Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 2

A New GIS Tool for Creating DSM2 Grid and Cross Sections

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STATE OF CALIFORNIA

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2 A New GIS Tool for Creating DSM2 Grid and Cross Sections

2.1 Introduction

DSM2 cross-sections are defined using bathymetry data as a guide. The Cross-Section Development Program (CSDP) was developed for this purpose and has been used extensively in the past for creating DSM2 cross-sections (Tom 2001). CSDP was developed almost 20 years ago when geographic information system (GIS) tools were not very sophisticated. Since then, ArcGIS has developed many features for geospatial analysis and visualization. To leverage these capabilities, a tool was proposed for ArcMap that would add cross-section drawing capabilities for DSM2. A contract was executed with Tom Heinzer, GIS Manager/Software Developer, U.S. Bureau of Reclamation, to implement this new tool.

With the new tool as an add-in to ArcMap, users can use both standard ArcMap functions and the new tool's functions. The add-in allows users to:

- Add, remove, and edit the locations of the nodes.
- Edit the flowlines of channels, which are used to determine the length of the channels.
- Cut cross-sections from a Digital Elevation Model (DEM) by using a vertical plane's intersection to determine the profile.
- Edit the profiles of cross-section shapes.
- Calculate the area, width, and wetted perimeter for user-defined levels from profiles.
- Export the channel grid and cross-section data in DSM2 format.

This chapter is a brief tutorial on how to use the tool. Delta Modeling Section staff have been using the tool to develop a new refined grid and cross-sections.

2.2 Installation and Tutorial

This tool requires ArcMap version 10.2 or later. To install the tool, copy both files (DSM2_Tools.esriAddIn and XSections.mpk) to your local hard drive and then double-click the DSM2_Tools.esriAddIn file. Then start ArcMap, and a new DSM2 1.5 toolbar will appear.

Then double-click the XSections.mpk file. It should install the map package layers, as shown in Figure 2-1. You may want to modify the DEM property to display the DEM in color. Do this by right clicking the DEM layer and select property, and under the symbology tab, pick a color ramp.

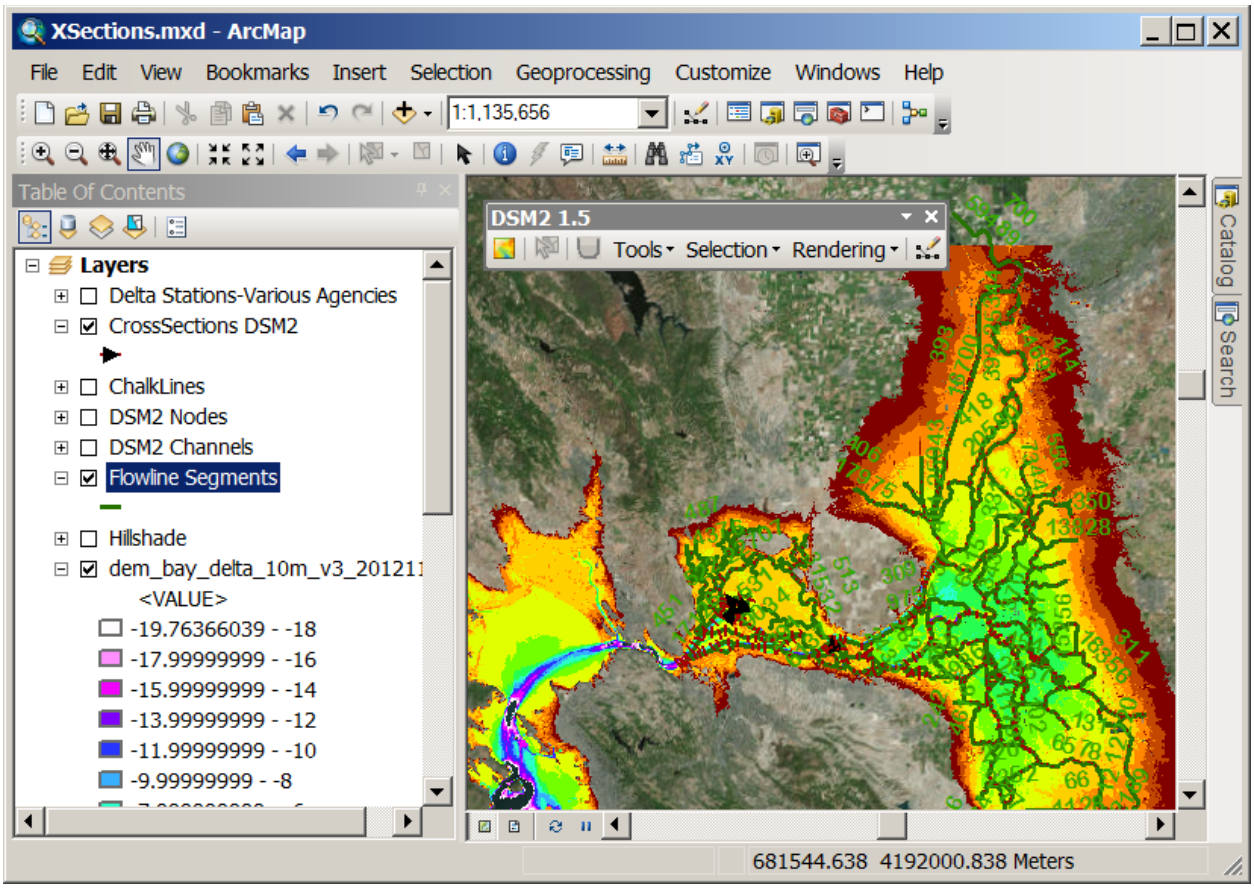


Figure 2-1 ArcMap Window after Installing the Tool and Map Package Layers

Step 1. Click the first icon on the left in the DSM2 1.5 toolbar to set up the necessary parameters (Figure 2-2).

