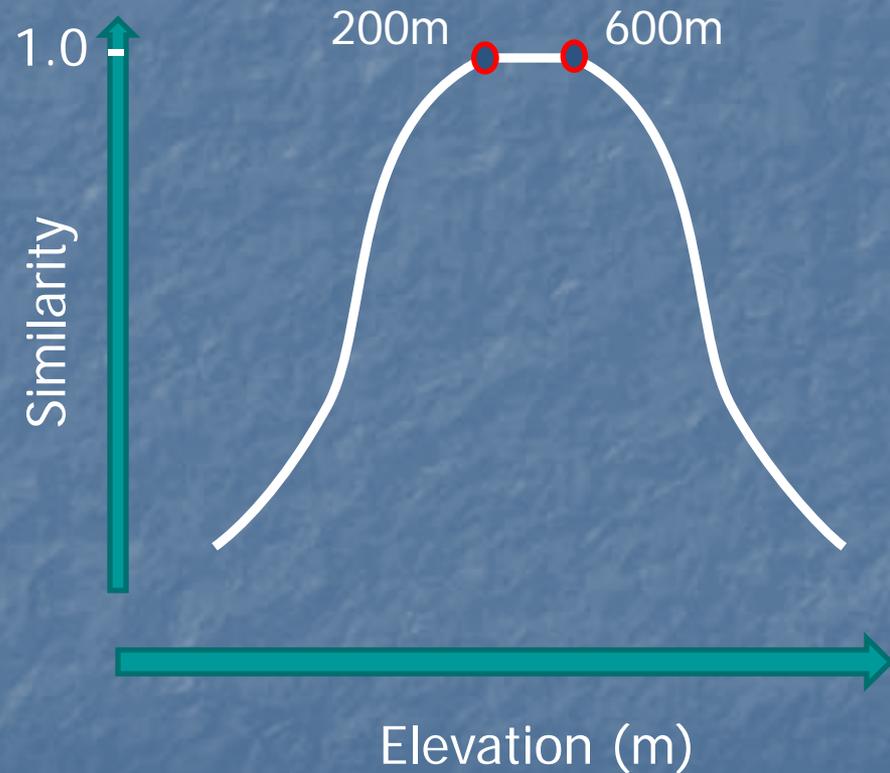


Cabot soil

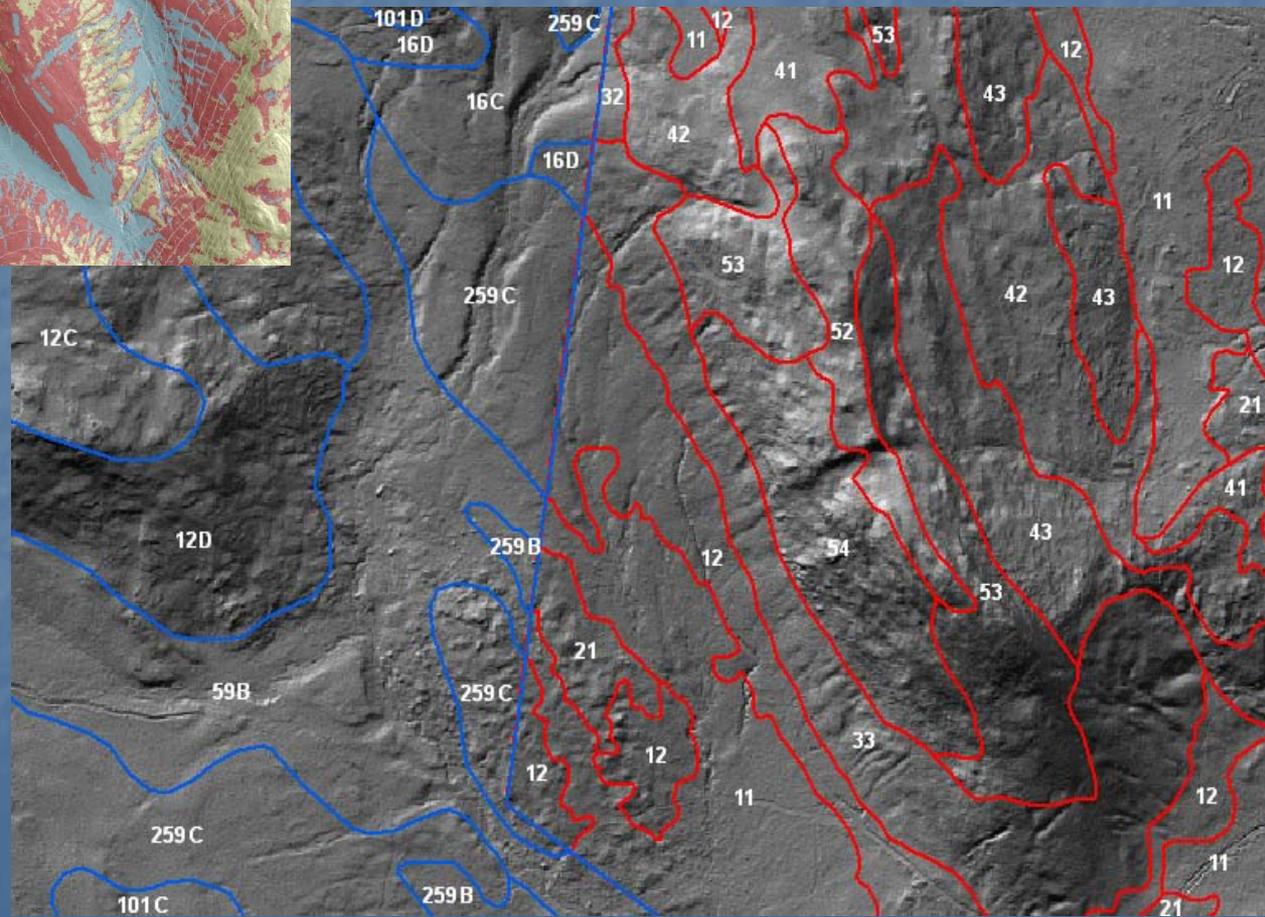
Knowledge Represented as a Rule

Elevation 200–600m
is typical for soil A.

As elevation
deviates from this
range, the soil's
similarity to type A
gradually decreases.



Raster Values must be Logically Integrated to Create....



.....the SSURGO Product

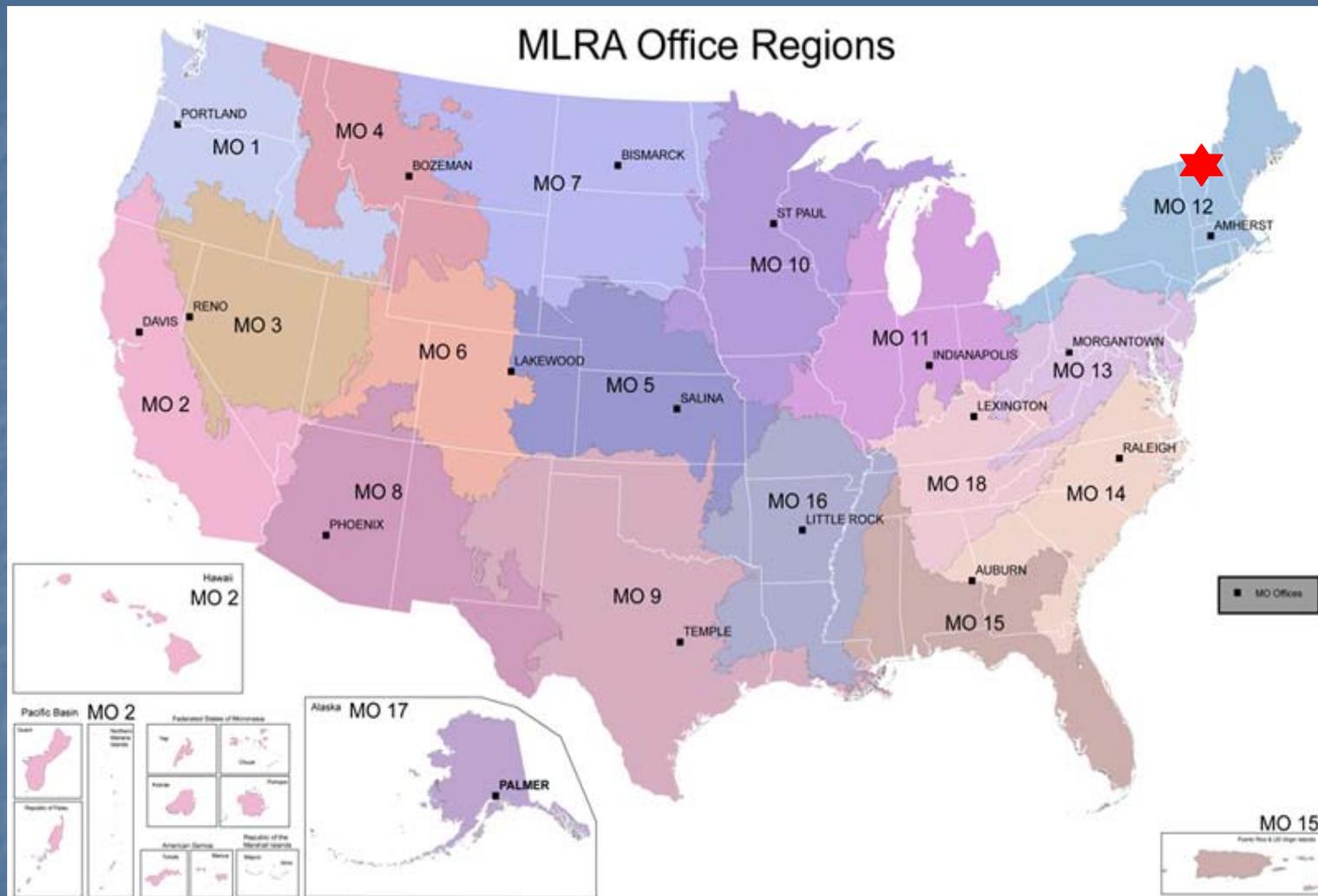
Real advancement of SIE began in 2004 in Essex County, VT

- Dr. Xun Shi, Dartmouth College
 - National Geospatial Development Center* staff
 - VT-NRCS Project Soil Survey Office staff
-
- 2007, the first version of ArcSIE, an ArcMap extension, was released and CCE certified.

