



The Flood Control District of Maricopa County DDMSW Training Workshops **RIVER MECHANICS**

June 5, 2018



**Maricopa County Department of Transportation (MCDOT)
Computer Training Room
2919 W Durango St, Phoenix, Arizona 85009**

**Presented by:
Kenneth Lewis, P.E.
KVL Consultants, Inc.**



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RIVER MECHANICS

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DDMSW Training Workshops

River Mechanics

Training Dates: June 5, 2018
June 12, 2018

Location: Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Instructor: Kenneth V. Lewis, P.E.
DDMSW Developer

This training class is designed for hydraulic and hydrologic engineers interested in learning DDMSW, an application program that implements the District's Design Methodologies and Standards.

Agenda

- 8:30 – 9:00 Application Overview**
System Overview, Program Installation, General Features, Files, Tools, Administration, Help, New Features
- 9:00 – 10:30 River Mechanics Overview**
- 10:30 – 10:45 Morning Break**
- 10:45 – 12:00 River Mechanics Examples**
Scour, Riprap Sizing, Launchable Riprap, Lateral Erosion, Sediment Yield
- 12:00 – 1:00 Lunch Break**
- 1:00 – 2:00 Scour Analysis Tutorial**
- 2:00 – 2:45 Riprap Sizing and Launchable Riprap Tutorial**
- 2:45 – 3:00 Afternoon Break**
- 3:00 – 3:30 Lateral Erosion Tutorial**
- 3:30 – 4:00 Sediment Yield Tutorial**

DDMSW 5.6.0

Training Workshops

RIVER MECHANICS

Engineering Application Development and River Mechanics Branch
Engineering Division
Flood Control District of Maricopa County

June 2018

This document contains step-by-step tutorials for the River Mechanics module of DDMSW. The tutorials for the River Mechanics cover the computations of total scour for bank protection at a bend, riprap sizing for bank protection, launchable riprap, lateral erosion and sediment yield analysis for a watershed.

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II RIVER MECHANICS

2.1 Total Scour for Bank Protection

To estimate the total scour depth for a channel bank protection at a mild or moderate bend (use *“Equilibrium Slope for Sediment-Laden Flow”* method for long-term scour, use *“Lacey”* method for general scour including bend).

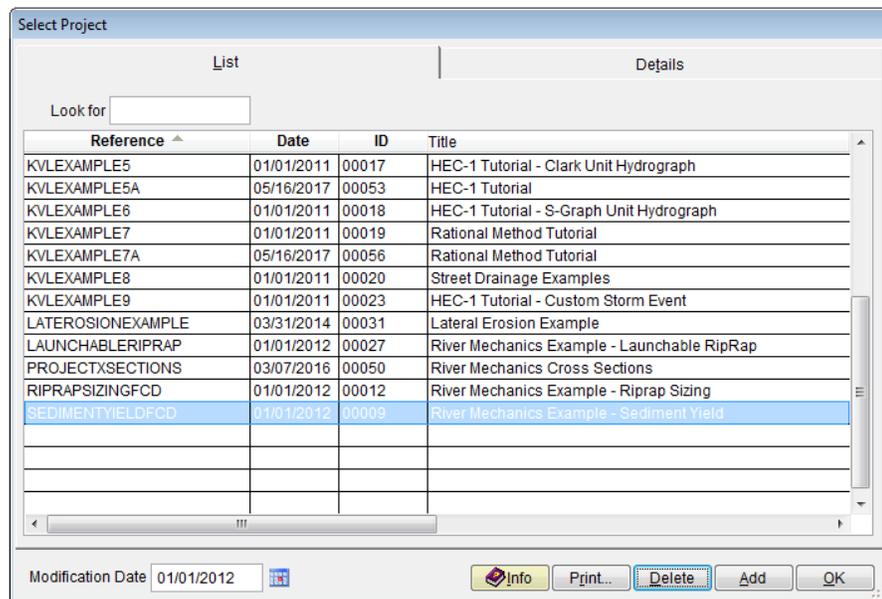
1. Establish a New Project and Default Set-up
2. Prepare the Cross Section Hydraulics
3. Compute Total Scour
 - A. Set up Total Scour Basic Data
 - B. Calculate the Long Term Scour
 - C. Calculate the General Scour
 - D. Calculate the Bedform Scour
 - E. Calculate the Low Flow Scour
 - F. Calculate the Total Scour
4. Report and Documentation of Results

2.1.1 Establish a New Project and Defaults Set-up

- (a) Click the **DDMSW** icon on the Desktop or Program menu to launch the **DDMSW**. Click OK to accept the software disclaimer as is shown in the following figure.

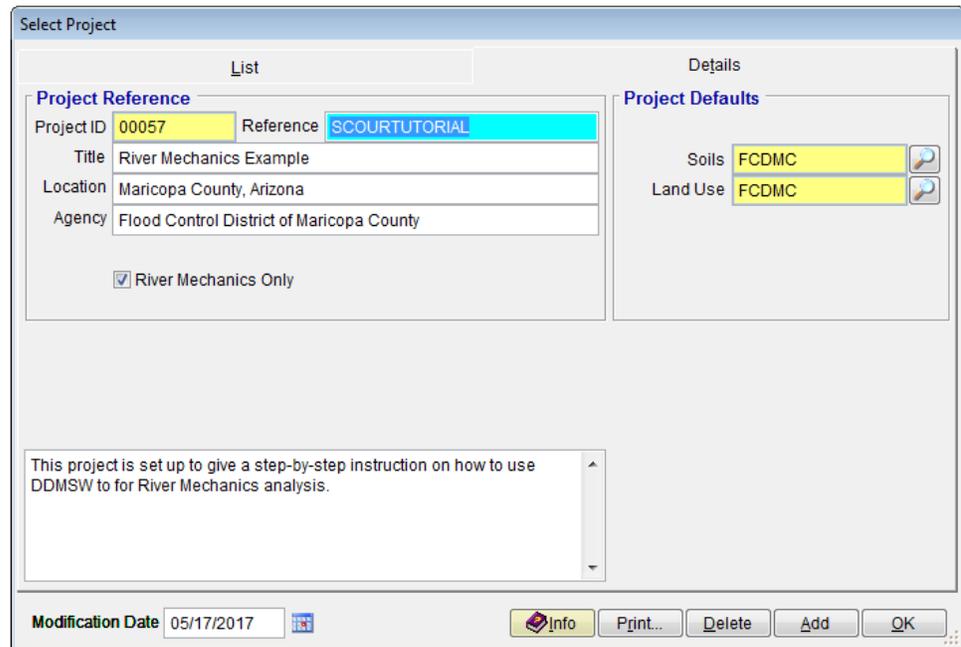


After the **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened as is shown in the following figure.



- (b) Click the **Add** button on the **SELECT PROJECT** window to start a new project (Or **File** → **New Project** → **Add**).
- (c) On the **NEW PROJECT OPTIONS** form, select **River Mechanics** checkbox and click the **OK** button to close the form.

- (d) Type “SCOURTUTORIAL” into the **Reference** textbox. This is the name of this newly created project. The users can choose any name as long as it does not exist in the **DDMSW** database.
- (e) Type into the **Title** textbox a brief descriptive title of this project (**Optional**).
- (f) Type into the **Location** textbox the location of this project (**Optional**).
- (g) Type into the **Agency** textbox the agency or company name (**Optional**).
- (h) Check **River Mechanics Only** checkbox for this project.
- (i) Type a detailed description of this project into the comment area under the **Project Reference** frame (**Optional**).
- (j) Set the **Modification Date** using today’s date by clicking on the Calendar icon.
- (k) Click the **Save** button to save the entered data.
- (l) Click the **OK** button on the **SELECT PROJECT** window to close the window, the following figure shows what the window looks like.
- (m) Click the **OK** button on the pop-up message box.



Note: The **Project ID** “00057” in the above figure is the database records unique read-only identifier of the project, which is automatically generated by the program when a new project is created. When users create a new project, the **Project ID** of this new project will not be the same as the **Project ID** shown in the above figure.

2.1.2 Prepare the Cross Section Hydraulics

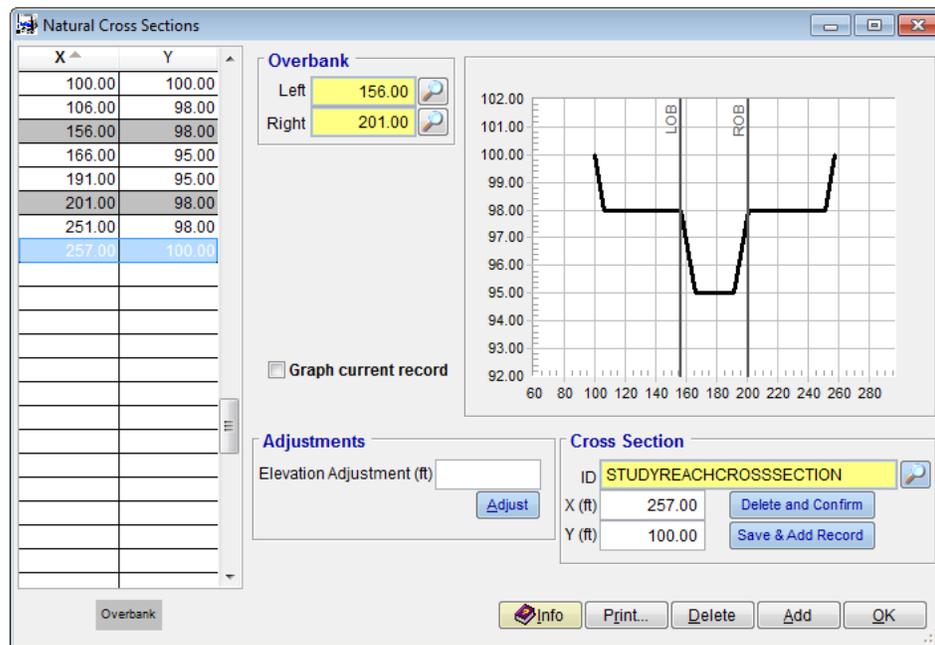
- From the menu bar of the main application window, click River Mechanics → Cross Section Hydraulics to open the **RIVER MECHANICS – CROSS SECTION HYDRAULICS** window.
- Select the “*Calculate Data*” for the **Source** (“*Enter Data*” can also be selected for the **Source** if the hydraulic results for a cross-section are available.)
- Type “*STUDYREACHCROSSECTION*” into the **Cross Section ID** textbox
- By default, both the **Design** and **Dominant** textboxes in the **Entire Cross Section** frame are checked. If not, please check these two checkboxes.
- Type in “*3200*” and “*800*” into the **Flow Rate (cfs)** textboxes for **Design** and **Dominant**, respectively
- Type in “*0.015*” and “*0.015*” into the **Slope (ft/ft)** textboxes for **Design** and **Dominant**, respectively
- Type in “*0.035*” and “*0.035*” into the **Manning’s n Channel** textboxes for **Design** and **Dominant**, respectively. Type in “*0.045*” and “*0.045*” for the **Manning’s n LOB** and **Manning’s n ROB** textboxes.
- Check **Same as Channel Cross Section** checkboxes for both **Design** and **Dominant** in the **Main Channel (Bedform Scour)** frame (Note: These boxes are checked if the bedform scour computation is based on the Channel cross-section hydraulics).
- After the data entry, click the **Save** button. The form should look like the following figure.

- (j) Click the **OK** button to close the window.
- (k) From the menu bar of the main application window, click **River Mechanics** → **Cross Section Geometry** to open the **RIVER MECHANICS – CROSS SECTION GEOMETRY** form.
- (l) Click the “Magnifying Glass” on the right side of the **ID** textbox in the **Cross Section** frame to open the **SELECT CROSS SECTION ID** form. Highlight **Cross Section ID “STUDYREACHCROSSSECTION”** and click **OK** to close the form.
- (m) Click the **Add** button on the **NATURAL CROSS SECTIONS** form and type “100” and “100” into the **X (ft)** and **Y (ft)** textboxes, respectively. Click the **Save & Add Record** button. For the last record, just Click **Save**.
- (n) Repeat the above step (n) for the rest of pairs of **X** and **Y** values provided below.

Station (X)	Elevation (Y)	Notes
106	98	
156	98	<i>Left Bank Station</i>
166	95	
191	95	
201	98	<i>Right Bank Station</i>
251	98	
257	100	

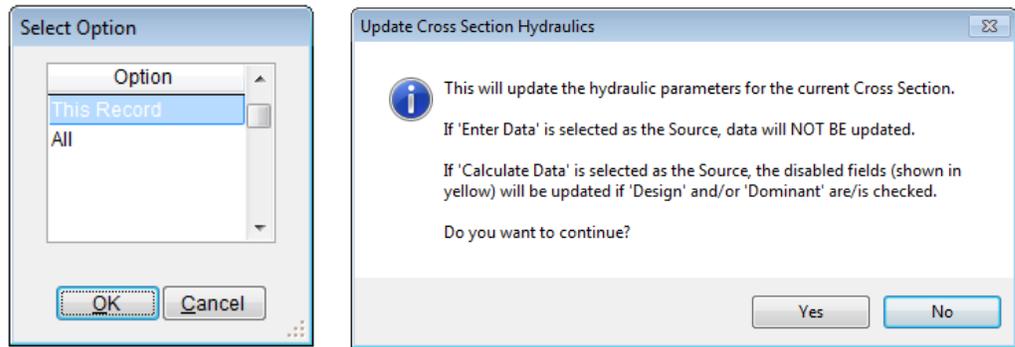
- (o) To define the LOB, highlight the X value = 156 and Click the button adjacent to the Left Overbank. To define the ROB, highlight the X value = 201 and Click the button adjacent to the Right Overbank.

After all the **X** and **Y** values and LOB and ROB are entered, the **NATURAL CROSS SECTIONS** form should look like the following figure.

