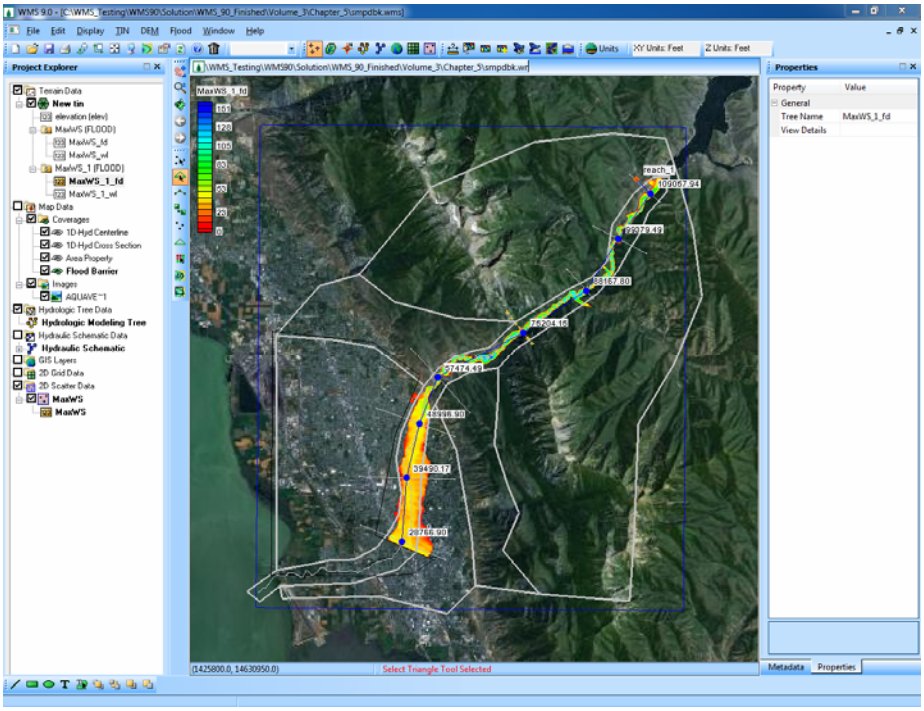
WMS

v. 9.0

WMS 9.0 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 Contents

2 Introduction

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, you can create a good picture of the aerial extents of a flood resulting from a dam break.

3 Preparing the Model

3.1 Running TOPAZ

In this section, you will 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. Close all instances of WMS
2. Open WMS
3. Select ***File*** | ***Open***

4. Locate the ***smpdbk*** folder in your tutorial files. If you have used default installation settings in WMS, the tutorial files will be located in ***\My documents\WMS 9.0\Tutorials\.***
5. Open *"smpdbk.gdm"*
6. Select ***Edit | Current Projection...***
7. Select *Global Projection*, then the *Set Projection* button
8. Ensure that *UTM*, *NAD 83*, *METERS*, and *12 (114°W - 108°W – Northern Hemisphere)* are selected for the *Projection*, *Datum*, *Planar Units* and *Zone* respectively
9. Select *OK*
10. Set Vertical Projection to *NAVD 88 (US)*
11. Set Vertical Units to *Meters*
12. Select *OK*
13. Select ***Edit | Reproject...***
14. In the *New Projection* section select *Global Projection*, then the *Set Projection* button
15. Set *Planar Units* to *FEET (U.S. SURVEY)* and leave everything else at the default values. Select *OK*.
16. Set Vertical Units to *U.S. Survey Feet*
17. Select *OK*
18. Switch to the *Drainage* module 
19. Select ***DEM | Compute Flow Direction/Accumulation…***
20. Select *OK*
21. Select *OK*
22. Choose *Close* once TOPAZ finishes running (you may have to wait a few seconds to a minute or so)

You should now see a network of streams on top of your DEM. TOPAZ computes flow directions for individual DEM cells and creates streams based on these directions. You can change the flow accumulation threshold so that smaller or larger streams show up.

23. Right-click on *DEM* on the Project Explorer and select ***Display Options*** 
24. On the DEM tab, change the Min Accumulation for Display to 5.0
25. Select *OK*

3.2 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 3-1. 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.