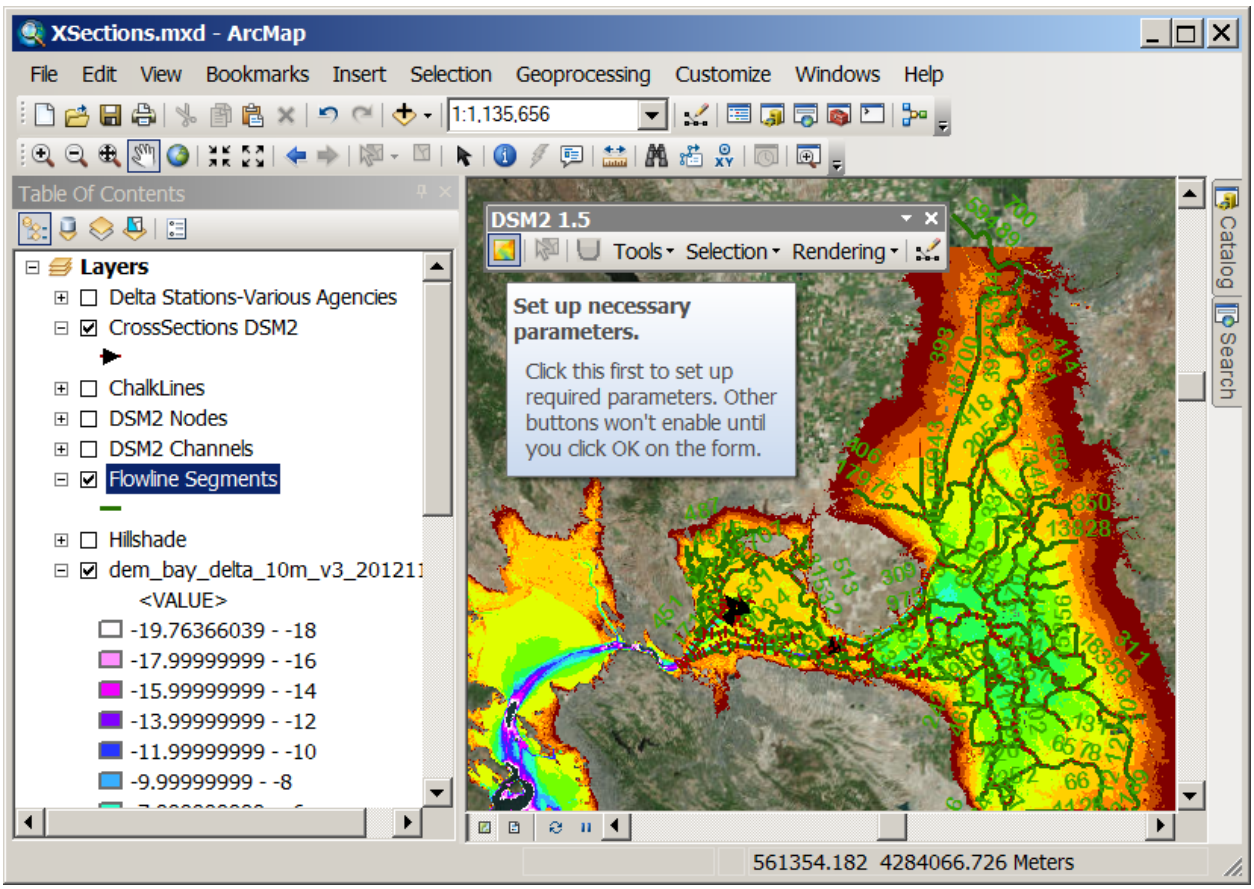


Figure 2-2 First Icon Sets Up the Necessary Parameters

Select the pulldown menu choices for Elevation Layer, Cross-Sections Layer, and Flowlines Layer, as shown in Figure 2-3. Click in the Selectable Only box next to the Cross-Sections Layer pulldown menu and a checkmark will appear. The DSM2 Channels Layer is not used by this tool. Finally, click OK.

