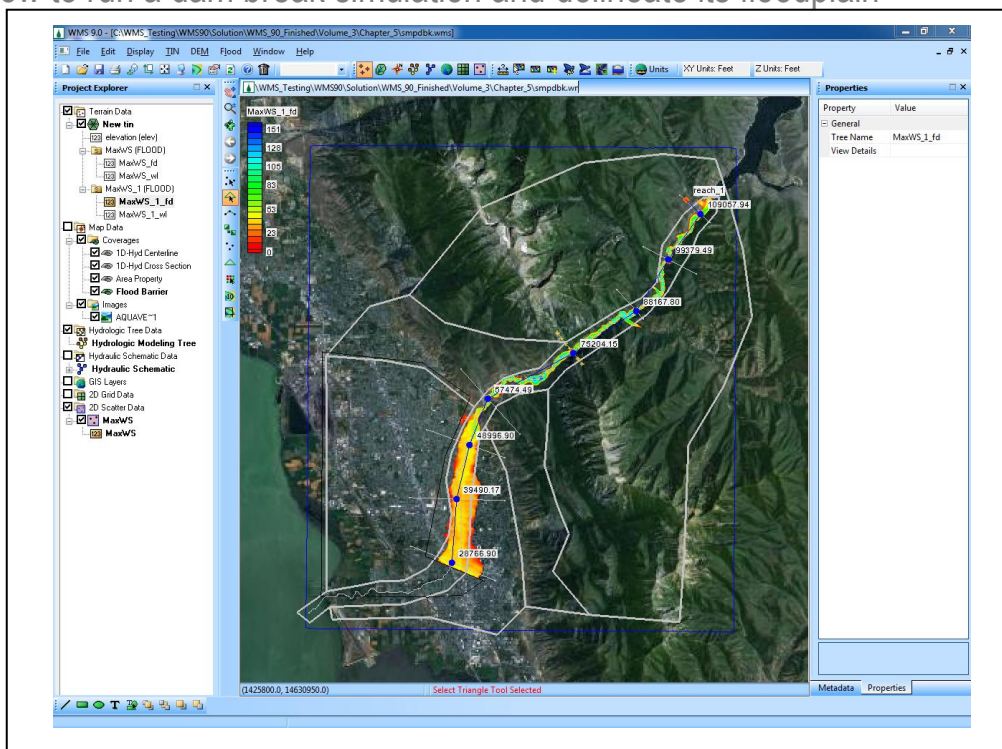


## WMS 10.1 Tutorial

# Hydraulics and Floodplain Modeling – Simplified Dam Break

Learn how to run a dam break simulation and delineate its floodplain



## Objectives

Setup a conceptual model of stream centerlines and cross sections for the simplified dam break (SMPDBK) model. Export the conceptual model to SMPDBK and run the analysis code. Read the results back into WMS and delineate the floodplain to determine the impact of the dam break.

## Prerequisite Tutorials

- Introduction – Images
- Introduction – Basic Feature Objects
- Editing Elevations – DEM Basics
- Editing Elevations – Using TINs

## Required Components

- Data
- Drainage
- Map
- River

## Time

- 30-60 minutes

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## 1 Introduction

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Simplified Dam Break (SMPDBK) is a model that does just what its name says—it models dam failures using simplified methods. One alternative to using SMPDBK is to use sophisticated dam break models such as the National Weather Service’s (NWS) DAMBRK model. These models require extensive data, time, and computing power. When these data or resources are not available, SMPDBK can be used to create a “quick and dirty” solution to the flood depths downstream of a dam failure. By combining the SMPDBK results with the floodplain delineation and display capabilities of WMS, it’s possible to create a good picture of the aerial extents of a flood resulting from a dam break.


## 2 Preparing the Model


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### 2.1 Running TOPAZ


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In this section, load the DEM and run TOPAZ to compute the flow directions and flow accumulations. The purpose of doing this is to obtain a stream arc that represents the centerline of the stream downstream from the dam. This stream arc will be used in a 1D-Hydraulic Centerline coverage to create the geometry for the SMPDBK model in WMS.

