HEC-RAS Geometry for Dam Breach Analysis

Cameron Ackerman, P.E., BC.WRE

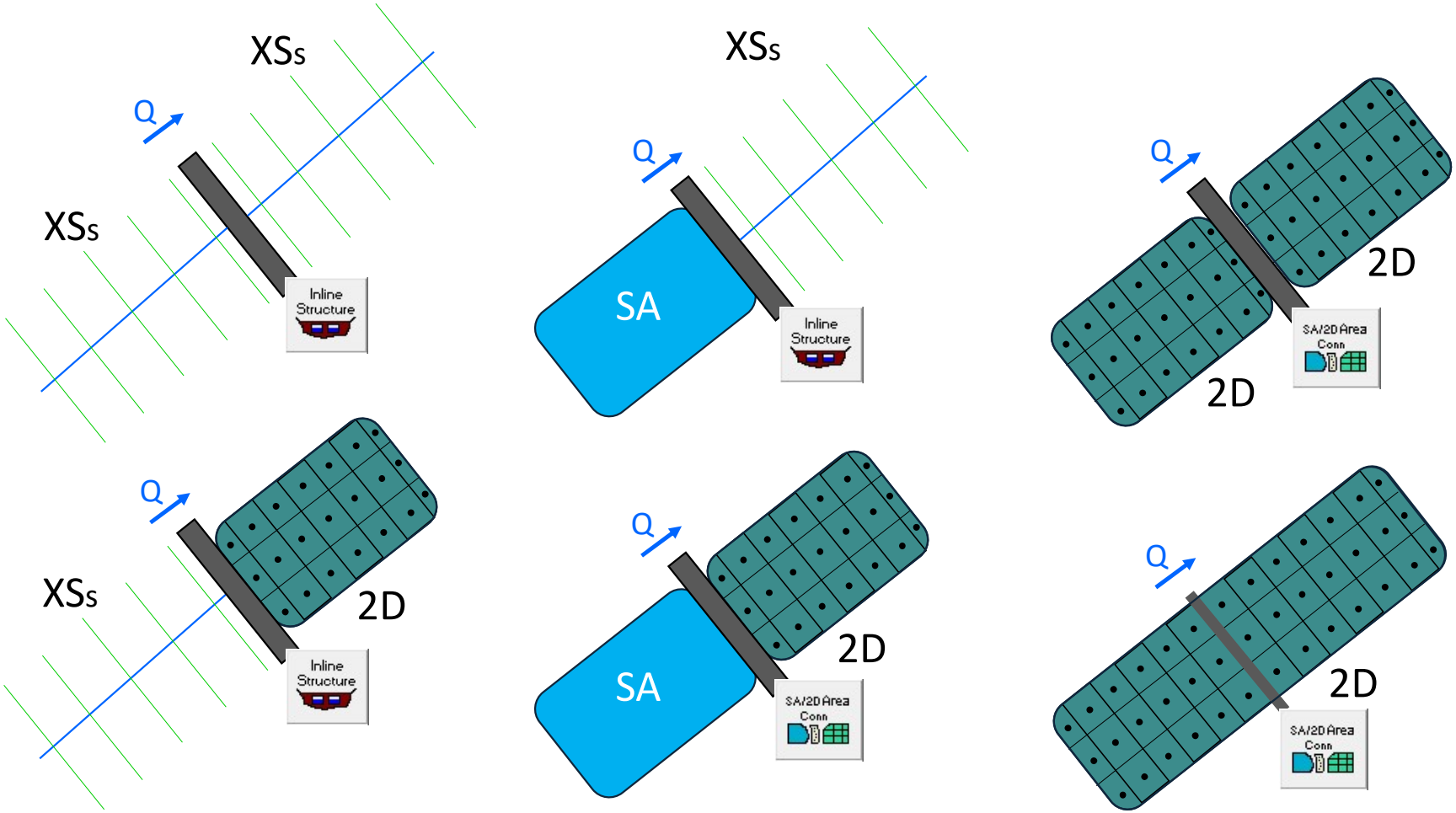
USACE, Institute for Water Resources, Hydrologic Engineering Center

US Army Corps of Engineers

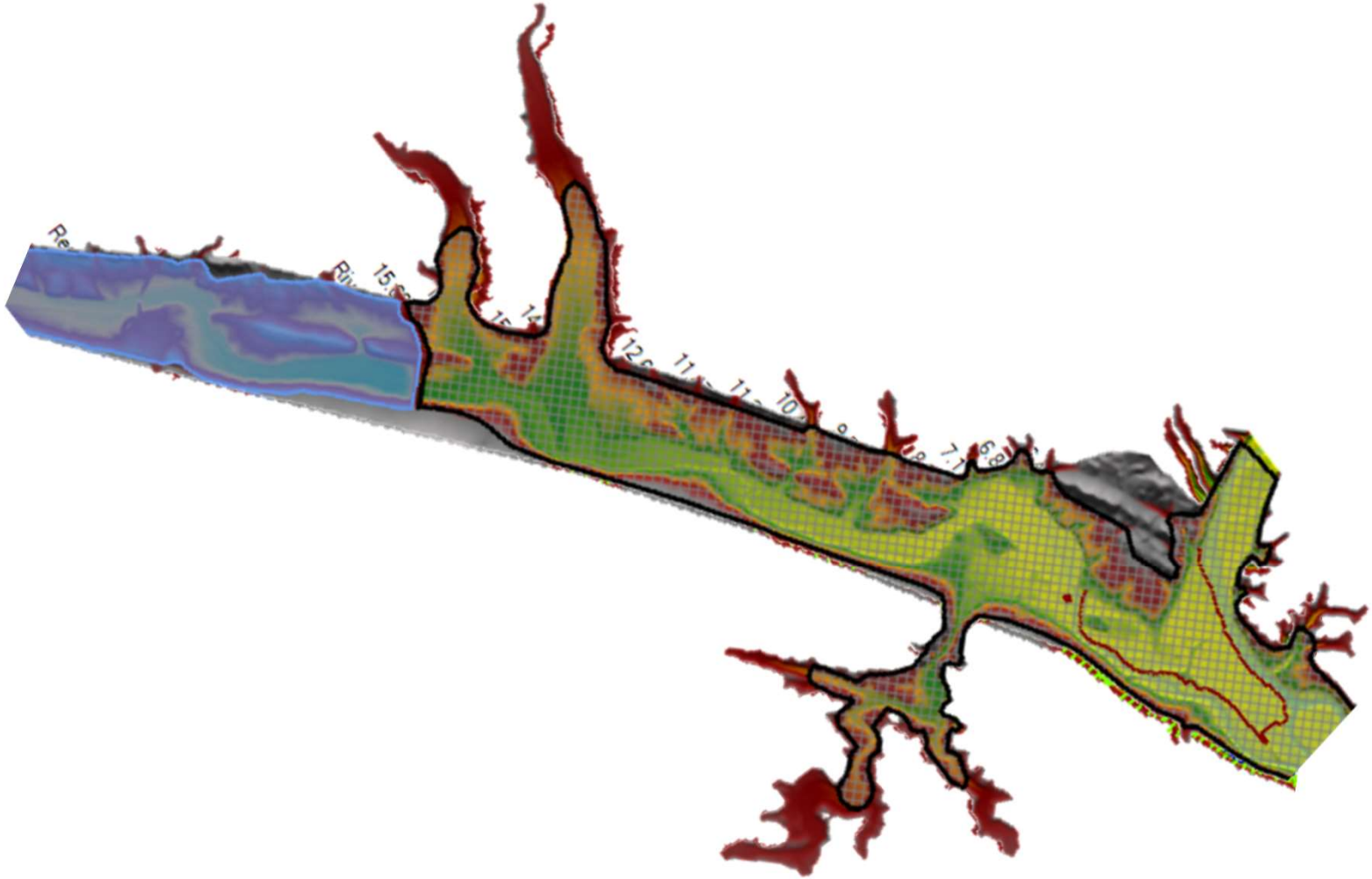
Objectives

- HEC-RAS Introduction and Model Configuration
- Creating a RAS Terrain
- Editing Layers
- 1D and 2D Modeling Layers
- 2D Subgrid Technology

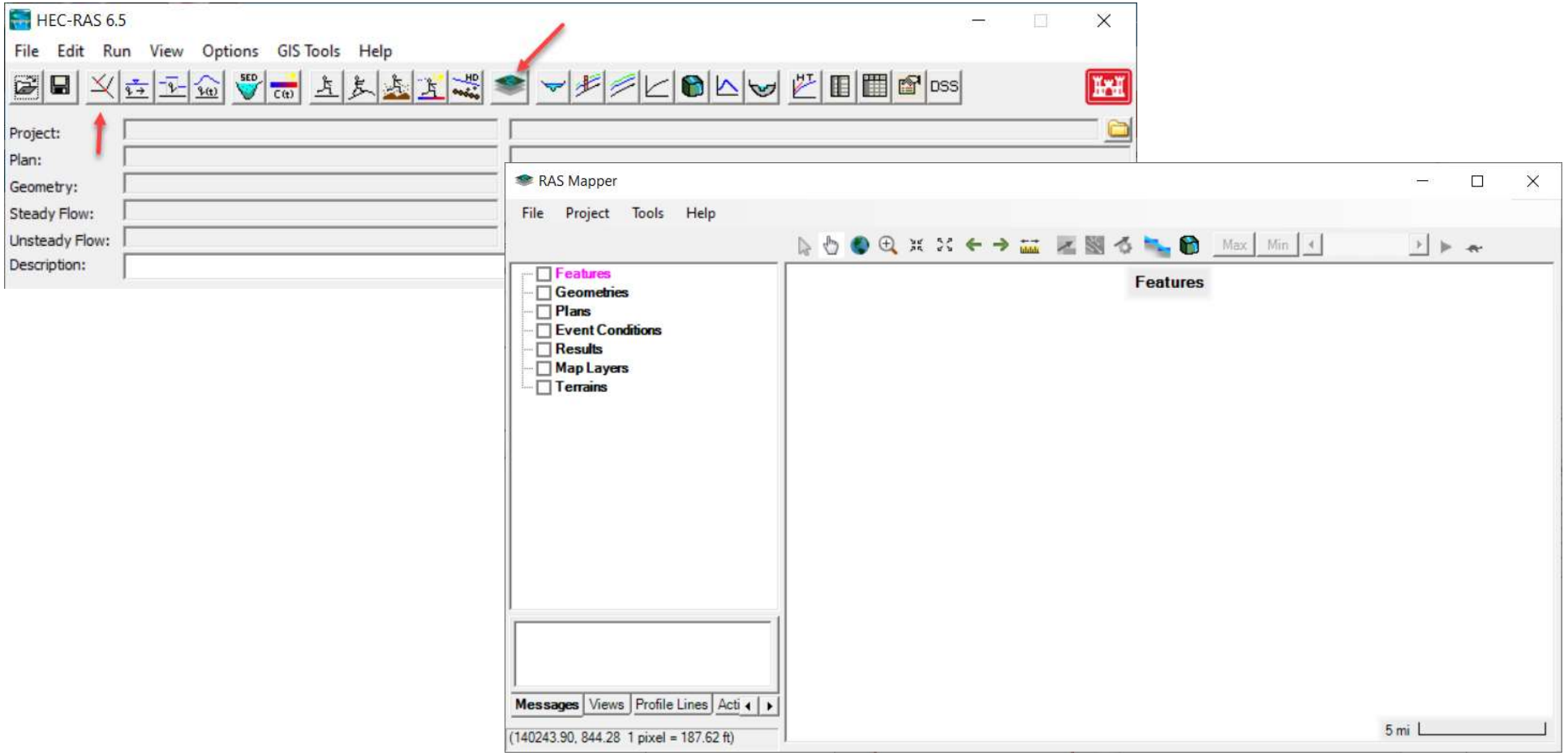
Breach Model Configurations



RAS Model Creation – RAS Mapper

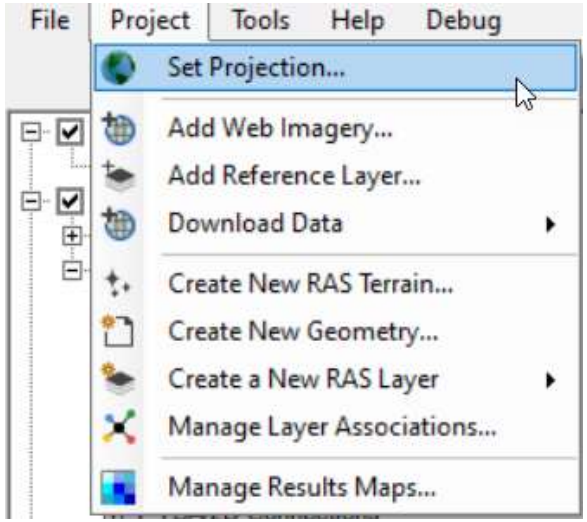


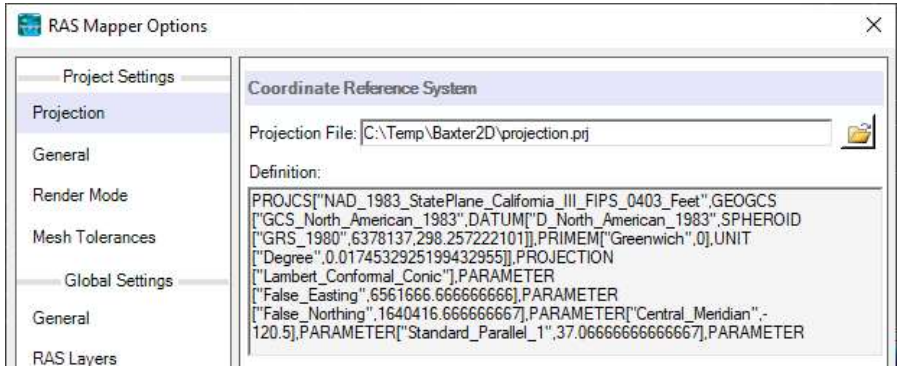
HEC-RAS


HEC-RAS 6.5
File Edit Run View Options GIS Tools Help
Project:
Plan:
Geometry:
Steady Flow:
Unsteady Flow:
Description:
RAS Mapper
File Project Tools Help
Features
Geometries
Plans
Event Conditions
Results
Map Layers
Terrains
Max Min
Features
Messages Views Profile Lines Acti
(140243.90, 844.28 1 pixel = 187.62 ft)
5 mi

Projection

- Data used in RAS Mapper must be a common coordinate system.
