

Creating a RAS Terrain for 2D Modeling

Chris Nygaard, P.E.
Cameron Ackerman, P.E., BC.WRE

USACE, Institute for Water Resources, Hydrologic Engineering Center





Overview

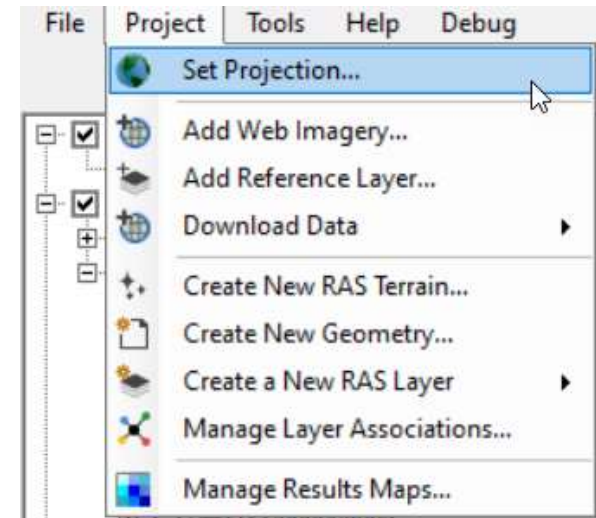
- Projection
- Creating a RAS Terrain Layer
 - Types of Terrain Models
 - Building a Terrain Model
 - Key Feature Considerations
 - Cell Size Considerations
 - Importing Terrain Information to RAS



Overview

- Projection
- Creating a RAS Terrain layer

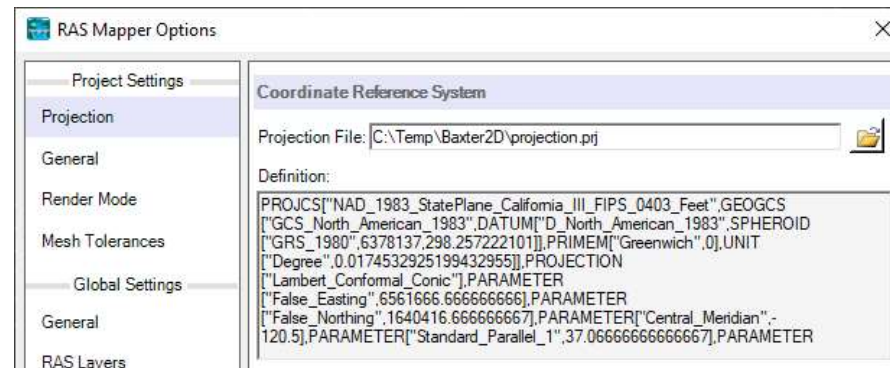
Projection





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.

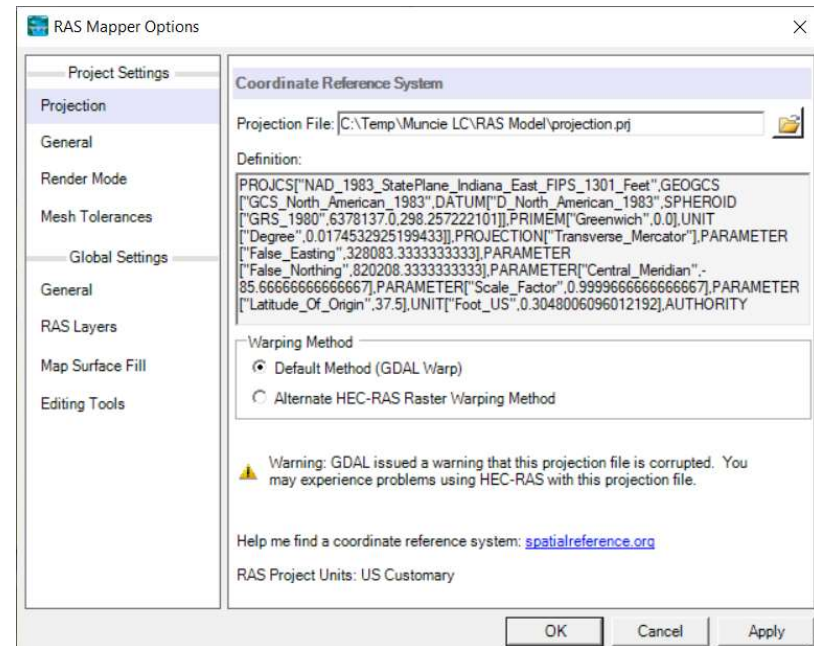
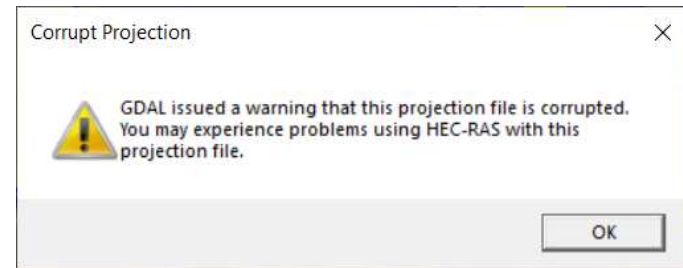




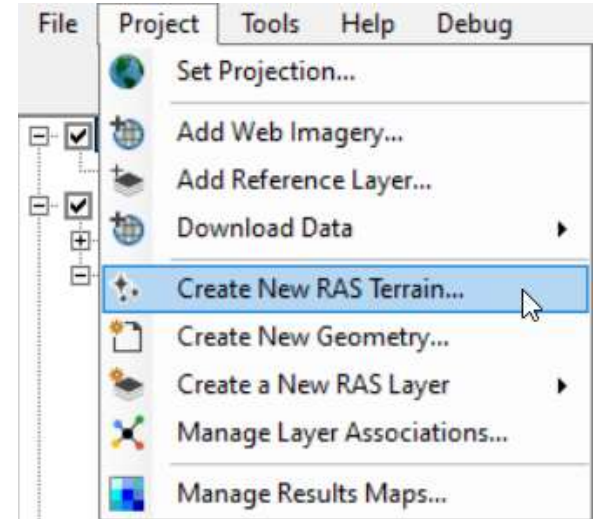
Projection Files

- 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],
PARAMETER["Latitude_Of_Origin",39.33333333333334],
UNIT["Foot_US",0.3048006096012192]].
```

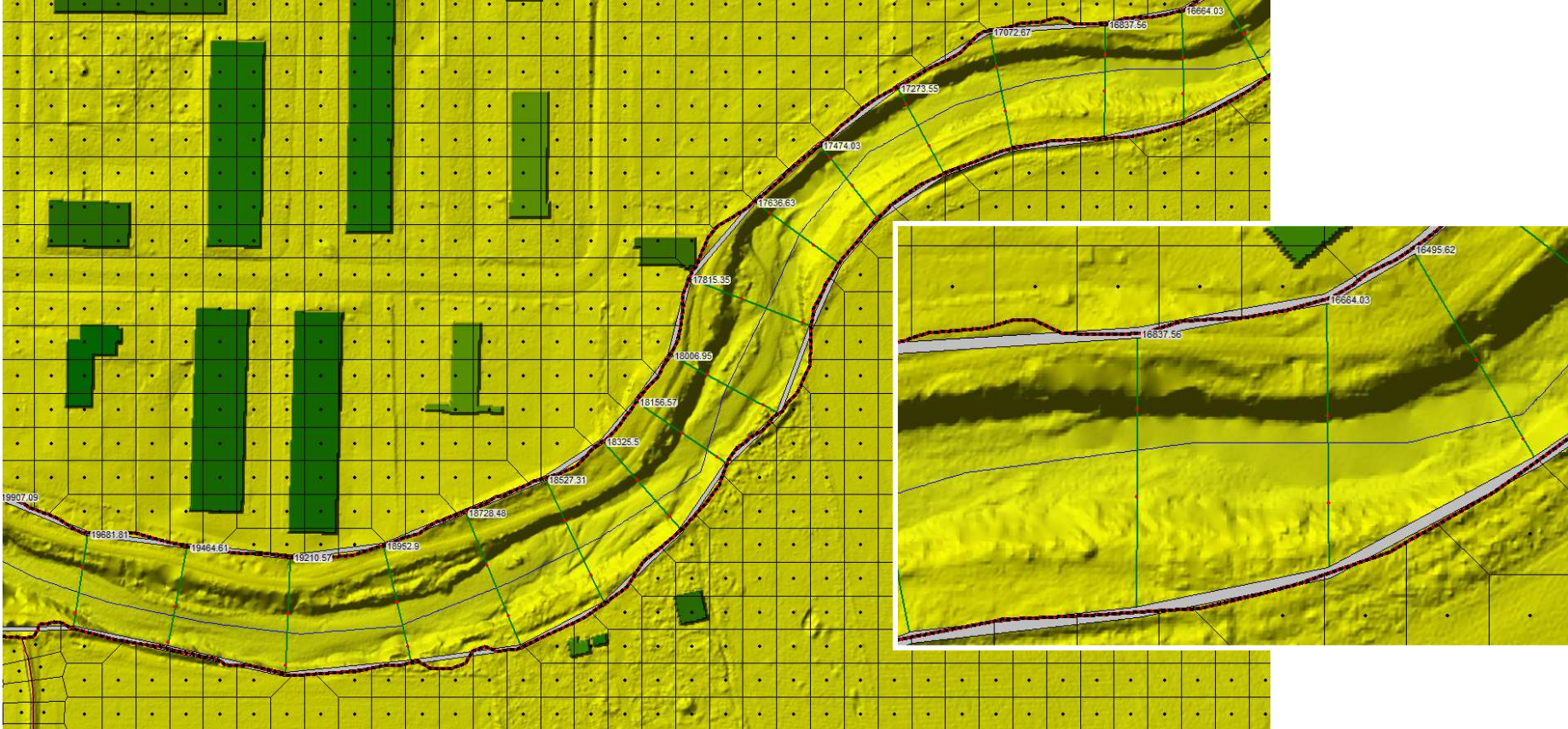


Terrain





A good model starts with good terrain ...





