

Geometric Data Development in HEC-RAS

Mark Jensen

USACE, Institute for Water Resources, Hydrologic Engineering Center



US Army Corps
of Engineers®



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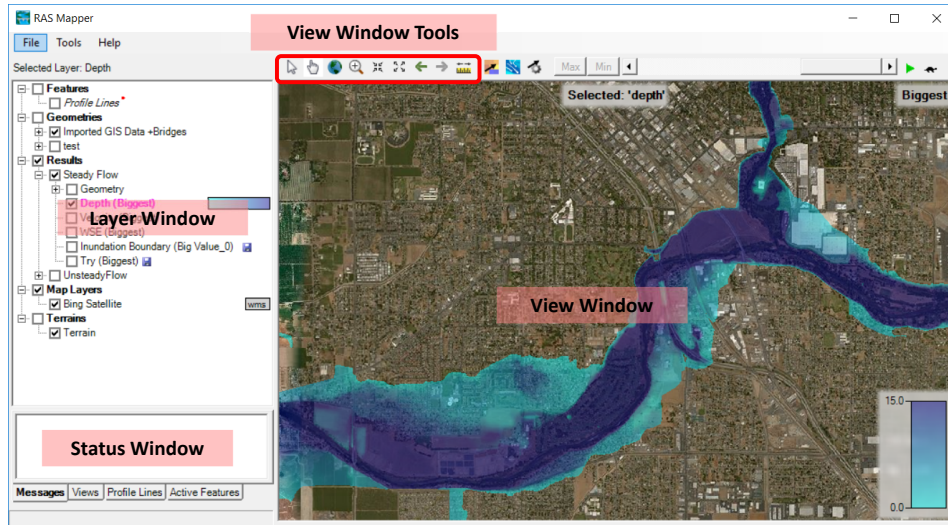


Overview of Data Development

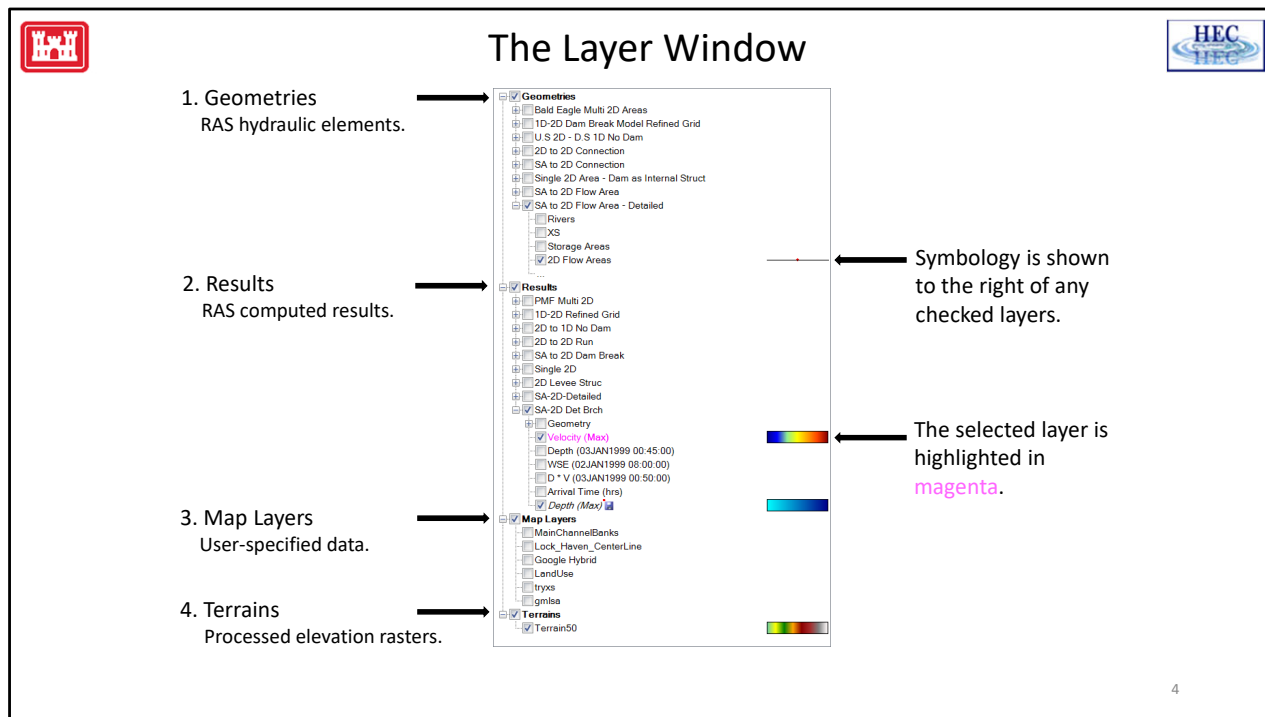
- RAS Mapper
- RAS Terrain
- New Geometry
- Editing Tools
- River Network
- Cross Sections



HEC-RAS Mapper



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There are 4 main groups in the layer window: Geometries, Results, Map Layers, Terrains. Every data layer that is checked in the layer window will be rendered in the RAS Mapper view window (all parents in the tree must be checked as well)

Items in the tree render top-down: Geometries draws above Results, draws above Map Layers, etc. Similarly, “Velocity (Max)” will draw above “Depth (Max)”

Geometries:

These layers store all of your RAS geometry elements (Rivers, Meshes, etc.) and work from the .g01 and .g01.hdf files.

Results:

These layers store all of your computed RAS results, as well as a copy of the geometry used to create it. Results can be viewed by adding maps of different types (Depth, Velocity, etc). The save icon indicates a map is stored on disk. The red asterisk indicates something is wrong – hover your mouse to see more information.

Map Layers:

These include any custom user layers, as well as web imagery and land cover layers.

