



De-Bugging a HEC-RAS Unsteady Flow Model

Geometry Processor

| | | | |
|-----------|----------------|------------|---------------|
| River: | NBCR West Fork | RS: | 17.76965 |
| Reach: | DS S Navy | Node Type: | Cross Section |
| IB Curve: | | | |

Unsteady Flow Simulation

| | | | |
|-------------------|----------|-----------|----------|
| Simulation: | | | |
| Time: | 120.0000 | 17SEP2008 | 00:00:00 |
| Iteration: | 0 | | |
| Writing Profiles: | 400 | | |

Post Process

| | | | |
|-------------|----------------|------------|---------------|
| River: | NBCR West Fork | RS: | 26523.93 |
| Reach: | US N Navy | Node Type: | Cross Section |
| Profile: | 12SEP2008 0200 | | |
| Simulation: | 3/3 | | |

HEC-RAS Finished Computations

Geometry Processor

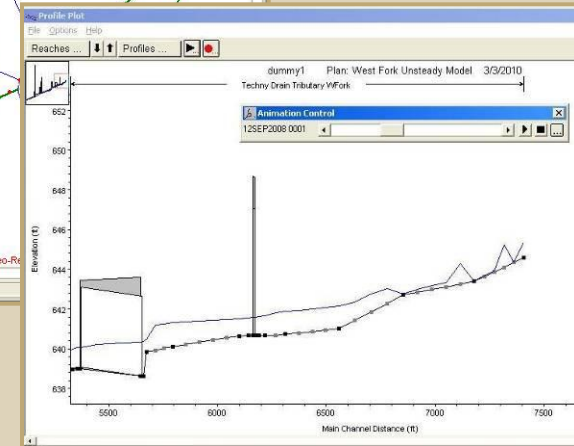
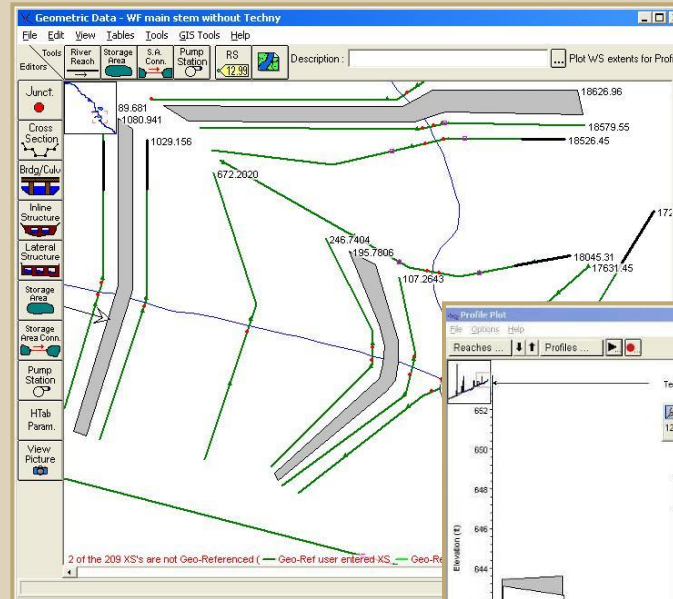
| | | | |
|-----------|----------------|------------|---------------|
| River: | NBCR West Fork | RS: | 17.76965 |
| Reach: | DS S Navy | Node Type: | Cross Section |
| IB Curve: | | | |

Unsteady Flow Simulation

| | | | |
|-------------------|----------|-----------|----------|
| Simulation: | | | |
| Time: | 120.0000 | 17SEP2008 | 00:00:00 |
| Iteration: | 0 | | |
| Writing Profiles: | 3400 | | |

Post Process

| | | | |
|-------------|----------------|------------|---------------|
| River: | NBCR West Fork | RS: | 17.76965 |
| Reach: | DS S Navy | Node Type: | Cross Section |
| Profile: | 16SEP2008 2400 | | |
| Simulation: | 242/242 | | |



Presented by:

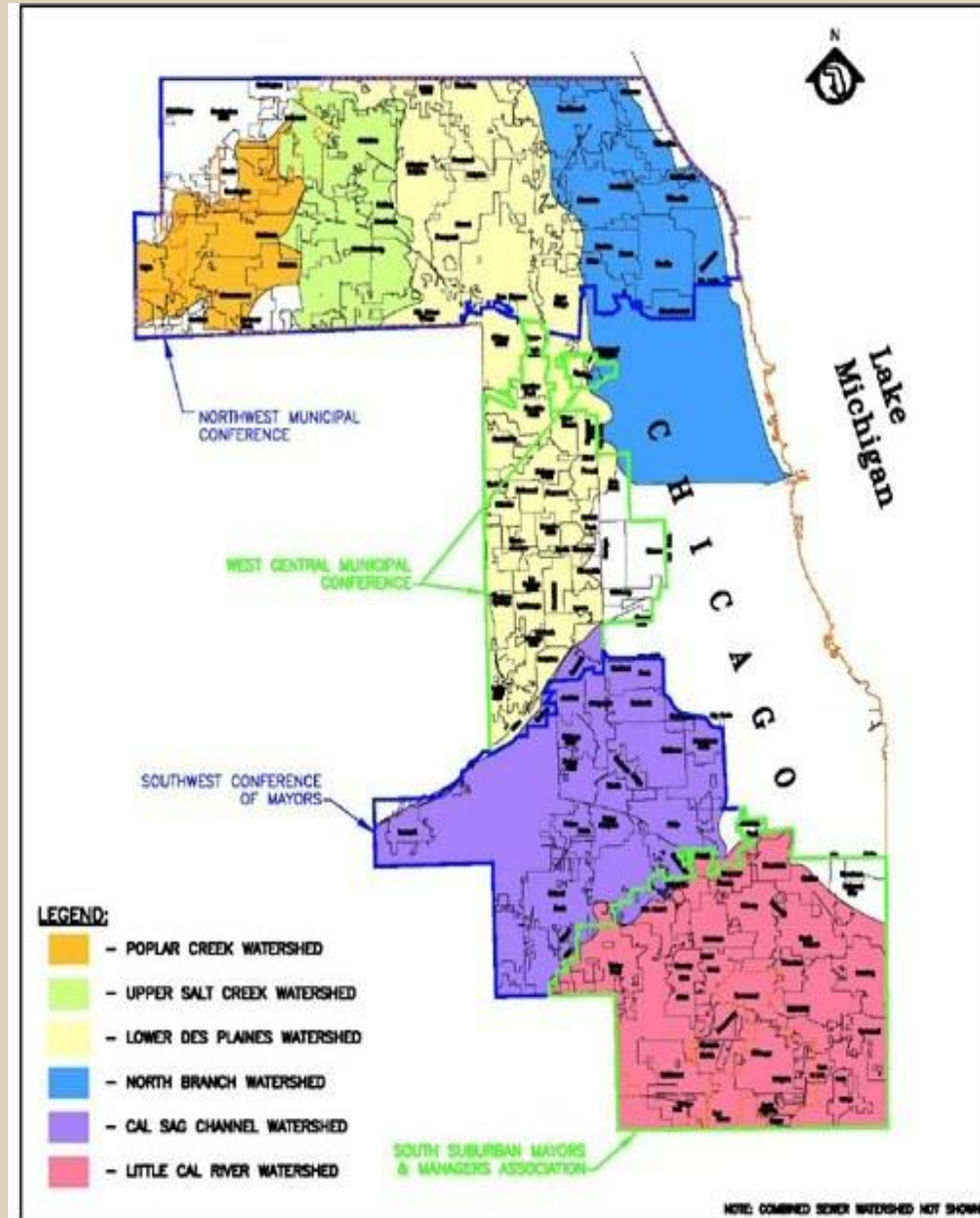
Jennifer Maercklein, P.E., CFM

V3 Companies



Presentation Agenda

- Goals
- Model Errors Before Simulation Begins
- De-bugging Initial Conditions
- De-bugging Runtime Errors
- Resources for Help
- Questions





