Fixed Bed Sediment Modeling Workshop

Introduction

Sediment computations add run time to hydraulic models, sometimes making sediment runtimes substantial. Two-dimensional sediment models can take even longer to run. The sediment computations for multiple grain classes are computationally expensive, and a well-designed sediment model can increase model run time by an order of magnitude or more over a hydraulic model.

HEC-RAS includes a range of modeling options that offer tradeoffs between run time and feature richness. HEC added a fixed bed sediment modeling mode as an intermediate analysis option. Because much of the run time in the mobile-bed sediment model is in the bed mixing and elevation updates, a fixed bed sediment capacity tool can provide some of the insight at a fraction of the runtime.

The capacity-only option is a fixed-bed, 2D, sediment model that computes capacity without sediment transport while the concentration-only model solves the AD equation without bed change. Both simplifications can provide some of the value of a 2D sediment model for an intermediate level of effort (and run time) and make good screening level tools. This workshop will introduce some of the important hydraulic variables you can view without a sediment model and then introduce the fixed-bed sediment modeling options.

Warning: The models in this workshop are intended for pedagogical purpose only. They have been simplified and modified to fit into a brief workshop and should not be used for scientific or engineering analysis.

Objective

This reach was a depositional zone for years, requiring more dredging than any other reach in this large sand bed river. (Here is a <u>Video</u> of the reach).



Then the District added four structures that increased the transport capacity, and this reach has not required dredging since. We will model a rising hydrograph with and without the structures and compute the difference in capacity to develop an understanding of how these structures affected capacity.

Part 1: Add Boundary Conditions, Enter Flows, and Run Model

1. <u>Open the workshop model</u>. The model has a geometry and mesh like you created in the previous workshop, a flow file, and a plan file ready to go. But it needs flow boundary conditions.

2. Add Boundary Conditions in Mapper:

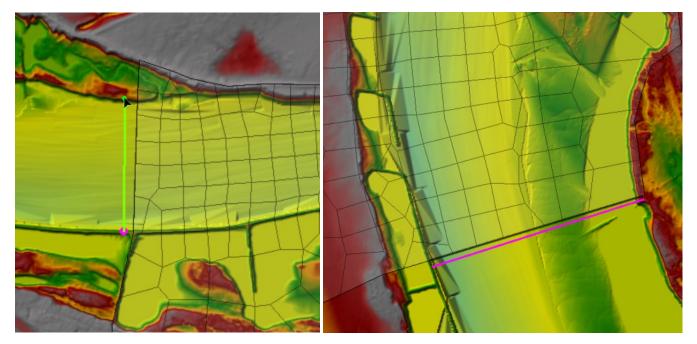


Open RASMapper Right click on the Fixed Bed Workshop Geometry and start editing. This will expand the geometry tree and make the **Boundary Conditions Lines** available. Click in the **Boundary Condition Lines** node and select the drawing tool.

Geometries Fixed Bed Workshop O 2D Flow Areas (16 Empty Layers)		Layer Properties	Lateral Structures SA/2D Connections Say Pump Stations	IJ
Event Conditions Results	Ⅲ	Open Attribute Table	Boundary Condition Lines 🦯	
Map Layers	1	Edit Geometry	Initial Condition Points	

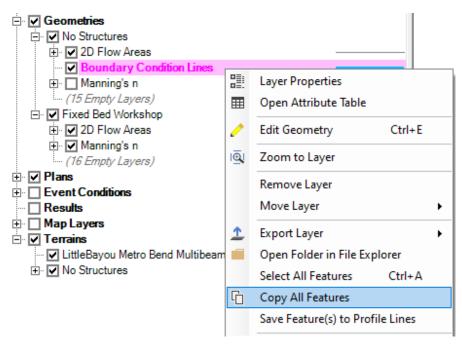
Draw boundary conditions lines across the *channel* just outside the upstream and downstream mesh boundaries. Give them intuitive names (e.g. **US BC** and **DS BC**).

Stop Editing and save the geometry.



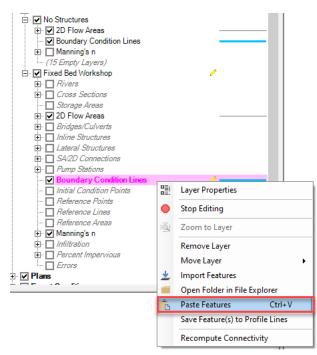
Next, you need to copy these boundary conditions to the other geometry to make sure they are identical (because they will be sharing a flow file).

Right click on the **Boundary Conditions Line** node on the tree and select **Copy All Features**.



Select the other Geometry File and press the Pencil Zto start editing.

Select the Boundary Conditions Line and select Paste Features.



Press the stop sign to stop editing.

3. Define Flows and Stage:

We developed a downstream stage rating curve for a low Mississippi stage from the 1D steady flow model. These data are in the **DS Rating Curve** Tab of the **Workshop Data.xls** file.

