

DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 6.0.5

TUTORIAL # 21 PRESSURE FLOW SCOUR ANALYSIS HEC-18 PROCEDURE



KVL Consultants, Inc.

PRESSURE FLOW SCOUR ANALYSIS [HEC-18 PROCEDURE]

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PRESSURE FLOW SCOUR ANALYSIS [HEC-18 PROCEDURE] <u>DATE UPDATED</u>: APRIL 20, 2022 <u>TUTORIAL TIME</u>: 40 MINUTES

1.0 INTRODUCTION

Evaluation of pressure flow scour underneath a bridge structure from significant flood events is critical for safe bridge design and for assessing bridge stability. **FIGURE 1** below shows a typical bridge condition where pressure flow impacts the transport and stability of the bed materials giving rise to bed degradation and the formation of scour. FHWA (2012) has developed a number of useful procedures to evaluate such scour depth. The analysis procedure for predicting scour depths have been established for the following conditions:

- (a) Live-bed with overtopping (or submerged) condition;
- (b) Live-bed with no overtopping (or not submerged) condition;
- (c) Clear-water with overtopping condition; and,
- (d) Clear-water with no overtopping condition.

For a more thorough coverage on this topic, please refer to the following reference materials:

(a) River Mechanics Manual for DDMSW by FCDMC (April 30, 2021)



(b) HEC-18 – Evaluating Scour at Bridges by FHWA (April 2012).

FIGURE 1: Vertical contraction under the bridge (FHWA, 2012)

2.0 SYMBOLS AND DEFINITION OF TERMS

The different symbols used to describe the parameters presented in **Figure 1** associated with pressure flow scour are defined below.

No.	Symbol	Definition			
1	D ₅₀	Average size of the bed material upstream of the bridge. It is the sediment particle size in which 50% are smaller (mm).			
2	h _b	Vertical height of the bridge opening prior to scour (ft),			
3	h _c	Vertical flow height in ft.			
4	ht	Distance from the water surface to the lower face of the bridge girders in ft, i.e., $h_t = h_u - h_b$;			
5	h _{u,} y _a	Average depth of flow upstream of the bridge (ft),			
6	h _{ue}	Effective upstream channel flow depth for live-bed conditions and bridge overtopping in ft.			
7 h _w		Weir flow height in ft. $h_w = h_t - T$ for $h_t > T$ $h_w = 0$ for $h_t < T$;			
8	Q1	Flow in the upstream channel transporting sediment (cfs),			
9	Q2	Flow in the contracted channel section (cfs),			
10	t	Maximum thickness of the flow separation zone (ft),			
11	Т	Height of obstruction that includes girders, deck, and parapet, ft.			
12	Vc	Critical velocity (ft/s),			
13	W ₁	Bottom width of the upstream channel that is transporting bed material (ft).			
14	W ₂	Bottom width of the main channel in the contracted section less pier widths (ft).			
15	У1	Average depth of flow in the upstream main channel (ft), (hydraulic depth),			
16	У2	Average depth of flow in the contracted section (ft), (hydraulic depth),			
17	Уs	Pressure flow scour depth, ft.			

3.0 PROBLEM STATEMENT

This tutorial document was developed to show how scour analysis is performed for bridge structures involving pressure flow conditions with live-bed and no bridge overtopping. The conditions are described below:

- All the flow is through the bridge with no overtopping.
- There are no piers (clear span)
- Upstream channel width (W₁) and bridge opening width (W₂) = 40 ft;
- Total discharge (Q₂) = 5000 cfs;
- Upstream channel discharge (Q₁) = 4000 cfs;
- Upstream floodplain discharge = 1000 cfs
- Upstream channel flow depth $(y_1 = h_u) = 10.14$ ft
- Bridge opening height (h_b) = 8.0 ft;
- Deck thickness (T) = 3 ft;
- Bed material, D₅₀ = 20 mm (V_c = 6.63 fps)
- Upstream channel velocity (V = Q₁/(W₁h_u) = 5000/(40 x 10.14) = 9.86 fps;

Determine the magnitude of live-bed contraction scour for pressure flow conditions.

4.0 REQUIRED DATA

The following data are the basic data that will be used for the pressure flow scour analysis.