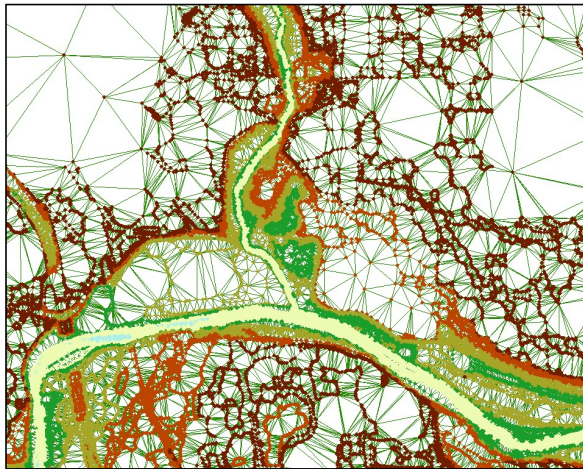
Terrain Cell Size Considerations

- Purpose and scale of model
 - Detailed bridge analysis - piers in terrain
 - Typical riverine model – only bridge opening in terrain
- Small enough to represent the land surface accurately, NOT any smaller
- Terrain model for 2D computations needs to accurately reflect features that direct flow
 - Align 2D cell faces with the controlling features



Terrain Model Types

- Triangulated Irregular Network (TIN)
- Triangulated points define surface allows for higher density in important areas.
- User-defined triangulation through points and break lines
- Grid
- Single value at regular intervals. Cell size determines surface resolution.
- Fast mathematical computations





Building a Terrain Model

Verify and Process Points

- Remove of points that are not necessary/incorrect in representing the ground surface
 - Redundant points (more points = more processing)
 - Bridge deck elevations
- Make sure to add important features
 - Top of roads
 - Top of levees