* Now Geospatial Research Unit

ArcSIE in the Context of Digital Soil Mapping in Essex County, VT

- First initial soil survey in the US completed to SSURGO standards using entirely digital techniques, and (mostly) raster results from automated mapping software



MLRA Soil Survey Region 12 (Glaciated Northeast)



Essex County, Vermont



Typical Landscape and Land Use

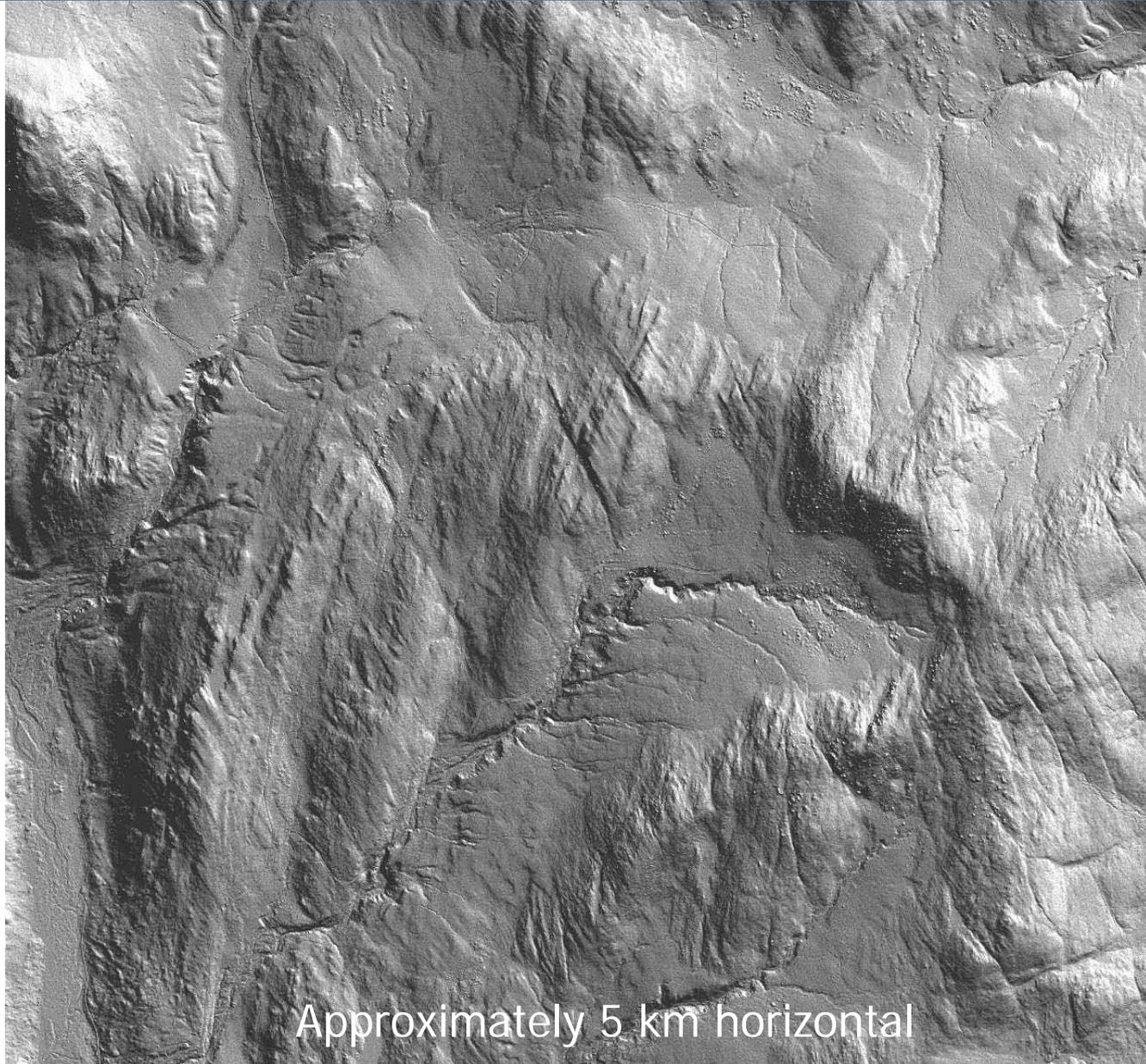
Typical Landforms



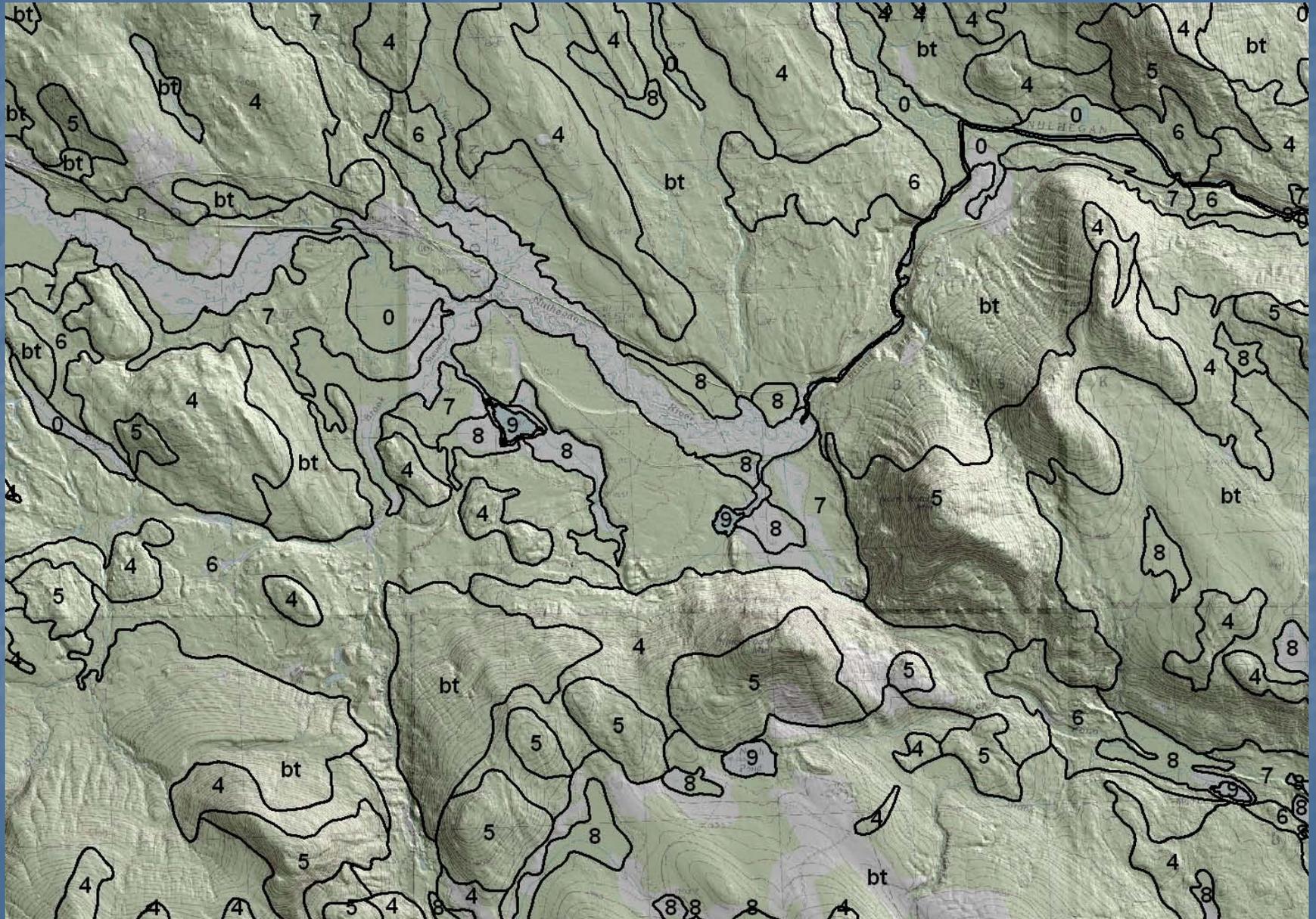
Basic Steps

- Process Environmental Data
- Delineate Landforms and Soil Parent Materials
- Perform Soil Inference in Suitable Areas
- Use other DSM Techniques as Appropriate
- Construct Polygon Map (SSURGO)

Hillshade from 1 meter LiDAR DEM- Used for Visualization and Manual Delineation of Parent Materials/Landforms



Parent Material/Landform Maps Provide the Basis for all Subsequent Soil Mapping



Basal Till Soils are Modeled with ArcSIE



Cabot (poorly drained)



Colonel
(somewhat
poorly drained)



Dixfield (moderately
well drained)

Bedrock Controlled Landforms – Manual Delineations, Automated Map Unit Phases

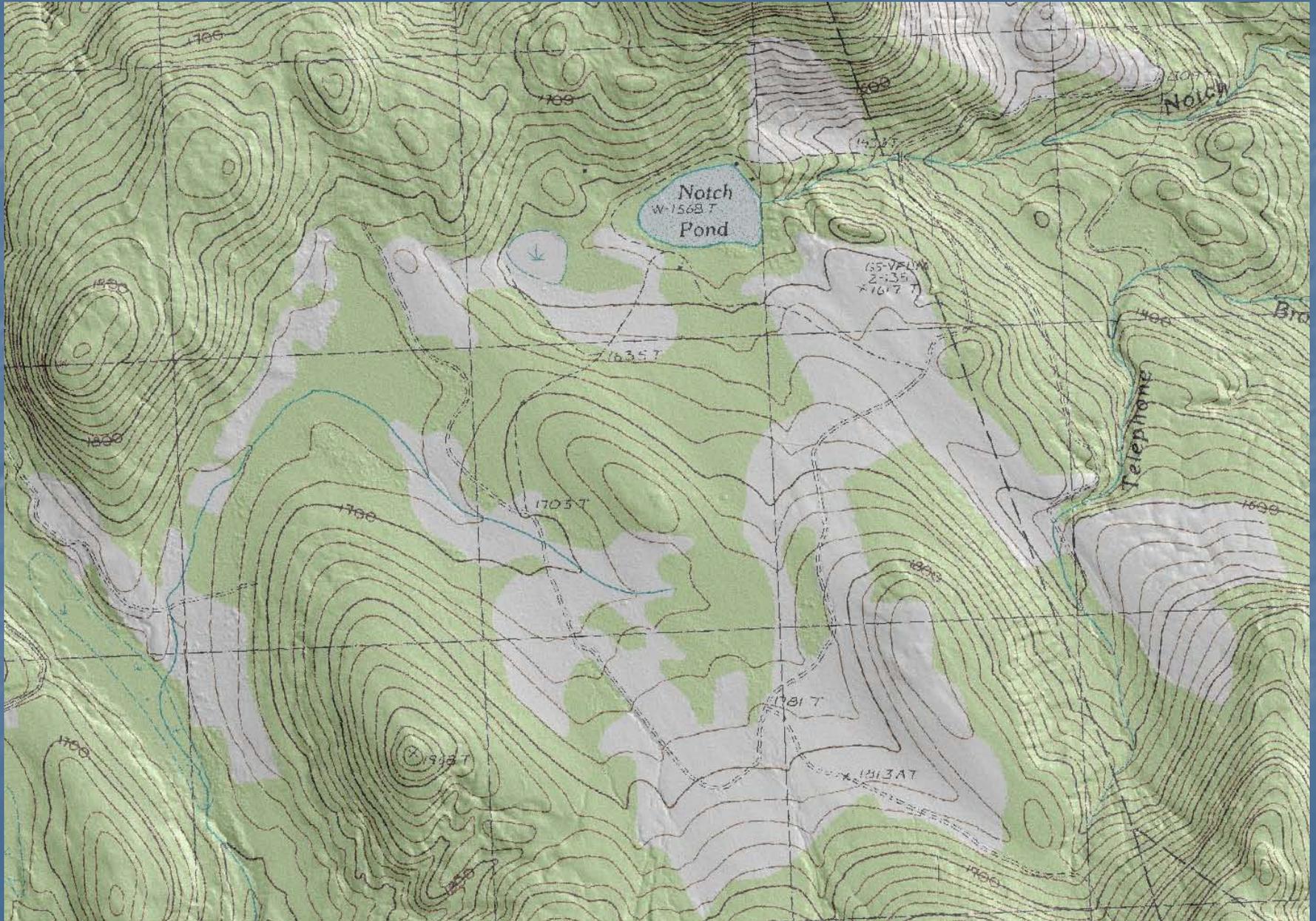


Outwash, Alluvial, and Lacustrine Soils are Mapped Using More Traditional Methods