- (a) Data at the Bridge Cross-Section
 - i. Bridge Cross-Section Data The cross-section geometry where the bridge is located is provided below:

No	Station (X)	Elevation (Y)	Notes
1	0	20	
2	20	19	Left Bank Station
3	20.01	4	
4	40.01	4	
5	60.01	4	
6	60.02	19	Right Bank Station
7	80.02	20	

- No piers (Clear Span)
- Height of obstruction/ Deck thickness, T (ft): 3.0
- Bridge opening width, W₂ (ft) 40
- Bridge opening height, h_b (ft): 8.00
- ii. Flow Rates and Related Data:

٠	Design Flow Rate (cfs):	5000
•	Dominant Flow Rate (cfs):	1000
•	Channel Slope for Design Flow (ft/ft):	0.010
•	Channel Slope for Dominant Flow (ft/ft):	0.010
٠	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:	0.035
•	LOB Manning's n for Dominant Flow:	0.035

- ROB Manning's n for Dominant Flow: 0.035
- (b) Data at the Upstream Cross-Section
 - i. Upstream Cross-Section Data The representative geometry of the upstream cross-section is provided below:

No	Station (X)	Elevation (Y)	Notes
1	0	20	
2	20	19	Left Bank Station
3	20.01	4	
4	40.01	4	
5	60.01	4	
6	60.02	19	Right Bank Station
7	80.02	20	

ii. Flow Rates and Related Data:

iii.

• Design	Flow Rate (cfs):	4000
• Channe	l Slope (ft/ft):	0.0070
• Channe	l Manning's n:	0.045
• LOB Ma	nning's n:	0.045
ROB Ma	anning's n:	0.045
• Bottom	width of upstream channel, W_1 (ft):	40.00
Sediment Da	ita:	

• Bed material, D₅₀ (mm): 20.00

5.0 STEP-BY-STEP PROCEDURE

The general procedure for evaluating scour involving pressure flows at bridges is as follows:

- (i) Create a new river mechanics project and set-up project defaults
- (ii) Prepare the cross-section geometry and evaluate the hydraulics
- (iii) Calculate the pressure flow scour
- (iv) Reporting and documentation of results

5.1 STEP 1 - CREATE A NEW PROJECT AND SET-UP PROJECT DEFAULTS

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



After **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened.

Select Project							
List		Details	Default Table Versions				
Group River Mechanics							
Project Group 🔺	ID	Reference	Title				
River Mechanics	00107	PROJECTXSECTIONS	River Mechanics Cross Sections				
River Mechanics	00110	RIPRAPSIZINGFCD	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	T15_LAUNCHABLERR	Tutorial #15 - Launchable Riprap Analysis				
River Mechanics	00141	V605_ABUTMENT_NCHRP1	Abutment Scour using HEC-18 NCHRP Procedure				
River Mechanics	00142	V605_ABUTMENT_NCHRP2	Abutment Scour using HEC-18 NCHRP Procedure				
River Mechanics	00144	V605_GUIDEBANK_NCHR2	Guide Bank Scour using HEC-18 NCHRP Procedure				
River Mechanics	00143	V605_GUIDEBANK_NCHRP	Guide Bank Scour using HEC-18 NCHRP Procedure				
Street Drainage	00105	KVLEXAMPLE12	Street Drainage Example				
Street Drainage	00101	KVLEXAMPLE8	Street Drainage Examples				
			¥				
<	<						
Modification Date	03/31/202	22 Update Project Defa	aults Info Print Delete Add QK				

- (b) Click the *Add* button on the **SELECT PROJECT** form to start a new project (Alternatively, *File* → *New Project*).
- (c) Select *River Mechanics* checkbox, then click the *OK* button on the New **PROJECT OPTIONS** form.
- (d) On the SELECT PROJECT form, enter "V605_PRESSURE_SCOUR" into the Reference textbox. This is the name of the new project. Users can choose any project name to be entered on the Reference textbox as long as it does not already exist in the DDMSW project database.
- (e) Type into the *Title* textbox a brief descriptive title of this project. (Optional) (e.g., 'Pressure Flow Scour using HEC-18 NCHRP Procedure').
- (f) Type into the *Location* textbox the location of this project. (Optional) (e.g., 'Maricopa County, Arizona')
- (g) Type into the **Agency** textbox the agency or company name. (Optional) (e.g., 'Flood Control District of Maricopa County').
- (h) Check the *River Mechanics Only* checkbox.
- (i) Type a detailed description of this project into the comment area under the **Project Reference** frame. (Optional) (e.g., 'This is a tutorial project for evaluating Pressure Flow Scour using HEC-18 NCHRP Procedure').
- (j) Set the *Modification Date* using today's date by clicking on the Calendar icon.

