

High-Speed Viewshed Computation for Web Mapping Applications

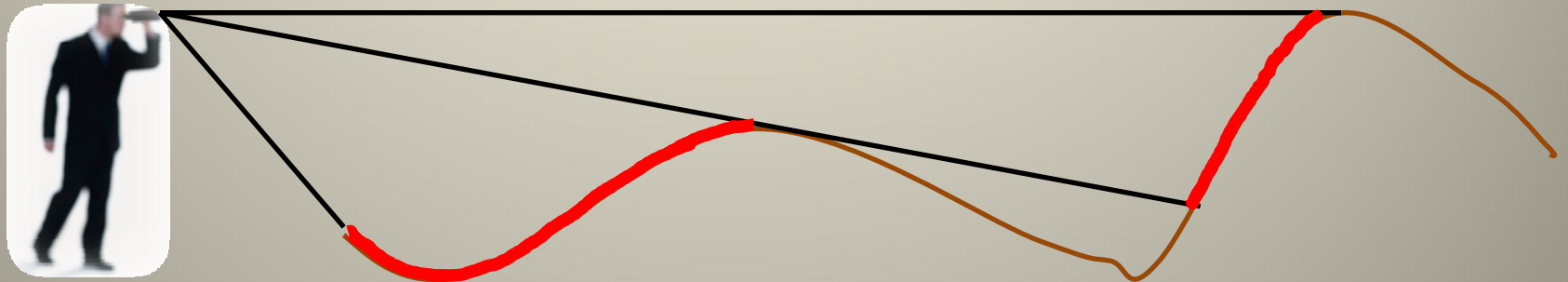
Malcolm Williamson¹, Peter Smith¹, Seth Warn²,
and Jackson Cothren¹

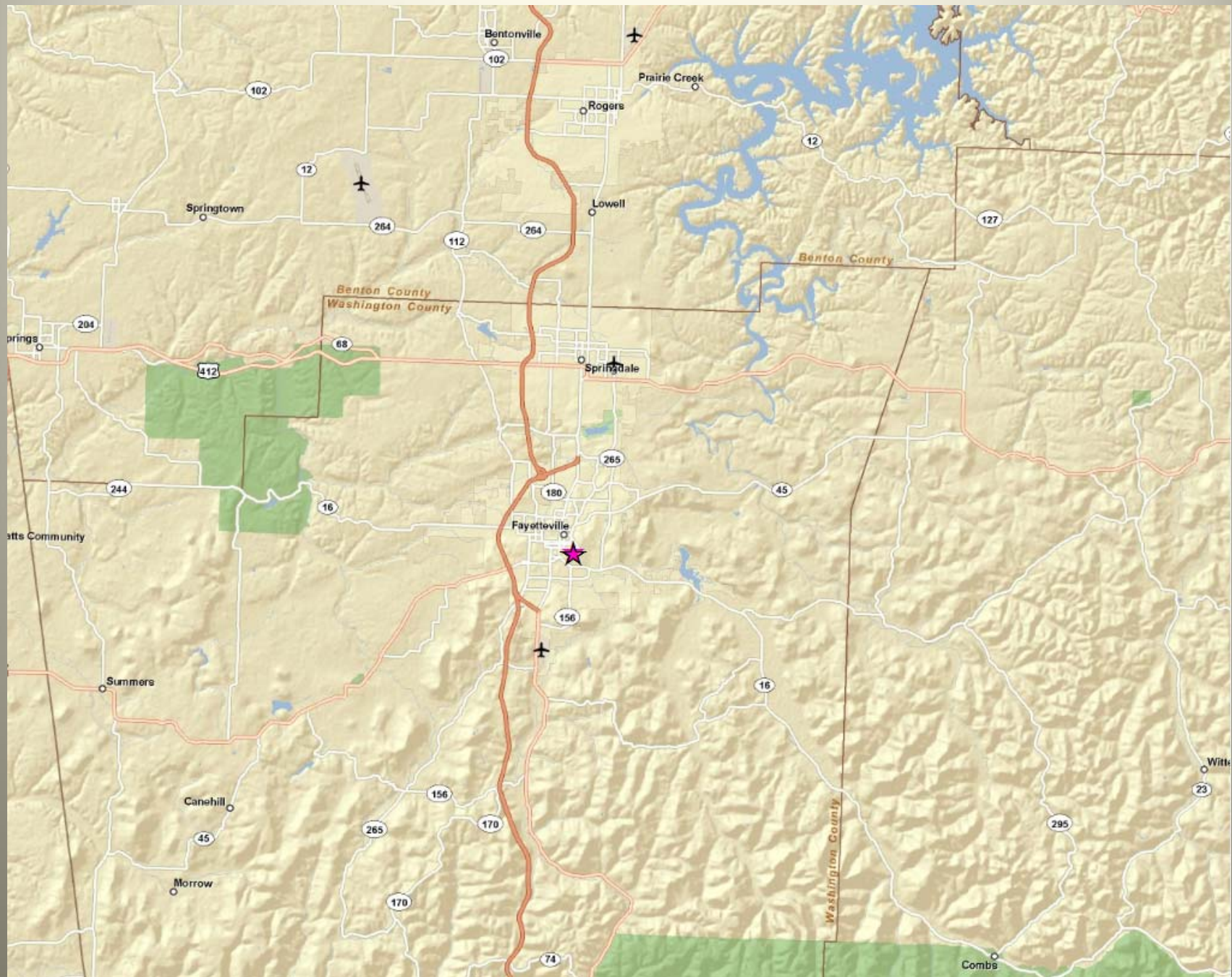
¹Center for Advanced Spatial Technologies (CAST),
University of Arkansas