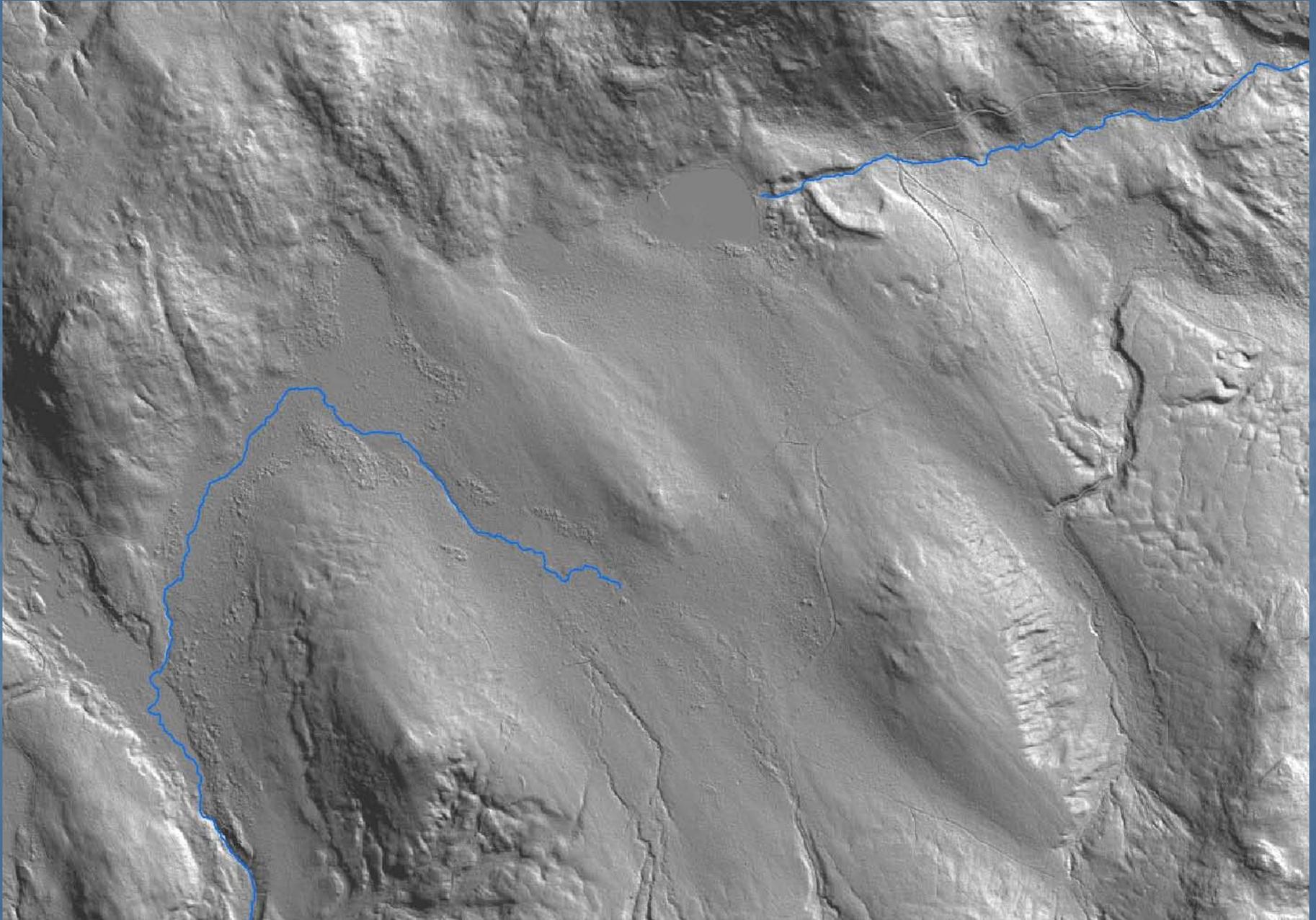


...and organic soils are digitized on-screen.

ArcSIE Predictive Model Demo Area, Basal Till Catena (approximately 4 km by 3 km)



Hillshade



- We define the typical soil formative environment in the model, and the resulting fuzzy membership values represent the similarity of the soil at each pixel location to a particular soil series.

Wetness Index Rule for the Majority of Poorly Drained Cabot Soils

Inference

Attribute Rule
 Point Case
 Line Case
 Polygon Case
 Raster Case

Cabot_RB
[-] Cabot
Major_Cabot
Level_Cabot

Limiting	Feature
<input checked="" type="checkbox"/>	multiwetasm
<input checked="" type="checkbox"/>	slope30

Positive
 Negative

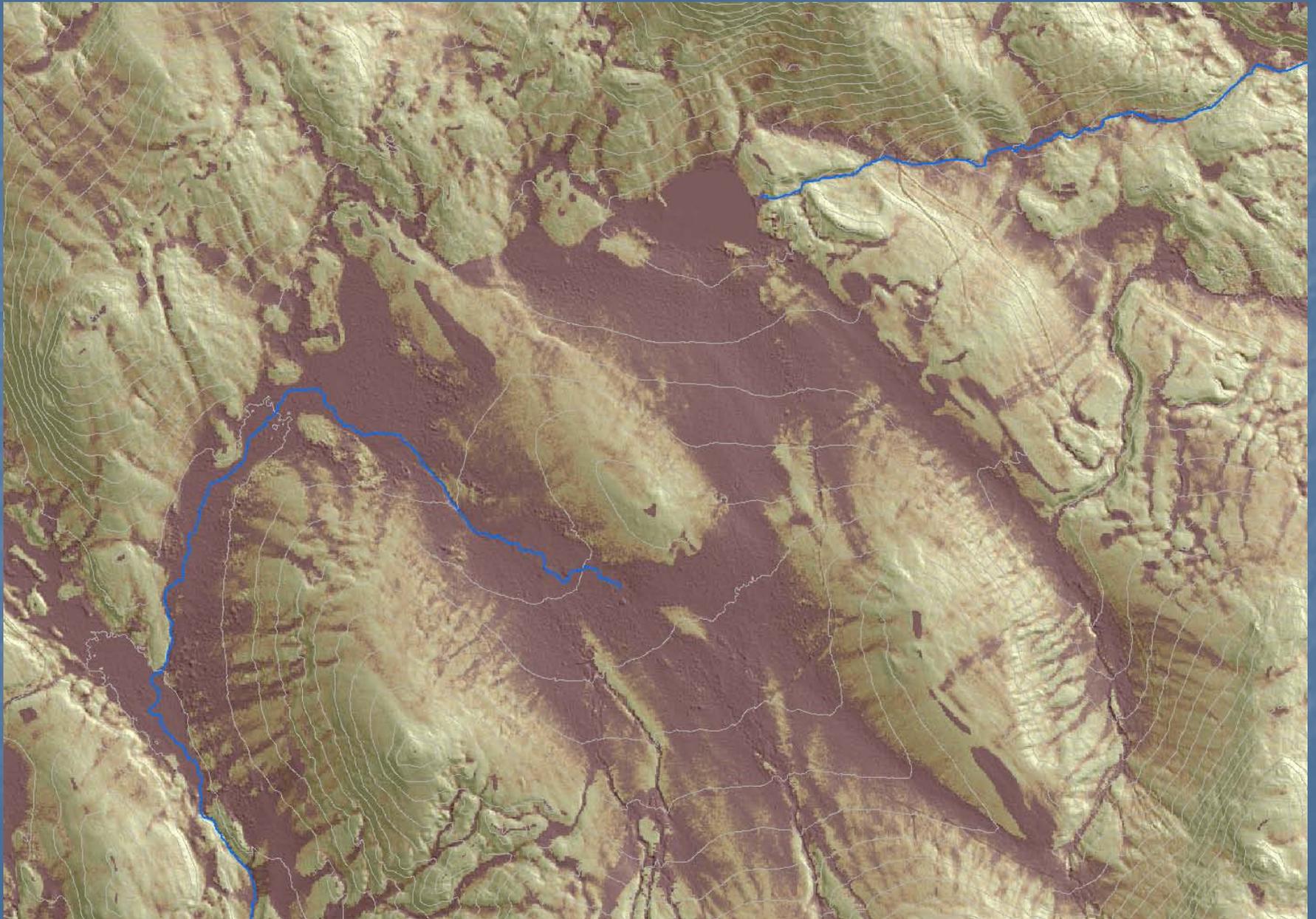
Membership Value:

Make Fuzzy Bnd

v1 v2
w1 w2
r1 r2

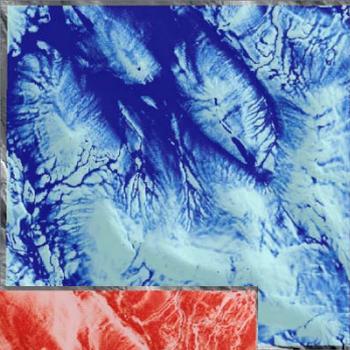
View Type:

ArcSIE Fuzzy Results for Cabot Soil



Hardening (Defuzzification)