Select Projec	t							
	<u>L</u> ist		Details		Default	Table Versions		
Project F	Reference				Project Defaults			
Project ID	00145	Referenc	e V605_PRESSURE_SCOUR					
Title	Pressure Flow	Scour usin	g HEC-18 NCHRP Procedure		Soils	FCDMC	\sim	
Location	Maricopa Coun	ty, Arizona			Land Use	FCDMC	\sim	
Agency	Flood Control D	istrict of M	aricopa County					
	Hydrology and Hydraulics Only River Mechanics Only							
This is a tu NCHRP Pr	itorial project for o	evaluating	Pressure Flow Scour using HEC	>18 ^				
Modification	Date 03/31/202	2	Update Project Defaults 🧳	Info	P <u>r</u> int <u>D</u> el	ete <u>A</u> dd	<u>0</u> K	

The following figure shows what the form should look like.

- (k) Click the *Save* button to save the entered data.
- Note: The *Project ID "00145"* in the above figure is the unique database record identifier for the project, which is automatically generated by the program. Each time a new project is created, a *Project ID* is assigned by the program. The *Project ID* assigned to your project will not necessary be the same as the *Project ID* shown in the above figure.
- (I) Click the **OK** button to exit/close the **SELECT PROJECT** form.

5.2 STEP 2 - PREPARE THE CROSS-SECTION DATA AND EVALUATE THE SECTION HYDRAULICS

Two channel section data are considered in the analysis where hydraulics information would be evaluated. They are the cross-section data of: (a) upper channel reach; and, (b) bridge channel. Geometric and relevant data are entered in DDMSW to evaluate relevant flow hydraulics to be used by the program in evaluating the Pressure Flow scour depth.

From the menu bar of the main application window, open the **CROSS SECTION HYDRAULICS** form (*River Mechanics* \rightarrow *Cross Section Hydraulics*).

Flood Co	ontrol District of Ma	ricopa County Version: 6.0.5 - V605_PRESSURE_SCOUR	
File Edit	River Mechanics	Project Defaults Help	
	<u>S</u> cour <u>T</u> halweg Elevat	on Comparison	
	<u>R</u> iprap <u>L</u> aunchable Ri	rap	
	Lateral Erosion		
	Sediment Yield	•	
	<u>Cross</u> Section	lydraulics	
	Cross Section	eometry	
	Import Cross S Import Cross S	ections from Another <u>P</u> roject ections from a <u>C</u> SV File	
	<u>M</u> anning's Cal	ulator	
Edit cross sec	tion hydraulics		

5.2.1 Create the Bridge Cross-Section Data and Evaluate the Hydraulics

- (a) On the **CROSS SECTION HYDRAULICS** form, click the **Add** button.
- (b) Enter "*BRIDGEXS*" into the *Section ID* textbox, then click the *Save* button.
- (c) Check both the *Design* and the *Dominant* checkboxes.
- (d) Enter *"5000"* into the *Design Flow Rate (cfs)* textbox.
- (e) Enter "0.01" into the **Design Slope (ft/ft)** textbox.
- (f) Enter "0.035" into the **Design Manning's n Channel** textbox.
- (g) Enter "0.035" into the **Design Manning's n LOB** textbox.
- (h) Enter "0.035" into the **Design Manning's n ROB** textbox.
- (i) Enter *"1000"* into the *Dominant Flow Rate (cfs)* textbox.
- (j) Enter "0.01" into the **Dominant Slope (ft/ft)** textbox.
- (k) Enter "0.035" into the **Dominant Manning's n Channel** textbox.
- (I) Enter "0.035" into the **Dominant Manning's n LOB** textbox.
- (m) Enter "0.035" into the **Dominant Manning's n ROB** textbox.
- (n) Click the *Save* button to save the entered data for the Bridge Section.

- (o) Click the <u>X</u> Section button at the bottom of the CROSS SECTION HYDRAULICS form to enter the X and Y coordinates of the Bridge Section.
- (p) On the NATURAL CROSS SECTION form, enter the first X and Y values (i.e., X= "0.00" and Y = "20.00") from the Bridge Cross Section data table into the Station (ft) and Elevation (ft) text boxes shown below. Click the Save & Add Record button when done to continue with the next XY dataset.