 - Top of floodwalls
 - Bridge approaches
 - Hydraulic structures
- Replace over-water returns with bathymetric data



Building a Terrain Model

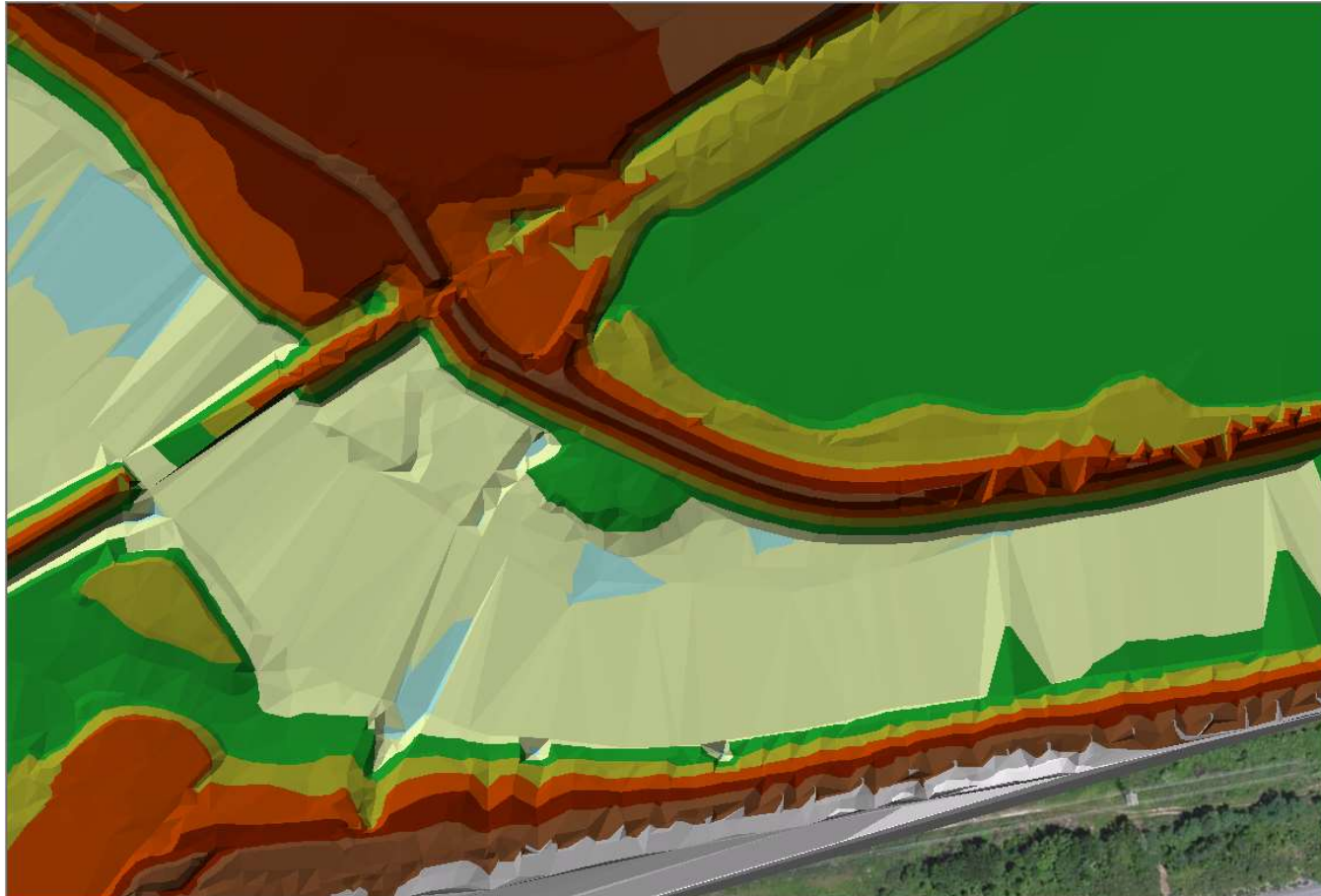
Bare Earth Points





Building a Terrain Model

Bare Earth Points



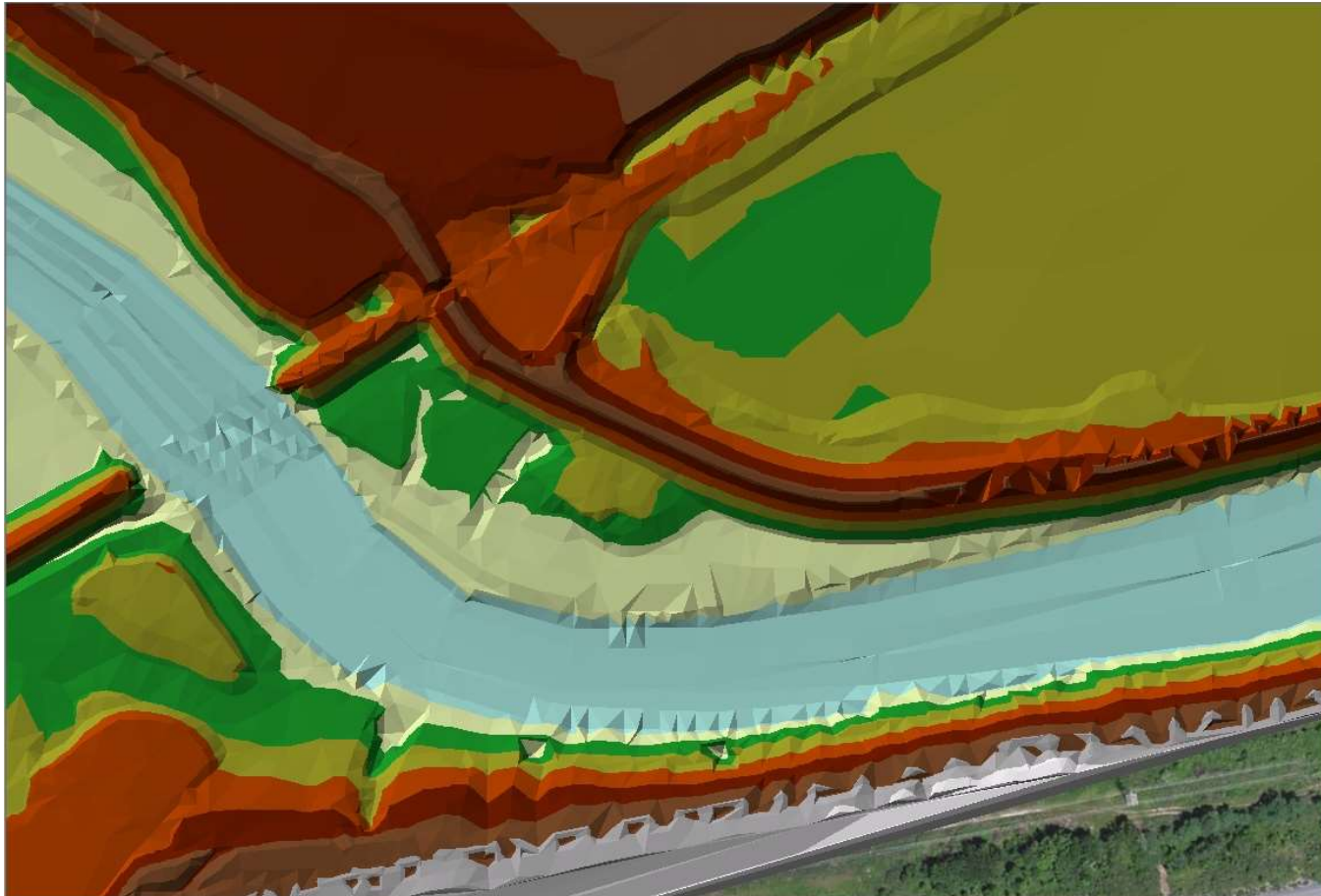


Building a Terrain Model Bathymetry Points



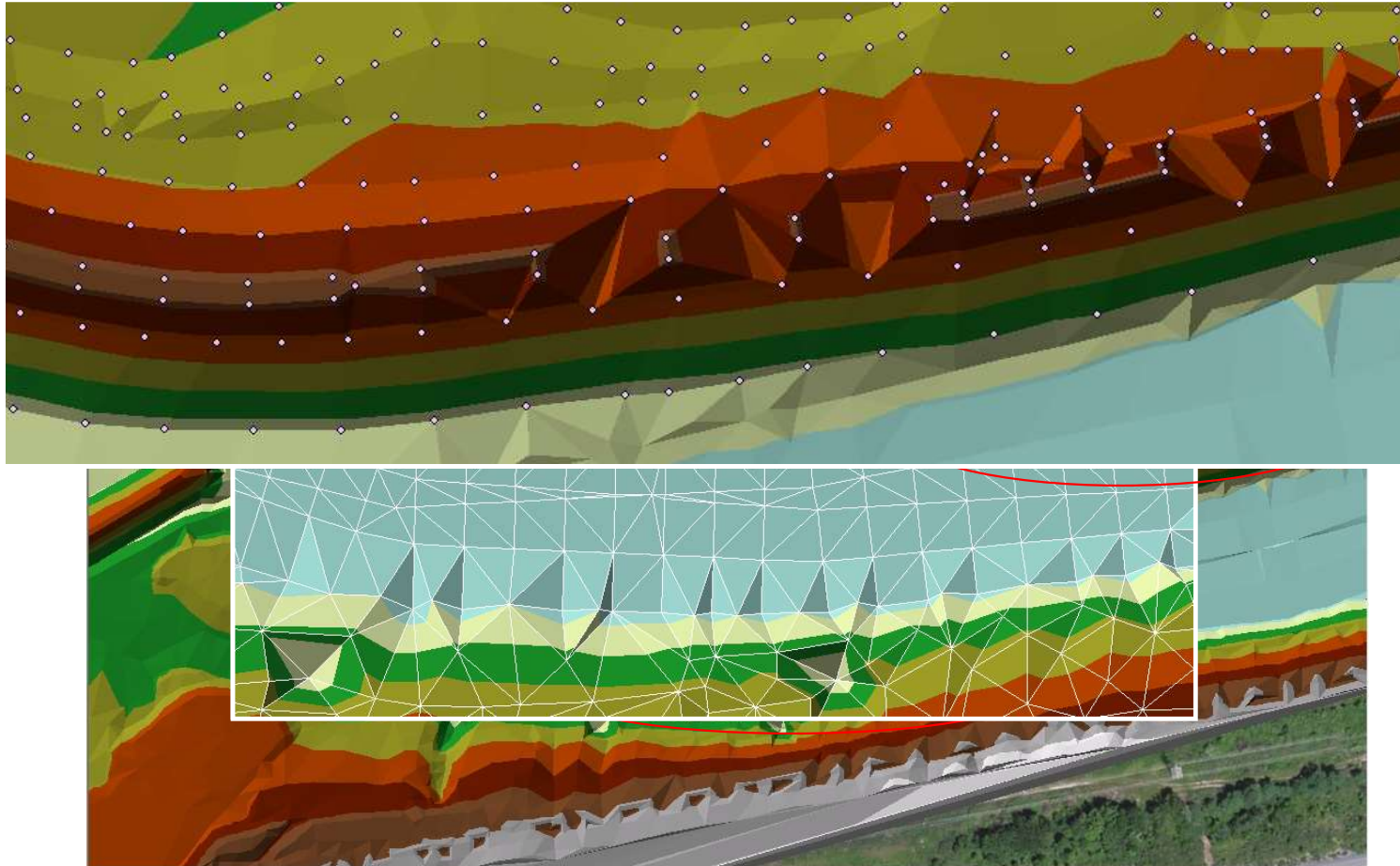


Building a Terrain Model Bathymetric Data Added





Building a Terrain Model Problems?





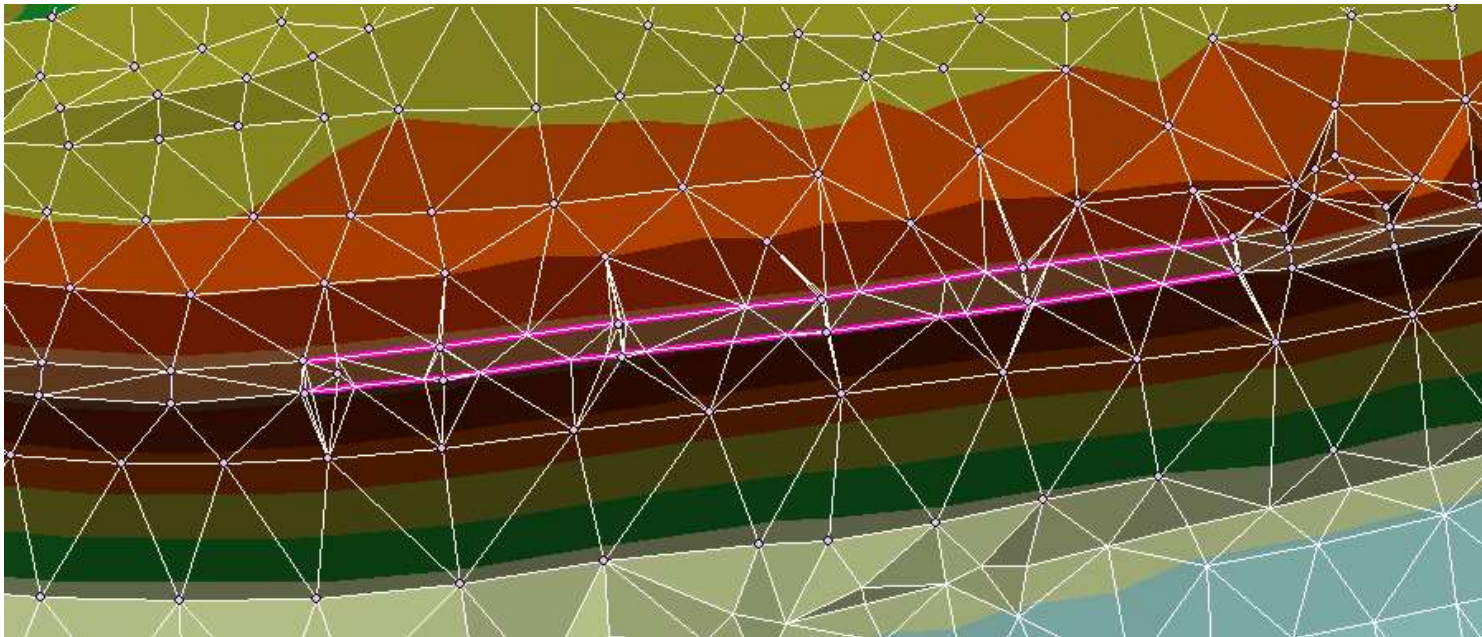
Building a Terrain Model Breaklines

- Breaklines are used to enforce triangle edges and elevations. They ensure that interpolation is done “correctly” along linear features.
 - Channel banks
 - Steep drops (drop structures, waterfalls)
 - Roadways
 - Levees
 - Bathymetry points



Building a Terrain Model Breaklines

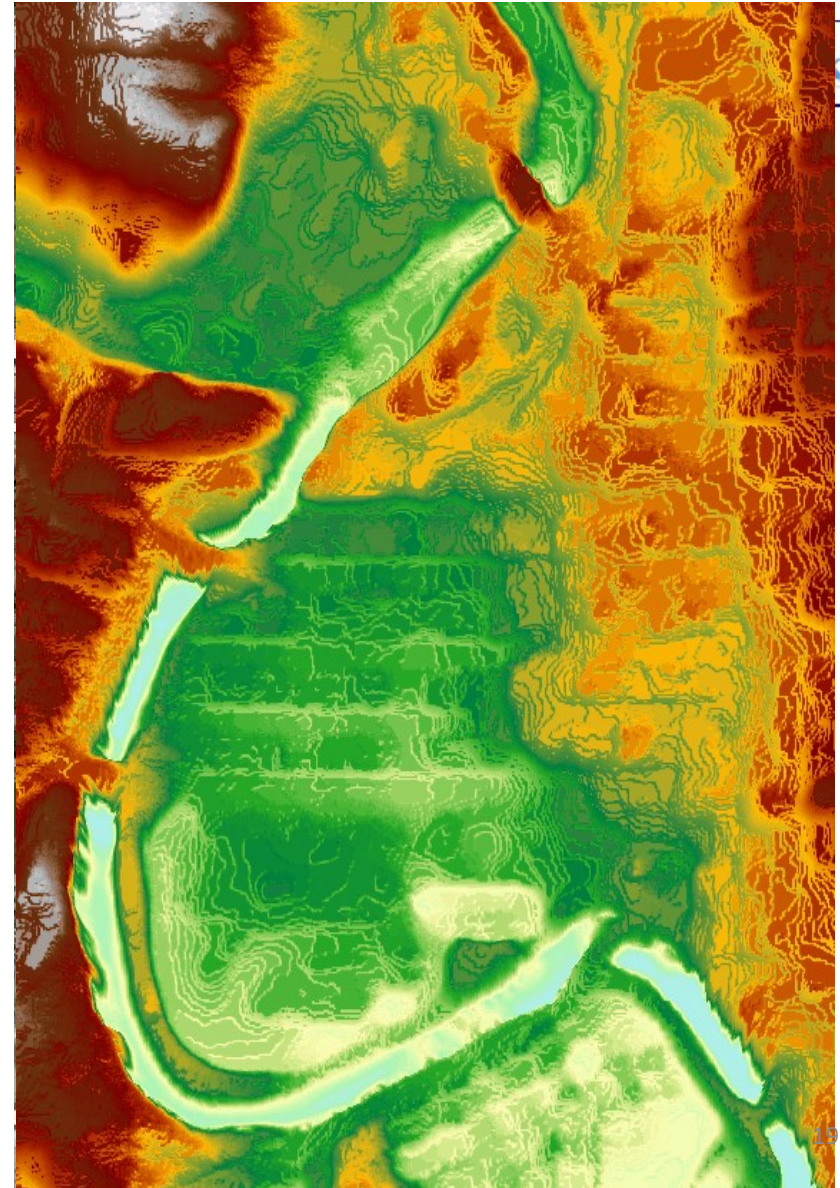
- Breaklines with elevations insert points to enforce elevations and triangle edges





Bridges

- Removal of bridges from terrain data is important for 2D modeling.