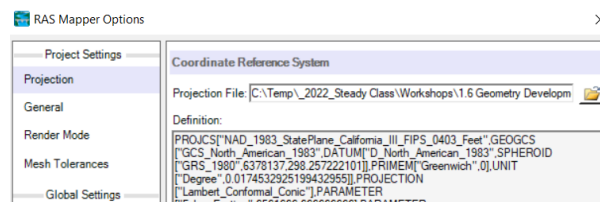
Terrains:

These layers store the processed RAS elevation rasters



Projection

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



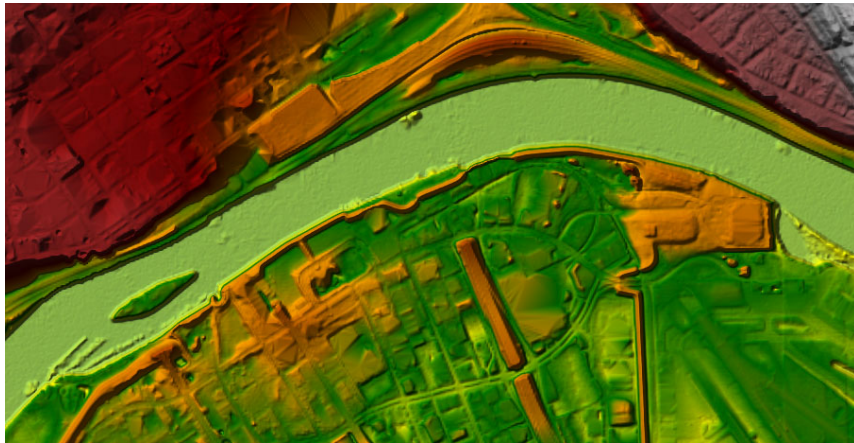
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The Projection (Spatial Reference System) is defined in RAS using an ESRI well-known text PRJ file. Having this defined will allow you to export data to be used with other GIS layers and allow other GIS layers to be displayed with your data. RAS Mapper has the ability to display Web Imagery. If the projection is correctly defined, the web imagery will be projected as a background map. How cool is that! Depending on the projection used for the data the web imagery labels may look great (using local projection) or not so great if you are using a national projection (US Albers) and your data is on the edge of projection limits.



Terrain Model

- Terrain should include important elevations



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The first step is to start with a terrain model. The terrain model for should include important features such as levees, floodwalls and roadways that direct the flow of water.



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.

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RAS support the import of various file formats into the GeoTIFF format. Common GIS formats that are supported are the FLT, esri Grid, and GeoTIFF, but there tons of other formats. Refer to http://www.gdal.org/formats_list.html for a full list (there are like 100 of them).

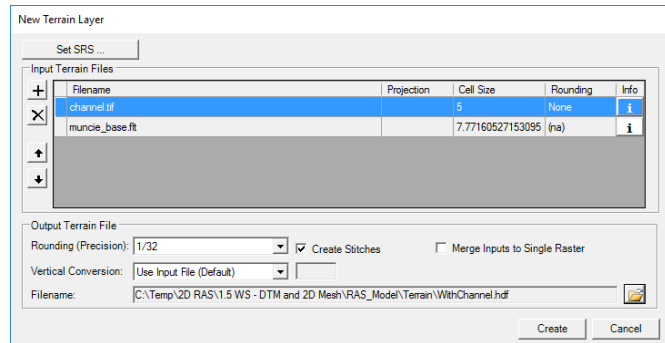
Imported data is also rounded. Rather than keeping data stored out to the 8th decimal place, the data will be rounded. The default is to round the data to 1/32 (or ~0.03ft). We have found that round algorithms using Base2 compression is more successful than Base10, so that is the default. We also allow the user to not round and keep the data as is, or use a Base10 compression.

Because you are using a Terrain model for data extraction and mapping, it is important that the data has a defined projection and that it is set in the RAS Mapper interface!



Create New Terrain

- 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



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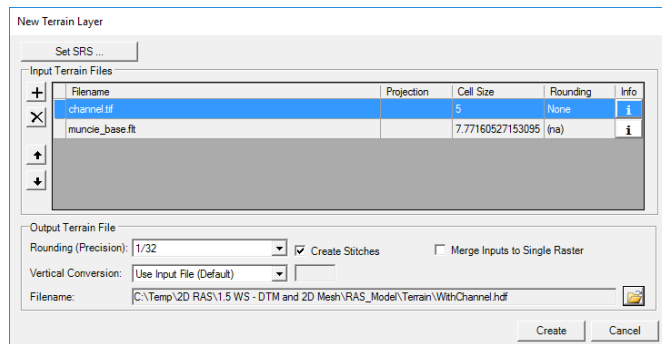
Once a projection is defined, then you can Add a New Terrain. The Terrain will be created from input terrain models. This is how it works.

1. Add File of interest
2. You specify the Priority for using the terrain files (highest is most important).



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



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Once a projection is defined, then you can Add a New Terrain. The Terrain will be created from input terrain models. This is how it works.

1. You provide the Rounding Precision and as the GeoTIFF is built the data is rounded, compressed, and tiled.
2. You decide on the Terrain Filename to create a GeoTIFF of each of the input files. An HDF file will be created. This is the file that is loaded into RAS. It will have a pointer to the TIF file – the actual elevation data.



Terrain Importer

- Data is re-projected and rounded
- Data is pyramided and compressed
- Terrain.hdf is the single layer loaded to RAS Mapper

```
Compute Window - Creating Terrain Terrain
-----
Importing 1 of 2: BEC_20ft.tif
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.tif Import Complete... | 14
-----
Importing 2 of 2: BEC_DEM.tif
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.tif 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
-----
Close
```

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Once a projection is defined, then you can Add a New Terrain. The Terrain will be created from input terrain models. This is how it works.

1. You decide on the Name and location to store the data and the name is used to create a GeoTIFF of each of the input files
2. You specify the Priority for using the terrain files (highest is most important).
3. You provide the Rounding Precision and as the GeoTIFF is built the data is rounded, compressed, and tiled.
4. The data is projected (if necessary)
5. A "Terrain.hdf" file is created that manages the data as one layer. Within Terrain.hdf file there is also information which includes triangulation of the data across boundaries if multiple terrain models or holes in the data exist.

An output dialog provides the status of the GeoTIFF import process.



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



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The file format that HEC-RAS has adopted for raster data is the GeoTiff file format. This file format allows for efficient data storage and some benefits that assist in data visualization.