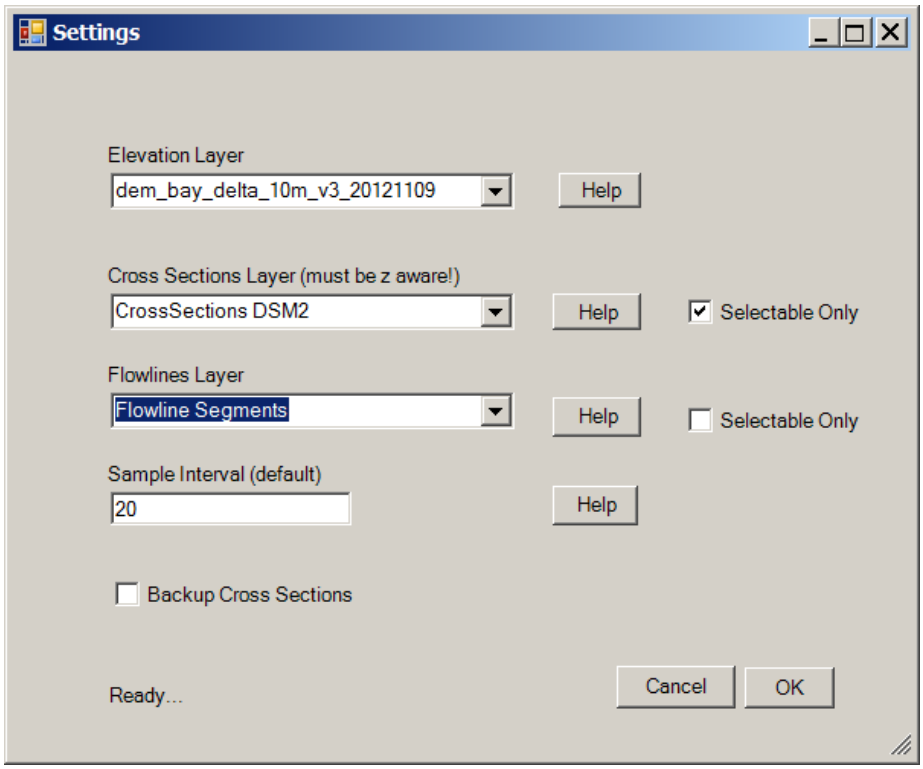


Figure 2-3 Selecting Layers

Step 2. Zoom into a channel by using and click the Select Feature button . Then click on a cross-section to select it. The cross-section line turns a light blue color when selected, as seen in Figure 2-4, where the cross-section in the middle of channel 434 is selected.

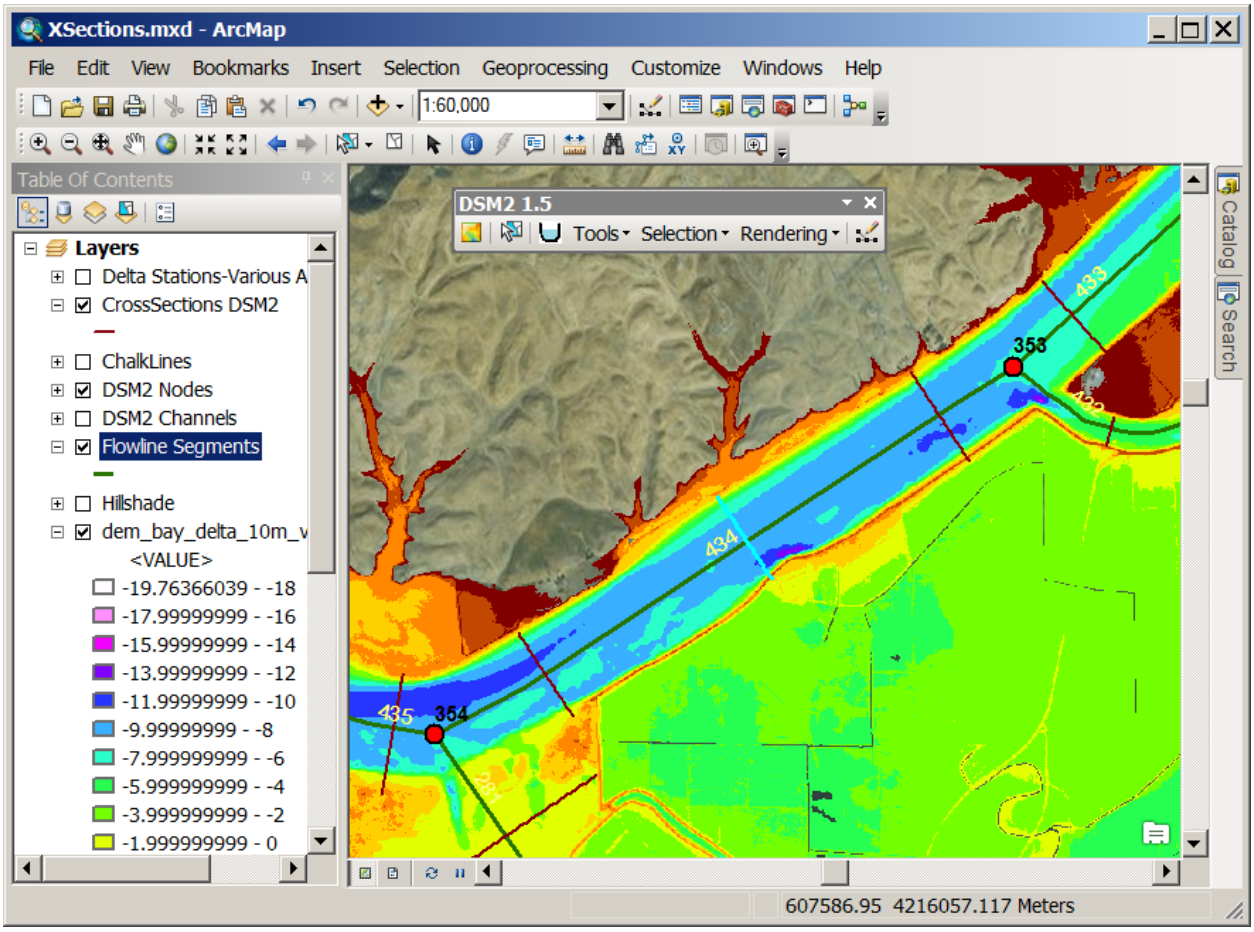


Figure 2-4 Selecting a Cross-Section

Step 3. Click the View/Edit Selected Cross-Section tool (Figure 2-5).