Natural Cross Section				N	
Station Clevation	Overbank			45	
	Right 2	27.00 - 24.00 - 21.00 -			
		18.00 15.00			
		9.00			
		3.00			
	Graph	-3.00 -6.00 -9.00	I I	1 I	1 1 1
	Lateral Erosion	-80	-60 -40 -2	20 0 20	40 60 80
	Adjustments Elevation Adjustment (ft)		D BRIDGE	on XS	Ĩ
		<u>A</u> djust	Station (ft) Elevation (ft)	0.00	Delete and Confirm Save & Add Record
Overbank		_ ⊘ Info	P <u>r</u> int	<u>D</u> elete	Add <u>O</u> K

(q) Follow the same procedure until all the *Station* (X) and *Elevation* (Y) data pairs are entered.

The completed form should look like the figure below.

Natural Cross Sections		
X ▲ Y 0.00 20.00 20.01 19.00 20.01 4.00 40.01 4.00 60.02 19.00 80.02 20.00 1 1 1	Overbank Left Right Image: Constraint of the second	24.00 20.00 <td< th=""></td<>
Overbank		

(r) After entering all the Station (X) and Elevation (Y) data, set the left and right overbank stations. The left overbank station is set by selecting the row with Station value of "20.00" and then clicking the "Selection" button on the right side of the Left Overbank textbox. Similarly, the right overbank station is set by selecting the row with Station value of "60.02" and then clicking the "Selection" button on the right side of the Right Overbank textbox.

Natural Cross Section		2	
Station Elevation 0.00 20.00 20.01 19.00 20.01 4.00 40.01 4.00 60.02 19.00 20.02 20.00	Overbank Left 20.00 Right 60.02 Overbank Image: Comparison of the second of	24.00 22.00 18.00 16.00 14.00 10.00 10.00 -10 0 10 20 Cross Section ID BRIDGED Station (ft) Elevation (ft)	Image: Construction of the second
Overbank			<u>D</u> elete <u>A</u> dd <u>O</u> K

- (s) Once the data entry is complete, close the **NATURAL CROSS SECTION** form by clicking the **OK** button.
- (t) On the RIVER MECHANICS CROSS SECTION HYDRAULICS form, click the Update button to update the hydraulic analysis at the Bridge Section, BRIDGEXS, for both the Design and Dominant flow conditions.
- (u) On the **SELECT OPTION** dialog box, select *"This Record"*, then click **OK** to close. When the **UPDATE CROSS SECTION HYDRAULICS** dialog box appears, click **Yes** to continue.

Select Option	
Option	^
This Record	
All	
	~
<u>O</u> K <u>C</u> ancel	



(v) After successful analysis update, the **RIVER MECHANICS - CROSS** SECTION HYDRAULICS form should look like the figure below:

🙀 River Mechanics - Cross Section Hyd	rauli	cs					[-	• 🗙
Section ID		Entire Cross S	ection —						
BRIDGEXS		Source	Calculate D	ata 🗸	/	🗹 Design	🗹 Domii	nant	
		Total Scour	F	low Rate (c	fs)	5000) 1	000	
Cross Section ID A	1			Slope (f	t/ft)	0.01000	0.010	000	
UPSTREAMXS			Mannin	g's n Chani	nel	0.038	5 0.	035	Man's n
			Mai	nning's n L(ов	0.035	5 0 .	035	
			Mar	ning's n R	ов	0.035	5 0 .	035	
	-		FI	ow Area (sq	qft)	352.07	7 12	2.67	
	-		Wetted	Perimeter	(ft)	57.60) 4	5. 1 3	
			Ave	rage Width	(ft)	40.01	I 40	0.00	
	.			Top Width	(ft)	40.01	I 40	0.00	
	-		Hydra	ulic Depth	(ft)	8.80) ;	3.07	
	-		Normal or	Max Depth	(ft)	8.80) :	3.07	
< >	~	Total Cros	ss Section \	elocity (ft/s	ec)	14.20)	3.15 ⁻	
	~								
	<u>С</u> ор	y <u>D</u> elete	<u>A</u> dd	<u>G</u> raph	<u>X</u> Se	ction <u>D</u> et	ail <u>U</u> pda	ate	<u>0</u> K .:

5.2.2 Create the Upstream Cross Section Data and Evaluate the Hydraulics

- (a) On the **RIVER MECHANICS CROSS SECTION HYDRAULICS** form, click the *Add* button.
- (b) Enter "UPSTREAMXS" into the Section ID textbox, then click the Save button.