- Projection will be used to re-project Terrain data that is imported into RAS Mapper.
  - Defined using esri PRJ file.
- Web Imagery will be projected on-the-fly to RAS Mapper coordinate system.





Projection Files

- Not all PRJ files are the same

```
PROJCS["NAD_1983_StatePlane_Pennsylvania_South_FIPS_3702_Feet",
GEOGCS["GCS_North_American_1983",
DATUM["D_North_American_1983",
SPHEROID["GRS_1980",6378137.0,298.257222101]],
PRIMEM["Greenwich",0.0],
UNIT["Degree",0.0174532925199433]],
PROJECTION["Lambert_Conformal_Conic"],
PARAMETER["False_Easting",1968500.0],
PARAMETER["False_Northing",0.0],
PARAMETER["Central_Meridian",-77.75],
PARAMETER["Standard_Parallel_1",39.93333333333333],
PARAMETER["Standard_Parallel_2",40.96666666666667],
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UNIT["Foot_US",0.30480060960121921],
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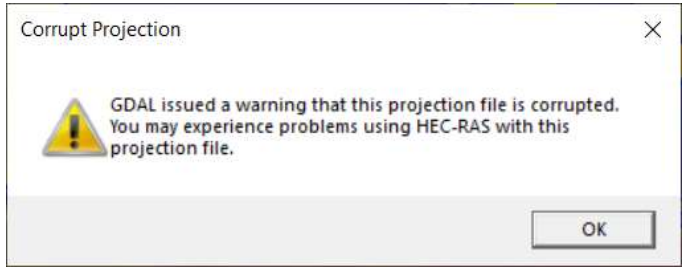
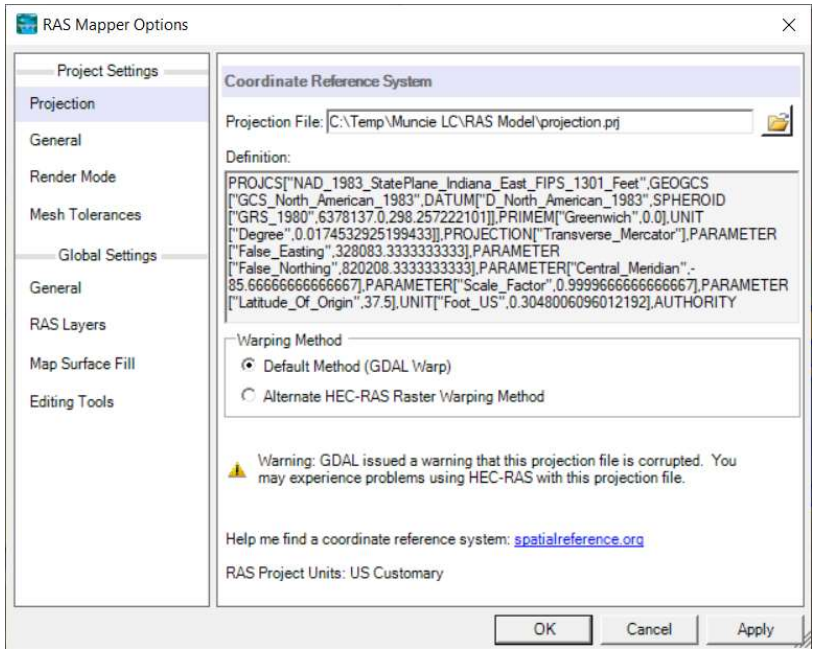
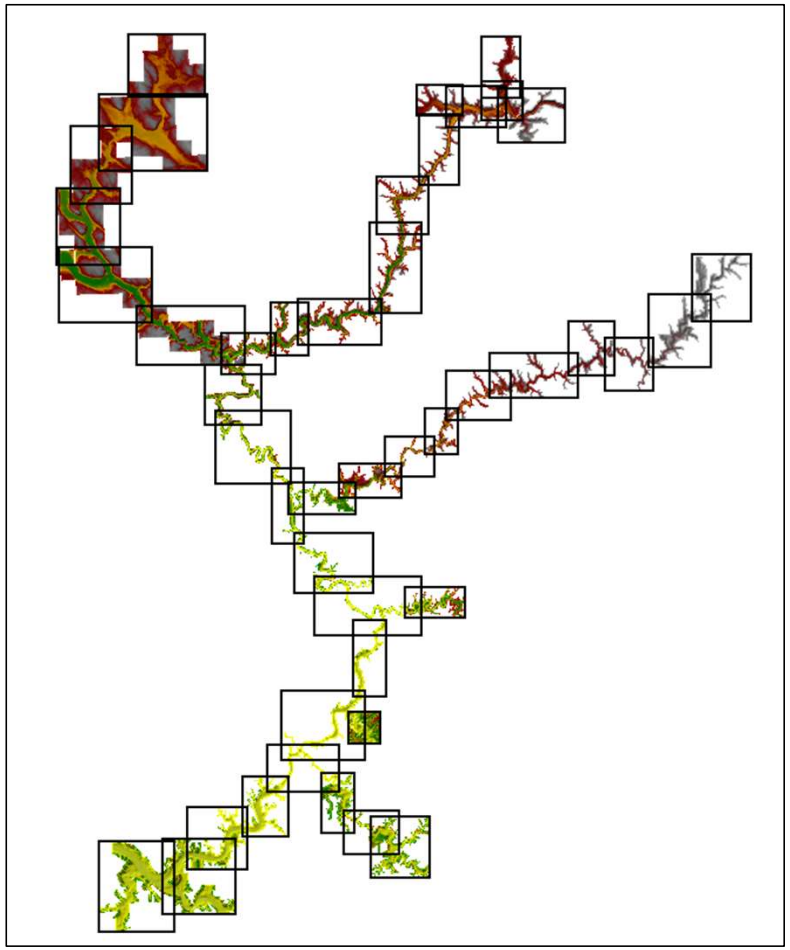




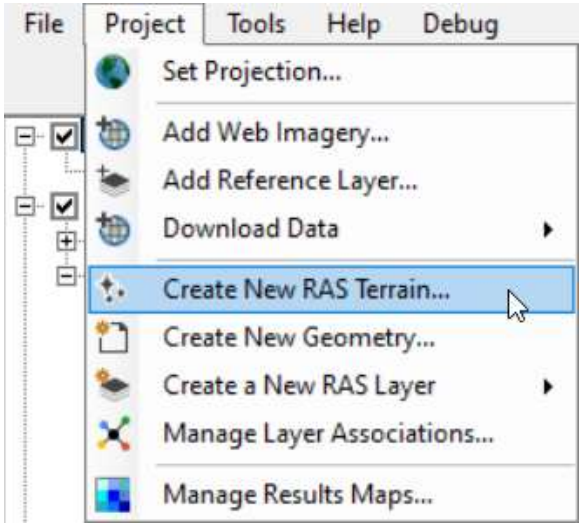
Terrain in RAS Mapper

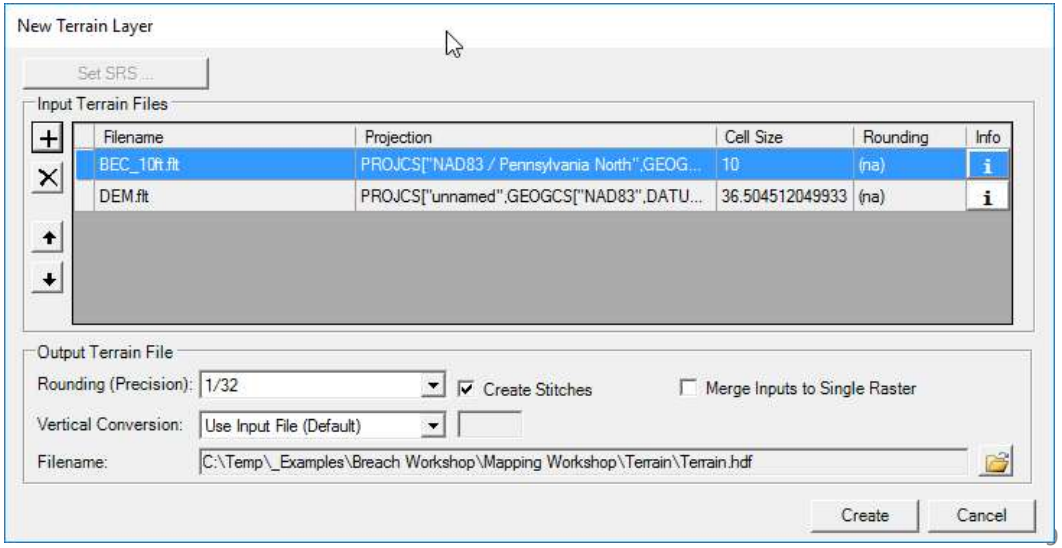
- Uses GeoTIFF format
  - Tiled data for more efficient storage
  - Compressed data for efficient storage
  - Pyramided data for fast visualization
    - Allows for on-the-fly inundation mapping
- One Layer for Multiple Terrain Models
- No file size limitations – BigTiFF supported



Terrain Importer

- Click **Project | Create New RAS Terrain**
- **Add** raster files for import

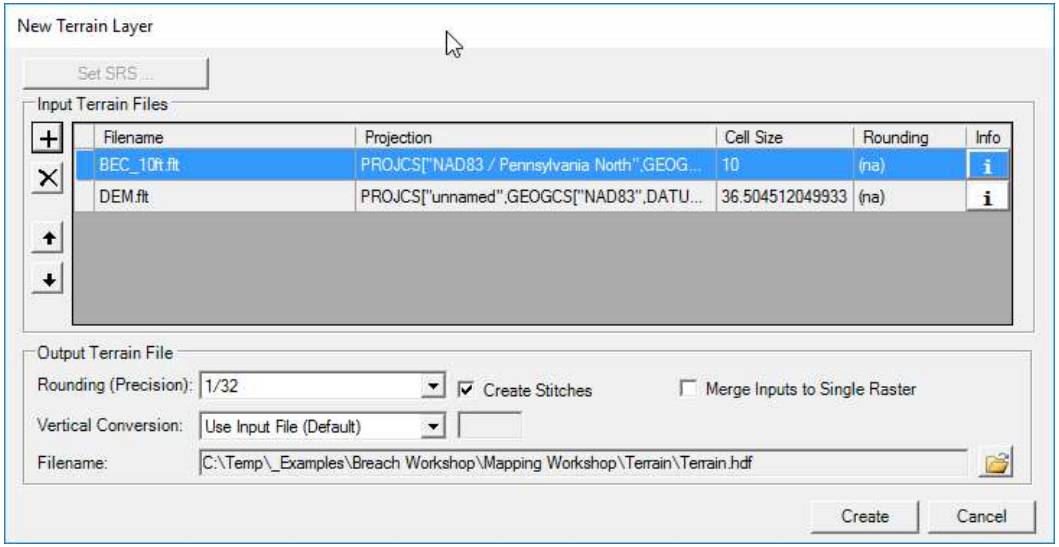




- Click **Create**

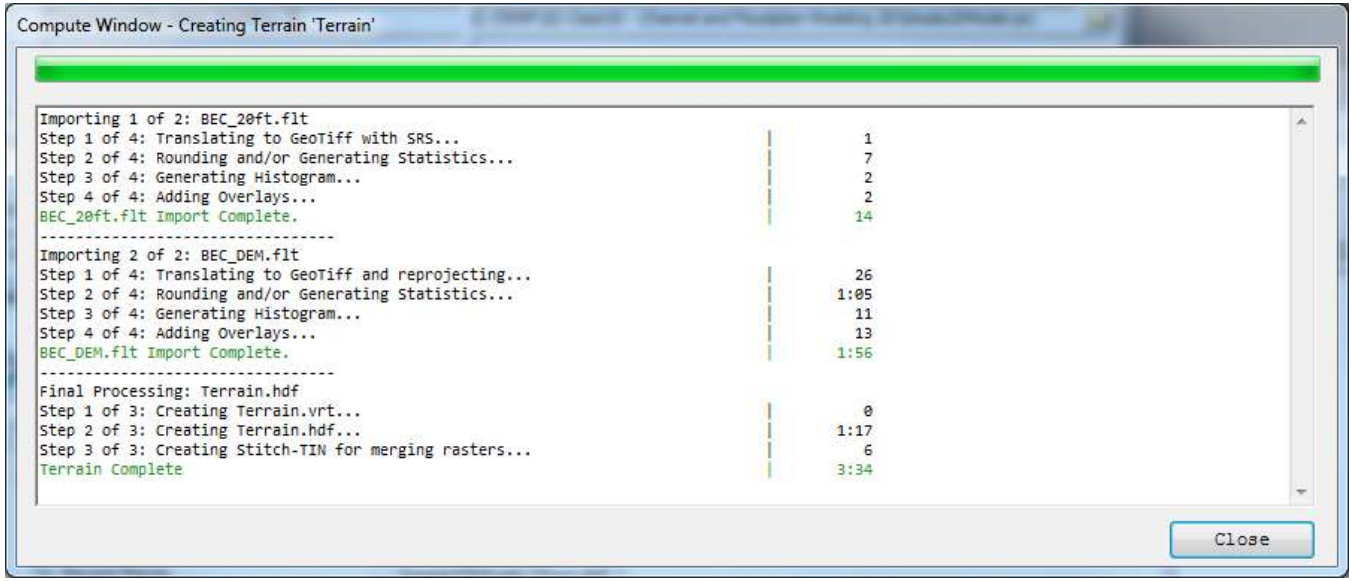
Terrain Importer

- Add files – allows user to select rasters for import
- Order raster files based on **Priority** on what cell value should be used if there is overlap by the terrain models.
