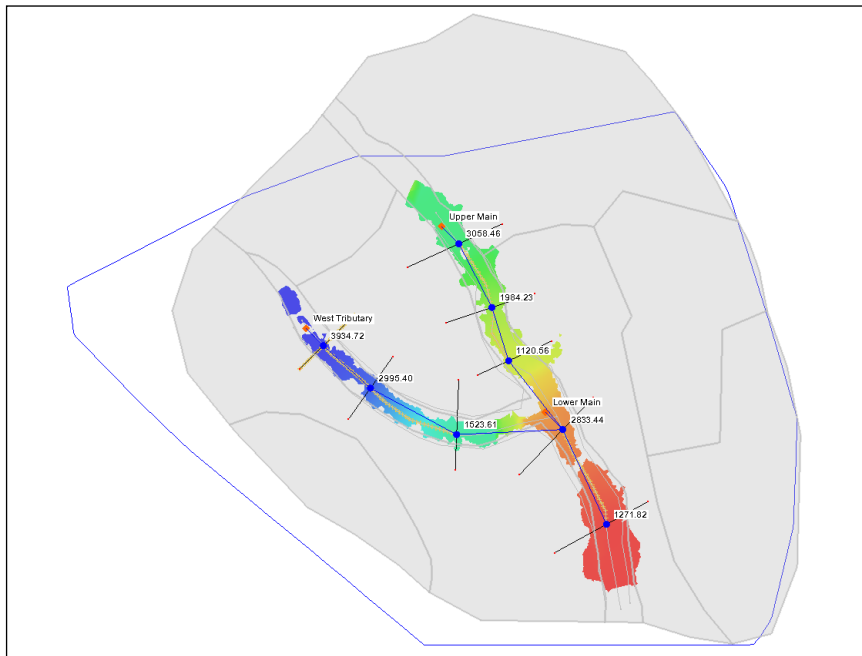


WMS 11.0 Tutorial **HEC-RAS Analysis**

Learn how to setup a basic HEC-RAS analysis using WMS



Objectives

Learn how to build cross sections, stream centerlines, and bank lines in a conceptual model format. Cut cross sections from digital elevation data, define Manning's roughness polygons, and assign conceptual model data to a HEC-RAS model. Export and run a HEC-RAS model and read and view the results from the WMS interface.

Prerequisite Tutorials

- Images
- Basic Feature Objects
- DEM Basics
- Using TINs

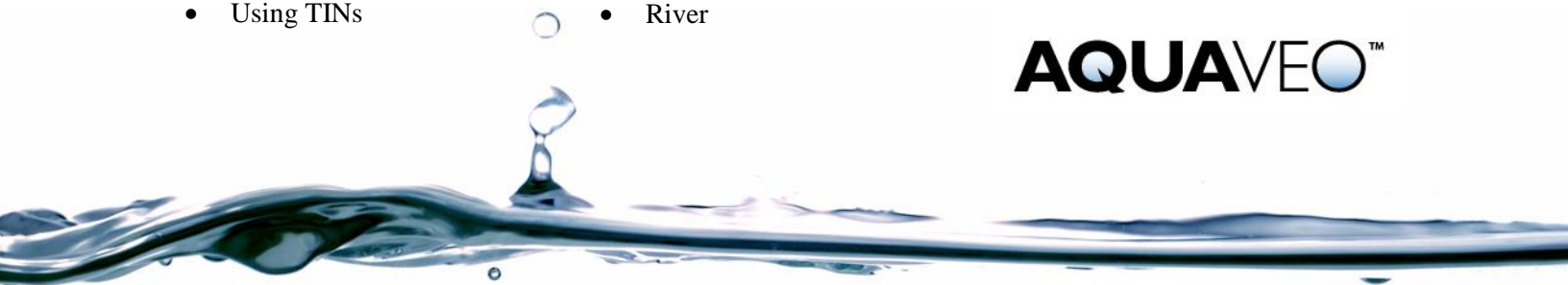
Required Components

- Data
- Drainage
- Map
- River

Time

- 20–40 minutes

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1 Introduction





HEC-RAS was developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center. HEC-RAS performs a step backwater curve analysis for either steady state or transient conditions to determine water surface elevations and velocities. This exercise will cover how to use the WMS River tools to construct a HEC-RAS steady flow model. This includes the following:

- Preparing the conceptual model
- Mapping the conceptual data to a hydraulic model representation
- Running the simulation within HEC-RAS
- Viewing results in WMS

2 Preparing the Conceptual Model

The first step to creating a HEC-RAS model is to create a conceptual model which defines the river reaches (layout and attributes), the position of cross sections on those reaches (orientation and station values), bank locations, and material zones. The conceptual model will be used to create a network schematic inside the Hydraulic Modeling Module.