Fuzzy Results Maps



Cabot

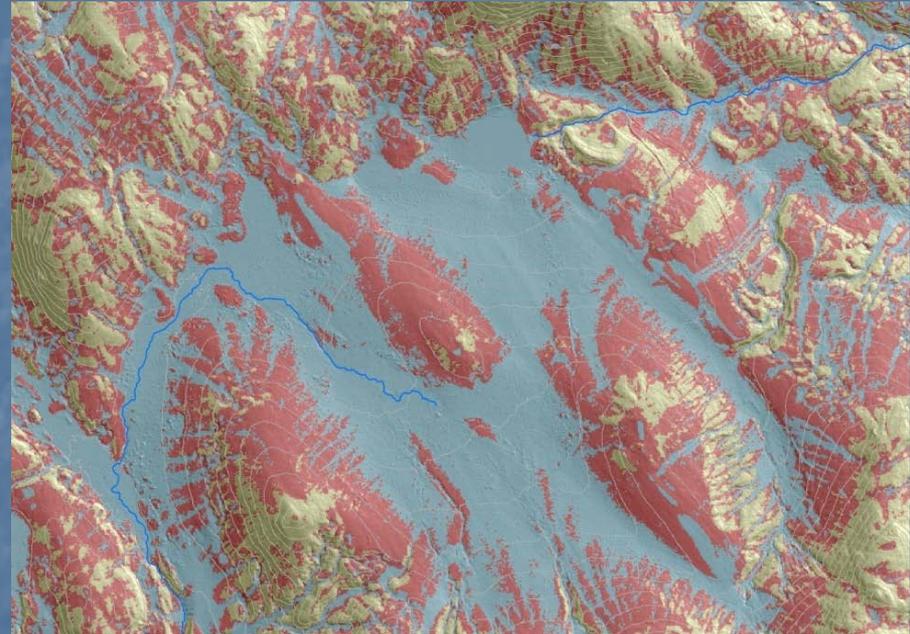


Colonel

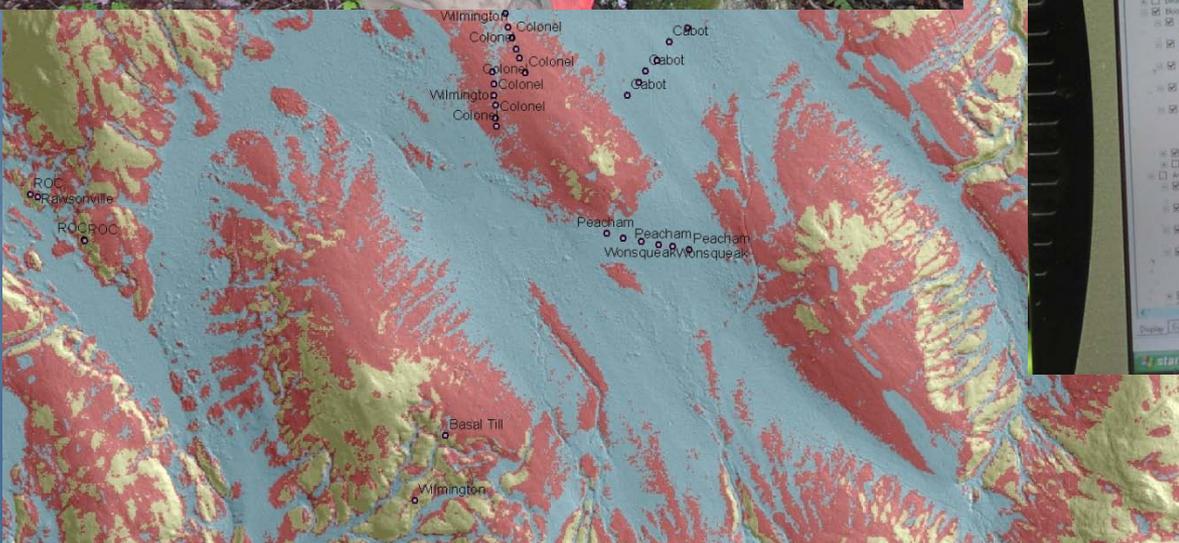


Dixfield

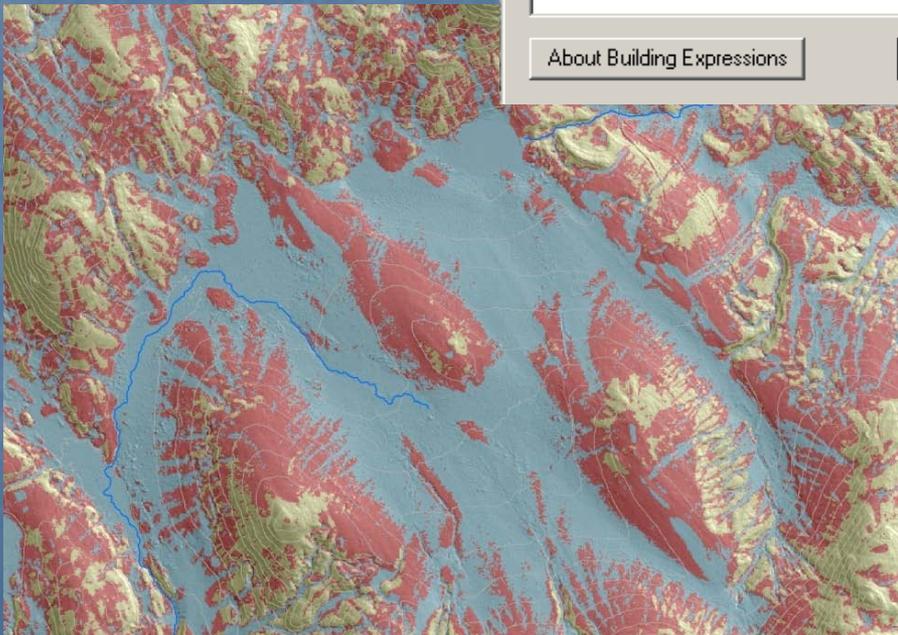
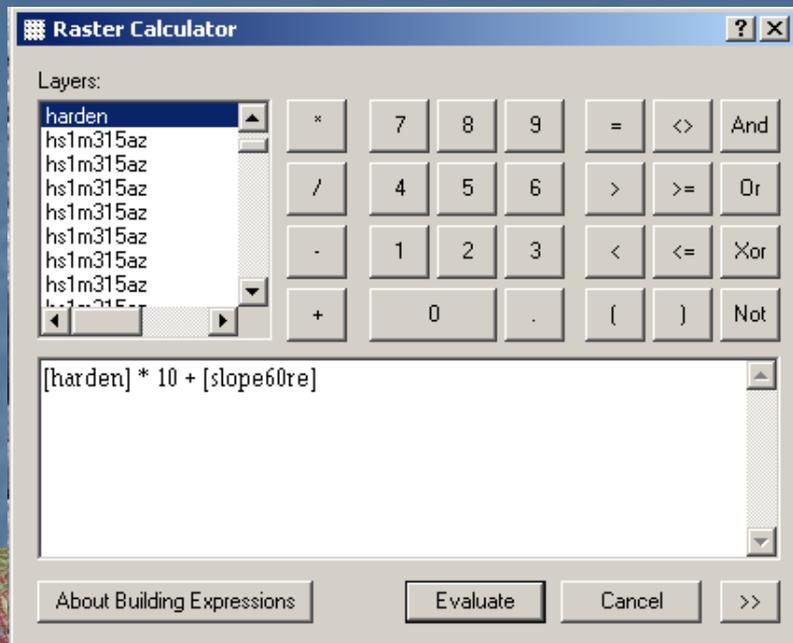
Hardened Map