WSE (ft)	Flow (cfs)	WSE (ft)	Flow (cfs)
162	0	182.05	260000
162.37	10000	183.34	310000
164.5	30000	184.9	360000
169.19	70000	186.7	430000
177.03	150000	187.36	480000
178.16	175000	190.47	625000
178.63	185000		
	-		

Open the unsteady flow file in and select the downstream boundary condition. Press the **Rating Curve** button and add the rating curve data.

Then select the upstream boundary condition and choos the **Flow Hydrograph**.

Flow Hydrograph Choose a sereis of flows between 30,000 and 110,000 cfs at 12 hour increments to simulate a series of rising flows. (Note: We will work with with warmup and intial conditions in a future workshop, but they are set for you in this one).

Set your energy grade slope to distribute your upstream flows to 0.0004.

EG Slope for distributi	ng flow along BC Line:	0.00004	TW Check

Open the unsteady flow simulation editor and adjust the time window to accommodate your flow series. Then simulate.

L Unsteady Flow Data						_		\times		
File Options Help										
Description:						÷	Apply	Data		
Boundary Conditions In	itial Conditions Me	eteorolog	gical Data 🛛 🕻	Observed Data	2					
	Bour	ndary Co	ondition Types	S						
Stage Hydrograph	Flow Hydrogra	aph	Stage/F	low Hydr.		Rating Curve				
Normal Depth	Lateral Inflow H	lydr,	Uniform La	ateral Inflow	Grou	undwater Inte	rflow			
T.S. Gate Openings	Elev Controlled	Gates	Navigal	tion Dams		IB Stage/Flow	,			
Rules	Precipitatio	n	i							
	Add Bou	undarv (- Condition Loca	ation						
Add RS Add SA	/2D Flow Area		Conn	Add Pump St	a	Add Pipe No	de			
	elect Location in table	a than a	elect Boundar	ry Condition Ty	700		_			
	each R			y Condition	pe					
1 Pool2 River ch	nannel 50	.00								
2 Pool2 River ch	nannel 16	.80	Rating Cur	ve						
		Rating C	Curve							
					Pool2 R	iver Reach: cha	nnel RS: 16	.80		
		C Read	from DSS befor	re simulation				Select DSS	file and P	ath
		File:								
		Path:	I							
		• Enter	Table							
		· citter	Table			Del Row	Ins Row	. 1		
						Hydrograph Da				
				Stage (ft)				Flow (cfs)		
			52.37			10000 30000				
			64.5 65.77			40000				
			56.96			50000				
			58.04			60000				
			59.19			70000				
			70.29			80000				_
			71.66 72.71			90000				
			74.66			12000				
		11 1				14000				-
		1				F	- Plot Data	OK	1	Cancel

ļυ	Jnsteady Flow D	ata				_	
	Options Help iption:	p	Meteorolog	ical Data 🗍 (Observed Data		<u></u> App
5	Stage Hydrograpl		Boundary Cor rograph		s Flow Hydr.	Rat	ing Curve
	Normal Depth	Lateral Infl	ow Hydr.	Uniform L	ateral Inflow	Groundv	vater Interflow
Т	.S. Gate Opening	is Elev Contro	lled Gates	Naviga	tion Dams	IB S	itage/Flow
	Rules	Precipit	ation				<u> </u>
		d SA/2D Flow Area . Select Location in	table then se				d Pipe Node
_	River Pool2 River	Reach channel	RS 50.00	Flow Hydro	y Condition		
_	Pool2 River	channel	16.80	Rating Cur			
l	 Enter Table Select/Enter 	the Data's Starting 1	Timo Doforon		Dai	ta time inter	val: 12 Hour
	 Use Simula Fixed Star No. Ordinate 	ation Time:	Date: Date:	Del Ro		-	
	C Fixed Star	ation Time: I rt Time: I s Interpolate M	Date: Date:	Del Ro	Time: Time: W Ins Ro	-	,
	C Fixed Star	ation Time:	Date: Date:	Del Ro Hydrograph Simulation	Time: w Ins Ro Data Time	-	Flow
	C Fixed Star	ation Time: I rt Time: I s Interpolate M	Date: Date:	Del Ro	Time: Tins Ro	-	,
	C Fixed Star	ation Time: I rt Time: I s Interpolate Mi Date	Date: Date:	Del Ro Hydrograph Simulation (hours	Time: Tins Ro	w _	Flow
	C Fixed Star	ation Time: I rt Time: I s Interpolate M Date 31Dec0999 2400 01Jan 1000 1200 01Jan 1000 2400	Date: Date:	Del Ro Hydrograph Simulation (hours 0:00:0 12:00:1 24:00:1	Time: Ins Ro Data Time :) 10 00 00 00 00	40000 50000 60000	Flow
	C Fixed Star	ation Time: I rt Time: I s Interpolate M Date 31Dec0999 2400 01Jan 1000 1200	Date: Date:	Del Ro Hydrograph Simulation (hours 0:00:0 12:00:1	Time: Ins Ro Data Time () 00 00 00 00 00 00 00 00	w 40000 50000	Flow

4. Open Plan and Simulate:

Open the unsteady flow simulation editor (to the "Capacity Only (with Struc)" Plan which includes Structures) and adjust the time window to accommodate your flow series.