²Dept. of Computer Science & Computer Engineering
University of Arkansas

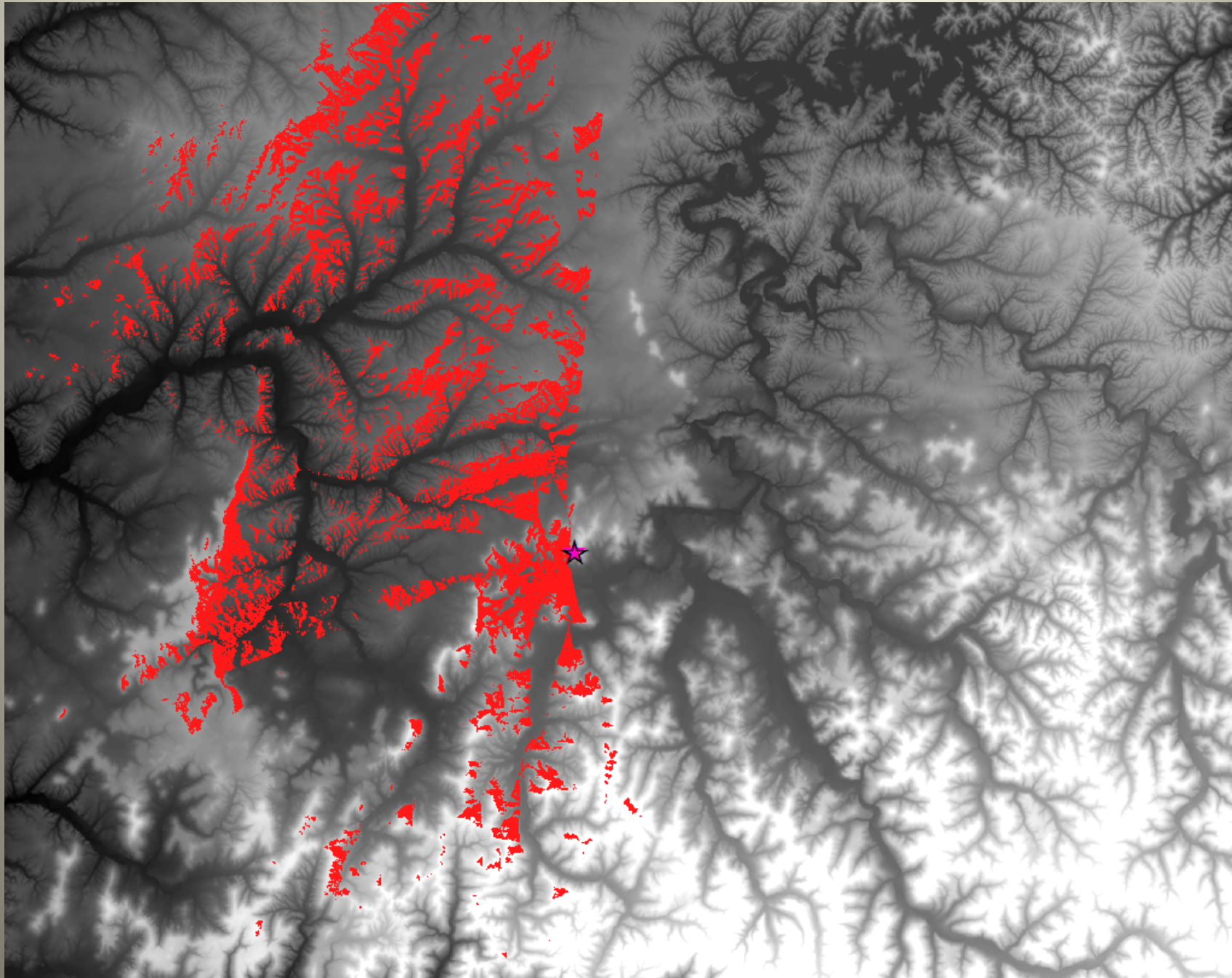
Oklahoma SCAUG 2011

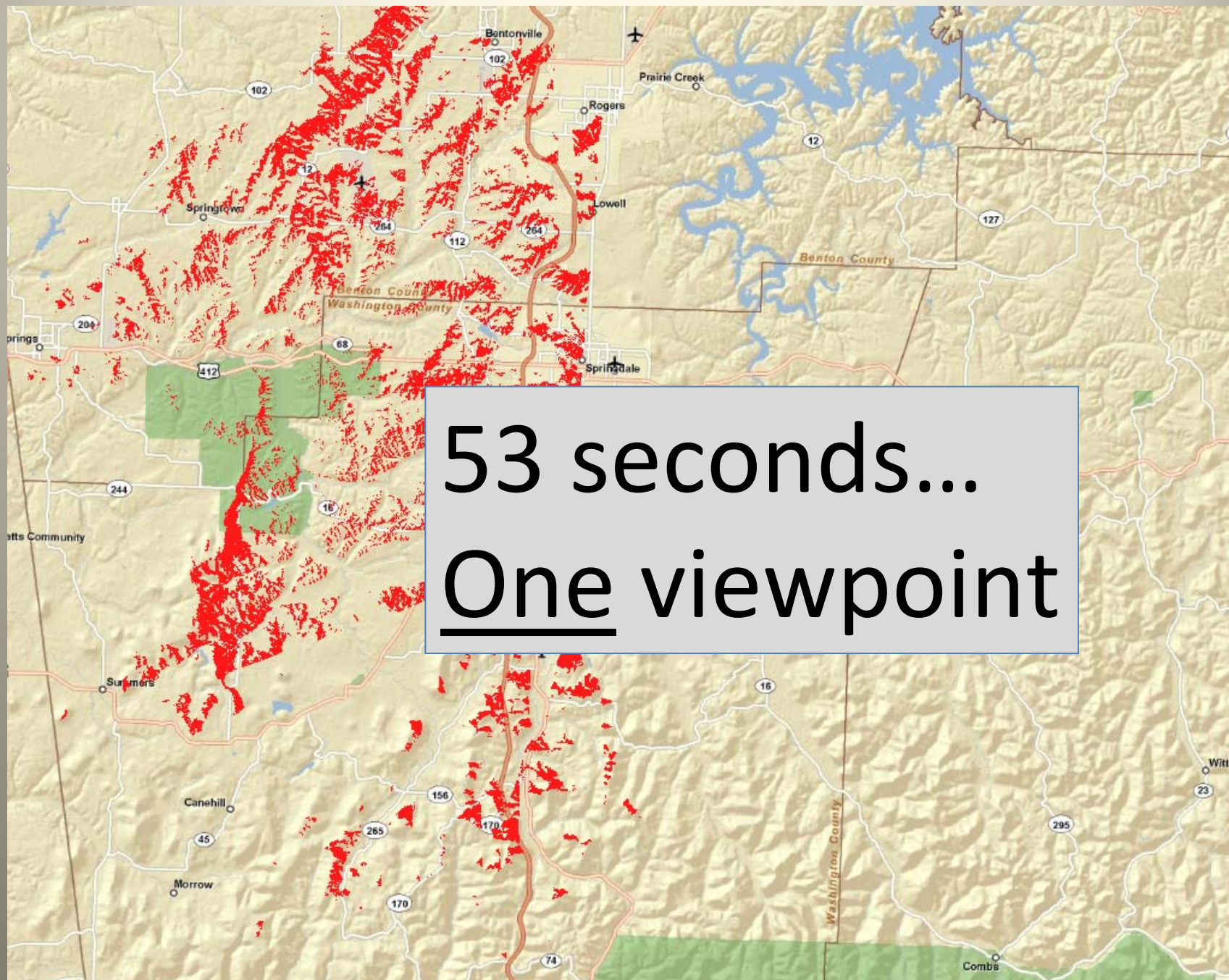
Viewshed Basics



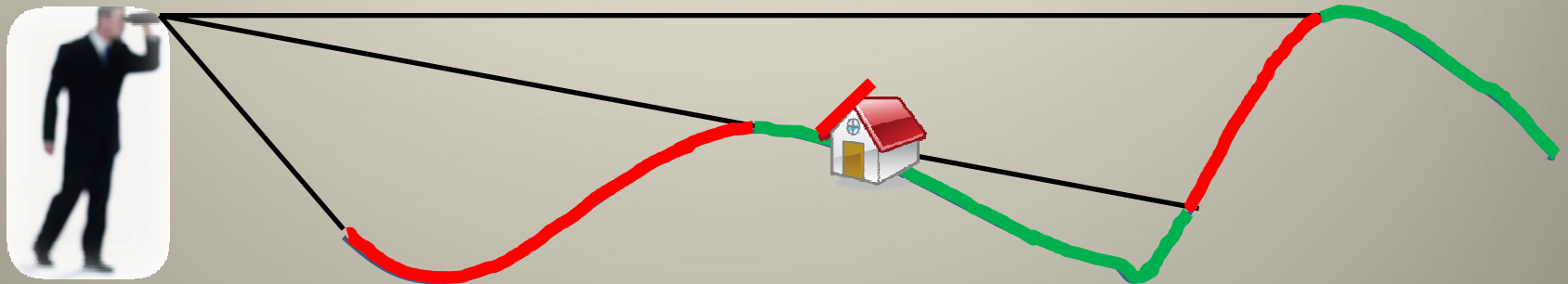








Viewshed Basics

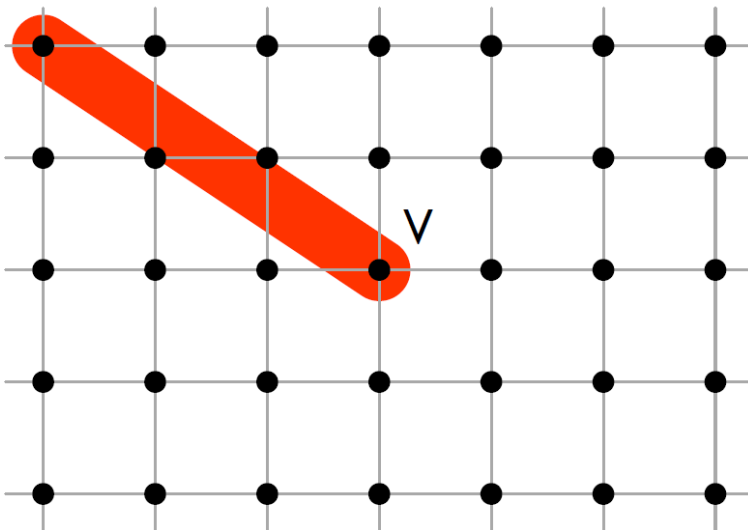


Two Goals...

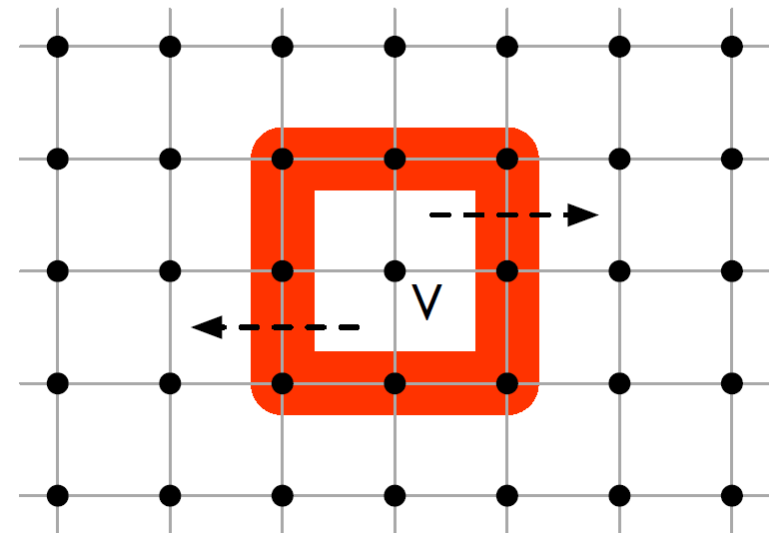
- Speed up processing time
- Calculate maximum non-visible height for non-visible locations