1. Open WMS. If WMS is already open, select *File / New* then click **No** if asked to save changes.
2. Select *File / Open*  to access the *Open* dialog.
3. Locate the “smpdbk” folder in the files for this tutorial. If needed, download the tutorial files from [www.aquaveo.com](http://www.aquaveo.com).
4. Open “smpdbk.gdm”.
5. Select *Display / Display Projection...* to open the *Display Projection* dialog.
6. Select *Global Projection*, then the **Set Projection** button.



7. In the *Select Projection* dialog, ensure that *Projection* is set to “UTM”, *Zone* is set to “12 (114°W - 108°W – Northern Hemisphere)”, *Datum* is set to “NAD 83” and *Planar Units* are set to “METERS”.
8. Select **OK**.
9. Set *Vertical Projection* to “NAVD 88 (US)”.
10. Set *Vertical Units* to “Meters”.
11. Select **OK**.
12. Select *Edit / Reproject...* to open the *Reproject Current* dialog.
13. In the *New Projection* section, select *Global Projection*, then the **Set Projection** button.
14. In the *Select Projection* dialog, set *Planar Units* to “FEET (U.S. SURVEY)”. Select **OK**.
15. Set *Vertical Units* to “U.S. Survey Feet”.
16. Select **OK**.
17. Switch to the **Drainage**  module.
18. Select *DEM / Compute Flow Direction/Accumulation...*
19. The *Flow Direction/Accumulation Run Options* dialog will open. Select **OK**.
20. Select **OK**.
21. Choose **Close** once TOPAZ finishes running (wait a few seconds to a minute or so).

A network of streams should appear on top of the DEM. TOPAZ computes flow directions for individual DEM cells and creates streams based on these directions. Change the flow accumulation threshold so that smaller or larger streams show up.

22. Right-click on “DEM (Converted)” on the Project Explorer and select **Display Options**  to open the *Display Options* dialog.
23. On the *DEM* tab, change the *Min Accumulation for Display* to “5.0” sq miles.
24. Select **OK**.

## 2.2 Creating Outlets and Streams

The next step in creating a SMPDBK model is to convert the computed TOPAZ flow data to a stream arc. This arc can then be used as the stream centerline in the SMPDBK model.

1. In the *Drainage* module , choose the **Create Outlet Point** tool .
2. Create an outlet on the river in the lower left corner of the DEM, as seen in Figure 2-1. Be sure to click close enough to the river so the outlet snaps to the flow accumulation cell on the stream. The dam is located in the upper right corner of the DEM.

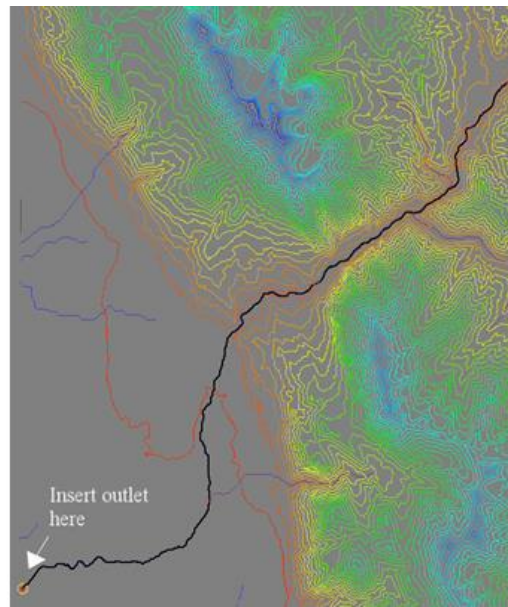




Figure 2-1: New outlet point.

3. Select *DEM / DEM* → **Stream Arcs**
4. Select **OK**
5. Switch to the *Map* module 
6. Choose the **Select Feature Arc** tool 
7. While holding down on the *SHIFT* key, select the three stream arcs that branch off of the main arc
8. Press *DELETE*
9. Select **OK**

The main stream arc is now isolated. The screen should look like Figure 2-2.

