



# **DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 5.6.0**

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## **Tutorial # 20 Guide Bank Scour Analysis HEC-18 (NCHRP) Procedure**

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**KVL Consultants, Inc.**

# GUIDE BANK SCOUR ANALYSIS (HEC-18 PROCEDURE)

## TABLE OF CONTENTS

No.	Section	Page
<b>1.0</b>	<b>Problem Statement .....</b>	<b>1</b>
<b>2.0</b>	<b>Guide Bank Scour For Live-bed Condition .....</b>	<b>1</b>
2.1	Step-by-Step Procedures.....	1
2.1.1	Step 1 - Establish a New Project and Defaults Set-up.....	1
2.1.2	Step 2 - Set up Guide Bank Scour Basic Data.....	4
2.1.3	Step 3 - Calculate the Guide Bank Scour.....	6
2.1.4	Step 4 - Report and Document the Results .....	7
<b>3.0</b>	<b>Guide Bank Scour For Clear-water Condition .....</b>	<b>8</b>
3.1	Step-by-Step Procedures.....	8
3.1.1	Step 1 - Establish a New Project and Defaults Set-up.....	8
3.1.2	Step 2 - Set up Guide Bank Scour Basic Data.....	11
3.1.3	Step 3 - Calculate the Guide Bank Scour – Grain Size Equation .....	13
3.1.4	Step 4 - Calculate the Guide Bank Scour – Shear Stress Equation.....	14
3.1.5	Step 5 - Report and Document the Results .....	16

## 1.0 PROBLEM STATEMENT

Based on the ratio between the embankment projected length (L) and floodplain width ( $B_f$ ), guide bank scour can be computed based on two conditions: live-bed condition and clear-water condition. If the ratio ( $L/B_f$ ) is greater than or equal to 0.75, the live-bed condition equations will be used. If the ratio ( $L/B_f$ ) is less than 0.75, the clear-water condition equations will be used. The guide bank scour procedure is similar to abutment scour procedure computed for spillthrough abutment.

## 2.0 GUIDE BANK SCOUR FOR LIVE-BED CONDITION

If the ratio ( $L/B_f$ ) is greater than or equal 0.75, the live-bed guide bank scour equations should be used to compute the local scour component due to guide bank. The live-bed condition is also referred as Condition (a) in HEC-18 manual (Federal Highway Administration, 2012).

To estimate the guide bank scour using HEC-18 (NCHRP) procedure use the following given conditions:

- ❖ Parameters for guide bank scour conditions:
  - **Projected length of embankment (ft):** 85.00
  - **Width of floodplain (ft):** 100.00
- ❖ Parameters for *live-bed condition calculation*:
  - **Upstream flow depth (ft):** 10.00
  - **Unit discharge at upstream floodplain ( $\text{ft}^2/\text{s}$ ):** 57.00
  - **Unit discharge at constricted opening ( $\text{ft}^2/\text{s}$ ):** 78.60
  - **Flow depth prior to scour (ft):** 9.50

### 2.1 Step-by-Step Procedures

Step 1: Establish a New River Mechanics Project and Defaults Set-up

Step 2: Set up Guide Bank Scour Basic Data

Step 3: Calculate Guide Bank Scour

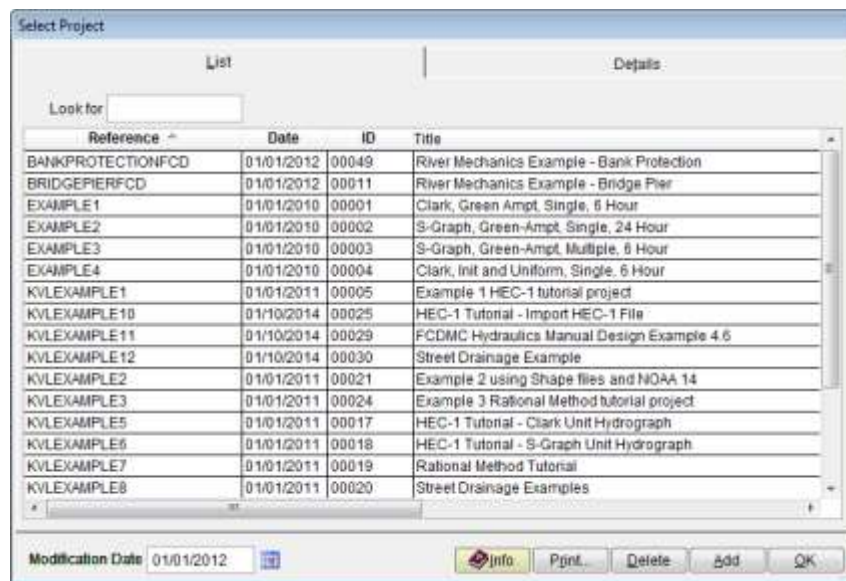
Step 4: Report and Document the results

#### 2.1.1 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.



After the **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened as 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) Select **River Mechanics** checkbox and click the **OK** button on the **NEW PROJECT OPTIONS** form.

- (d) Type “GUIDEBANK\_NCHRP” 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 a software window titled "Select Project" with two main sections: "List" and "Details".

**List Section:**

- Project Reference:**
  - Project ID: 00054
  - Reference: GUIDEBANK\_NCHRP
  - Title: Guide Bank Scour using HEC-18 NCHRP Procedure
  - Location: Maricopa County, Arizona
  - Agency: Flood Control District of Maricopa County
  - River Mechanics Only
- Project Defaults:**
  - Soils: FCDMC
  - Land Use: FCDMC

At the bottom of the "List" section is a text area containing the comment: "This is a tutorial project about the guide bank scour using HEC-18 NCHRP procedure."

