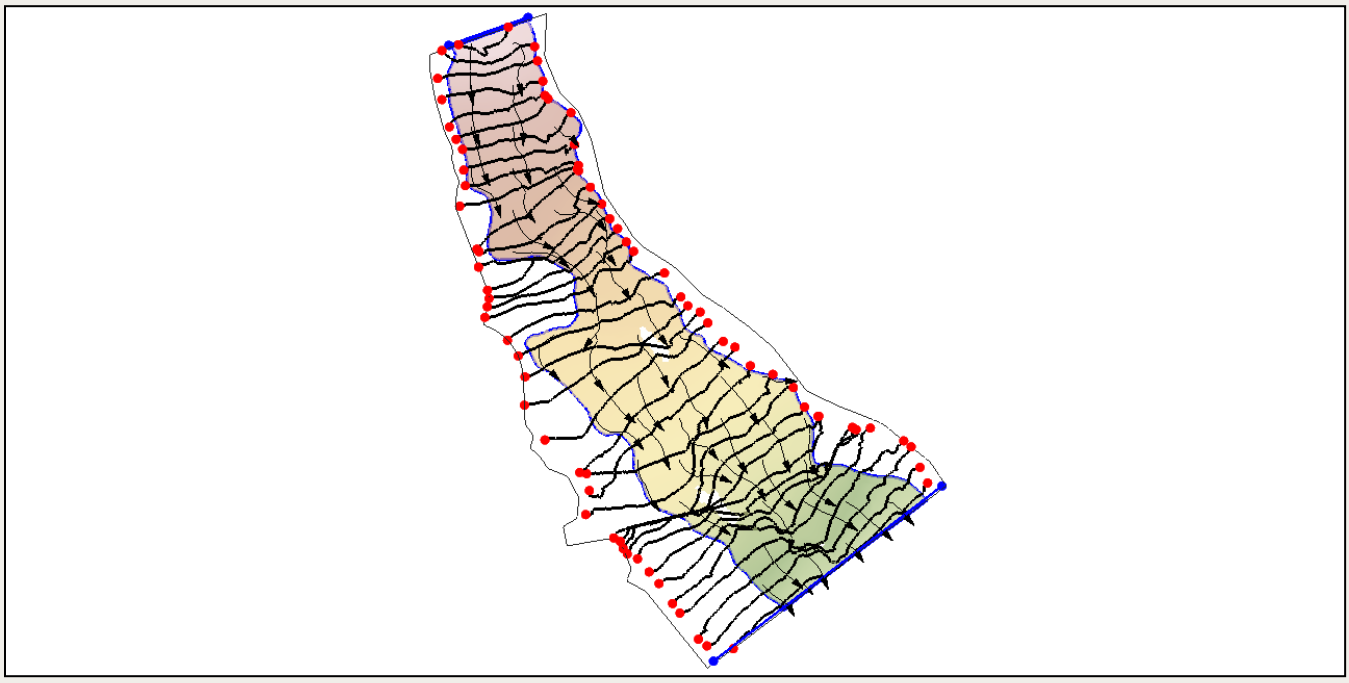
SMS 13.3 Tutorial

Floodway Delineation Using Unit Flow Rates

Defining a floodway using unit flow rates



Objectives

Learn to define a floodway corridor using unit flow rates.

Prerequisite Tutorials

- Overview
- Map Module
- Mesh Generation
- SRH-2D

Required Components

- SMS Core
- SRH-2D Model & Interface

Time

- 10–15 minutes
- Additional 15 minutes model run time

1 Introduction

A floodway is defined by the Federal Emergency Management Agency (FEMA) as:

> The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.[1]

This tutorial demonstrates a method for delineating a floodway in SMS using computed unit flow rates. These flow rates are computed from a hydraulic simulation containing water depth and velocity magnitude datasets. All input data can be found in the *data file*s folder for this tutorial. (Multiple methods for defining floodways have been investigated. Others are illustrated in separate tutorials.)

In the first section of the tutorial, a candidate floodway corridor will be defined using SRH-2D result datasets from an unconstrained 2D simulation.