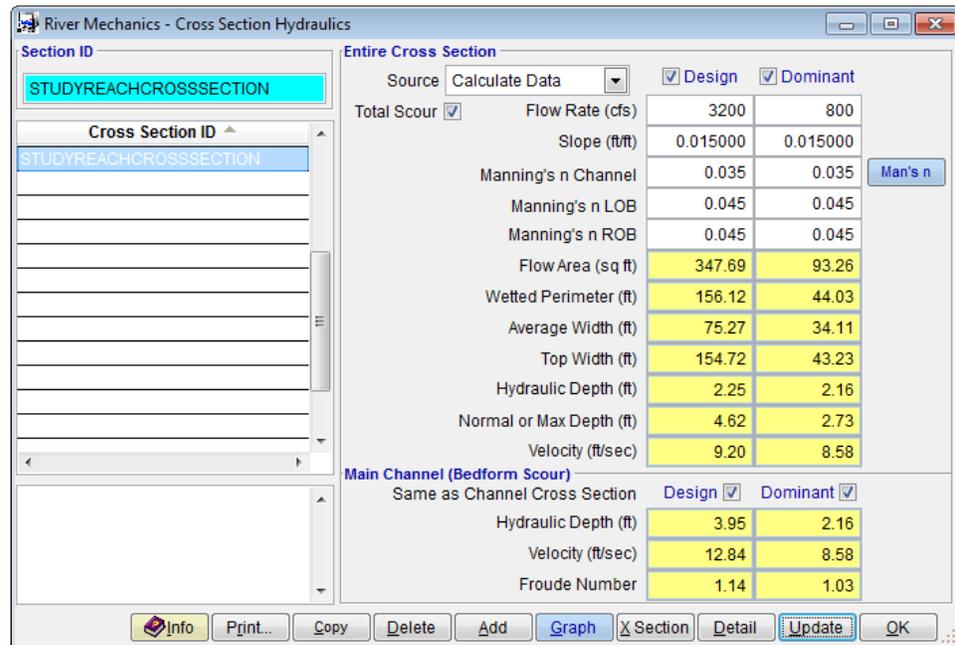


Cross-section data can be imported into **DDMSW**. However, the X-Y data must be prepared based on **DDMSW** X-Y data format before the cross-section is imported. To know the **DDMSW** X-Y data format, export the data of an existing cross-section (**File** → **Export Data** → select “Cross Sections” under “Hydraulics” Section on the **SELECT A TABLE TO EXPORT** form. Click the **Export** button and on the **SELECT FIELDS TO EXPORT** form, select “XLS” as the **Export Type**. Click **Save** to save the setting, and click **Export**. On the **SAVE As** form, navigate to where you want to save the exported file and click the **Save** button. Finally, click **OK**. Once the file is created, the format can be examined. The format could be used as template for creating importable *.XLS files to DDMSW).

- (p) Click **OK** to close the **NATURAL CROSS SECTIONS** form.
- (q) Go back to the main application window, and click **River Mechanics** → **Cross Section Hydraulics** from the menu bar to open the **RIVER MECHANICS – CROSS SECTION HYDRAULICS** form. Click the **Update** button to update the hydraulic parameter listed on the form by performing a hydraulic analysis using the geometric data provided. The textboxes with yellow highlights will be populated with results from the analysis.
- (r) Highlight “This Record” and click the **OK** button to close the **SELECT OPTION** form. Click **Yes** on the **UPDATE CROSS SECTION HYDRAULICS** form to continue.



After the update, the **RIVER MECHANICS – CROSS SECTION HYDRAULICS** form should look like the following figure.

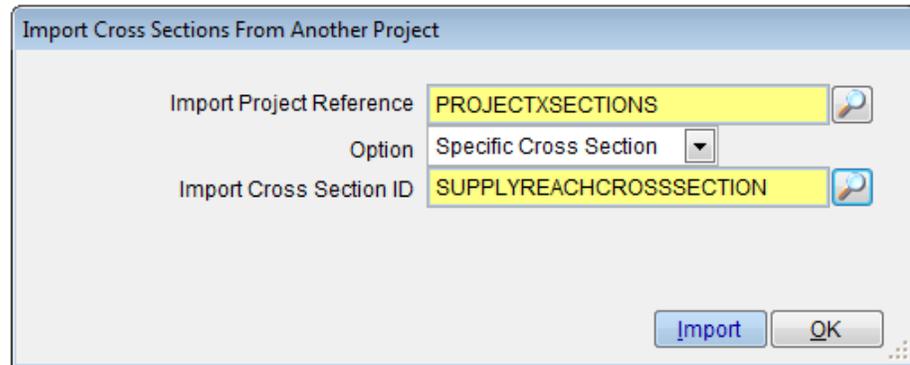


To create the supply reach cross section data for the project, the user can manually enter the dataset using the same procedure [i.e., Step 2, from (a) to (r)]. In this tutorial, since the data have already been created in another project, the "SUPPLYREACHCROSSSECTION" dataset will be imported.

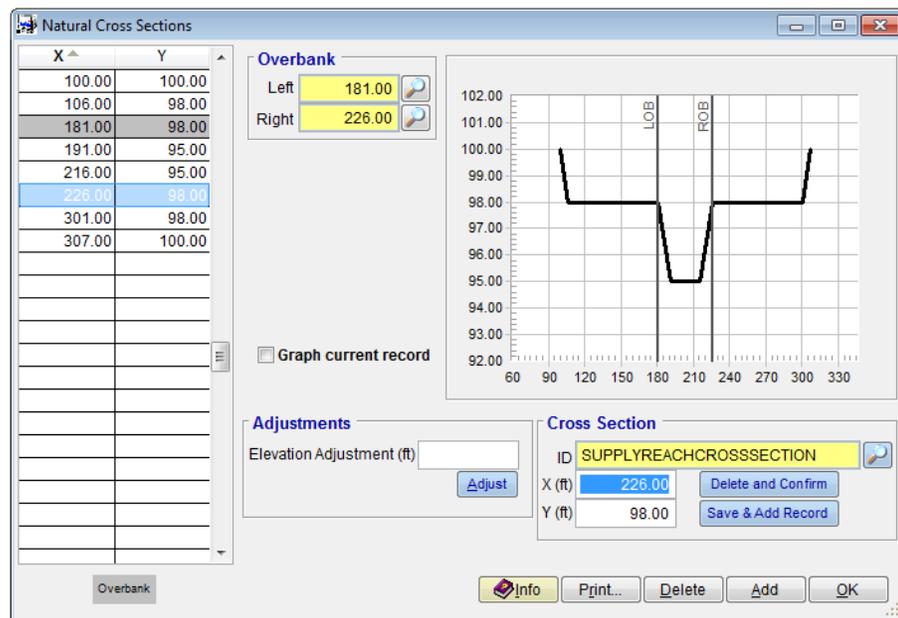
- (s) To import all cross sections that will be used in this tutorial, open the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form (**River Mechanics** → **Import Cross Sections from Another Project**).
- (t) On the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form, use the data provided below. Click **Import** to import the cross section data into the project. Select **Yes** to continue, and hit **OK** to close the form.

- **Import Project Reference:** PROJECTXSECTIONS
- **Option:** Specific Cross Sections

- **Import Cross Section ID:** *SupplyReachCrossSection*



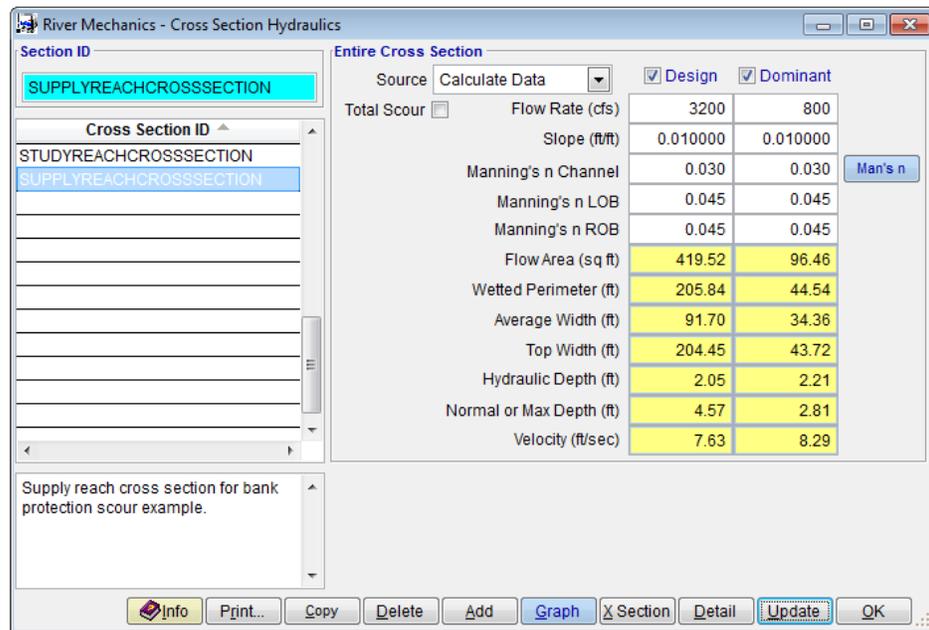
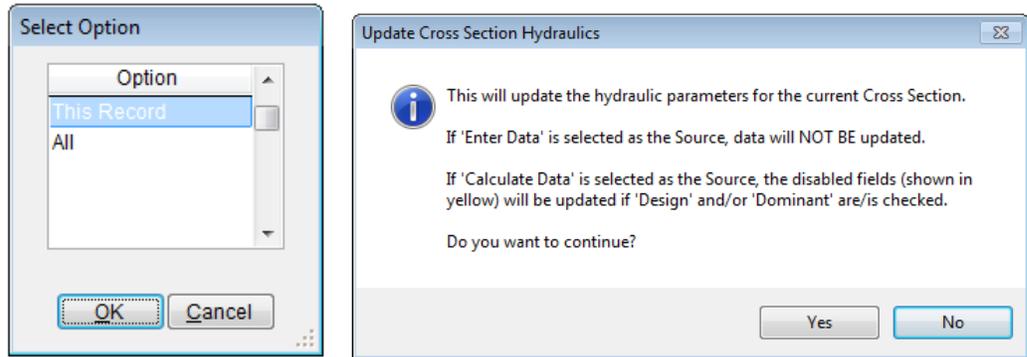
To check if the cross section data has been successfully imported, open the **NATURAL CROSS SECTIONS** form (**River Mechanics** → **Cross Section Geometry**).



(u) Go back to the main application window, and click **River Mechanics** → **Cross Section Hydraulics** from the menu bar to open the **RIVER MECHANICS – CROSS SECTION HYDRAULICS** form. Highlight the “SUPPLYREACHCROSSECTION” and enter the following data:

- **Uncheck Total Scour**
- **Design Flow Rate (cfs):** 3200
- **Dominant Flow Rate (cfs):** 800
- **Design and Dominant Slope (ft/ft):** 0.010
- **Design and Dominant Manning’s n Channel:** 0.030
- **Design and Dominant Manning’s n LOB, and ROB:** 0.045

- (v) Click the **Update** button to update the hydraulic analysis results.
- (w) On the **SELECT OPTION** form, select *"This Record"* and click **OK**. Hit **Yes** to continue.



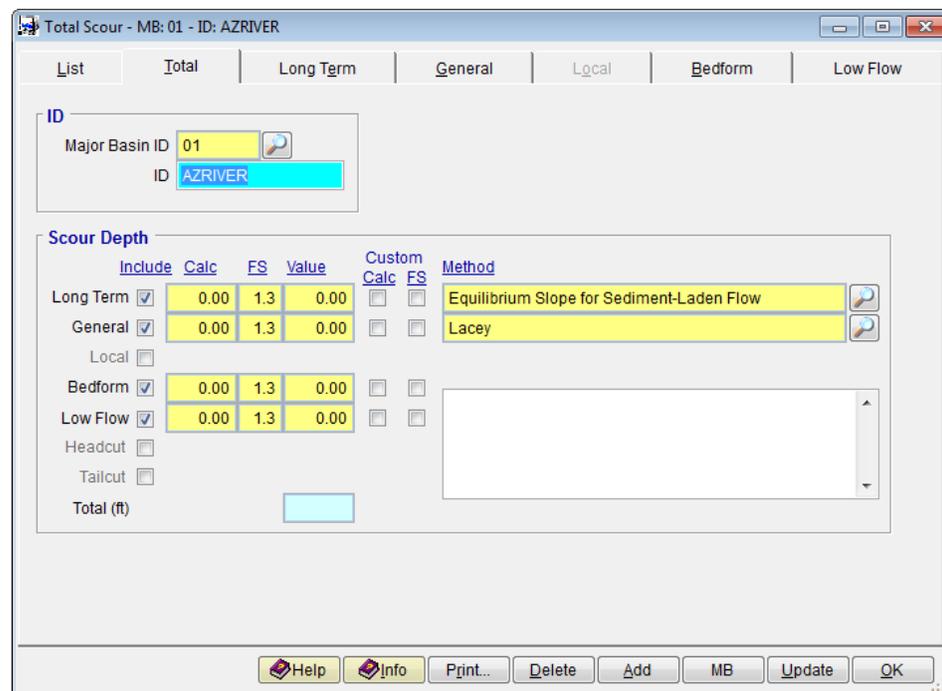
- (x) Click **OK** to close the **RIVER MECHANICS – CROSS SECTION HYDRAULICS** form.

Creating the two cross sections and evaluating their respective hydraulics in **Step 2** are essential steps before proceeding to **Step 3** of this tutorial.

2.1.3 Compute Total Scour

A. Set up Total Scour Basic Data

- From the menu bar of the main application window, click **River Mechanics** → **Scour**, to open the **TOTAL SCOUR** form.
- Click the **Add** button on the **TOTAL SCOUR** form to activate the data entry fields.
- Type “AZRIVER” into the **ID** textbox.
- Check the check boxes for **Long Term**, **General**, **Bedform**, and **Low Flow** (Note: Do not check **Local**)
- Click the browse button  in the **Method** column across **Long Term** check box and select “*Equilibrium Slope for Sediment-Laden Flow*”.
- Click the browse button  in the **Method** column across **General** check box and select “*Lacey*” method from the **SELECT METHOD** form to identify the method to use for General scour analysis.
- Click the **Save** Button to save the entered data. The **TOTAL SCOUR** form should look like the following figure.



