



DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS

VERSION 6.8.0

TUTORIAL # 11

TOTAL SCOUR FOR BRIDGE PIERS



KVL Consultants, Inc.

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TOTAL SCOUR ANALYSIS FOR BRIDGE PIERS

DATE UPDATED: MAY 7, 2024

TUTORIAL TIME: 40 MINUTES

1.0 PROBLEM STATEMENT

To estimate the total scour depth for a bridge pier (use “*Equilibrium Slope for Sediment-Laden Flow*” method for long-term scour, use “*Neil*” method for general scour including a moderate bend, and use the local scour at the piers) with the following given conditions:

❖ The Cross Section “*BRIDGECROSSSECTION*”

➤ Parameters for Hydraulics and Geometry:

- **Design Flow Rate (cfs):** 3200
- **Dominant Flow Rates (cfs):** 800
- **Channel Slope for Design Flow (ft/ft):** 0.015
- **Channel Slope for Dominant Flow (ft/ft):** 0.015
- **Channel Manning’s n for Design Flow:** 0.035
- **LOB Manning’s n for Design Flow:** 0.035
- **ROB Manning’s n for Design Flow:** 0.035
- **Channel Manning’s n for Dominant Flow:** 0.030
- **LOB Manning’s n for Dominant Flow:** 0.030
- **ROB Manning’s n for Dominant Flow:** 0.030
- **The geometric data (station and elevation) of the cross section:**

Station (X)	Elevation (Y)	Notes
100	100	
106	98	
131	98	<i>Left Bank Station</i>
141	95	
166	95	
176	98	<i>Right Bank Station</i>
201	98	
207	100	

❖ The Cross Section “*STUDYREACHCROSSSECTION*”

➤ Parameters for Hydraulics and Geometry:

- Design Flow Rate (cfs): 3200
- Dominant Flow Rates (cfs): 800
- Channel Slope for Design Flow (ft/ft): 0.015
- Channel Slope for Dominant Flow (ft/ft): 0.015
- Channel Manning's n for Design Flow: 0.035
- LOB Manning's n for Design Flow: 0.035
- ROB Manning's n for Design Flow: 0.035
- Channel Manning's n for Dominant Flow: 0.030
- LOB Manning's n for Dominant Flow: 0.030
- ROB Manning's n for Dominant Flow: 0.030
- Length to Pivot Point (ft): 800
- The geometric data (station and elevation) of the cross section:

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

❖ The Cross Section "*SUPPLYREACHCROSSSECTION*"

➤ Parameters for Hydraulics and Geometry:

- Design Flow Rate (cfs): 3200
- Dominant Flow Rates (cfs): 800
- Channel Slope for Design Flow (ft/ft): 0.010
- Channel Slope for Dominant Flow (ft/ft): 0.010
- Channel Manning's n for Design Flow: 0.035
- LOB Manning's n for Design Flow: 0.035
- ROB Manning's n for Design Flow: 0.035
- Channel Manning's n for Dominant Flow: 0.030
- LOB Manning's n for Dominant Flow: 0.030
- ROB Manning's n for Dominant Flow: 0.030

- The geometric data (station and elevation) of the cross section:

Station (X)	Elevation (Y)	Notes
100	100	
106	98	
181	98	Left Bank Station
191	95	
216	95	
226	98	Right Bank Station
301	98	
307	100	

❖ Parameters for the **Long Term Scour** :

- **D50 (mm)** for Study Reach: 1.50
- **D84 (mm)** for Study Reach: 10.00
- **D16 (mm)** for Study Reach: 0.50
- **D50 (mm)** for Supply Reach: 1.50
- **D84 (mm)** for Supply Reach: 12.00
- **D16 (mm)** for Supply Reach: 1.00

❖ Parameters for the **General Scour**:

- **Exponent m:** Coarse Gravel (0.85)
- **Bend Factor, z:** Moderate Bend (0.60)
- **D50 (mm):** 1.50
- **Bend Angle (Degrees):** 45.00

❖ Parameters for the **Low Flow Scour**:

- **Low Flow Rate (cfs):** 100.00
- **Channel Material** Medium Sand

❖ Parameters for the **Local Scour**:

- **Pier Width, a (ft):** 2.50
- **Pier Length, L (ft):** 60.00
- **Angle of Attack (Degrees):** 30.00
- **D50 (mm):** 1.50
- **D95 (mm):** 20.00
- **Nose Shape Factor, K1:** 1.0 (Round Nose)

- **Bed Condition Factor, K3:**

1.2 (Medium Dune)


2.0 STEP-BY-STEP PROCEDURES

- Step 1: Establish a New Project and Defaults Set-up
- Step 2: Prepare the Cross Section Hydraulics
- Step 3: Import Cross Section and Hydraulic Data
- Step 4: Calculate Total Scour at Bridge Piers
 - Step 4.1: Set up Total Scour Basic Data
 - Step 4.2: Calculate the Long Term Scour
 - Step 4.3: Calculate the General Scour
 - Step 4.4: Calculate the Local Scour
 - Step 4.5: Calculate the Low Flow Scour
 - Step 4.6: Calculate the Total Scour
- Step 5: Report and Document the Results

2.1 Step 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 the **OK** button to accept the software disclaimer as shown in the following figure.

Agreement



Drainage Design Management System

This program has been written to aid in the management of drainage design. It is provided as a public service to aid in implementation of the technical information data, and procedures, presented in the Drainage Design Manuals. The user of this information releases, indemnifies and holds free the Flood Control District of Maricopa County and KVL Consultants, Inc. from any and all liabilities, damages, lawsuits and causes of action that result as a consequence of their reliance on and use of the DDMSW computer program and the data supplied with it. The use of this program and the results developed are the responsibility of the user.

Many of the default values provided are generic and serve to guide users in their modeling. Users must exercise judgement to evaluate and modify default values based on the specific watershed. An approval for default table values for a specific watershed must be obtained from the appropriate agency

Continuing signifies your acceptance of this disclaimer.