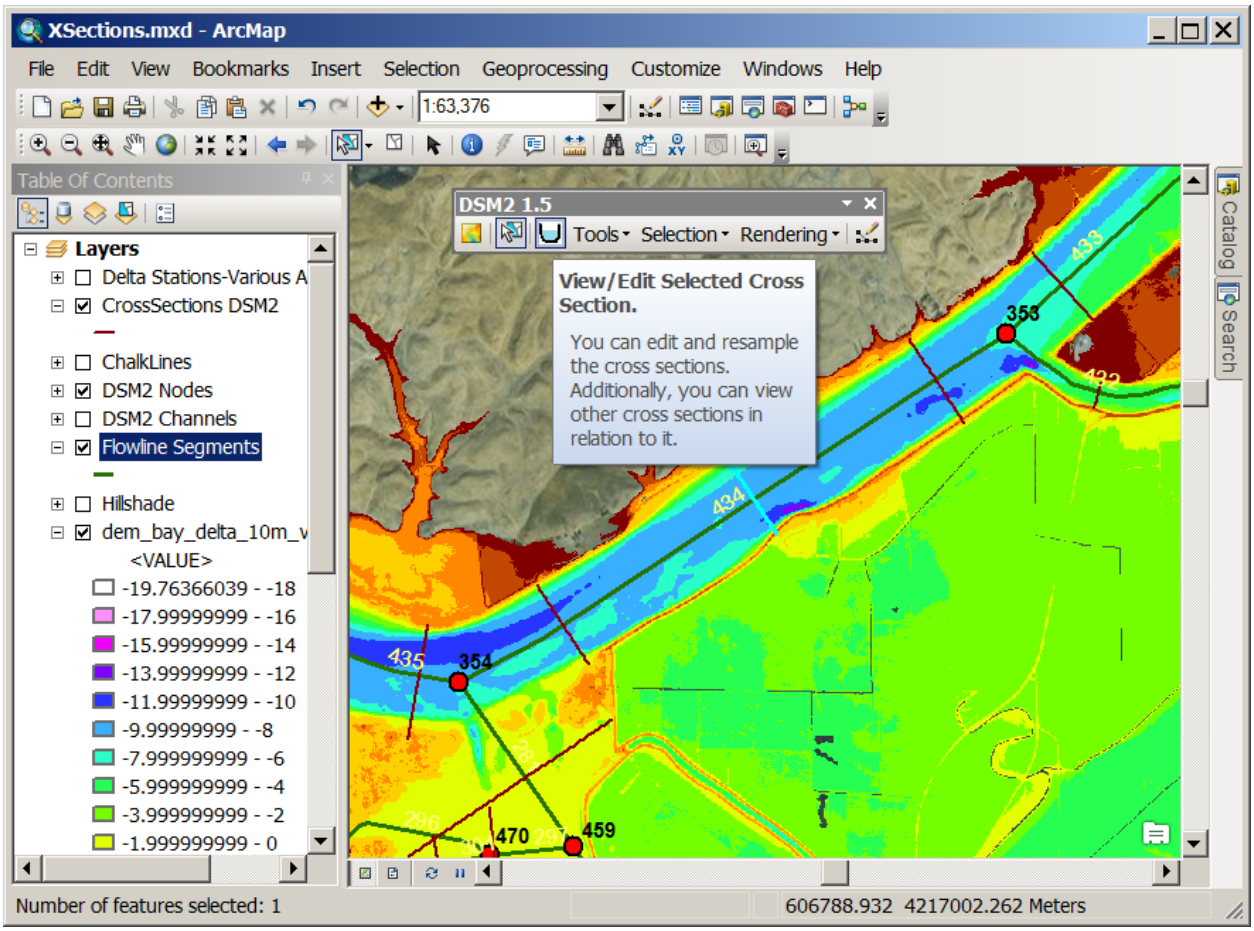


Figure 2-5 View/Edit Cross-Section Tool Icon

The Cross-Section View window will appear (Figure 2-6). First, use the Function button Sample to sample the elevation profile. The sample interval recommended to use is the DEM resolution 10 for 10-meter DEM and 2 for 2-meter DEM. After the profile has been sampled, it is necessary to specify a few levels for the cross section. Click the Go button next to the No. of levels box, and a few uniformly distributed levels will be created (Figure 2-6). The cross-sectional properties (i.e., width, area, and wetted perimeter) will be calculated at these levels. The levels can be interactively dragged up or down, added, or deleted using the mouse to better represent the channel. Keep in mind that DSM2 uses a trapezoidal rule to calculate channel area, so well-placed levels will yield more accurately calculated areas. Near the channel bottom, river bathymetry usually changes abruptly, and a lot of levels might be needed to capture the changes (Figure 2-7). We avoided this difficulty by keeping the area between channel bottom and the lowest level the same as the DEM-calculated area, so no detailed levels are needed near the bottom. This is achieved by using a post-processing script to calculate an equivalent width at the cross-section bottom, so that the DSM2 calculated area will be exactly the same as the real area from the DEM. Figure 2-8 shows the final levels for this cross section.