This plan file has warmup parameters and other features already defined.

Then simulate by pressing the **Compute Button**.

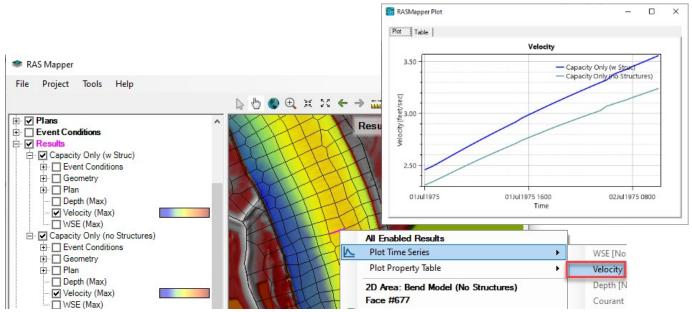
Then open the other unsteady file and run that simulation.

File Options Help	
Plan: Capacity Only (with Struc) Short ID: Capacity Only (w Struc)	-
Geometry File: Fixed Bed Workshop]
Unsteady Flow File: 30k-100k cfs]
Programs to Run ─ Plan Description ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─	
Floodplain Mapping	
Simulation Time Window Starting Date: 01Jul1975 Ending Date: 02Jul1975 Ending Date: 02Jul1975]
Computation Settings Computation Interval: 20 Second Hydrograph Output Interval: 1 Hour Mapping Output Interval: 1 Hour Froject DSS Filename: C:Users\q0hecsag\Documents\Projects\Classes\St Louis	
Comoute	

Part 2: Plot Sediment Related Hydraulic Variables (Velocity and Shear Stress)

5. Map Velocity:

Open RAS Mapper and Select the velocity results. Plot the velocity time series at several location. Try plotting velocity for cells and cell faces.



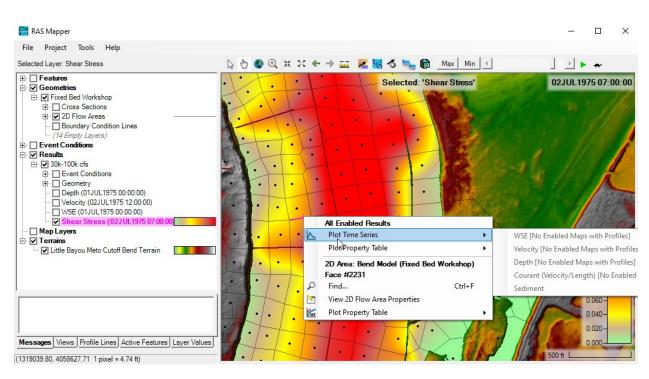
(Note: In the plot above we set the velocity color ram between 0 and 6 ft/s in the layer properties for both results, and set Opacity to ~50% by right clicking on the **Velocity** result and selecting **Layer Properties**).

6. Map Two Different Shear Stress Results:

- Shear Stress is an important hydraulic variable for a range of sediment transport analyses, and can be a useful heuristic for sediment processes if you only have a hydraulic model.
- But there are a couple ways to get Shear Stress results from RASMapper that are worth exploring. Select the shear stress output in your current simulation.
- Right click on the Result and select **Create a New Results Map Layers.** Create a New Results Map Layer... Then expand the **Hydraulics** tree and select **Shear Stress**. Map shear stress and try to plot a time series of shear stress at a cell or a face.

Can you plot a time series of Shear Stress?_

The hydraulic shear stress parameter is computed on the fly from hydraulic results, so there are no stored shear stress values. To plot a time series of shear stress, you have to request shear stress output.



7. Request Shear Stress Output:

To request output that do not come standard with a RAS run, open the unsteady flow Computation Window, and select the **Options**→**Output Options** menu.

Select the HDF5 Write Parameters.

There are a number of very helpful features on this tab, but in particular, you can choose to write several additional 2D variables.