Viewshed Algorithms

Brute Force

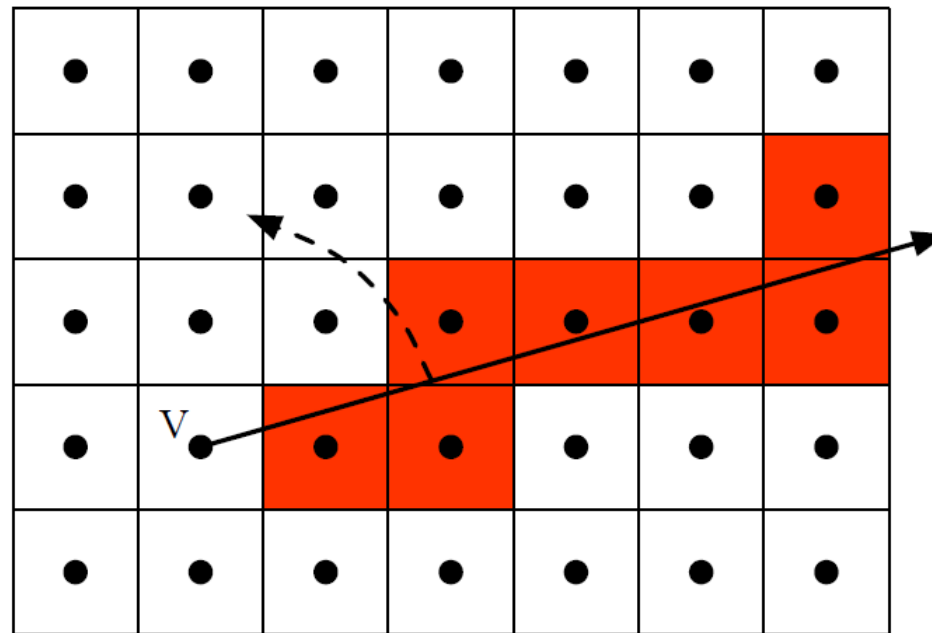


Ring-Growing



Viewshed Algorithms

Planar Sweep



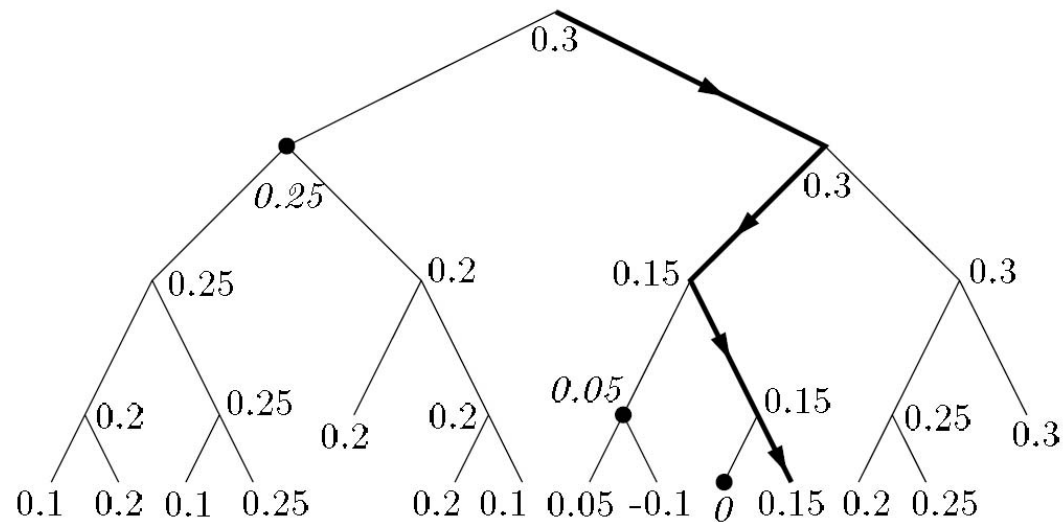
Optimization

Angular Ordering

17	15	14	12	11	9	8
18	16	13	10	7	6	5
20	19	V	1	2	3	4
21	22	23	24	25	26	27

Optimization

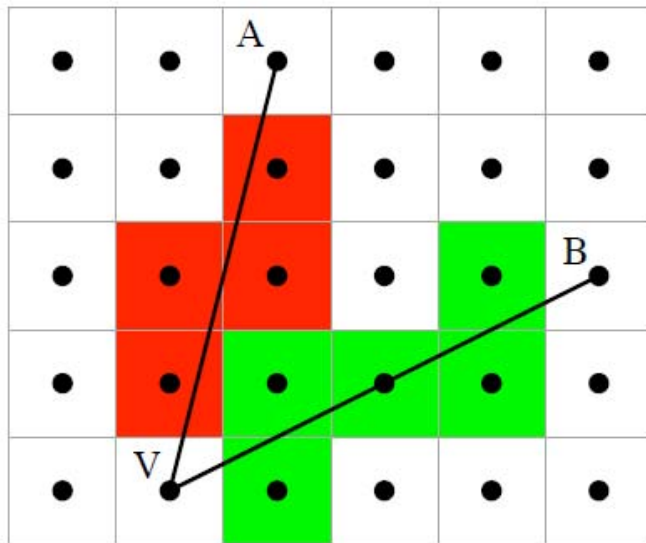
Status Structure



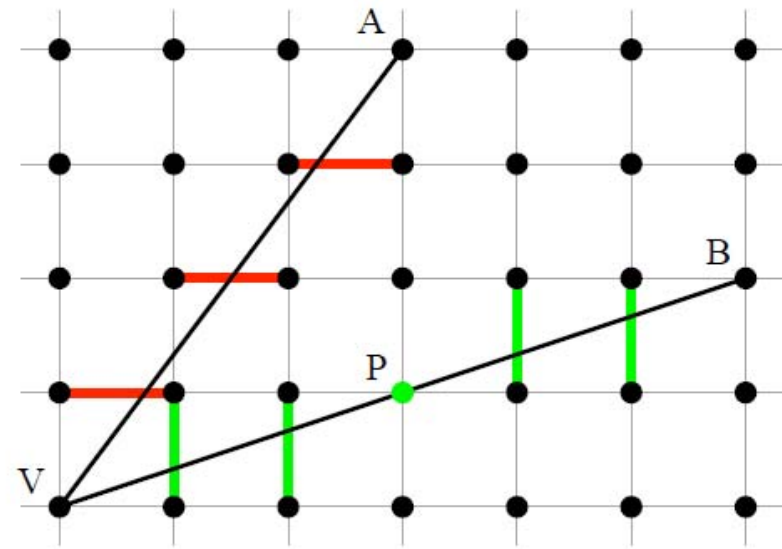
source: van Krevald 1996

Optimization

Interpolating Height Values



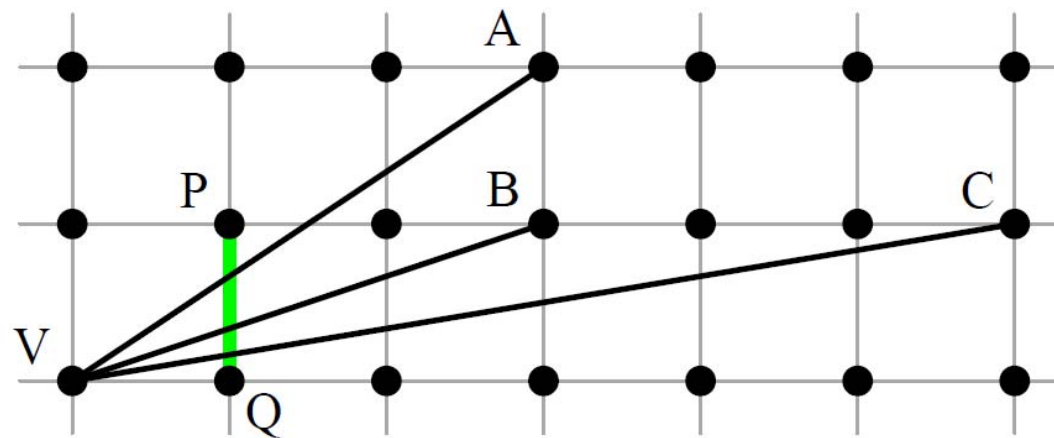
van Kreveld



Warn

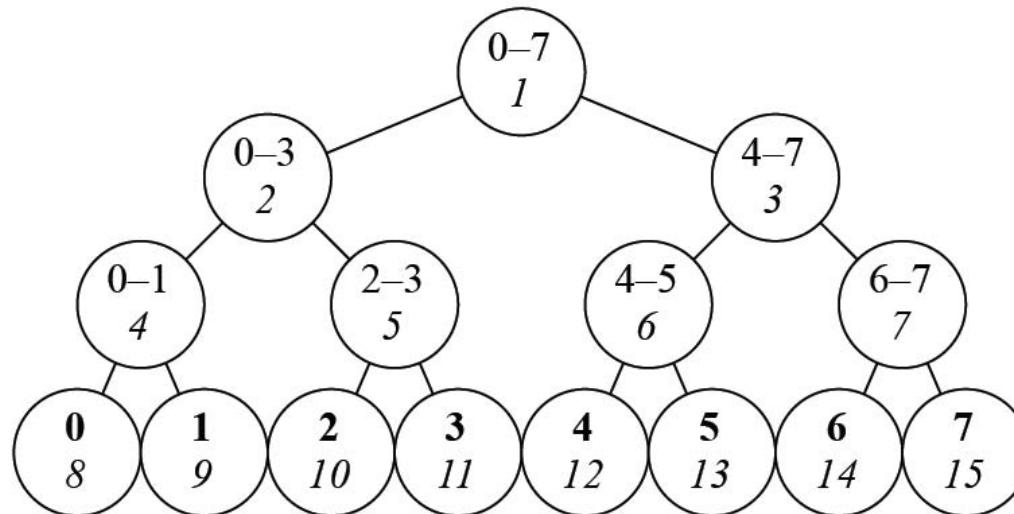
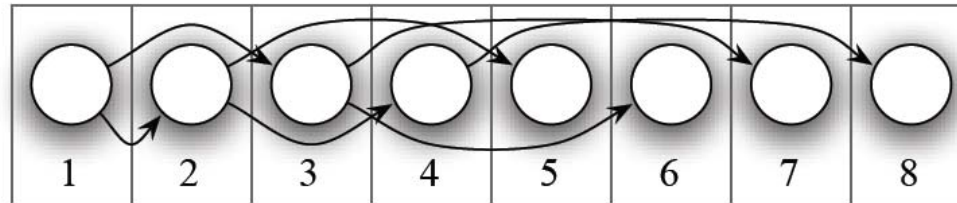
Optimization

Interpolation and Reuse



Optimization

New Status Structure



Multi-Core Parallelization

		serial version	parallel threads			
			1	2	4	8
Event Sort	time (s)	37.5	38.2	20.2	10.9	8.2
	speedup	-	0.98	1.86	3.44	4.57
	efficiency	-	98%	93%	86%	-
Planar Sweep	time (s)	45.6	45.6	23.0	11.8	10.3
	speedup	-	1.00	1.98	3.86	4.43
	efficiency	-	100%	99%	96%	-
Total	time (s)	85.6	86.3	45.7	25.3	21.1
	speedup	-	0.99	1.87	3.83	4.06
	efficiency	-	99%	94%	85%	-

time to analyze 16,000×16,000 DEM

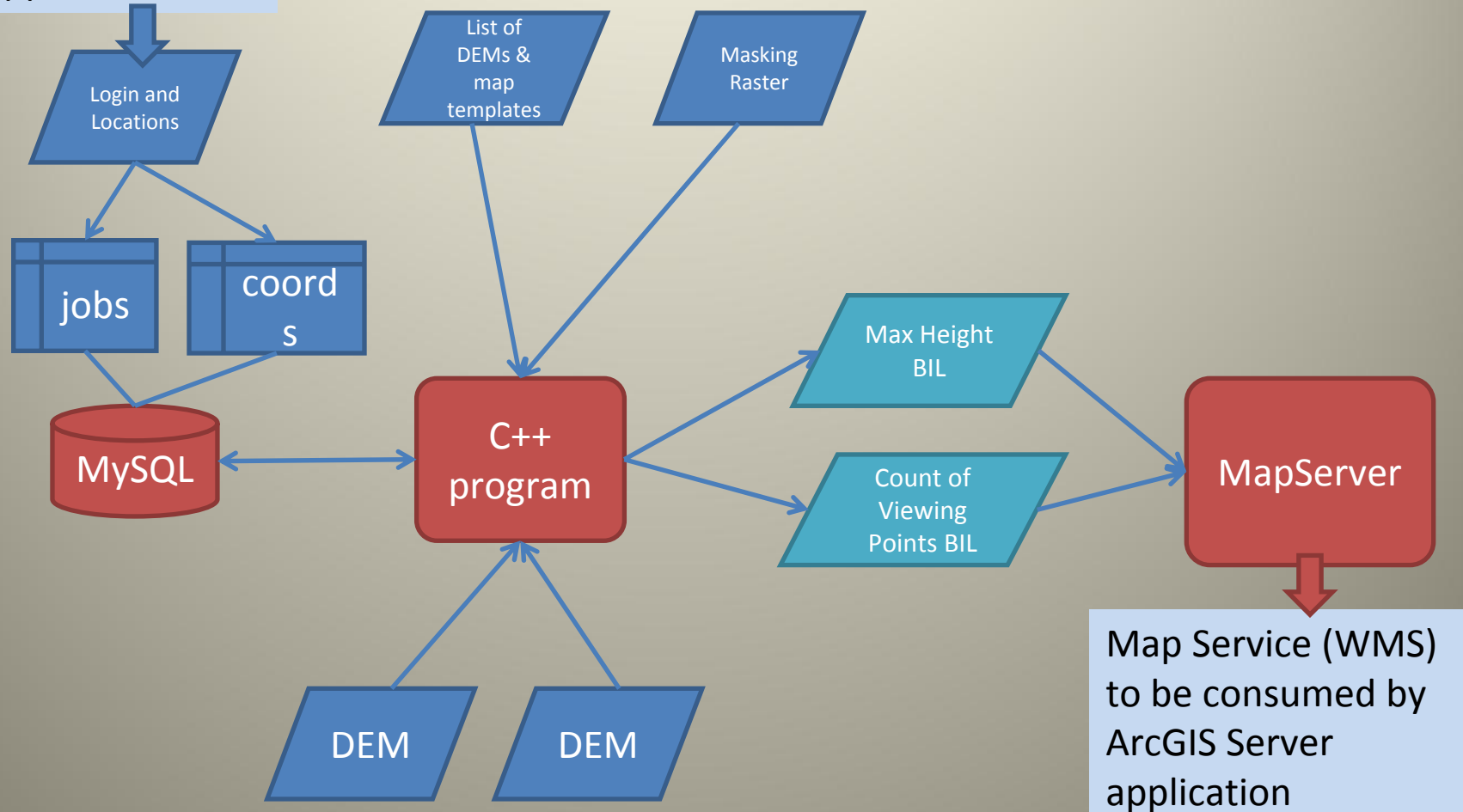
Optimization Results

Time to calculate $N \times N$ viewshed in seconds

size	pvshed	GRASS	MATLAB	ArcInfo
500	0.015	5	10.613	1
1000	0.056	115	30.616	3
2000	0.236	1668	203.294	8
4000	1.041	-	1446.834	26
8000	4.531	-	-	-
16000	20.992	-	-	-
19000	34.102	-	-	-

Fast Viewshed Server

URL string from ArcGIS
Server application



VIRAMMS: Visual Impact Ri x

lingo1.cast.uark.edu/WIND/viewer/index.aspx

VIRAMMS: Visual Impact Risk Assessment and Mitigation Mapping System

[Create a Risk Map](#) [Site Infrastructure](#) [Import/ Export](#) [Print Map](#) [Get Help](#)

☒ **Natural and Cultural Features** [Legend](#)

☒ Key Observation Points [Legend](#)

☒ Landmarks [Legend](#)

☒ Trails [Legend](#)

☐ Wild and Scenic Rivers [Legend](#)

☒ **Environmental Layers** [Legend](#)

☐ Wind Potential (Combined) [Legend](#)

☐ Vegetation Type [Legend](#)

☐ Topographic Position Index [Legend](#)

☒ **Visual Impact Layers** [Legend](#)

☐ Viewsheds From Towns [Legend](#)

☐ Distance From Closest KOP Towns [Legend](#)

☐ Combined (VAC, SQ, SI) [Legend](#)

☐ Visual Absorption Capability [Legend](#)

☐ Scenic Quality [Legend](#)

☐ Scenic Integrity [Legend](#)

☒ **Computed Layers** [Legend](#)

☒ Sensitivity Surface [Legend](#) [Parameters](#)

☒ Exclusion Zones [Legend](#)