**Footer:**

- Modification Date: 05/10/2018
- Buttons: Info, Print..., Delete, Add, OK


**Note:** the **Project ID** “00054” 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.

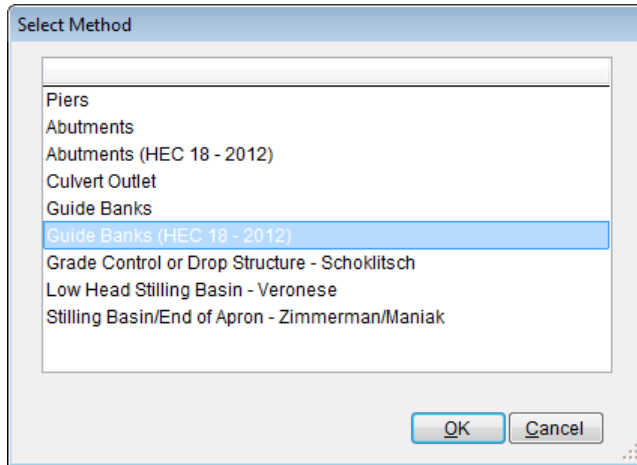
## 2.1.2 Step 2 - Set up Guide Bank Scour Basic Data

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

The image shows two windows from the software. The top window is titled 'Flood Control District of Maricopa County Version: 5.6.0 - ABUTMENT\_NCHRP' and has a menu bar with 'File', 'Edit', 'River Mechanics', and 'Help'. The 'River Mechanics' menu is open, showing options: 'Scour', 'Riprap', 'Launchable Riprap', 'Lateral Erosion', 'Sediment Yield' (with a right-pointing arrow), 'Cross Section Hydraulics', 'Cross Section Geometry', and 'Import Cross Sections from Another Project'. The 'Scour' option is highlighted.

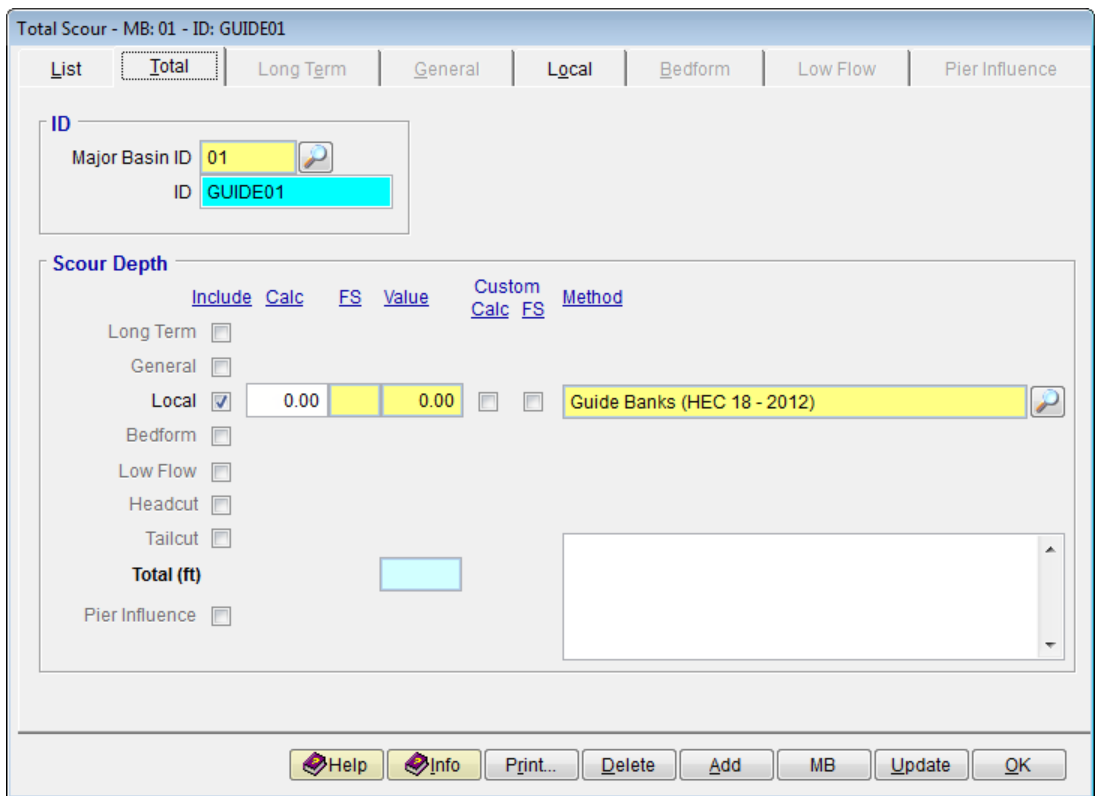
The bottom window is titled 'Total Scour - MB: 01 - ID:' and has a tabbed interface with tabs for 'List', 'Total', 'Long Term', 'General', 'Local', 'Bedform', 'Low Flow', and 'Pier Influence'. The 'Total' tab is active. It contains a table with the following columns: ID, Cross Section ID, Long Term Scour, General Scour, Local Scour, Bedform Scour, Bend Scour, Low Flow Scour, and Total Scour. The table has 14 empty rows. At the bottom of the window, there are buttons for 'Help', 'Info', 'Print...', 'Delete', 'Add', 'MB', 'Update', and 'OK'.