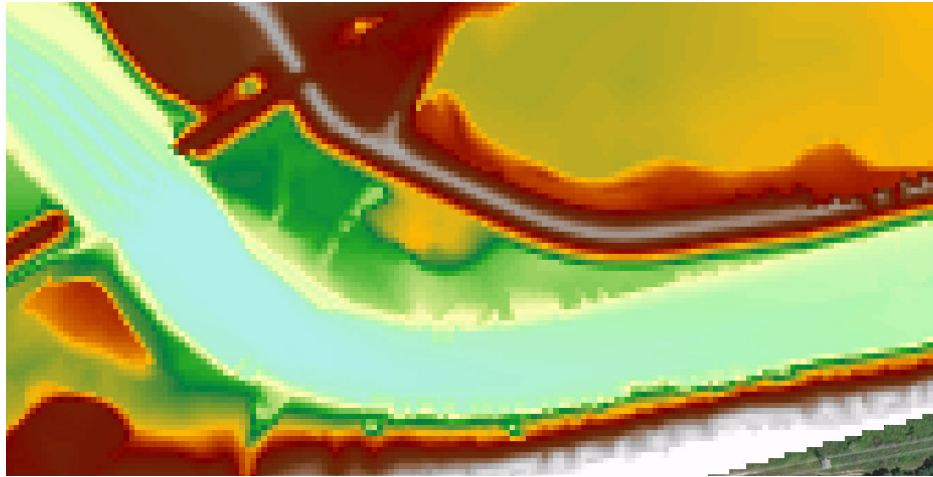
1. The data is compressed for smaller file size. Smaller file size means faster read/write times. (For example 46 tiles of 13GB compresses to 2.3GB)
2. Pyramids allow for fast visualization based on a particular zoom level. For instance, if you are zoomed out, there is no need to render the entire dataset, just a resample version that matches the number of pixels on your screen. Because RAS is only plotting the number of cell values corresponding to the number of pixels on the screen, RAS can use the pyramiding to do on-the-fly map generation. No need to store depth grids – just generate what the user wants.

RAS manages multiple terrain model files as one 1 layer within RAS (we'll talk about that in the coming slides).

No file size limitations! – the library used for reading GeoTiffs has been modified to read BigTIFF.



Raster Cell Size

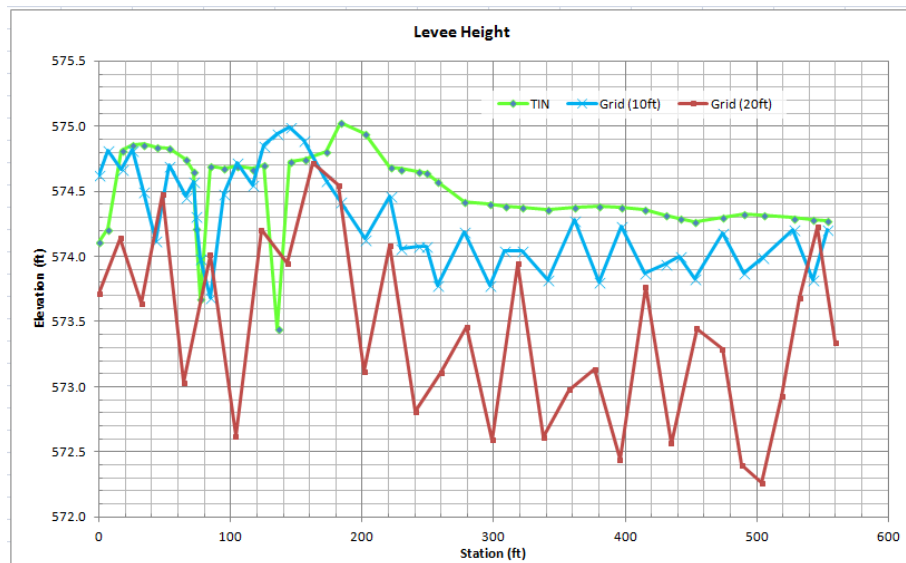


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This slide shows various resolutions of grid cells used to represent the ground surface. What resolution allows for definition of the levee? 100, 50, 20, 10 ft?



Raster Cell Size

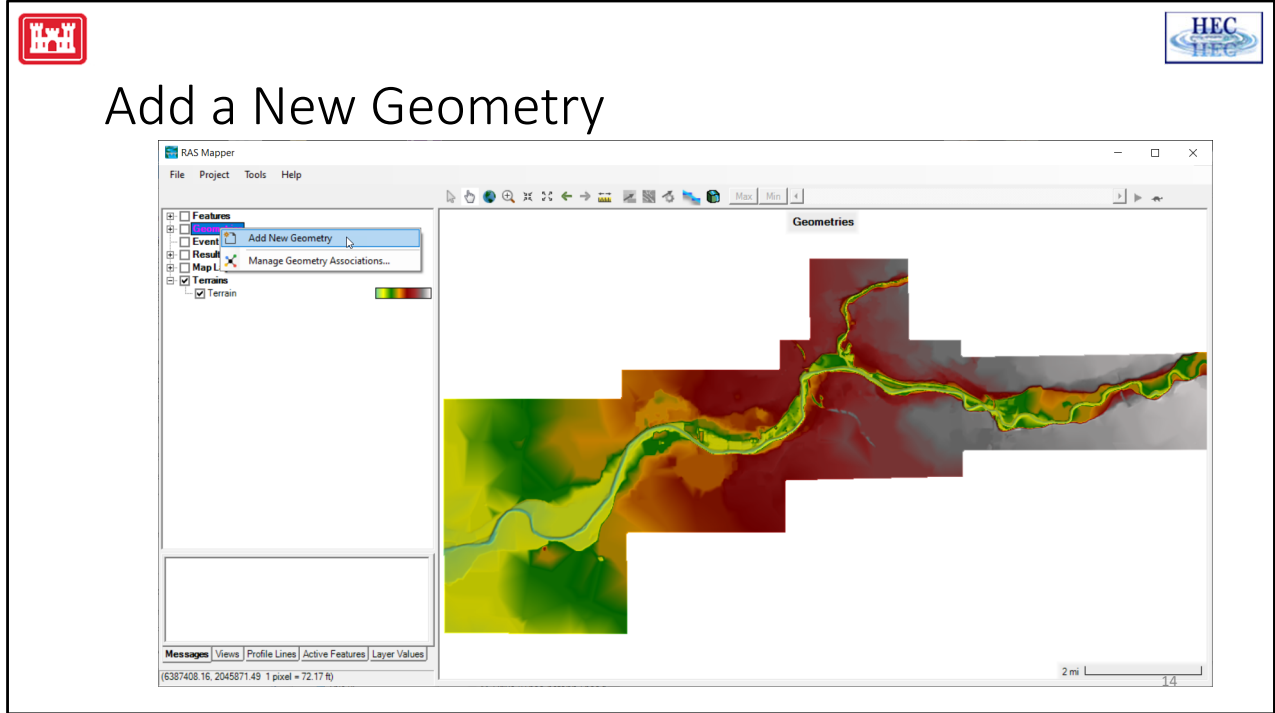


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If we take a profile line along the top of levee we can see the affect of the terrain model on the resulting data. The green line is the data taken from the TIN, the blue line from a grid with 10ft spacing, and the red line a 20ft grid. If we use the levee line from the 20ft spacing the levee will be overtopped 2ft lower!