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

Select Project

List

Group River Mechanics

Project Group	ID	Reference	Title
River Mechanics	00106	BANKPROTECTIONFCD	River Mechanics Example - Bank Protection
River Mechanics	00109	BRIDGEPIERFCD	River Mechanics Example - Bridge Pier
River Mechanics	00056	GUIDEBANK_NCHRP	Guide Bank Scour using HEC-18 NCHRP Procedure
River Mechanics	00055	GUIDEBANK_NCHRP2	Guide Bank Scour using HEC-18 NCHRP Procedure
River Mechanics	00112	LATEROSIONEXAMPLE	Lateral Erosion Example
River Mechanics	00111	LAUNCHABLERIPRAP	River Mechanics Example - Launchable RipRap
River Mechanics	00146	LJ	
River Mechanics	00117	MODELTHALWEG	Sedimentation Model Examples
River Mechanics	00054	PIER_INFLUENCE	Pier Influence Zone calculation using HEC-18 Procedure
River Mechanics	00053	PRESSURE_SCOUR	Pressure Flow Scour using HEC-18 Procedure
River Mechanics	00107	PROJECTXSECTIONS	River Mechanics Cross Sections
River Mechanics	00110	RIPRAPSTIZINGFCD	River Mechanics Example - Riprap Sizing
River Mechanics	00081	SCOURTUTORIAL	River Mechanics Example
River Mechanics	00108	SEDIMENTYIELDFCD	River Mechanics Example - Sediment Yield
River Mechanics	00125	SEDMODELS	Import Sediment Transport Model Long Term Scour
River Mechanics	00136	TEST	

Details

Date 05/07/2024

- (b) Click the **Add** button on the **SELECT PROJECT** window to start a new project (Or **File** → **New Project** → **Add**).
- (c) Select **River Mechanics** checkbox and click the **OK** button on the **NEW PROJECT OPTIONS** form.
- (d) Type “**BRIDGEPIERFCD1**” into the **Reference** textbox. This is the name of this newly created project. Users can choose any name for the Reference textbox as long as it does not exist in the current **DDMSW** project database.
- (e) Type into the **Title** textbox a brief descriptive title for 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 and click the **OK** button on the pop-up message box. The following figure shows what the window looks like.

The screenshot shows the 'Select Project' window with two tabs: 'List' and 'Details'. The 'Details' tab is active, displaying the 'Project Reference' and 'Project Defaults' sections.

Project Reference

- Project ID: 00159
- Reference: BRIDGEPIERFCD1
- Title: River Mechanics Example - Bridge Pier
- Location: Maricopa County
- Agency: Flood Control District of Maricopa County
- ☐ Hydrology and Hydraulics Only
- ☒ River Mechanics Only

Project Defaults

- Soils: FCDMC
- Land Use: FCDMC

At the bottom of the window, there is a 'Date' field set to 01/01/2012, a calendar icon, and buttons for 'Update Defaults', 'Default Versions', 'Info', 'Print...', 'Delete', 'Add', and 'OK'.

Note: the **Project ID** “00159” in the above figure is the unique database record identifier for 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 the new project will not be the same as the **Project ID** shown in the above figure.

2.2 Step 2 - Prepare the Cross Section Hydraulics

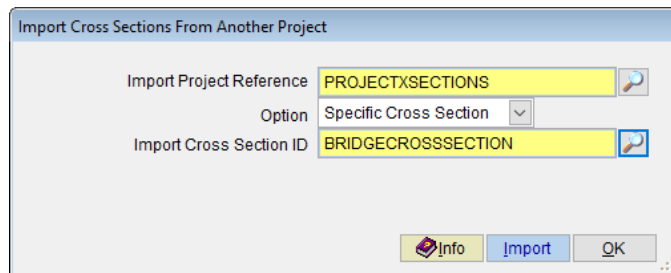
All the three (3) cross section data that will be used for this tutorial will be imported from another project. These cross section data are:

- Bridge Cross Section Data *“BRIDGECROSSSECTION”*
- Study Reach Cross Section Data *“STUDYREACHCROSSSECTION”*
- Supply Reach Cross Section Data *“SUPPLYREACHCROSSSECTION”*

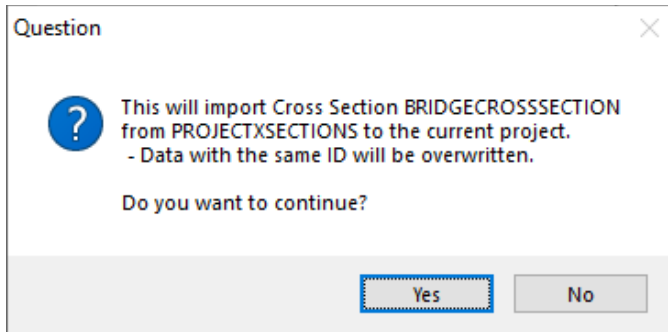
a. Import the Bridge Cross Section Data

- (a) To import the first cross section data (Bridge Cross Section Data), open the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form (**River Mechanics** → **Import Cross Sections from Another Project**). Use the following data on the form.

- **Import Project Reference:** *PROJECTXSECTIONS*
- **Option:** *Specific Cross section*
- **Import Cross Section ID:** *BRIDGECROSSSECTION*



- (b) 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.



- (c) To check if the bridge cross section data has been successfully imported, open the **NATURAL CROSS SECTIONS** form (**River Mechanics** → **Cross Section Geometry**). For the **Cross Section ID**, select “**BRIDGECROSSSECTION**” by clicking the Selector button at the right side of the **ID** textbox.

Compare the geometric data on the **NATURAL CROSS SECTIONS** form against the tabulated data listed below. Make necessary data edits or adjustments on the form, if necessary. Click **OK** to close the form.