- (c) In the *Entire Cross Section* data frame, check the *Design* checkbox and uncheck the *Dominant* checkbox.
- (d) Enter "4000" into the **Design Flow Rate (cfs)** textbox.
- (e) Enter "0.007" into the **Design Slope (ft/ft**) textbox.
- (f) Enter "0.045" into the **Design Manning's n Channel** textbox.
- (g) Enter "0.045" into the **Design Manning's n LOB** textbox.
- (h) Enter "0.045" into the **Design Manning's n ROB** textbox.
- (i) Click the *Save* button to save the entered data.
- (j) Click the <u>X</u> Section button at the bottom of the form to enter the X and Y coordinates of the Upstream cross section.
- (k) On the NATURAL CROSS SECTION form, enter the first X and Y values (i.e., X = "0.00" and Y = "20.00") from the Upstream Cross Section data table into the Station (ft) and Elevation (ft) text boxes as shown below. Click the Save & Add Record button when done to continue with the next XY dataset.

Station Elevation 0.00 20.00 Right 27.00 24.00 21.00 21.00 21.00 1 1	Natural Cross Section		
Graph -3.00 Current Record -6.00 Lateral Erosion -80 Adjustments Cross Section Elevation Adjustment (ft) Duest Elevation (ft) Adjust Station (ft) 0.00 Station (ft) 20.00 Save & Add Record	Station Elevation	Overbank Left Right	27.00 24.00 21.00 15.00 12.00 9.00 6.00 3.00 0.00
		Graph Current Record Lateral Erosion Adjustments Elevation Adjustment (ft)	-3.00 -6.00 -9.00 -8.0 -60 -40 -20 0 20 40 60 80 Cross Section ID LIPSTREAMXS Station (ft) 0.00 Elevation (ft) 20.00 Save & Add Record

(I) Follow the same procedure until all the *Station* and *Elevation* data pairs are entered.

Natural Cro	oss Section		
Station 🔺	Elevation	Overbank	
0.00	20.00	Left	
20.00	19.00	Diebt	22.00
20.01	4.00	Right	20.00
40.01	4.00		18.00
60.01	4.00		16.00
60.02	19.00		14.00
80.02	20.00		12.00
			10.00
			8.00
			6.00
			2 00
		Graph	0.00
		Current Record	-10 0 10 20 30 40 50 60 70 80 90
		Lateral Erosion	
		Adjustments	Cross Section
		Elevation Adjustment (ft)	
			Adjust Station (ft) 80.02 Delete and Confirm
			Elevation (ft) 20.00 Save & Add Record
			20.00
	×		
Ove	erbank		Info Print Delete Add OK

(m) After entering all the Station and Elevation dataset, define the left and right over bank stations. The left bank station is set by selecting the row with Station value of "20" and then clicking the "Selection" button on the right side of the Left Overbank textbox. Similarly, the right bank station is set by selecting the row with Station value of "60.02" and then clicking the "Selection" button on the right side of the Right Overbank textbox.

Natural Cross Section		
Station Elevation 0.00 20.00 20.00 19.00 20.01 4.00 40.01 4.00 60.02 19.00 0.02 20.00	Overbank Left 20.00 Right 60.02 Overbank Image: Complexity of the second of	24.00 22.00 20.00 9 18.00 9 14.00 14.00 12.00 14.00 12.00 14.00 10.00 10.00 10.00
Overbank		

- (n) To close the **NATURAL CROSS SECTION** form, click the **OK** button.
- (o) On the **RIVER MECHANICS CROSS SECTION HYDRAULICS** form, click the **Update** button to update the hydraulics analysis at the upstream cross section, UPSTREAMXS.
- (p) On the **SELECT OPTION** dialog box, select *"This Record"*, then click **OK** to close. When the **UPDATE CROSS SECTION HYDRAULICS** dialog box appears, click **Yes** to continue.

Select Option		
Ontion	•	
This Record		
	Ŧ	
<u>O</u> K <u>C</u> ancel		



(q) The **RIVER MECHANICS - CROSS SECTION HYDRAULICS** form should now look like the following figure:

River Mechanics - Cross Section Hydr	aulics						
Section ID	Entire Cross	Section					
UPSTREAMXS	Source	Calculate Da	ata 🗸 🗸		esign	Dominant	
	Total Scour	E Flo	ow Rate (cf	s)	4000		
Cross Section ID A	^		Slope (ft/	ft) 0.0	07000		
UPSTREAMAS		Manning	's n Chann	el	0.045		Man's n
		Man	ning's n LC	в	0.045		
		Manr	ning's n RC	в	0.045		
		Flo	w Area (sq	ft) 4	405.83		
		Wetted F	Perimeter (ft)	60.29		
		Avera	age Width (ft)	40.01		
		1	Top Width (ft)	40.01		
		Hydrau	ulic Depth (ft)	10.14		
		Normal or M	lax Depth (ft)	10.14		
< >	Total Cro	ss Section Ve	locity (ft/se	c)	9.86		
	^						
	<u>C</u> opy <u>D</u> elete	Add	<u>G</u> raph	X Section	<u>D</u> etail	Update	<u>о</u> к

(r) Click the *OK* button to close the form.