  - Highest Priority to the top

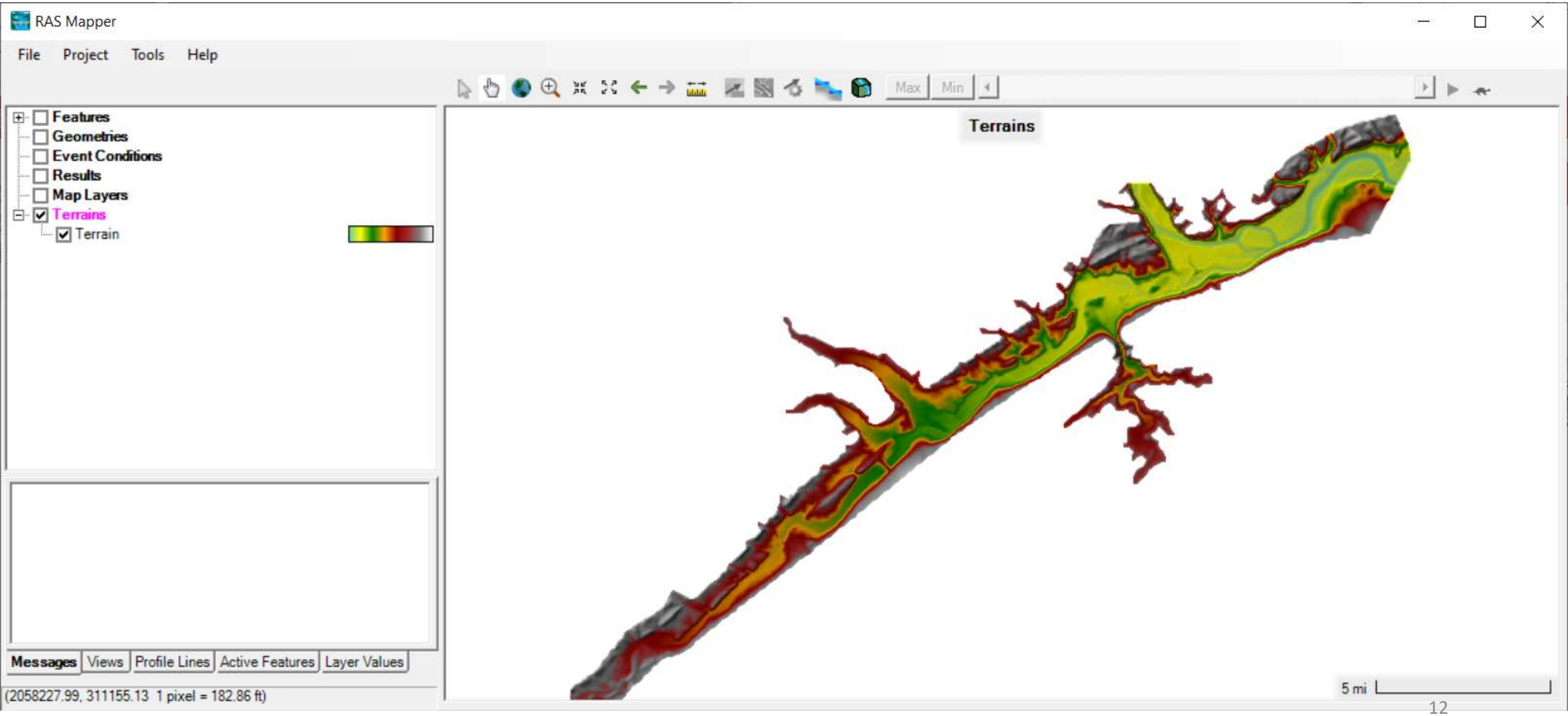


Terrain Importer

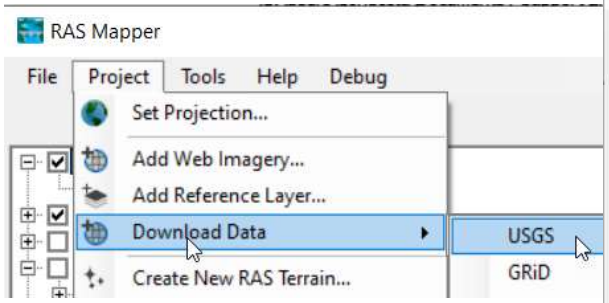
- Data is translated (to .tif), projected, and rounded for all data
- Data is pyramided (overlays created) and compressed
- TIN stitches are created for overlapping regions
- **Terrain.hdf** is the single layer loaded to RAS Mapper



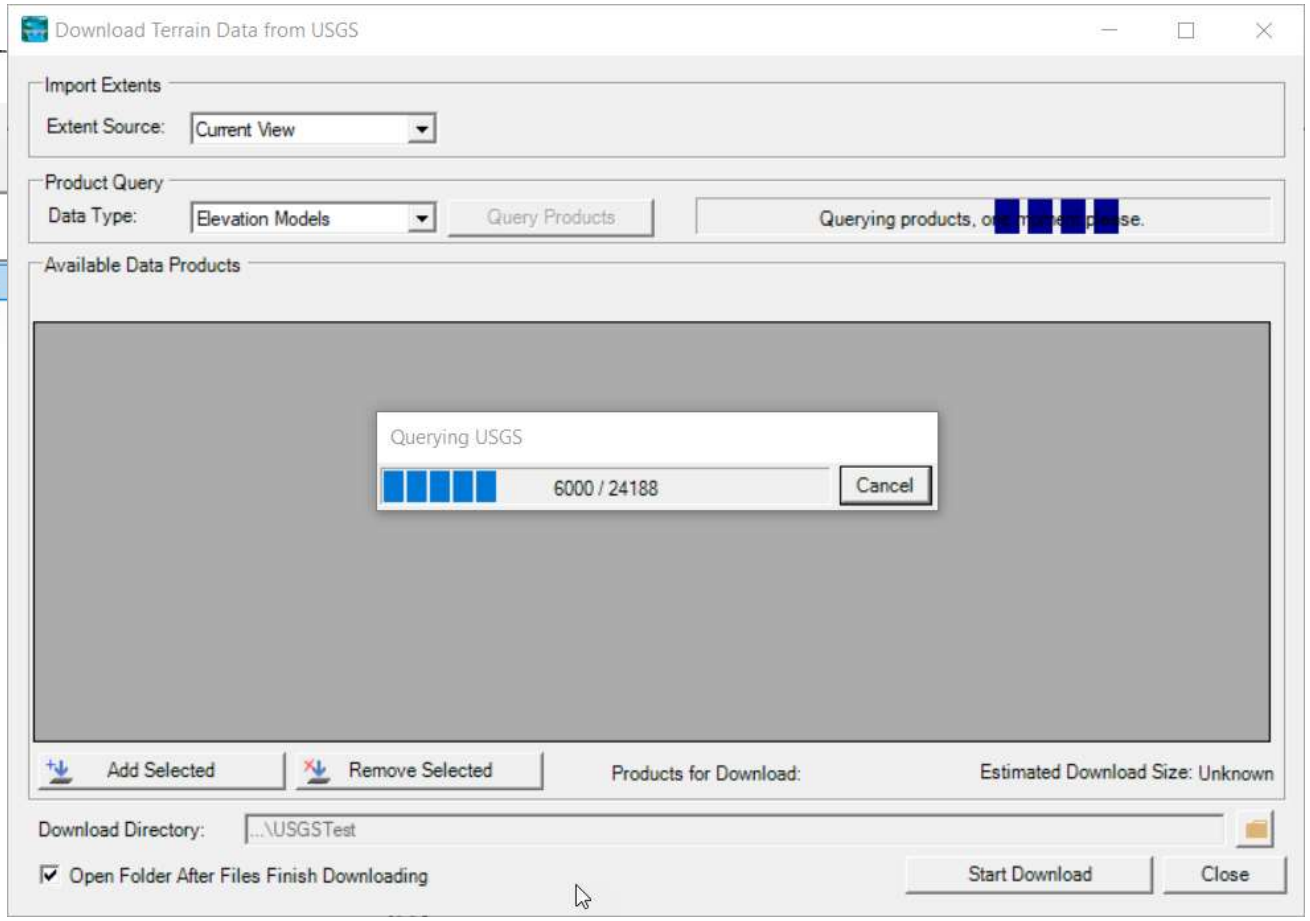
Terrain in RAS Mapper



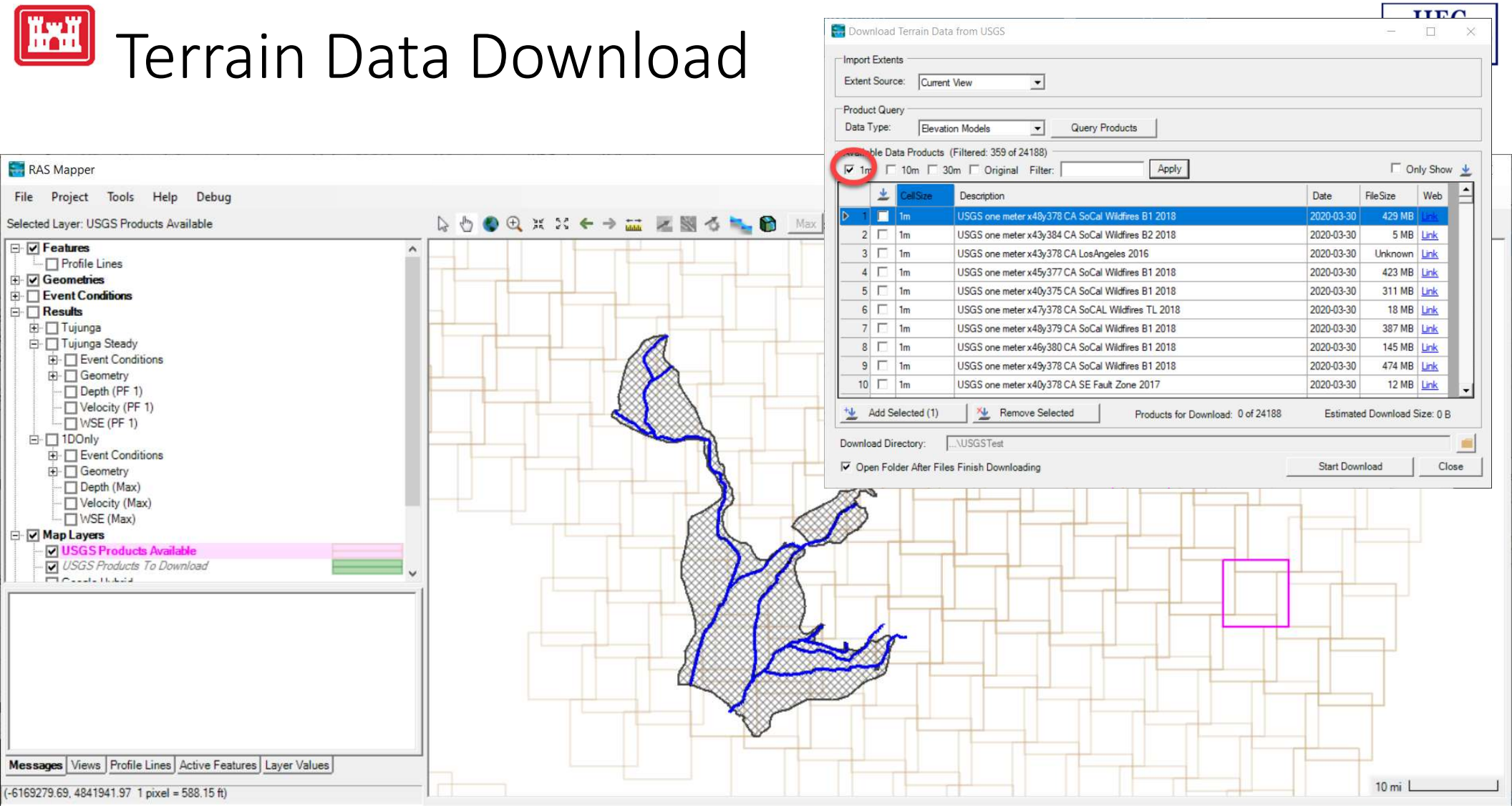
Terrain Data Download



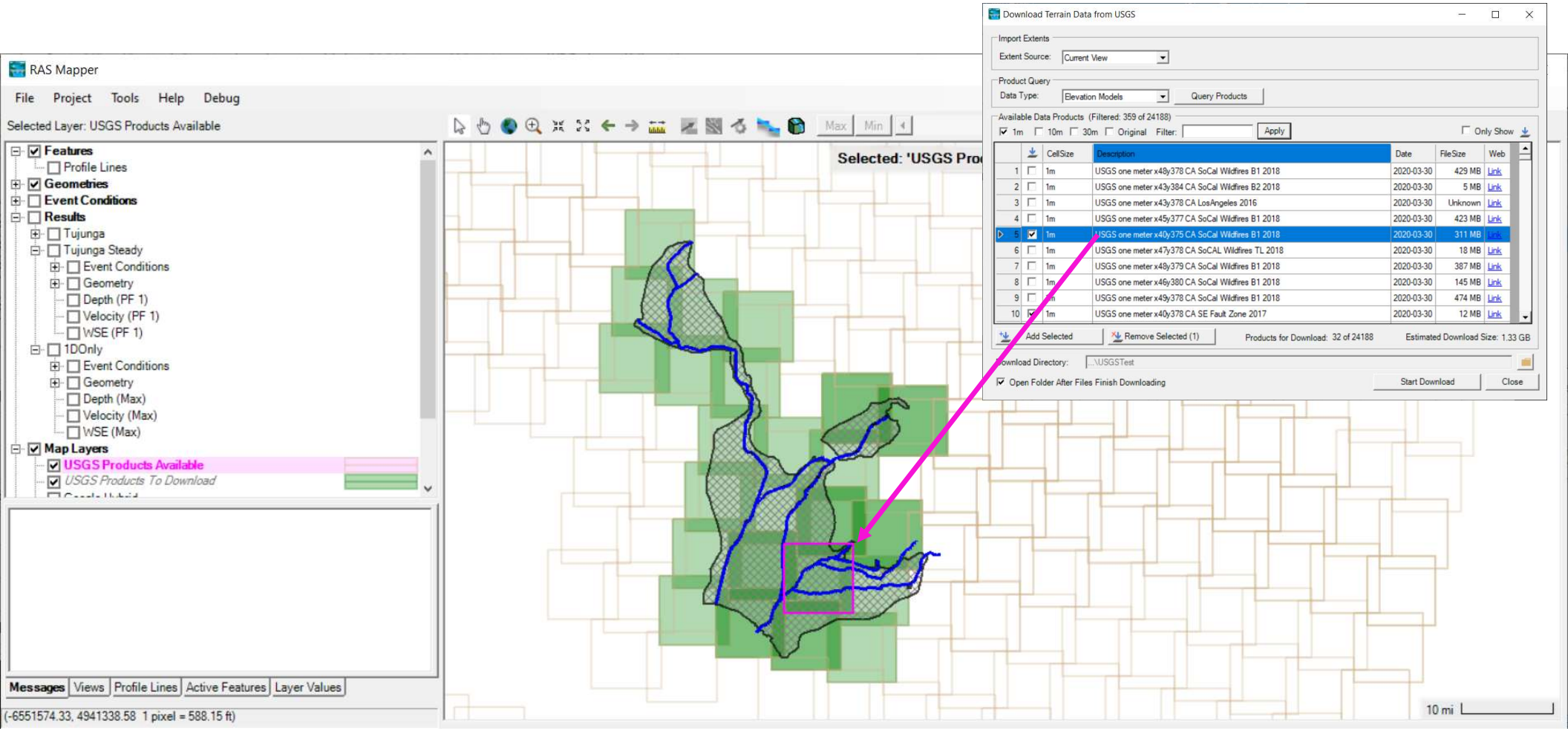
- USGS Terrain
- GRiD (CRREL)



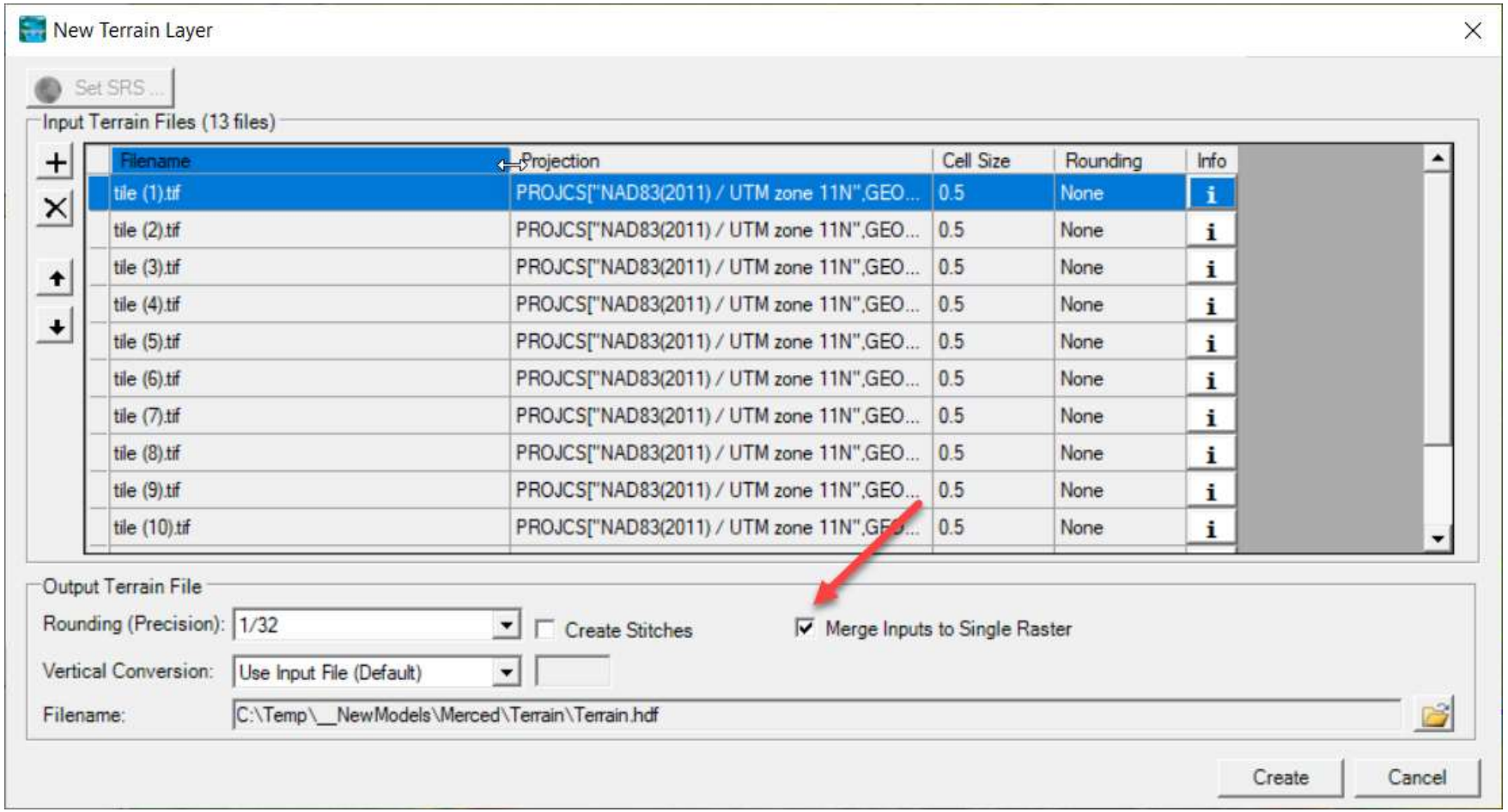
Terrain Data Download