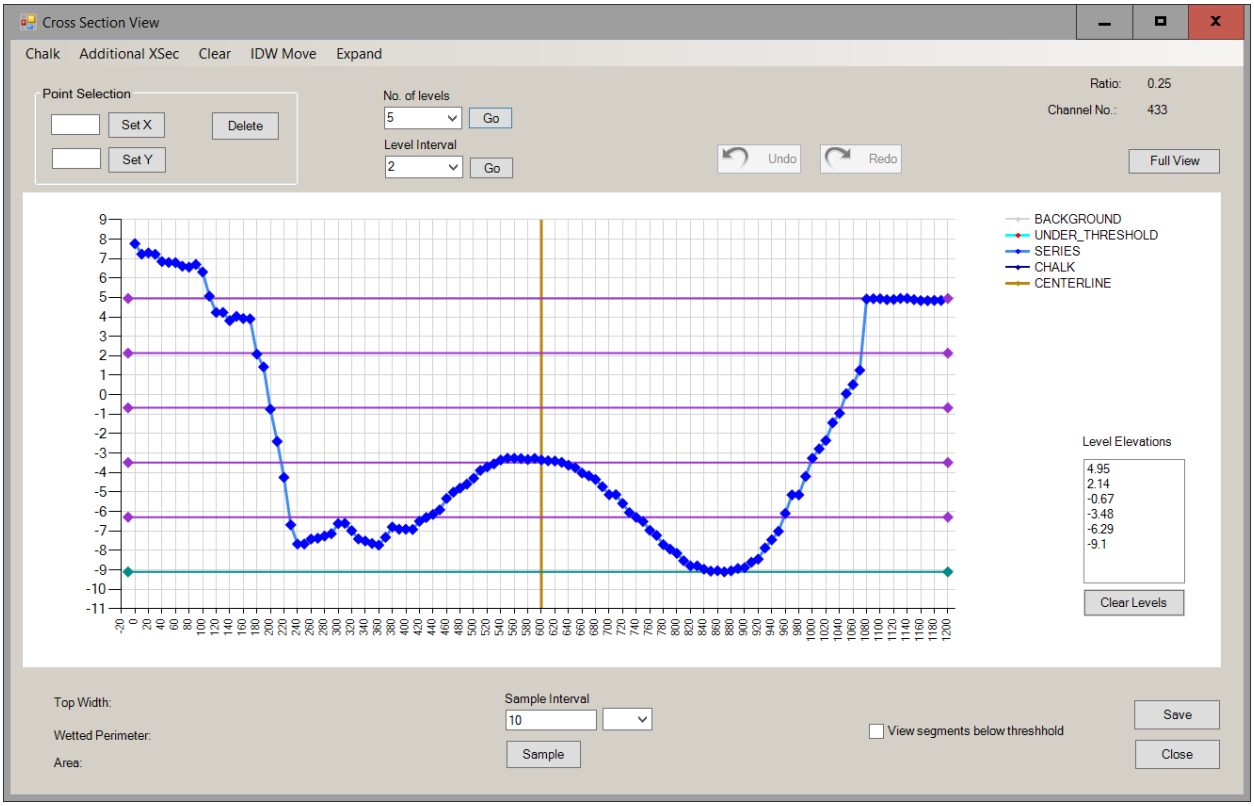


Figure 2-6 Cross-Section View Window

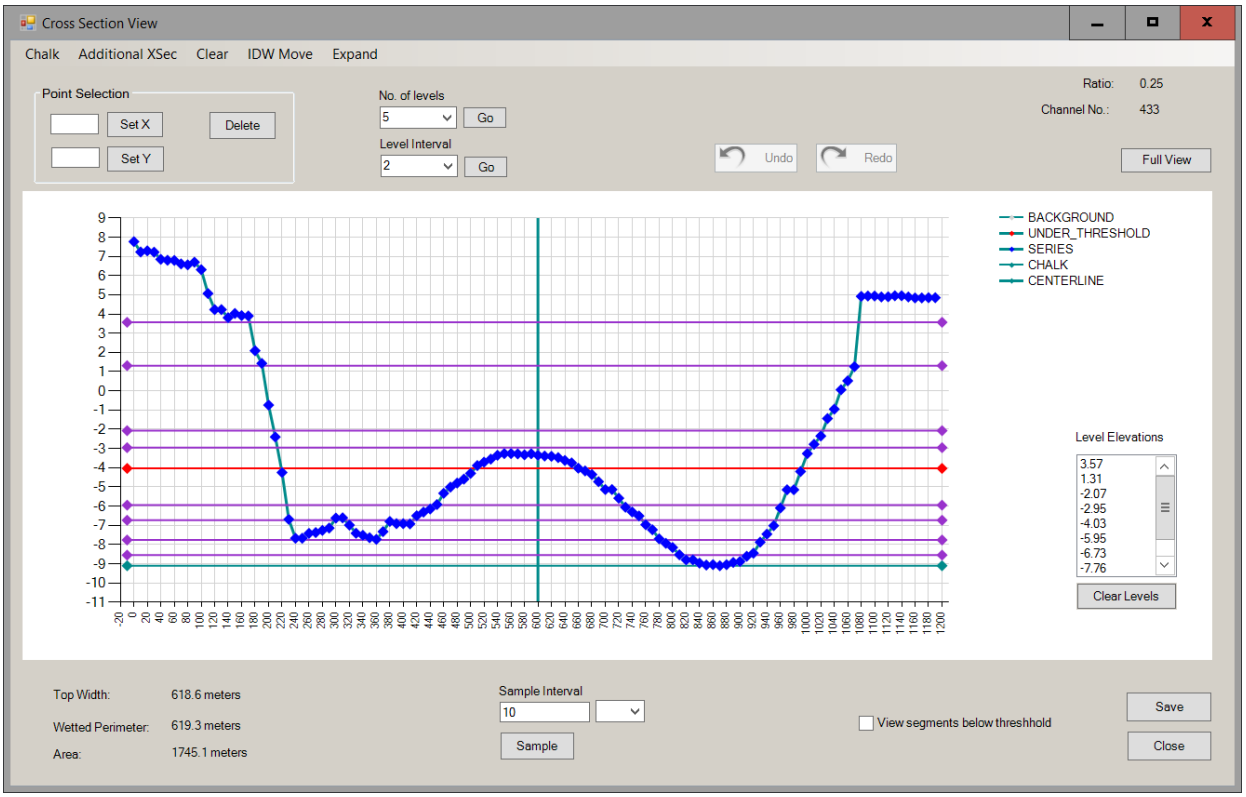


Figure 2-7 Cross-Section View Window

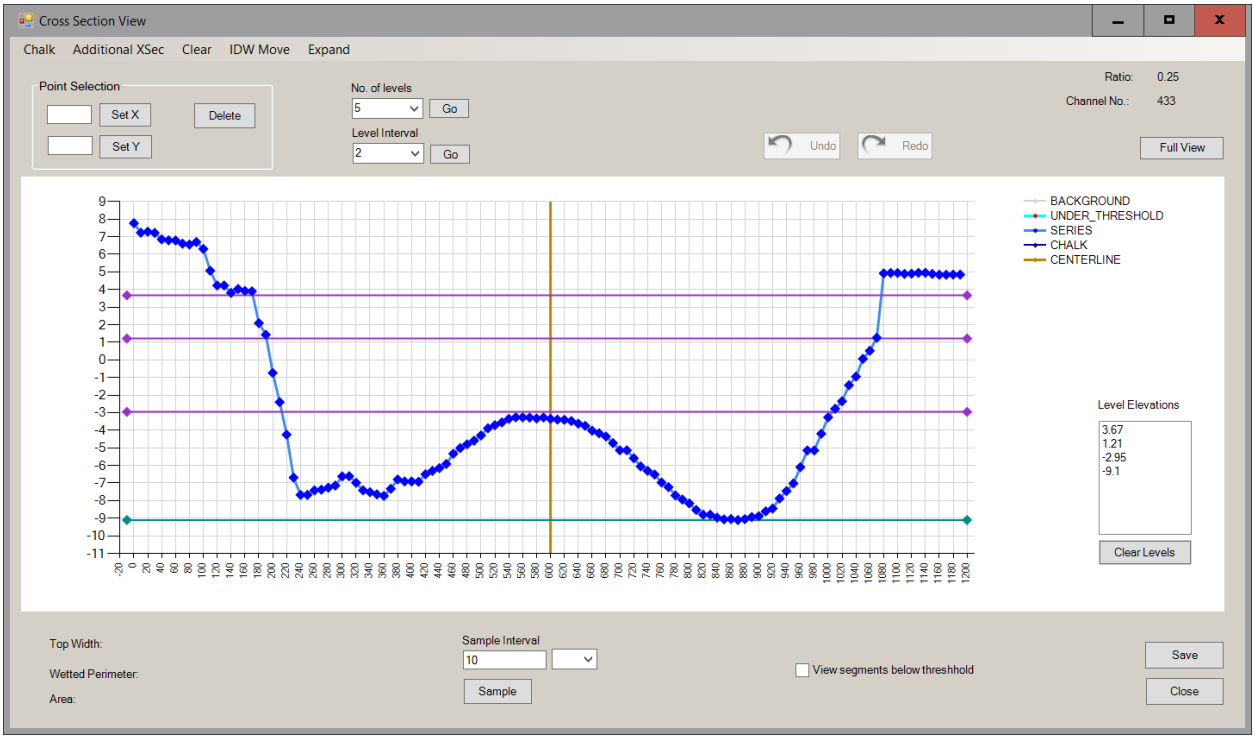
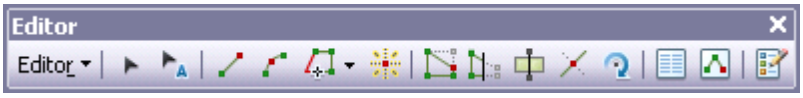


Figure 2-8 Cross-Section View Window

Step 4. To add new cross sections or change flowlines, use the standard ArcMap editor. Click on the DSM2 1.5 tools menu, which is the last icon on the right, to show the Editor toolbar.



Under the Editor menu, select Start Editing, and the Start Editing window will appear (Figure 2-9). Select CrossSections DSM2, and click OK to start editing (e.g., drawing new cross sections or changing sections as shown in Figure 2-10). The node locations can be adjusted and flowlines can be drawn interactively using the mouse. Once editing is completed and saved, use the Cross-Section tool to view/sample the cross sections.