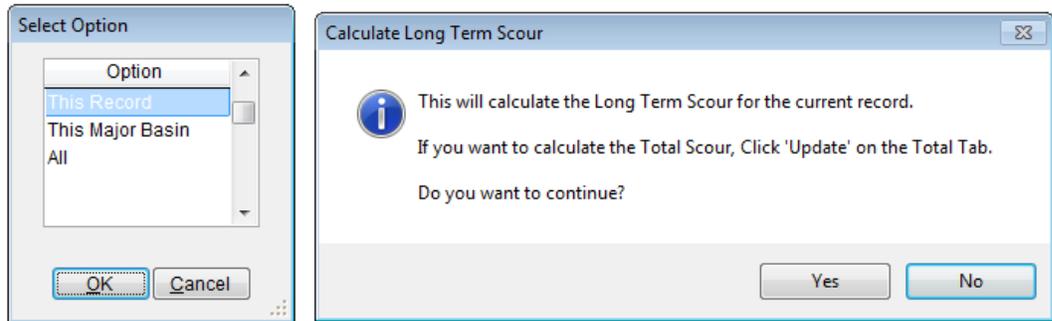
The screenshot shows the 'Total Scour' form for Major Basin ID '01' and ID 'AZRIVER'. The 'Total' tab is active. The 'Scour Depth' section contains a table with the following data:

	Include	Calc	FS	Value	Custom Calc	FS	Method
Long Term	<input checked="" type="checkbox"/>	0.00	1.3	0.00	<input type="checkbox"/>	<input type="checkbox"/>	Equilibrium Slope for Sediment-Laden Flow
General	<input checked="" type="checkbox"/>	0.00	1.3	0.00	<input type="checkbox"/>	<input type="checkbox"/>	Lacey
Local	<input type="checkbox"/>						
Bedform	<input checked="" type="checkbox"/>	0.00	1.3	0.00	<input type="checkbox"/>	<input type="checkbox"/>	
Low Flow	<input checked="" type="checkbox"/>	0.00	1.3	0.00	<input type="checkbox"/>	<input type="checkbox"/>	
Headcut	<input type="checkbox"/>						
Tailcut	<input type="checkbox"/>						
Total (ft)							

The 'Total (ft)' field is currently empty. The bottom of the form features buttons for Help, Info, Print..., Delete, Add, MB, Update, and OK.

B. Calculate the Long Term Scour

- (a) Select the **Long Term** tab as shown in the following figure.
- (b) Click browse button  beside the **Study Reach Cross Section ID** to select the cross section ID *"STUDYREACHCROSSECTION"*.
- (c) Click browse button  beside the **Supply Reach Cross Section ID** to select the cross section ID *"SUPPLYREACHCROSSECTION"*.
- (d) Enter the **D50 (mm)** values *"2.0"* and *"1.5"* for **Supply** and **Study**, respectively.
- (e) Enter the **D84 (mm)** values *"12"* and *"10"* for **Supply** and **Study**, respectively.
- (f) Enter the **D16 (mm)** values *"1.0"* and *"0.5"* for **Supply** and **Study**, respectively.
- (g) Enter *"800"* into **Length to Pivot Pt (ft)** textbox
- (h) Click the **Save** button to save the entered data.
- (i) Click the **Update** button to start the computation; select *"This Record"* from the **SELECTION OPTION** window, and click **Yes** to continue.



After the update, the final result of the **Long Term Scour calculation** is shown in the following figure.

Total Scour - MB: 01 - ID: AZRIVER

List | Total | Long Term | General | Local | Bedform | Low Flow | Pier Influence

Equilibrium Slope Sediment-Laden (use Dominant flow rate)

Study Reach Cross Section ID: STUDYREACHCROSSECTION

Supply Reach Cross Section ID: SUPPLYREACHCROSSECTION

	Supply	Study	Equilib
Flow Rate (cfs)	800	800	800
Slope (ft/ft)	0.010000	0.015000	0.01067268
Manning's n	0.030	0.035	0.035
Wetted Area (sq ft)	96.46	93.26	104.99
Hydraulic Depth (ft)	2.21	2.16	2.33
Normal or Max Depth (ft)	2.81	2.73	3.00
Average Width (ft)	34.36	34.11	34.11
Average Velocity (ft/s)	8.29	8.58	7.62
D50 (mm)	2.000	1.500	
D84 (mm)	12.000	10.000	
D16 (mm)	1.000	0.500	
Length to Pivot Pt (ft)		800	

	Supply	Study	Equilib
Gradation Coefficient	4.00	4.83	4.83
Total Bed Mat'l Q (cfs)	3.98	7.84	4.59

Scour Depth (ft): 3.46

Help | Info | Print... | Delete | Add | MB | Update | OK

C. Calculate the General Scour

- Click the **General** tab to evaluate the General scour.
- Click browse  button beside the **Cross Section ID** to select the cross section ID "STUDYREACHCROSSECTION".
- Enter "1.5" into the **D50 (mm)** textbox.
- Click the browse  button beside the **Bend Factor, Z** and select "Moderate Bend".
- Click the **Save** button to save the entered data.
- Click the **Update** button and select "This Record" from the **SELECTION OPTION** window. Click **Yes** on the **CALCULATE GENERAL SCOUR** form to proceed.

Select Option

Option

- This Record
- This Major Basin
- All

OK Cancel

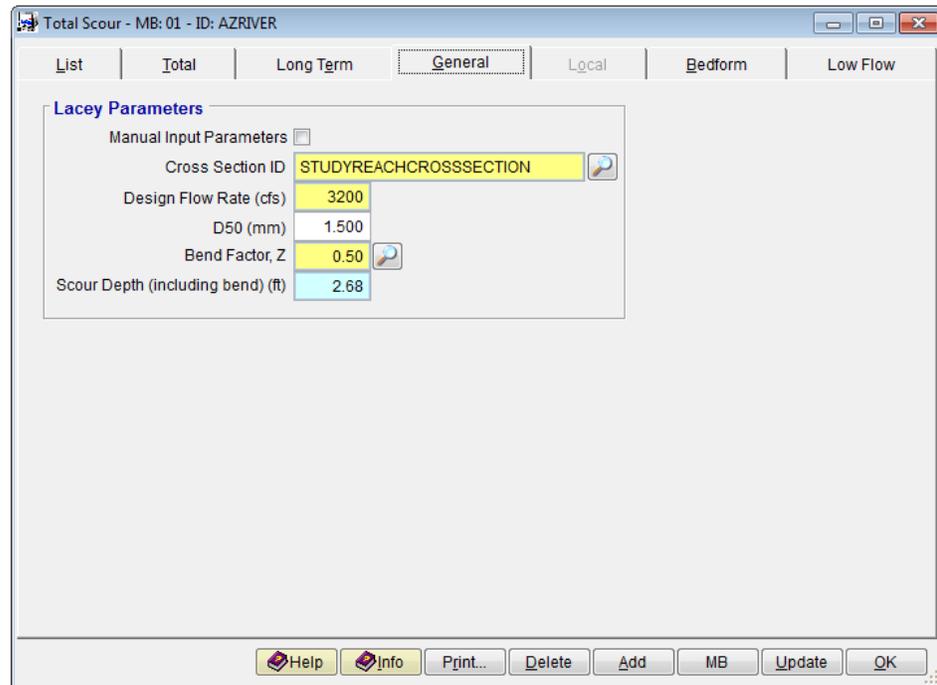
Calculate General Scour

 This will calculate the General Scour for the current record.
If you want to calculate the Total Scour, Click 'Update' on the Total Tab.

Do you want to continue?

Yes No

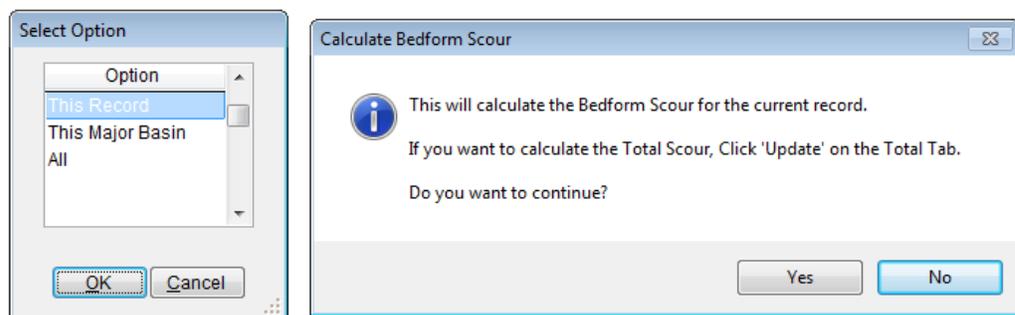
After the update, the final result of the general term scour calculation is shown in the following figure.



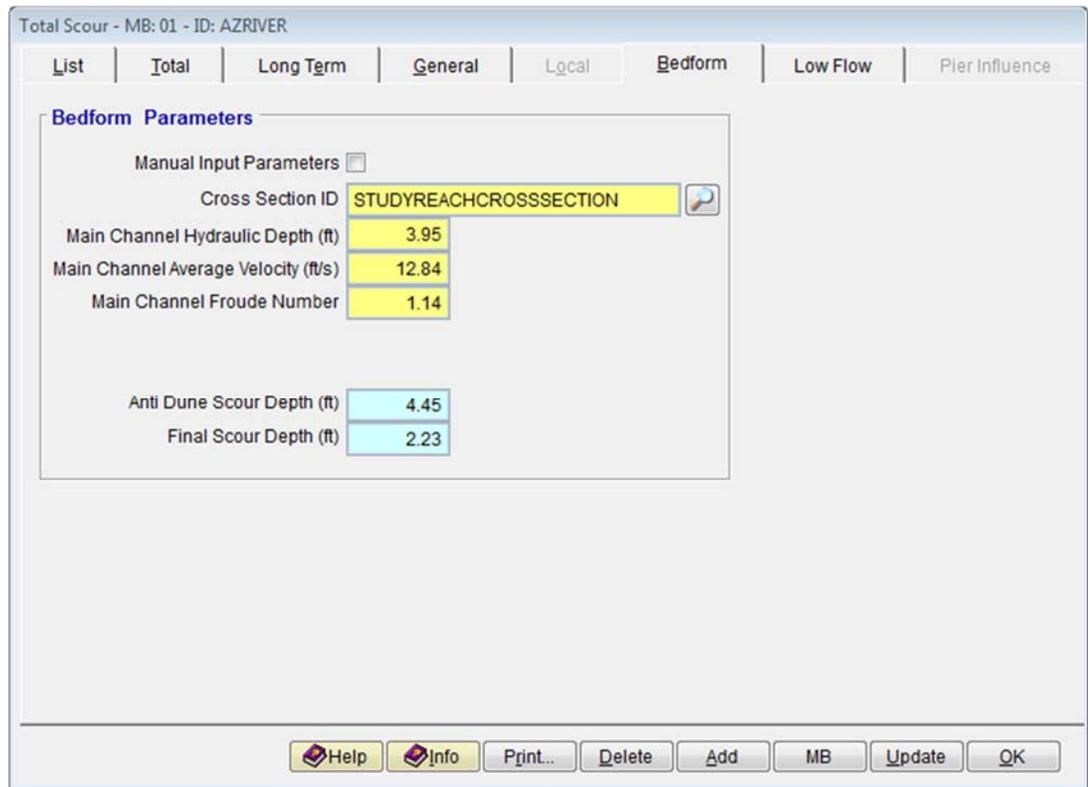
D. Calculate the Bedform Scour

In this section, a procedure on how to calculate the bedform scour will be provided.

- Click browse  button beside the **Cross Section ID** to select the cross section ID *"STUDYREACHCROSSECTION"*.
- Set the **Dune Height/Depth** value to *"0.20"*.
- Click the **Save** button to save the data just entered.
- Click the **Update** button and select *"This Record"* from the **SELECTION OPTION** window. Click **Yes** on the **CALCULATE GENERAL SCOUR** form to proceed.



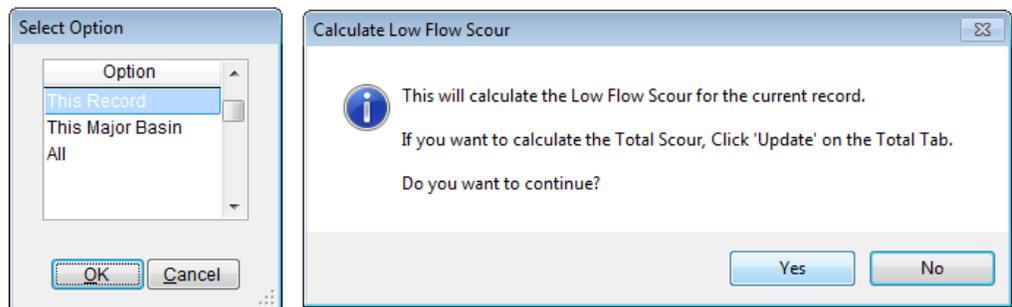
After the update, the final result of the bedform scour calculation is shown in the following figure.