上U	nsteady Fl	ow Analysis	
File	Options	Help	
Plan:	Stag	ge and Flow Output Locations	þ
	Flov	w Distribution Locations	t
	Flov	w Roughness Factors	H
Pro	Sea	sonal Roughness Factors	-
V	Aut	omated Roughness Calibration	Ī
	Uns	teady Encroachments	
	Ung	gaged Lateral Inflows	
	Dan	n (Inline Structure) Breach	
Sim	Lev	ee (Lateral Structure) Breach	ł
	SA	Connection Breach	Ē
Cor	Con	nputation Options and Tolerances	ĺ
Cor	Out	put Options	-
Map	Fric	tion Slope Method for Cross Sections	
Pro	Fric	tion Slope Method for Bridges	

HEC-RAS - Set Output Control Options	
Restart File Options Detailed Log Output Computation Level Output Options	ADF5 Write Parameters
Optional HDF Output Parameters Write warmup time steps to output file	
Write time sliced steps (in addition to basic time steps)	
Commit writes (normally writes are buffered, use when computations	crash, not go unstable, but crash)
Additional 2D Variables Written to Results File (not used/needed for RAS)	<u>*</u>
Face Period-Average Flow	^
Face Cumulative Volume	
Face Mixture Dynamic Viscosity	
Face Point (Node) Velocities*	
Face Shear Stress	
Face Tangential Velocity (Both sides of each face)	
Face Water Surface	
Face Wind Shear Stress	
Face Wind Velocity	✓ Advanced HDF Options
·	
	OK Cancel

Re-run your result. After your new simulation, right click on the result in Mapper again, and choose

Create a New Results Map Layers again. 💶 Create a New Results Map Layer...

But this time expand the Additional 2D Variables section. You will find the new Shear Stress result under there. Select it and press Add Map.

	Map Type
1	⊡ Hydraulics
	⊢ Additonal 2D Variables
	Shear Stress
	Cumulative Iteration
	Maximum Water Surface Error
	Face Velocity Maximum
	Face Velocity Minimum
1	-

Now you have two shear stress maps. The new Shear Stress map has default units that are not very informative. You can copy the units from the other Shear Stress Map.

Right Click on the on-the-fly shear stress result and open Layer Properties.



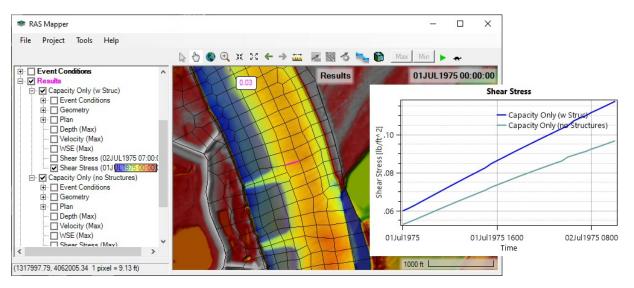
At the bottom of the Layer Properties editor, press the Copy Symbology button.

Copy Symbology

Next, right click on the new Shear Stress result, and select Layer Properties and Paste

Symbology. Paste Symbology

Now plot the shear stress time series by right clicking on the map. Try clicking on cells and cell faces.



What do you notice about shear stress through this reach?

Part 3: Set Up Sediment Model

To use the capacity only, fixed bed sediment features, you still need to set up a full sediment model, which means you will need a sediment file, gradations, and a sediment boundary condition (even though you will not use the latter).

SED .

8. Open the Sediment Data Editor:

Either select the Edit \rightarrow Sediment Data menu or use the sediment data button.

9. Select Sediment Equations:

We recommend starting with one of the 2D transport equations. You have to scroll down to find the 2D equations in the Transport function list.

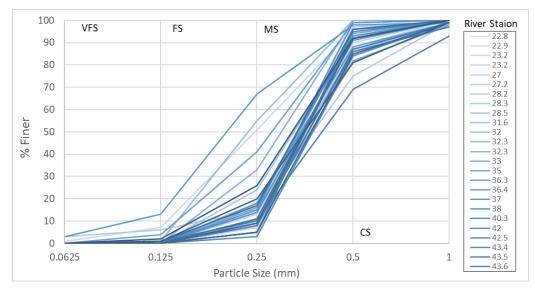
Transport Function:	Wu
Sorting Method:	Active Layer 🗨
Fall Velocity Method:	Soulsby 💌

<u>Note</u>: It does not matter what sorting method you choose, 2D sediment will always use a customized version of the Active Layer approach.

10. Estimate Bed Gradation:

Fixed bed sediment models partition transport capacity by grain class like a mobile bed model, so sediment bed gradations are the minimum data requirement.

This river has 35 bed gradation samples from September 2003. These samples are plotted with river station (light blue-downstream/dark blue – upstream) in the following figure.



These data are also in the **Bed Gradation** tab of the Workshop Data.xlsx file.

Do the data have a clear longitudinal trend?

How many grain classes do you think you need to represent the bed material load in this system? _____

In this model, we used a simplified bed gradation layer, that attributes one bed gradation with the whole model. Estimate the percentage you would associate with each grain class (and convert it into % Finer):

Grain Class	%	% Finer
Very Fine Sand (VFS)		
Fine Sand (FS)		
Medium Sand (MS)		
Coarse Sand (CS)		
Very Coarse Sand (VCS)		

11. Enter Bed Gradation:

In the **Sediment Data Editor**, press the **Define/Edit Bed Gradation** button to enter your bed gradation.