A conceptual model has been started, defining the display projection, background image, and scattered bathymetric (elevation) data in the form of a TIN. The centerlines and bank arcs have also already been defined and set up in the appropriate coverage.

1. Open WMS. If WMS is already open select *File / New* then click **No** if prompted to save changes.
2. Select *File / Open*  to bring up the *Open* dialog.
3. Browse to *hecras\hecras* and select “analysis.wms”
4. Select **Open** to close the *Open* dialog.
5. Right-click on “ New” under “ Terrain Data” in the Project Explorer and select  **Display Options** to open the *Display Options* dialog.
6. On the *TIN* tab, uncheck *Unlocked vertices* (it may already be unchecked), *Triangles*, and the *TIN Contours* toggle boxes.
7. Ensure that the *Boundaries* box is checked.
8. Select **OK** to close the *Display Options* dialog.

2.1 Creating Land Use / Materials Coverage

One of the properties HEC-RAS uses is roughness values. It is necessary to designate materials to different areas of the model, then assign each material a roughness value. The material zones are stored in WMS as an Area Property coverage.

1. Select *Edit / Materials...* to open the *Materials Data* dialog.
2. Click the **New** button to create a new material.
3. Rename the new material as “River”. This is also where the colors and patterns for each material may be chosen, as shown in Figure 1 below. To change the pattern, click on the color of the material to open the *Pattern Attributes* dialog.

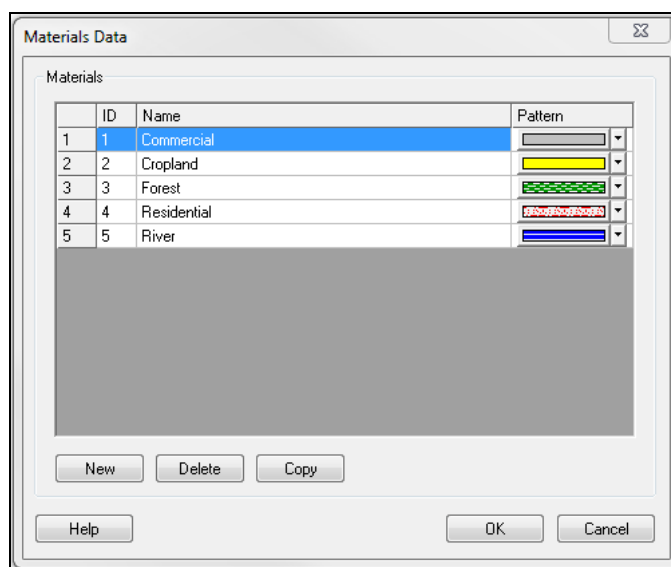


Figure 1 Materials Data headings

4. Select **OK** to close the *Materials Data* dialog.
5. Make sure the newly created coverage, “Materials”, is active in the Project Explorer.

Having defined all the materials, it is now necessary to assign a material type to each polygon in the “Materials” coverage.

6. Select the **Select Feature Polygon** tool.
7. Double-click on the polygon that defines the river area (see Figure 2). This will open the *Land Poly Atts* dialog.
8. Set the *Polygon Type* to *Material* and choose “River” from the drop-down list.
9. Select **OK** to close the *Land Poly Atts* dialog.

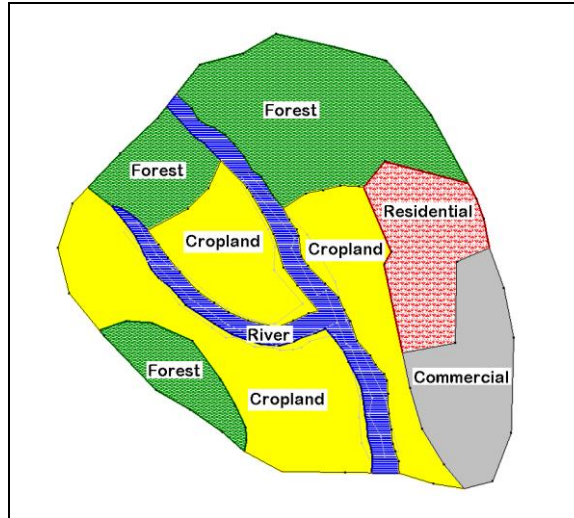




Figure 2 Materials used in HEC-RAS simulation

2.2 Creating the Cross Sections

HEC-RAS associates most of its model data with cross sections and generates solutions or output at the cross sections. Therefore, cross sections are the most important part of the map. HEC-RAS requires at least two cross sections on each reach. To create the cross sections:

1. In the Project Explorer, click on “ ID-Hyd Cross Section” to activate the coverage.
2. Select the **Create Feature Arc**  tool.
3. Create a cross section near the top of the leftmost reach by clicking a point on one side of the reach then double-clicking a point on the other side of the reach as shown in Figure 3.