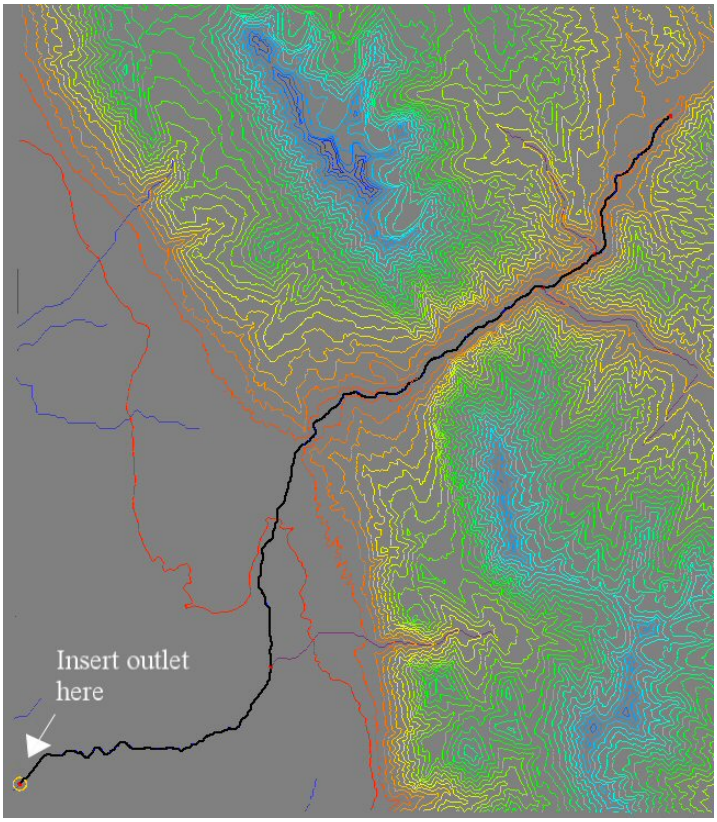


Figure 3-1: New outlet point.

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*

You have now isolated the main stream arc. Your screen should look like Figure 3-2.

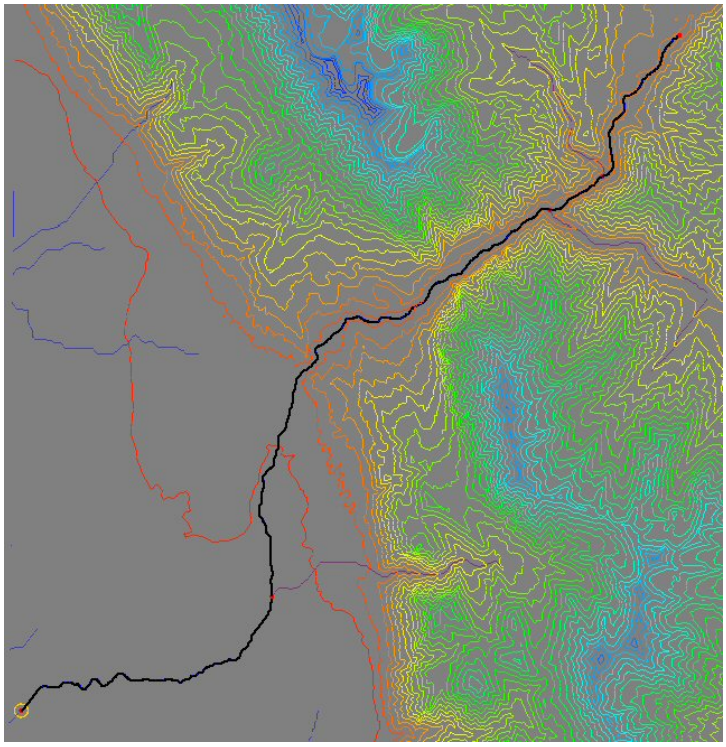


Figure 3-2: Main stream arc.

3.3 Creating 1D Hydraulic Coverages

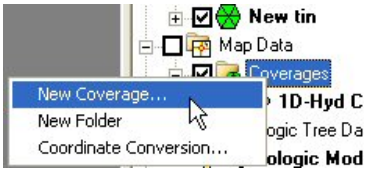
The next step is to create arcs representing the stream centerline (in a 1D-Hydraulic Centerline coverage) and to create cross section arcs along this centerline (in a 1D-Hydraulic Cross Section coverage).

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, you can zoom in on a small portion of the stream. There are small blue arrows indicating the direction of the flow. 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* on 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 3-3