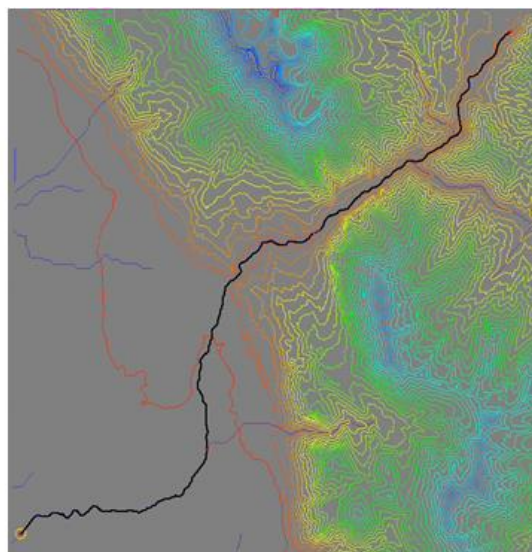







Figure 2-2: Main stream arc.

## 2.3 Creating 1D Hydraulic Coverages

The next step is to create arcs representing the stream centerline (in a 1D-Hydraulic Centerline coverage) and to create cross section arcs along this centerline (in a 1D-Hydraulic Cross Section coverage).

1. Choose the *Select Feature Point/Node* tool 
2. Drag a box around the entire stream arc. Five nodes should be selected.
3. Select **Feature Objects / Vertex <-> Node**. This will convert all the selected nodes to vertices, turning the stream centerline into a single arc.
4. In the Project Explorer, right-click on the Drainage coverage and select **Type / 1D-Hyd Centerline**
5. Choose the **Select Feature Arc** tool 
6. Select the stream centerline arc
7. Select **Feature Objects / Reverse Directions**

The Reverse Directions command changes the direction of the flow of the stream. To view this change, go to the map display options and turn on the *Stream Arrows* option. A small blue arrow will appear indicating the direction of the flow at the center of the stream. The direction should indicate that the stream is flowing down and to the left (southwest).

8. Switch to the *Terrain Data* module 
9. Right-click on *DEM (Converted)* in the Project Explorer and select **Convert / DEM → TIN / Filtered**
10. Make sure that *Triangulate new TIN* and *Delete DEM* options are toggled on
11. Choose **OK**
12. In the Project Explorer, right-click on the *New tin* and select **Display Options** 
13. In the *TIN Data* options, toggle off *Triangles*
14. Select **OK**
15. In the Project Explorer, right-click on the **Coverages** folder and select **New Coverage** from the pop-up menu
16. Choose “1D-Hyd Cross Section” from the *Coverage type* drop-down box
17. Select **OK**
18. Choose the **Create Feature Arc** tool 
19. Create eight cross sections as shown in Figure 2-3



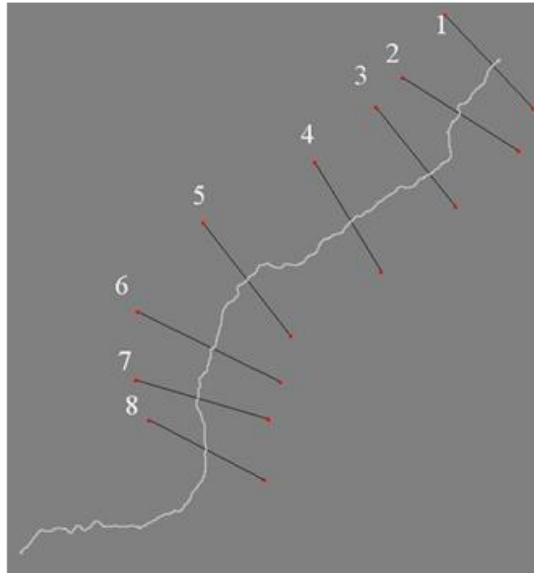





Figure 2-3: Cross Sections on Stream Arc.


## 2.4 Reading in Area Properties

An Area Property coverage is used to assign Manning's roughness values to the cross sections in SMPDBK. Area Property coverages contain polygons with materials (representing land cover types) assigned to each polygon. In this section load an existing Area Property coverage. Also create an area property coverage from a background image or map.