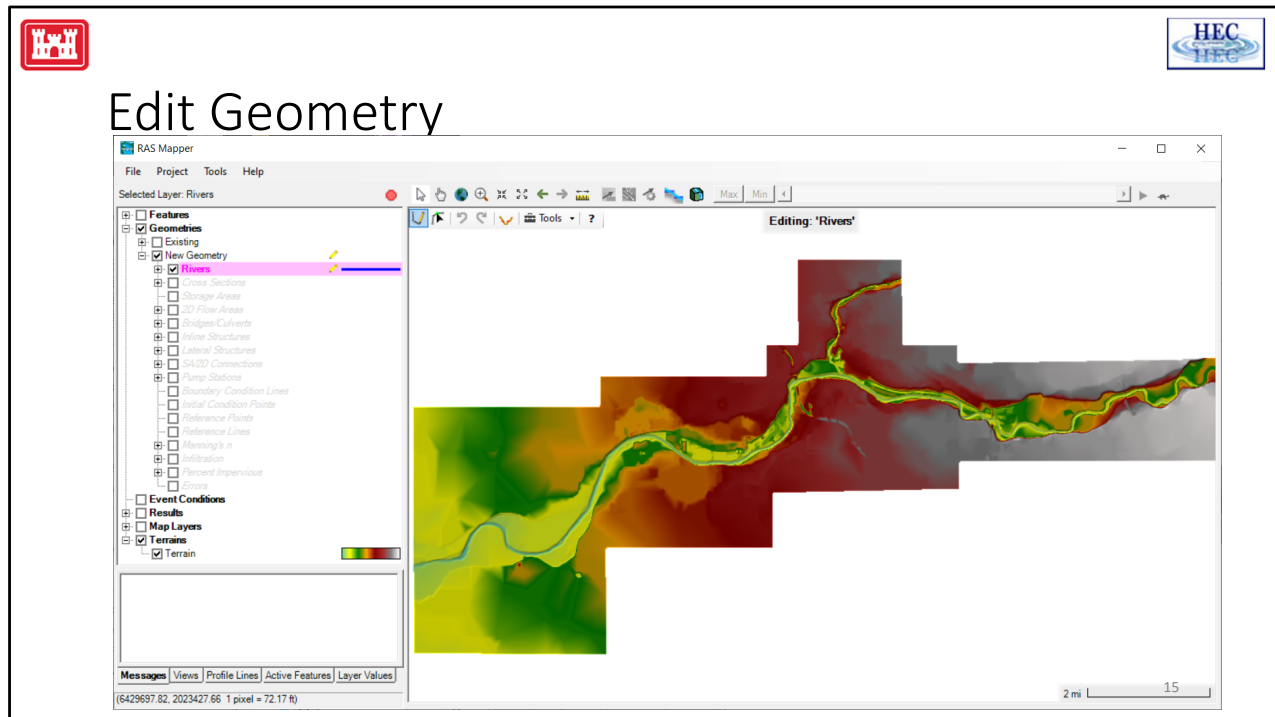
Add a New Geometry



Add a new Geometry to RAS Mapper by right-clicking on Add New Geometry.



Edit Geometry



Once the Geometry is added, start editing by selecting the Geometry or a RAS Layer, right-clicking and choose start editing.

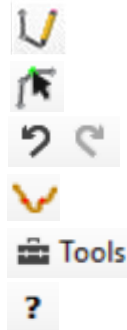
Once an editable layer is selected, the Edit Toolbar will become available.



Editing Toolbar



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



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Add New -Adds a new feature. Left-click to Add a point. Double-click to Finish editing the feature.

Select/Edit Feature - Select features by left-clicking and dragging. Double-click on a selected feature to Open a feature to start editing. Double-click to stop editing (Close) an open feature.

Insert a point with a left-click near the line.

Move a point by left-click on a point and drag.

Delete a point by selecting it and pressing the Delete key.

Undo - Undo the last edit operation.

Redo - Redo the last edit operation

Plot Profile - Plot the elevation profile under the selected feature.

Tools - There are many edit operations that will work on the selected set.

Copy, Paste and **Delete** Feature options are available.

Reverse Feature will reverse the order of the points in a line feature.

Merge Feature will combine the selected features. For line features, this tool is very robust, but for polygon features, the polygons must overlap.

Clip - Preserve will clip against overlapping polygons, preserving the selected feature. (Polygons must intersect.)

Clip - Discard will clip against overlapping polygons, discarding the overlapping portion of the selected feature. (Polygons must intersect.)

Buffer Polygon will enlarge or shrink the selected feature by the buffer value.

Filter will filter the points on a feature given a user tolerance. The Douglas-Peucker filtering algorithm used throughout RAS is implemented with this tool.

View/Edit Points will bring up a dialog with all of the points in the feature. You can then modify the points in the table.

Help -Opens an interactive help dialog to give the user quick tips on the editing options.

Additional Options

Right-click to re-center the Map View on the cursor.

Hold the Shift key to Pan or use the middle mouse button to Pan.

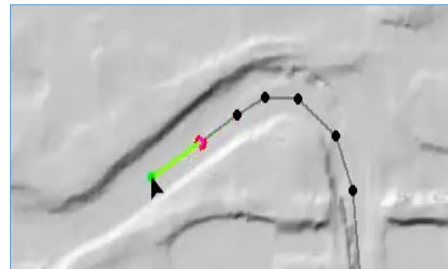
Use the Tab key to switch between Add New and Edit Feature

modes.



Add New

- 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 or using the Shift key.



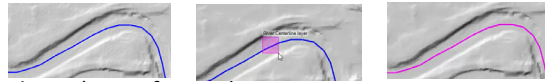
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Edit / Select

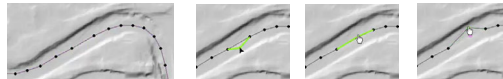
- Edit / Select Tool

- **Select feature(s)**
and then



- **Double-click** to Start Editing (Open feature)

- **Edit**
(move,
add points,
delete, etc).