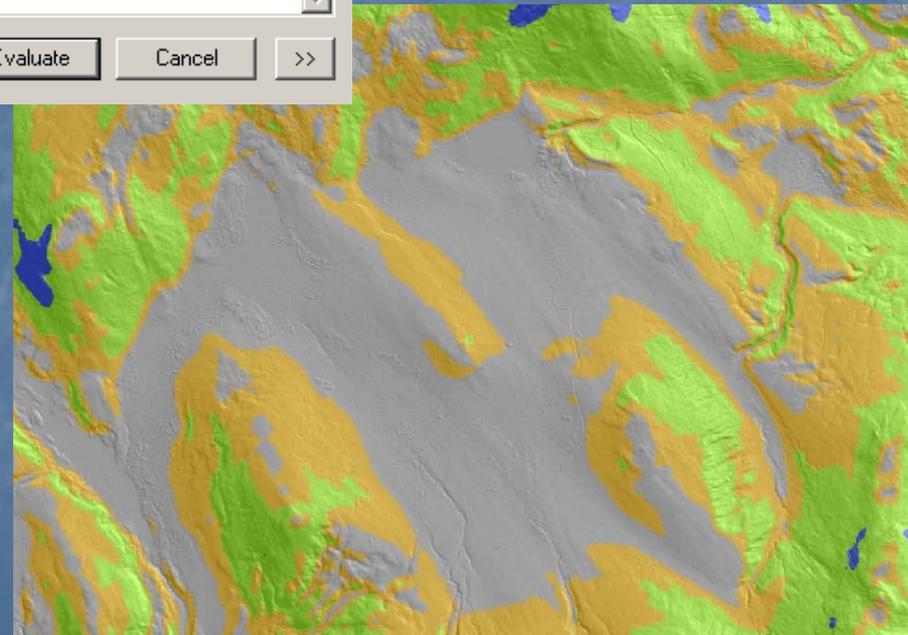
SIE Results are Validated in the Field



Integrate Slope Phases with Hardened Results

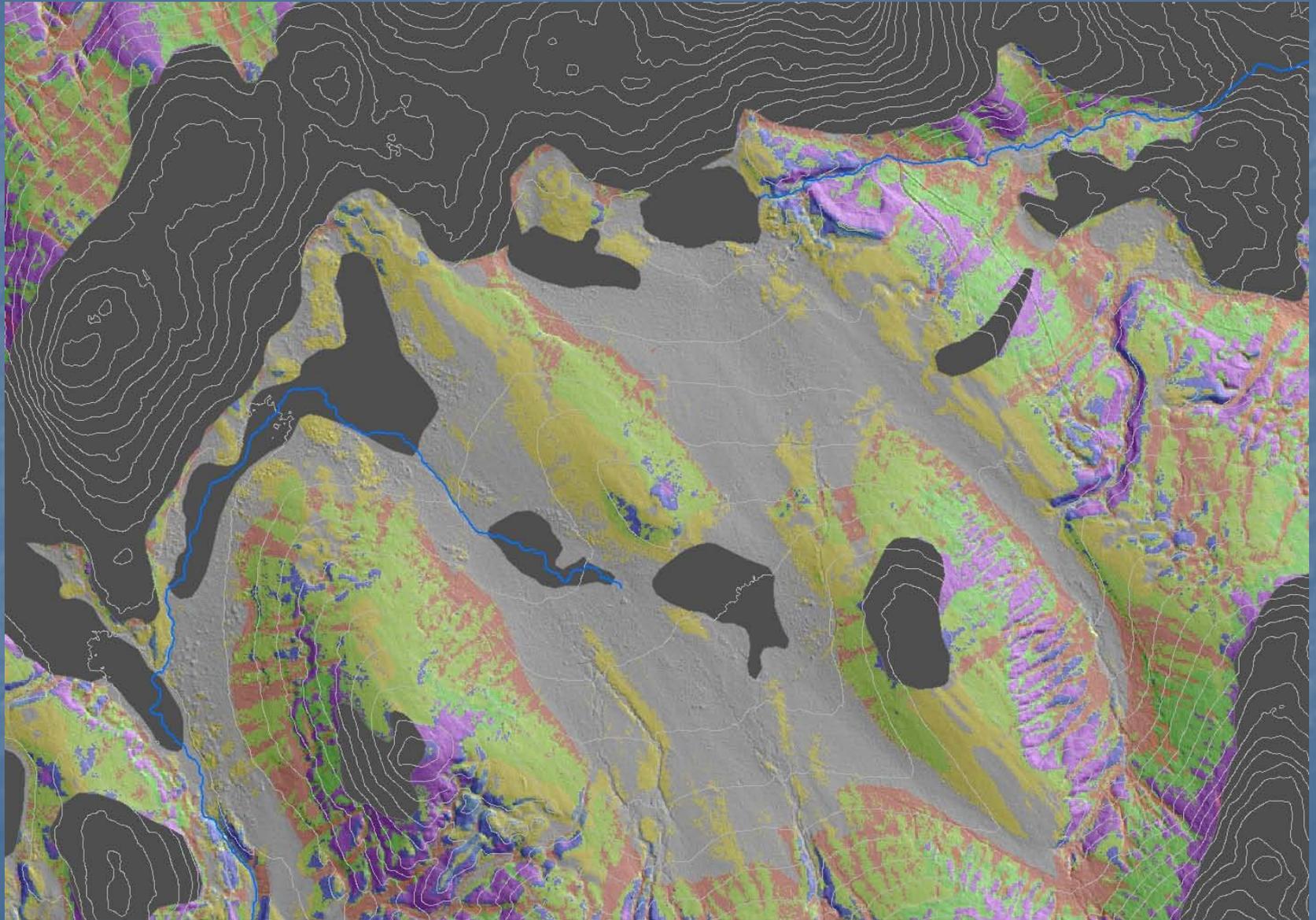


Hardened Results

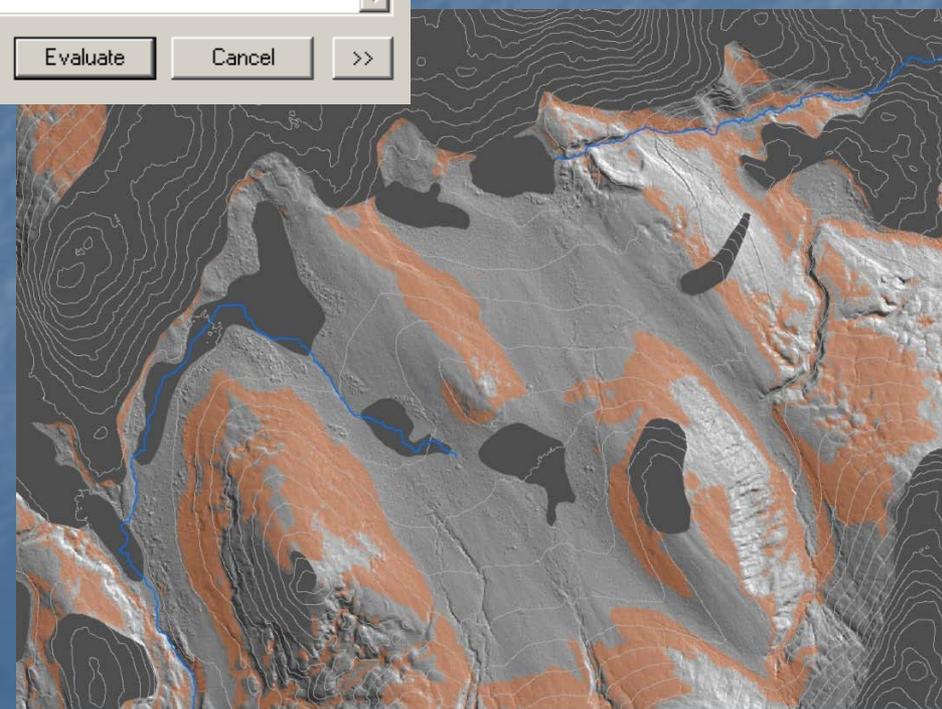
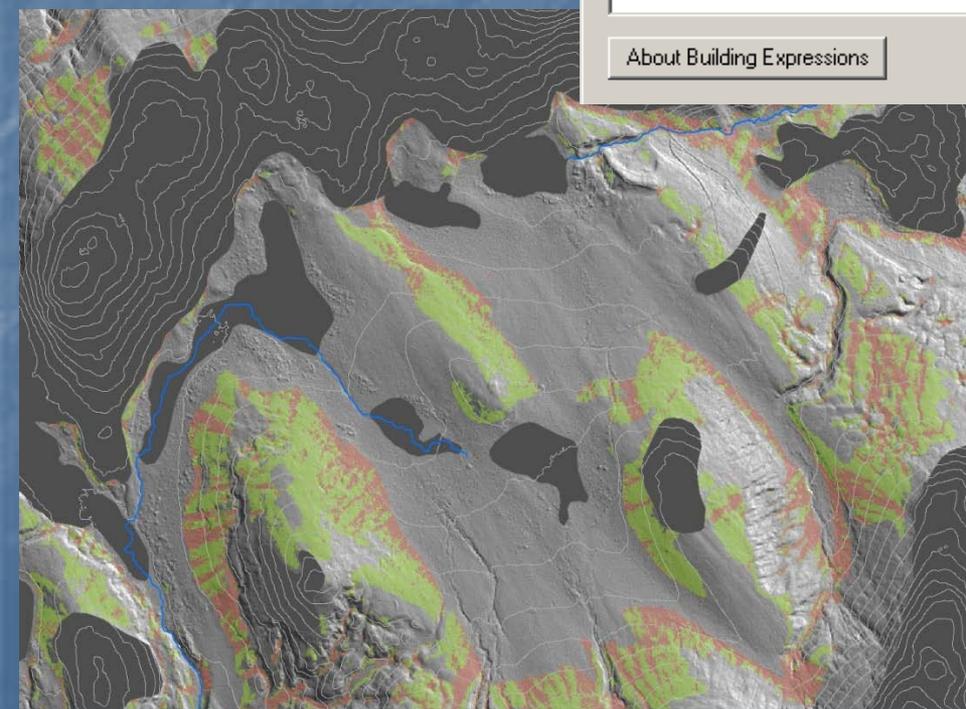
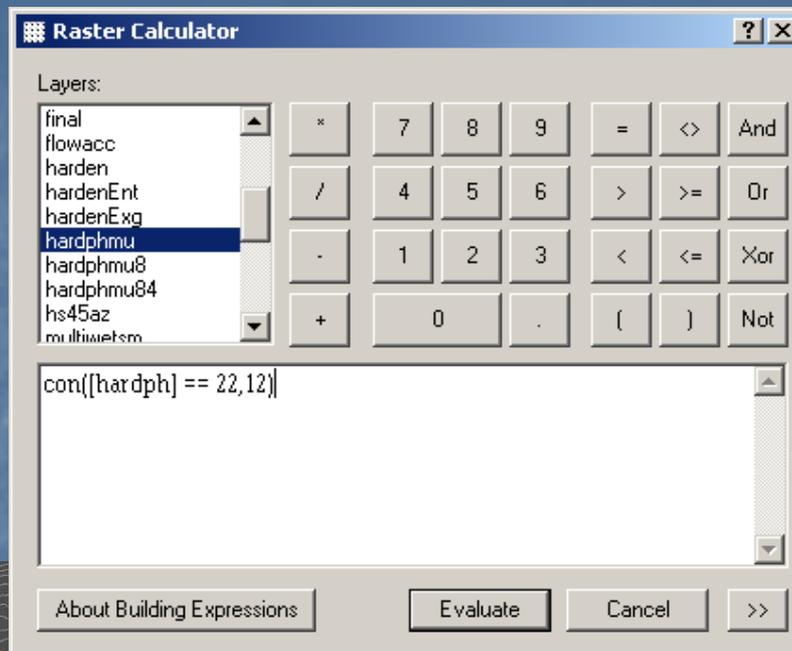


Slope Phases

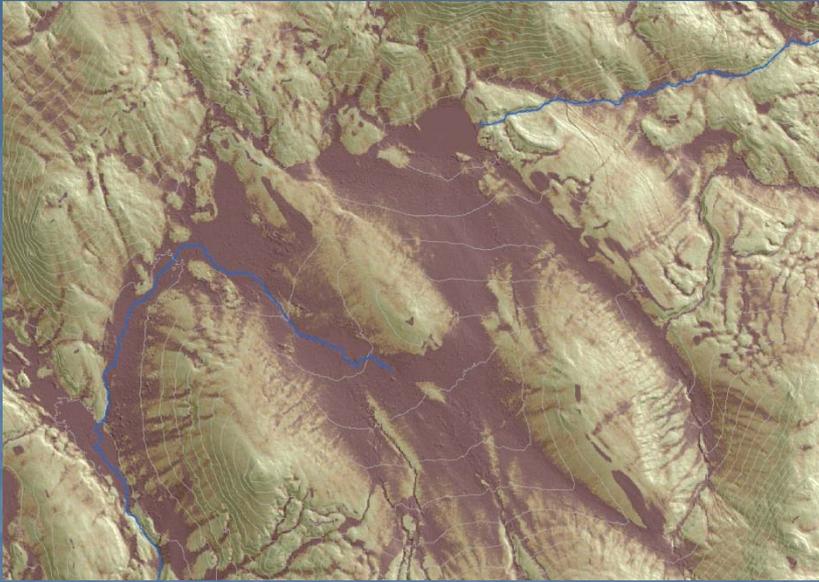
Hardened Results by Slope Phase



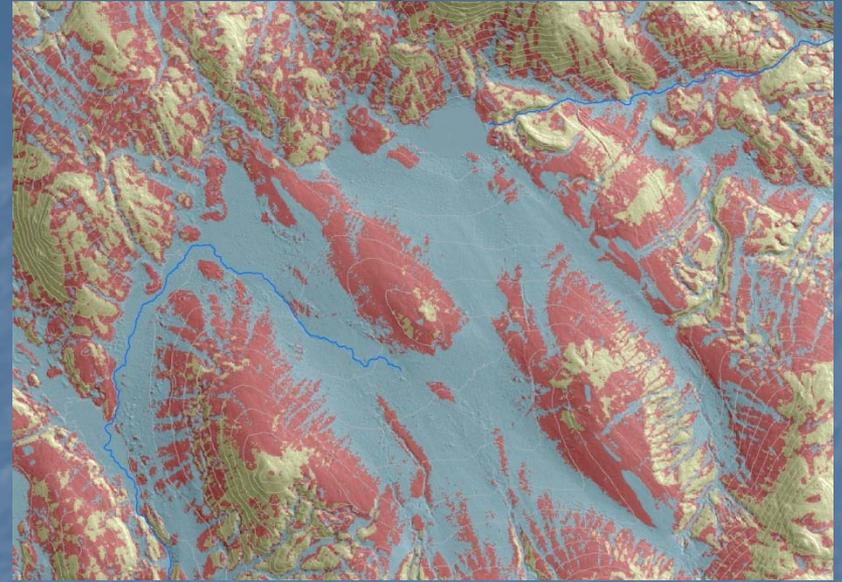
Combine Some Results to Form Logical Map Units