To determine the impact of constraining flow to the defined corridor, a floodway simulation will be derived from the original simulation consisting of a new materials coverage and boundary condition coverage.

A comparison of the water levels, using floodway tools developed in SMS will then be set up to illustrate evaluation of the floodway.

2 Getting Started

To begin the tutorial, import the project files.

1. Launch SMS. If it is already launched, press *Ctrl*+*N* to reset to the default settings.
2. Select *File* | **Open…** to bring up the *Open* dialog.
3. Select “Project Files (*.sms)” from the *Files of type* drop-down.
4. Browse to the *data files* folder for this tutorial and select “Elkhorn.sms”.
5. Click **Open** to import the project into SMS.

The project should appear similar to Figure 1. This project includes an SRH-2D simulation with results datasets.

[1] See https://www.fema.gov/floodway for more details.

When creating a floodway, care should be taken to ensure that the simulation has reached a converged, steady state condition.

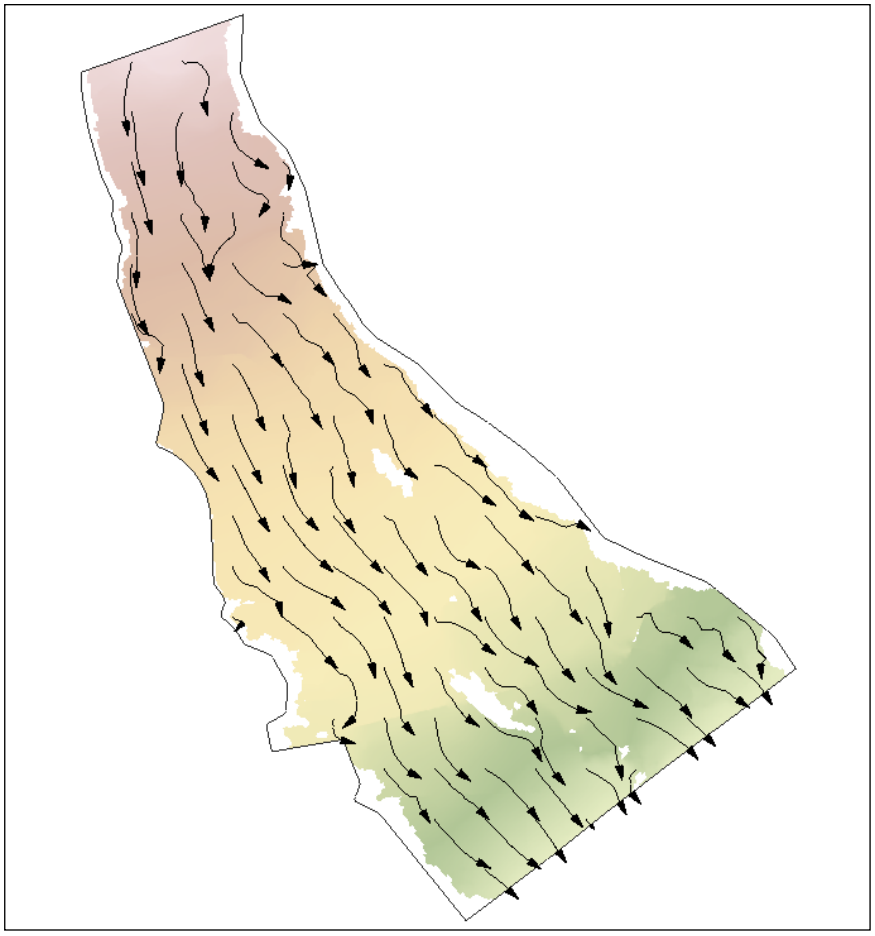


Figure 1 Initial project

3 Creating a Candidate Floodway

The first step is to use the Floodway tool to generate a new coverage containing the floodway corridor. This method of floodway delineation does not require a centerline; however, it can make use of bank arcs in a centerline coverage to require that the floodway include the channel. Also, for consistency of workflow with the other floodway approaches, the command is accessed by right-clicking on a centerline coverage. To define a candidate floodway corridor:

1. Right-click "1D-Hyd Centerline" and select **Floodway…** to bring up the *Floodway* dialog (Figure 2).
2. In the *Floodway method* combo box select the "Unit Discharge Method" option.
3. Click **Select…** to the right of *Geometry* to bring up the *Select Tree Item* dialog.
4. Select "Elkhorn" from the list and click **OK** to close the *Select Tree Item* dialog.
5. In the *Unit Q method* combo box select the "Specify depth and velocity" option.