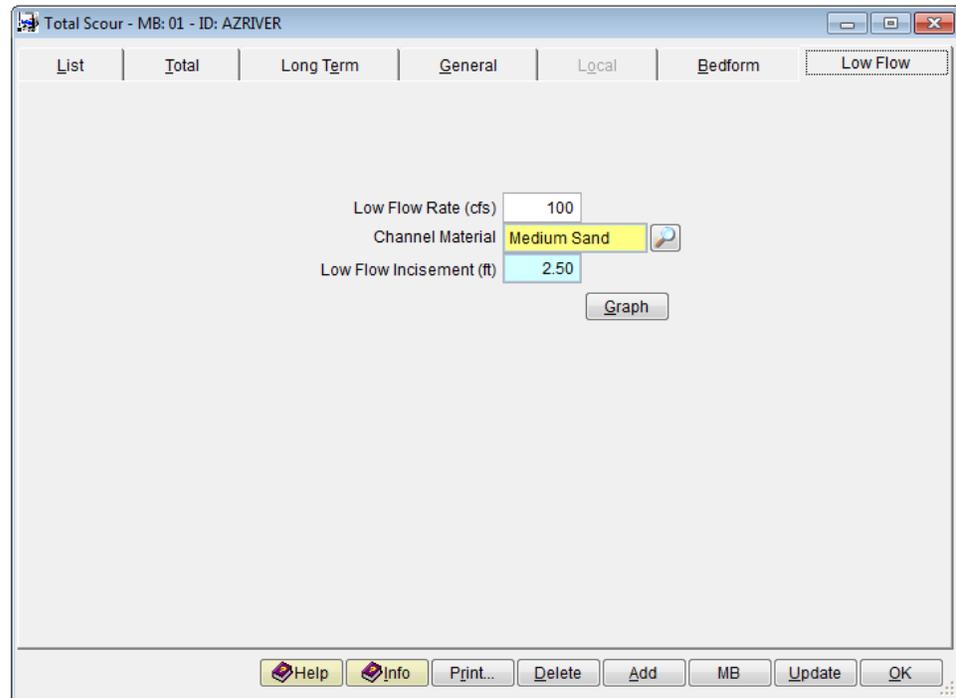
E. Calculate the Low Flow Scour

In this section, a procedure on how to calculate the low-flow scour will be provided.

- (a) Enter "100" into the **Low Flow Rate (cfs)** textbox.
- (b) Click browse  button beside the **Channel Material** to select the channel material data and choose "Medium Sand".
- (c) Click the **Save** button to save the data just entered.
- (d) Click the **Update** button and select "This Record" from the **SELECTION OPTION** window. Click **Yes** on the **CALCULATE GENERAL SCOUR** form to proceed.

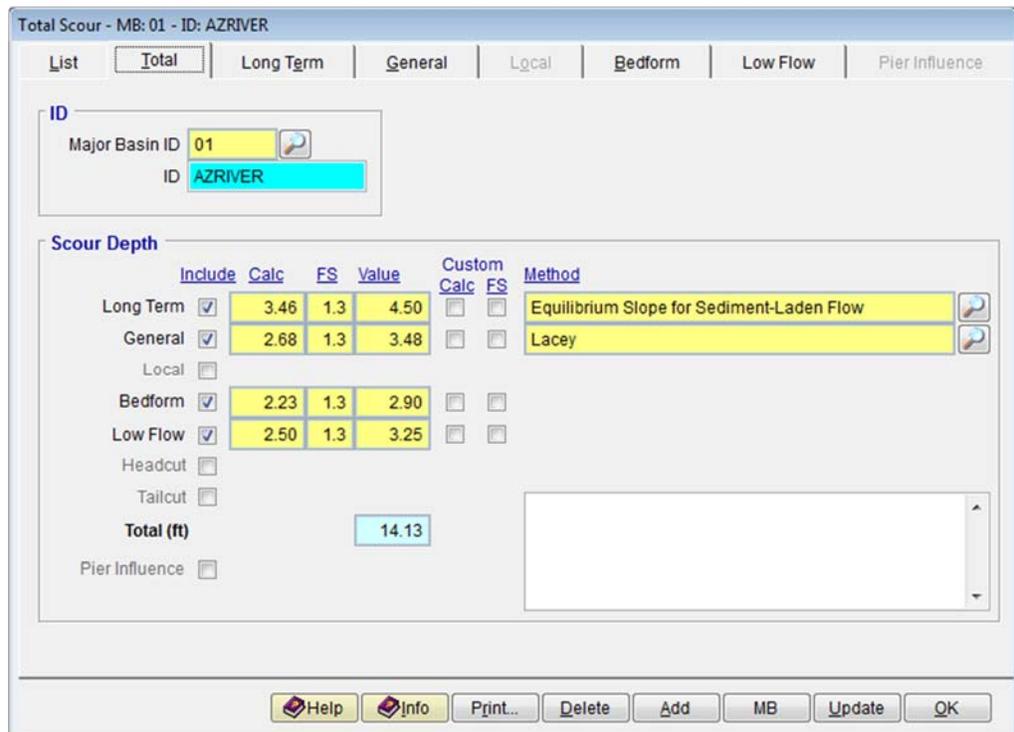


After the update, the final result of the low flow scour calculation is shown in the following figure.



F. Calculate the Total Scour

On the **TOTAL SCOUR** form, select the **Total** tab. The following figure shows what the form looks like. As shown, the analysis results for the total scour which is the combination of the individual scour components previously analyzed are displayed.



2.1.4 Report and Documentation of Results

In this section, procedures will be given on how to view, print, and export the calculation results for the total scour analysis.

The total scour is the sum of the long term scour, general scour, local scour, bedform scour and low flow scour. In this tutorial, only the following four scours are covered, that is, the long term scour, general scour, bedform scour and low flow scour.

Make sure all the four scours listed above are checked in the **Total** tab and all the listed scours are updated.

- (a) To view the results on the screen, click the **Print ...** button on the **TOTAL SCOUR – MB: 01 – ID: AZRIVER** form, a report will be generated as shown in the following figure.

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - TOTAL SCOUR
Project Reference: SCOURTUTORIAL2

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Major Basin: 01
ID: AZRIVER Cross Section ID: STUDYREACHCROSSSECTION

Type	Calc (ft)	F.S	Value (ft)	Method
Long Term	3.48	1.30	4.50	Equilibrium Slope for Sediment-Laden Flow
General	2.68	1.30	3.48	Lacey
Local		1.30		
Bedform	2.23	1.30	2.90	Comments
Low Flow	2.50	1.30	3.25	
Pressure Flow	0.00	1.30	0.00	
Headout	-	1.30	-	
Tailout	-	1.30	-	
Total			14.13	

- (b) To print out the results on a printer, click the printer symbol ).
- (c) To export the results in PDF format or other formats, click the export symbol )
- (d) The individual scour components results and cross section hydraulics results can also be viewed, printed, and exported by clicking the **Print...** button under individual component scour menus and **Cross Section Hydraulics** menu.

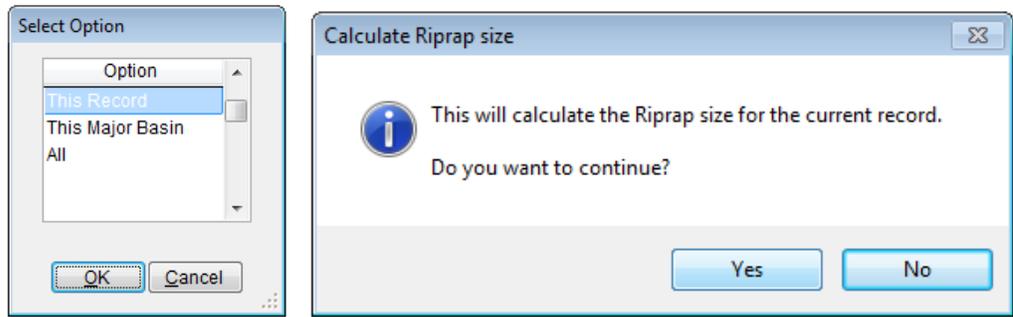
2.2 Riprap Sizing for Bank Protection

Estimate the riprap sizing for bank protection using “*Channel Banks on Curved Reach*”.

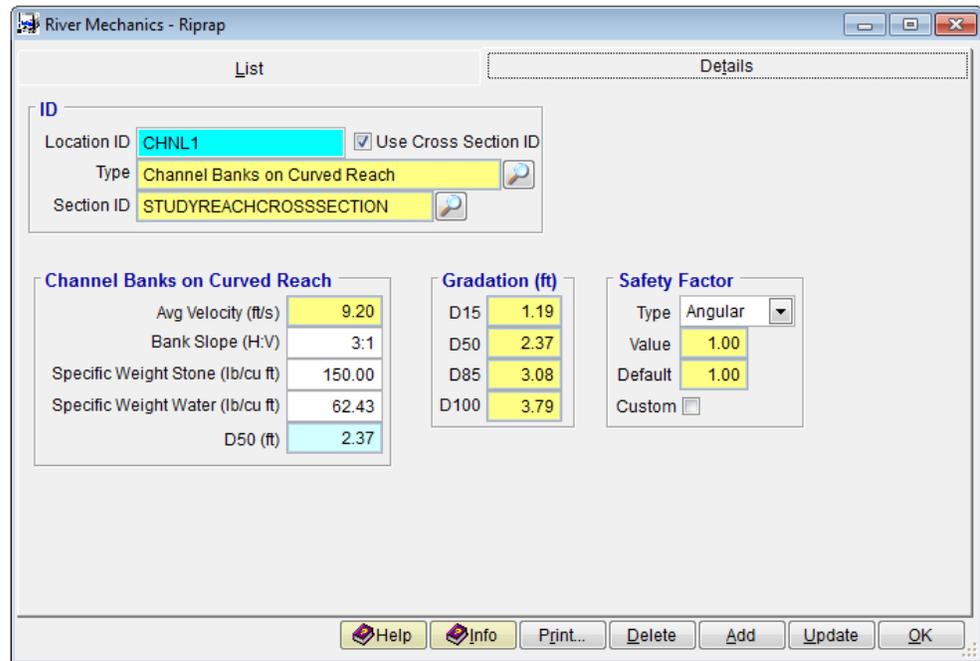
1. Calculate Riprap Sizing
2. Report and Document the Results

2.2.1 Calculate Riprap Sizing

- (a) From the menu bar of main application window, click **River Mechanics** → **Riprap** to open the **RIVER MECHANICS - RIPRAP** window.
- (b) Click **Add** button on the **RIVER MECHANICS - RIPRAP** window.
- (c) Enter “*CHNL1*” into the **Location ID** textbox
- (d) Browse for “*Channel Banks on Curved Reach*” in the **Type** textbox
- (e) Click **OK** on the **SELECT TYPE** dialog box.
- (f) Check **Use Cross Section ID** check box
- (g) Browse for “*STUDYREACHCROSSSECTION*” in the **Section ID** textbox.
- (h) Click **OK** on the **SELECT CROSS SECTION ID** dialog box.
- (i) Enter “*3:1*” into the **Bank Slope (H:V)** textbox
- (j) Enter “*150.00*” into the **Specific Weight Stone (lb/cu ft)** textbox
- (k) Enter “*62.43*” into the **Specific Weight Water (lb/cu ft)** textbox (if not entered)
- (l) Select “*Angular*” from the drop down for Riprap **Type** in the **Safety Factor** frame.
- (m) Click the **Save** button.
- (n) Click **Update** button to compute riprap median size **D50 (ft)**.
- (o) Highlight “*This Record*” in the **SELECTION OPTION** window and click **OK**. Click **Yes** when the **CALCULATE RIPRAP SIZE** dialog box opens.



After the update process is finished, the window looks like what is shown in the following figure. Click **OK** to close the window.



2.2.2 Report and Document the Results

- (a) Click the **Print ...** button on the **RIVER MECHANICS – RIPRAP** window. A report will be generated as is shown in the following figure.

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - RIPRAP
Project Reference: BANKPROTECTIONFCDD

5/18/2017

ID	Type	Section ID	Design Q (cfs)	Slope (ft/ft)	Width (ft)	Average Velocity (ft/s)	Specific Weight Stone (lb/cu ft)	Specific Weight Water (lb/cu ft)	Bank Slope (H:V)	Safety Factor	D50 (ft)
CHNL1	Channel Banks on Curved Reach	STUDYREACHCROSSSECTION	3,200	0.02	75.27	9.20	150.00	62.43	3:1	1.00	2.37

This concludes this tutorial for riprap size for bank protection.

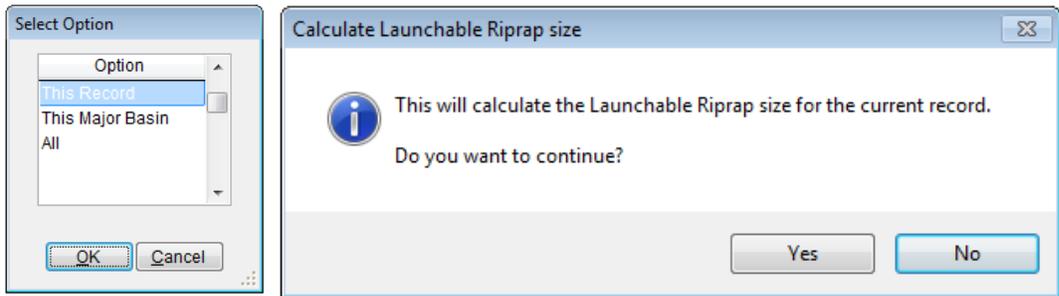
2.3 Launchable Riprap Sizing for Bank Protection

Estimate the launchable riprap sizing for bank protection using “*Channel Banks on Curved Reach*”.