Terrain Data Download

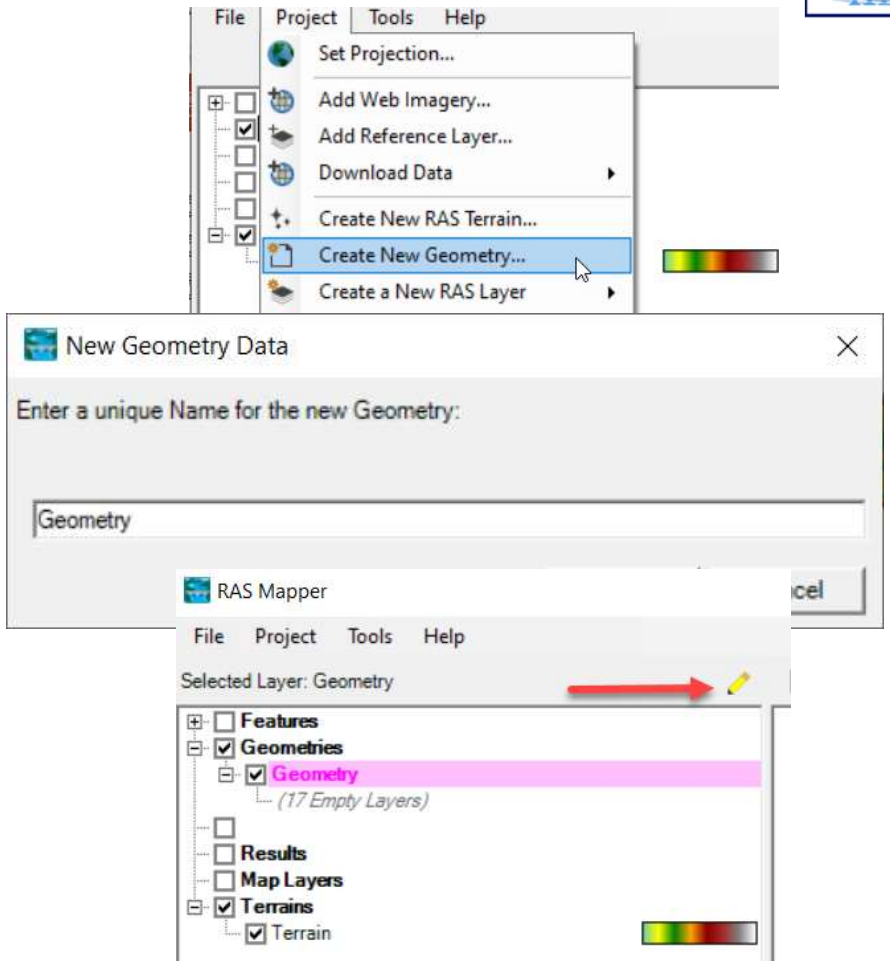


Terrain Build



Create a New Geometry

- Create a New Geometry
- Provide a Name
- Select the Geometry
- Edit the New Geometry



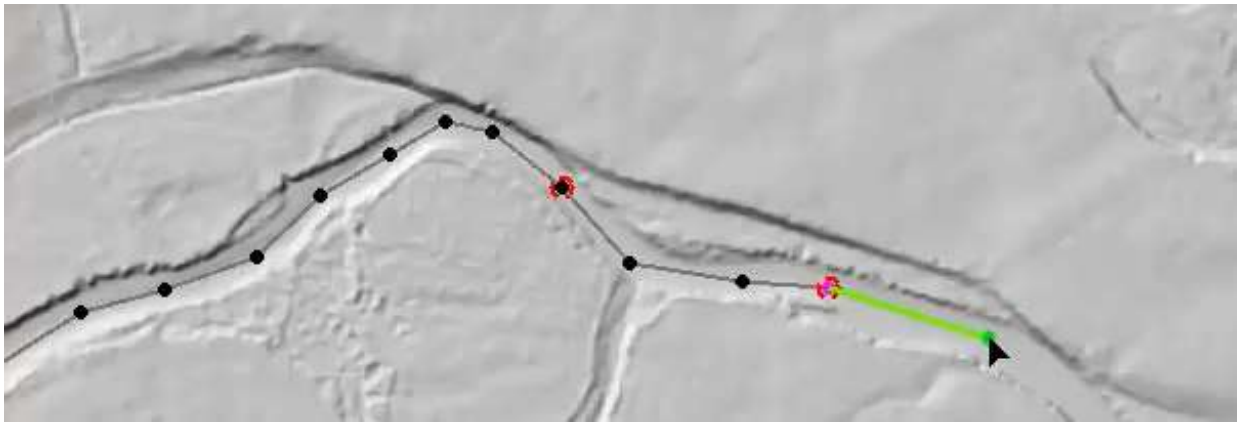
Editing Tools

- Add New Feature
- Select/Edit Feature
- Undo/Redo
- Plot Profile
- Tools
- Help

Add New Feature

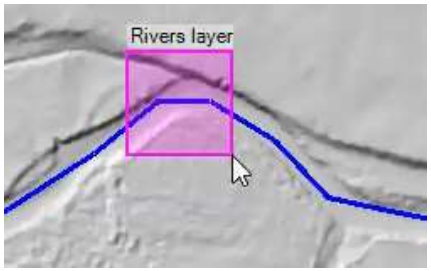
- Left-click to start adding a new point, line, or polygon
- Double-click to end a line or polygon

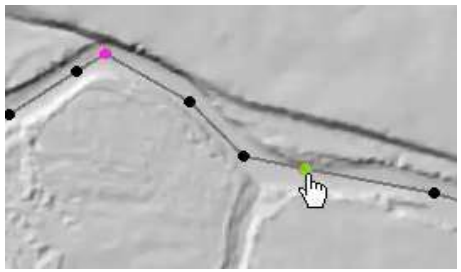
- Pan by switching to Pan tool, Shift key, Middle Mouse, or right-click to re-center.