1. Select **File / Open** 
2. Open "areaprop.map"
3. Switch to the **Map** module 
4. Choose the **Select Feature Polygon** tool 
5. Double-click on the polygons to view the assigned materials

## 2.5 Extracting Cross Sections

Once having completed the centerline, cross section, and Area Property coverages; extract the cross sections from the TIN. Then, convert the coverage data to a hydraulic model.

1. Click on the 1D-Hyd Cross Section coverage to make it the active coverage
2. Select **River Tools / Extract Cross Section**
3. Toggle on *Using arcs* and select *1D-Hyd Centerline* from the drop-down list
4. Choose *Area Property* from the Material Zones drop-down list
5. Select **OK**
6. Save the file as "xsections"
7. Choose the **Select Feature Arc** tool 




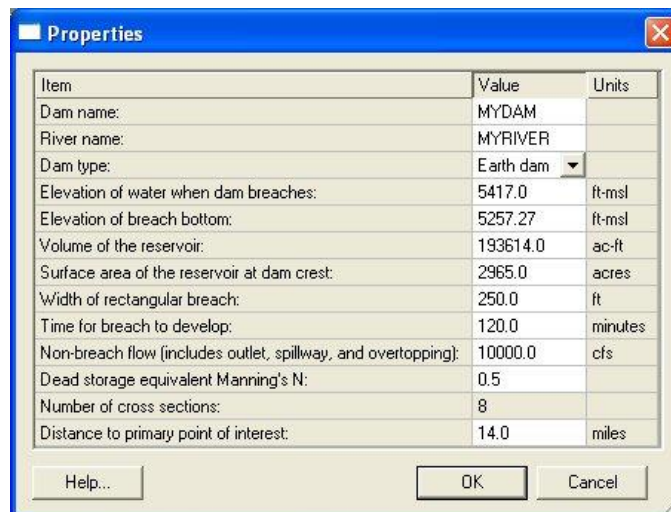
8. Double-click on a cross section
9. Click on *Assign Cross Section* to view the cross section profile
10. Select *Cancel* twice to exit the dialogs
11. Click on the 1D-Hyd Centerline coverage to make it the active coverage
12. Select **River Tools / Map -> 1D Schematic**

### 3 Using SMPDBK

Setting up the hydraulic model geometry is 90% of the work associated with creating a SMPDBK model. The other 10% involves entering information about the dam and the Manning's roughness values for each of the different area properties. Find this information on the Internet or in the National Inventory of Dams (NID) database. This section will guide through the process of finishing the SMPDBK model setup.

#### 3.1 Edit Parameters

1. Choose the *River* module 
2. From the Model drop-down box, choose *SMPDBK*
3. Select *SMPDBK / Edit Parameters*
4. Enter the values shown in Figure 3-1

Item	Value	Units
Dam name:	MYDAM	
River name:	MYRIVER	
Dam type:	Earth dam	
Elevation of water when dam breaches:	5417.0	ft-msl
Elevation of breach bottom:	5257.27	ft-msl
Volume of the reservoir:	193614.0	ac-ft
Surface area of the reservoir at dam crest:	2965.0	acres
Width of rectangular breach:	250.0	ft
Time for breach to develop:	120.0	minutes
Non-breach flow (includes outlet, spillway, and overtopping):	10000.0	cfs
Dead storage equivalent Manning's N:	0.5	
Number of cross sections:	8	
Distance to primary point of interest:	14.0	miles

Buttons: Help... OK Cancel

Figure 3-1: Properties Dialog.

5. Select **OK**
6. Select *SMPDBK / Material Properties*
7. Enter the following values:

River	0.05
Shrub/Brush	0.06
Residential	0.08
Forest	0.08

8. Select *OK*
9. Select ***SMPDBK / Model Control***
10. Choose *Materials* from the drop-down box
11. Select *OK*
12. Select ***SMPDBK / Export SMPDBK File***
13. Save the file as “smpdbk.dat”
14. Select *OK* to continue saving the data if any errors are encountered

### 3.2 Running the Simulation

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The model is now finished and ready to run the simulation. When running the SMPDBK simulation, WMS saves the SMPDBK input file, runs SMPDBK, and attempts to read the SMPDBK solution. A solution point is placed where each cross section intersects the stream centerline in the hydraulic model.