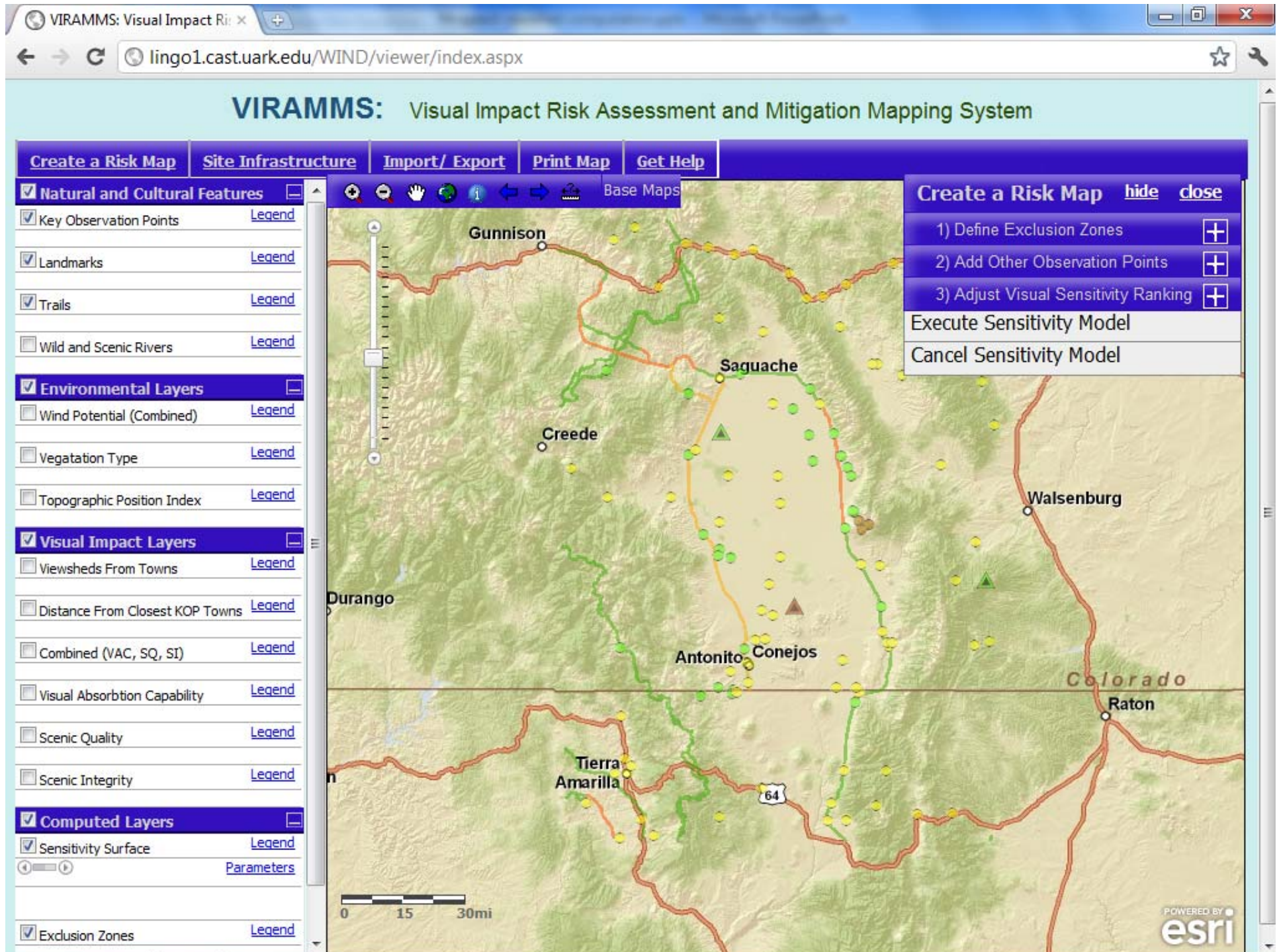
Map navigation using mouse:

- Drag to pan
- SHIFT + Click to recenter
- SHIFT + Drag to zoom in
- SHIFT + CTRL + Drag to zoom out
- Mouse Scroll Forward to zoom in
- Mouse Scroll Backward to zoom out
- Use Arrow keys to pan
- + key to zoom in a level
- - key to zoom out a level
- Double Click to Center and Zoom in

0 15 30mi

POWERED BY esri

The screenshot shows the VIRAMMS web application interface. At the top, there's a browser window with the URL 'lingo1.cast.uark.edu/WIND/viewer/index.aspx'. Below the browser window is the application header with the title 'VIRAMMS: Visual Impact Risk Assessment and Mitigation Mapping System'. A navigation bar contains links: 'Create a Risk Map', 'Site Infrastructure', 'Import/ Export', 'Print Map', and 'Get Help'. On the left, a sidebar lists various map layers under three categories: 'Natural and Cultural Features', 'Environmental Layers', and 'Visual Impact Layers'. Each category has a sub-header and a list of layers with checkboxes and 'Legend' links. The 'Visual Impact Layers' category is currently selected. The main map area displays a topographic map of Colorado with several towns labeled: Gunnison, Canon City, Pueblo, Durango, Walsenburg, and Raton. A scale bar at the bottom left indicates 0, 15, and 30 miles. A 'Help' popup window is open in the center of the map, providing instructions on map navigation using a mouse. The bottom right corner features the 'POWERED BY esri' logo.



VIRAMMS: Visual Impact Ri: x

lingo1.cast.uark.edu/WIND/viewer/index.aspx

VIRAMMS: Visual Impact Risk Assessment and Mitigation Mapping System

Create a Risk MapSite InfrastructureImport/ ExportPrint MapGet Help

☒ Natural and Cultural Features

☒ Key Observation PointsLegend

☒ LandmarksLegend

☒ TrailsLegend

☐ Wild and Scenic RiversLegend

☒ Environmental Layers

☐ Wind Potential (Combined)Legend

☐ Vegetation TypeLegend

☐ Topographic Position IndexLegend

☒ Visual Impact Layers

☐ Viewsheds From TownsLegend

☐ Distance From Closest KOP TownsLegend

☐ Combined (VAC, SQ, SI)Legend

☐ Visual Absorption CapabilityLegend

☐ Scenic QualityLegend

☐ Scenic IntegrityLegend

☒ Computed Layers

☒ Sensitivity SurfaceLegendParameters

☒ Exclusion ZonesLegend

3) Adjust Visual Sensitivity Ranking

This optional step allows you to adjust the weights used in the Visual Impact Risk Model. You can adjust the weights for each type of Observation Point below. Default values have been provided as well should you desire to use those. [More information about curves.](#)

TownCultural (Pts)Cultural (Linear)Scenic (Pts)Scenic (Linear)User Added

Here you may adjust values assigned to the distance a visible pixel is away from a Key Observation Point:
First you may select how rapidly the score decreases with distance:
linearrapidlyslowly

Multiply scores from these features by 1.0

Consider Points up to 25 miles away.