5.3 STEP 3 - CALCULATE THE PRESSURE FLOW SCOUR

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

Flood C	ontrol District of Ma	aricopa County Version: 6.0.5 - V605_PRESS	SURE_SCOUR	
File Edit	River Mechanics	Project Defaults Help		
	<u>Scour</u> <u>T</u> halweg Elevat <u>R</u> iprap <u>L</u> aunchable Ri La <u>t</u> eral Erosion <u>S</u> ediment Yield <u>C</u> ross Section <u>C</u> ross Section Import Cross S Import Cross S	tion Comparison prap Hydraulics Geometry Sections from Another Project Sections from a CSV File culator		
Model scour				

Total Scour - MB: 01 - ID:											
List Total Long Term General Local Bedform Low Flow Pier Influence											
ID Cross Section Long Term General Local Bedform Bend Low Flow Total											
•	ID	Scour	Scour	Scour	Scour	Scour	Scour	Scour			
<											
				1							
	Help	<u>∕I</u> nfo P <u>r</u> i	nt <u>D</u> e	elete	Add	MB	<u>U</u> pdate	<u>О</u> К			

- (b) Click the *Add* button to activate the necessary data entry fields
- (c) On the *Total* tab of the **TOTAL SCOUR** form, enter "*PRESSQSCOUR*" into the *ID* textbox
- (d) Check the *General* check box only.

Total Scour	- MB: 01 - ID	: Add									
<u>L</u> ist	Total	Long	T <u>e</u> rm	<u>G</u> eneral	L	. <u>o</u> cal	<u>B</u> edforn	1	Low Flow	Pierl	nfluence
ID Majo	r Basin ID (ID F Depth	D1) OUR								
	Inc	clude <u>Calc</u>	<u>FS V</u>	alue Cu Ca	istom <u>Ic FS</u>	Method					
	Long Term General		1.3								
	Local										
	Bedform										
	Low Flow										
	Headcut										
	Tailcut										^
	iotal (ft)	_									
Pie	r Influence										_
		[<u>S</u> ave	<u>C</u> ancel	P <u>r</u> int.	<u>D</u> e	lete 🖉	dd	MB	<u>U</u> pdate	<u>0</u> K

(e) Click the browse button and under the *Method* column across the *General* checkbox to launch **SELECT МЕТНОР** dialog box.

Sel	lect Method	
	Lacey	
	Neill and HEC-18	
	Neill and HEC-18 With Pressure Flow	
	Blench	
	<u>O</u> K <u>C</u> ancel	. :

- (f) Select *"Neill and HEC-18 With Pressure Flow"* from the **Select Метнор** dialog box, then click **OK** to exit.
- (g) On the **TOTAL SCOUR** form, click the *Save* button to save the entered data.
- (h) To perform the pressure flow scour analysis, click the *General* tab

Total Scour	- MB: 01 - II	D: PRESS	QSCOUR									
List	<u>T</u> otal	L	ong T <u>e</u> rm	Gene	ral	L	ocal <u>B</u> e	dform	Low Flow	Pier In	fluence	
ID Major Basin ID 01 ID PRESSOSCOUR												
Scour Depth												
	<u>In</u>	<u>clude</u> (Calc FS	Value	Calc F	s	Method					
	Cong Term		1	2		_	Noill and HEC		recours Flow			
	Local		1.	2					ressure riow			
	Bedform											
	Low Flow											
	Headcut											
	Tailcut										^	
	Total (ft)]							
Pie	r Influence											
											~	
			⊘ He	lp 🤌 In	io P <u>r</u>	int	Delete	<u>A</u> dd	MB	<u>U</u> pdate	<u>О</u> К	

- (i) On the *General* tab of the TOTAL SCOUR form, select "BRIDGEXS" for the Bridge Section ID.
- (j) Select "UPSTREAMXS" for the Upstream Section ID.
- (k) In the Neill Parameters (use Bridge Section) frame, select "Sand" for Exponent m textbox and select "Straight Reach" for Bend Factor Z textbox.
- In the *HEC-18 Pressure Flow Upstream Parameters* frame, enter "20" into the *D50 (mm)* textbox.
- (m) Check the Manual Input Parameters checkbox and enter "10.14" into the Hydraulic Depth (ft) textbox, and "9.86" into the Avg Velocity (ft/s) textbox.
 After entering the data, uncheck the Manual Input Parameters checkbox.