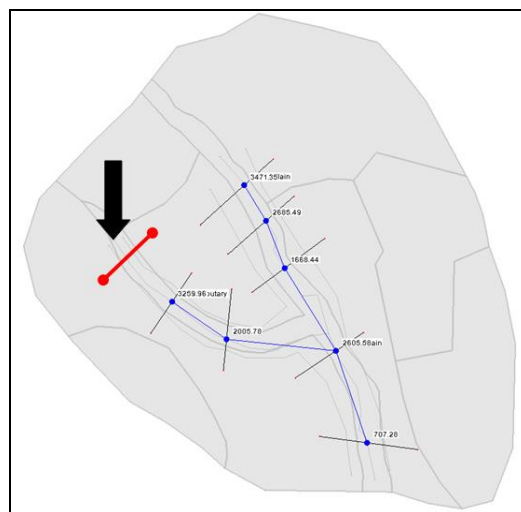


Figure 3 Cross section coverage

2.3 Extracting Cross Sections


In the cross section coverage, all arcs are cross section arcs. Their position and orientation define the location of the cross sections in the system, but as of yet, they do not have any data assigned. The next step is to assign elevation data, materials, and point property locations to the cross sections. This information will be extracted from the TIN, the area property coverage, and the centerline coverage. To extract this data:

1. Select *River Tools* / **Extract Cross Section...** The *Extract Cross Sections* dialog will appear.

WMS will extract an elevation point at every triangle edge along the cross section arc. The default extraction settings are to use the centerline coverage to generate point properties and the area property coverage to define material zones.

2. Select **OK** to accept the defaults and close the *Extract Cross Sections* dialog.

Each cross section arc now stores a link to a cross section database record which contains xyz data, materials properties, bank locations, and thalweg locations. To view and edit the information at a cross section:

3. Choose the **Select Feature Arc**  tool.
4. Double-click on any cross section. This brings up the *River Cross Section Attributes* dialog.
5. Click on the **Assign Cross Section** button. This brings up the *Assign Cross Section Profile* dialog, which is used to view the current cross section shape and select a different cross section from a cross section database if desired.
6. Click on the **Edit** button. This brings up the *Cross-Section Attributes* dialog. This dialog can be used to view and/or edit the properties of the cross section.
7. Click on the *Line Props* tab to view the materials that are assigned to the cross section.
8. Click on the *Point Props* tab to view the locations of the left bank, right bank, and thalweg.
9. Select **Cancel** to close the *Cross-Section Attributes* dialog.
10. Select **Cancel** to close the *Assign Cross Section Profile* dialog.
11. Select **Cancel** to close the *River Cross Section Attributes* dialog.

For this exercise, the cross sections were extracted from a TIN, but for a project it is often necessary to edit a cross section, or merge surveyed cross sections and perform other editing procedures. This is the topic of a separate [tutorial](#) and therefore is not covered in detail here.

3 Creating the Network Schematic

WMS interacts with HEC-RAS using a HEC-GeoRAS geometry file. This file contains the cross sectional data used by HEC-RAS in addition to three dimensional georeferencing data. To create this geometry file, the conceptual model must be converted to a network schematic diagram in the River module. To convert the conceptual model to a network schematic:

1. Set the active coverage to “ 1D-Hyd Centerline” by clicking on it in the Project Explorer.

2. Select *River Tools / Map* → **1D Schematic**.

The screen should appear similar to Figure 4.