- High ground directs flow – determined directly from ground surface model.
- 1D modeling place cross sections at appropriate locations as work around.



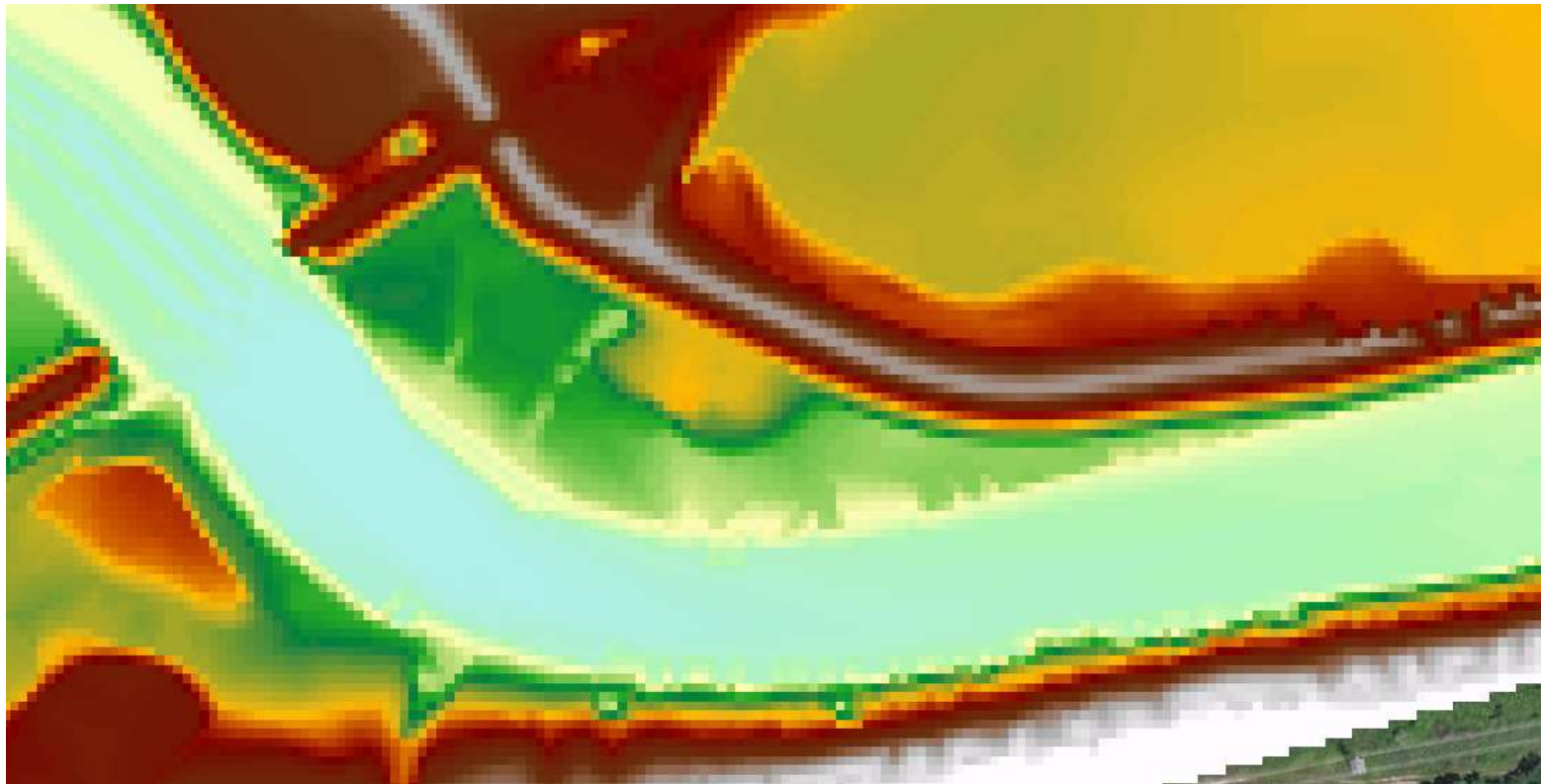


Terrain Cell Size Considerations

- Purpose – scale of model
 - Detailed bridge analysis requires piers be represented
 - Riverine model requires flow opening is represented
- Small enough to represent the land surface accurately, NOT any smaller
- Terrain model needs to accurately reflect linear features that direct flow. HEC-RAS uses a 2D computational grid as the underlying representation of terrain. 2D cell faces should be aligned with linear feature in the terrain.

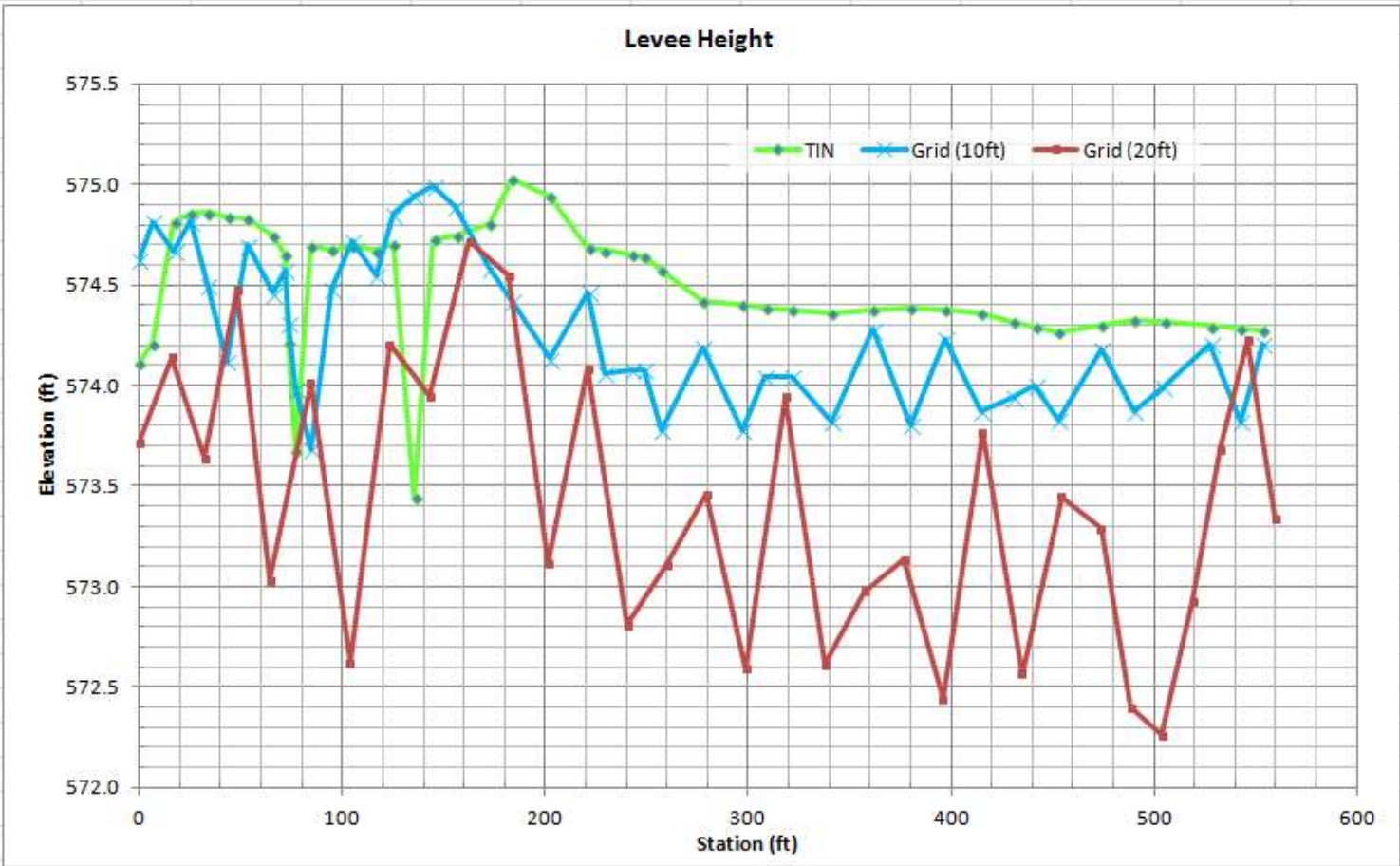


Raster Cell Size



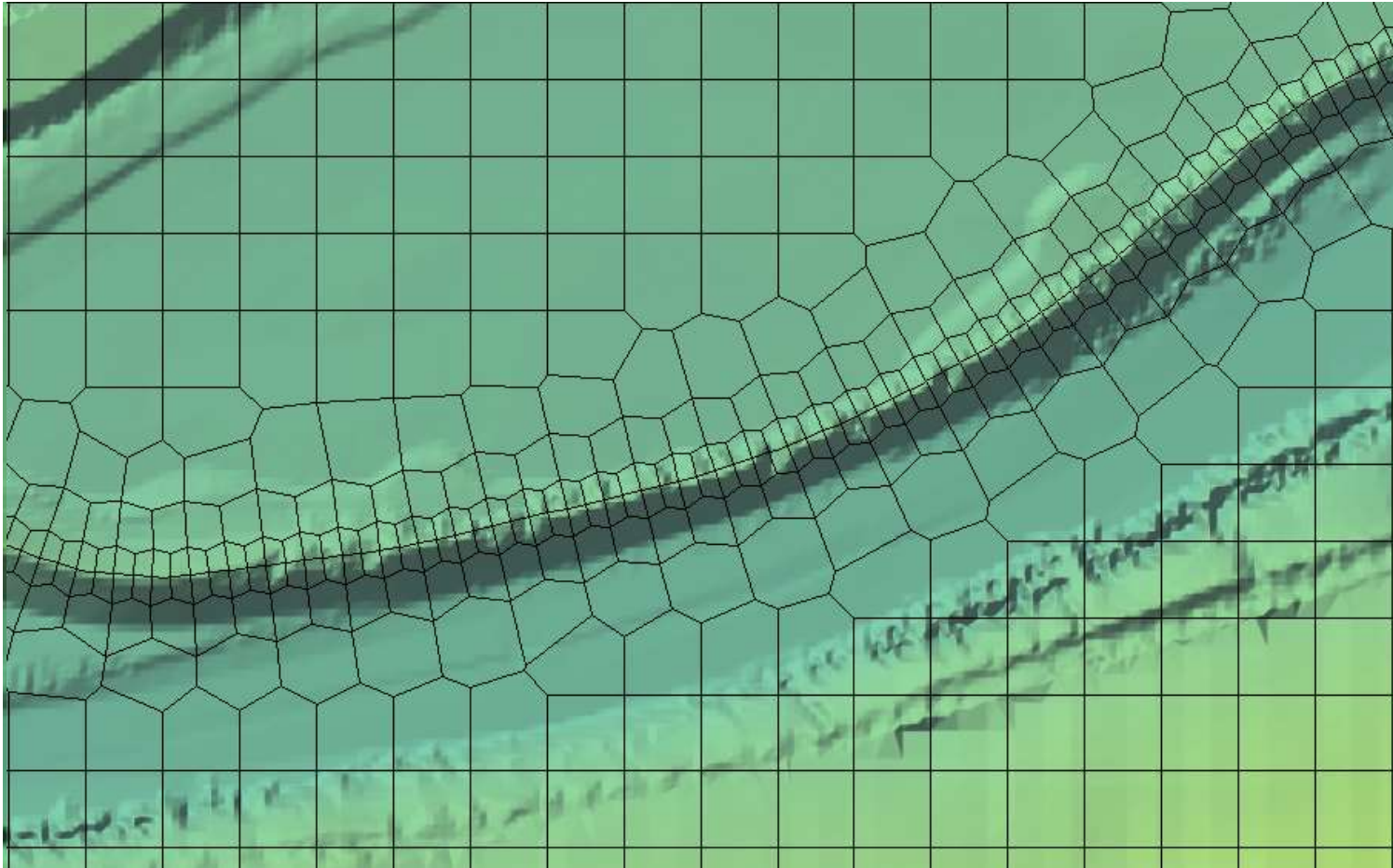


Raster Cell Size



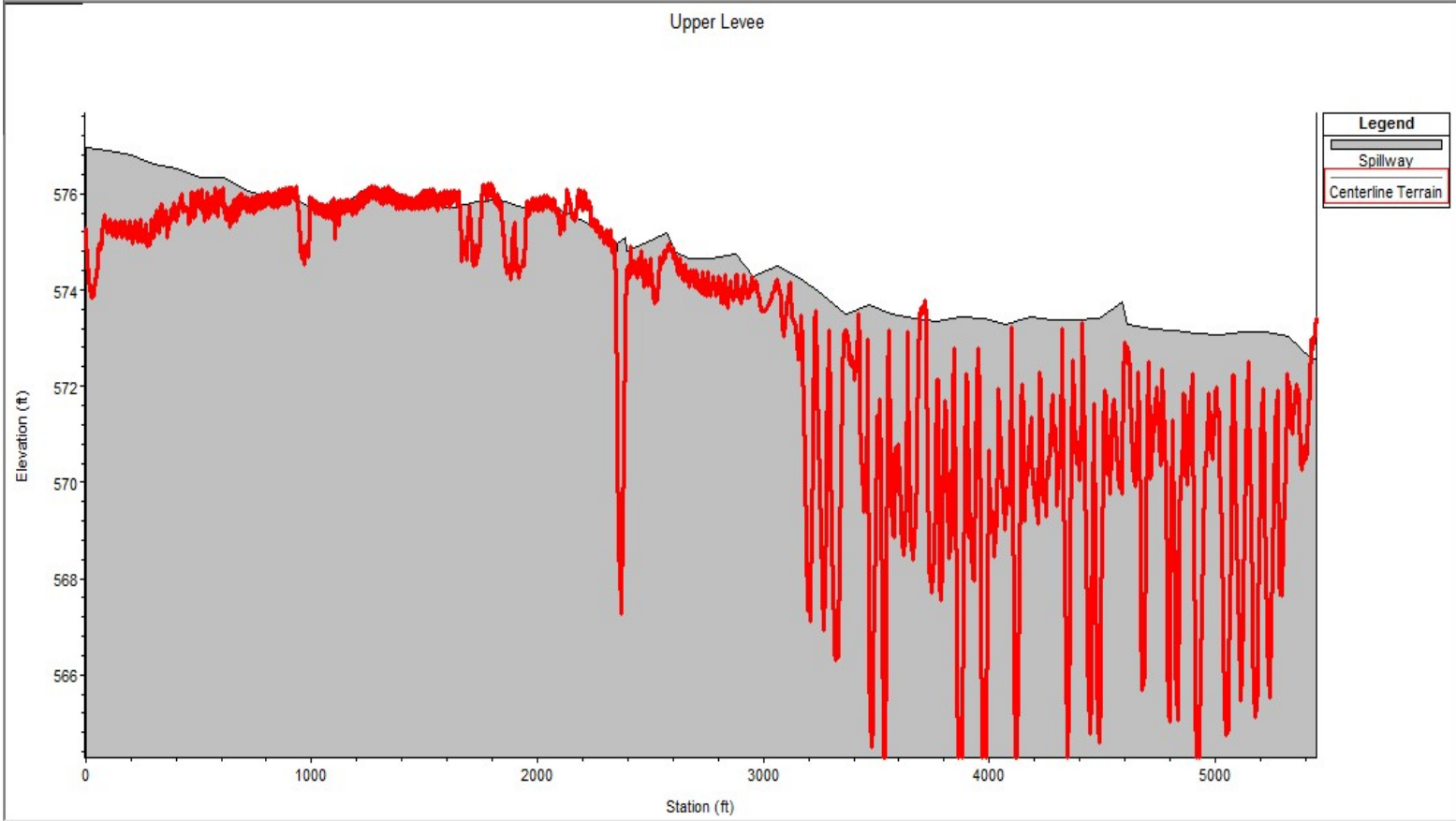


HEC-RAS Terrain Fixes





Hydraulic Structure Elevations