- (b) Click the **Add** button to activate the necessary data entry fields.
- (c) Type “GUIDE01” into the **ID** textbox (this **ID** indicates that it is for Guide Bank No.1).
- (d) Check the checkboxes **Local** only.
- (e) Click the browse button  in the **Method** column across **Local** check box to launch local scour method select menu.



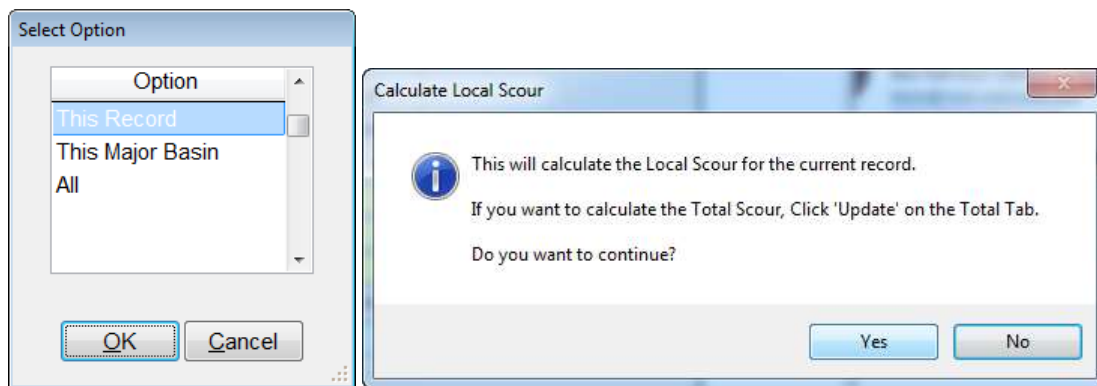
Select the “*Guide Banks (HEC 18 – 2012)*” from the **SELECT METHOD** window, and click **OK** to close the **SELECT METHOD** window

- (f) Click the **Save** button to save the entered data. The **TOTAL SCOUR – MB: 01 – ID: GUIDE01** window shows up like following figure.



### 2.1.3 Step 3 - Calculate the Guide Bank Scour

- (a) Click the **Local** tab
- (b) Enter "85" into the **Projected Length of Abutment, L (ft)** textbox.
- (c) Enter "100" into the **Width of Floodplain, Bf (ft)** textbox.
- (d) Enter "10" into the **Upstream Flow Depth, y1 (ft)** textbox.
- (e) Enter "57" into the **Upstream Unit Discharge, q1 (sq ft/sec)** textbox.
- (f) Enter "78.6" into the **Unit Discharge in the Constricted Opening, q2c (sq ft/sec)** textbox.
- (g) Enter "9.5" into the **Flow Depth Prior to Scour, Yo (ft)** textbox.
- (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 **Yes** from the confirmation message to proceed.



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



Total Scour - MB: 01 - ID: GUIDE01

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

**Guide Bank Parameters (HEC 18 - 2012)**

Projected Length of Abutment, L (ft) 85.00  
 Width of Floodplain, Bf (ft) 100  
 Guide Bank Scour Condition A

**Condition A**

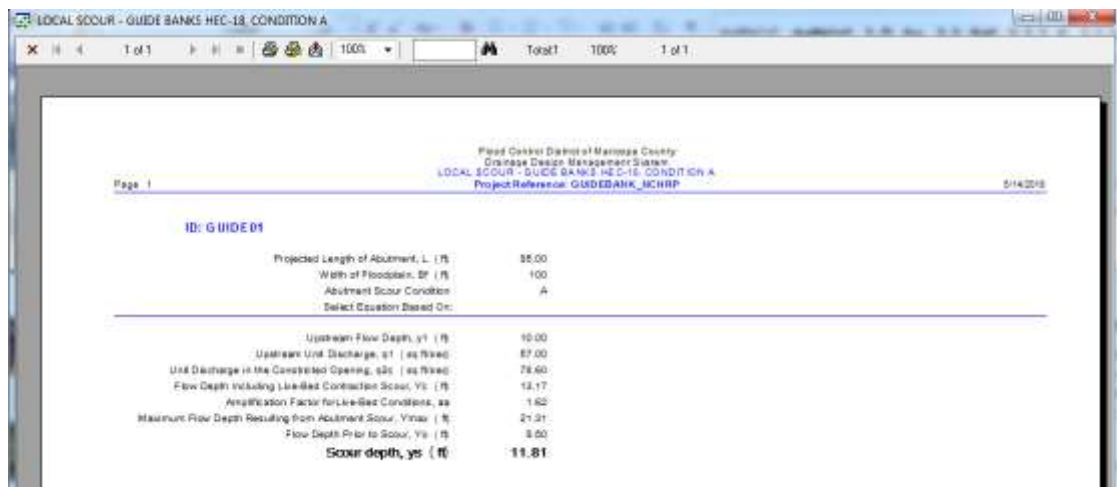
Upstream Flow Depth, y1 (ft)	10.00
Upstream Unit Discharge, q1 (sq ft/sec)	57.00
Unit Discharge in the Constricted Opening, q2c (sq ft/sec)	78.60
Flow Depth Including Live-Bed Contraction Scour, Yc (ft)	13.17
Amplification Factor for Live-Bed Conditions, aa	1.618
Maximum Flow Depth Resulting from Abutment Scour, Ymax (ft)	21.31
Flow Depth Prior to Scour, Yo (ft)	9.50
Abutment Scour Depth, Ys (ft)	11.81



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

### 2.1.4 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 guide bank scour.

- (a) To view the results on the screen, click the **Print ...** button on the Local Tab of **TOTAL SCOUR – MB: 01 – ID: GUIDE01** window, a report will be generated as is shown in the following figure.