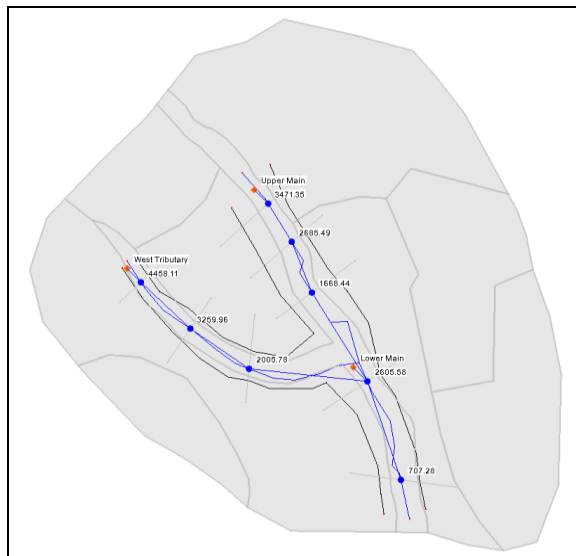



Figure 4 Schematic diagram

Now WMS includes two separate representations of the data. The first is created as a conceptual model, which is stored as a series of coverages. The second is a numeric model stored as a schematic of cross sections organized into reaches. Modifications to the network schematic that can be used by HEC-RAS can be made directly in the Hydraulic Modeling Module, or indirectly by editing the conceptual model in the Map module and mapping to a new network schematic.

HEC-RAS needs Manning's roughness values for the materials found in the cross section database. The roughness values are stored as part of the 1D model in the River module. To specify the roughness values for the each of the materials:

3. Switch to the **Hydraulic Modeling Module** .
4. Select *HEC-RAS / Material Properties...* The *Hecras Material Properties* dialog will appear.
5. Enter the roughness values for each material as shown in Figure 5.

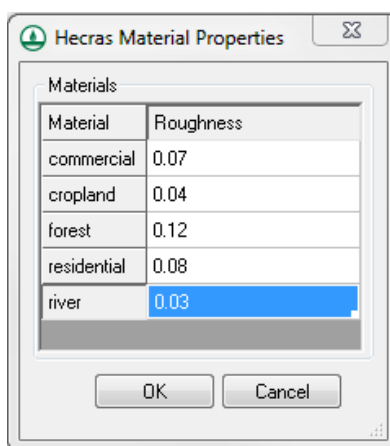


Figure 5 HEC-RAS Material Properties dialog

6. Select **OK** to exit the *Hecras Material Properties* dialog.

The next step is to tell HEC-RAS which set of line properties in the database should be used as material types. To do this:

7. Select *HEC-RAS / Model Control...* to open the *HEC-RAS Model Control* dialog.
8. From the *Roughness* drop-down, select “Materials”. This is the line property name that stores the roughness values for the cross section database.
9. Select **OK** to close the *HEC-RAS Model Control* dialog.

4 Creating the HEC-RAS Project File

1. Select *HEC-RAS / Export GIS File...* to open the *Enter a filename to save an HEC-RAS project file* dialog.
2. Name the file “hecras.prj” and select **Save** to close the *Enter a filename to save an HEC-RAS project file* dialog.
3. Select **Yes** to overwrite existing files, if prompted.

After saving out the HEC-RAS project file, WMS automatically opens the HEC-RAS application and loads the project.

5 Using HEC-RAS

Within HEC-RAS, setup and run the simulation and then export the results for post-processing in WMS. The setup will include entering junction lengths, specifying flow values, and assigning river boundary conditions.

1. In HEC-RAS, select *Edit / Geometric Data...* to open the *Geometric Data* dialog.

The screen should appear similar to Figure 6.

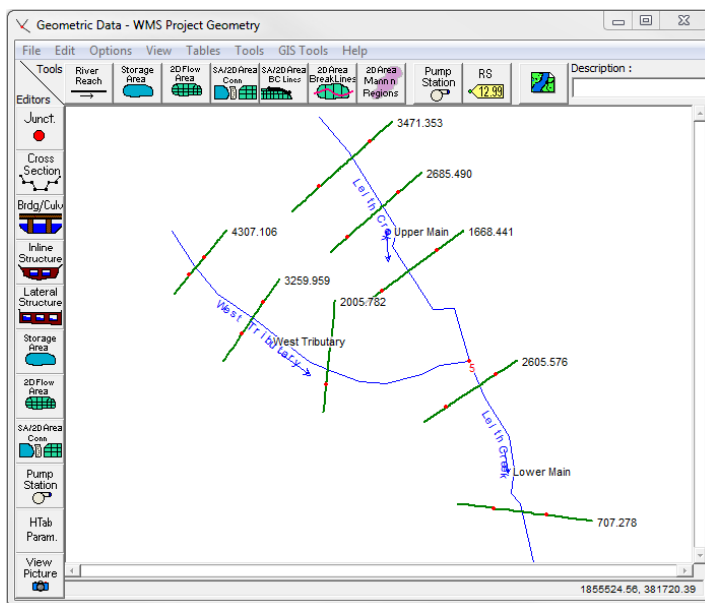




Figure 6 Geometric Editor in HEC-RAS

In the case that an excessive number of points are extracted from the cross section arcs, HEC-RAS has a tool that will filter points that are too close together to run an analysis. Since there are many data editing tools available within HEC-RAS in addition to the filtering tool, simply be aware of such tools and browse the HEC-RAS user's manual for more information if needed.