Terrain Model Development Summary

- Terrain models are developed as TINs
- Model is typically exported to a Grid for visualization and analysis
 - TINs are more difficult to render
 - TINs are more expensive to store
 - Calculations with TINs more difficult than with rasters
- Grid-cell size determines the effective accuracy of the resulting terrain model
 - How are you going to represent a levee in a raster with a 20ft grid cell?

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





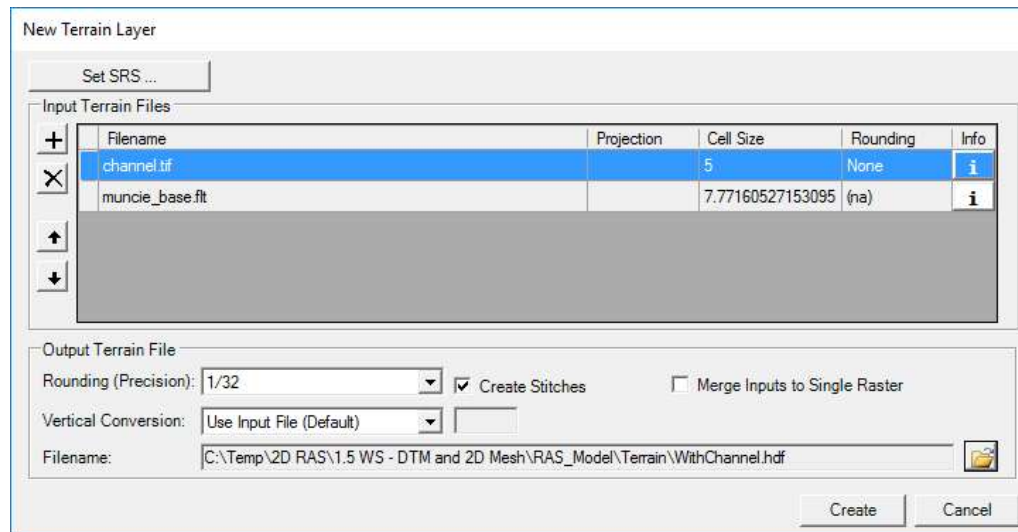
Terrain in RAS Mapper

- Various formats are supported
 - Binary Floating Point Raster (FLT)
 - Esri Arc/Info Grid format
 - GeoTIFF (still rounds and compresses)
 - Others (e.g. USGS DEM, etc)
- Imported data is rounded to based on precision selected
 - Default is 1/32 (~0.03 ft) (1/128 for metric)
- Recommended that a projection is defined for the RAS Mapper project first.