The process creates a “Unit_q” dataset that can be used in subsequent iterations of the process. In those iterations, the “Specify unit Q” option will be used.

6. Click **Select…** to the right of *Depth* to bring up the *Select Tree Item* dialog.
7. Select “Water_Depth_ft” under “Q100 (SRH-2D)” in the list and click **OK** to close the *Select Tree Item* dialog.
8. Click **Select…** to the right of *Velocity magnitude* to bring up the *Select Tree Item* dialog.
9. Select “Vel_Mag_ft_p_s” under “Q100 (SRH-2D)” in the list and click **OK** to close the *Select Tree Item* dialog.
10. Click **Select…** to the right of *Material Coverage* to bring up the *Select Tree Item* dialog.
11. Select “Mats” from the list and click **OK** to close the *Select Tree Item* dialog.
12. Enter “5.0” cfs/ft as the *Threshold* of unit flow.

Regions with this flow rate or higher will be conglomerated to form a flow corridor. The value will be determined based on a trial-and-error approach.

13. Leave the *Smoothing* option set to “Complex smoothing” and click **OK** to close the *Floodway* dialog and create the new floodway coverage.

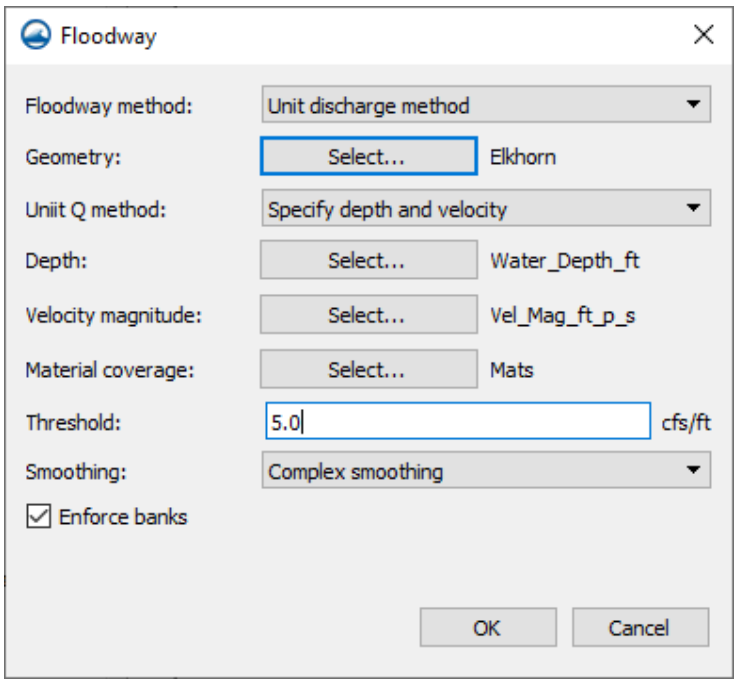


Figure 2 Floodway dialog with unit flow options.

14. When it appears, select “Floodway Unit Q = 5.00” to make it active.

SMS has now computed the floodway corridor by computing the unit flow rate (depth X velocity) and enclosing the region with a unit flow rate higher than the specified threshold. This region is smoothed and modified to enforce that the main channel is included. This is illustrated by the floodway following the bank arc on the left side of the channel.

SMS has also created a new coverage named “Floodway Materials”. This consists of the input materials coverage, trimmed to the floodway corridor. The region outside

the corridor is outside of all material polygons, so this becomes inactive or off in subsequent simulations which use this material coverage.

The project should appear similar to Figure 3.