Station (X)	Elevation (Y)	Notes
100	100	
106	98	
131	98	<i>Left Bank Station</i>
141	95	

166	95	
176	98	<i>Right Bank Station</i>
201	98	
207	100	

(d) To check if the imported hydraulic data has all the correct **Flow Rates (cfs)**, **Slopes (ft/ft)**, and **Manning's n (Channel, LOB, and ROB)** data, open the **CROSS SECTION HYDRAULICS** form (**River mechanics** → **Cross Section Hydraulics**). Make sure that the **Cross Section ID** is set to "BRIDGECROSSSECTION" and compare the data on the form and the following data:

- **Cross Section ID:** *BRIDGECROSSSECTION*
- **Design Flow Rate (cfs):** *3200*
- **Dominant Flow Rate (cfs):** *800*
- **Design Slope (ft/ft):** *0.015*
- **Dominant Slope (ft/ft):** *0.015*
- **Design Manning's n (Channel, LOB, and ROB):** *0.035*
- **Dominant Manning's n (Channel, LOB, and ROB):** *0.030*

River Mechanics - Cross Section Hydraulics

Section ID: **BRIDGECROSSSECTION**

Entire Cross Section

Source	Calculate Data	<input checked="" type="checkbox"/> Design	<input checked="" type="checkbox"/> Dominant
Total Scour	<input type="checkbox"/>		
Flow Rate (cfs)		3200	800
Slope (ft/ft)		0.015000	0.015000
Manning's n Channel		0.035	0.030
Manning's n LOB		0.035	0.030
Manning's n ROB		0.035	0.030
Flow Area (sq ft)		287.18	83.81
Wetted Perimeter (ft)		107.35	42.48
Average Width (ft)		59.66	33.37
Top Width (ft)		105.88	41.74
Hydraulic Depth (ft)		2.71	2.01
Normal or Max Depth (ft)		4.81	2.51
Total Cross Section Velocity (ft/sec)		11.14	9.55

Buttons: Info, Print..., Copy, Delete, Add, Graph, X Section, Detail, **Update**, OK

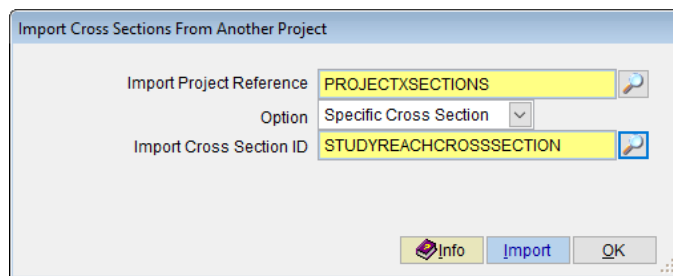
(e) If everything checks out, click the **Update** button to update the hydraulic analysis results. If not, edit the data to match the above figure. On the **SELECT OPTION** form, select “*This Record*” and click **OK**. Hit **Yes** to continue.

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

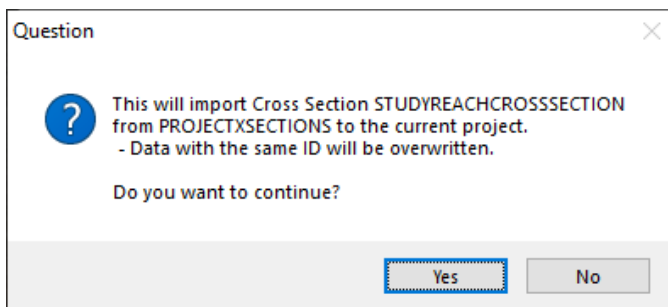
b. Import the Study Reach Cross Section Data

(a) To import the second cross section data (Study Reach Cross Section Data), open the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form (**River Mechanics → Import Cross Sections from Another Project**). Use the following data on the form.

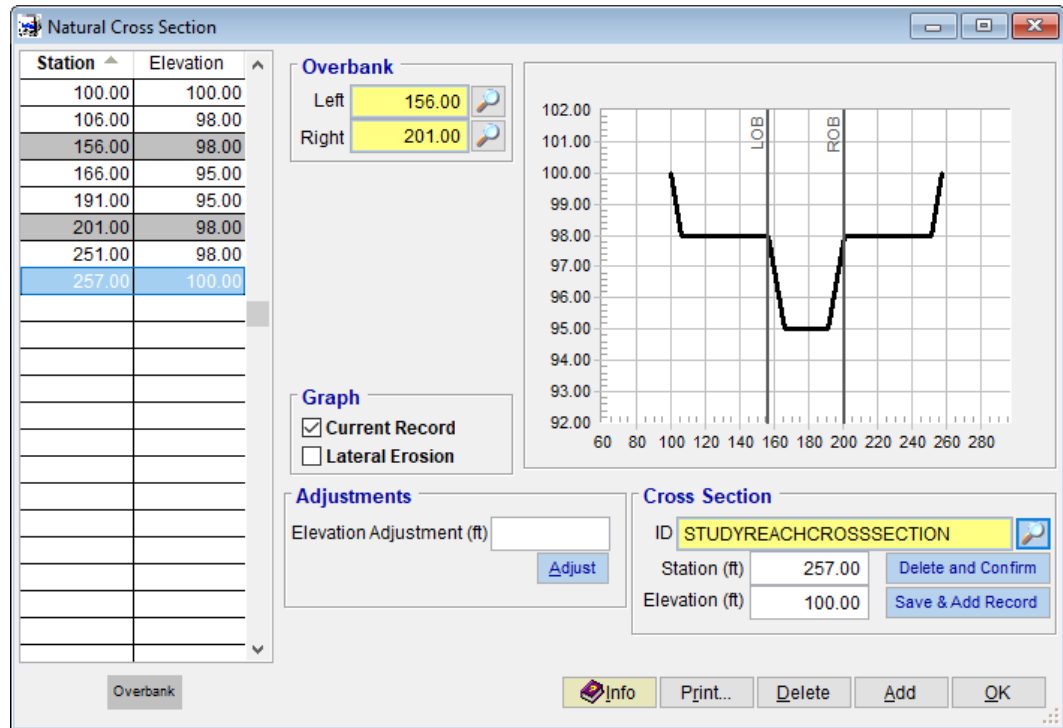
- **Import Project Reference:** *PROJECTXSECTIONS*
- **Option:** *Specific Cross section*
- **Import Cross Section ID:** *STUDYREACHCROSSECTION*



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



(c) To check if the study reach cross section data has been successfully imported, open the **NATURAL CROSS SECTIONS** form (**River Mechanics → Cross Section Geometry**). For the **Cross Section ID**, select “*STUDYREACHCROSSECTION*” by clicking the Selector button at the right side of the **ID** textbox.