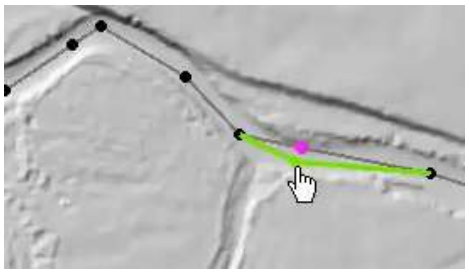


Select / Edit

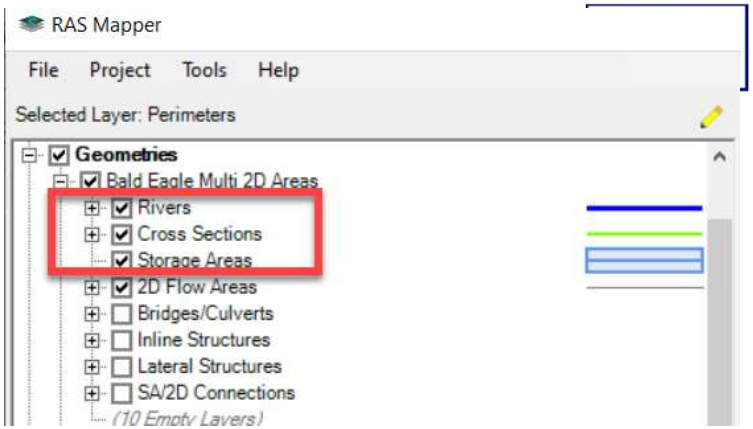
- Select / Edit tool is used to select feature(s) and then begin editing (move, add points, delete, etc).
  - Double-click to Start Editing (Open feature)
  - Double-click to End Editing (Close feature)
- Mouse hover indicates action
  - **Green** point indicates: Move, Insert, Delete point



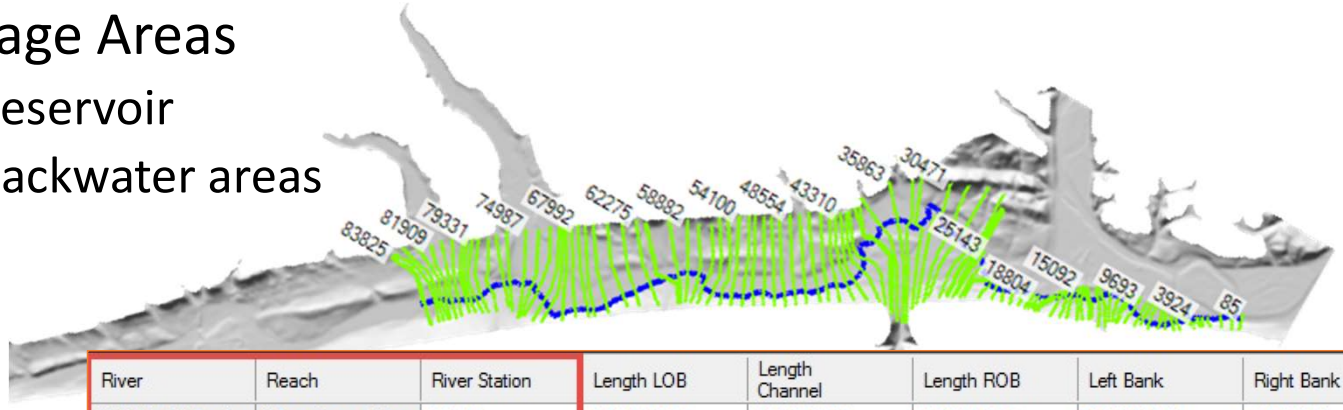




1D Model Areas



- Rivers
- Cross Sections
  - Oriented from the left to right bank (looking d/s)
  - Perpendicular to flow for correct XS area
  - Elevations are extracted from the DTM
- Storage Areas
  - Reservoir
  - Backwater areas

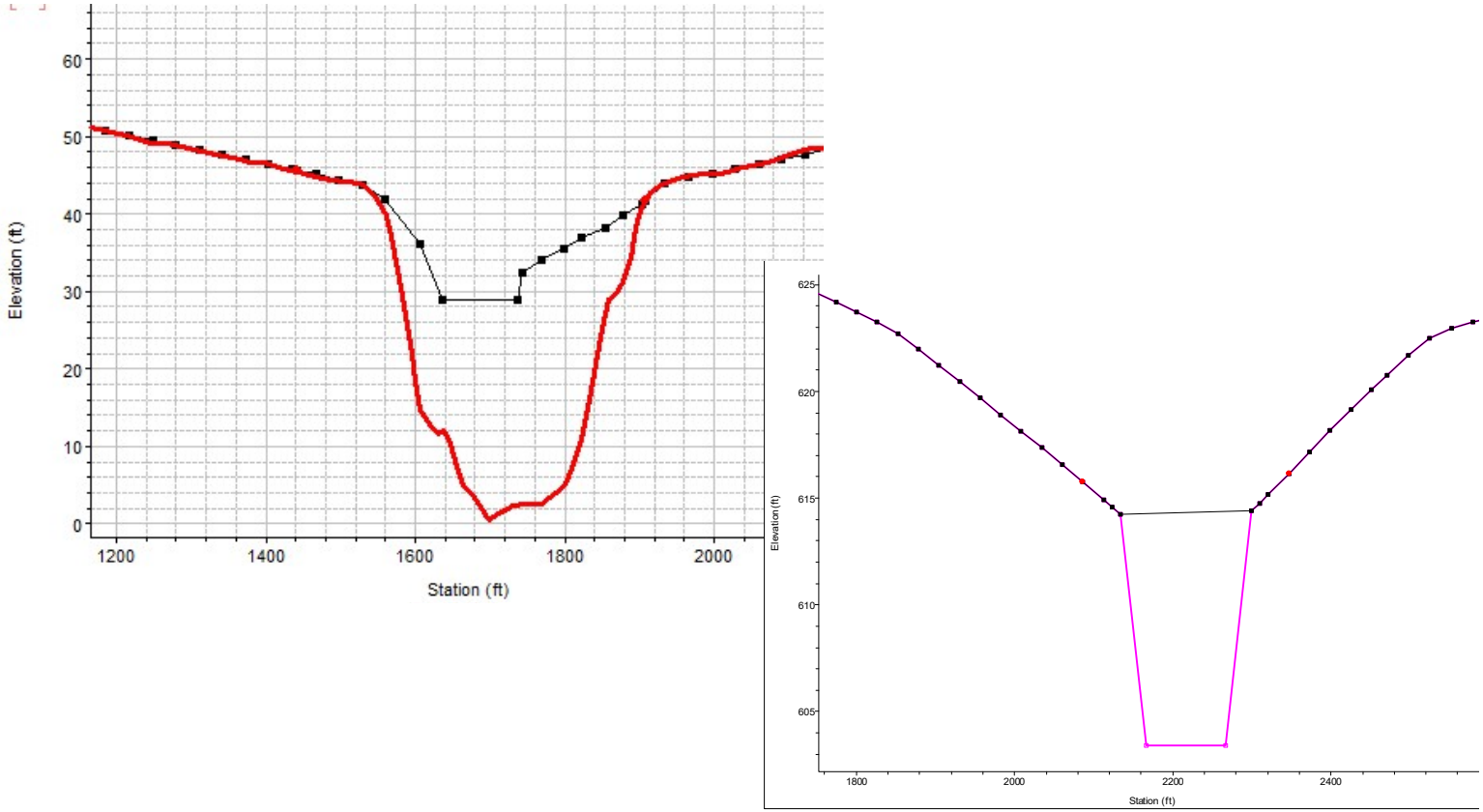


River	Reach	River Station	Length LOB	Length Channel	Length ROB	Left Bank	Right Bank
Bald Eagle Creek	Below Sayers Dam	82671	332.924347	332.924347	332.924347	5393.39844	5593.358
Bald Eagle Creek	Below Sayers Dam	82338	429.508026	429.508026	429.508026	5113.08154	5319.7915
Bald Eagle Creek	Below Sayers Dam	81909	494.6595	494.6595	494.6595	4921.44873	5068.88867
Bald Eagle Creek	Below Sayers Dam	81414	527.047241	527.047241	527.047241	5033.24268	5154.98242
Bald Eagle Creek	Below Sayers Dam	80887	688.114441	688.114441	688.114441	5083.96826	5224.024

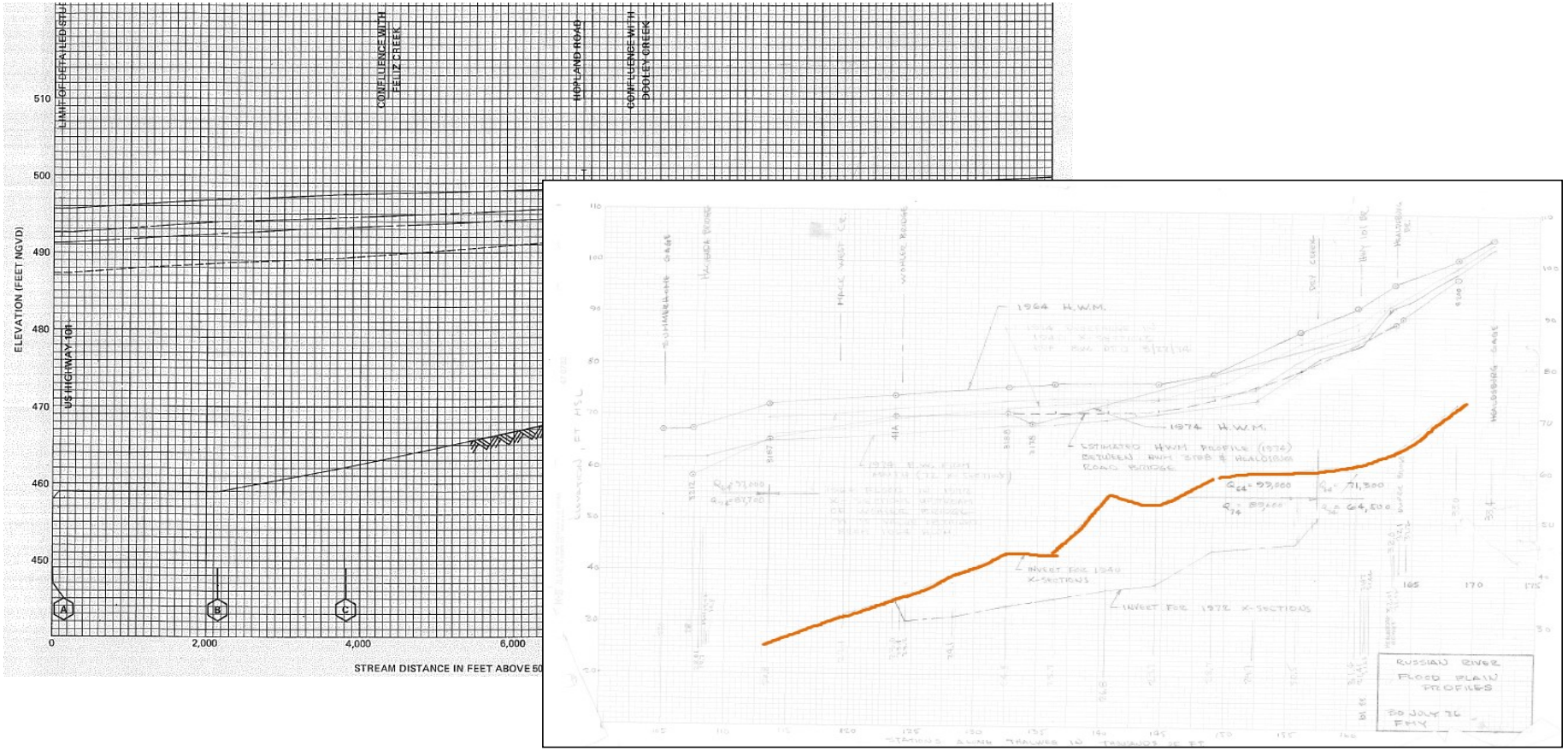
Main Channel

- Terrain often doesn’t clearly indicate location of main channel.