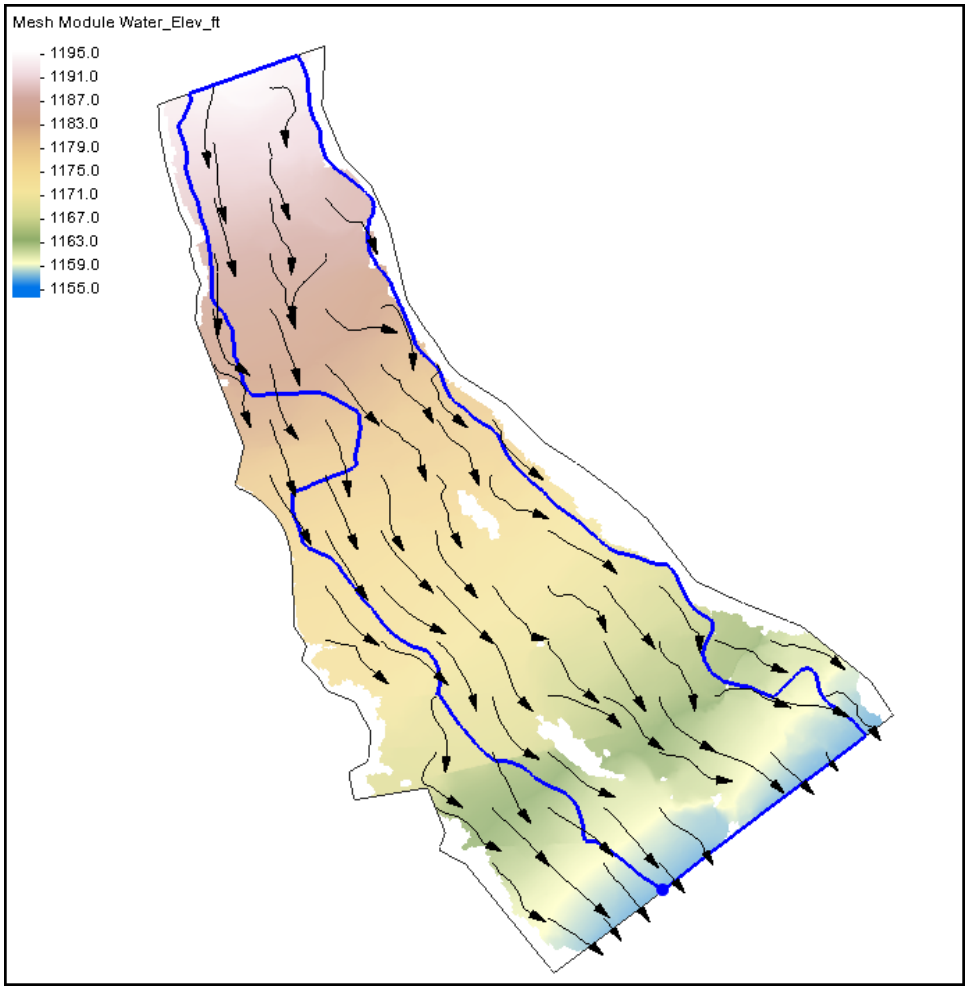


Figure 3 Computed candidate floodway corridor with the "Water_Elev_ft" dataset active

4 Creating a Floodway Simulation

SMS can create a new simulation in order to evaluate the proposed floodway. This also creates a new boundary condition coverage to reflect the raised water level. To create the new simulation:

1. Right-click on the "Q100" simulation and select *Tools* | **Generate Floodway Simulation (Beta)** to open the *SRH2D Generate Floodway Simulation* dialog.
2. Click **OK** to accept the default value of 1.0 ft for the *WSE Maximum Rise* for the floodway simulation and close the *SRH2D Generate Floodway Simulation* dialog and open the *Generate SRH-2D Floodway Simulation* dialog.

At this time, SMS gives a warning/error message that an error occurred updating the boundary condition value. This is because the existing boundary condition coverage uses a rating curve to determine the water level at the outflow boundary. The tool currently does not include the capability to create a modified rating curve for the

constrained domain. This requires manual attention which is illustrated later in this tutorial.