Compare the geometric data on the **NATURAL CROSS SECTIONS** form against the tabulated data listed below. Make necessary data edits or adjustments on the form, if necessary. Click **OK** to close the form.

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

(d) To check if the imported hydraulic data has all the correct **Flow Rates (cfs)**, **Slopes (ft/ft)**, and **Manning's n (Channel, LOB, and ROB)** data, open the **CROSS SECTION HYDRAULICS** form (**River mechanics** → **Cross Section Hydraulics**). Make sure that the **Cross Section ID** is set to "STUDYREACHCROSSSECTION" and compare the data on the form and the following data:

- **Cross Section ID:** *STUDYREACHCROSSSECTION*

- Design Flow Rate (cfs): 3200
- Dominant Flow Rate (cfs): 800
- Design Slope (ft/ft): 0.015
- Dominant Slope (ft/ft): 0.015
- Design Manning's n (Channel, LOB, and ROB): 0.035
- Dominant Manning's n (Channel, LOB, and ROB): 0.030

Section ID: STUDYREACHCROSSSECTION

Entire Cross Section

Source	Calculate Data	Design	Dominant
Total Scour	<input type="checkbox"/>		
Flow Rate (cfs)		3200	800
Slope (ft/ft)		0.015000	0.015000
Manning's n Channel		0.035	0.030
Manning's n LOB		0.035	0.030
Manning's n ROB		0.035	0.030
Flow Area (sq ft)		328.86	83.81
Wetted Perimeter (ft)		155.35	42.48
Average Width (ft)		73.12	33.37
Top Width (ft)		153.98	41.74
Hydraulic Depth (ft)		2.14	2.01
Normal or Max Depth (ft)		4.50	2.51
Total Cross Section Velocity (ft/sec)		9.73	9.55

Buttons: Info, Print..., Copy, Delete, Add, Graph, X Section, Detail, Update, OK

(e) If everything checks out, click the **Update** button to update the hydraulic analysis results. If not, edit the data to match the above figure. On the **SELECT OPTION** form, select "This Record" and click **OK**. Hit **Yes** to continue.

Select Option

Option: This Record

Buttons: OK, Cancel

Update Cross Section Hydraulics

This will update the hydraulic parameters for the current Cross Section.

If 'Enter Data' is selected as the Source, data will NOT BE updated.

If 'Calculate Data' is selected as the Source, the disabled fields (shown in yellow) will be updated if 'Design' and/or 'Dominant' are/is checked.

Do you want to continue?

Buttons: Yes, No

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

a. Import the Supply Reach Cross Section Data

- (a) To import the “SUPPLYREACHCROSSSECTION” dataset, open the **IMPORT CROSS SECTIONS FROM ANOTHER PROJECT** form (**River mechanics → Import Cross Sections from Another Project**).
- (b) 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 section*
 - **Import Cross Section ID:** *SUPPLYREACHCROSSSECTION*

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

Station	Elevation
100.00	100.00
106.00	98.00
181.00	98.00
191.00	95.00
216.00	95.00
226.00	98.00
301.00	98.00
307.00	100.00

Compare the geometric data on the **NATURAL CROSS SECTIONS** form against the tabulated data listed below. Make necessary data edits or adjustments on the form, if necessary. Click **OK** to close the form.

Station (X)	Elevation (Y)	Notes
100	100	
106	98	
181	98	Left Bank Station
191	95	
216	95	
226	98	Right Bank Station
301	98	
307	100	

(d) To check if the imported data has all the correct **Flow Rates (cfs)**, **Slopes (ft/ft)**, and **Manning's n (Channel, LOB, and ROB)** data, open the **Cross SECTION HYDRAULICS** form (**River mechanics → Cross Section Hydraulics**). To compare, make sure that the **Cross Section ID** is set to "SUPPLYREACHCROSSSECTION".

- **Cross Section ID:** SUPPLYREACHCROSSSECTION
- **Design Flow Rate (cfs):** 3200
- **Dominant Flow Rate (cfs):** 800
- **Design Slope (ft/ft):** 0.010
- **Dominant Slope (ft/ft):** 0.010
- **Design Manning's n (Channel, LOB, and ROB):** 0.035
- **Dominant Manning's n (Channel, LOB, and ROB):** 0.030

River Mechanics - Cross Section Hydraulics

Section ID: **SUPPLYREACHCROSSSECTION**

Cross Section ID

- BRIDGECROSSSECTION
- STUDYREACHCROSSSECTION
- SUPPLYREACHCROSSSECTION**

Entire Cross Section

Source: Calculate Data ☒ Design ☒ Dominant

Total Scour ☐ Flow Rate (cfs) 3200 800

Slope (ft/ft) 0.010000 0.010000

Manning's n Channel 0.035 0.030 **Man's n**

Manning's n LOB 0.035 0.030

Manning's n ROB 0.035 0.030

Flow Area (sq ft) 419.58 96.46

Wetted Perimeter (ft) 205.84 44.54

Average Width (ft) 91.71 34.36

Top Width (ft) 204.45 43.72

Hydraulic Depth (ft) 2.05 2.21

Normal or Max Depth (ft) 4.58 2.81

Total Cross Section Velocity (ft/sec) 7.63 8.29

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

- (e) If everything checks out, click the **Update** button to update the hydraulic analysis results. If not, edit the data to match the above figure.
- (f) On the **SELECT OPTION** form, select *"This Record"* and click **OK**. Hit **Yes** to continue.

Select Option

Option

- This Record**
- All

OK Cancel

Update Cross Section Hydraulics

i This will update the hydraulic parameters for the current Cross Section.

If 'Enter Data' is selected as the Source, data will NOT BE updated.

If 'Calculate Data' is selected as the Source, the disabled fields (shown in yellow) will be updated if 'Design' and/or 'Dominant' are/is checked.

Do you want to continue?