- Use imagery to establish bank station locations.

Main Channel

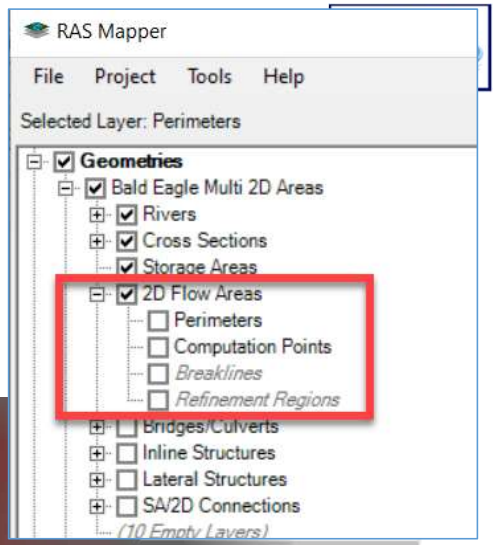


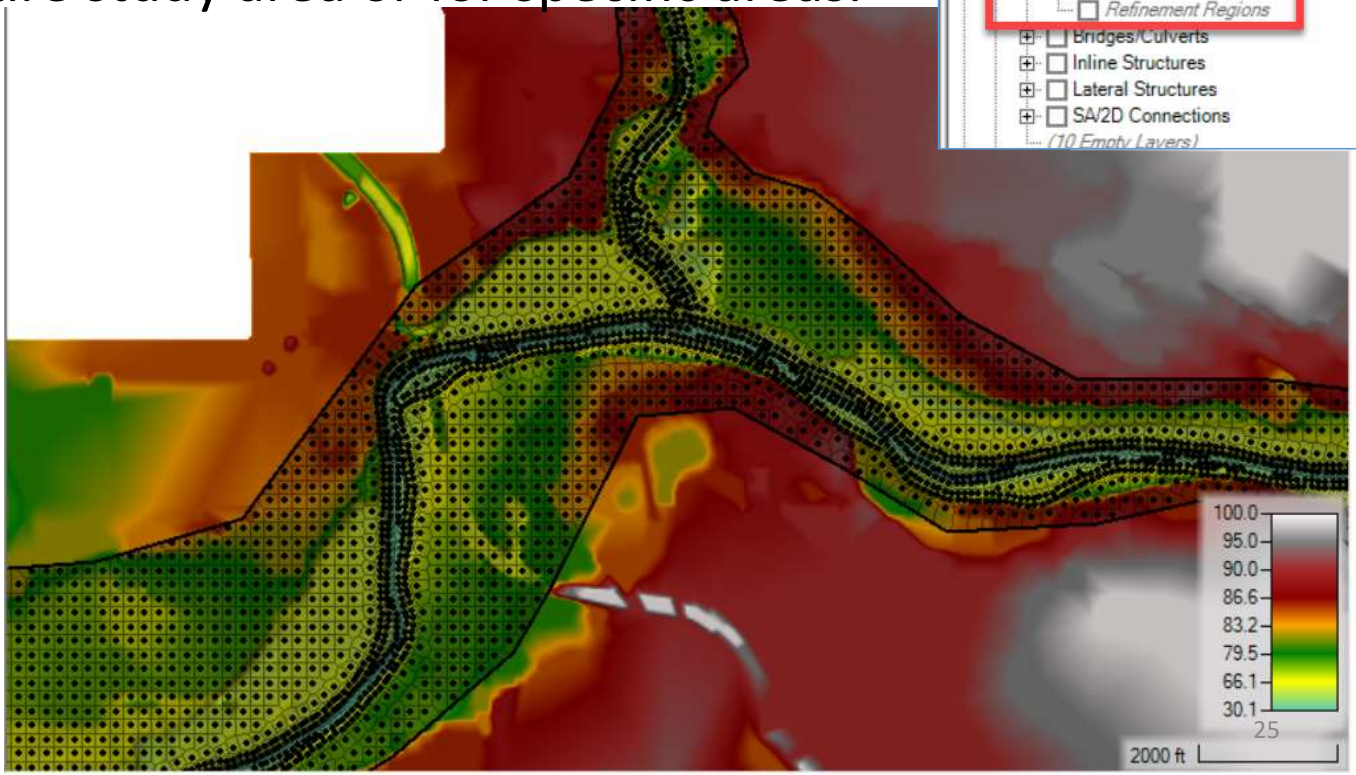
Published Elevation Data



2D Model Areas

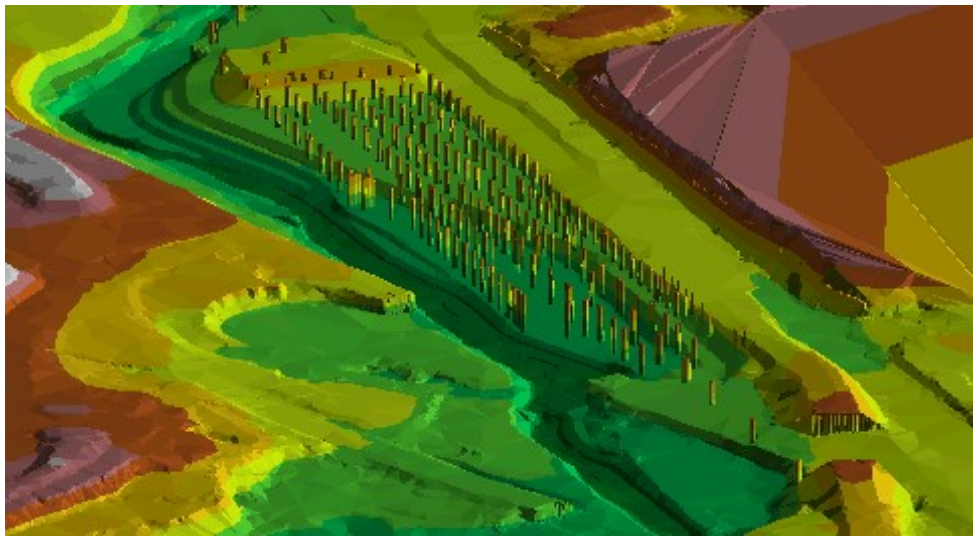
- 2D Flow Areas are used where flow direction is highly variable/unknown.
- Can use for the entire study area or for specific areas.
  - Reservoir
  - River Floodplain
  - Protected Area
  - Tributaries





2D Modeling Subgrid Technology

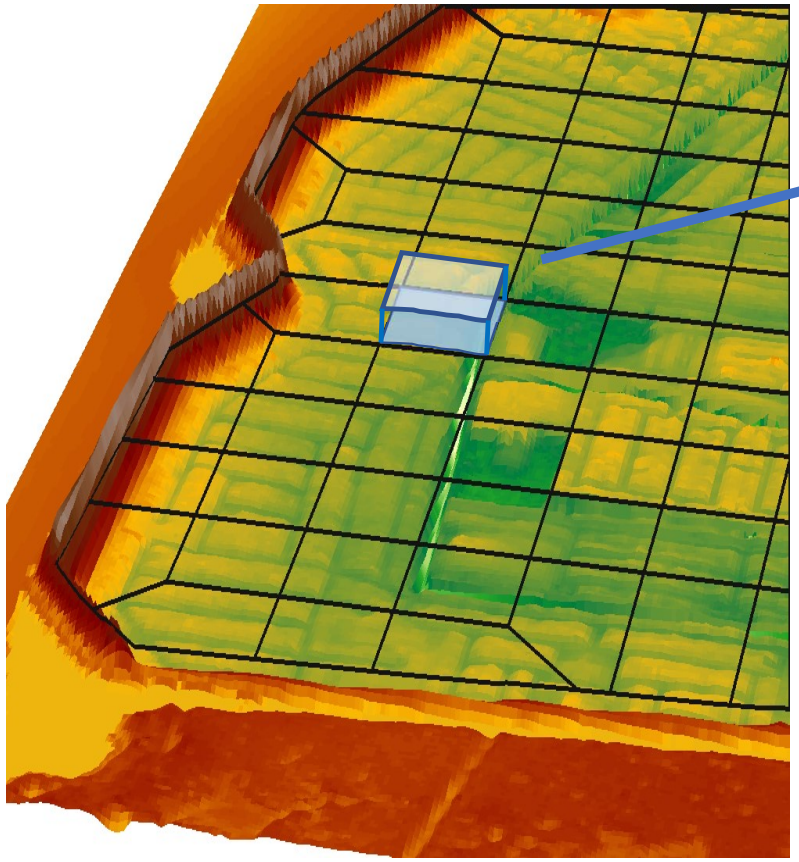
- Problem
  - Water levels usually vary much more smoothly than the terrain
  - Unfeasible to resolve every detail of the terrain with the computational mesh
- Approach
  - Utilize a grid resolution sufficient to resolve the hydraulics
  - Capture the details of the subgrid terrain through hydraulic properties tables

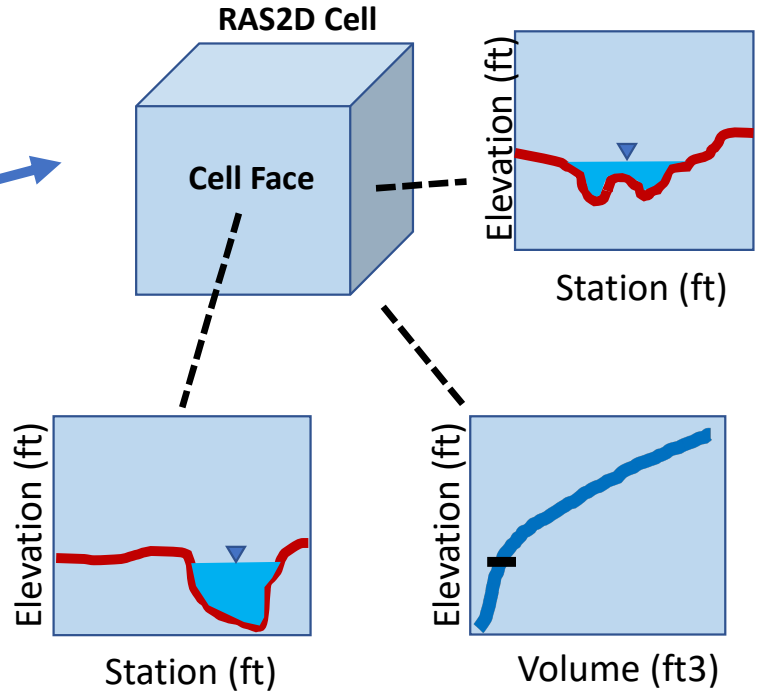


2D Modeling Subgrid Technology

- Detailed elevation-volume relationship for each 2D Cell.
- Hydraulic properties for each Cell Face (pre-computed).
- Cells can be partially wet.
- Allows for larger computational cells, without losing details of the underlying terrain.
- Larger cells = less computations = faster run times!
- HEC-RAS produces more detailed results for a given cell size than models using a single elevation for each cell and face.