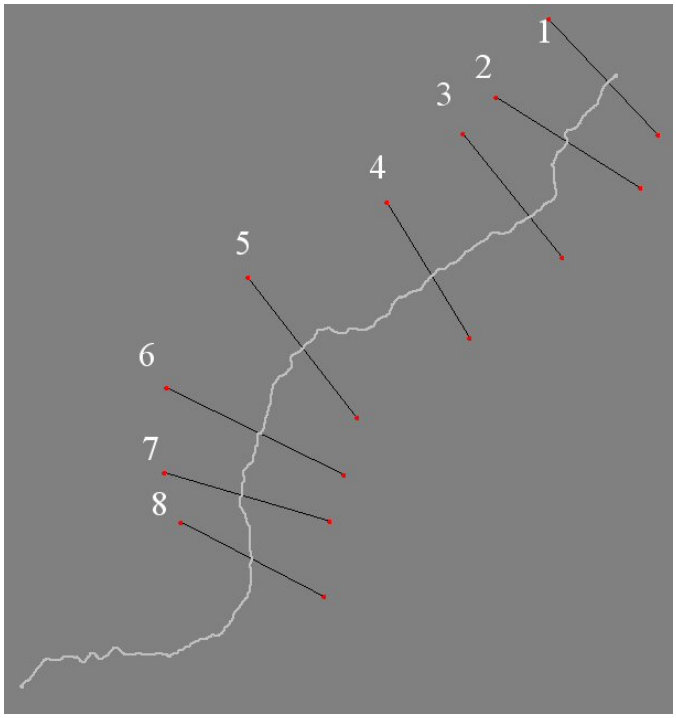


Figure 3-3: Cross Sections on Stream Arc.

3.4 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, you load an existing Area Property coverage. You could also create your own 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

3.5 Extracting Cross Sections

Once you have completed the centerline, cross section, and Area Property coverages, you are ready to extract the cross sections from the TIN. Then, you must convert your 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***

4 Using SMPDBK

Setting up your 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. You can find this information on the Internet or in the National Inventory of Dams (NID) database. This section will guide you through the process of finishing your SMPDBK model setup.

4.1 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 4-1

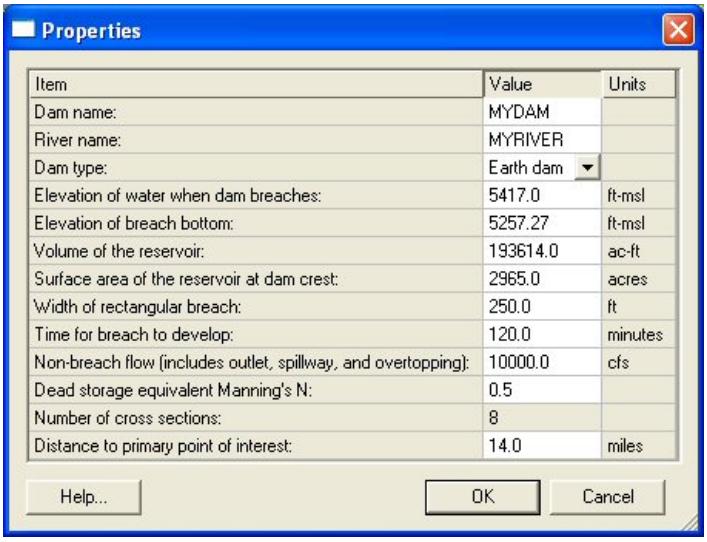


Figure 4-1: Properties Dialog.

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 your data if any errors are encountered

4.2 Running the Simulation

Your model is now finished and you are ready to run the simulation. When you run 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 your 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 you are running on a 64-bit Windows operating system, you will not be able to run SMPDBK from WMS. You can 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 you decide to use DOSBOX, after you start the program, you need to mount the drive(s) where SMPDBK is installed. You can mount a drive by typing ***mount C C:*** (for example) if all the files are located on your C drive. After mounting the drive, just type "C:" to go to your C drive. Then, change to the directory containing your "smpdbk.dat" file. For example, if your smpdbk.dat file is located in "C:\Users\aquaveo\Documents\smpdbk", you would type ***cd C:\Users\aquaveo\docume~1\smpdbk***. *Note* that the DOS truncates files and folders containing more than 8 characters to be 8 characters. You can 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 for you. Once you are in the directory containing your smpdbk.dat file, you can 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\", you would type ***c:\progra~1\WMS90\smpdbk.exe*** (note the truncated name) at the command prompt. Once SMPDBK is started, it asks you several questions. Make sure your 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. You can read this file using the ***SMPDBK | Read Solution*** menu command in WMS. After you have done this, continue on to the Post-Processing section.

4. Choose *Close* once SMPDBK finishes running (you may have to 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.

5 Post-Processing

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

5.1 Interpolation

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

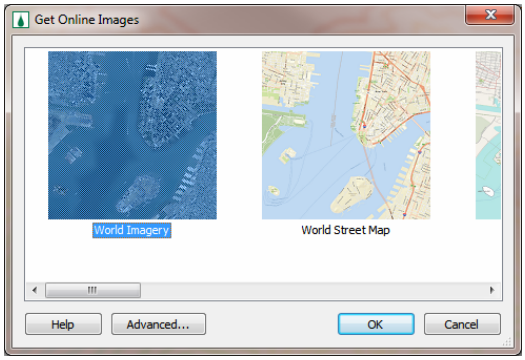
7. Select ***River Tools | Interpolate Water Surface Elevations***
8. Select *OK*

Skip sections 5.2 and 5.3 if you are not able to connect to the Internet using your computer.