- (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 ().

This concludes tutorial for Guide Bank Scour Live-bed Condition evaluation.

### 3.0 GUIDE BANK SCOUR FOR CLEAR-WATER CONDITION

If the ratio ( $L/B_f$ ) is less than 0.75, the clear-water guide bank scour equations should be used to compute the local scour component due to guide bank. The clear-water condition is also referred as Condition (b) in HEC-18 manual (Federal Highway Administration, 2012).

To estimate the guide bank scour using HEC-18 (NCHRP) procedure use the following given conditions:

- ❖ Parameters for guide bank scour conditions:
  - **Projected length of embankment (ft):** 65.00
  - **Width of floodplain (ft):** 100.00
- ❖ Parameters for *Clear-water guide bank calculation*:
  - **Unit discharge at upstream floodplain ( $\text{ft}^2/\text{s}$ ):** 5.70
  - **Unit discharge at constricted opening ( $\text{ft}^2/\text{s}$ ):** 10.10
  - **Particle size with 50 percent finer (ft):** 0.0010
  - **Manning's n of floodplain under the bridge:** 0.025
  - **Critical shear stress for floodplain material:** 0.04
  - **Flow depth prior to scour (ft):** 3.50

### 3.1 Step-by-Step Procedures

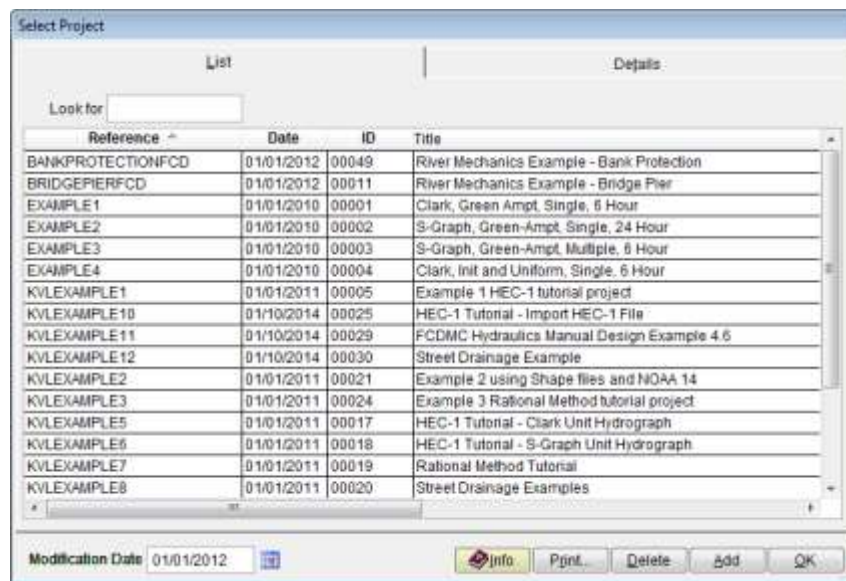
- Step 1: Establish a New River Mechanics Project and Defaults Set-up
- Step 2: Set up Guide Bank Scour Basic Data
- Step 3: Calculate Guide Bank Scour – Grain Size Equation
- Step 4: Calculate Guide Bank Scour – Shear Stress Equation
- Step 5: Report and Document the results