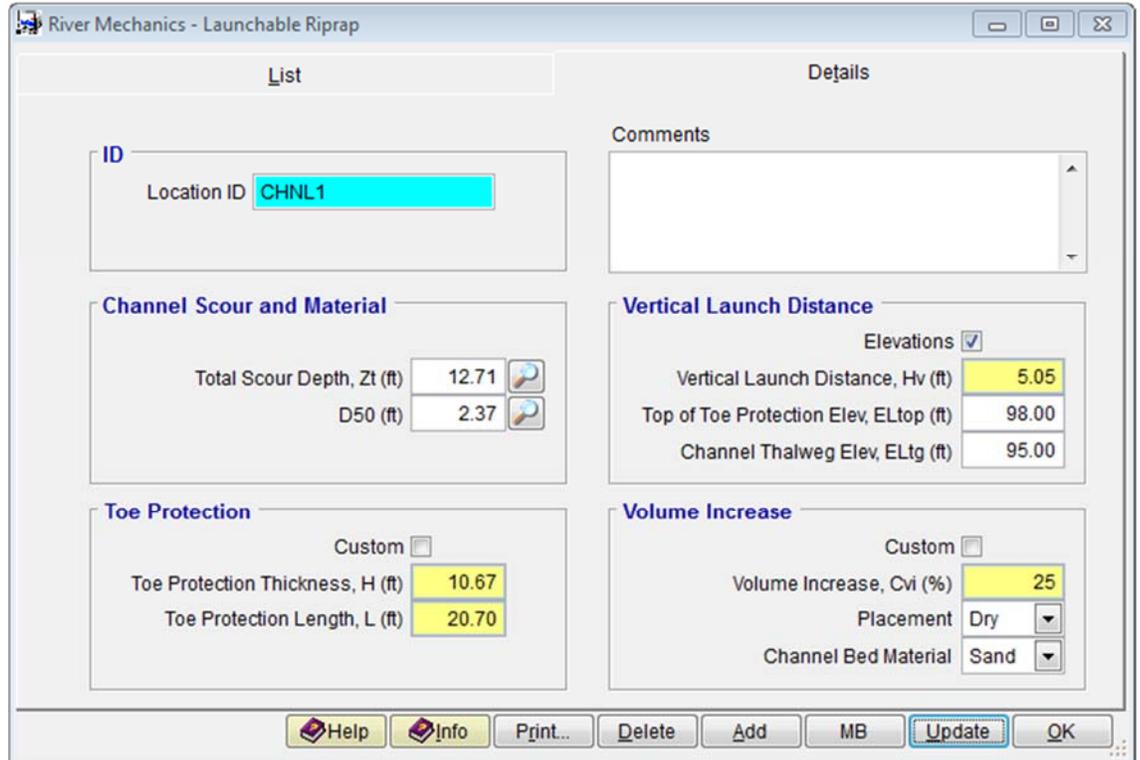
1. Calculate Launchable Riprap Sizing
2. Report and Document the Results

2.3.1 Calculate Launchable Riprap Sizing

- (a) From the menu bar of main application window, click **River Mechanics** → **Launchable Riprap** to open the **RIVER MECHANICS – LAUNCHABLE RIPRAP** window.
- (b) Click **Add** button on the **RIVER MECHANICS – LAUNCHABLE RIPRAP** window.
- (c) Enter “*CHNL1*” into the **Location ID** textbox
- (d) Enter 12.71 into the **Total Scour Depth** textbox (Note this value can be linked to a value already calculated by browsing for the data and selecting the Import Project Reference and Import ID)
- (e) Enter 2.37 into the **D50** textbox (Note this value can be linked to a value already calculated by browsing for the data and selecting the Import Project Reference and Import ID)
- (f) Check **Elevations** check box
- (g) Enter “*98.00*” in the **Top of Toe Protection Elev** textbox.
- (h) Enter “*95.00*” in the **Channel Thalweg Elev** textbox.
- (i) Select “*Dry*” for the **Placement**
- (j) Select “*Sand*” for the **Channel Bed Material**.
- (k) Click the **Save** button.
- (l) Click **Update** button to compute launchable riprap parameters.
- (m) Highlight “*This Record*” in the **SELECTION OPTION** window and click **OK**. Click **Yes** when the **CALCULATE LAUNCHABLE RIPRAP SIZE** dialog box opens.



After the update process is finished, the window looks like what is shown in the following figure. Click **OK** to close the window.



2.3.2 Report and Document the Results

Click the **Print ...** button on the **RIVER MECHANICS – LAUNCHABLE RIPRAP** window. A report will be generated as is shown in the following figure.

Flood Control District of Mariopa County
Drainage Design Management System
RIVER MECHANICS - LAUNCHABLE RIPRAP
Project Reference: SCOURTUTORIAL2

Page 1 5/21/2018

ID	Cross Section ID	D50 (ft)	Scour Depth (ft)	Vertical Launch (ft)	Top of Toe Elevation (ft)	Channel Thalweg Elevation (ft)	Volume Increase (%)	Layer Thickness (ft)	Toe Thickness (ft)	Toe Length (ft)
CHNL1		2.37	12.71	5.05	98.00	95.00	25	3.56	10.67	20.70

This concludes this tutorial for launchable riprap size for bank protection.

2.4 Lateral Erosion

Estimate the lateral erosion corridor for a watercourse as a basis to protect the public from potential hazard situation.

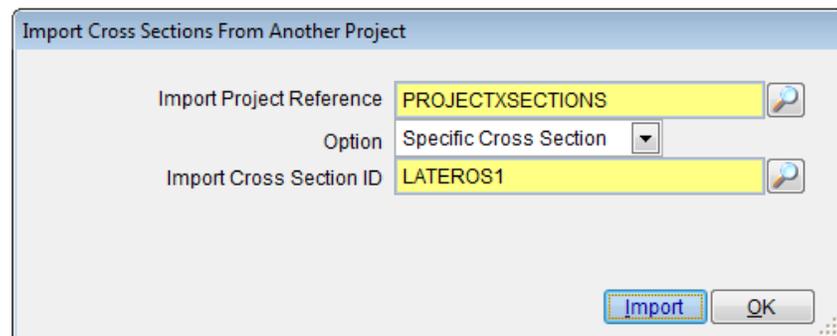
Calculation of Lateral Erosion Distance are made on the following basis:

- A. No Data Available
- B. Scour Data Available
- C. Scour and Historical Data Available
- D. Scour, Historical and Cross Section Data Available

2.4.1 Prepare the Cross Section and Hydraulics Data

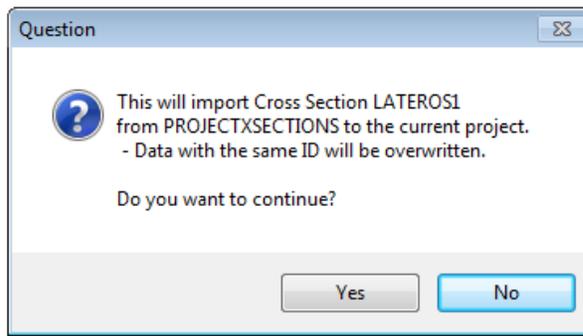
To develop the cross section and hydraulic data to be used for this project, the “*LATEROS1*” dataset will be used which will be imported from another project.

- (a) From the menu bar of main application window, click **River Mechanics** → **Import Cross Sections from Another Project** to open the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form.
- (b) On the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form, select the settings shown on the following form:

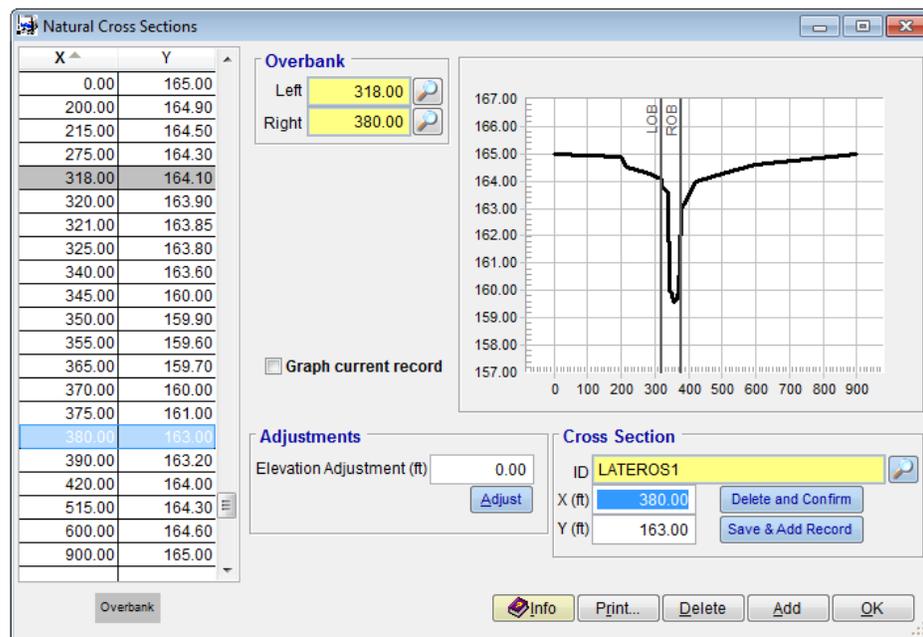


The screenshot shows a dialog box titled "Import Cross Sections From Another Project". It contains three input fields: "Import Project Reference" with the value "PROJECTXSECTIONS", "Option" with a dropdown menu set to "Specific Cross Section", and "Import Cross Section ID" with the value "LATEROS1". Each input field has a magnifying glass icon to its right. At the bottom right, there are two buttons: "Import" and "OK".

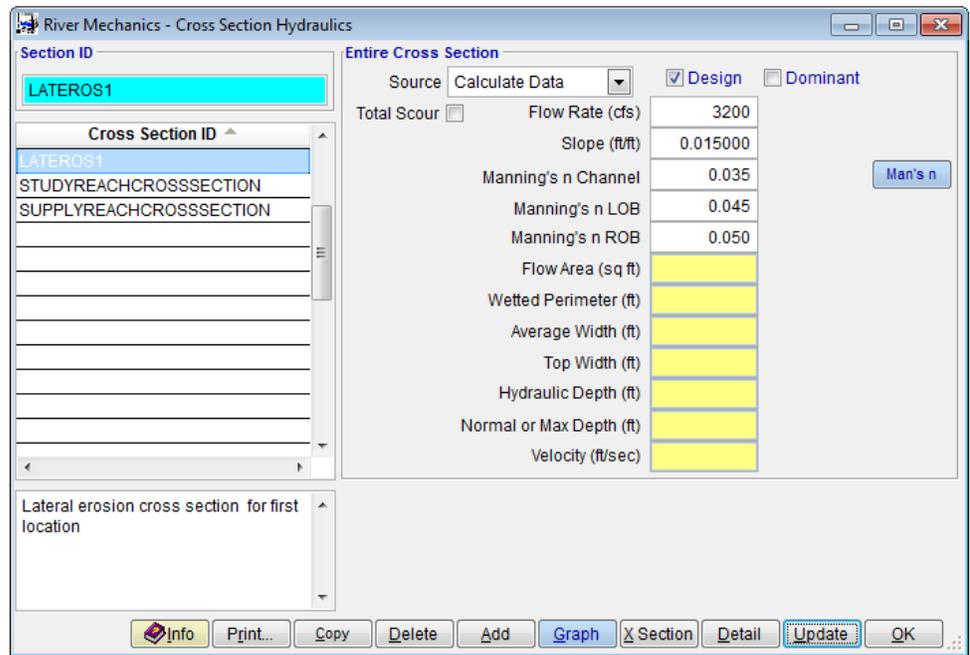
- (c) Once the specified data have been selected, click the **Import** button. Select **Yes** to proceed, and hit **OK** to close the **IMPORT CROSS SECTION FROM ANOTHER PROJECT** form.



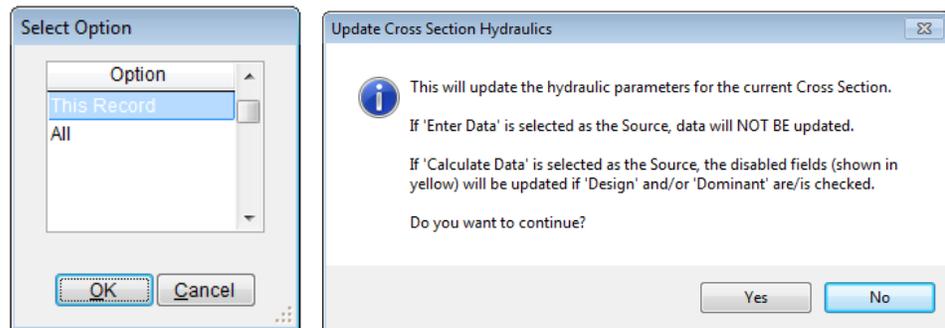
- (d) To check if the lateral erosion cross section data has been successfully imported, open the **NATURAL CROSS SECTIONS** form (**River Mechanics → Cross Section Geometry**).
- (e) On the form, select “*LATEROS1*” for the **Cross Section ID** by clicking the Selector button at the right side of the **ID** textbox.



- (f) To establish the cross-section hydraulic data, open the **CROSS SECTION HYDRAULICS** form (**River Mechanics → Cross Section Hydraulics**) and on the form select “*LATEROS1*” from the **Cross Section ID** listing, check the box **Design** and select “*Calculate Data*” in **Source** drop down list if not already selected or checked. Now enter the data shown on the following form:



- (g) Click **Save** to save the edits.
- (h) To recalculate or update the hydraulic analysis on this form, click **Update**.
- (i) Select “*This Record*” from the **SELECT OPTION** form. Click **OK** to close the form.
- (j) Click **Yes** on the **UPDATE CROSS SECTION HYDRAULICS** form to continue.



- (k) The results are shown on the following form:

River Mechanics - Cross Section Hydraulics

Section ID: **LATEROS1**

Cross Section ID: LATEROS1, STUDYREACHCROSSSECTION, SUPPLYREACHCROSSSECTION

Entire Cross Section

Source: Calculate Data Design Dominant

Total Scour Flow Rate (cfs): 3200

Slope (ft/ft): 0.015000

Manning's n Channel: 0.035

Manning's n LOB: 0.045

Manning's n ROB: 0.050

Flow Area (sq ft): 557.04

Wetted Perimeter (ft): 901.70

Average Width (ft): 102.90

Top Width (ft): 900.00

Hydraulic Depth (ft): 0.62

Normal or Max Depth (ft): 5.41

Velocity (ft/sec): 5.74

Lateral erosion cross section for first location

Info Print... Copy Delete Add Graph Section Detail Update OK

(I) Click **OK** to close the form.

2.4.2 Calculate Lateral Erosion Distance

Four (4) analysis scenarios will be presented in this tutorial. These different scenarios are dependent on availability of data for analysis. These scenarios include: (a) no data; (b) with scour data; (c) with scour and historical data; and (d) with scour, historical, and cross section data.