Create a Risk Maphideclose

1) Define Exclusion Zones

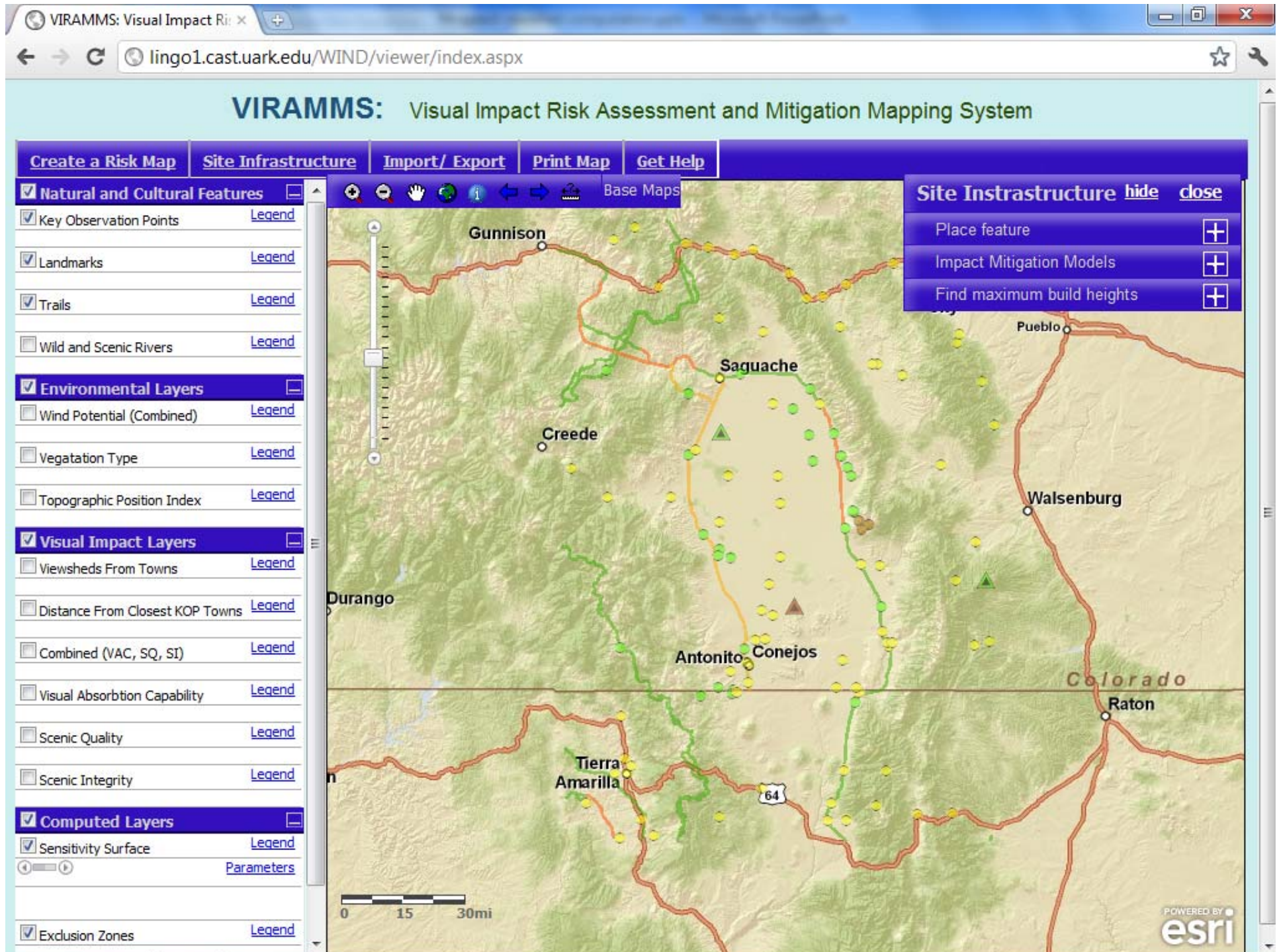
2) Add Other Observation Points

Execute Sensitivity Model

Cancel Sensitivity Model

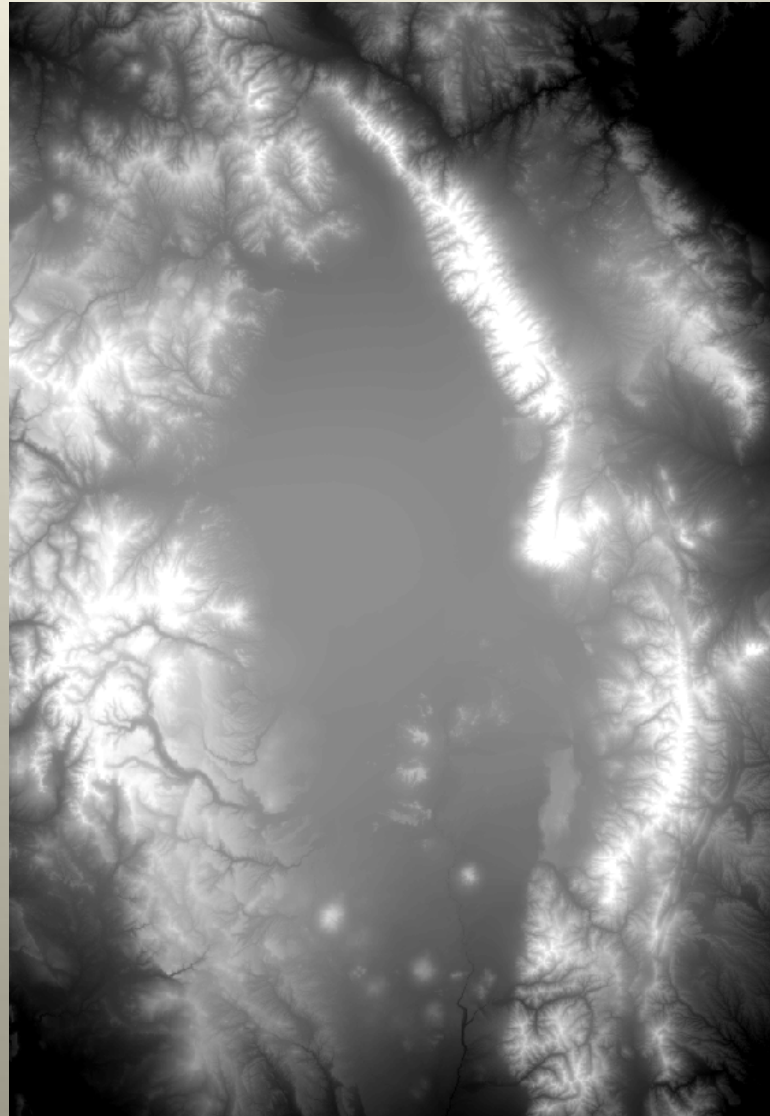
01530mi

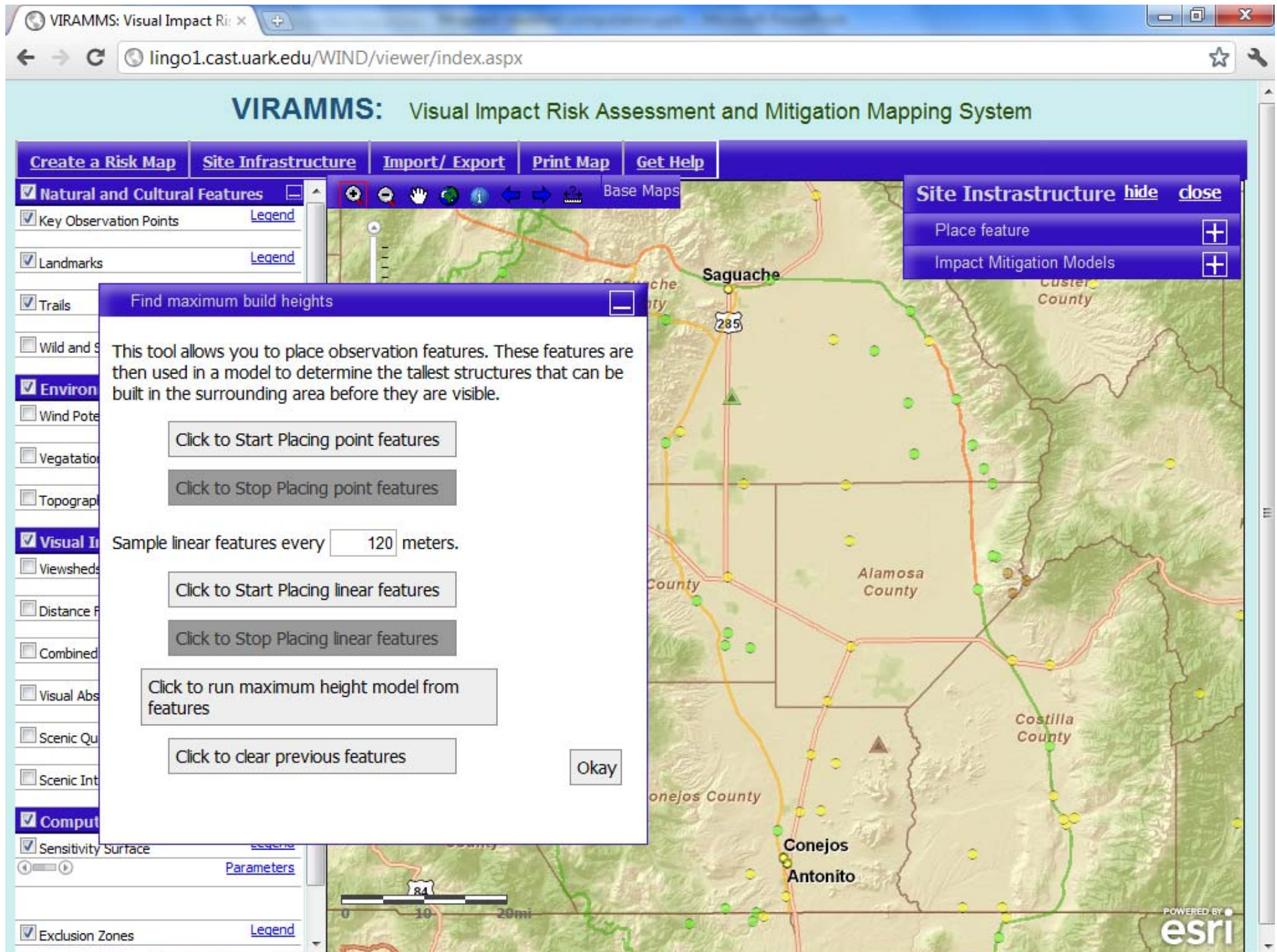
POWERED BY esri

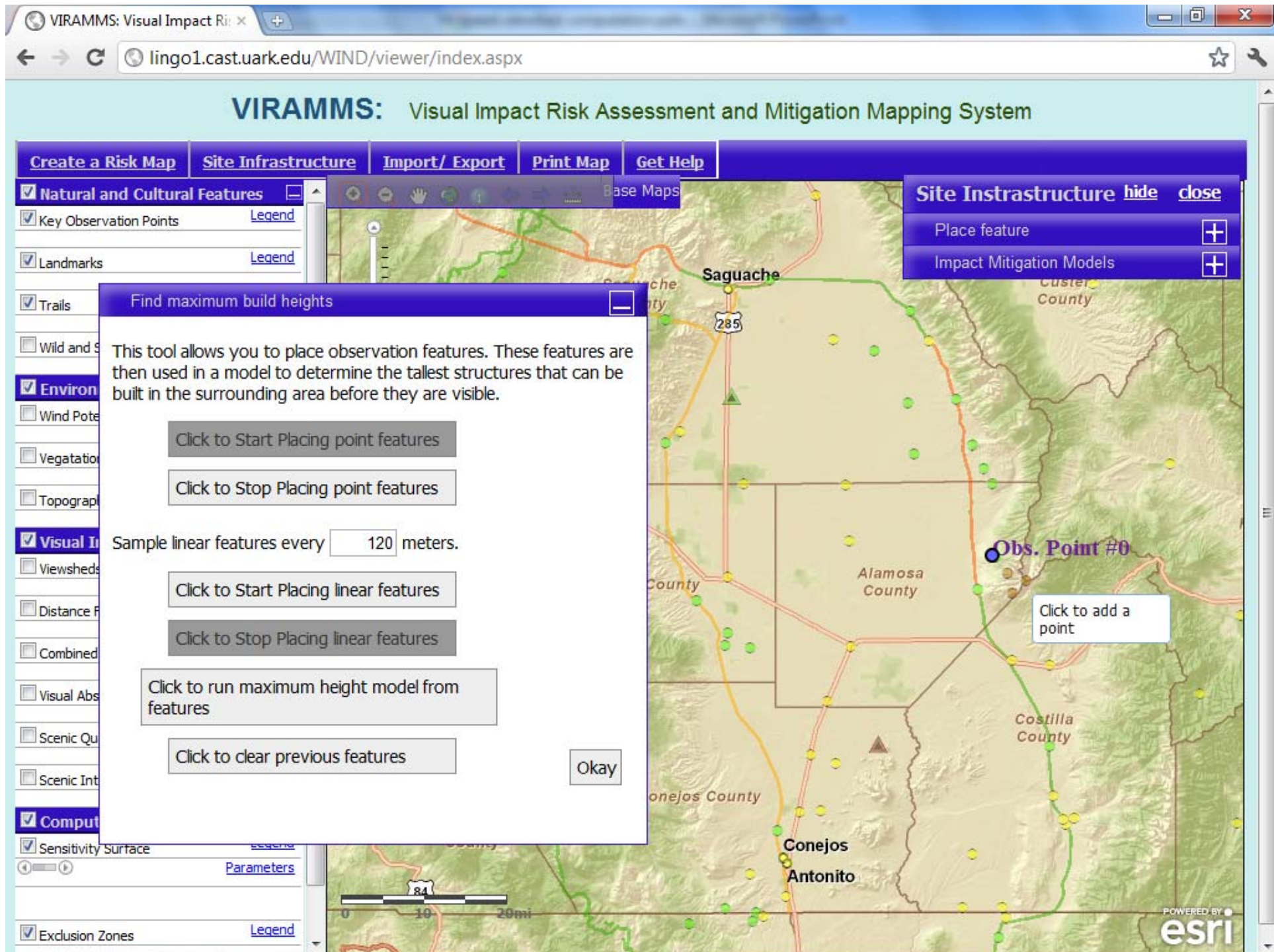


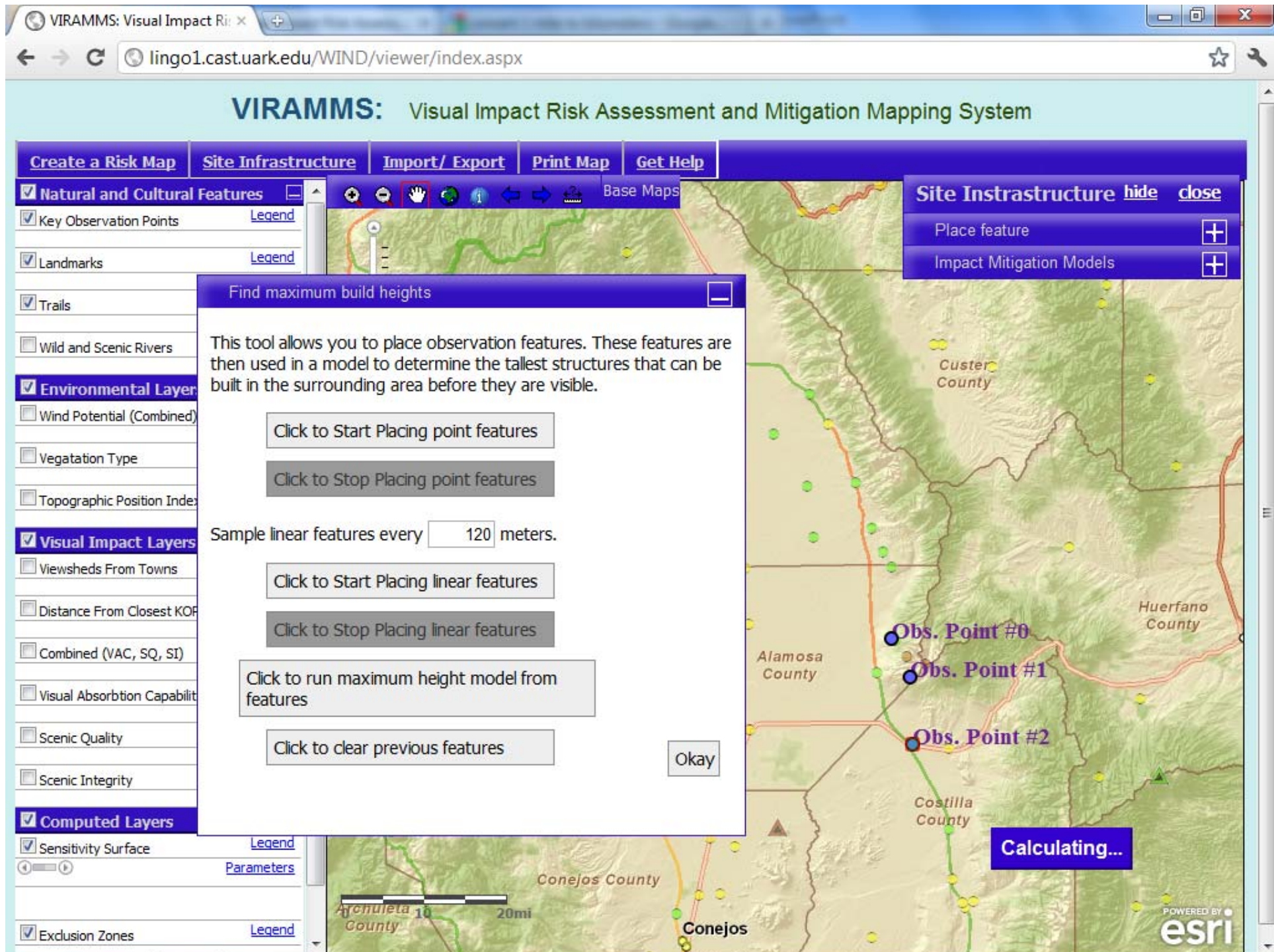
Pilot DEM (San Luis valley)