Yes No

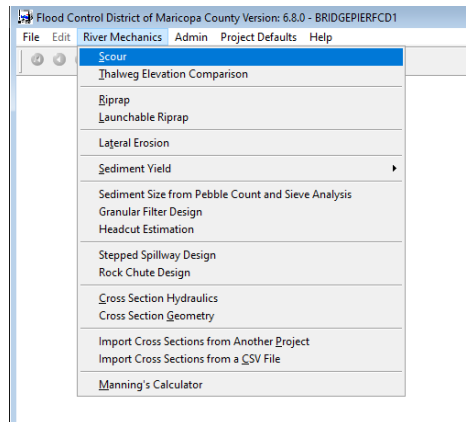
- (g) Click OK to close the **RIVER MECHANICS – CROSS SECTION HYDRAULICS** form.

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


2.3 Step 3 - Calculate Total Scour

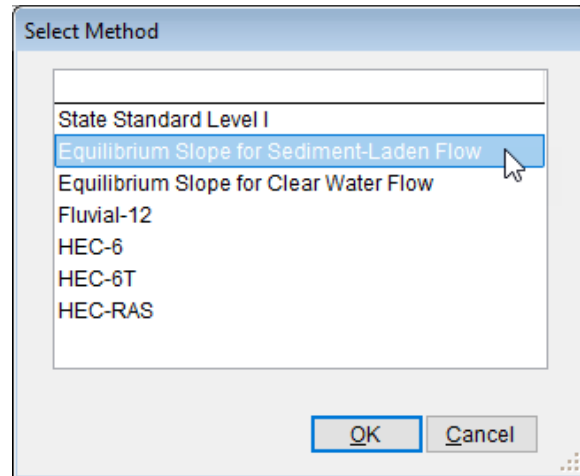
a. Set up Total Scour Basic Data

- (a) From the menu bar of main application window, click **River Mechanics** → **Scour**, to open the **TOTAL SCOUR** form.


A screenshot of the 'Total Scour' data entry form. The title bar says 'Total Scour - MB: 01 - ID:'. Below the title bar is a tabbed interface with tabs for 'List', 'Total', 'Long Term', 'General', 'Local', 'Bedform', 'Low Flow', and 'Pier Influence'. The 'Total' tab is active. The main area is a table with the following columns: 'ID' (with a small upward arrow icon), 'Cross Section ID', 'Long Term Scour', 'General Scour', 'Local Scour', 'Bedform Scour', 'Bend Scour', 'Low Flow Scour', and 'Total Scour'. The table has 15 empty rows. At the bottom of the form is a toolbar with buttons: 'Help' (with a question mark icon), 'Info' (with an 'i' icon), 'Print...', 'Delete', 'Add' (highlighted with a mouse cursor), 'MB', 'Update', and 'OK'.

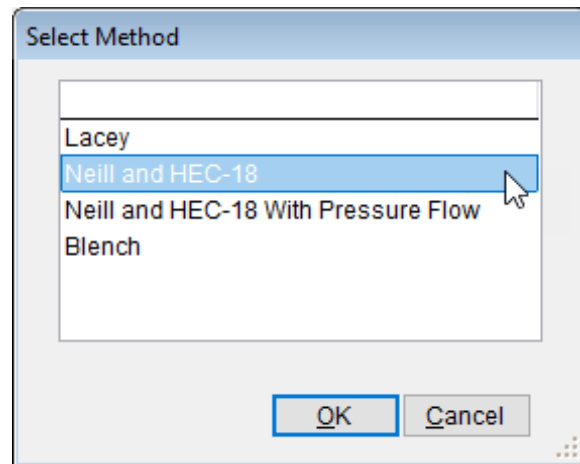
- (b) Click the **Add** button to activate the necessary data entry fields.
- (c) Type "**PIERNO1**" into the **ID** textbox (this **ID** indicates that it is for Pier No.1).


- (d) Check the checkboxes **Long Term**, **General**, **Local**, and **Low Flow (Bed Form** is not computed because it will be part of pier local scour computation where the K3 factor, the *Bed Condition Factor*, will be used).
- (e) Click the browse button  in the **Method** column across **Long Term** check box to launch long term scour method select menu.

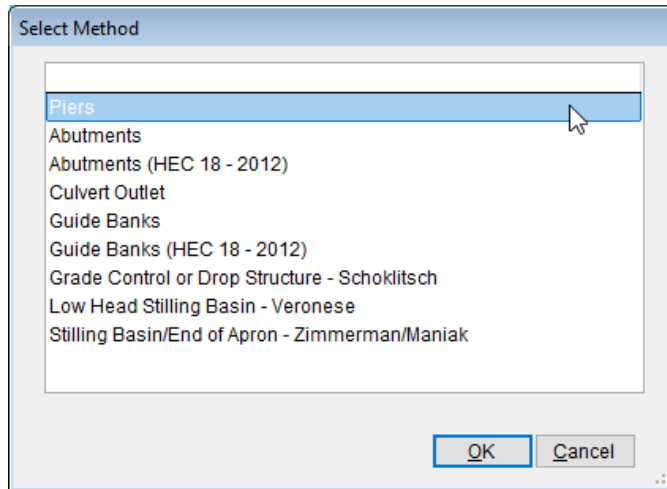


Select the “*Equilibrium Slope for Sediment-Laden Flow*” from the **SELECT METHOD** window, and click **OK** to close the **SELECT METHOD** window.

- (f) Click the browse button  in the **Method** column across **General** check box to launch general scour method select menu.





- (g) Select the “*Neil and HEC-18*” from the **SELECT METHOD** window and click **OK** to close the **SELECT METHOD** window.
- (h) Click the browse button  in the **Method** column across **Local** check box to launch local scour method select menu.