Total Scour - MB: 01 - ID: PRESSQSC	OUR										
List <u>T</u> otal		Long T <u>e</u> rm	General	L <u>o</u> cal	<u>B</u> edfor	m	Low Flow	Pier Influence			
Sections Manual Input	P ameters		HEC-18 Pressur Over	e Flow Upstream Part	rameters — H	lydraulic Depth (ft)	10.14				
Bridge Section ID BRIDGEXS Upstream Section ID UPSTREAM	XS		DE	50 (mm) 20.000	Ci	Avg Velocity (ft/s) ritical Velocity (ft/s)	9.86 6.63	Live Bed			
Neill Parameters (use Bridge	Section) -		No Overtopping - Live Be	d							
Design Flow Rate (cfs)	Design 5000	Dominant 1000	Flow in upst	tream channel, Q1 (cfs)		Vertical	size of the brid	dge opening, hb (ft)			
Hydraulic Depth (ft)	8.80	3.07	Bottom width of up	ostream channel, W1 (ft)		Distance from wa	ater to lower fa	ce of girders, ht (ft)			
Average Width (ft)	40.01	40.00	Bottom width of contr	action less piers,W2 (ft)		Height of the obstruction, T' (ft)					
Exponent m	0.67			Water Temp (C) Exponent K1	20	Maximum thick	Weir	flow height, hw (ft)			
Bend Factor Z	0.50	\gg	Average depth in u	pstream channel, Y1 (ft)		maximum unci		Scour depth, ys (ft)			
Scour Depth (Including Bend) (ft)			Average de	epth in contraction,Y2 (ft)							
Scour Depth (ft)			1								
Final General Scour (ft)											
				Help	<u>.</u> €§Info	P <u>r</u> int <u>D</u> elete	<u>A</u> dd	MB <u>U</u> pdate <u>O</u> P			

- (n) Enter "40" into the **Bottom width of upstream channel, W₁ (ft)** textbox.
- (o) Enter "40" into the **Bottom width of contraction less piers, W₂ (ft)** textbox.
- (p) Enter "8" into the *Vertical size of the bridge opening, h_b (ft)* textbox.
- (q) Enter "3" into the *Height of the obstruction, T (ft)* textbox.
- (r) Click the *Save* button to save the entered data.
- (s) Click the *Update* button to perform / update the analysis.
- (t) Select "This Record" from the SELECT OPTION window, then click OK to exit.

Sele	ect Option	
	Option	*
	This Record	
	This Major Basin	
	All	
		-
	OK Cancel	

(u) When the **CALCULATE GENERAL SCOUR** dialog box shows up, click **Yes** to continue.



(v) After the update, the general scour analysis results form should look like the screen shot shown below:

Total Scour - MB: 01 - ID: PRESS	SCOUR								
List I	tal	Long T <u>e</u> rm	<u>G</u> eneral	L <u>o</u> cal	Bedfor	m	Low Flow	Pie	er Influence
Sections			HEC-18 Pressure	e Flow Upstream Par	ameters —				
Bridge Section ID BRIDG	EXS		Manual Input Para	ameters 📃	H	lydraulic Depth (ft)	10.14		
Upstream Section ID UPSTR	EAMXS		Over	topping 📃		Avg Velocity (ft/s)	9.86		
			D5	i0 (mm) 20.000	C	ritical Velocity (ft/s)	6.63	Live Bed	
Neill Parameters (use Br	dge Section)		No Overtopping - Live Be	d					
	<u>Design</u>	Dominant	Flow in upst	ream channel, Q1 (cfs)	4000.00	Vertical	size of the brid	lge opening, hb (ft) 8.00
Design Flow Rate	(cfs) 5000	1000	Flow in the contr	racted channel, Q2 (cfs)	5000.00	Ups	stream channe	el flow depth, hu (ft) 10.14
Hydraulic Dep	h (ft) 8.80	3.07	Bottom width of up	stream channel, W1 (ft)	40.00	Distance from wa	ater to lower fa	ce of girders, ht (ft) 2.14
Average Wid	h (ft) 40.01	40.00	Bottom width of contra	action less piers,W2 (ft)	40.00		Height of the	e obstruction. T (f	3.00
Slope	(ft/ft) 0.010000	0.010000		Water Temp (C)	20		Weir	flow height, hw (ft) 0.00
Expone	nt m 0.67	· 🔎		Exponent, K1	0.64	Maximum thic	kness of the fl	ow separation. t (ft) 2.79
Bend Fac	tor Z 0.50		Average depth in up	pstream channel, Y1 (ft)	10 14			Scour depth vs (ft) 7.07
Scour Depth (Including Ben	l) (ft) 4.51		Average de	oth in contraction Y2 (ft)	12.28				
					12.20				
Scour Depth (ft)									
Final General Sco	<mark>ır (ft)</mark> 7.07								
				Help	<mark>.⊘Info</mark> P	<u>r</u> int <u>D</u> elete	Add	МВ <u>U</u> р	date <u>O</u> K

5.4 STEP 4 - REPORTING AND DOCUMENTATION OF RESULTS

(a) To view the analysis results on the screen, click the *Print ...* button on the *General* tab of the **TOTAL SCOUR** form.

Bige 1 Project Service Description of Live BED Project Reference: V902_PRESSURE_BOURD 0.0000 Bridge Section ID: BRIDGEXS Upstream Section ID: UPSTREAM SECONG Nell Parameters 0.0000 Paysan Flow Rate (cb) 0.000 Paysan Flow Rate (cb) 0.000 Paysan Section ID: UPSTREAMXED Nell Parameters 0.000 Paysan Flow Rate (cb) 0.000	_	1 of 1	•	▶ =	6	6	۵	9	8%	~		_	M		Fotal:1	100	1%	1 of	1			 					
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gr 1 Project Reservace: Volts_PRESSURE_SCOUR 4//22 ID: PRESSQSCOUR BRIDGEXS Upstream Section ID: UPSTREAMXS 0//22 Neill Parameters Design Flow Rate (cb) 5//00 Design Flow Rate (cb) 5//00 1//00 Here Flow Z 0//01 4//01 Average Vefin (b) 4//01 4//01 HEC-18 Pressure Flow No Overtopping - Live Bed Hydraulic Depth (tb) 1//01 Hydraulic Depth (tb) 0//01 4//01 Here Flow Z 0//00 Ventorial sce of the bridge opening, b (tb) 5//01 HEC-18 Pressure Flow No Overtopping - Live Bed Hydraulic Depth (tb) 1//01 Hydraulic Depth (tb) 1//01 4//01 4//01 Botem Web of Opteram Channel (01 (cb) 4//00 Upstateam channel flow depth, h(tb) 1//14 Botem Web of Opteram Channel (01 (cb) 1//00 Height of the opteram (h) 1//14 Botem Web of Opteram Channel (VII (tb) 1//14 Distates from height, h(tb) 1//14 Botem Web of Opteram Channel (VII (tb) 1//14 Height of the opteram (h) 1//14 Botem Web of Opteram (VIII (tb) 1//14 Height of the opteram (h) 1//14 Average Depth in Contractes, Y2 (tb) 1//14 Madmum Biokees of the flow r									G	NER	AL SCO	UR - 1	Drain EILL W	nage D VIT H P	esign M RESSU	anagem RE FLO	ent Sys N - NO	tem OVERT	OPPING	3 - LIVE	BED						
Hidge Section ID: BRIDGEXS Typtman Section ID: UPSTREAMXS Nell Parameters Design Flow Rate (choose 10, 000) 14 yang velow (ft) 4, 400 0.000 1, 000 1, 0		Mage 1							_	-b-		P	oject K	eterer	10e: V60	IS_PRE	SURE.	SCOUN									4/1/202
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			F	inal (Gen	era	Sc	our	r (ft)		7.07																
(m PressureFlowNDLB.rd - V orsion: 6.0.5																							(m)	ressureF	10wNOL8	3.rot - Ver	sion: 6.0.5

- (b) To print the results, click the printer symbol (B).
- (c) To export the results into a PDF file or other file formats, click the export symbol (🚵) and select the preferred file format

This concludes this tutorial for Pressure Flow Scour Analysis based on HEC-18 procedure.