#### 3.1.1 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.

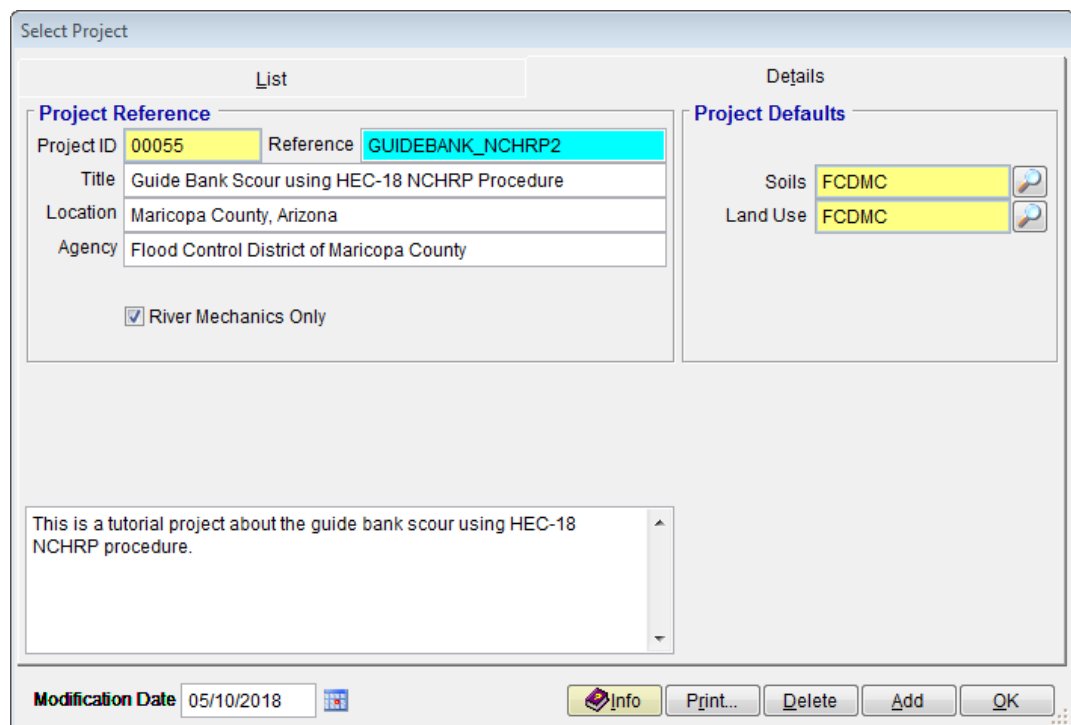


After the **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened as shown in the following figure.



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

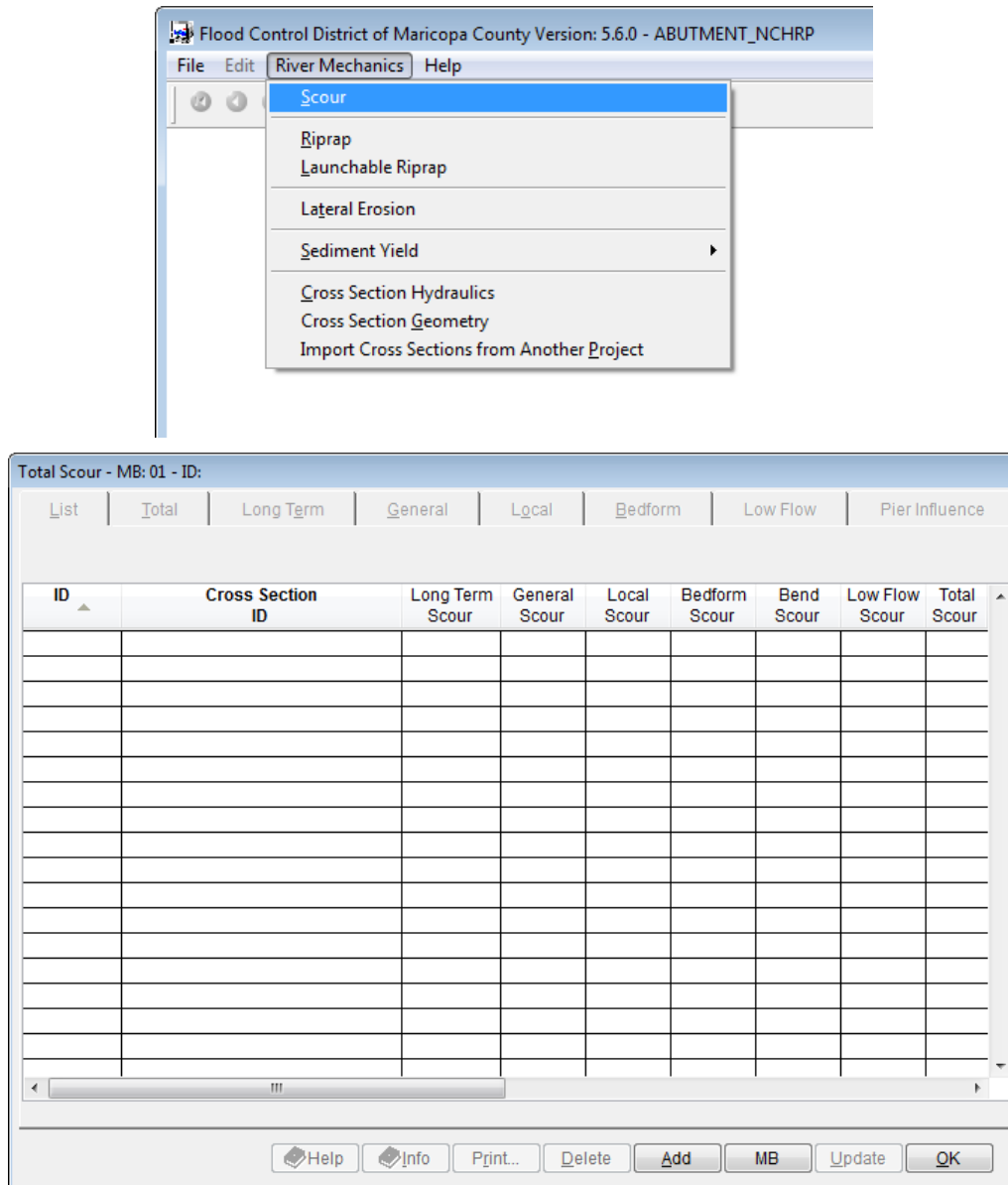
- (d) Type “GUIDEBANK\_NCHRP2” into the **Reference** textbox. This is the name of this newly created project. Users can choose any name for the Reference textbox as long as it does not exist in the current **DDMSW** project database.
- (e) Type into the **Title** textbox a brief descriptive title for 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.