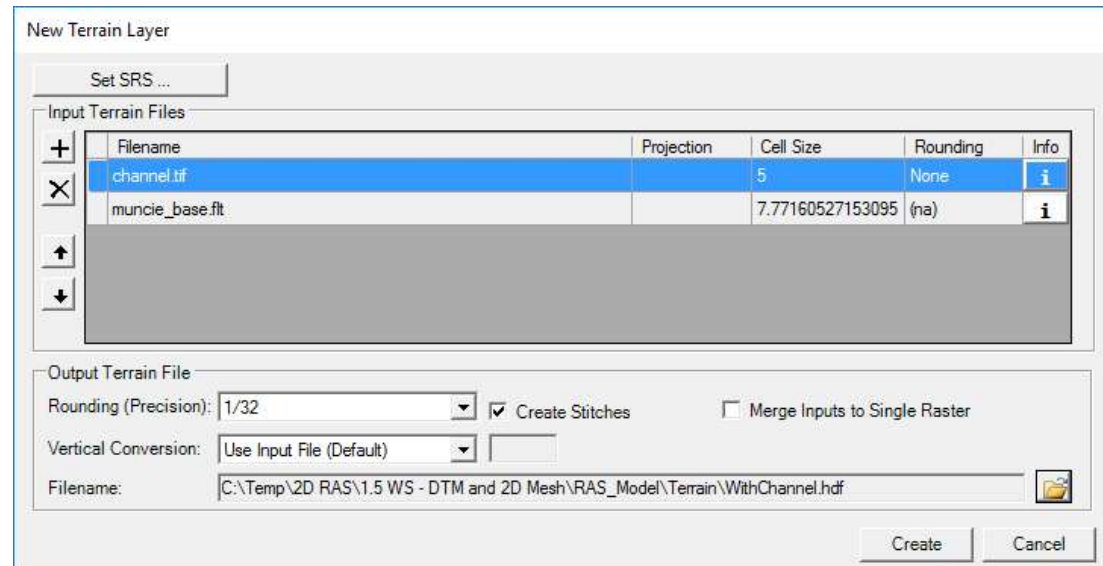
Terrain Importer

- 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

- Rounding – Precision which data is stored
- Terrain Filename and Folder
 - name.tilename.tif file for each imported terrain tile
 - name.hdf file contains “stitch” information for data gaps
 - name.vrt file contains statistics info and color ramp info



New Terrain Layer

Set SRS ...


Input Terrain Files

+	Filename	Projection	Cell Size	Rounding	Info
×	channel.tif		5	None	i
↑	muncie_base.ft		7.77160527153095	(na)	i
↓					

Output Terrain File

Rounding (Precision): 1/32 Create Stitches Merge Inputs to Single Raster

Vertical Conversion: Use Input File (Default)

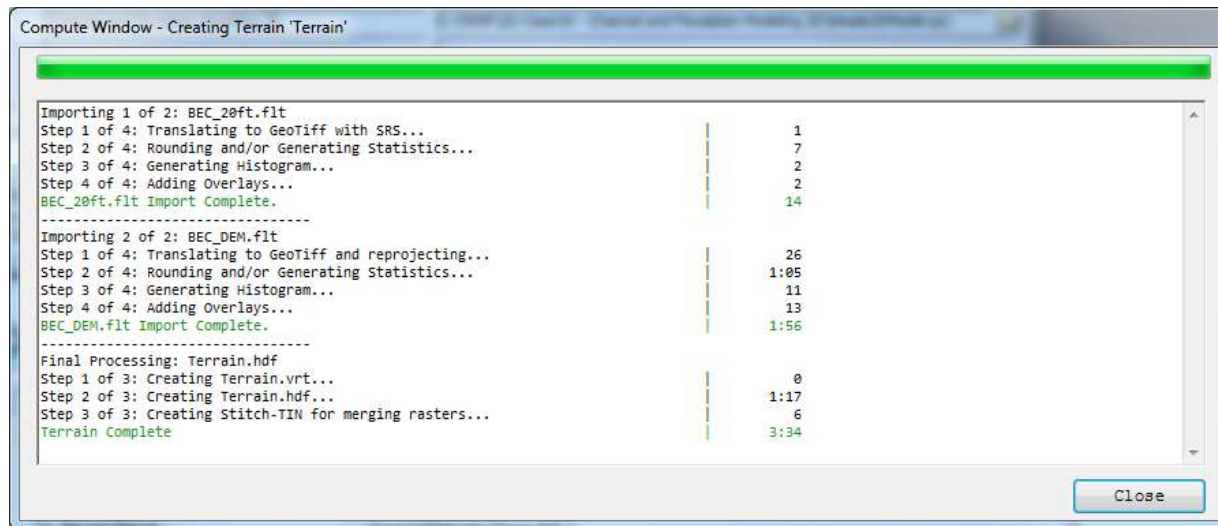
Filename: C:\Temp\2D RAS\1.5 WS - DTM and 2D Mesh\RAS_Model\Terrain\WithChannel.hdf 

Create Cancel



Terrain Importer

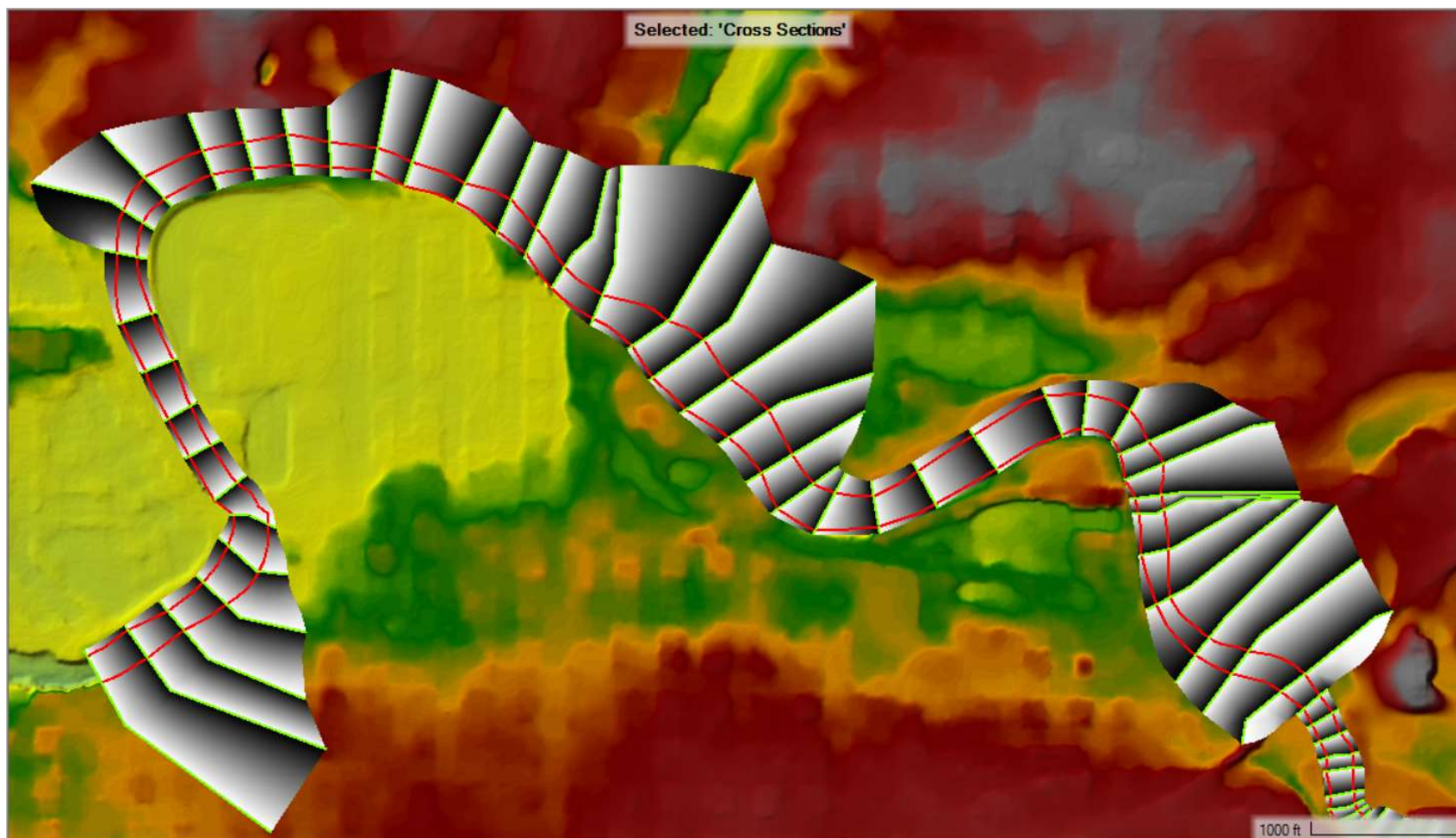
- Data is translated, projected, rounded for all data
- Data is pyramided (overlays) and compressed
- TIN stitches created for overlapping regions
- Terrain.hdf is the single layer loaded to RAS Mapper



```
Compute Window - Creating Terrain 'Terrain'
-----
Importing 1 of 2: BEC_20ft.flt
Step 1 of 4: Translating to GeoTiff with SRS...           |           1
Step 2 of 4: Rounding and/or Generating Statistics...    |           7
Step 3 of 4: Generating Histogram...                    |           2
Step 4 of 4: Adding Overlays...                          |           2
BEC_20ft.flt Import Complete.                           |          14
-----
Importing 2 of 2: BEC_DEM.flt
Step 1 of 4: Translating to GeoTiff and reprojecting...  |          26
Step 2 of 4: Rounding and/or Generating Statistics...    |         1:05
Step 3 of 4: Generating Histogram...                    |          11
Step 4 of 4: Adding Overlays...                          |          13
BEC_DEM.flt Import Complete.                           |         1:56
-----
Final Processing: Terrain.hdf
Step 1 of 3: Creating Terrain.vrt...                      |           0
Step 2 of 3: Creating Terrain.hdf...                     |         1:17
Step 3 of 3: Creating Stitch-TIN for merging rasters... |           6
Terrain Complete                                        |         3:34
```



Improving Channel Data – From XS





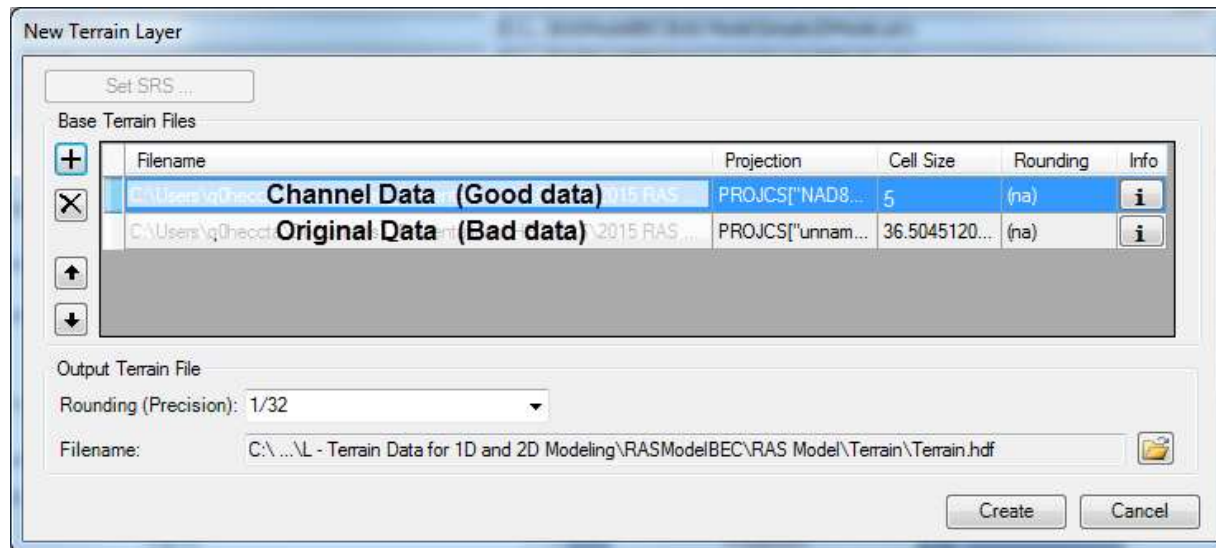
Export Channel Surface to GeoTiff

The screenshot shows the HEC-RAS software interface. On the left, the 'Geometries' tree is expanded to 'Muncie Base Geometry - 9 SAs', with 'Rivers' and 'Cross Sections' checked. A context menu is open over the 'Rivers' layer, with 'Export Layer' selected. A sub-menu is displayed, listing options such as 'Create Terrain GeoTiff from XS's (Overbanks and Channel)', 'Create Terrain GeoTiff from XS's (Channel Only)', and 'Create Point Shapefile of XS-River Intersections'. A red arrow points to the 'Create Terrain GeoTiff from XS's (Channel Only)' option. In the background, a 3D terrain model of a river channel is visible. An 'Export Terrain' dialog box is open in the foreground, with the 'Enter raster cell size' field set to '5' and 'OK' and 'Cancel' buttons.