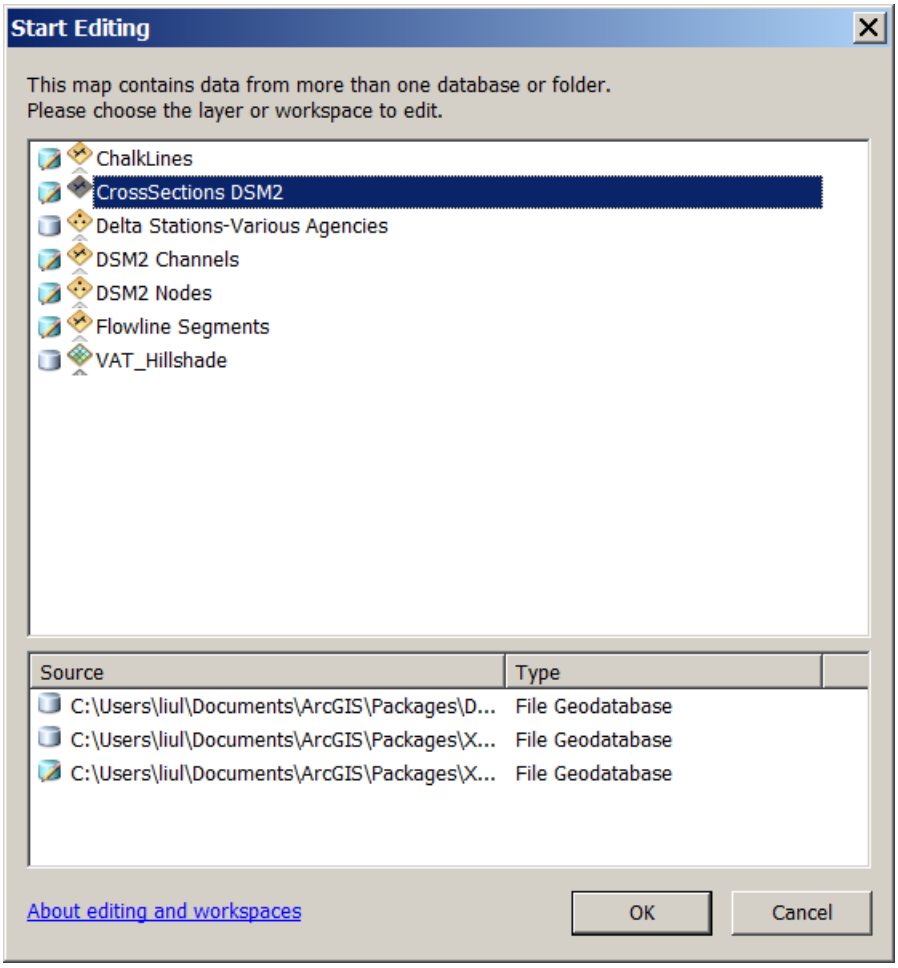


Figure 2-9 Start Editing Window

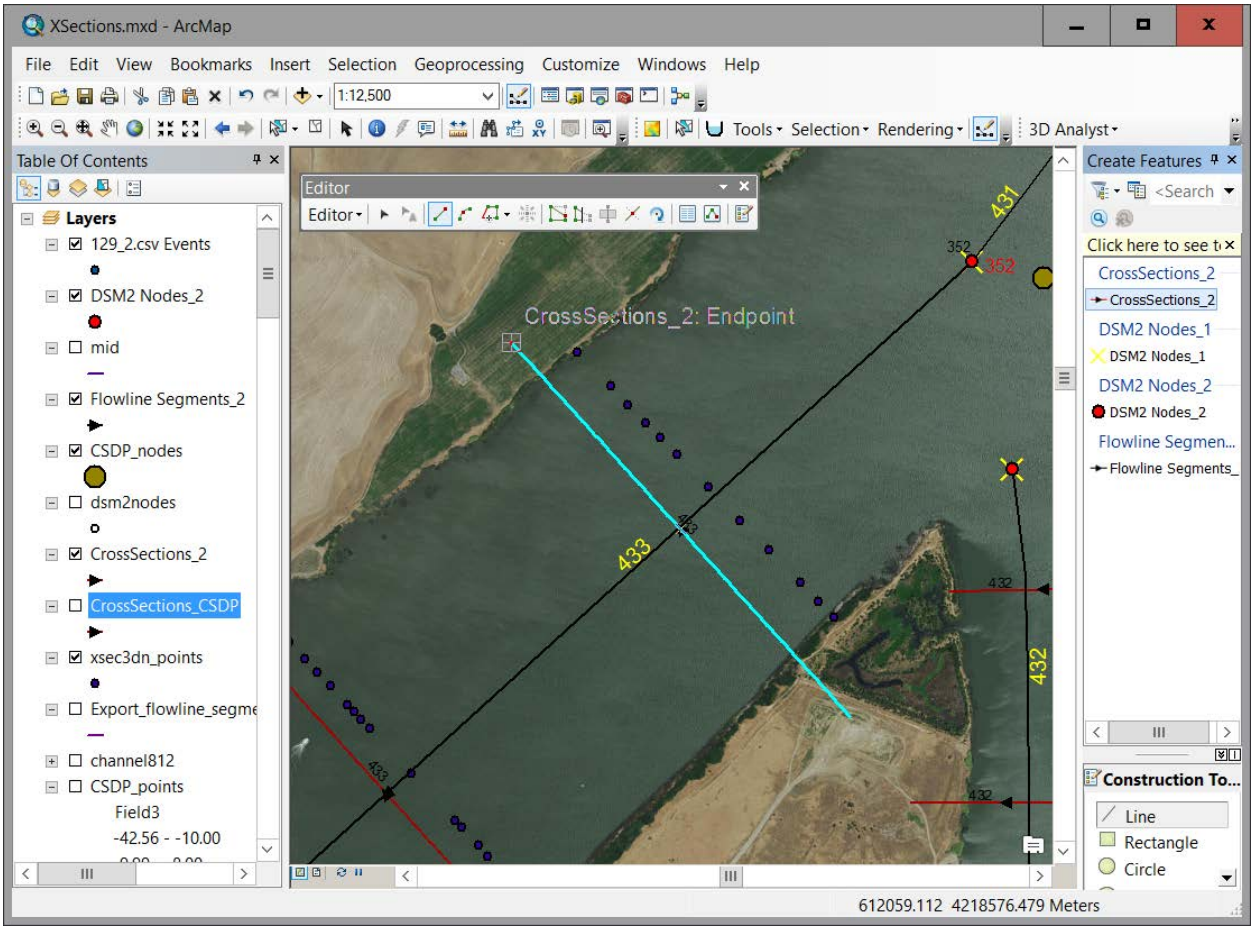


Figure 2-10 Editing Window

Step 5. There are a few helpful tools that can be used for batch processing under the DSM2 1.5 Tools menu (Figure 2-11). Some or all cross sections can be sampled together. Select all the cross sections you want to batch process, then click the Sample Elevation Model tool. Levels can also be created together for all selected cross sections by using the Create Levels for the All Selected Cross-Section tool. The Transect Generator tool generates cross sections at user-defined spacing and width. We suggest generating cross sections at the computational grid locations. For computational grid details, see Delong et al. (1997) and Liu et al. (2012).

Step 6. Once the editing is done and the files are saved, the cross sections can be exported to DSM2 format, as shown in Figure 2-10.