- **Double-click** to End Editing (Close feature)

- Mouse hover indicates action

- **Green** point indicates: Move, Insert, Delete point

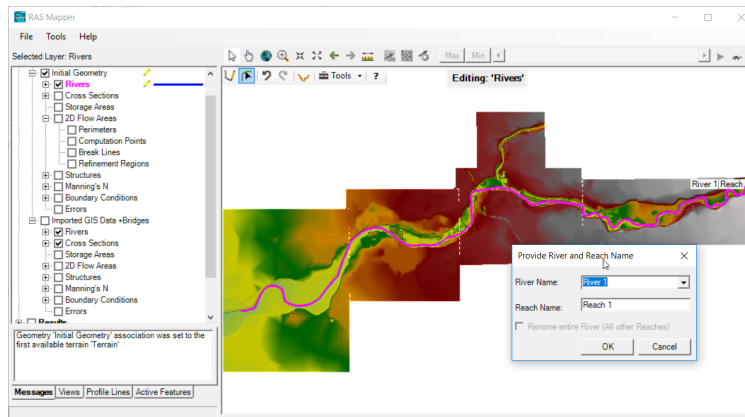
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In order to edit a feature, it must be “open for editing”. This is done by double-clicking the feature. Once the selected feature is opened, the feature will be drawn with the Editor Symbology, defined in the **Editor Options**. Typical editing operations such as inserting, moving and deleting points can then be performed on the open feature through a left click. To perform operations such as deletion on multiple points, perform a selection using click-drag and then press the Delete key. To finish editing a feature, double-click off of the feature to close it.



Create River Network

- Rivers created downstream to upstream
- Provide a unique River Reach name



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To create the river network, select the Rivers layer.

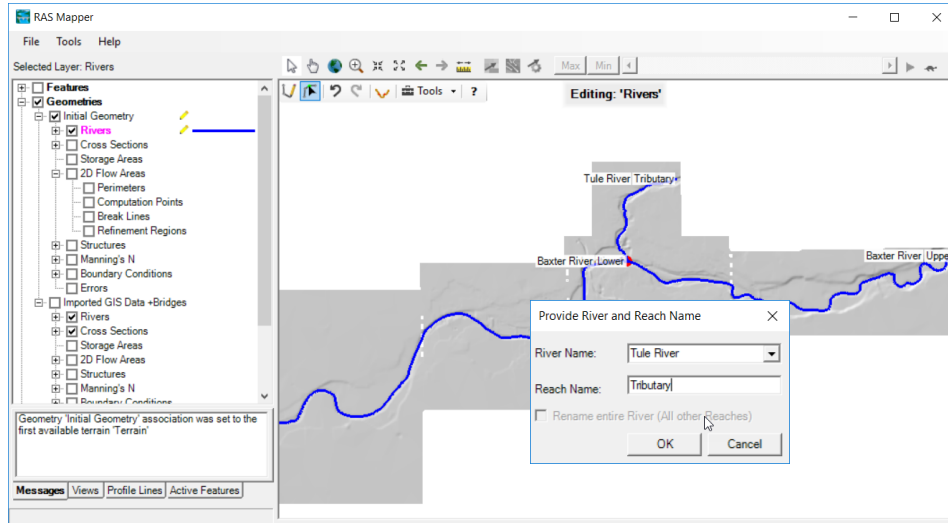
Then start laying out the river using the editing tools. Use the Add New tool to add the River. When finished you will need to provide a unique River and Reach name.

If you want to modify the line, use the Select/Edit tool to move and add points.

Once the river is complete, double-click to stop editing.



Tributaries

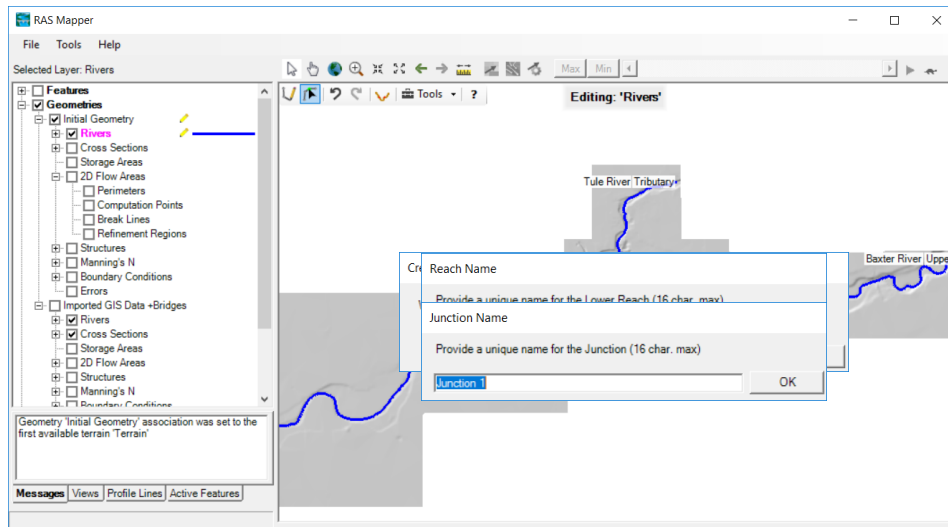


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Add a tributary to the river network, just as you'd add any other river. Create it and provide a name



Junctions



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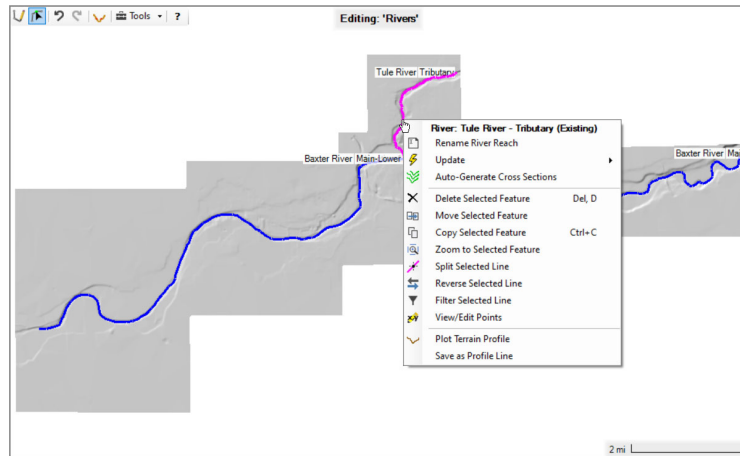
If the river ends on (or very near) another river, you will be asked if you'd like to split the river and create a junction. If you do split the river, you will be asked for a downstream reach name to differentiate it from the upstream reach. By default the reach will have a “-Lower” appended to the reach name.

After providing a reach name, you will be asked to provide a name for a new junction (that was automatically created for you).