A. Scenario #1 – No Data

- (a) On the **RIVER MECHANICS – LATERAL EROSION** form (**River Mechanics** → **Lateral Erosion** → **Details** tab).
- (b) Click **Add** to enter a new data and type in “*LOCID*” on the **Location ID** textbox and then make sure that all the check boxes in the **Available Data** frame are unchecked.
- (c) Type in “4.5” into the **Channel Depth, D (ft)** textbox. This information is assumed to be the field estimate made on the channel depth.
- (d) Click **Save** to save the data entered.
- (e) To calculate the **Lateral Erosion Distance, L (ft)**, click the **Update** button and select “*This Record*” from the **SELECT OPTION** form. Click **OK** to close the form.
- (f) Click **Yes** when the **CALCULATE LATERAL EROSION** form opens.

The following screen capture below shows the results of the analysis. The only data used was a field estimate of the **Channel Depth, D (ft)** at the location of interest.

The screenshot shows a software window titled "River Mechanics - Lateral Erosion" with two tabs: "List" and "Details". The "Details" tab is active. It contains several input fields and checkboxes. The "ID" section has a "Location ID" field with the value "LOCID". The "Available Data" section has three checkboxes: "Scour", "Historical Photo", and "Cross Section", all of which are unchecked. The "Lateral Erosion" section has a "Channel Depth, D (ft)" field with the value "4.50" and a "Lateral Erosion Distance, L (ft)" field with the value "81.0". The "Lateral Erosion Distance" field is highlighted in yellow. At the bottom, there is a "Comments" text area and a row of buttons: "Help", "Info", "Print...", "Delete", "Add", "Update", and "OK". The "Update" button is highlighted with a blue border.

B. Scenario #2 – Scour Data Available

- (a) Now check the **Scour** checkbox and leave the other two checkboxes unchecked.
- (b) Keep the value of the **Channel Depth, D (ft)** at “4.50”. Click **Save**.
- (c) Import the value from a scour analysis project. To use this feature, click the magnifying glass across the **Scour Depth, Zt (ft)** textbox.
- (d) On the **IMPORT TOTAL SCOUR FROM A PROJECT** form, use the data as shown:

Import Total Scour From a Project

Import Project Reference SCOURTUTORIAL2

Import ID AZRIVER

Total Scour (ft) 14.13

Automatically Update Scour Depth (Zt) to Total Scour

Info Cancel OK

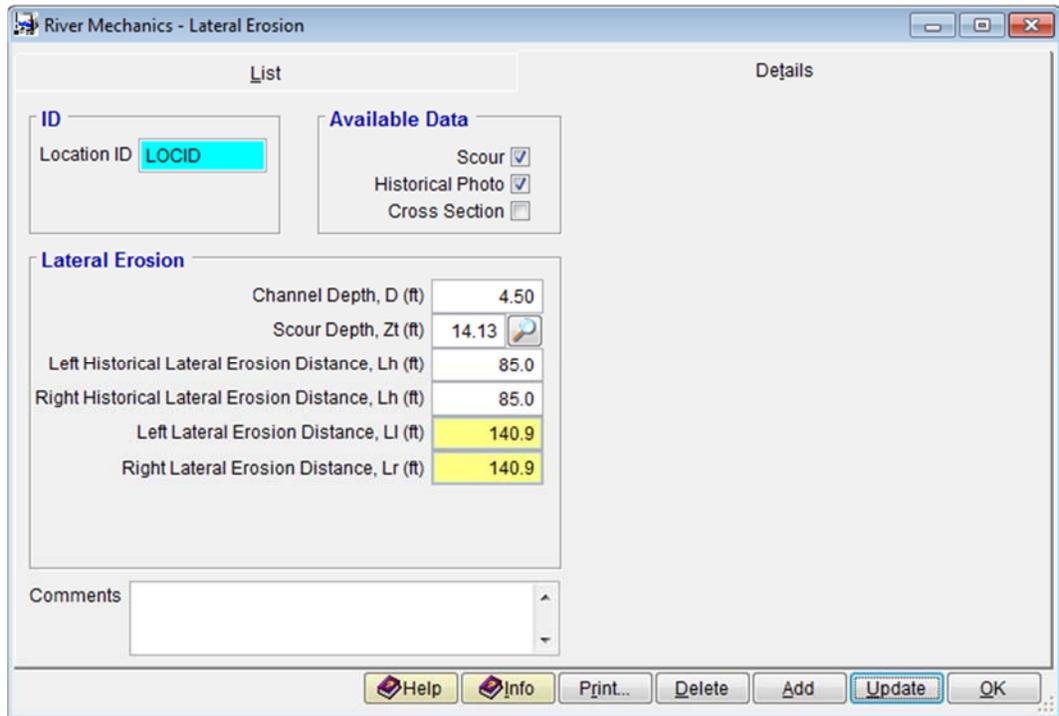
- (e) Click **OK** to close the form.
- (f) To calculate the **Lateral Erosion Distance, L (ft)**, click the **Update** button and select “*This Record*” from the **SELECT OPTION** form. Click **OK** to close the form.
- (g) Click **Yes** when the **CALCULATE LATERAL EROSION** form opens.

The following form shows the results of the lateral erosion analysis where scour data is available.

C. Scenario #3 –Scour and Historical Data Available

- (a) Now make sure that the **Scour** and **Historical Photo** checkboxes are checked. Leave the **Cross Section** checkbox unchecked.
- (b) Type in “85.0” into the **Left Historical Lateral Erosion Distance, Lh (ft)** and the **Right Historical Lateral Erosion distance, Lh (ft)** textboxes. Leave the **Channel Depth** and **Scour Depth, Zt (ft)** unchanged. Click **Save** to save the data.
- (c) To calculate the **Lateral Erosion Distance, L (ft)**, click the **Update** button and select “*This Record*” from the **SELECT OPTION** form. Click **OK** to close the form.
- (d) Click **Yes** when the **CALCULATE LATERAL EROSION** form opens.

The following form shows the results of the lateral erosion analysis where scour and historical data is available.

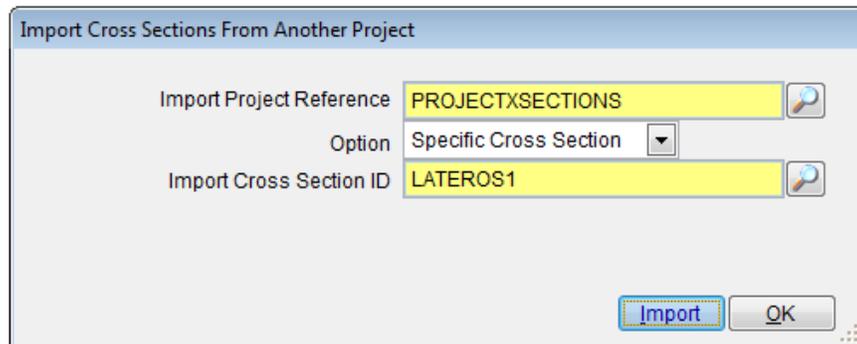


D. Scenario #4 –Scour, Historical and Cross Section Data Available

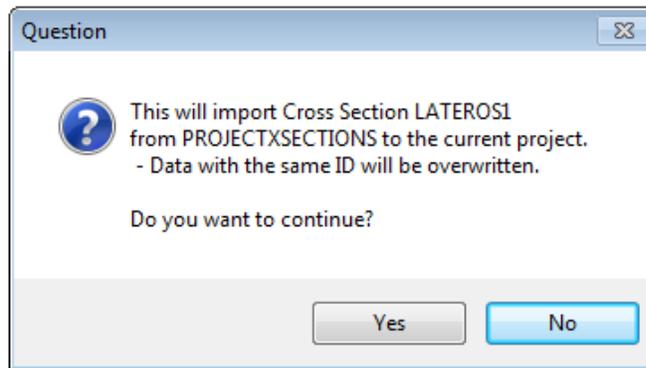
- (a) Make sure that all the checkboxes (i.e., **Scour**, **Historical Photo**, and **Cross Section**) are checked.

To develop the cross section and hydraulic data to be used for this project, the “*LATEROS1*” dataset will be used which will be imported from another project.

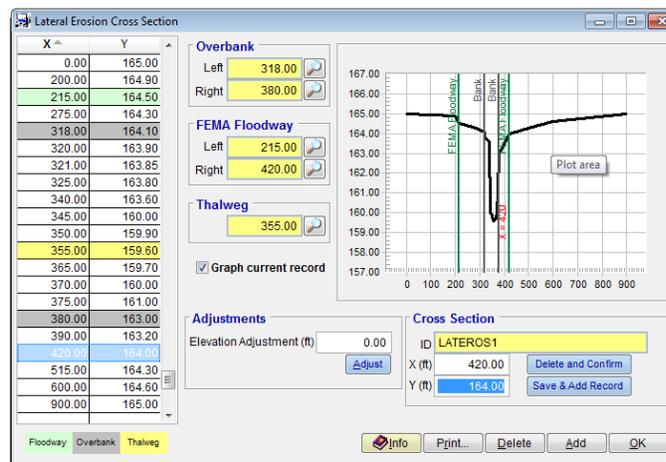
- (b) From the menu bar of main application window, click **River Mechanics** → **Import Cross Sections from Another Project** to open the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form if not already imported.
- (c) On the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form, select the settings shown on the following form:



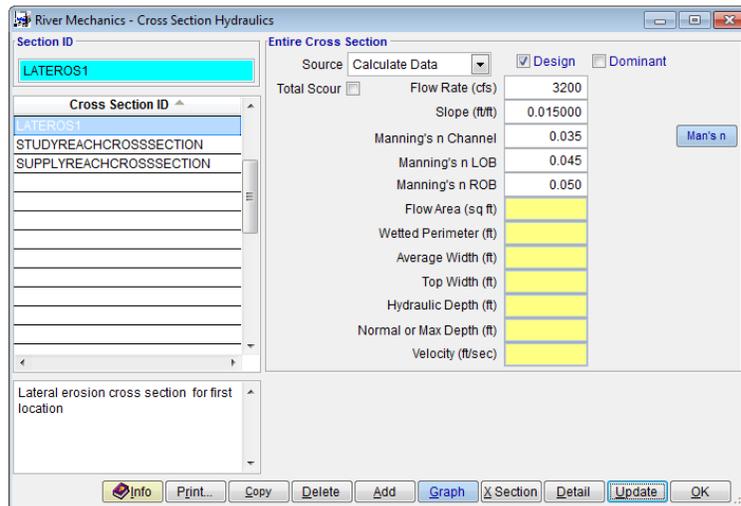
- (d) Once the specified data have been selected, click the **Import** button. Select **Yes** to proceed, and hit **OK** to close the **IMPORT CROSS SECTION FROM ANOTHER PROJECT** form.



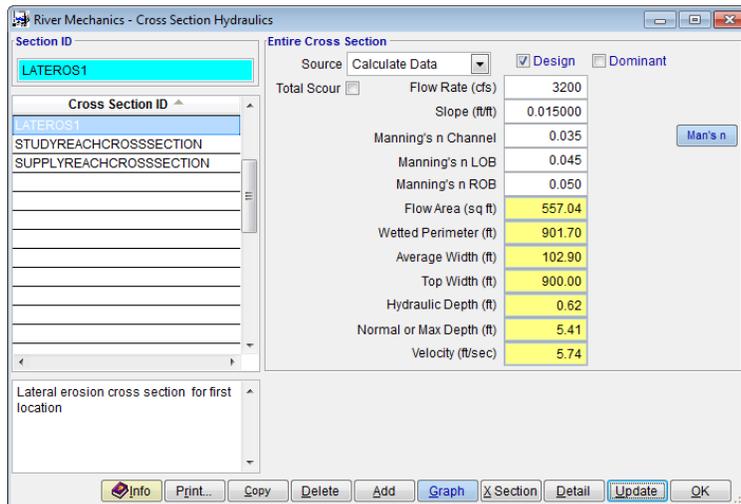
- (e) On the **RIVER MECHANICS – LATERAL EROSION FORM**, select “*LATEROS1*” for the **Cross Section ID** by clicking the Selector button at the right side of the **ID** textbox.
- (f) To check if the lateral erosion cross section data has been successfully imported, Click on the “**X Section Data**” tab to view the cross section data. Note that this form includes Overbank, FEMA Floodway and Thalweg data that is required for this analysis. See the following form.



- (g) To establish the cross-section hydraulic data, open the **CROSS SECTION HYDRAULICS** form (**River Mechanics → Cross Section Hydraulics**) and on the form select “*LATEROS1*” from the **Cross Section ID** listing and enter the data shown on the following form after checking the **Design** box and selecting “*Calculate Data*” in **Source** drop down list:



- (h) Click **Save** to save the edits.
- (i) Click **Update** to calculate the data. The following form shows the results.



- (j) To access the Cross Section Data for this project, click the **Selector** button (Magnifying glass) to the right of the **Section ID** textbox. On the **SELECT CROSS SECTION ID** form, select the "LATEROS1" from the list.
- (k) Click **OK** to close the **SELECT CROSS SECTION ID** form.

Note that by using the Cross Section Data, the "Channel Depth, D (ft)" textbox becomes "inactive" and a new value of the Channel Depth had replaced the manual data entered. This new value of the Channel Depth is the difference between the **FEMA Floodway Elevation** and the **Thalweg Elevation** (i.e., $164.50 - 159.60 = 4.90\text{ft}$).

If the Overbank left and right values, FEMA Floodway left and right values, and, Thalweg values are not automatically populated it may be required to re-define

these values by going into the cross section data dialog box from the “X Section Data” button and by selecting appropriate values for each of these parameters.

- (l) To calculate the **Left Lateral Erosion Distance L_l (ft)**, and the **Right Lateral Erosion Distance, L_r (ft)**, click the **Update** button.