1. Select ***SMPDBK / Run Simulation***
2. Save the file as “smpdbk.dat”
3. Select **Yes** to replace the file. A window will appear and SMPDBK will run in this window.

**IMPORTANT NOTE:** If running on a 64-bit Windows operating system, SMPDBK will not be able to run from WMS. Run SMPDBK from a DOS command prompt by installing a DOS emulation program such as DOSBOX (<http://www.dosbox.com/>) or a similar free product. If deciding to use DOSBOX, after starting the program, it's necessary to mount the drive(s) where SMPDBK is installed. Mount a drive by typing **mount C C:\** (for example) if all the files are located on the C drive. After mounting the drive, just type "C:" to go to the C drive. Then, change to the directory containing the "smpdbk.dat" file. For example, if the smpdbk.dat file is located in "C:\Users\aquaveo\Documents\smpdbk", type **cd C:\Users\aquaveo\documents~1\smpdbk**. Note that the DOS truncates files and folders containing more than 8 characters to be 8 characters. Determine the truncated name by typing **dir** at the command prompt or just begin typing the name and hit the **TAB** key to have the DOS emulator finish the name. Once in the directory containing the smpdbk.dat file, run smpdbk from a command prompt. WMS installs smpdbk.exe in the same directory as WMS, so if WMS is installed in "c:\program files\WMS90\", type **c:\progra~1\WMS90\smpdbk.exe** (note the truncated name) at the command prompt. Once SMPDBK is started, it asks several questions. Make sure the **CAPS LOCK** key is turned on and type the following answers for the SMPDBK questions: NO, YES, SMPDBK.DAT, NO, SMPDBK.OUT. A file called SMPDBK.OUT will be created. Read this file using the ***SMPDBK / Read Solution*** menu command in WMS. After doing this, continue on to the Post-Processing section.

4. Choose *Close* once SMPDBK finishes running (wait a few seconds to a minute or so). If SMPDBK finishes running successfully, a message such as “Stop—Program terminated” and “SMPDBK Finished” will appear in the model wrapper.



## 4 Post-Processing

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Once having finished running SMPDBK, WMS reads the solution as a 2D scattered dataset. This solution contains water surface elevation points where each cross section intersects the stream centerline. When delineating the floodplain, it's necessary to have additional solution points to create a well-defined map. This section will guide through the processes of interpolating solution points along the centerline and the cross sections. After interpolating to create additional solution points, delineate the floodplain from these points.

### 4.1 Interpolation

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1. Click on the 1D-Hyd Centerline coverage to make it the active coverage
2. Select **River Tools / Interpolate Water Surface Elevations**
3. Select the option to create a data point *At a specified spacing* (instead of at each arc vertex).
4. Change the Data point spacing to 1000
5. Select *OK*
6. Click on the 1D-Hyd Cross Section coverage to make it the active coverage
7. Select **River Tools / Interpolate Water Surface Elevations**
8. Select *OK*

If not able to connect to the internet, skip section 4.2.

### 4.2 Getting a Background Image


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Using an Internet connection, load a background image (Aerial photo or a topo map) for the project site. Use any of the Get Data tools in WMS to load images from the internet.

1. Select the arrow next to the *Add GIS Data* button  and select *Get Online Maps*  from the drop-down menu; this will open the *Get Online Maps* dialog.
2. Select *World Imagery* and click *OK*.
3. WMS will load the background image file. It will take few moments depending upon the internet connection. Once done, an aerial photo is added to the background.
4. Skip to section 4.4.


### 4.3 Open Background Image

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1. Select **File / Open** 
2. Open "*aerial.jpg*"

## 4.4 Floodplain Delineation

This section will show how to delineate a flood using the WMS floodplain delineation tools. It will also show how to adjust the display options to better display the results of the SMPDBK simulation.