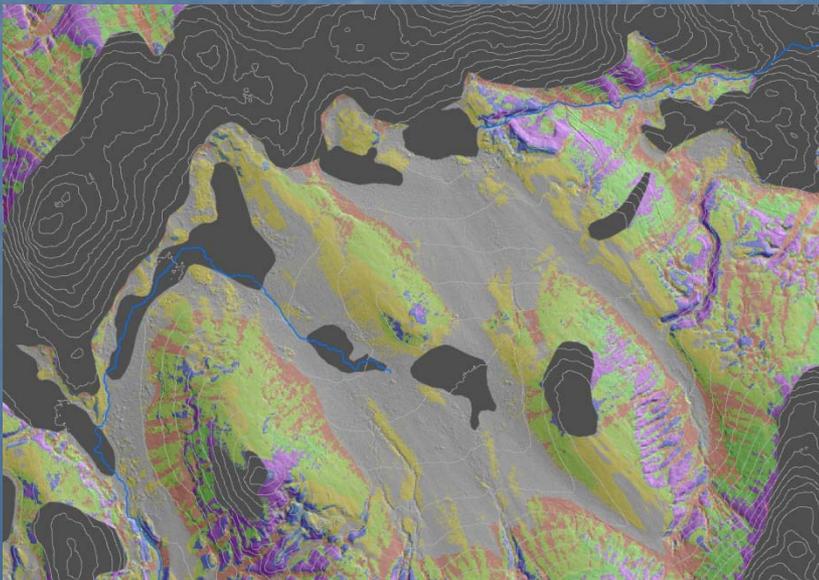
Review of ArcSIE Process Steps



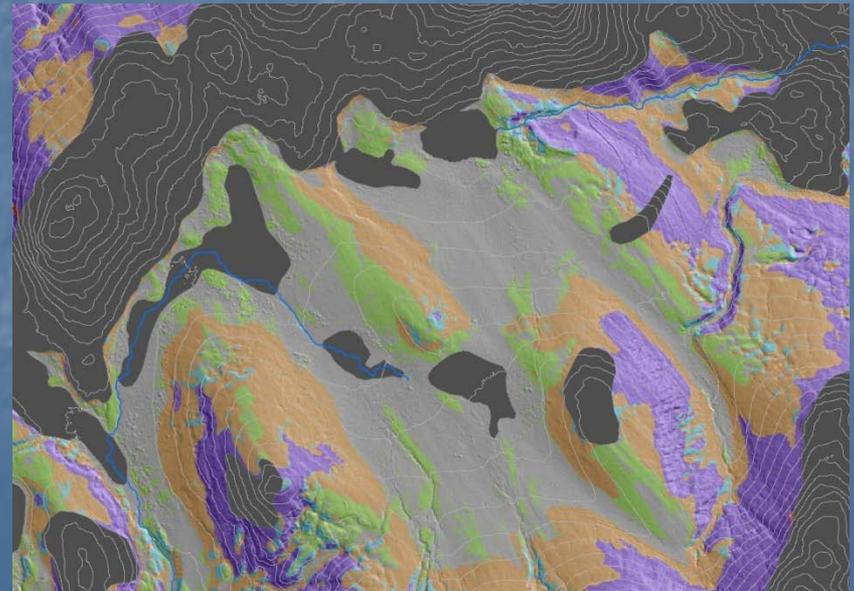
Inference by Soil Series



Harden Results

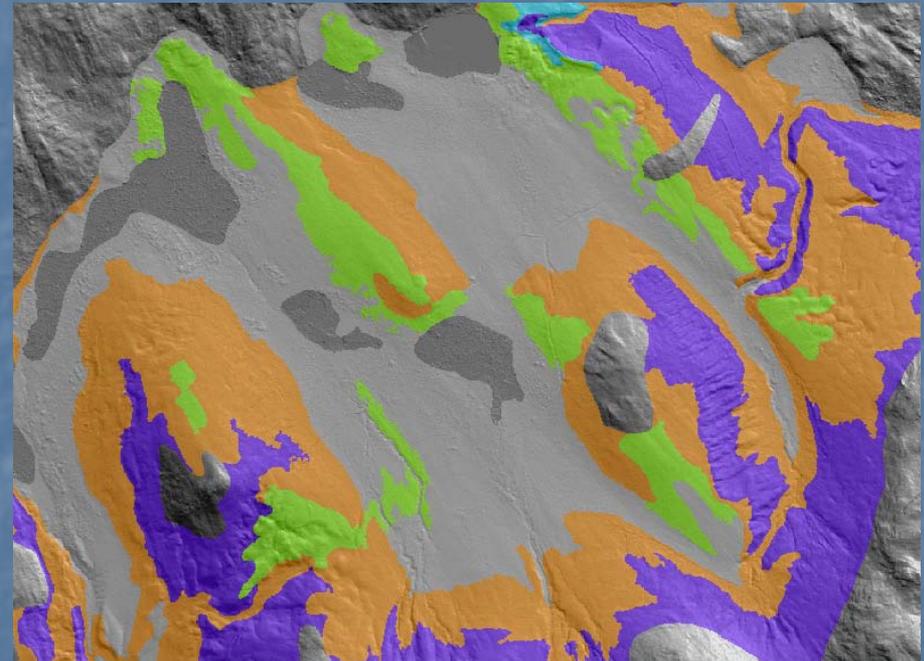
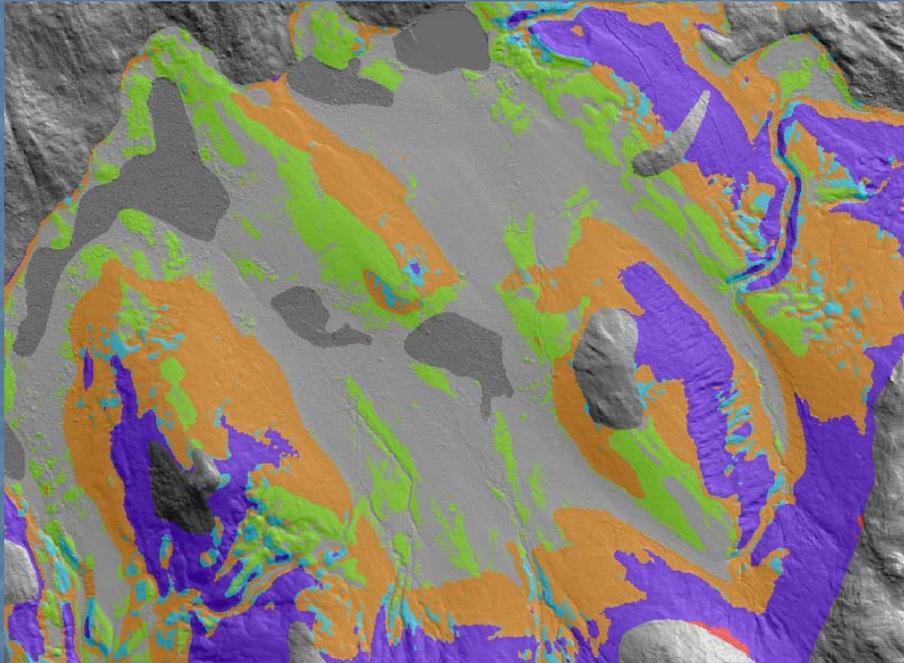