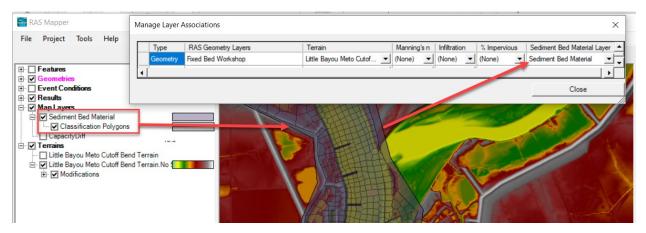
🤟 Sediment Data - Capacity Ony					
File Options View Help					
Initial Conditions and Transport Parame	ters Boundary Co	nditions USDA-ARS B	Bank Stability and Toe	e Erosion M	lodel (BSTEM) 2D Bed Grad
River: Reach:	•	Transport Function: Sorting Method:	Wu Active Layer	• •	Define/Edit Bed Gradation
Number of mobile bed channels:	1 💌	Fall Velocity Method:	Soulsby	•	Define Layers (2D)

This will launch the bed gradation editor. Press the **New** button to create a bed gradation and give it a descriptive name. Then enter the data. You can enter data as % Finer or the % in each grain class, which is often more intuitive. You could enter multiple gradations here, but for now, press **OK** when you are done.

Fa.	Red G	radation		N —	
5	beu o	radation		⊳ —	
Vie	w He	lp			
led	Gradati	on Template:	Pool 2		
	Class	diam (mm)	% Finer		
1	Clay	0.004			
2		0.008			
_		0.016			
	MM	0.032			
_		0.0625			
_		0.125			
7	FS	0.25			
	MS	0.5			
9	CS	1			
10		2		No Data for Plot	
11	VFG	4			
	FG	8			
_		16			
_		32			
_		64			
_	SC	128			
_		256			
18		512			
_	MB	1024			
20	LB	2048		4) F
•	% Fine	r 🔿 Grain Cla	ss % Convert:	Set Sample Specific Cohesive Para	ameters
-			%finer<>%	ОК	Cancel

12. Associate Bed Gradation:

After you create your bed gradation, you must associate it with the **Bed Gradation Layer** in Mapper. We have already created a simple Bed Gradation layer in mapper and associated it with the geometry. All that remains is associating the gradation you just entered with the only polygon in this layer.



Select the **2D Gradation** tab in the **Sediment Data Editor**.

This editor lists all of the gradation types listed in your **Bed Gradation Layer** (in this case there is only one, but if you had more gradations they would all appear in this list).

Click on the blank field next to the **Bed Material Type**.

This will give you a drop-down list of all the bed gradations you have entered (again, just one in this case) and another option that is always available (Non-Erodible Surface). Select the gradation you just created.

V Sediment Data - Capacity Ony	
File Options View Help	
Initial Conditions and Transport Param	eters Boundary Conditions USDA-ARS Bank Stability and Toe Erosion Model (BSTEM) 2D Bed Gradations
Bed Material Type	Gradation
1 Simplified Single Bed Gradation	Pool 2 Average Gradation
	Non-erodible surface
	Pool 2 Average Gradation

Note: If your gradation does not show up in the drop down list, try saving the sediment file and closing out. (Sometimes it even helps to close out of the HEC-RAS and reopen).

13. Select Sediment Boundary Condition:

Fixed bed sediment analysis (especially Capacity Only analysis) is not as sensitive to sediment boundary conditions.

So, for now, we will just use the **Equilibrium Load** sediment boundary condition. Select the **Boundary Conditions** tab in the **Sediment Data Editor**.

The upstream boundary populates automatically. Click on the blank field and press the **Equilibrium Load** button.

🤟 Sediment Data - Cor	ncentration Only			
File Options View	Help			
Initial Conditions and Tran	nsport Parameters Bounda	ary Conditions USDA-ARS	Bank Stability and Toe Er	rosion Model (BSTEM) 2D Bed Gradations
	Select I	Location for Sediment Boun	dary Condition	
Add Sediment Boundar	y Location(s) Delete Curr	rent Row Define Sedim	ent Split at Junction	
	5	Sediment Boundary Conditio	n Types	
Rating Curve	Sediment Load Series	Equilibrium Load	Capacity Ratio	Clear Water (no Sed)
Flow Wtd Sed Split	Potential Wtd Sed Split	GC Threshold Split	Sed Split by GC	
2DArea: BCI	Line US BC	Equilibrium Load		

Part 4: Capacity Analysis

14. Set Sediment Model to Capacity Only Mode:

Finally, this model is currently set up for a full mobile bed analysis. But we are not going to do that yet.

Select the **Options** \rightarrow **2D** Sediment Options menu from the Sediment Data Editor. Select **Capacity Only** from the **Simulation Components** dropdown box at the top of this editor.

V File	ediment Data - Capacity Ony Options View Help	1. 2D Sediment Options	- 🗆	×
	User Defined Grain Classes Set Cohesive Options Bed Change Options (1D) Transport Methods Calibrate Transport Function 2D Options BSTEM Options	Simulation Components: Sheet and Splash Erosion: Erodibility:	Capacity Only Capacity Only Concentration Only Gradation (no Elev) Bed Elev (no Grad) All Components	•

Save your sediment data as "Capacity Only".