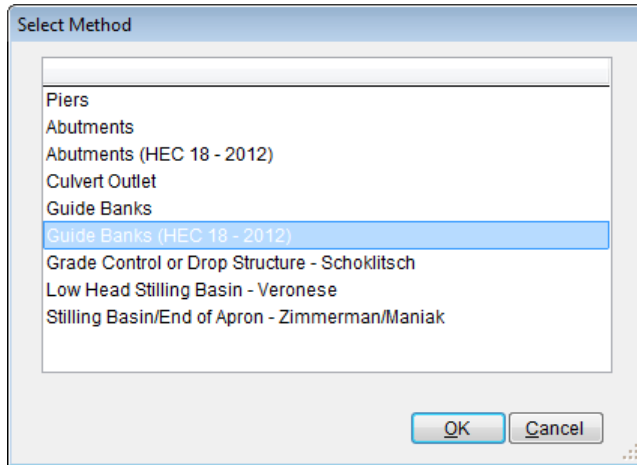
**Note:** the **Project ID** “00055” in the above figure is the unique database record identifier for the project, which is automatically generated by the program when a new project is created. When users create a new project, the **Project ID** of the new project will not be the same as the **Project ID** shown in the above figure.

### 3.1.2 Step 2 - Set up Guide Bank Scour Basic Data

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

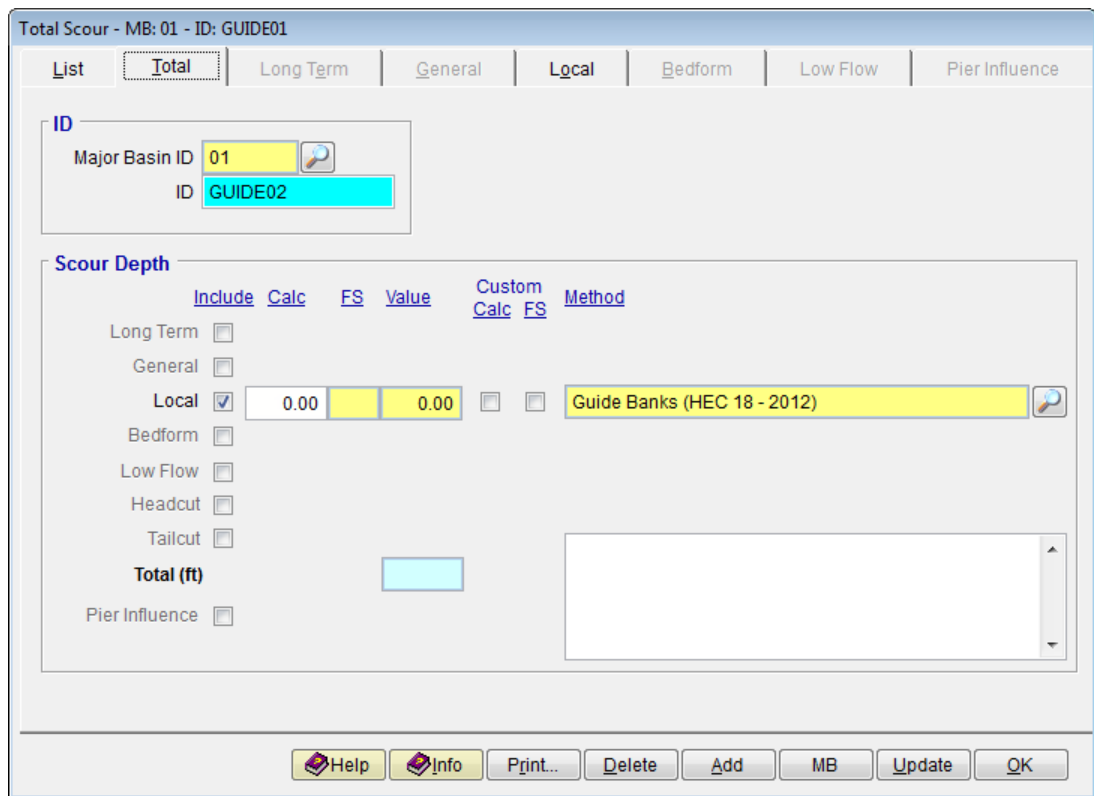


- (b) Click the **Add** button to activate the necessary data entry fields.
- (c) Type “GUIDE02” into the **ID** textbox (this **ID** indicates that it is for Guide Bank No.2).
- (d) Check the checkboxes **Local** only.
- (e) Click the browse button  in the **Method** column across **Local** check box to launch local scour method select menu.




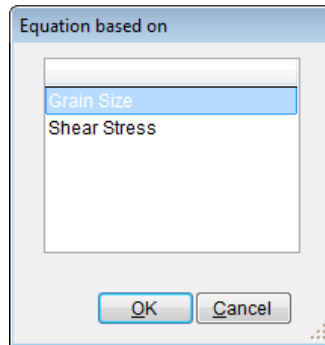
Select the “*Guide Bank (HEC 18 – 2012)*” from the **SELECT METHOD** window, and click **OK** to close the **SELECT METHOD** window.

- (f) Click the **Save** button to save the entered data. The **TOTAL SCOUR – MB: 01 – ID: GUIDE02** window shows up like following figure.