Integrate Slope Phases



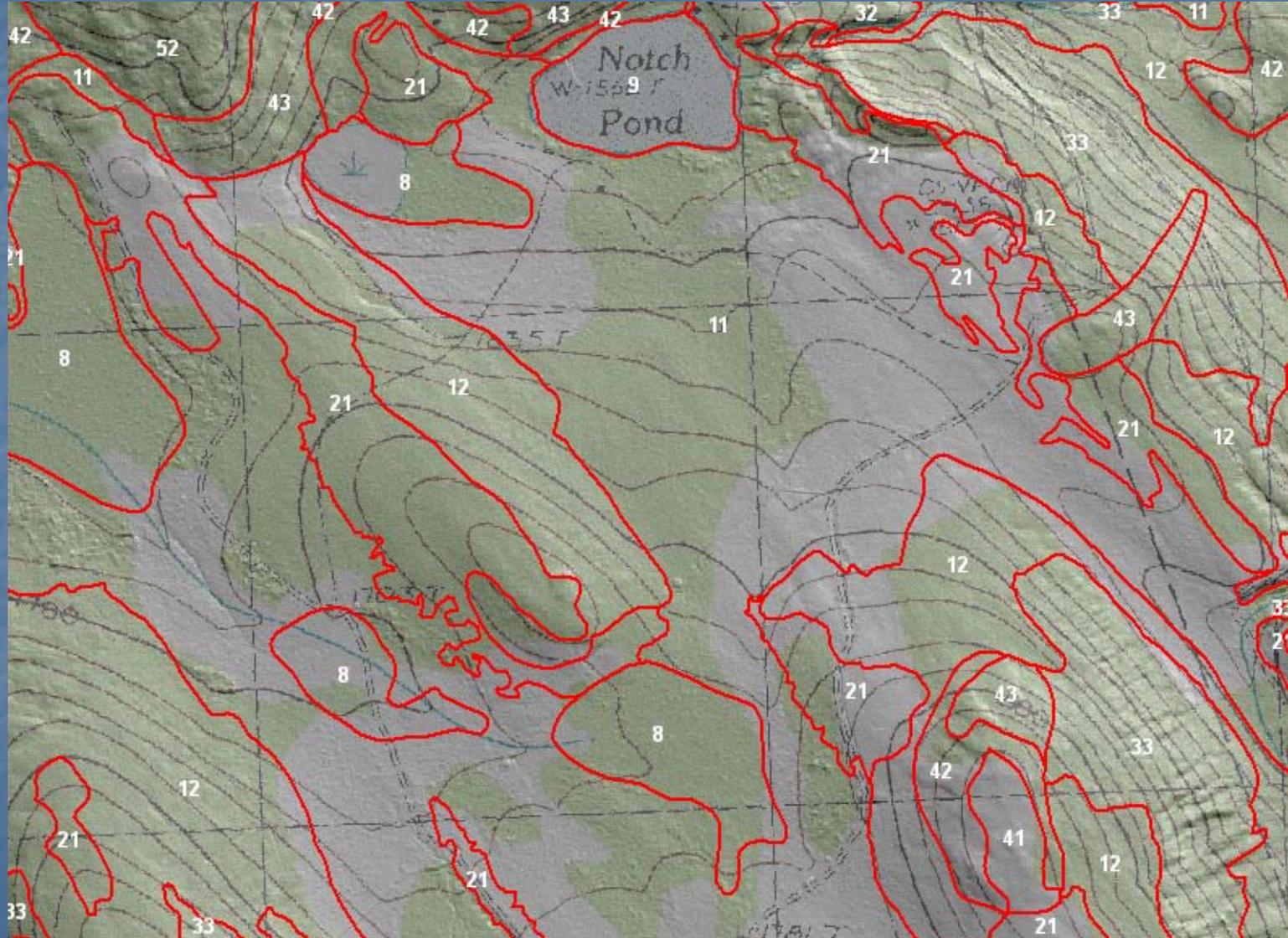
Create Logical Map Units

Create Minimum-size Delineations Using the "Remove Slivers" Tool

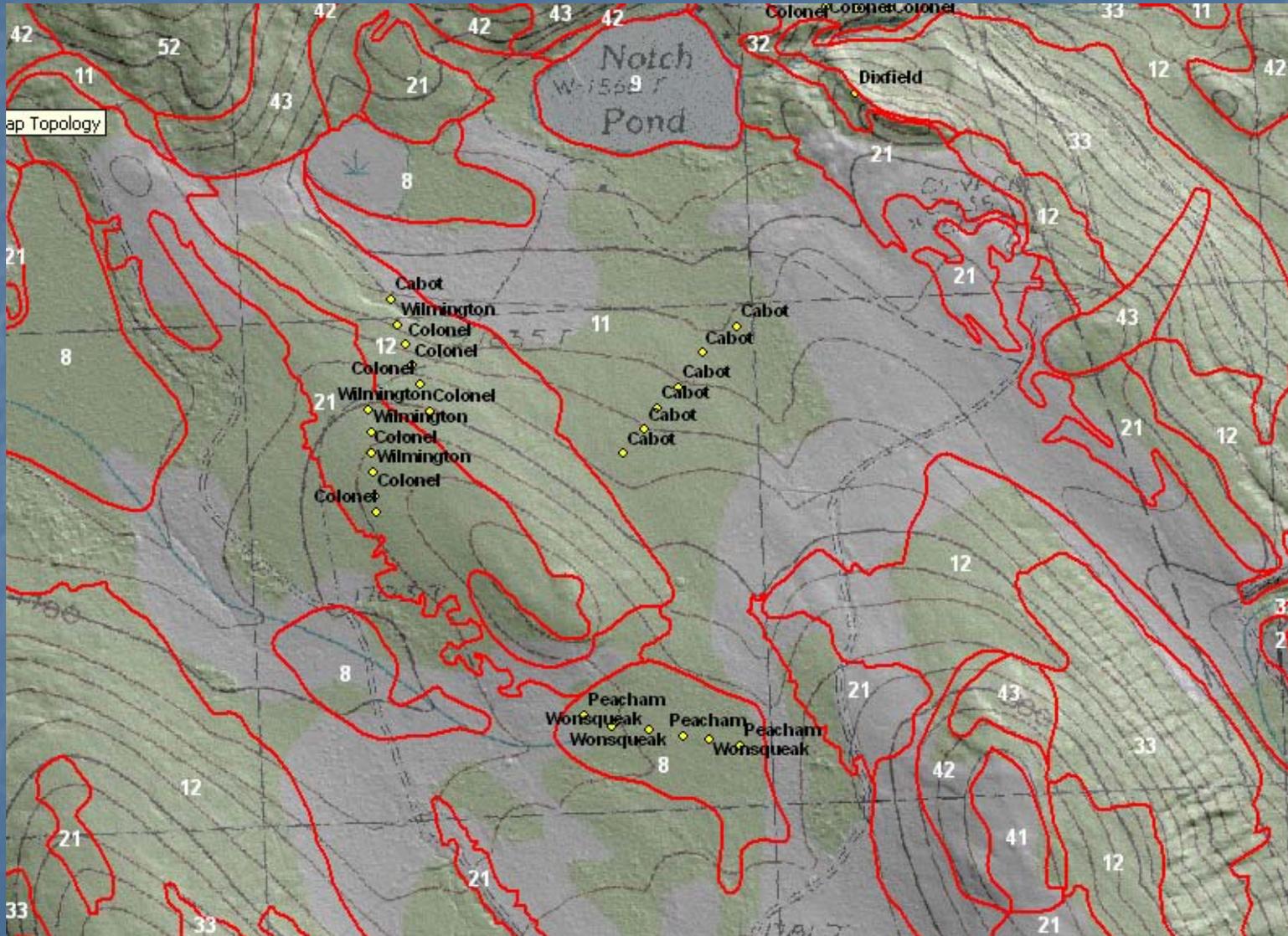


In Essex County, VT, 5 acres.

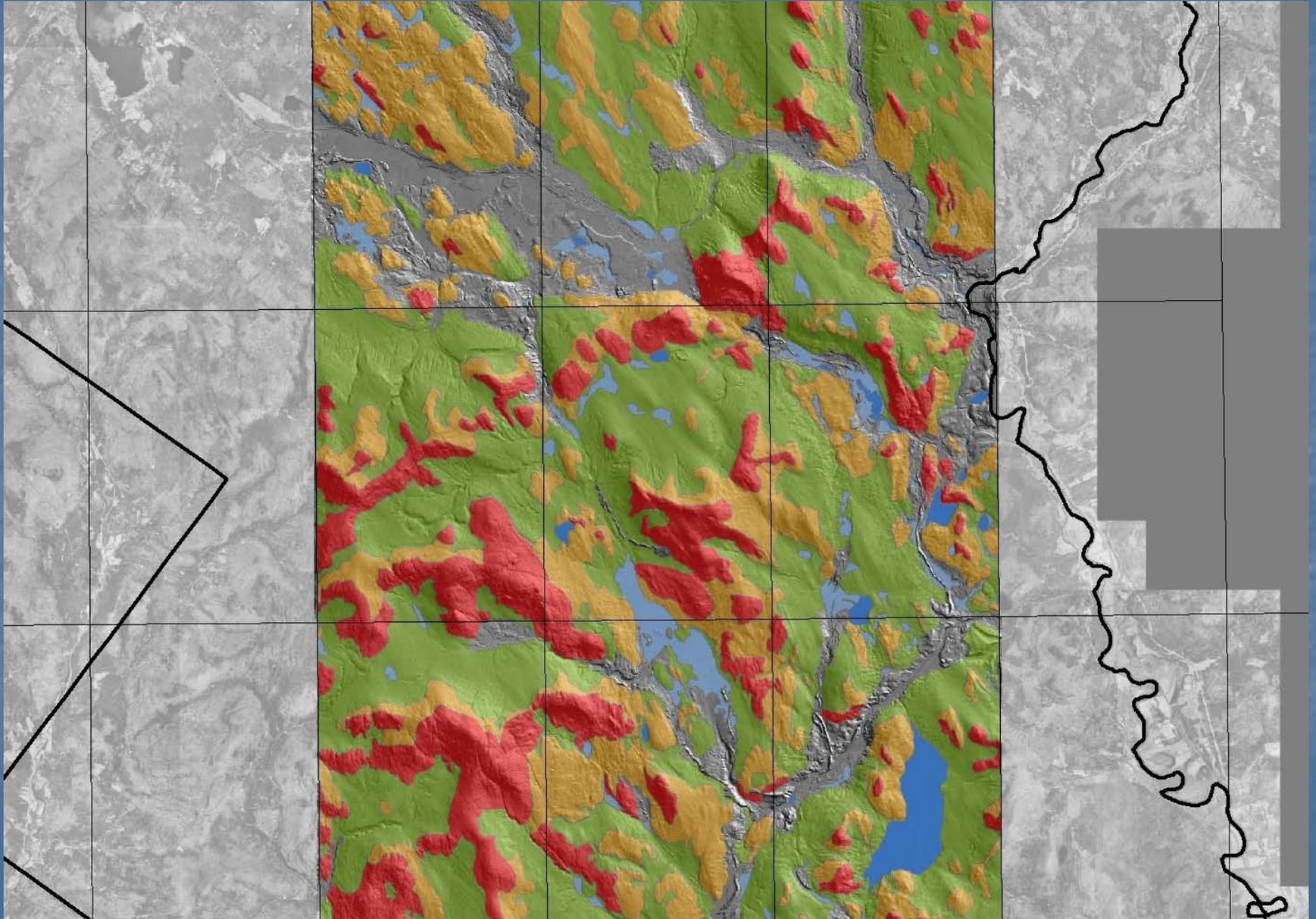
Raster Results are Further Processed and then Vectorized