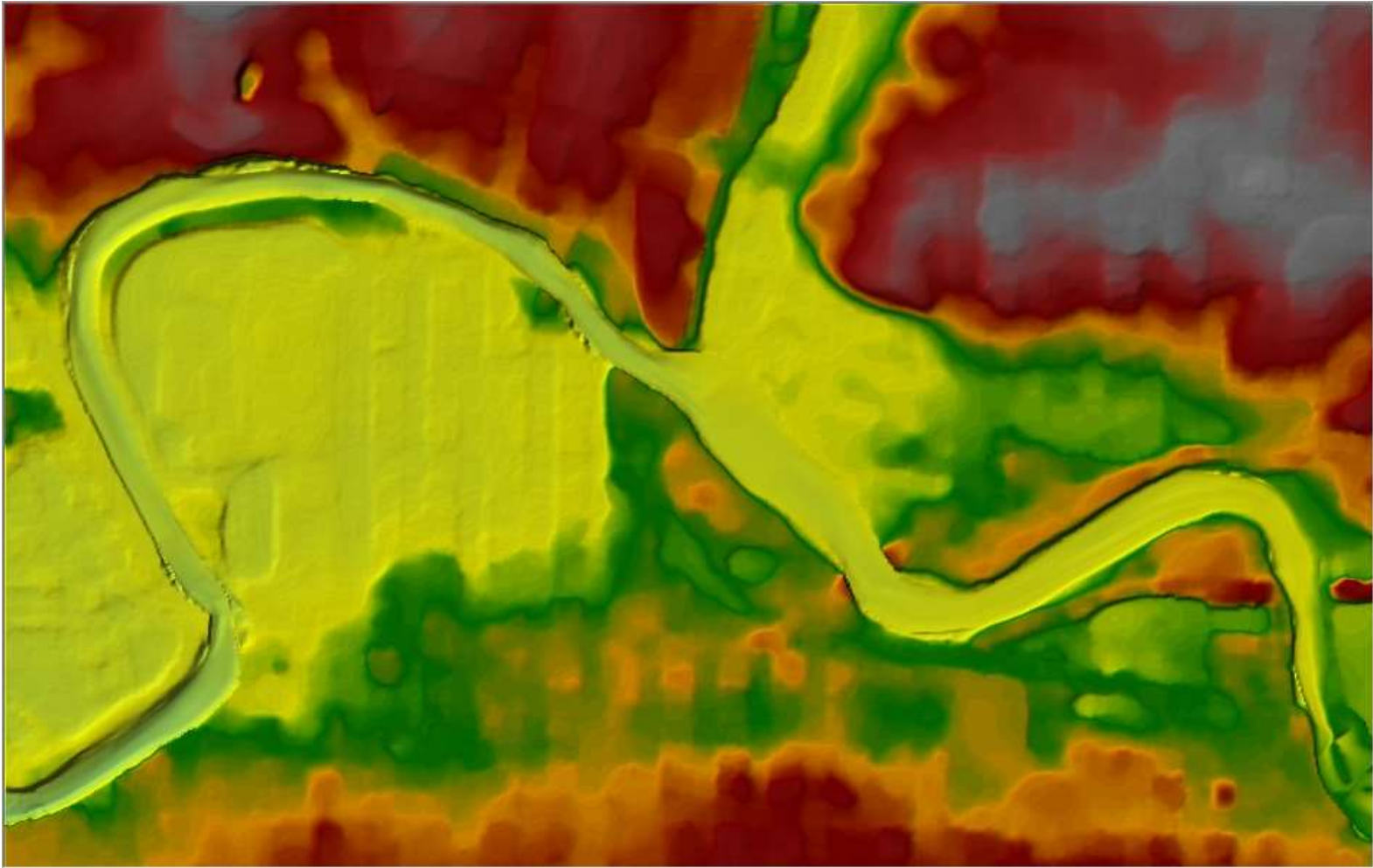
Adding Channel Data

- New Terrain
- Priority – Channel data highest



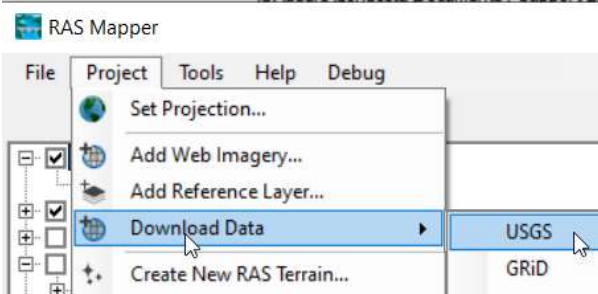


Terrain with Channel

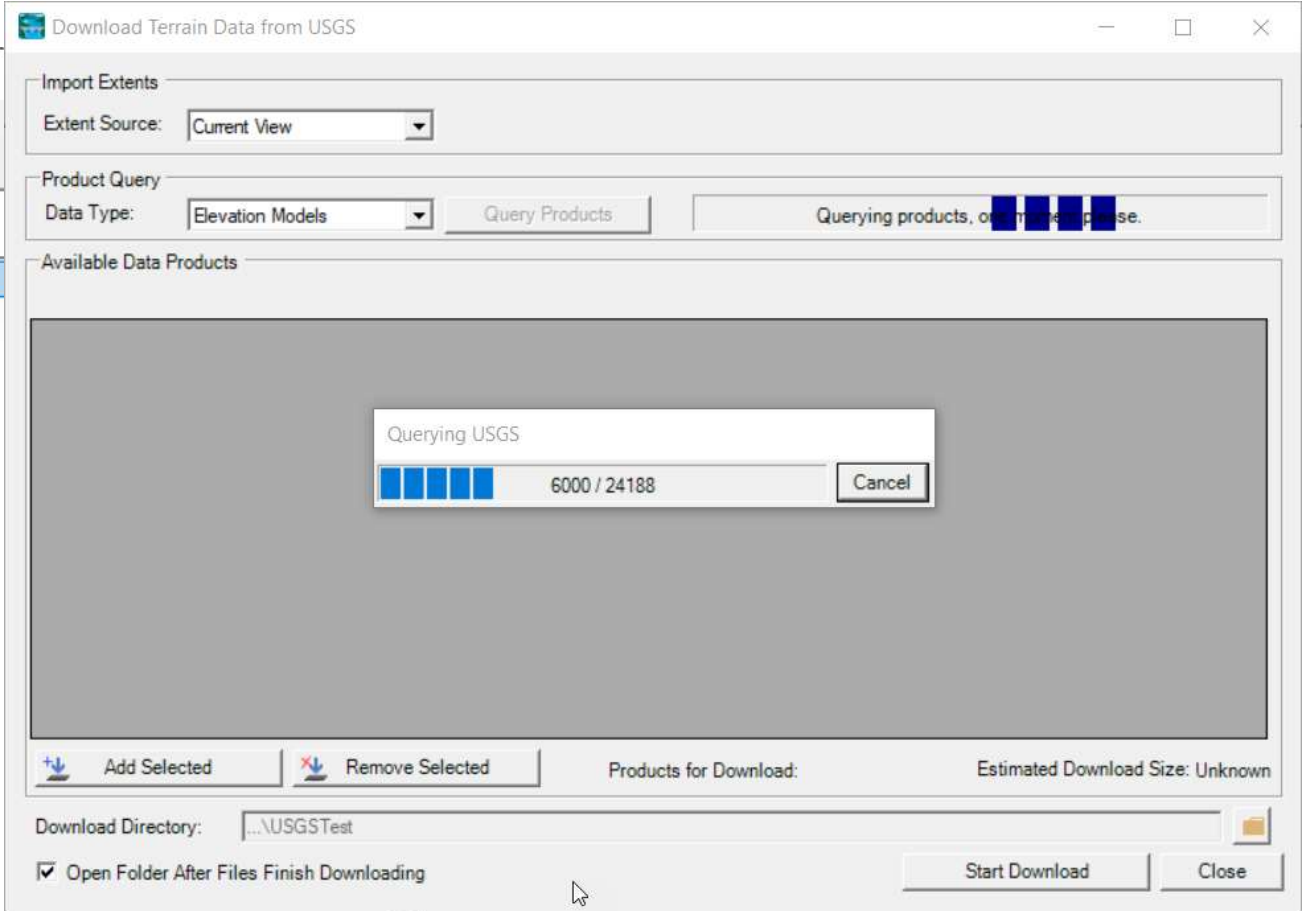




Terrain Data Download



- USGS Terrain
- GRiD (CRREL)





Terrain Data Download

RAS Mapper

File Project Tools Help Debug

Selected Layer: USGS Products Available

- Features
 - Profile Lines
- Geometries
- Event Conditions
- Results
 - Tujungang
 - Tujungang Steady
 - Event Conditions
 - Geometry
 - Depth (PF 1)
 - Velocity (PF 1)
 - WSE (PF 1)
 - 1DOnly
 - Event Conditions
 - Geometry
 - Depth (Max)
 - Velocity (Max)
 - WSE (Max)
- Map Layers
 - USGS Products Available
 - USGS Products To Download

Messages Views Profile Lines Active Features Layer Values

(-6169279.69, 4841941.97 1 pixel = 588.15 ft)

Download Terrain Data from USGS

Import Extents
Extent Source: Current View

Product Query
Data Type: Elevation Models Query Products

Available Data Products (Filtered: 359 of 24188)

1m 10m 30m Original Filter: Apply Only Show

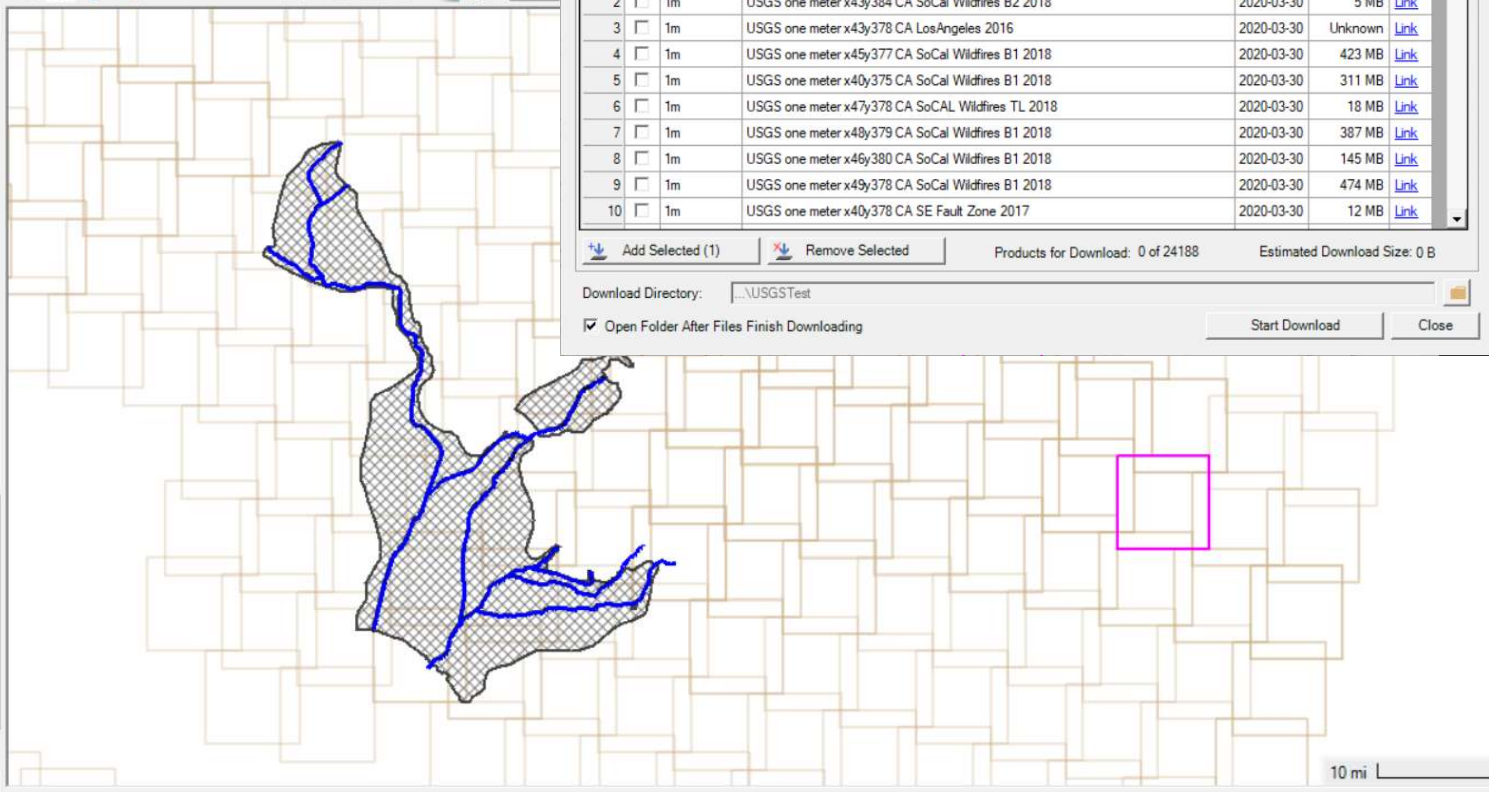
	CellSize	Description	Date	FileSize	Web
1	1m	USGS one meter x48y378 CA SoCal Wildfires B1 2018	2020-03-30	429 MB	Link
2	1m	USGS one meter x43y384 CA SoCal Wildfires B2 2018	2020-03-30	5 MB	Link
3	1m	USGS one meter x43y378 CA LosAngeles 2016	2020-03-30	Unknown	Link
4	1m	USGS one meter x45y377 CA SoCal Wildfires B1 2018	2020-03-30	423 MB	Link
5	1m	USGS one meter x40y375 CA SoCal Wildfires B1 2018	2020-03-30	311 MB	Link
6	1m	USGS one meter x47y378 CA SoCAL Wildfires TL 2018	2020-03-30	18 MB	Link
7	1m	USGS one meter x48y379 CA SoCal Wildfires B1 2018	2020-03-30	387 MB	Link
8	1m	USGS one meter x46y380 CA SoCal Wildfires B1 2018	2020-03-30	145 MB	Link
9	1m	USGS one meter x49y378 CA SoCal Wildfires B1 2018	2020-03-30	474 MB	Link
10	1m	USGS one meter x40y378 CA SE Fault Zone 2017	2020-03-30	12 MB	Link

Add Selected (1) Remove Selected Products for Download: 0 of 24188 Estimated Download Size: 0 B

Download Directory: ..\USGSTest