2. Click on the node (junction) that joins the West Tributary and Upper Main reaches.
3. Select **Edit Junction ...** from the pop-up menu to open the *Junction Data* dialog.

The Junction Length value should be entered as the distance stretching across the junction between adjacent cross sections. Measure these lengths with the Measure tool in WMS.

4. Activate the WMS window.
5. Switch to the **Map Module** .
6. Choose the **Measure Tool** .
7. As shown in the example in Figure 7 below, click along the lines to trace the distance along the centerline arc between the most downstream cross section arc on the West Tributary reach and the most upstream cross section arc on the Lower Main reach. Double click to end the measurement. Note the length displayed in the lower left hand corner of WMS for future use.

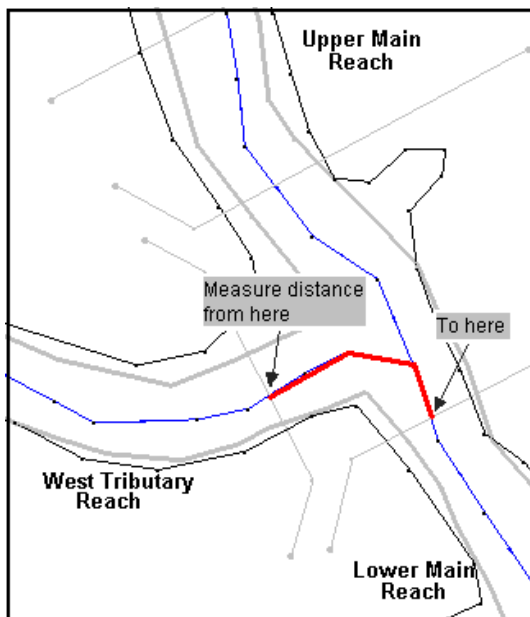


Figure 7 Measuring Junction Lengths

8. Revert back to the HEC-RAS *Junction Data* dialog.
9. Enter the measured length in the *Junction Length (ft)* field corresponding to the “To: West Tributary – West Tributary” row.
10. Repeat these steps to measure and enter the Junction Length between the most downstream cross section arc on the Upper Main reach and the most upstream cross section arc on the Lower Main reach.
11. Once finished entering both lengths, select **OK** to close the *Junction Data* dialog.
12. Select **File / Exit Geometry Data Editor** to close the *Geometric Data* dialog.

The next step is to define the flow and boundary conditions for the reaches. To define this information:

13. Select *Edit / Steady Flow Data...* to open the *Steady Flow Data* dialog.
14. For Profile 1 (PF 1), enter 4000 for Upper Main; enter 5000 for Lower Main; enter 1000 for West Tributary.
15. Click on the **Reach Boundary Conditions** button to open the *Steady Flow Boundary Conditions* dialog.

For the analysis, have HEC-RAS compute normal depths at the boundaries of the model. To do this:

16. Click on the empty cell in the *Leith Creek* row, under the *Upstream* column.
17. Click on **Normal Depth** to bring up the *HEC-RAS* dialog.
18. Enter 0.003, and press **OK** to close the *HEC-RAS* dialog.
19. Repeat steps 16-18 to enter the slopes for the last two reaches. Note that the empty cell for the “Lower Main” reach falls under the *Downstream* column. Enter 0.001 for “Lower Main” and 0.005 for “West Tributary”.
20. Select **OK** to close the *Steady Flow Boundary Conditions* dialog.
21. Click the **Apply Data** button in the *Steady Flow Data* dialog.
22. Select *File / Exit Flow Data Editor* to close the *Steady Flow Data* dialog.