15. Run the Sediment-Capacity Fixed Bed Model:



Save As a new plan with a descriptive name like "Capacity Only" so you will also keep the hydraulic simulation.

Then check the **Sediment** box under **Programs to Run**.

This will add a **Sediment Files** option to the file drop down boxes.

Select the sediment file you just created. Then press **Compute**.

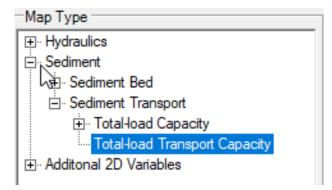
L Unsteady Flow Analysis	
File Options Help	
Plan: Capacity Only Short ID: Capacity Only	-
Geometry File: Fixed Bed Workshop]
Unsteady Flow File: 30k-100k cfs]
Sediment File: Capacity Ony	1
Programs to Run Plan Description Image: Geometry Preprocessor Image: Plan Description Image: Unsteady Flow Simulation Image: Plan Description Image: Plan Description Image: Plan Description	
Computation Interval: 20 Second • Hydrograph Output Interval: 1 Hour • Mapping Output Interval: 1 Hour • Detailed Output Interval: 1 Hour • Project DSS Filename: • d:\Classes\Little Rock 2D Sed\Workshops\2.2 Fixed Bed Se Image: Imag	
Compute	hund.

16. View the Fixed Bed Sediment Results:

Right click on the new result in RASMapper and choose Create a New Results Map Layers again.

Create a New Results Map Layer...

The **Map Type** tree has a new node.



Expand the **Sediment** node of the results tree.

Since we did not compute bed change, you won't be interested in the sediment bed results. Expand the **Sediment Transport** node and select **Total-load Transport Capacity.** Add this map.

You may need to adjust the display range to the common maximum and minimum capacities. If you adjust the **alpha** of the low-capacity colors, you can make them a little transparent.

RAS Mapper X File Project Tools Help 🕼 🖑 🌒 🕀 💥 🛠 🔶 🚟 🗾 🗾 🗾 📶 Max Min 🔳 > > * Selected Layer: Generic 2D Map E Features Selected: 'Total-load Transport Capacity' 02JUL1975 12:00:00 E Geometrie Event Conditions 100k cfs E Capacity Only Cupberty only Event Conditions Geometry Depth (01JUL1975 00:00:00) Velocity (01JUL1975 00:00:00) 55.7 E Total-load Capacity Total-load Trans 464 37.1- Capacity Only (no Structures) Conc Only (no Struct) 27.9-18.6-Deleted d:\Classes_Little Rock 2D Sed\Workshops\2.2 Fixed Bed Sediment Modeling\Fixed Bed Sediment \$ 9.3 0.0 Messages Views Profile Lines Active Features Layer Values 200 ft L (1318403.57, 4058794.61 1 pixel = 2.56 ft)

Where are the highest transport capacities?

Part 5: Concentration Analysis

17. Create a Concertation Analysis Plan:

Next you will experiment with the other fixed bed analysis mode.

To do that, you will need a mostly identical Sediment Data File.

Open the Sediment Data Editor and Save As.

Give it a descriptive name, like "Concentration Only".

Then switch the Simulation Component and Save the file.

-	ediment Data - Capacity Ony Options View Help	C3. 2D Sediment Options	- 0	\times
Initia R 1	User Defined Grain Classes Set Cohesive Options Bed Change Options (1D) Transport Methods Calibrate Transport Function 2D Options	Simulation Components: Sheet and Splash Erosion: Erodibility:	Capacity Only Capacity Only Concentration Only Gradation (no Elev) Bed Elev (no Grad) All Components	•

To change the Component select the **Options**→**2D** Sediment Options menu from the Sediment Data Editor.

Select **Concentration Only** from the **Simulation Components** dropdown box at the top of this editor.

Then Open the **Unsteady Flow Simulation** editor, make sure the Sediment File has changed to the file you just created.

Then save the new plan, give it a descriptive name, and press **Compute**.

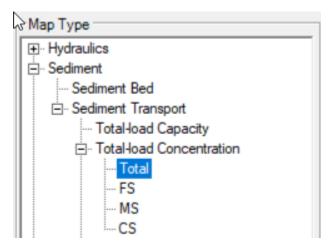
18. View the Concentration-Only, Fixed-Bed Results:

Open Mapper and Right Click the new result to add the Concentration Result. Expand the **Sediment**→**Sediment Transport** node of the **Map Type** tree.

Total-load Concentration is now on the list.

To just add total concentration, expand the **Total-load Concentration** tree and select **Total**. Then **Add Map**.