Presentation Goals

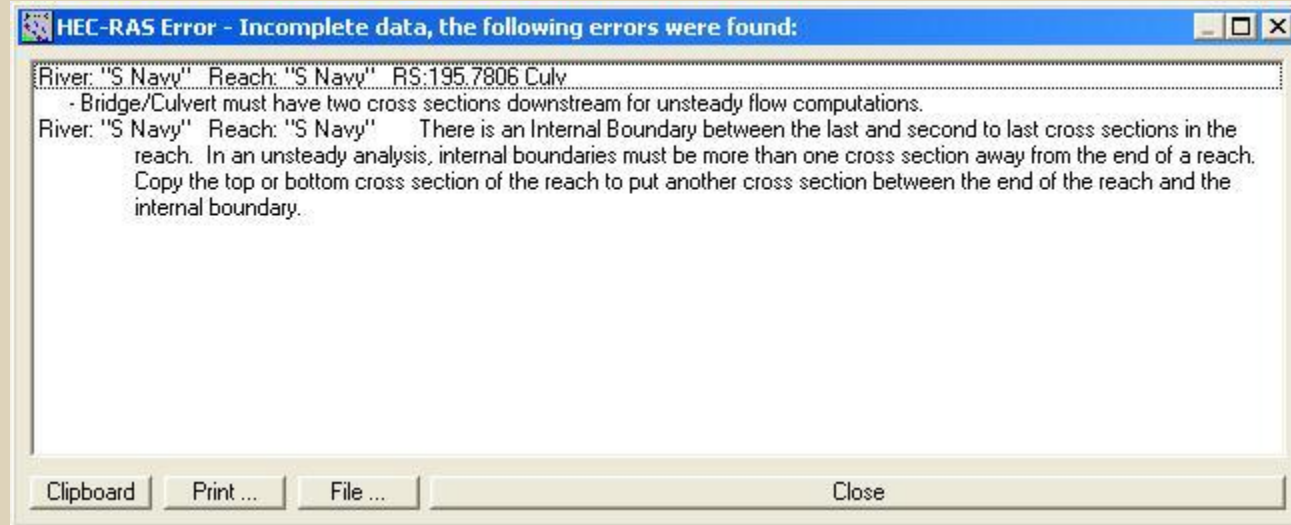
- Tips to get started with de-bugging
 - Useful HEC-RAS tools for debugging
 - Tips to find sources of error
- De-bugging ideas presented here do not represent an exhaustive list of de-bugging techniques
- Presentation Assumptions
 - Familiarity with HEC-RAS
 - Familiarity with Unsteady Flow Modeling