Additional River Options

- Rename River Reach
- Copy/Paste
- Reverse
- Filter
- Merge



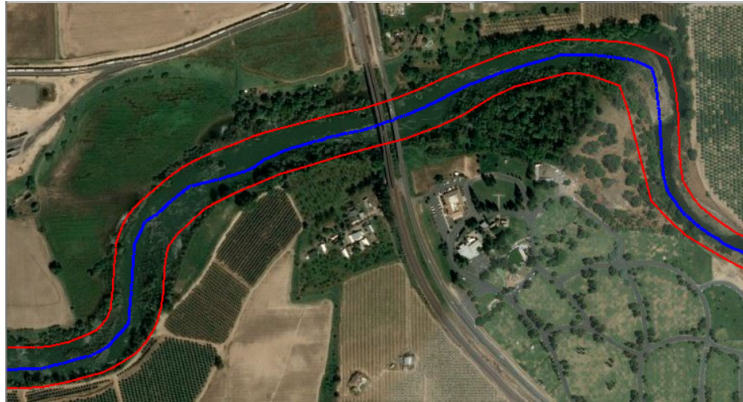
22

There are additional editing options available for each river reach. For instance, you'd like to rename it, or merge multiple reaches, filter, etc. These options are available through a context menu by right clicking on the line. Many of these options are also available by clicking on the Tools menu.



Bank Lines

- Bank lines are used to establish Bank Stations on the Cross Sections
- Identify the main channel from overbanks



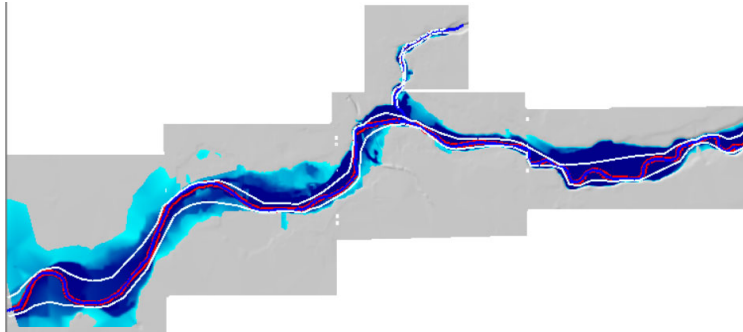
23

Bank lines are created to define the main channel from the overbank areas. The location of these lines can be defined by the high ground that defines the main channel or by using aerial photos if good terrain data are not available.



Flow Path Lines

- Flow path lines are used to compute reach lengths between cross sections
- Only left and right are needed, river line is used for main channel reach length
- Iterative approach needing an understanding of floods



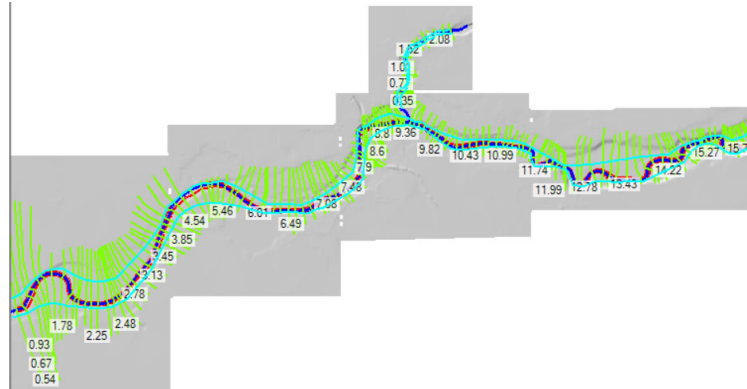
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Flow path lines are used to compute reach lengths for the left and right overbank. The river centerline is used to compute the reach length for the main channel. If flow paths are not provided, RAS will use the main channel lengths for the left and right. Flow path lines are created by identifying the center-of-mass of flow in the overbanks. Sometimes you don't know where that is, therefore, an iterative approach may be necessary to create them appropriately. This is done by using a flood inundation map for reference and then inferring where the center-of-mass of flow would travel.



Cross Sections

- Use the Terrain, River, Bank Lines, Flow Path Lines and other background data to lay out cross sections



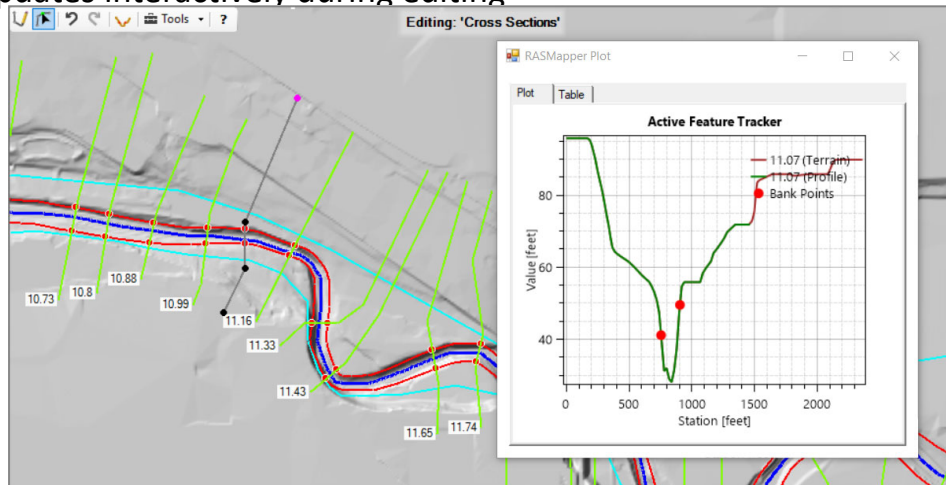
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Properly laying out cross sections requires you to evaluate the terrain data under various flow conditions so that the cross sections can be perpendicular to flow at all flow conditions. You must also evaluate how the flow will transition down the river from location to location. Using the Terrain layer, Bank Lines, Flow Path Lines, along with aerial imagery and historic floodplains data will greatly assist in identifying cross section locations and layout.



Profile Plot

- Updates interactively during editing



The profile plot allows you to see the terrain profile along a line. When editing a cross section, the profile plot will automatically update.