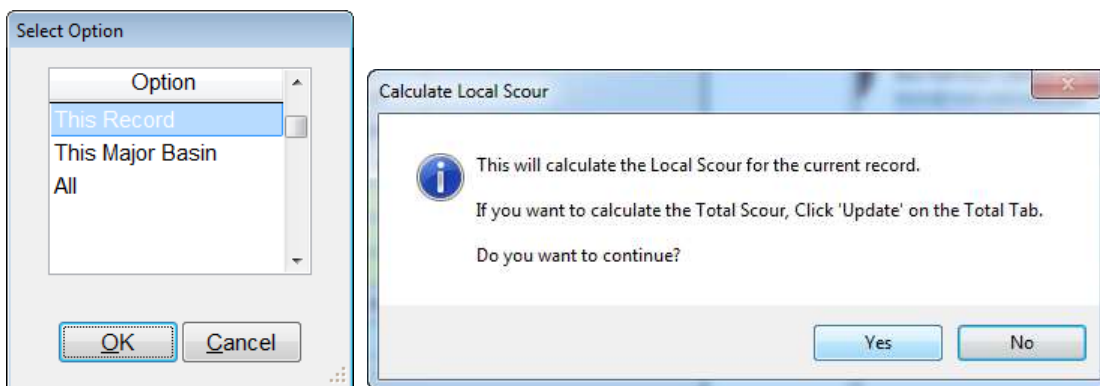


### 3.1.3 Step 3 - Calculate the Guide Bank Scour – Grain Size Equation

- (a) Click the **Local** tab
- (b) Enter “65” into the **Projected Length of Abutment, L (ft)** textbox.
- (c) Enter “100” into the **Width of Floodplain, Bf (ft)** textbox.
- (d) Click browse  button beside the **Select Equation Based On** to select the basis for guide bank equation. Choose “*Grain Size*” and click **OK** to exit the **Equation Based On** window.



- (e) Click the **Save** button to save the entered data.
- (f) Enter “5.7” into the **Upstream Floodplain Unit Discharge, qf (sq ft/sec)** textbox.
- (g) Enter “10.1” into the **Unit Discharge in the Constricted Opening, q2c (sq ft/sec)** textbox.
- (h) Enter “0.0010” into the **Particle Size with 50 Percent Finer, D50 (ft)** textbox.
- (i) Enter “3.5” into the **Flow Depth Prior to Scour, Yo (ft)** textbox.
- (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 'Local' tab selected. The 'Guide Bank Parameters (HEC 18 - 2012)' section is active, displaying the following values:


Projected Length of Abutment, L (ft)	65.00	Select Equation Based On:	Grain Size
Width of Floodplain, Bf (ft)	100		
Guide Bank Scour Condition	B		

The 'Condition B - Grain Size' section displays the following calculated values:

Upstream Floodplain Unit Discharge, qf (sq ft/sec)	5.70
Unit Discharge in the Constricted Opening, q2f (sq ft/sec)	10.10
Ku	11.170
Particle Size with 50 Percent Finer, D50 (ft)	0.0010
Flow Depth Including Clear-water Contraction Scour, Yc (ft)	6.60
Amplification Factor for Clear-water Conditions, ab	2.111
Maximum Flow Depth Resulting from Abutment Scour, Ymax (ft)	13.94
Flow Depth Prior to Scour, Yo (ft)	3.50
Abutment Scour Depth, Ys (ft)	10.44

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

### 3.1.4 Step 4 - Calculate the Guide Bank Scour – Shear Stress Equation

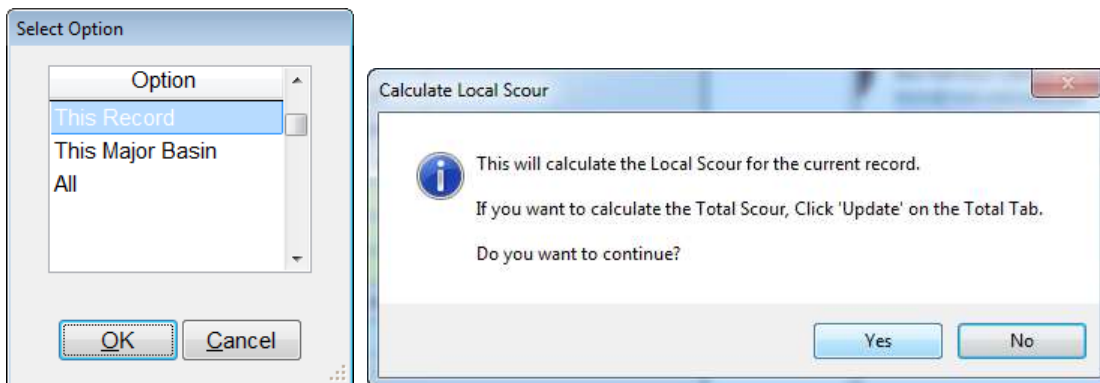
- Click the **Local** tab
- Enter “65” into the **Projected Length of Abutment, L (ft)** textbox.
- Enter “100” into the **Width of Floodplain, Bf (ft)** textbox.
- Click browse  button beside the **Select Equation Based On** to select the basis for guide bank equation. Choose “*Shear Stress*” and click **OK** to exit the **Equation Based On** window.

The 'Equation based on' dialog box shows a list with two options: 'Grain Size' and 'Shear Stress'. 'Shear Stress' is currently selected and highlighted in blue. At the bottom of the dialog are 'OK' and 'Cancel' buttons.