3. Click **OK** to close the warning message in the *Generate SRH-2D Floodway Simulation* dialog.

What the tool has created include:

- A new simulation named "Q100 (Floodway)" which is a duplicate of the original "Q100" simulation with adjustments made.
- A new BC coverage named "BC Q100 (Floodway)" which is a copy of the "BC Q100" coverage and is included in the new simulation. Any specified water level boundaries in the original coverage are offset by the specified water level rise.

4.1 Correcting the Floodway Boundary Coverage

As noted above, the conversion of the downstream boundary condition to reflect the raised water level of the floodway failed when the "BC Q100 (Floodway)" coverage created was not successful implemented.

To convert the downstream boundary condition for the simulation from a rating curve to a specified depth, do the following:

1. Select "BC Q100 (Floodway)" to make it active.
2. Using the **Select Feature Arc** tool, double-click on the upstream (inflow) boundary condition arc to open the *SRH2D Assign BC* dialog.
3. Click on the **XY Series…** button to open the *XY Series Editor* dialog.

View the specified boundary condition. Note that the flow rate for the floodway computation is 86,000 cfs.

4. Click **Cancel** to close the *XY Series Editor* dialog.
5. Click **Cancel** again to close the *SRH2D Assign BC* dialog.
6. Using the **Select Feature Arc** tool, double-click on the downstream (outflow) boundary condition arc to open the *SRH2D Assign BC* dialog.
7. Click on the **XY Series…** button to open the *XY Series Editor* dialog.

View the specified boundary condition. Scroll down to note the water level associated with a flow rate of 86,000 cfs, which is approximately 1156.7 ft.

8. Click **Cancel** to close the *XY Series Editor* dialog.
9. Change the *Water surface (WSE) option* to "Constant".
10. For *Constant wse*, enter "1157.7" ft. This reflects an increased water level for the constricted floodway.
11. Click **OK** to accept the change and close the *SRH2D Assign BC* dialog.

4.2 Associating the Floodway Materials Coverage with the Simulation

The floodway simulation was created without a material coverage. However, the creation of the floodway corridor created that coverage. This coverage needs to be associated with the simulation.

To do this:

1. Right-click on "Floodway Materials" and select *Apply to* | **SRH-2D Simulations → Q100 (Floodway)**.

The new simulation is now ready to run.

4.3 Running SRH-2D

Now to run the "Q100 (Floodway)" simulation:

1. Right-click on "Q100 (Floodway)" and select **Save Project, Simulation and Run**.
2. Click **Yes** when asked to renumber the "Floodway Materials" coverage.

The *Simulation Run Queue* dialog will appear.

3. Monitor the progress of the simulation using the various plot options.

Completion time will vary depending on computer speed. In most cases, it will take about 15 minutes.

4. When SRH-2D finishes, review the plots to ensure that convergence was reached (the flux across inflow and outflow lines match and are steady) and then click **Load Solution** to import the solution into SMS.
5. Click **Close** to exit the *Simulation Run Queue* dialog.

The new datasets should appear in the "Q100 (Floodway) (SRH-2D)" folder under the "Elkhorn" mesh in the Project Explorer.

5 Evaluating the Impact of the Floodway

The concept of a floodway requires that the resulting change of water level not exceed a specified amount. In this case, 1 ft was assumed.

5.1 Adjusting the Display

Before continuing, change the contour display.

1. Select the "Mesh Module to make it active.
2. Click the **Contour Options** macro to open the *Display Options* dialog with the *Contours* tab open.
3. Click the **Label Options** button to open the *Contour Label Options* dialog.
4. Turn on *Automatic labels* under the *Settings* sections.
5. In the *Settings* section, change the drop-down menu to be "One label per contour".
6. Click **OK** to close the *Contour Label Options* dialog.
7. Click **OK** to close the *Display Options* dialog.

5.2 Generating Floodway Cross Sections

With the advent of 2D hydrodynamic models, FEMA and several other U.S. governmental agencies have been discussing how to evaluate water level rise in a consistent fashion. One consideration is to represent a similar situation simulated in a 1D model.