Cross Sections

- Information is extracted from the intersection of the Cross Sections Layer with other RAS Layers
- River, Reach, River Station
- Bank Stations, Reach Lengths

FID	Feature	Count	Length	River	Reach	River Station	Node Name	Node Descriptors	Length LOB	Length Channel	Length ROB	Left Bank	Right Bank	Stationing Offset
0	PolylineXY	3	1267.33032147	Baeter River	Upper	15.06			232.6	815.3	641.6	1232.4	1494.7	0
1	PolylineXY	6	2566.583901075	Baeter River	Upper	15.91			448.2	446.1	152.7	823	1548.5	0
2	PolylineXY	5	2593.545819825	Baeter River	Upper	15.82			263	132.4	112.2	558.5	739	0
3	PolylineXY	3	2699.845291110	Baeter River	Upper	15.79			400.7	398.4	403.3	628.6	807.4	0
4	PolylineXY	3	2889.687888290	Baeter River	Upper	15.71			402.4	364.8	138.1	669.9	985.8	0
5	PolylineXY	5	2766.771181957	Baeter River	Upper	15.64			601.7	679	411.7	516.6	902	0
6	PolylineXY	4	2659.762651450	Baeter River	Upper	15.52			110.4	201.9	244.3	570	928.9	0
7	PolylineXY	5	2630.395344202	Baeter River	Upper	15.48			527.5	481.9	151.9	518.7	863.8	0
8	PolylineXY	5	2299.023341603	Baeter River	Upper	15.39			419.4	320.3	109.8	135.9	378.8	0
9	PolylineXY	4	2461.678773288	Baeter River	Upper	15.33			279.9	287.2	288.5	260.1	437	0
10	PolylineXY	4	2362.734154857	Baeter River	Upper	15.27			314.8	251.4	115.5	217.2	417.3	0
11	PolylineXY	5	2423.736709126	Baeter River	Upper	15.22			450.7	799.7	180	373.3	611.9	0
12	PolylineXY	4	2429.740271661	Baeter River	Upper	15.07			238.9	495	693.4	992.9	1341.3	0
13	PolylineXY	3	2124.555028310	Baeter River	Upper	14.98			240.9	424.2	451.6	1098.2	1313.5	0

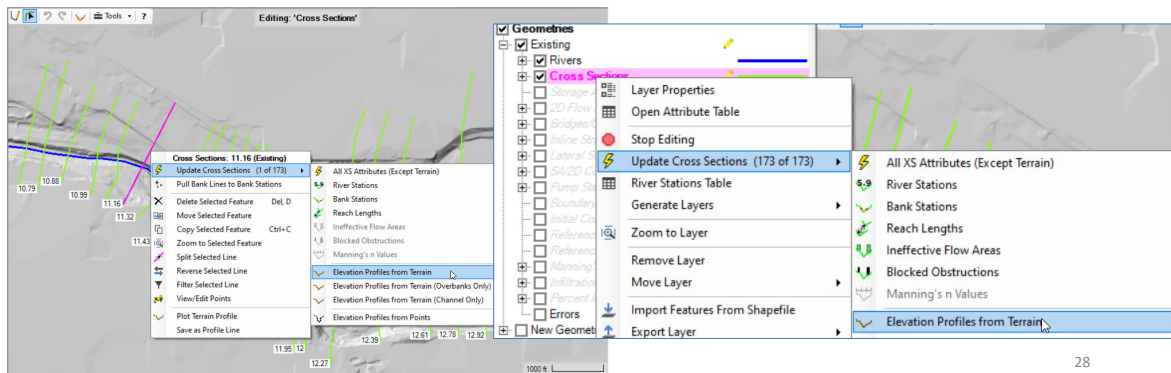
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Information extracted from RAS Mapper is stored on the Cross Section layer in an attribute table. Some information are in text fields that you can read and access (though best not to overwrite data unless you KNOW what you are doing). Other data will be stored as a blob that cannot be accessed by the user.



Cross Section Updates

- Cross Section information **AUTOMATICALLY** updates while it is a **NEW** cross section.
- **EXISTING** cross sections must be **MANUALLY** updated.
- Cross sections are new when created until the edit session it was created in is closed.



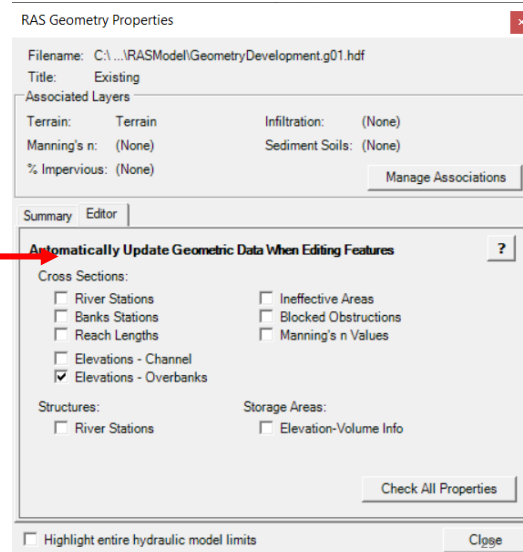
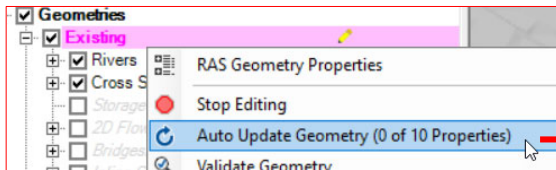
Cross section information is automatically updated by RAS Mapper each time you make an edit. Once you have save your edit session, however, the data is treated as existing and is not updated. This is to keep you from accidentally overwriting information on the cross section that should not be changed. For instance, you may have supplemented the channel data with new surveyed data in the Cross Section editor and you don't want data reextracted from the terrain model!

You can update information manually either for the Selected Set of cross sections or for all of the cross sections. You can choose to update just one parameter (like reach lengths) or all of them.



Cross Section Updates

- Auto Update Option

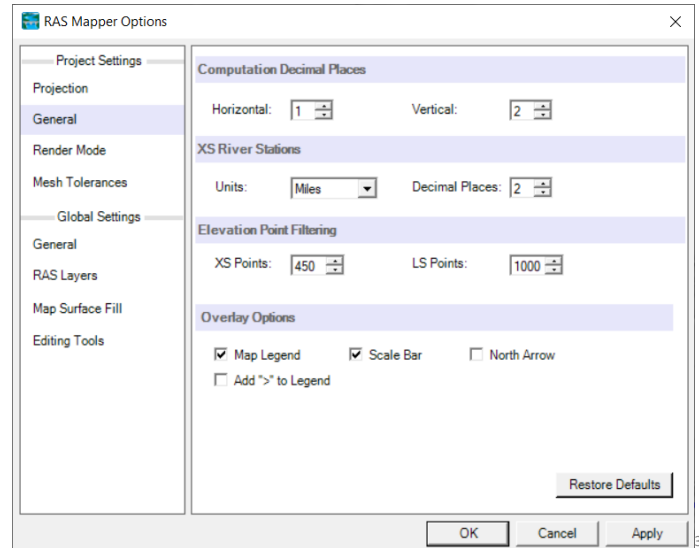


If you would like your data to always be kept “up to date” you can choose the “Auto Update Geometry” option. It will update everything every time you make a change to one of the RAS Layers. If you only want to update a specific parameter, you can turn on just that option by accessing the RAS Geometry Properties dialog and enabling those data you want updated.