It is necessary to set flow distribution locations so that velocity profiles can be computed, before running the simulation. To set this option and perform the analysis:

23. Select *Run / Steady Flow Analysis* to open the *Steady Flow Analysis* dialog.
24. Select *Options / Flow Distribution Locations* to open the *Set Locations for Flow Distribution* dialog.
25. Change the *Set Global SubSections* to 3 for each of the three fields (LOB, Channel, and ROB).
26. Select **OK** to exit the *Set Locations for Flow Distribution* dialog.
27. Click the **Compute** button. This runs the 1D analysis
28. Close the *Steady Flow Analysis* dialog
29. Exit out of the HEC-RAS program and save information, if prompted.


6 Post-Processing

Now that HEC-RAS has computed water surface elevations, it is possible to read the solution into WMS. The water surface elevations are read in as 2D scatter points and can be used to perform a floodplain delineation. To read the solution:



1. In WMS, switch to the **Hydraulic Modeling Module** .
2. Select *HEC-RAS / Read Solution*.

Notice that a new scatter point file has been read into WMS. These points contain the water surface elevations computed by HEC-RAS. Since eight cross sections were used in the model, there are only eight scatter points with which to perform the floodplain delineation.



WMS has a tool that interpolates scatter points along centerline and cross section arcs which achieves more accurate floodplain delineation.

3. Select the “ 1D-Hyd Centerline” coverage from the Project Explorer.
4. Select *River Tools* / **Interpolate Water Surface Elevations** to open the *Interpolate Stages* dialog.

Note that *hecras* is selected as the *Scattered dataset*. In this case, it is the only scatter dataset available. But if there were multiple datasets, specify which one to use for the interpolation.

5. For the *Create a data point* option, choose “At a specified spacing” from the drop-down.
6. Enter 60 for the *Data point spacing*.
7. Select **OK** to close the *Interpolate Stages* dialog.
8. Select the “ 1D-Hyd Cross Section” coverage from the Project Explorer.
9. Select *River Tools* / **Interpolate Water Surface Elevations** to open the *Interpolate Stages* dialog.
10. Select **OK** to close the *Interpolate Stages* dialog.
11. Switch to the **Terrain Data Module** .
12. Select *Flood* / **Delineate** to open the *Floodplain Delineation* dialog.
13. Make sure *Search radius* is checked on, and enter 1000 for the *Max search radius*.
14. Make sure *Quadrants* is checked on, and enter 4 for the *Number of stages in a quadrant*.
15. Select **OK** to close the *Floodplain Delineation* dialog.

WMS now computes two new datasets corresponding to floodplain depths and water surface elevations (river bed elevation and flood depth).

16. Select the dataset named “ W.S. Elev-PF 1_wl” in the Project Explorer.
17. Select *Display* /  **Display Options** to open the *Display Options* dialog.
18. Under the *TIN* tab, turn on *TIN Contours* and choose the **Options** button to open the *elevation (elev) Contour Options* dialog.
19. Choose “Color fill” under *Contour Method*.
20. Under *Data Range*, select *Specify a Range*.
21. Deselect *Fill below* and *Fill above*.
22. Select **OK** to exit the *elevation (elev) Contour Options* dialog.
23. Select **OK** to close the *Display Options* dialog.

These color-filled contours, shown in Figure 8, represent the varying water surface elevations in the computed floodplain. For more information and practice on floodplain delineation, see [Floodplain Delineation](#).

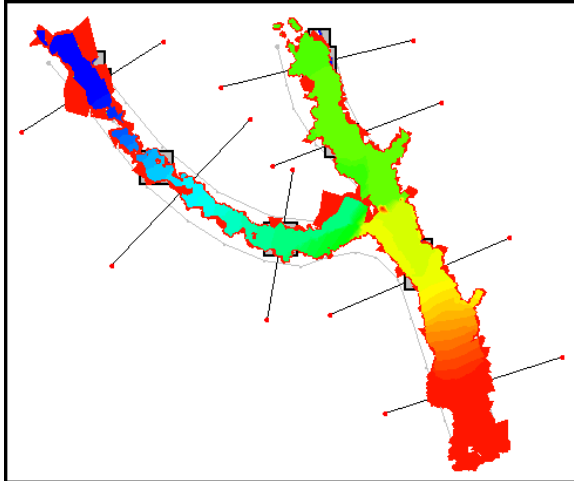


Figure 8 Resulting TIN from the floodplain delineation.

7 Conclusion

This concludes the WMS HEC-RAS Analysis tutorial. This exercise showed how to use WMS River Tools to construct a HEC-RAS steady flow model. As part of this process, the following was show:

- Preparing a conceptual model
- Mapping the conceptual data to a hydraulic model representation
- Running the simulation within HEC-RAS
- Viewing the results in WMS