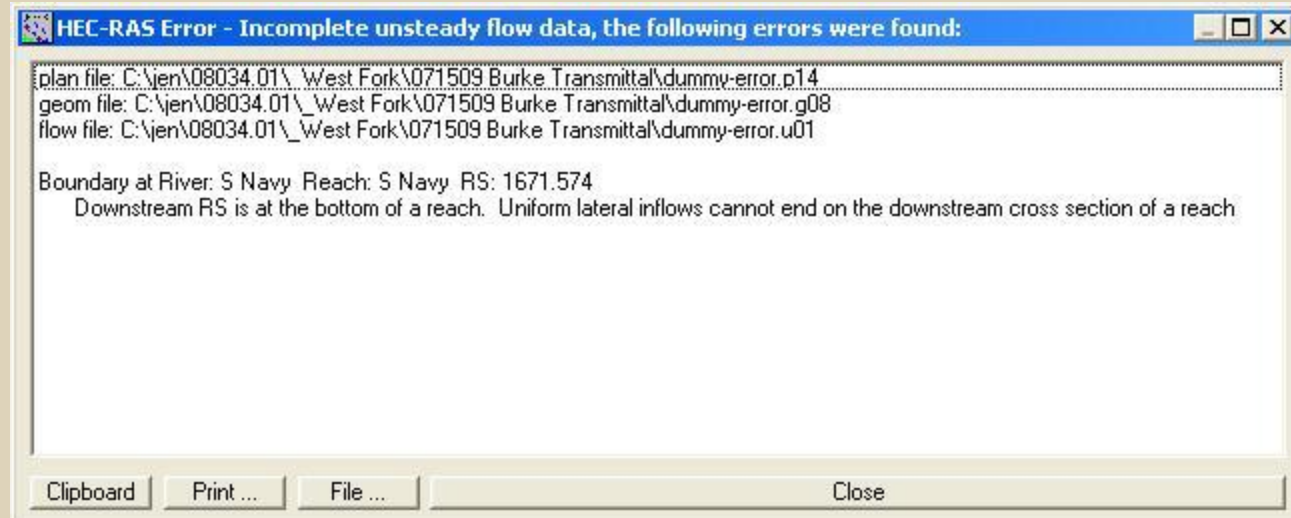
Model Errors Before Simulation Begins

- Model Errors – Before Simulation Begins

- Cross Section Location Errors



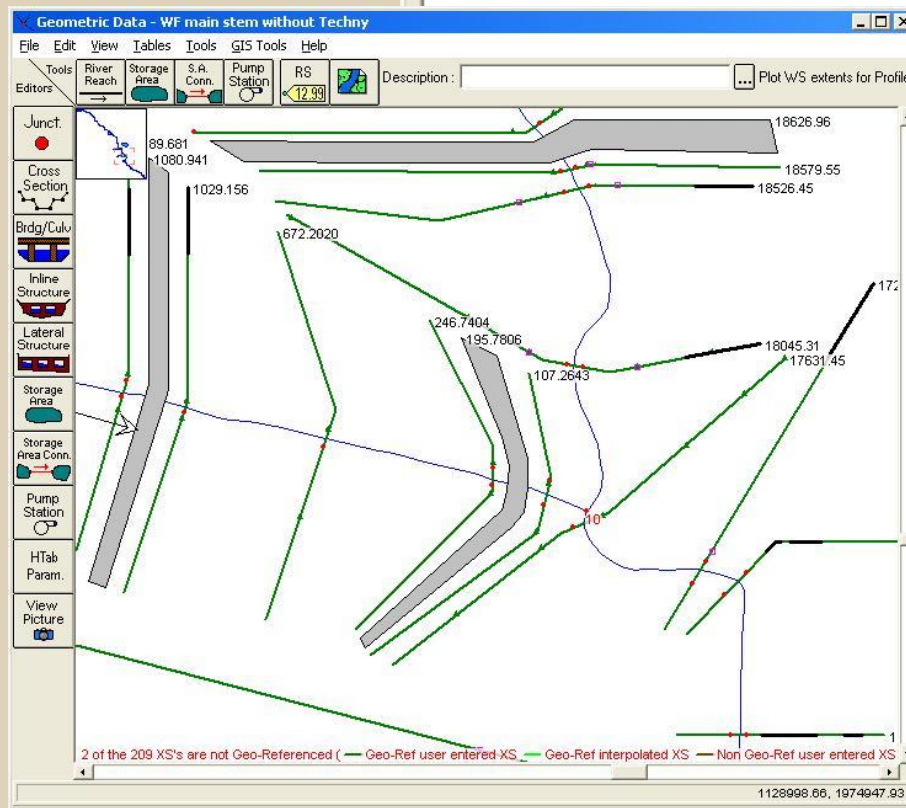
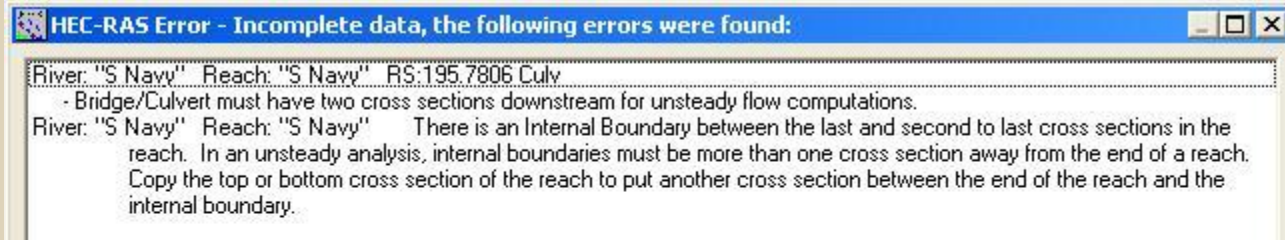
- Unsteady Flow Inflow Errors