This approach uses cross sections through the floodway and evaluates average rise on each cross section. One approach that has been proposed is to generate cross sections at even intervals of water level. The SMS interface includes a new (beta) tool to perform this operation. To do this:

1. Right-click on the "Q100 (Floodway)" simulation and select *Tools* | **Generate Hydraulic Evaluation Lines (Beta)** to open the *Generate Floodway Evaluation Lines* dialog.
2. Leave off the *Intersect contours with centerline* option. This option only includes cross sections that cross the centerline.
3. Click **Select…** to the right of *Water surface elevation dataset* to bring up the *Select Tree Item* dialog.
4. Select "Water_Elev_ft" under "Q100 (SRH-2D)" in the list.

This is used as the base floodplain elevation so that the cross sections span the entire floodplain.

5. Click **OK** to close the *Select Tree Item* dialog.
6. Review the rest of the input (they can be left at default) and click **OK** to close the *Generate Floodway Evaluation Lines* dialog.

SMS generates a new coverage named "Floodway Evaluation Lines". This can be used to create a summary table comparing the floodplain water levels and speeds to the floodway water levels and speeds.

5.3 Creating a Floodway Comparison Table

The following steps generate a table comparing the floodway simulation to the base floodplain simulation:

8. Right-click on the "Q100 (Floodway)" simulation and select *Tools* | **Compare Simulation Data (Beta)** to open the *Compare Simulation Data* dialog..

Note that the geometry (mesh) options are defaulted to the mesh in the current simulation. These can be left as specified. If there is a different geometry for either the floodplain or the floodway, they can be used.

9. Click **Select…** to the right of *Base WSE dataset* to bring up the *Select WSE Dataset* dialog.
10. Select "Water_Elev_ft" under "Q100 (SRH-2D)" in the list and click **OK** to close the *Select WSE Dataset* dialog.

This is the base floodplain elevation.

11. Click **Select…** to the right of *Base vel mag dataset* to bring up the *Select Velocity Magnitude Dataset* dialog.

12. Select "Vel_mag_ft_p_s" under "Q100 (SRH-2D)" in the list and click **OK** to close the *Select Velocity Magnitude Dataset* dialog.

This is the base floodplain velocity magnitude.

13. Click **Select…** to the right of *Revised WSE dataset* to bring up the *Select WSE Dataset* dialog.
14. Select "Water_Elev_ft" under "Q100 (Floodway) (SRH-2D)" in the list and click **OK** to close the *Select WSE Dataset* dialog.
15. Click **Select…** to the right of *Revised vel mag dataset* to bring up the *Select Velocity Magnitude Dataset* dialog.
16. Select "Vel_mag_ft_p_s" under "Q100 (Floodway) (SRH-2D)" in the list and click **OK** to close the *Select Velocity Magnitude Dataset* dialog.
17. Click **Select…** to the right of *Cross-section coverage* to bring up the *Select Cross Section Coverage* dialog.
18. Select "Floodway Evaluation Lines" in the list and click **OK** to close the *Select Cross Section Coverage* dialog.
19. Click **OK** to close the *Compare Simulation Data* dialog and generate the comparison table in the *Compare Floodway Simulation Data* dialog that appears.

This table lists all of the cross sections with the average values for water elevation and velocity magnitude from both simulations and the maximum and average differences between these values. Note that the average difference in water surface elevation at the downstream end where the new boundary condition has been enforced is 0.96 ft, matching the imposed 1 ft rise. For the other cross sections, the change in water level varies from 0.113 ft, mostly on the upstream end of the reach, up to 1.716 ft where the floodway is the narrowest.

Feel free to review the results using the data visualization tools. For more details on using these tools in SMS, see the "Observation" and "Data Visualization" tutorials.

At this point, the candidate floodway can either be accepted or rejected.

New candidates for the floodway could be created by either changing the unit flow threshold used to create the floodway, or manually editing the shape of the floodway.

6 Conclusion

This concludes the "Floodway Delineation Using Unit Flow Rates" tutorial. Feel free to experiment with creating additional floodway candidates and evaluating their behavior.

When done experimenting with the SMS interface, exit the program.