Open Folder After Files Finish Downloading

Start Download Close





Terrain Data Download



RAS Mapper

File Project Tools Help Debug

Selected Layer: USGS Products Available

Selected: 'USGS Pro'

Map Layers

- USGS Products Available
- USGS Products To Download

CellSize	Description	Date	FileSize	Web
1m	USGS one meter x48y378 CA SoCal Wildfires B1 2018	2020-03-30	429 MB	Link
1m	USGS one meter x43y384 CA SoCal Wildfires B2 2018	2020-03-30	5 MB	Link
1m	USGS one meter x43y378 CA LosAngeles 2016	2020-03-30	Unknown	Link
1m	USGS one meter x45y377 CA SoCal Wildfires B1 2018	2020-03-30	423 MB	Link
1m	USGS one meter x40y375 CA SoCal Wildfires B1 2018	2020-03-30	311 MB	Link
1m	USGS one meter x47y378 CA SoCal Wildfires TL 2018	2020-03-30	18 MB	Link
1m	USGS one meter x48y379 CA SoCal Wildfires B1 2018	2020-03-30	387 MB	Link
1m	USGS one meter x46y380 CA SoCal Wildfires B1 2018	2020-03-30	145 MB	Link
1m	USGS one meter x49y378 CA SoCal Wildfires B1 2018	2020-03-30	474 MB	Link
1m	USGS one meter x40y378 CA SE Fault Zone 2017	2020-03-30	12 MB	Link

Download Directory: .\USGSTest

Start Download Close

10 mi



Terrain Build



New Terrain Layer

Set SRS ...

Input Terrain Files (13 files)

+	Filename	Projection	Cell Size	Rounding	Info
X	tile (1).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
↑	tile (2).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
↓	tile (3).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (4).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (5).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (6).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (7).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (8).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (9).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i
	tile (10).tif	PROJCS["NAD83(2011) / UTM zone 11N",GEO...	0.5	None	i

Output Terrain File

Rounding (Precision): 1/32 Create Stitches Merge Inputs to Single Raster

Vertical Conversion: Use Input File (Default)

Filename: C:\Temp_NewModels\Merced\Terrain\Terrain.hdf

Create Cancel

Questions?