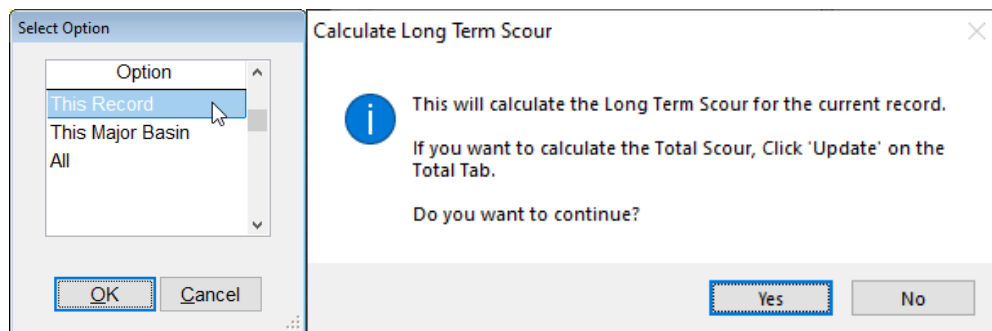


- (i) Select the “*Piers*” from the **SELECT METHOD** window and click **OK** to close the **SELECT METHOD** window.
- (j) Click the **Save** button to save the entered data. The **TOTAL SCOUR – MB: 01 – ID: PIERNO1** window shows up like following figure.

	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"/>	Neill and HEC-18
Local	<input checked="" type="checkbox"/>	0.00	1.3	0.00	<input type="checkbox"/>	<input type="checkbox"/>	Piers
Bedform	<input type="checkbox"/>				<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)							
Pier Influence	<input type="checkbox"/>						

b. Calculate the Long Term Scour

- (a) Click the **Long Term** tab.
- (b) Click browse  button beside the **Study Reach Cross Section ID** to select the cross section ID *"STUDYREACHCROSSSECTION"*, and click **OK** to close the **SELECT CROSS SECTION ID** window.
- (c) Click browse  button beside the **Supply Reach Cross Section ID** to select the cross section ID *"SUPPLYREACHCROSSSECTION"*, and click **OK** to close the **SELECT CROSS SECTION ID** window.
- (d) Enter the **D50 (mm)** values *"1.5"* and *"1.5"* for **Study** and **Supply**, respectively.
- (e) Enter the **D84 (mm)** values *"10"* and *"12"* for **Study** and **Supply**, respectively.
- (f) Enter the **D16 (mm)** values *"0.5"* and *"1.0"* for **Study** and **Supply**, respectively.
- (g) Enter *"800"* into **Length to Pivot Pt (ft)**.
- (h) Click the **Save** button to save the entered data.
- (i) Click the **Update** button to update the data.
- (j) Select *"This Record"* from the **SELECTION OPTION** window and click the **Yes** button on the **CALCULATE LONG TERM SCOUR** dialog box to proceed.





After the update, the result of the long term scour calculation shows in the following figure.

Total Scour - MB: 01 - ID: PIERNO1

[List](#) |
 [Total](#) |
 [Long Term](#) |
 [General](#) |
 [Local](#) |
 [Bedform](#) |
 [Low Flow](#) |
 [Pier Influence](#)

Equilibrium Slope Sediment-Laden (use Dominant flow rate)



Study Reach Cross Section ID: 

Supply Reach Cross Section ID: 




	Supply	Study	Equilib
Flow Rate (cfs)	800	800	800
Slope (ft/ft)	0.010000	0.015000	0.01023000
Manning's n	0.030	0.030	0.030
Wetted Area (sq ft)	96.46	83.81	95.70
Hydraulic Depth (ft)	2.21	2.01	2.19
Normal or Max Depth (ft)	2.81	2.51	2.79
Average Width (ft)	34.36	33.37	33.37
Average Velocity (ft/s)	8.29	9.55	8.36
D50 (mm)	1.500	1.500	
D84 (mm)	10.000	12.000	
D16 (mm)	0.500	1.000	
Length to Pivot Pt (ft)		800	



	Supply	Study	Equilib
Gradation Coefficient	4.83	4.75	4.75
Total Bed Mat'l Q (cfs)	5.16	9.39	5.16

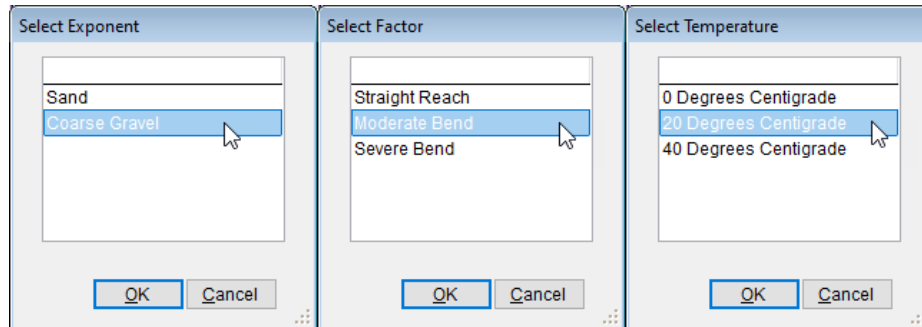
Scour Depth (ft):

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

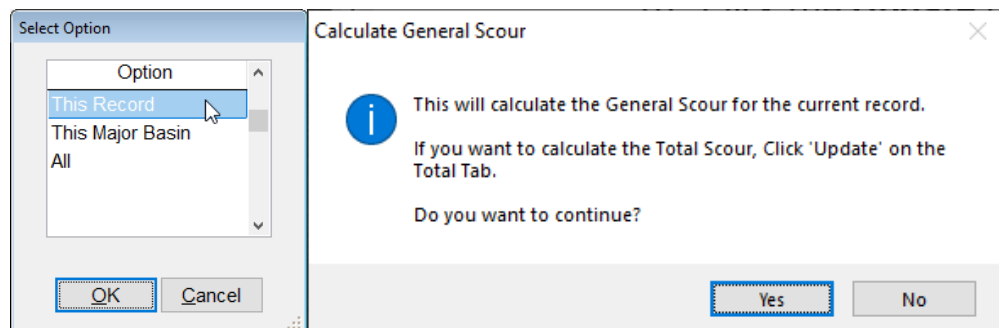
Calculate the General Scour

- Click the **General** tab.
- Click the browse  button beside the **Bridge Section ID** textbox to open the **SELECT CROSS SECTION ID** window. Select the "**BRIDGECROSSSECTION**" and click **OK** to close the window.
- Click the browse  button beside the **Upstream Section ID** textbox to open the **SELECT CROSS SECTION ID** window. Select the "**STUDYREACHCROSSSECTION**" and click **OK** to close the window (**Note:** Upstream section is for the area upstream of the bridge contraction. It can be generally represented by the study reach cross-section. The supply reach cross-section is not used as the upstream section because it is upstream of the study reach and is generally far away upstream from the bridge).
- Click the browse  button beside the **Exponent m** textbox to open the **SELECT EXPONENT** window. Select the "**Coarse Gravel**", and click **OK** to close the window.