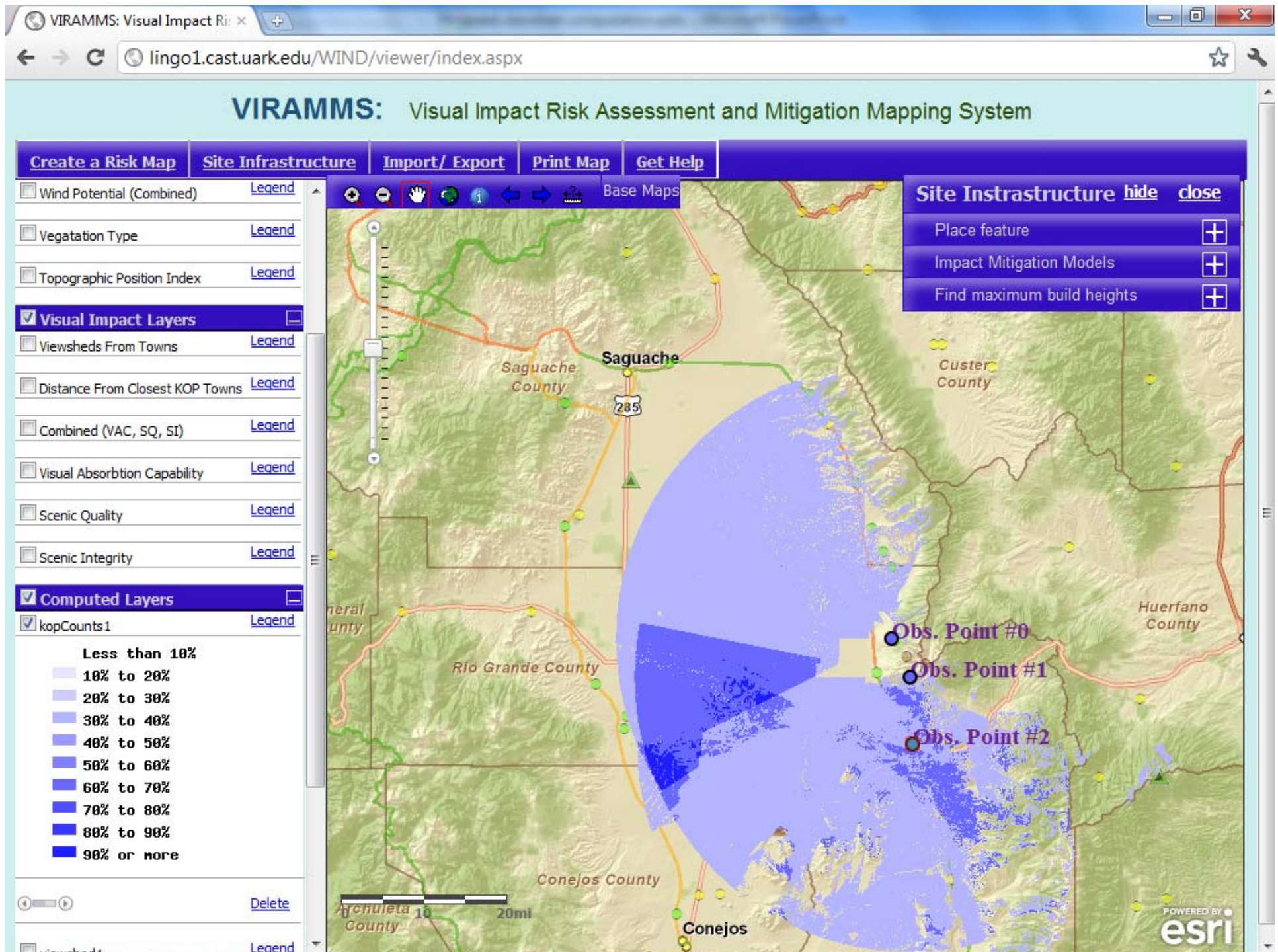
- 5717 x 8183 cells

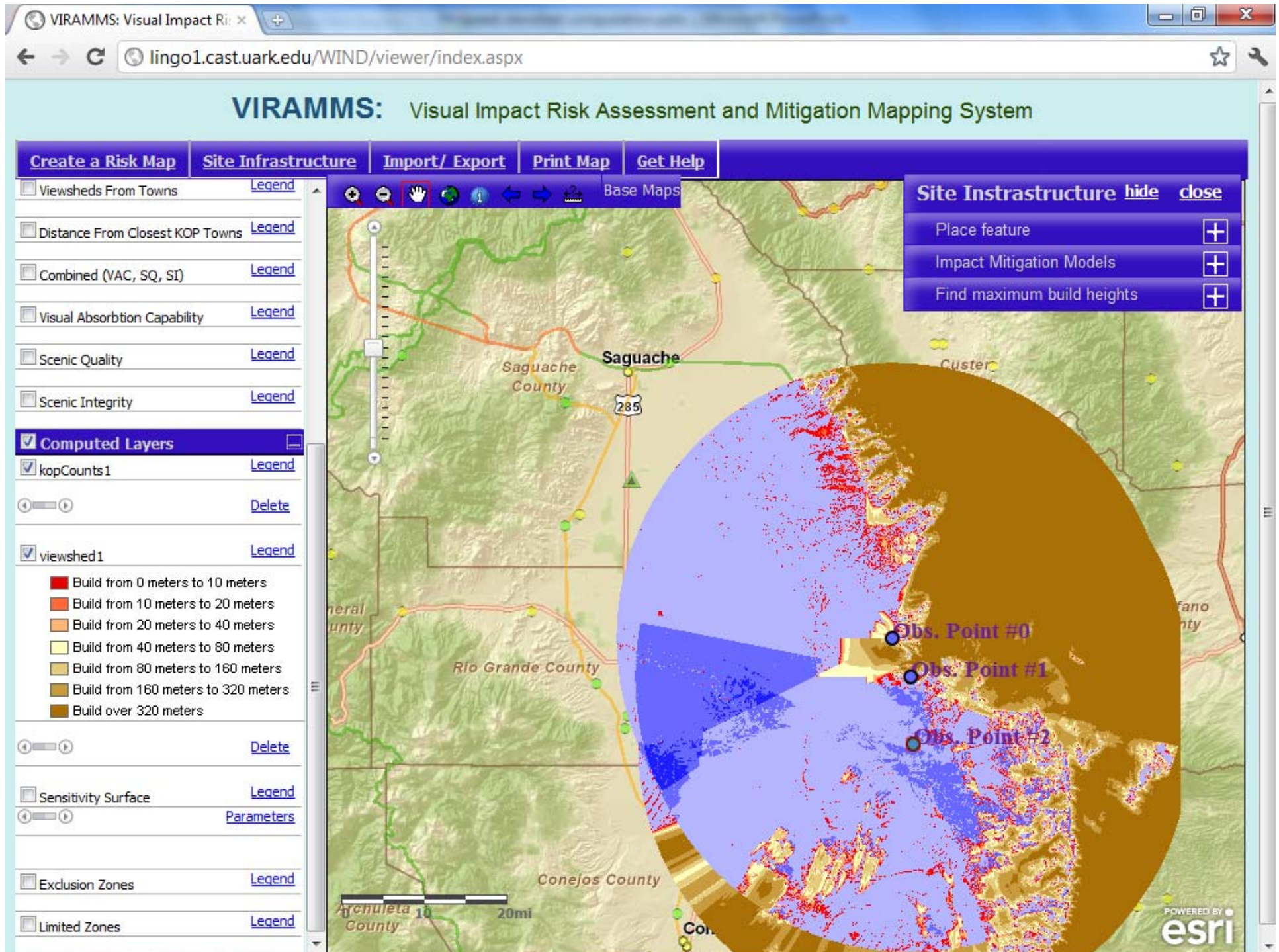


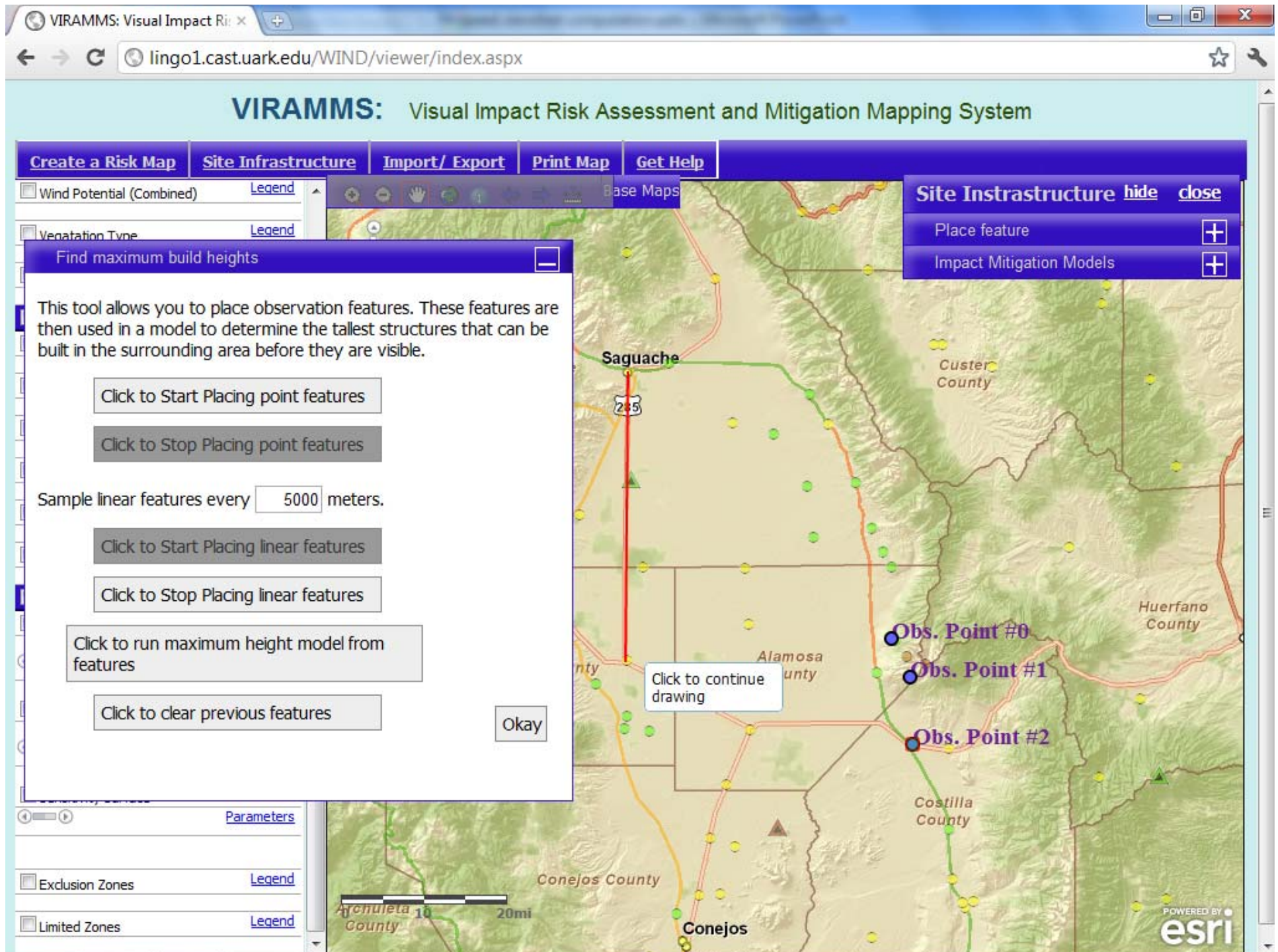


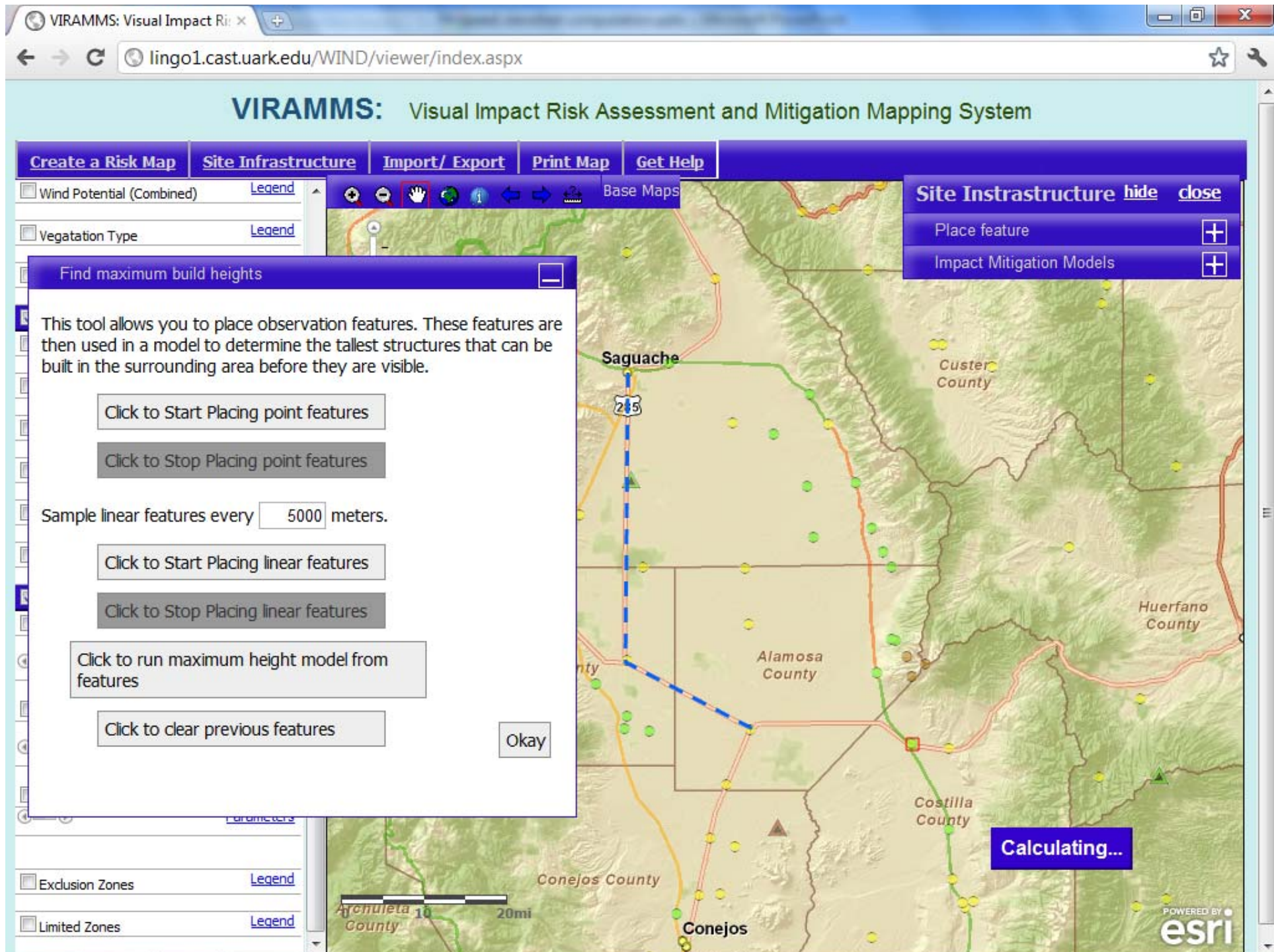


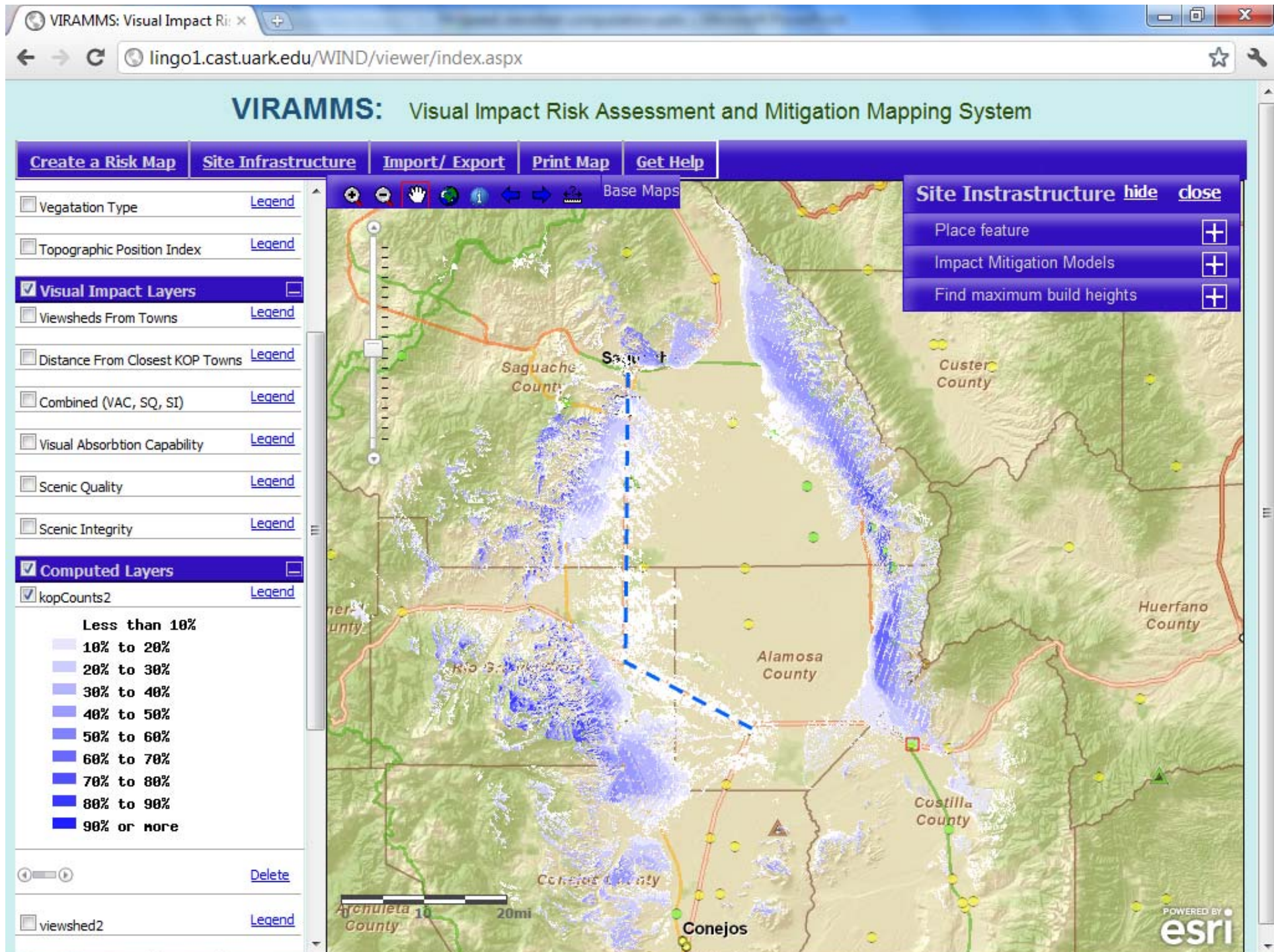


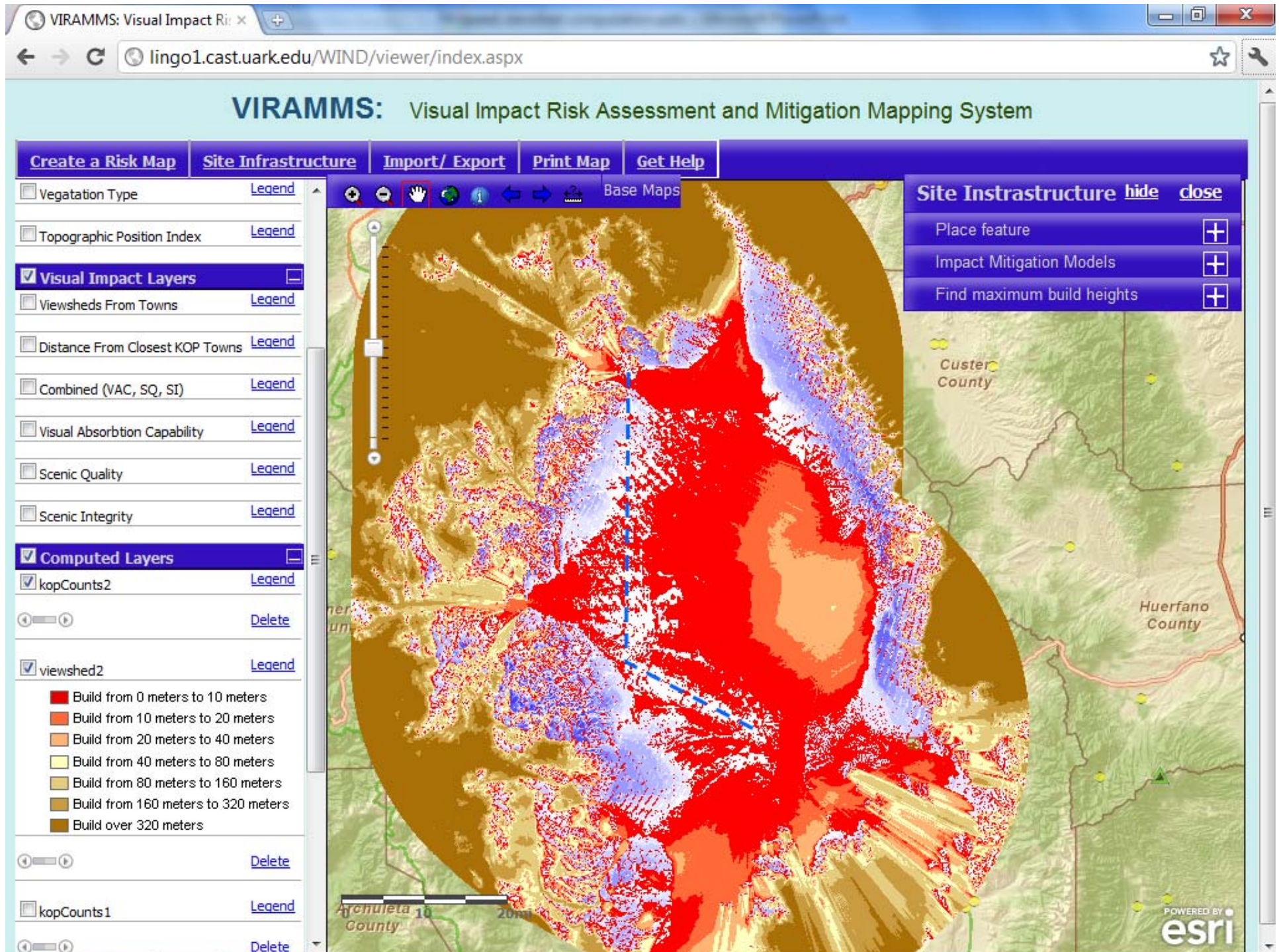


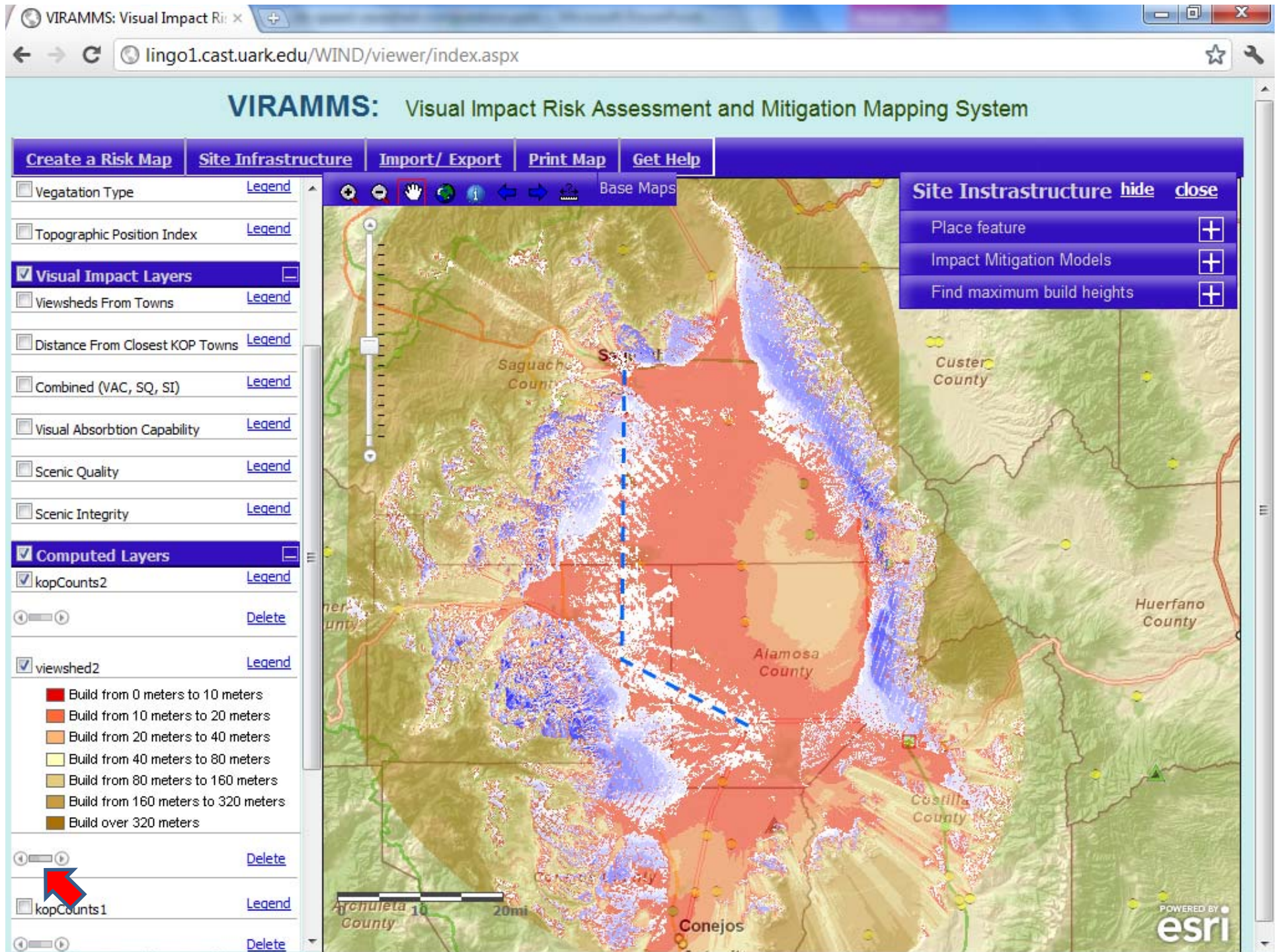


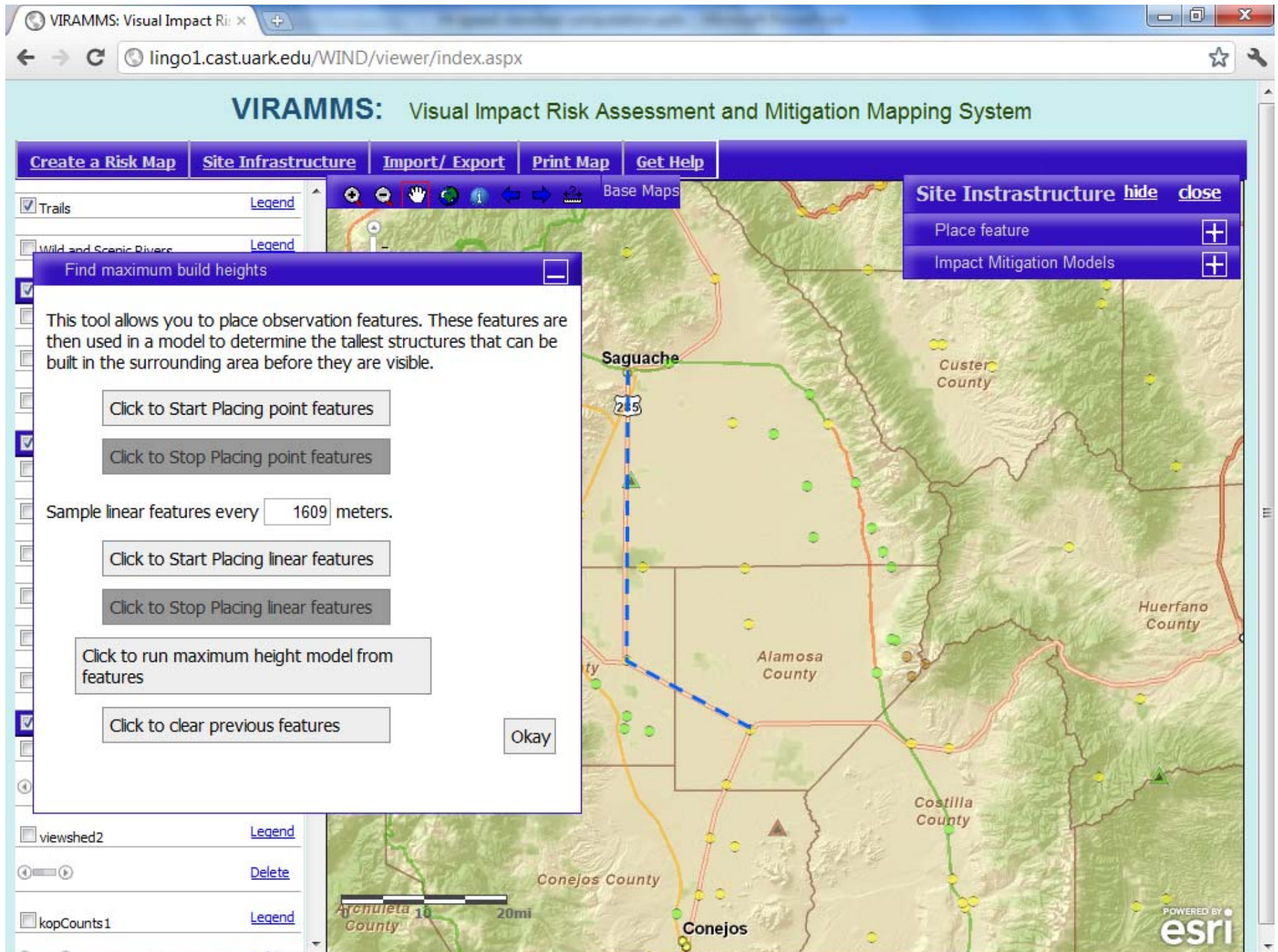












VIRAMMS: Visual Impact Risk Assessment and Mitigation Mapping System

lingo1.cast.uark.edu/WIND/viewer/index.aspx

Create a Risk Map | Site Infrastructure | Import/ Export | Print Map | Get Help

Trails Legend
Wild and Scenic Rivers Legend
viewshed2 Legend
kopCounts1 Legend

Find maximum build heights

This tool allows you to place observation features. These features are then used in a model to determine the tallest structures that can be built in the surrounding area before they are visible.