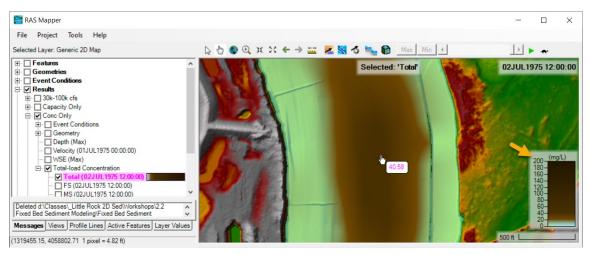
(Note: you can add results for individual or all grain classes, but this can get unwieldly at this point, so start with just the total).



To view concentration results, you will often have to reduce the max, since local concentration spikes or initial condition effects can stretch the color band.

There are also two Concentration display options.

You might want to experiment with which works best for each map.



Part 6: Compare Capacity Results With and Without Structures

These results are useful to indicate relative regions of high and low capacity.

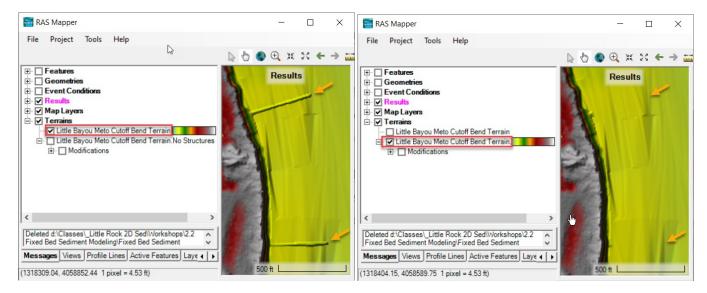
But we want to be able to weigh in on the impact of the structures.

So in this section you are going to repeat the capacity calculation on a terrain without the structures, and compare the results to try to quantify the impact of the structures before we begin mobile bed modeling.

19. Create a New Plan with No-Structure Geometry and Compute:

We have used RASMapper mods to clone the terrain and remove the four structures, reducing them to the surrounding grade.¹

The project has this second terrain (which only points to the original on your computer).



It is a little awkward to associate this terrain with a new sediment plan, however.

Terrains can only be associated with geometries.

Therefore, **you will have to create a new geometry** (even if it is identical) and associate the new terrain with it to run a sediment model on this terrain.

We have already done that for you.

There is a second geometry file associated with this no-structure terrain.



¹ HEC created a video that walks through this process: <u>https://youtu.be/c4enO6qUynE</u>

Open the **Unsteady Flow Simulation Editor**, save the plan as a new plan (with a name indicating it does not have the structures.

Then choose the **Geometry File** dropdown and select the "No Structures" geometry. Then **Save** and **Compute**.

🙇 Unsteady Flow Analysis			×
File Options Help			
Plan: Capacity Only (no Struct)		Short ID:	Capacity Only (no Structures)
Geometry File:	No Structures		•
Unsteady Flow File:	Fixed Bed Workshop No Structures		
Sediment File:	Capacity Ony		- 5
Programs to Pup	Plan Description		

20. Open the RASter Calculator:

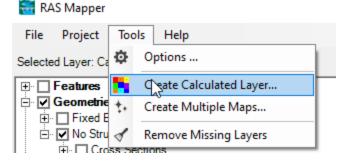
The objective of this study is to evaluate the effect of these structures.

You can view the results and set them to the same output symbology, and toggle them on and off to see differences, but that is qualitative and not particularly effective.

Instead, you are going to use to RASter Calculator to compute a map of capacity difference between the two simulations to quantify and illustrate the effect of the structures.

Create Calculated Layer...

In RAS Mapper, select the **Tools** \rightarrow **Create Calculated Layer** option.



This will launch the **RASter Calculator** Editor (see next editor).

21. Define the Capacity Maps as Variables:

To difference the capacity results, you will have to define each capacity result Layer as a variable.

Push the Add New Layer Variable button 🛨 in the top left corner of the editor.

Select the **Plan** and **Map Type** (Total-load Transport Capacity).

Leave the Animation Behavior to the default (Dynamic).

	Plan	Мар	Туре	Animation Behavior
Definition:	Capacity Only	▼ Total-load	Transport Cap 💌	Dynamic 💌
RASter Cal	lculator			×
	ser Defined aster Layer Definition	Raster Lay	ers	Terrains Little Bayou Meto Cutoff Bend Te Little Bayou Meto Cutoff Bend Te Little Bayou Meto Cutoff Bend Te
	Plan	Мар Туре	Animation Behavior	Profile
Definition:	Capacity Only 💌	Water Surface Elevation	Dynamic	•
Variable	= Capacity Only WSE D	FS ∧ MS VCS Total FS MS CS Total-load Transport Caps ▼	able	Add VariableClose

Then give the layer a brief but descriptive variable name in the **Name** field (e.g. CapWithStruc). Press the **Add Variable** button.

This should add the variable to the **Map Layer** window in the upper left of the editor.