- (e) Click the browse  button beside the **Bend Factor, Z** textbox to open the **SELECT FACTOR** window. Select the “*Moderate Bend*” bend factor and click **OK** to close the window.
- (f) Click the browse  button beside the **Water Temp (C)** textbox to open the **SELECT TEMPERATURE** window. Select the “*20 Degrees Centigrade*” and click **OK** to close the window.



- (g) **D50 (mm)**: Use the default value of “1.5” in the textbox (the default value is from the D50 value entered in study reach under Long Term scour menu for **Supply**). Or enter a value directly in this box. (**Note**: if a different value is entered here, the D50 value in Long Term for **Supply** will be changed).
- (h) Enter “45” into the **Bend Angle (Degrees)** textbox
- (i) Click the **Save** button to save the entered data.
- (j) Click the **Update** button on the **General** tab to update the data.
- (k) Select “*This Record*” from the **SELECTION OPTION** window and click the **Yes** button on the **CALCULATE GENERAL SCOUR** dialog box to proceed.





The following figure shows what the window looks like after the data entry.

Total Scour - MB: 01 - ID: PIERN01



Sections

Manual Input Parameters ☐

Bridge Section ID 

Upstream Section ID 


Neill Parameters (use Bridge Section)

	Design	Dominant
Design Flow Rate (cfs)	3200	800
Hydraulic Depth (ft)	2.76	2.01
Average Width (ft)	60.20	33.37
Exponent m	0.85	
Bend Factor Z	0.60	
Scour Depth (Including Bend) (ft)	2.37	


Scour Depth (ft)



Final General Scour (ft)

HEC-18 Contraction and Bend Parameters

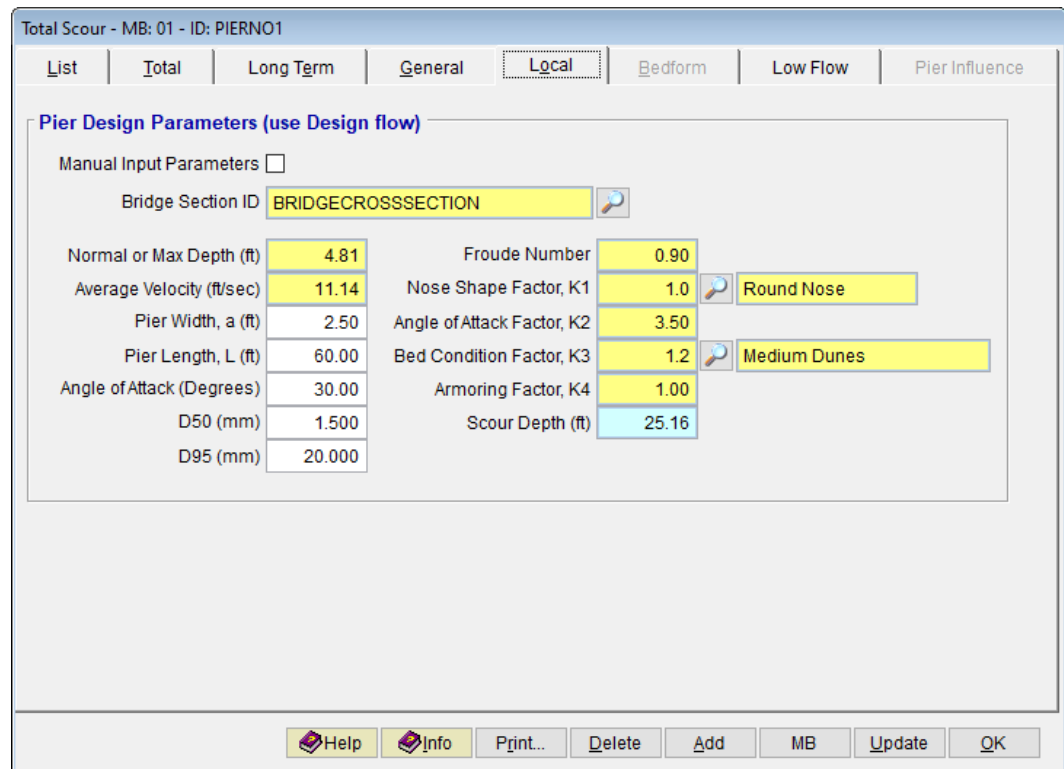
	Upstream	Design
Design Flow Rate (cfs)	3200	3200
Hydraulic Depth (ft)	2.14	2.76
Avg Velocity (ft/s)	9.73	
Critical Velocity (ft/s)	2.16	
Avg Width (ft)	73.12	60.20
Energy Slope (ft/f)	0.015000	0.015000
D50 (mm)	1.500	1.500
Water Temp (C)	20	
Contraction Scour (ft)	0.00	
Flow Condition	Live Bed	
Bend Angle (Degrees)	45.0	
Normal or Max Depth (ft)	4.50	
Bend Scour (ft)	2.64	
Contraction + Bend Scour (ft)	2.64	

c. Calculate the Local Scour



- Click the **Local** tab.
- Click the browse button  beside the **Bridge Section ID** textbox to open the **SELECT CROSS SECTION ID** window. Select the **"BRIDGECROSSSECTION"** and click the **OK** button to close the window.
- Enter **"2.5"** into the **Pier Width, (ft)** textbox.
- Enter **"60"** into the **Pier Length, L (ft)** textbox.
- Enter **"30"** into the **Angle of Attack (Degree)** textbox.