1. Switch to the *Terrain Data* module 
2. Select *Flood / Delineate*
3. Set the Max search radius to 5000
4. Select **OK**
5. Select *MaxWS\_fd* from the Terrain Data folder of the Project Explorer
6. Right-click on *MaxWS\_fd* and select *Contour Options* from the pop-up menu
7. Set the Contour Method to *Color Fill* and set the transparency to 40%
8. Select the check box for *Specify a range*
9. Deselect *Fill below* and *Fill above*
10. Select the **Legend** button
11. Toggle on the *Display Legend* option
12. Select **OK** two times to exit the dialogs

The flood depths from the SMPDBK simulation can now be viewed as a spatial map. Notice that some areas appear flooded that they know are not actually flooded if the dam breaches. These areas can be corrected by drawing polygons around the areas known to be not flooded and then re-delineating the floodplain. The following steps explain how to do this.

13. Right-click on the Coverages folder in the Project Explorer and select **New Coverage** from the pop-up menu
14. Choose *Flood Barrier* from the Coverage Type drop-down box
15. Select **OK**
16. Choose the **Create Feature Arcs** tool 
17. Draw an arc representing a polygon around the extra data that needs to be deleted. This includes areas clearly outside of the floodplain and areas where data does not exist to give accurate results, such as outside the extents of the hydraulic model (see Figure 4-1). WMS will ignore the areas inside this polygon when delineating the floodplain. Be sure the arc forms a closed loop.



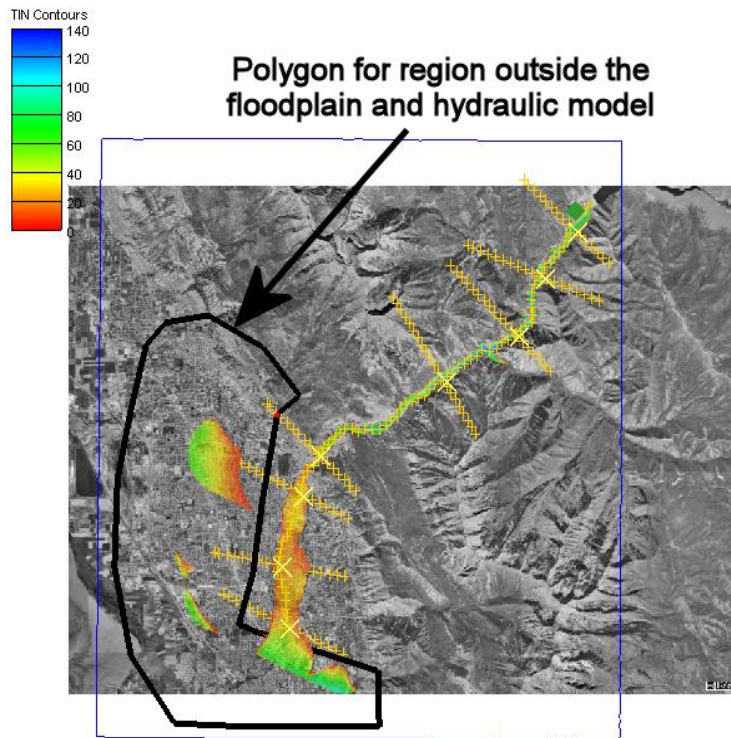




Figure 4-1: Creating a polygon for regions outside the model extents

18. Switch to the *Map* module 
19. Select *Feature Objects* | **Build Polygon**
20. Select **OK** to use all arcs
21. Switch to the *Terrain Data* module 
22. Select *Flood* / **Delineate**
23. Select the *User defined flood barrier coverage* option
24. Change the solution name to “MaxWS\_1”
25. Select **OK**
26. To view the new data, open the MaxWS\_1 (FLOOD) solution folder and select *MaxWS\_1\_fd* in the Project Explorer

Toggle between MaxWS\_fd and MaxWS\_1\_fd in the Project Explorer to view the effects of the flood barrier coverage on the floodplain delineation

## 5 Conclusion

In this exercise, the following was covered:

- Setup a conceptual model of stream centerlines and cross sections for the simplified dam break (SMPDBK) model
- Export the conceptual model to SMPDBK and run the analysis code

- Read the results back into WMS and delineate the floodplain to determine the impact of the dam break.