River Mechanics - Lateral Erosion

List | **Details**

ID
Location ID: **LOCID**

Available Data
 Scour
 Historical Photo
 Cross Section

Cross Section
Section ID: **LATEROS1**

Lateral Erosion

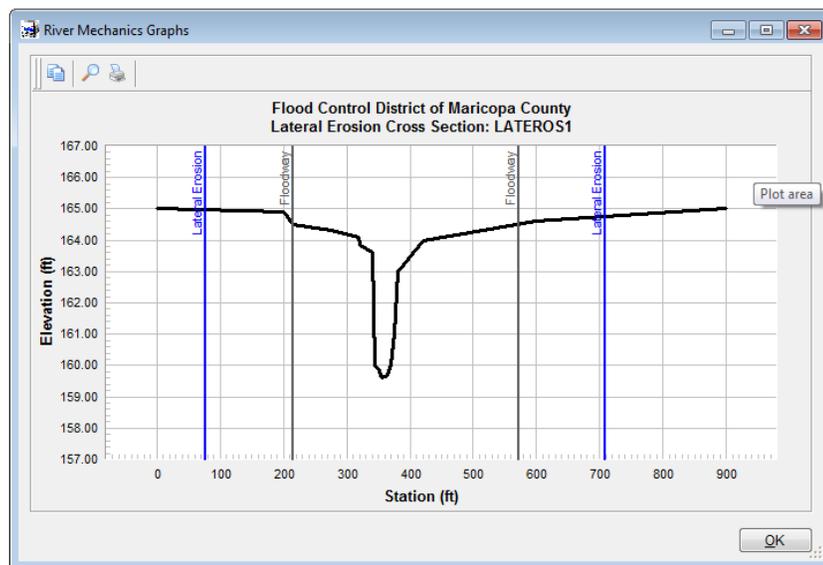
Channel Depth, D (ft)	4.90
Scour Depth, Zt (ft)	14.13
Left Historical Lateral Erosion Distance, Lh (ft)	85.0
Right Historical Lateral Erosion Distance, Lh (ft)	85.0
Left Lateral Erosion Distance, L_l (ft)	142.1
Right Lateral Erosion Distance, L_r (ft)	142.1
Left Lateral Erosion Station (ft)	72.9
Right Lateral Erosion Station (ft)	713.8

Comments:

Cross Section Data

Overbank	Station (ft)	Elevation (ft)
Left	318.0	164.10
Right	380.0	163.00
FEMA Floodway		
Left	215.0	164.50
Right	420.0	164.00
Thalweg		
	355.0	159.60
Opposite Side		
	571.7	164.50

- (m) To view the plot of the Lateral Erosion analysis results, click the **Graph** button.



2.5 Sediment Yield for a Watershed

Estimate the sediment yield for a watershed.

1. Prepare Sediment and Relevant Data
 - A. Set up Sediment Yield Basic Data
 - B. Prepare ESRI Shape Files
 - C. Use GIS to Develop Land Use and Soils Data
 - D. Review Land Use and Soils Data
2. Calculate the Sediment Yield

2.5.1 Prepare Sediment and Relevant Data

A. Set up Sediment Yield Basic Data

- (a) From the menu bar of main application window, click **River Mechanics** → **Sediment Yield** → **Model Sediment Yield** to open the **RIVER MECHANICS – SEDIMENT YIELD - MB: 01** window.
- (b) Click **Add** button to activate the necessary data entry fields.
- (c) Type “*DAM1*” into the **ID** textbox, a unique **ID** for the location on the water course.
- (d) Check the **Wash Load** and **Bed Load** checkboxes in the **Calculate** frame.
- (e) Click the browse button beside the **Return Periods for Analysis** textbox in the **Calculate** frame to select “*All*” for the return periods.
- (f) Check all the checkboxes in the **Sediment Yield Parameters** frame to activate all the discharges and volumes textboxes. Enter the following discharge and volume values for the sediment yield parameters

<u>Return Period</u>	<u>Q (cfs)</u>	<u>Volume (ac-ft)</u>
2 year	277	12.00
5 year	486	18.00
10 year	645	23.00
25 year	869	30.00
50 year	1046	36.00
100 year	1231	42.00
Design	1231	42.00

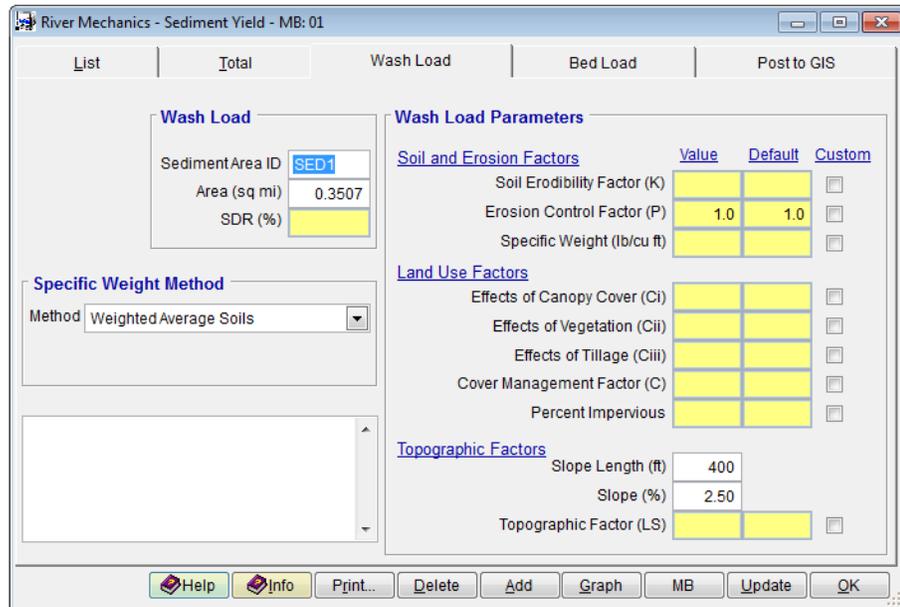
- (g) Click the **Save** button to save the entered data. After the data entry, the window should look like the following figure.

The screenshot shows the 'River Mechanics - Sediment Yield - MB: 01' window. The 'Total' tab is selected. The 'ID' section shows 'Major Basin ID' as '01' and 'ID' as 'DAM1'. The 'Calculate' section has 'Wash Load' and 'Bed Load' checked, and 'Return Periods for Analysis' set to 'All'. The 'Sediment Yield Parameters' table is as follows:

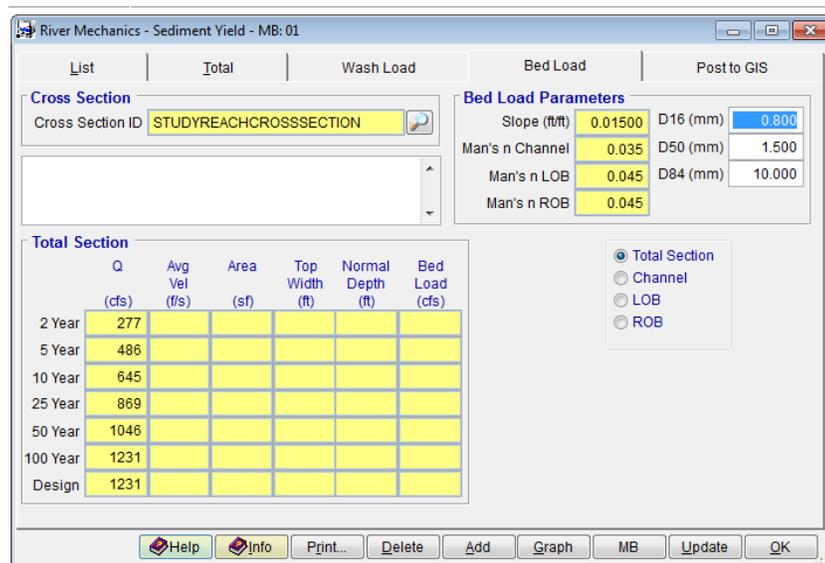
Include	Q (cfs)	Volume (ac-ft)
<input checked="" type="checkbox"/>	277	12.00
<input checked="" type="checkbox"/>	486	18.00
<input checked="" type="checkbox"/>	645	23.00
<input checked="" type="checkbox"/>	869	30.00
<input checked="" type="checkbox"/>	1046	36.00
<input checked="" type="checkbox"/>	1231	42.00
<input checked="" type="checkbox"/>	1231	42.00
<input checked="" type="checkbox"/>		

The 'Sediment Yield (ac-ft)' table has columns for 'Wash Load', 'Bed Load', and 'Total Yield'. The 'Required Sediment Basin Volume (ac-ft)' section shows 'Cleanout Years' as 3. The 'Annual Sediment Yield Per Square Mile (ac-ft)' section is empty. The bottom of the window has buttons for Help, Info, Print..., Delete, Add, Graph, MB, Update, and OK.

- (h) Click the **Wash Load** tab.
- (i) Enter “*SED1*” into the **Sediment Area ID** textbox (**Sediment Area ID** is the unique ID for the drainage area that contributes sediment to the study location. This ID is used when land use and soil data are used to compute the wash load).
- (j) Enter “*0.3507*” in the **Area (sq mi)** textbox.
- (k) Select “*Weighted Average Soils*” as the **Specific Weight Method**.
- (l) Enter “*400*” into the **Slope Length (ft)** text box in the **Wash Load Parameters** frame.
- (m) Enter “*2.50*” into the **Slope (%)** textbox in the Wash Load Parameters frame.
- (n) Click the **Save** button to save data entry. The **RIVER MECHANICS – SEDIMENT YIELD** form should look like the following figure.



- (o) Click the **Bed Load** tab and click browse button  beside the **Cross Section ID** textbox in the **Cross Section** frame to select “*STUDYREACHCROSSSECTION*” as the cross section ID. Click **OK** to exit the **SELECT CROSS SECTION ID** form.
- (p) On the **Bed Load Parameters** frame in the **Bed Load** tab, enter the following data:
- **D16 (mm):** *0.80*
 - **D50 (mm):** *1.50*
 - **D84 (mm):** *10.00*
- (q) Click the **Save** button to save the data entry. The **RIVER MECHANICS – SEDIMENT YIELD** form should look like the following figure.



(r) Click **OK** to close the window.

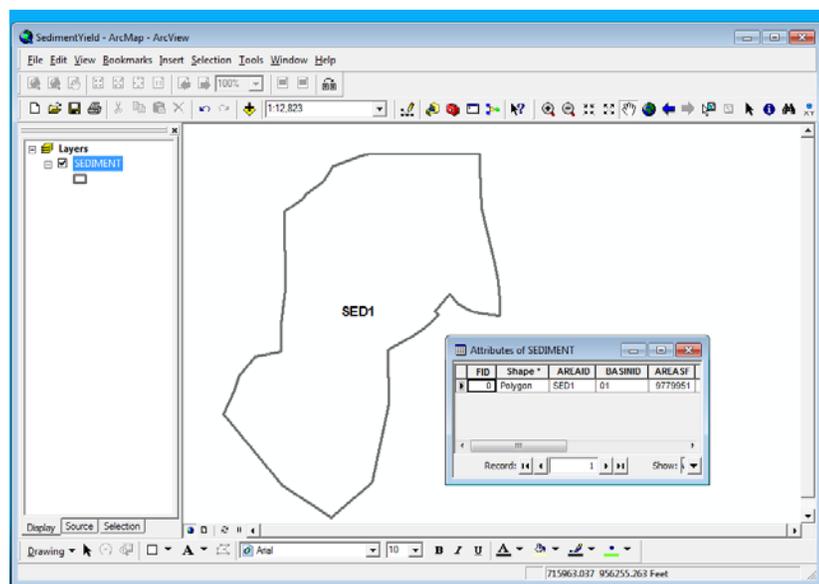
B. Prepare ESRI Shape Files

This step is only for information purposes. There is no action required for the tutorial user in this step. Several ESRI shape files must be prepared. They are: *Sediment*, *Land Use* and *Soils*. As part of the shape files, the table structures must include specific fields. For the purposes of this tutorial, all these shape files have already been prepared. This tutorial does not cover the creation of the shape files. For tutorials on how to create ESRI shape files, please refer to “**HOW TO PREPARE ESRI SHAPE FILES FOR DDMSW**” document that can be downloaded from <http://www.fcd.maricopa.gov/264/How-to-Prepare-ESRI-Shape-Files>. The following section describes the general requirement for the required shape file table. Specific file names for the shape files are not necessary however for the purpose of this tutorial the following map files will be used. However the field names inside the tables must be fixed and are shown in the following section.

Sediment

The Sediment map (*Sediment.shp*) will contain a single polygon with the following fields:

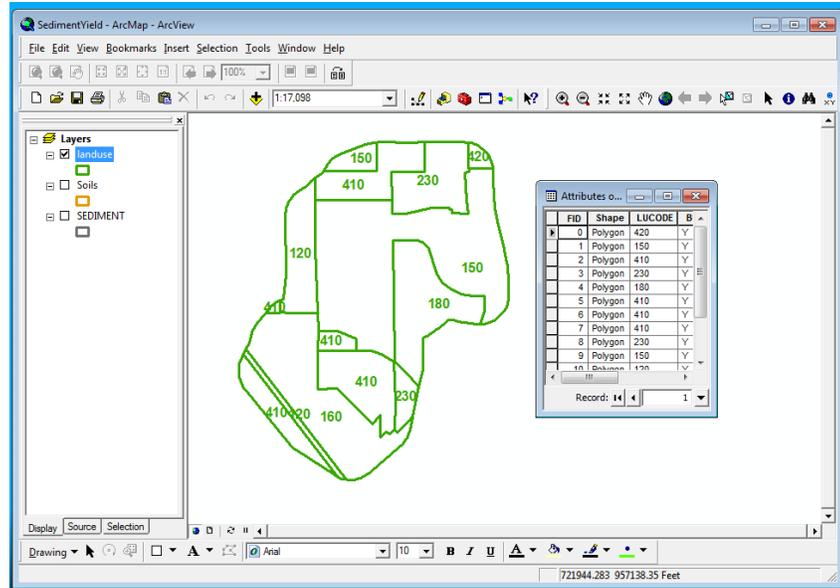
- ❖ **AREAID** Character 6 Enter unique **Sediment ID**
- ❖ **BASINID** Character 2 Enter **Major Basin ID**
- ❖ **AREASF** Numeric 12.0 Data entered into this field will be overwritten internally **DDMSW**. This field contains the Sediment in square feet. The data for this field is calculated automatically when the Update button is clicked in the Update from **GIS** form in **DDMSW**.