- (f) Enter "1.5" into the **D50 (mm)** textbox.
- (g) Enter "20.0" into the **D95 (mm)** textbox.
- (h) Click the browse button  beside the **Nose Shape Factor, K1** textbox to open the **NOSE SHAPE** window. Select "*Round Nose*" item, and click **OK** button to close it.
- (i) Click the browse button  beside the **Bed Condition Factor, K3** textbox to open the **BED CONDITION** window. Select "*Medium Dunes*" item and click **OK** button to close the window.
- (j) Click the **Save** button to save the entered data.
- (k) Click the **Update** button to update the data.
- (l) Select "*This Record*" from the **SELECTION OPTION** window and click **Yes** from the confirmation message to proceed.

After the update the window looks like what is shown in the following figure.




The screenshot shows the 'Total Scour' software window with the title bar 'Total Scour - MB: 01 - ID: PIERNO1'. The 'Local' tab is selected, showing the 'Pier Design Parameters (use Design flow)' section. The 'Manual Input Parameters' checkbox is unchecked. The 'Bridge Section ID' is 'BRIDGECROSSSECTION'. The parameters are as follows:

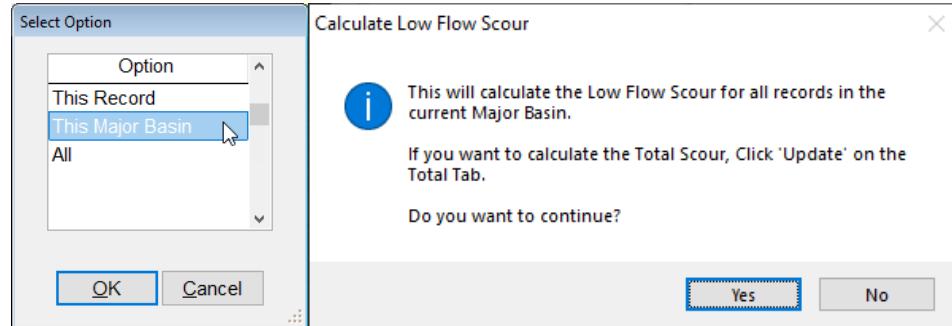
Normal or Max Depth (ft)	4.81	Froude Number	0.90
Average Velocity (ft/sec)	11.14	Nose Shape Factor, K1	1.0  Round Nose
Pier Width, a (ft)	2.50	Angle of Attack Factor, K2	3.50
Pier Length, L (ft)	60.00	Bed Condition Factor, K3	1.2  Medium Dunes
Angle of Attack (Degrees)	30.00	Armoring Factor, K4	1.00
D50 (mm)	1.500	Scour Depth (ft)	25.16
D95 (mm)	20.000		

The bottom of the window contains buttons: Help, Info, Print..., Delete, Add, MB, Update, and OK.

d. Calculate the Low Flow Scour

On the **TOTAL SCOUR** form, select the **Low Flow** tab. The following figure shows what the window looks like before data entry.

- (a) Enter “100” into the **Low Flow Rate (cfs)** textbox.
- (b) Click browse  button beside the **Channel Material** to select the channel material data. Choose “*Medium Sand*” and click **OK** to exit the **SELECT CHANNEL MATERIAL** window.
- (c) Click the **Save** button to save the data just entered.
- (d) Click the **Update** button and select “*This Major Basin*” from the **SELECTION OPTION** window. Click **Yes** to continue.



After the update the final result of the low flow scour calculation result shows in the following figure

Total Scour - MB: 01 - ID: PIERNO1

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

Low Flow Rate (cfs)

Channel Material Medium Sand

Low Flow Incisement (ft)

e. Calculate the Total Scour

- (a) Click the **Update** button to compute the total scour and individual scour components.
- (b) Select *"This Record"* from the **SELECTION OPTION** window to proceed.

After the update the window, the total scour results and individual scour components are displayed as shown in the following figure.

Total Scour - MB: 01 - ID: PIERNO1

List Total Long Term General Local Bedform Low Flow Pier Influence

ID

Major Basin ID 01

ID PIERNO1

Scour Depth

	Include	Calc	FS	Value	Custom Calc	FS	Method
Long Term	<input checked="" type="checkbox"/>	3.82	1.3	4.97	<input type="checkbox"/>	<input type="checkbox"/>	Equilibrium Slope for Sediment-Laden Flow
General	<input checked="" type="checkbox"/>	2.64	1.3	3.43	<input type="checkbox"/>	<input type="checkbox"/>	Neill and HEC-18
Local	<input checked="" type="checkbox"/>	25.16	1.3	32.71	<input type="checkbox"/>	<input type="checkbox"/>	Piers
Bedform	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	
Low Flow	<input checked="" type="checkbox"/>	2.50	1.3	3.25	<input type="checkbox"/>	<input type="checkbox"/>	
Headcut	<input type="checkbox"/>						
Tailcut	<input type="checkbox"/>						
Total (ft)				44.36			
Pier Influence	<input type="checkbox"/>						

Help Info Print... Delete Add MB Update OK

2.4 Step 4 - Report and Document the Results

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

The total scour is the sum of the long term scour, general scour, local scour, bedform scour and low flow scour. In this tutorial, these scour components are covered.

- To view the results on the screen, click the **Print...** button on the **TOTAL SCOUR – MB: 01 – ID: PIERNO1** 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 - TOTAL SCOUR

Project Reference: BRIDGEPIERFCD1

Page 1



5/7/2024

Major Basin: 01

ID: PIERNO1

Cross Section ID: STUDYREACHCROSSSECTION

Type	Calc (ft)	FS	Value (ft)	Method
Long Term	3.82	1.30	4.97	Equilibrium Slope for Sediment-Laden Flow
General	2.64	1.30	3.43	Neill
Local	25.16	1.30	32.71	Piers
Bedform		1.30		Comments
Low Flow	2.50	1.30	3.25	
Pressure Flow	0.00	0.00	0.00	
Headout	-	1.30	-	
Tailout	-	1.30	-	
Total			44.36	

- (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.

This concludes this tutorial for bridge pier scour evaluation.