5.2 Getting a Background Image

Using an Internet connection we can load a background image (Aerial photo or a topo map) for the project site. WMS uses built in web services tool to load such images.

1. Select the *Get Online Maps* tool located near the menu bar. It will open *Get online Images* dialog.
2. Select *World Imagery* and click *OK.*

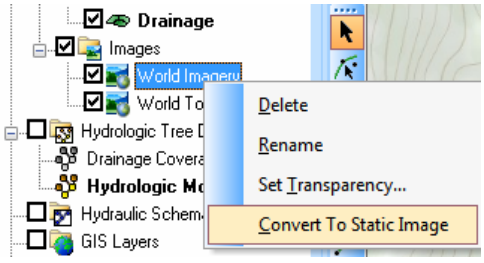


3. WMS will load the background image file. It will take few moments depending upon the internet connection. Once done, you can see an aerial photo added to the background.

5.3 Create a local copy of the images

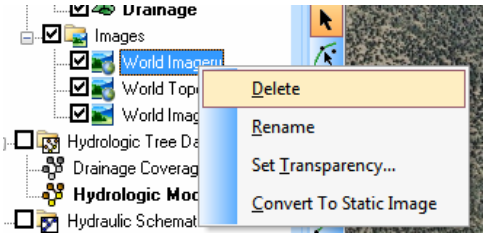
The image you just loaded are read in from the server and sometimes take longer time to zoom and pan around. You can create a local copy of the image to expedite such navigations.

1. In the project explorer, under *Images* folder, right click *World Imagery* and select *Convert To Static Image.*



2. Select *OK* to accept suggested value of *resample magnification.* Resample magnification factor of 1 means the image will have exactly as many pixels as it is being displayed on the screen. You can increase the factor if you need a higher resolution image. But, note that it will take longer time to download.

3. WMS will download the image to your local drive. You can see the download progress.
4. Once the image is downloaded, you can remove the bigger online image (the one that has little *globe* on its icon).



WMS will automatically open the image after downloading it. If you were able to successfully complete all the steps in this section you can skip section 5.4.

5.4 Open Background Image

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

5.5 Floodplain Delineation

This section will show you how to delineate a flood using the WMS floodplain delineation tools. You will also learn 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. You will notice that some areas appear flooded that you know are not actually flooded if the dam breaches. These areas can be corrected by drawing polygons around the areas you know are 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 5-1). WMS will ignore the areas inside this polygon when delineating your floodplain. Be sure your arc forms a closed loop.

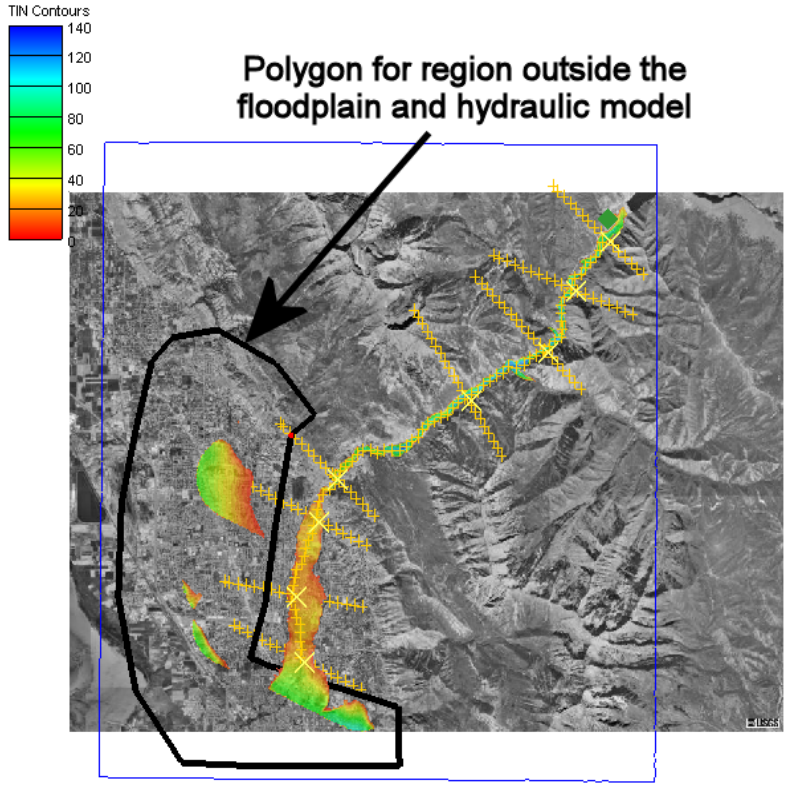


Figure 5-1: Creating a polygon for regions outside the model extents

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

You can 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