Click to Start Placing point features
Click to Stop Placing point features
Sample linear features every 1609 meters.
Click to Start Placing linear features
Click to Stop Placing linear features
Click to run maximum height model from features
Click to clear previous features

Long executing maximum building heights

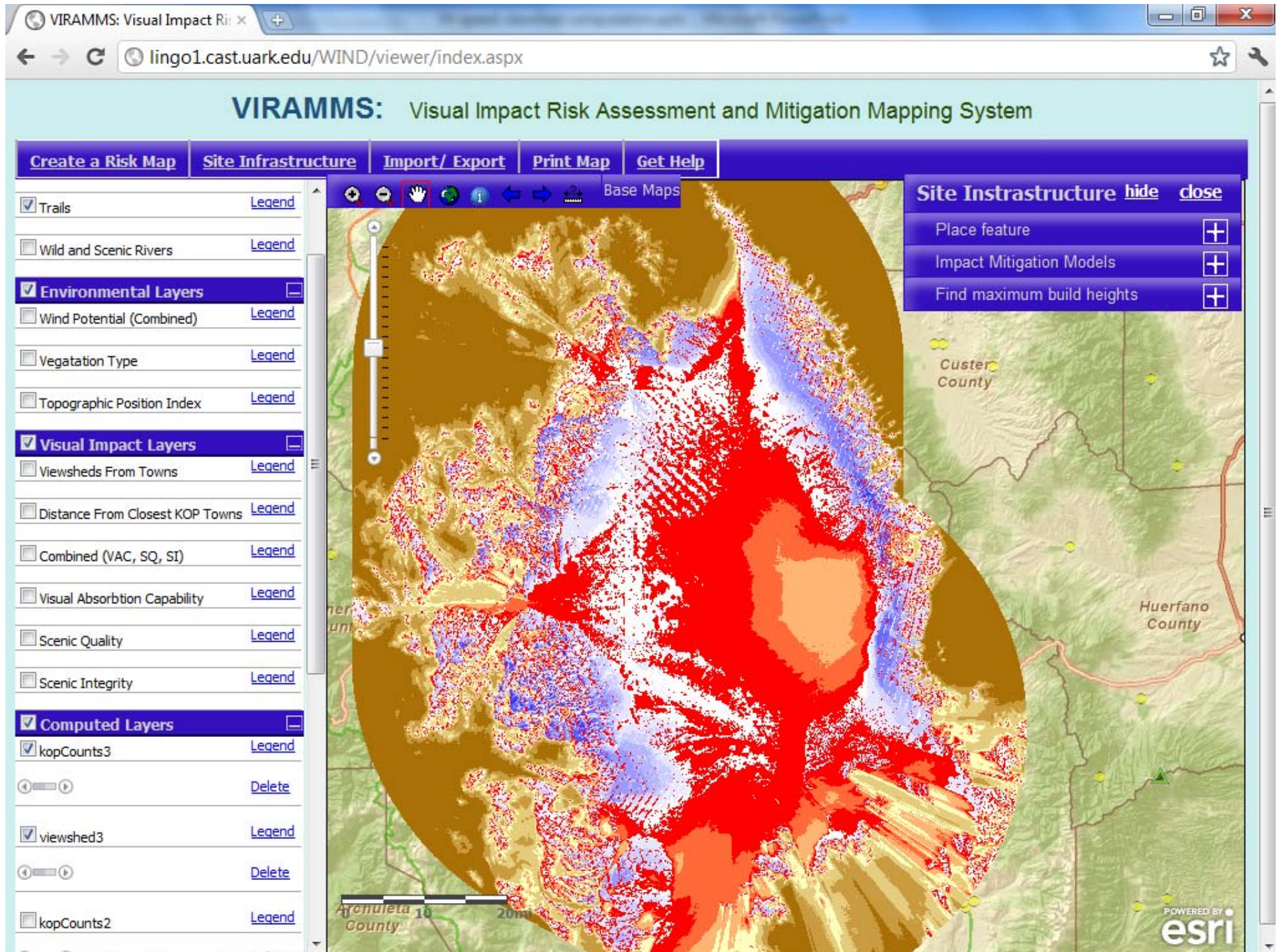
The source data for this model is very large and will likely take over 9 minutes to execute. You can either receive the results in real time by clicking the start model button or you can input your email address to schedule the model to be run at a later time with the results emailed to you.

Click to Start Model
Enter your email address:
Click to Schedule Model
Click to Cancel Request

Base Maps
Site Infrastructure hide close
Place feature
Impact Mitigation Models

Saguache
Custer County
Huerfano County
Conejos County
Archuleta County
Conejos

20mi
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Wrap-Up

- Seth Warn
 - Optimized viewshed algorithm for speed
 - Added calculations for max height of non-visible cells
- Peter Smith
 - Developed stand-alone implementation which can communicate with ArcGIS Server or other input apps.
 - Output is Web Mapping Service (WMS)

Wrap-Up

- Useful for Web or desktop applications
- Offers possibility of “real-time” multi-viewpoint viewshed calculations over large areas.
- Provides information about non-visible cells that is not provided by most competing software.

Questions?