Map Unit Composition is Determined Through Field Investigations



Typical Applicability of Automated Digital Soil Mapping Processes

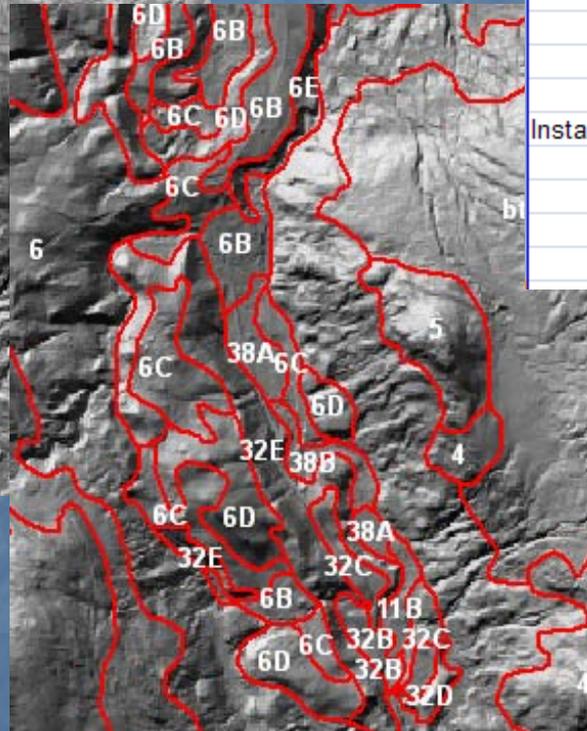
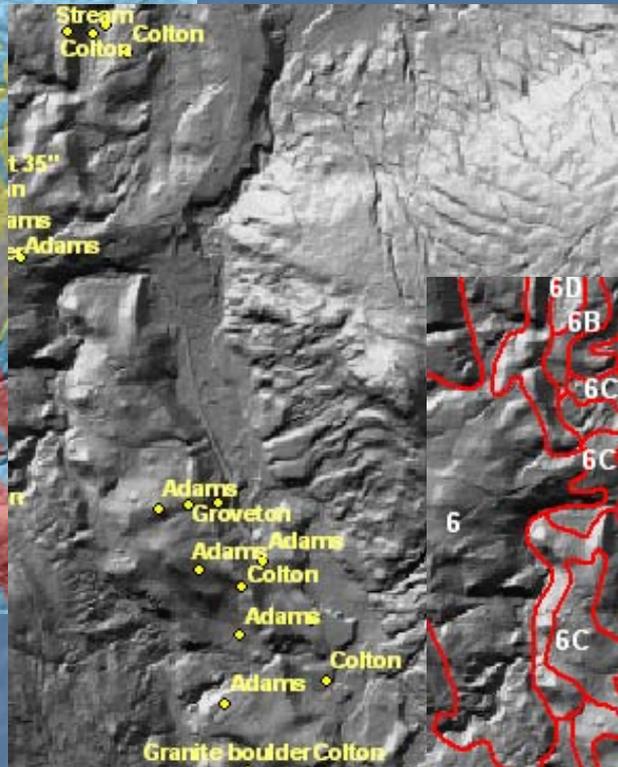
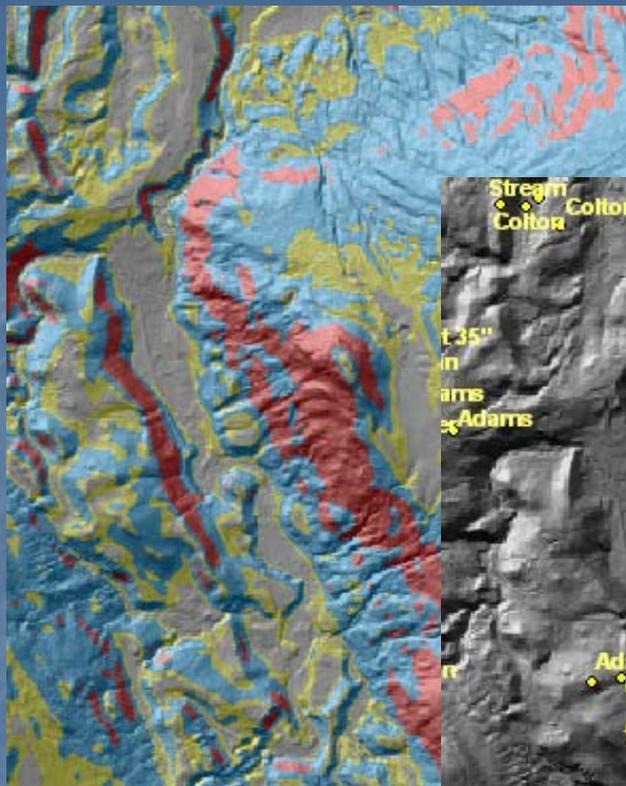


Positives-

- Mapping production increased by approximately 100%
- Maps are of consistently better quality

Negatives-

- Requires well trained and equipped staff
- Dependent on LiDAR elevation data (for order 2 surveys in the glaciated NE)



Current Rules			
		Cabot	
Instance 1		limiting factor	
		Wetness	
	V1	6.3	
	W1	1.5	
		Slope	
	V2	8	
	W2	12	
		Cabot	
Instance 2		limiting factor	
		Slope	
	V2	1.9	
	W2	0.1	

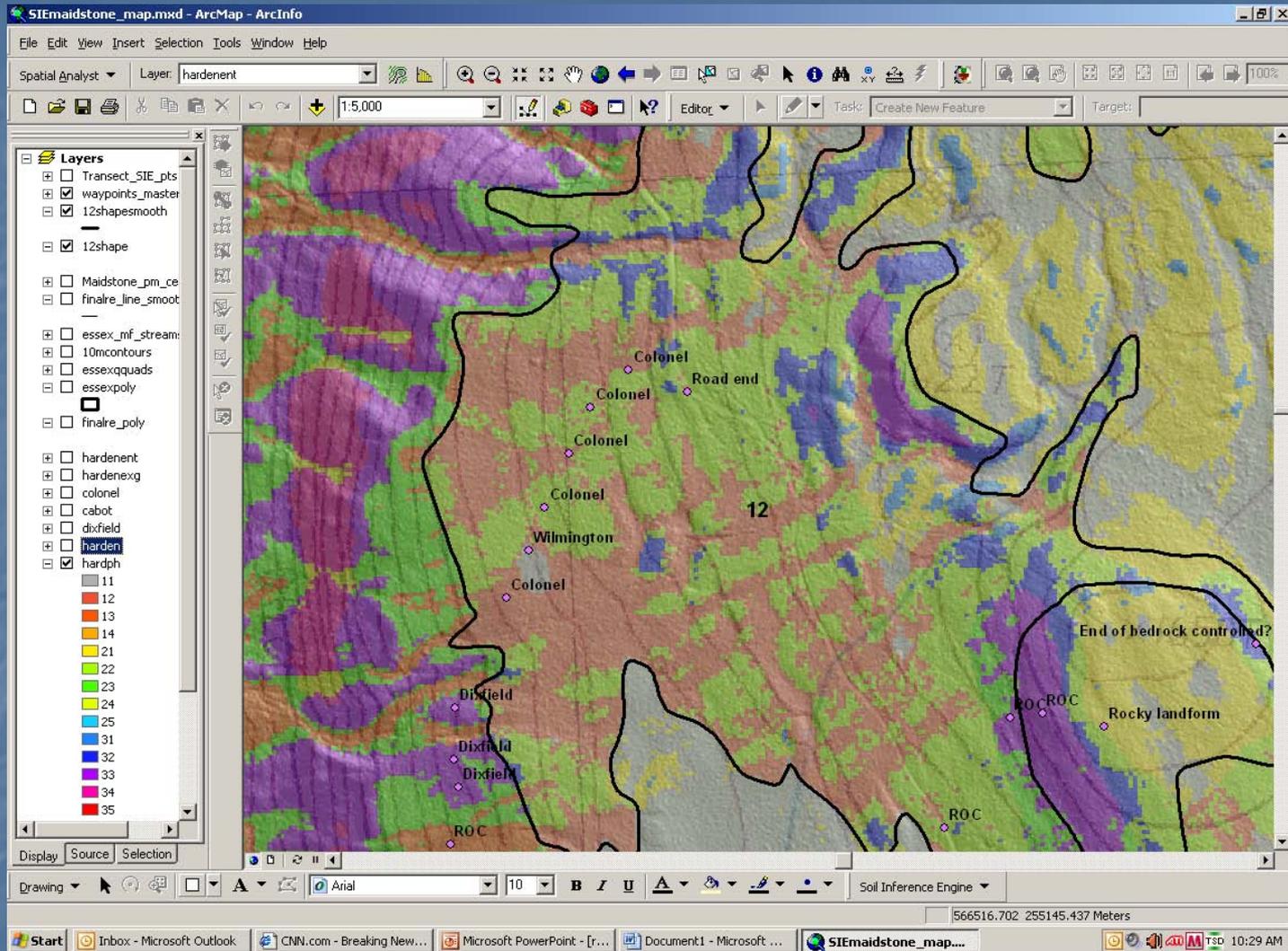
We can now preserve and communicate most of the knowledge and data about the survey area.

Future Direction.....

DSMII "Processes with ArcSIE" FY2011 Pilot



Continued technical support and formal training



Delivery of raster products to enhance SSURGO

DRAFT PROJECT PLAN

Automated Soil Survey Update Utilizing Arc Soil Inference Engine (ArcSIE), May 3, 2011

Objective: To test a knowledge-based digital process for soil survey map updating. The process is supported by "Knowledge Discoverer", a new component of ArcSIE.

Development of tools for map updating

Knowledge Discoverer Interface

The screenshot displays the Knowledge Discoverer interface with several key components:

- Table:** A table listing environmental data layers with columns for Name and File.

Name	File
Elevation	C:\XunResearch\src\Documentation\ArcSIE_Tutorial\Data\Ele
Slope	C:\XunResearch\src\Documentation\ArcSIE_Tutorial\Data\Slo
Profile	C:\XunResearch\src\Documentation\ArcSIE_Tutorial\Data\Pro
Planform	C:\XunResearch\src\Documentation\ArcSIE_Tutorial\Data\Pla
- Graph:** A graph showing relationship curves. The x-axis ranges from 461.6 to 830.8, and the y-axis ranges from 0 to 1. Two green curves are shown, with a blue curve in between. Key values on the x-axis are 628.5, 669.9, 680.9, and 711.3. The y-axis has markers at 0.5 and 1.0. A blue line connects the x-axis values 669.9 and 680.9 to the y-axis value 0.5.
- Vector Map:** A tree view on the left showing a hierarchy of polygons: Polygons_CB, Hogback, Hogback_1, Dixfield, Dixfield_1, Dixfield_2, Dixfield_3, Colonel, and Tunbridge. A red label "SSURGO polygons" is overlaid on this area.
- Rule Base:** A tree view on the right showing a hierarchy of rule bases: Polygons_CB_RB, Dixfield, and Dixfield_1. A red label "New rule for map updating" is overlaid on this area.
- Statistics:** Two panels at the bottom provide statistical data:

Case Statistics	
Min: 701.199	Median: 713.437
Max: 718.903	Mode: 718.903
Mean: 710.85	Std Dev: 3.72544

Env Layer Statistics	
Min: 461.55	Median: 0
Max: 830.778	Mode: 0
Mean: 664.192	Std Dev: 56.7201

Discover, verify, and revise the soil-landscape model implicit in the existing soil map. Then apply the revised model to create updated polygons.

Want to Know More?

Soil Inference Engine (SIE) Progress Report

USDA- Natural Resources Conservation Service
Geography Department, Dartmouth College
March, 2009

Shi, X., Long, R., DeKett, R., Philippe, J., 2009. Integrating different types of knowledge for digital soil mapping. *Soil Science Society of America Journal*. 73:1682–1692.

Philippe, J.M., 2008. Utilizing a knowledge-based system to test the transferability of a soil-landscape model in northeastern Vermont. Masters Thesis, University of Florida.

ArcSIE User's Guide, and Vermont Digital Soil Mapping Cookbook

Contact Bob Long- robert.long@vt.usda.gov