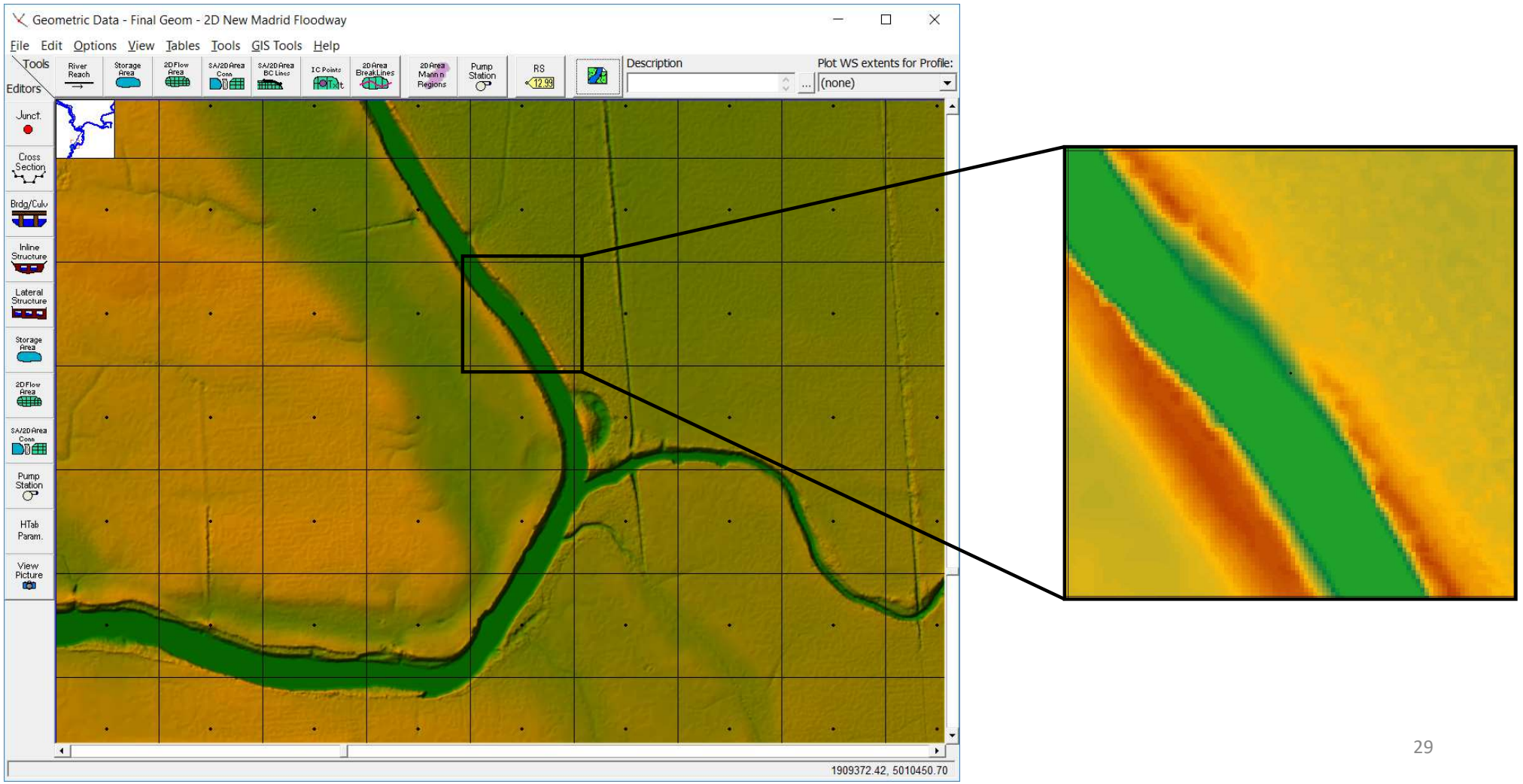
2D Computational Mesh Subgrid Terrain



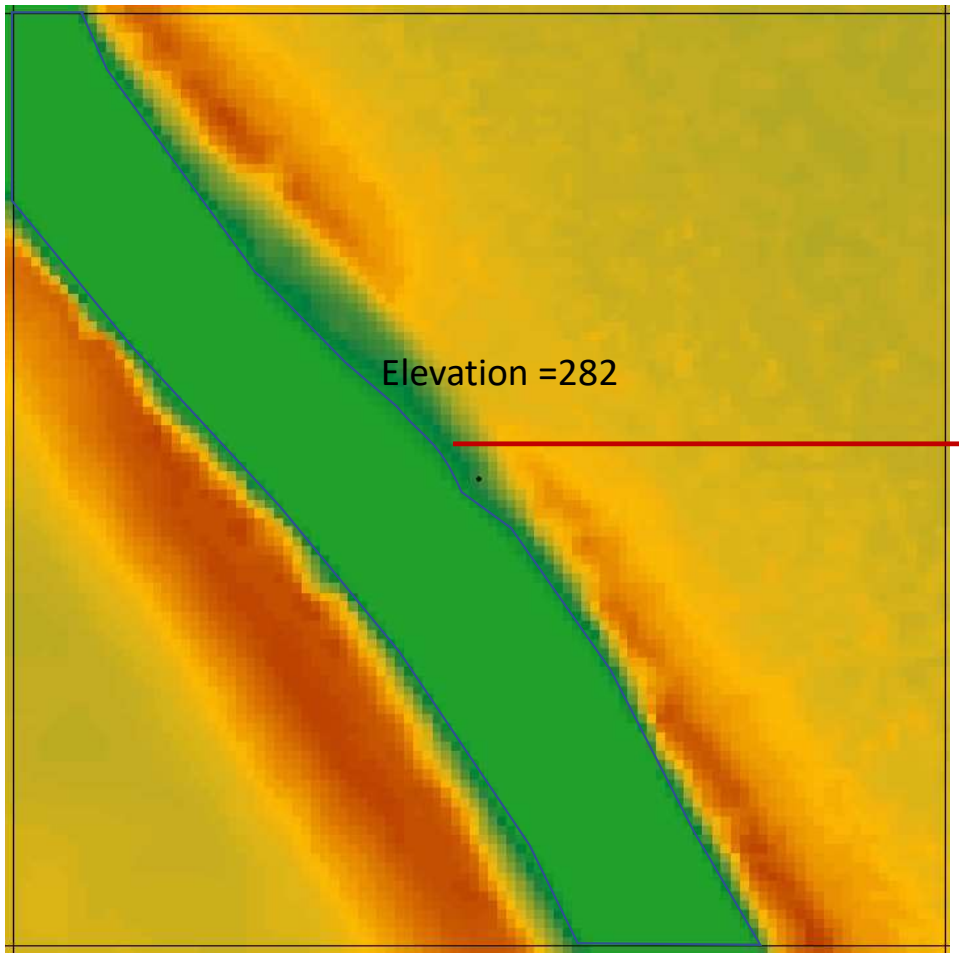


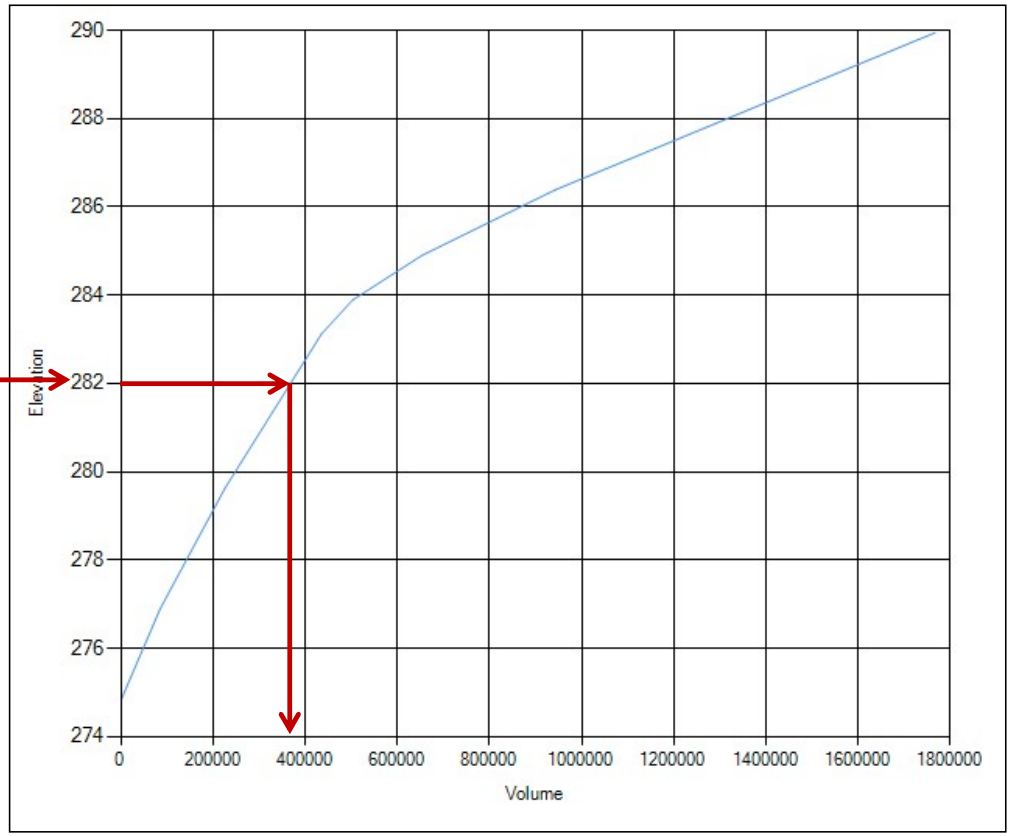
Each cell face profile and stage-volume curve is based on hundreds to thousands topo-bathymetric data-points, depending of resolution of underlying terrain raster.
Cell approach very efficiently discretizes space including complex terrain & surface roughness.

Computational Mesh Sub-grid Terrain

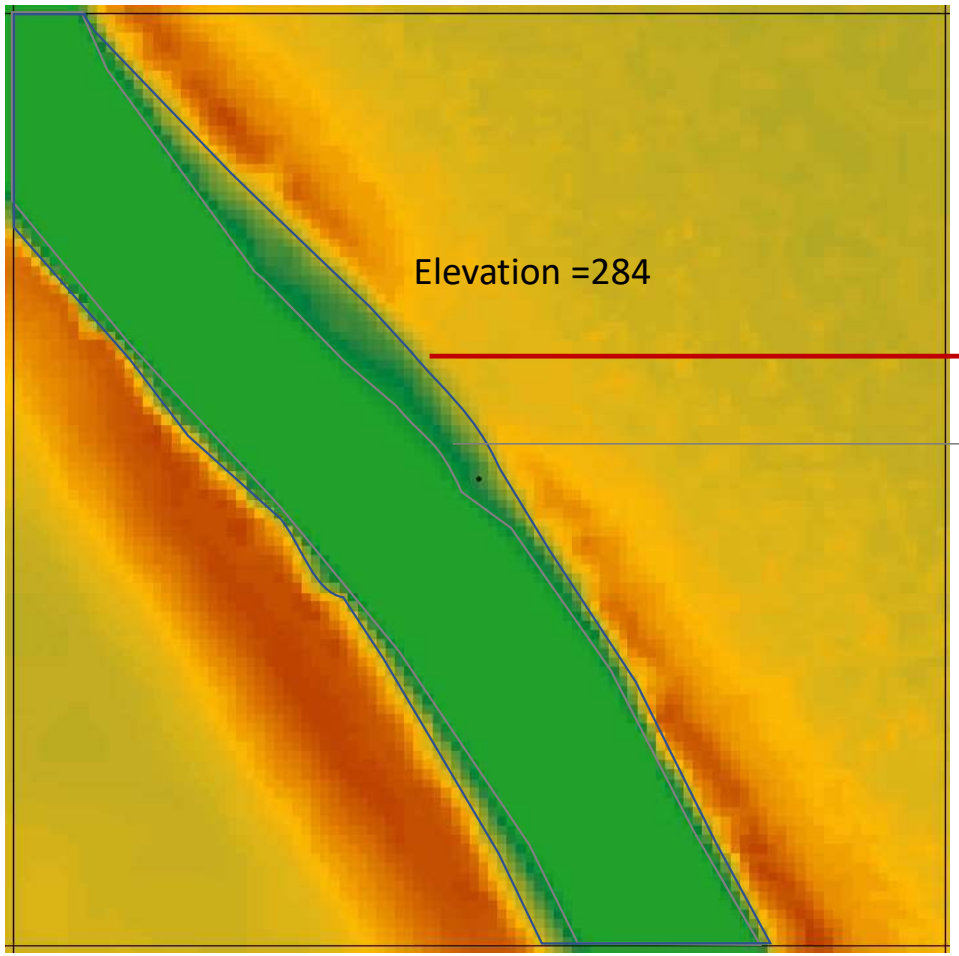


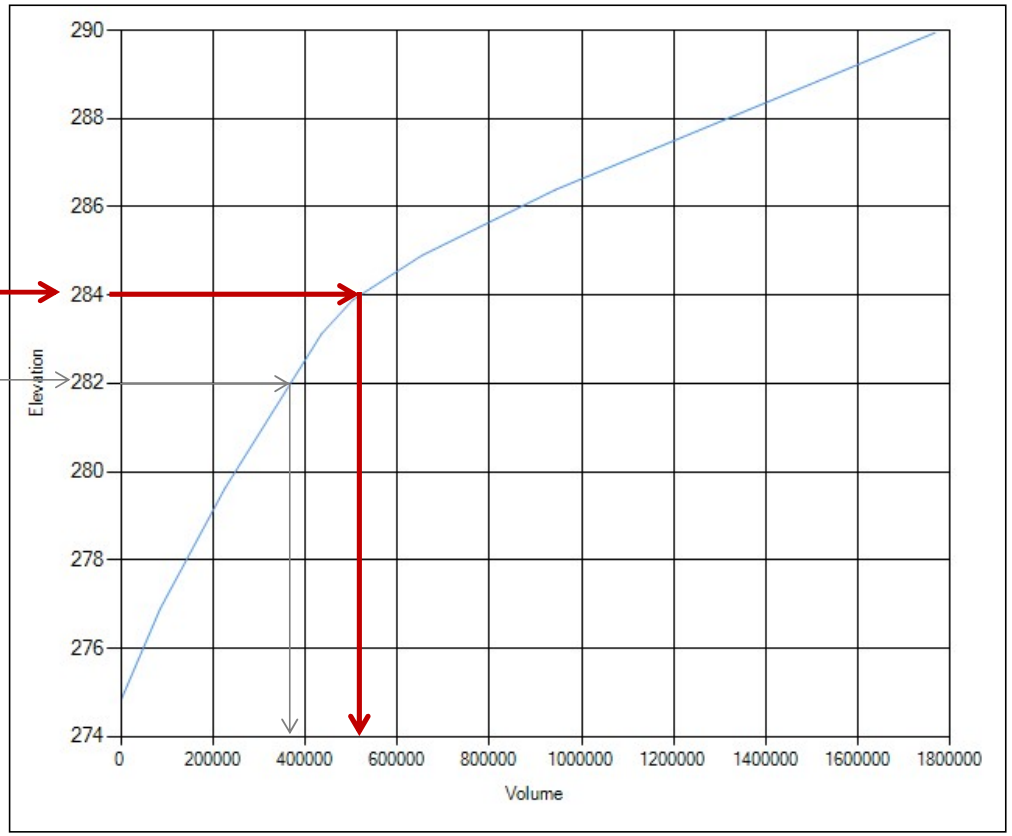
Computational Cells - Elevation vs. Volume





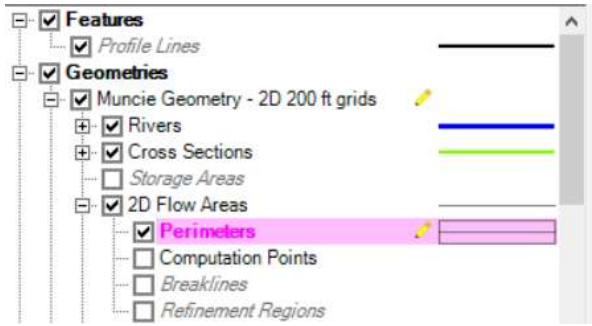
Computational Cells - Elevation vs. Volume



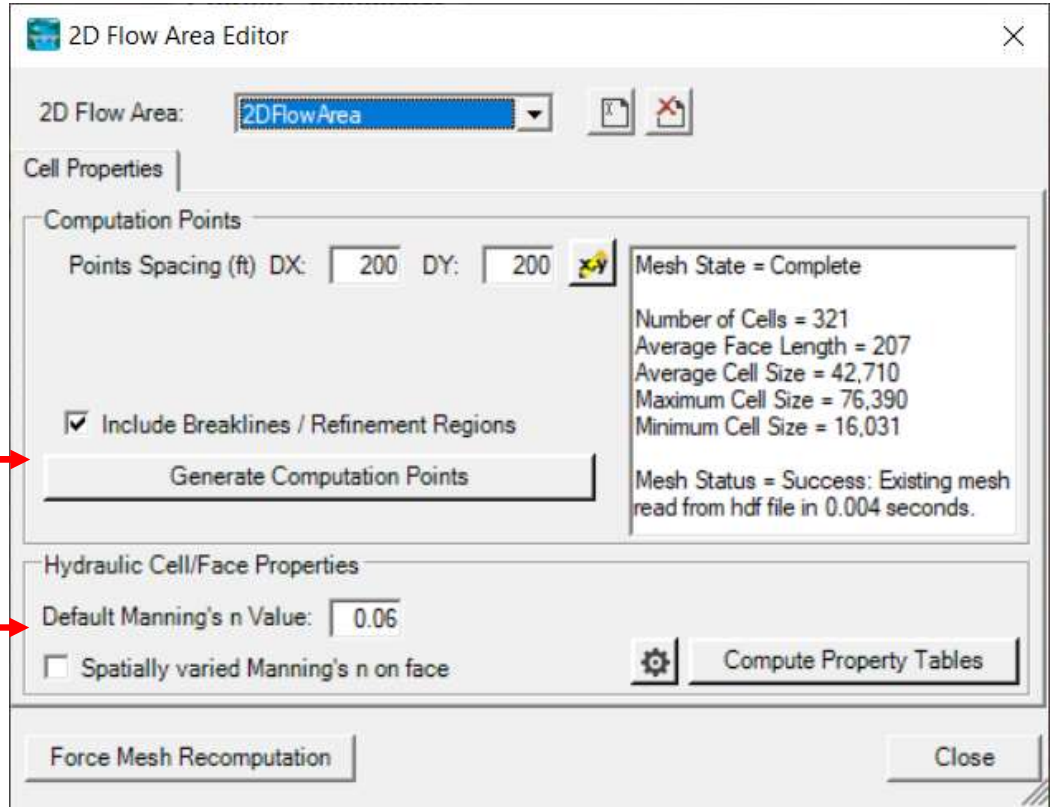