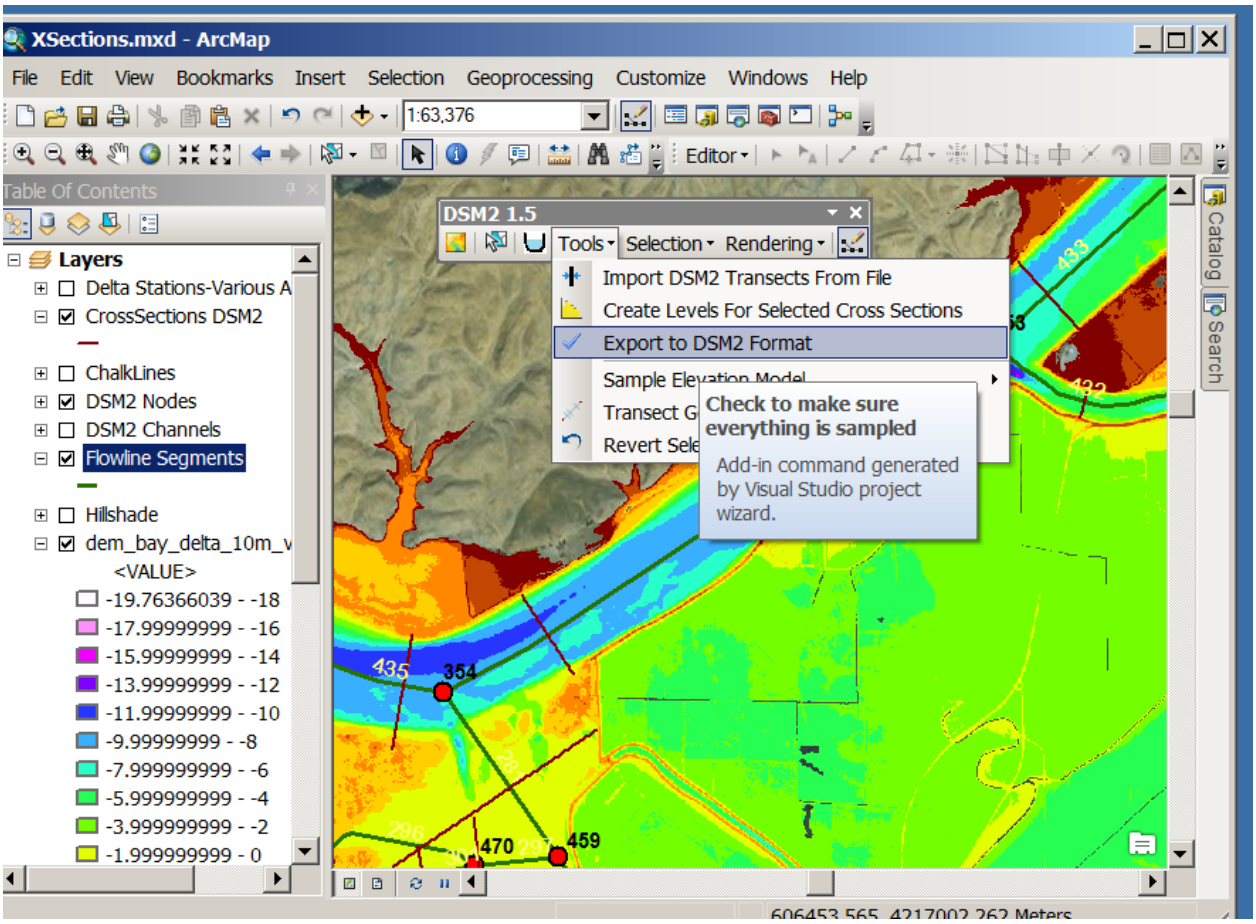


Figure 2-11 Tools for Batch Processing

Although it is very useful, this tool has some limitations and could be improved in the following ways.

1. In some channels, flowline segments need to be disconnected from nodes to represent the real channel length.
2. Only three decimal places are necessary in the exported DSM2 cross-section file.
3. The complete channel input file could be exported. Manning's N and dispersion coefficient fields must be added to do this.
4. Fix existing bugs.
    a. When resampled, the cross-section is slightly reduced and should be its original size.
    b. The Expand function causes the program to close at times.

5. Add more GIS coverage.
    a. Add gate coverage to show gates on the map with gate information in a table.
    b. Show open-water areas and connections on a map.
    c. Show consumptive-use (DICU) nodes.
    d. Show DSM2 output locations and add an export function for the output location file.

2.3 Summary

Delta Modeling Section staff have been using this tool to create a refined DSM2 grid and cross-sections to better represent the channels. This tool leverages ArcMap functionality to provide a robust and complete working environment to view/edit the DSM2 channels, nodes, and cross-sections. The tool helps to automate many of the tasks of determining cross-sections. Nonetheless, the tool requires manual manipulation to be totally effective. Each cross section needs to be checked and the levels need some manual adjustments to better represent the channels. In addition, cross sections could be modified for dredging or other planning purposes rather than be derived from the DEM.

2.4 Reference

Tom B. 2001. “Cross-Section Development Program.” Sacramento (CA): Bay-Delta Office. Delta Modeling Section. California Department of Water Resources [Website]. Viewed online at: http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/csdp/csdp.cfm.

DeLong LL, Thompson DB, and Lee JK. 1997**.** The computer program FourPt (Version 95.01) — a model for simulating one-dimensional, unsteady, open-channel flow. U.S. Geological Survey. Water Resources Investigations Report. 97-4016. 69 pp.

Liu L, Ateljevich E, and Prabhjot S. 2012**.** “Improved Geometry Interpolation in DSM2-Hydro.” In: *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh.* 33rd Annual Progress Report to the State Water Resources Control Board. Sacramento (CA): Bay-Delta Office. Delta Modeling Section. California Department of Water Resources.