Land Use

Land Use data can often be obtained from the jurisdictional agency. The data may have to be modified to be consistent with DDMSW requirements. The Land Use map (*Landuse.shp*) will contain polygons for land use data. There can be more than one polygon with the same land use ID. It is vitally necessary that the land use coverage extends beyond the extent of Sediment polygons. The required fields include:

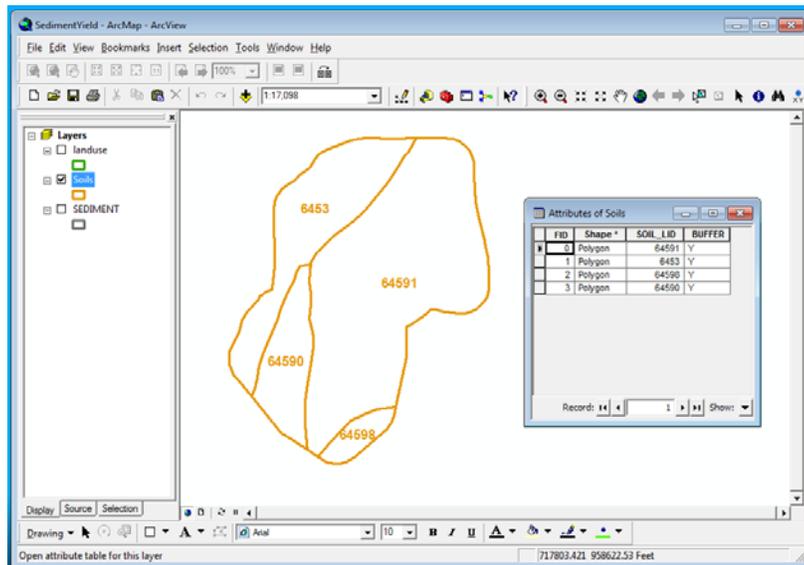
- ❖ **LUCODE** Character 15 **LUCODE** values should be consistent with the values in the **DDMSW** land use defaults table.



Soils

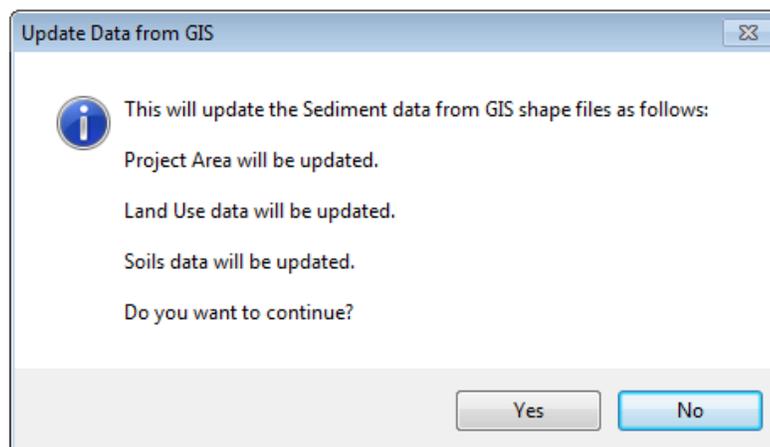
Soils data can often be obtained from the FCDMC. The data should be reviewed to make sure it is consistent with DDMSW requirements. The Soils map will contain polygons for soils data. A **GIS** map for soils data can be obtained from the Flood Control District. There can be more than one polygon with the same Soil ID. It is vitally necessary that the soils coverage extends beyond the extent of all Sub-Basins. The required fields include:

- ❖ **SOIL_LID** Numeric 15 **SOIL_LID** values should be consistent with the values in the **DDMSW** soil defaults table.



C. Use GIS to Develop Land Use and Soils Data

- (a) From the menu bar of the main application window, click **River Mechanics** → **Sediment Yield** → **Update from GIS** to open the **UPDATE FROM GIS** form. The form below shows the items to be selected.
- (b) Migrate to the location of the Sediment, Land Use and Soils shapefiles to select the Sediment, Land Use and Soils shapefiles respectively. The actual path may be different to what is shown on the following form.
- (c) Make sure to check Land Use and Soils in the **Update Options**.
- (d) Enter **"LUCODE"** as the Land Use Code in the **Shape File Key Field Name**
- (e) Click **Update** to develop the Land Use and Soils data.

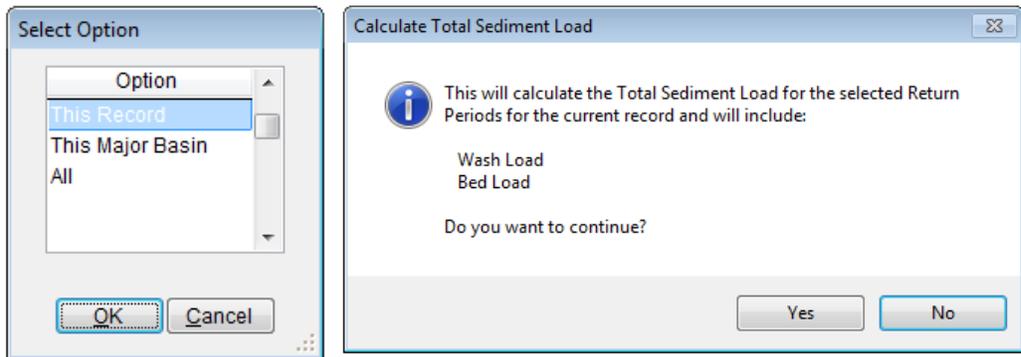


- (f) Click **Yes** to continue.

2.5.2 Calculate the Sediment Yield

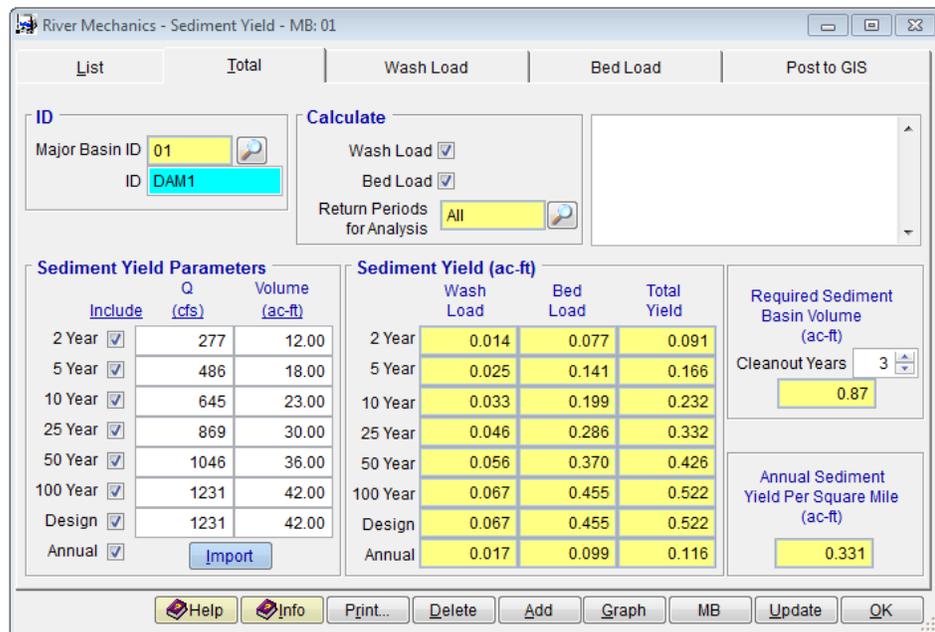
Open the **RIVER MECHANICS – SEDIMENT YIELD** form from the menu bar (**River Mechanics** → **Sediment Yield** → **Model Sediment Yield** and click the **Total** tab.

- (a) Click the **Update** button on the **RIVER MECHANICS – SEDIMENT YIELD** form to compute the sediment yield. A new window **SELECT OPTION** opens, select “*This Record*”, and click **OK** to close it.



- (b) On the **CALCULATE TOTAL SEDIMENT LOAD** dialog box, click **Yes** to continue.

The following three figures show the results in the **Total**, **Wash Load** and **Bed Load**.



River Mechanics - Sediment Yield - MB: 01

List | Total | Wash Load | Bed Load | Post to GIS

Wash Load

Sediment Area ID: SED1
 Area (sq mi): 0.3507
 SDR (%): 67.8

Wash Load Parameters

Soil and Erosion Factors

	Value	Default	Custom
Soil Erodibility Factor (K)	0.12	0.12	<input type="checkbox"/>
Erosion Control Factor (P)	1.0	1.0	<input type="checkbox"/>
Specific Weight (lb/cu ft)	83.26	83.26	<input type="checkbox"/>

Land Use Factors

	Value	Default	Custom
Effects of Canopy Cover (Ci)	0.69	0.69	<input type="checkbox"/>
Effects of Vegetation (Cii)	0.85	0.85	<input type="checkbox"/>
Effects of Tillage (Ciii)	0.31	0.31	<input type="checkbox"/>
Cover Management Factor (C)	0.18	0.18	<input type="checkbox"/>
Percent Impervious	46	46	<input type="checkbox"/>

Topographic Factors

	Value	Default	Custom
Slope Length (ft)	400		
Slope (%)	2.50		
Topographic Factor (LS)	0.37	0.37	<input type="checkbox"/>

Specific Weight Method
 Method: Weighted Average Soils

Buttons: Help, Info, Print..., Delete, Add, Graph, MB, Update, OK

River Mechanics - Sediment Yield - MB: 01

List | Total | Wash Load | Bed Load | Post to GIS

Cross Section

Cross Section ID: STUDYREACHCROSSSECTION

Bed Load Parameters

	Value	Default	Custom
Slope (ft/ft)	0.01500		
Man's n Channel	0.035		
Man's n LOB	0.045		
Man's n ROB	0.045		

Total Section

	Q (cfs)	Avg Vel (f/s)	Area (sf)	Top Width (ft)	Normal Depth (ft)	Bed Load (cfs)
2 Year	277	6.12	45.28	35.05	1.51	1.768
5 Year	486	7.34	66.17	38.82	2.07	3.809
10 Year	645	8.03	80.34	41.19	2.43	5.572
25 Year	869	8.80	98.78	44.07	2.86	8.282
50 Year	1046	8.51	122.95	145.74	3.12	10.747
100 Year	1231	8.15	151.04	146.89	3.32	13.330
Design	1231	8.15	151.04	146.89	3.32	13.330

Radio buttons: Total Section (selected), Channel, LOB, ROB

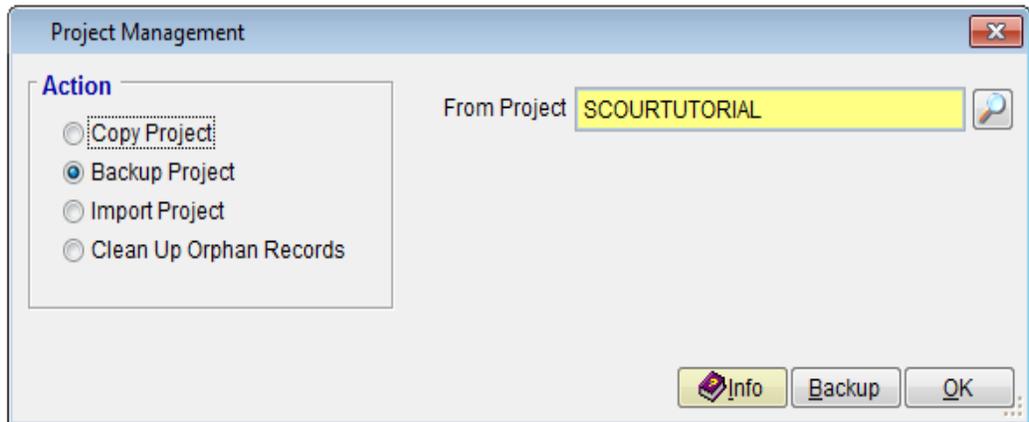
Buttons: Help, Info, Print..., Delete, Add, Graph, MB, Update, OK

(c) Click the **OK** button to close the **SEDIMENT YIELD** form.

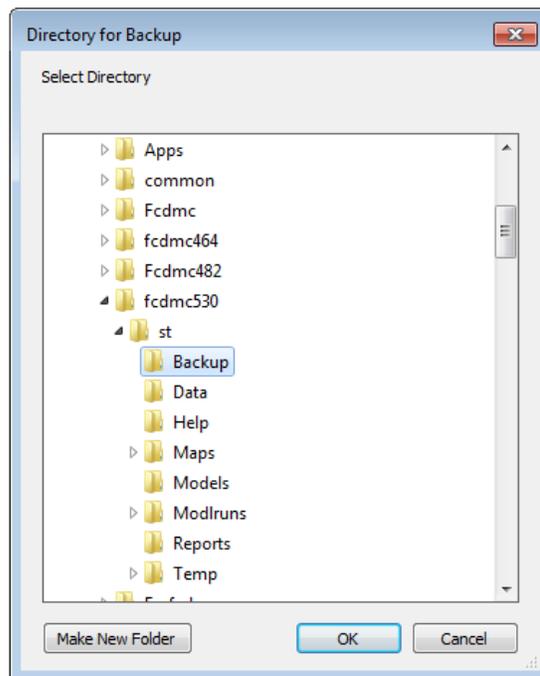
2.6 Backup Project

To backup your project, perform the following steps:

- (a) From the menu bar of the main application window, click **File** → **Project Management** as shown in the following figure and the **PROJECT MANAGEMENT** window opens.



- (b) Check **Backup Project**
- (c) Click **Backup**.
- (d) Select a folder for your backup zip file (defaults to **Backup** sub directory)



- (e) Click **OK**

This concludes all the tutorials.