Cross Section Options

- River Station Units
- Points Filter



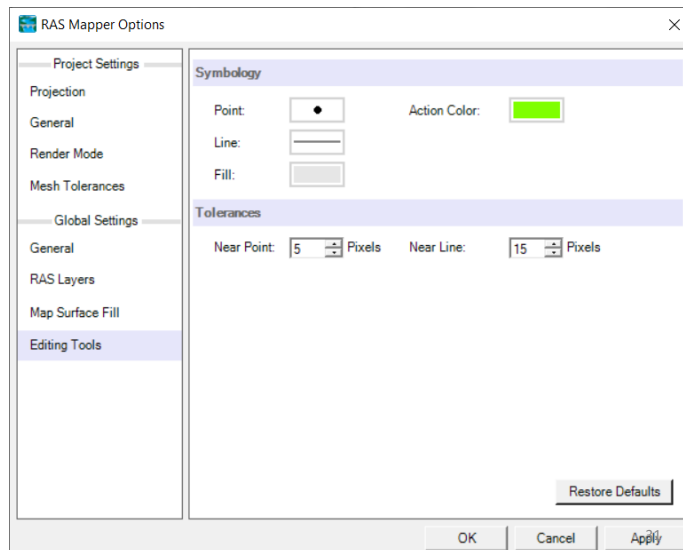
The XS River Station Units allows you to either set the unit for the river stations on the cross sections. If you are in an EDIT session when you change the units and press the OK button, the river stations FOR ALL CROSS SECTIONS will automatically be computed in the selected units (to the number of decimal places specified). If you are NOT in an Edit session, then the next time the river station for a cross section is computed, the “new” unit option will be used. However, RAS will always make sure that the computed river station makes sense (for instance, a cross section will not be assigned a value of 1.5 between two cross sections that already have a station of 5280 and 10,400).

The Points Filter option reduces the number of points that are stored for the cross section after extracting the station-elevation data. There is a limit of 500 points in HEC-RAS for all cross section elevation points (and parameter data), so the default number is 450.



Editing Options

- Symbology
- Tolerance



The default Editing Symbology is tried and true, but if you want to change it, it is done on the Editing Tools tab of the Options menu.

The default Action color is bright green – green means go. This color is intended to inform you that something will happen if you perform a mouse click.

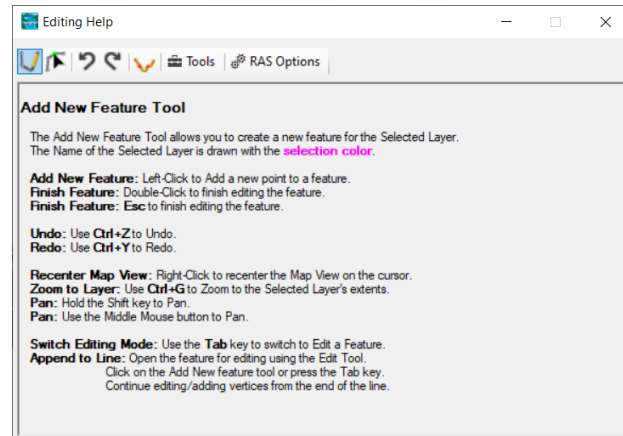
The Near Point Tolerance is the distance the mouse pointer needs to be from an point to select it. 5 pixels is the defaults. I don't think you will ever want to change this.

The Near Line Tolerance is the distance the mouse points needs to be from a line. As the mouse gets with the tolerance, a new point can be inserted. This option is ideal for refining a line during digitizing. You may want to make this tolerance much larger; however, the default value is 15.



Help

- Toolbar provides quick access to a help summary. Click on a tool to understand how it works.



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There is a dynamic help window available on the Editing Toolbar. It will give you a quick summary of how to use the tools and might have a few informative tricks.



Handy Features

- Tab – switch between Add and Edit modes
- Spacebar + Click – change selected layer
- Ctrl + Click – add to selected set
- Middle Mouse – Pan
- Shift – Pan
- Wheel – Zoom In/Out
- Right Click – Re-centers window to mouse while digitizing a line

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There are some handy feature in the editing tools in RAS Mapper. These are some that I use all the time!

Tab – switch between Add and Edit modes (only while editing)

Spacebar + Click – change selected layer (only while editing, a feature cannot be open for editing)

Ctrl + Click – add to selected set

Middle Mouse – switch to Pan mode

Shift – switch to Pan mode

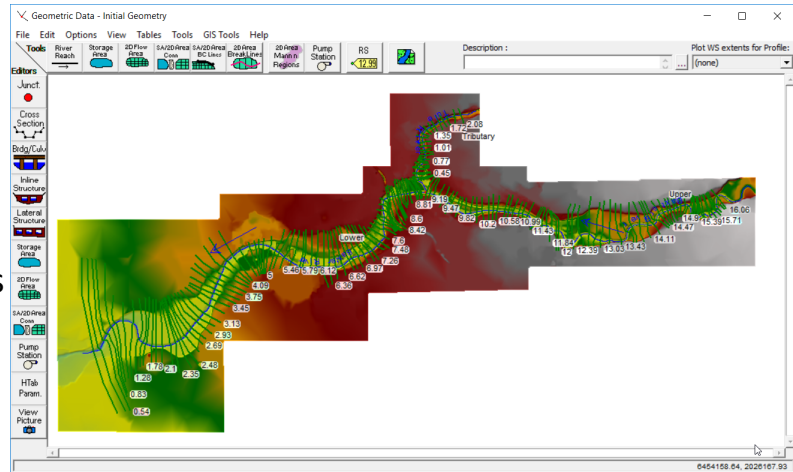
Wheel – Zoom In/Out

Right Click – Re-centers window to mouse while digitizing a line



Finish HEC-RAS Data

- Open the geometry
- Review Cross Sections
- Complete data such as Hydraulic Structures



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After you have completed your edits in RAS Mapper, go to the Geometric Data Editor and open the geometry of interest. From there, you will need to complete the data that was not finished in RAS Mapper. Hydraulic structures and associated data need to also be completed.

Questions?



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