Create	Raster Layer Definition				×
	Plan	Map Type	Animation Behavior	Profile	
Definition:	Capacity Only	▼ Total-load Transport Cap ▼	Dynamic	-	T
CapWith	Struc = Capacity Only	/ Total-load Transport Capacity Name: Cap	Mith Struc	Add Variable	Close

Repeat the process with the no-structure plan, and press Add Variable.

💶 Create R	aster Layer Definition				×
	Plan	Мар Туре	Animation Behavior	Profile	
Definition:	Capacity Only 30k-100k cfs Capacity Only	▼ Total-load Transport Cap ▼	Dynamic	•	Ŧ
CapNoSt	Conc Only Capacity Only (no Structure	-load Transport Capacity	Dynamic		
	Conc Only (no Struct)		NoStruc	Add Variable	Close

These variables should show up in the upper left corner of the editor as depicted in the following figure.

Once you add the first variable, the editor automatically populates a "stub" if-then statement to handle no-data conditions. You are going to make the minor changes to that statement pictured below to complete the analysis.

RASter Calculator		×
Script: User Defined Layers Raster Layers + CapWithStruc = Capacity Only Face Total-load Trar CapNoStruc = Conc Only (no Struct) Face Total-load Image: Cap With Struc = Capacity Only (no Struct) Face Total-load + Image: Cap With Struc = Capacity Only (no Struct) Face Total-load Image: Capacity Only (no Struct) Face Total-load	Terrains Little Bayou Meto Little Bayou Meto	
Calculation Check Code View Full Code	Language: Visual Ba	
If CapWithStruc = NoData andalso CapNoStruc = NoData Then Output = 0 Else Output = CapWithStruc - CapNoStruc End If	unguage. visual be	×
<		>
Raster Output Folder: e Rock 2D Sed\Workshops\2.2 Fixed Bed Sediment Modeling\Fixed Bed Sediment Modeling Name: CapacityDiff	ing - Solution\Calculate	ed Layers 🛛 💕
	Create Layer	Close

22. Write Logic to Difference Layers:

First, the data check will look at the first variable you add, but you want it to apply to both layers.

So add andalso ("Layer 2 Name") = No Data to include it.

Then, if the NoData condition obtains, we want to set the map value to zero so we don't compare maps where only one of them has values.

Therefore **Output = 0**.

Finally, in the **Else** statement, change the result to the difference between the layer variables. **Output = (**"Layer 1 Name") - ("Layer 2 Name")

After you have completed the code, press the **Check Code** button to see if it is complete.

If not, press the **View Full Code** button, which will help you find the error.

Otherwise, press Create Layer.

23. Write Logic to Difference Layers:

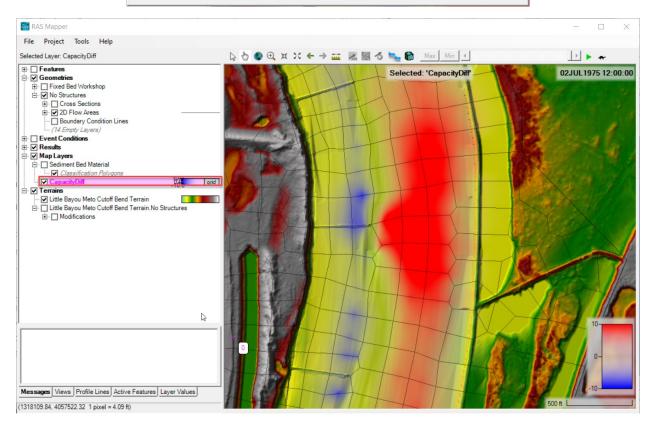
The new layer will appear in the **Map Layers** portion of the mapper tree.

The result will import with an unhelpful 0-100 greyscale symbology.

So switch it to the Red-White-Blue "Bed Change" symbology.

I switched the red and blue to make red indicate more capacity with the structures). If you set the **Alpha** of the white to zero, you will make the low-difference cells transparent.

sualization and Inform	nation	🚟 Select Surface F	ill		-	- 🗆	×	
Vector Point:	Line:	Surface Symbol Setti Available Color Ra	-	Defaults 🔽	User Def	ined		-
Label Features	with At	Color Ramp:	Custom			• ×		
Surface		Surface Symbol Max: 10.00	Use Dataset Mir	n/Max				
10	Strete	Min: -10.00 N Keep user Values	o. Values: 3 with color ramp cł	hange		Create Rai	mp Values	
0-	Opaci	Value	Color	Red (0-255)	Green (0-255)	Blue (0-255)	Alpha (0-255)	
		-10.00		0	0	255	255	
-10	_	0.00		255	255	255	0	
Contours / Hillshad	le 🚽	10.00		255	0	0	255	
Plot Contours	Interv							
Plot Hillshade	Z Fac	Reverse Colors	Save Color Ran	mp				



How much (%) does the capacity increase with the structures? (roughly)

If you have extra time: Try to make a % Change capacity map.