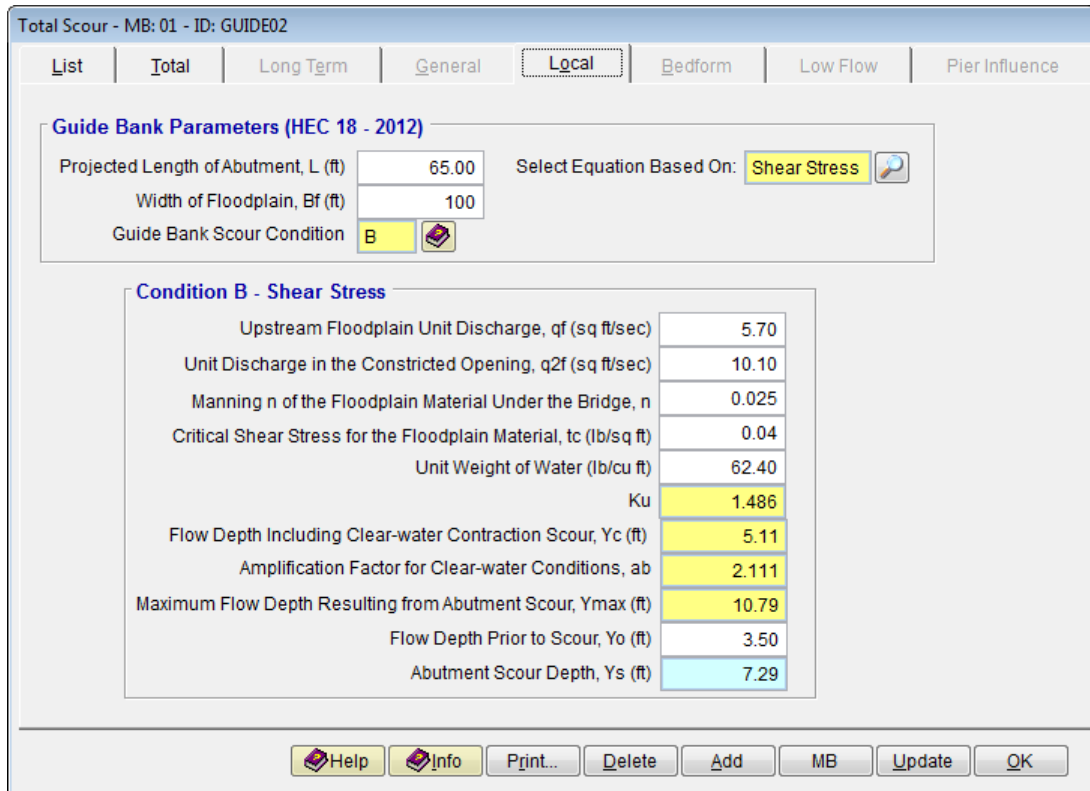
- Click the **Save** button to save the entered data.



- (f) Enter "5.7" into the **Upstream Unit Discharge,  $q_f$  (sq ft/sec)** textbox.
- (g) Enter "10.1" into the **Unit Discharge in the Constricted Opening,  $q_{2c}$  (sq ft/sec)** textbox.
- (h) Enter "0.025" into the **Manning n of the Floodplain Material Under the Bridge, n** textbox.
- (i) Enter "0.04" into the **Critical Shear Stress for the Floodplain Material,  $t_c$  (lb/sq ft)** textbox.
- (j) Enter "3.5" into the **Flow Depth Prior to Scour,  $Y_o$  (ft)** textbox.
- (k) Click the **Save** button to save the entered data.
- (l) Click the **Update** button to update the data.
- (m) Select "*This Record*" from the **SELECTION OPTION** window, and click **Yes** from the confirmation message to proceed.



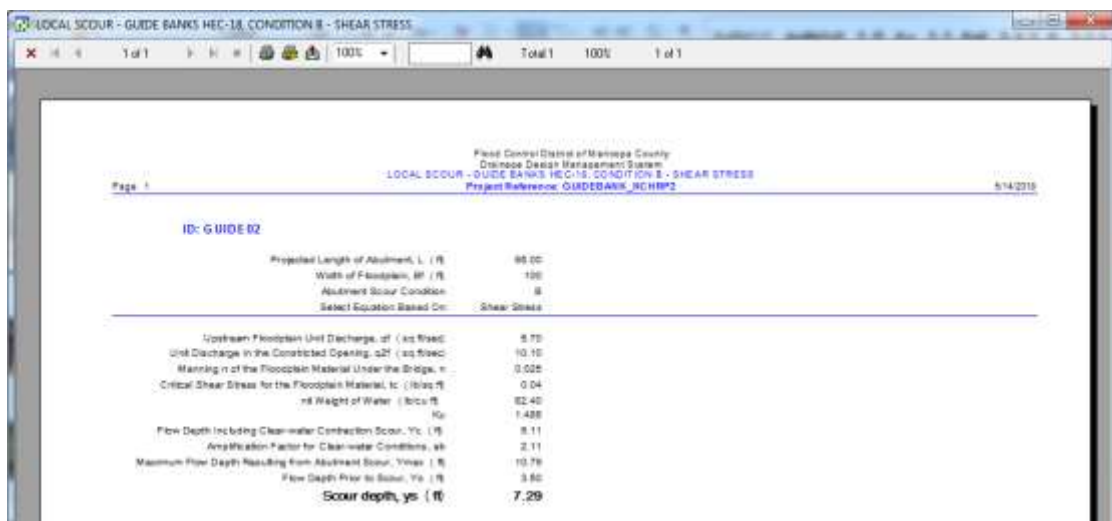
After the update the window looks like what is shown in the following figure.




### 3.1.5 Step 5 - 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 guide bank scour.

- (a) To view the results on the screen, click the **Print ...** button on the Local Tab of **TOTAL SCOUR – MB: 01 – ID: GUID02** window, a report will be generated as is shown in the following figure.



- (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 (  )

This concludes this tutorial for Guide Bank Scour clear-water Condition evaluation.