Subgrid = Higher fidelity cell volume tracking

2D Flow Areas

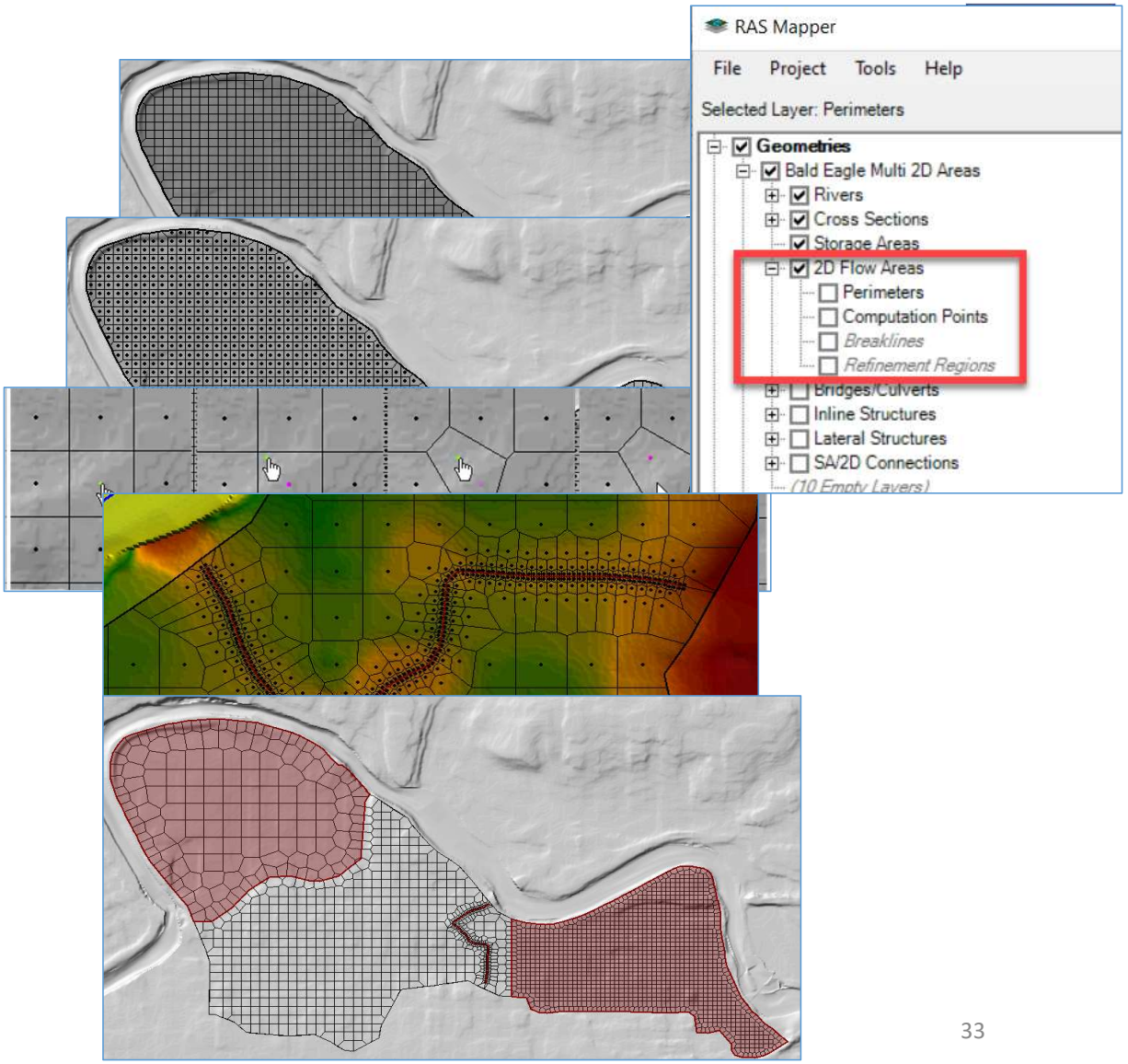


- Tools to autogenerate computation points
- Manning's n values
  - Single - or –
  - Spatially Varied



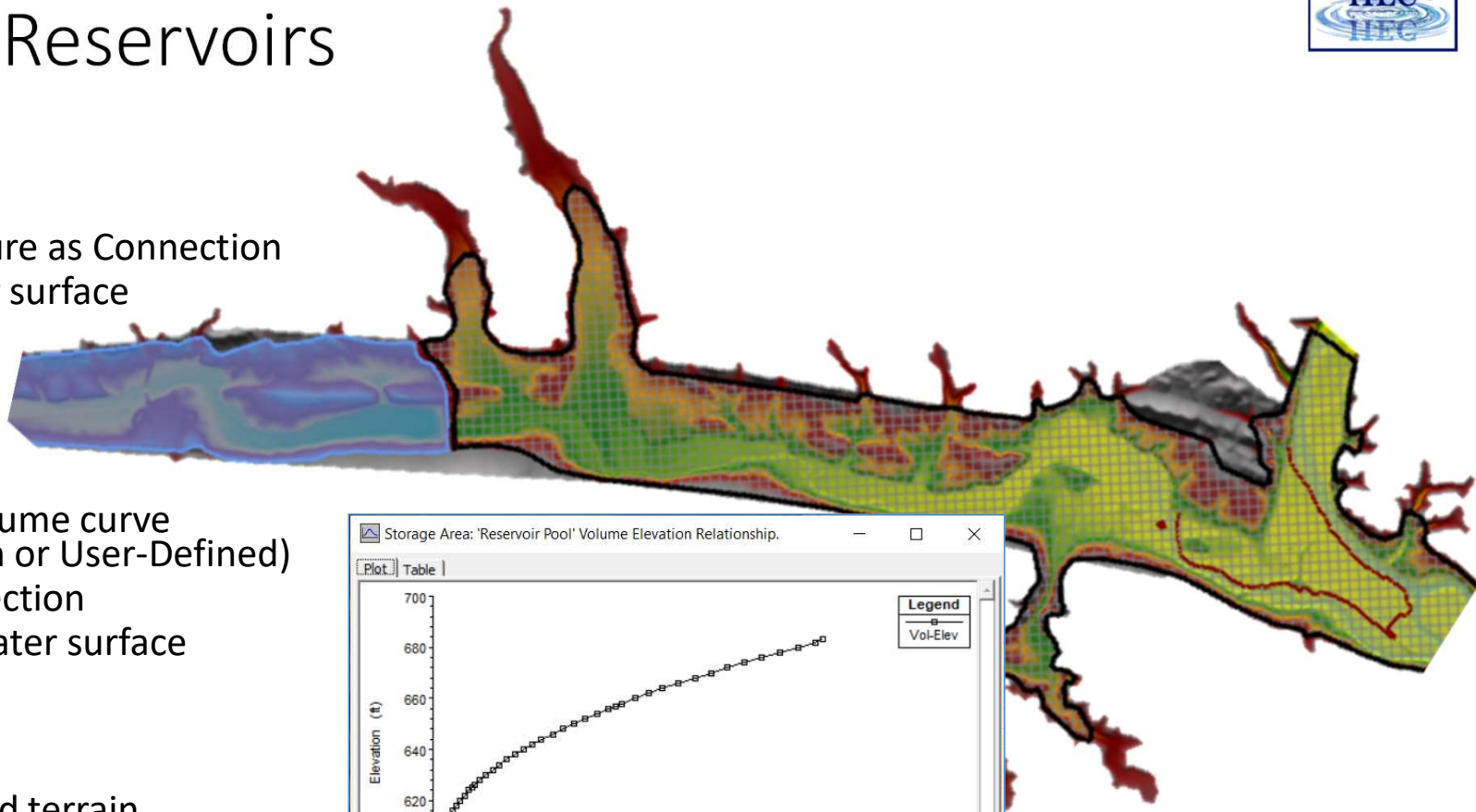
2D Flow Areas

- Perimeter
- Computation Points
- Breaklines
- Refinement Regions



Modeling Reservoirs

- Cross Sections
  - Use Terrain
  - Inline Structure as Connection
  - Sloped water surface



- Storage Area
  - Elevation Volume curve (From Terrain or User-Defined)
  - SA/2D Connection
  - Horizontal water surface

- 2D Flow Area
  - Requires good terrain
  - 2D Connection
  - Sloped water surface

Questions?

US Army Corps of Engineers