Model Errors Before Simulation Begins

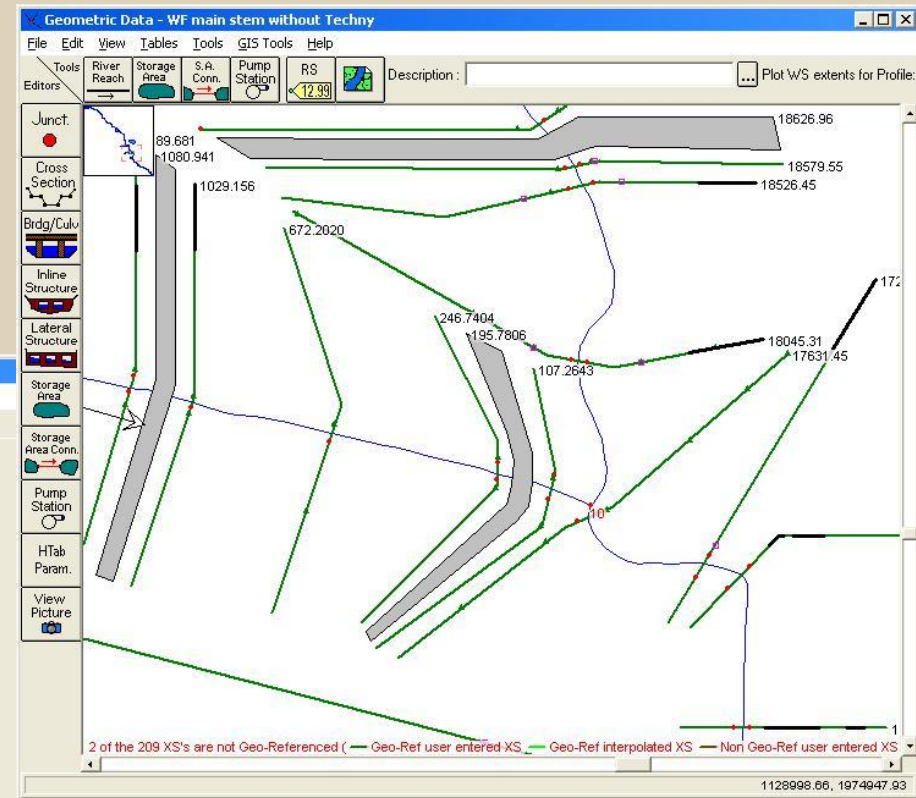
- Cross Section Locations



- Two XS d/s of each structure
- Two XS between internal boundary and confluence



VISIO
VERTERE
VIRTUTE



- Uniform Lateral Inflow Can't Span Structures
- Uniform Lateral Inflow Can't End at D/S End of Reach



De-bugging Initial Conditions

- Model crashes at beginning of simulation
- Problem with Initial Conditions
 - Flow too low, reaches go “dry”
 - Flow u/s of confluence \neq flow d/s
 - Supercritical
- Computational Time Step

HEC-RAS Finished Computations

Geometry Processor
River: NBCR West Fork RS: 17.76965
Reach: DS S Navy Node Type: Cross Section
IB Curve:

Unsteady Flow Simulation
Simulation:
Time: 120.0000 17SEP2008 00:00:00 Iteration: 0
Writing Profiles 6400

Post Process
River: NBCR West Fork RS: 17.76965
Reach: DS S Navy Node Type: Cross Section
Profile: 11SEP2008 2400
Simulation: 2/2

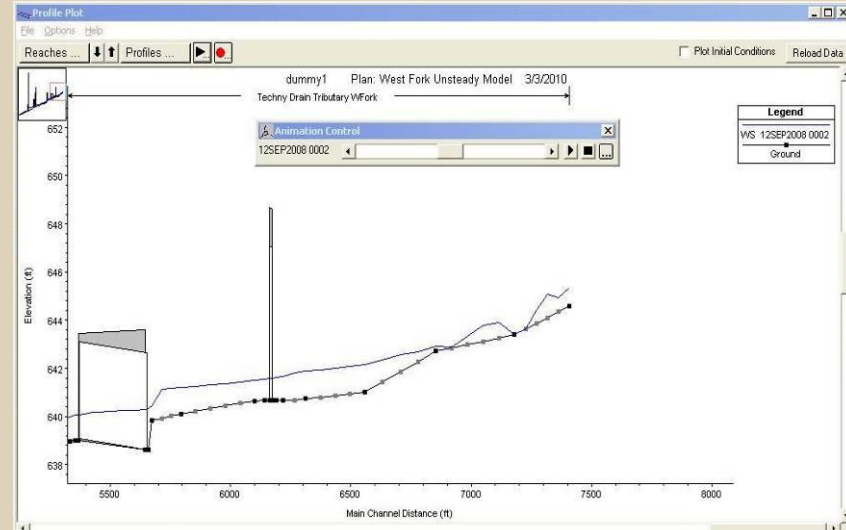
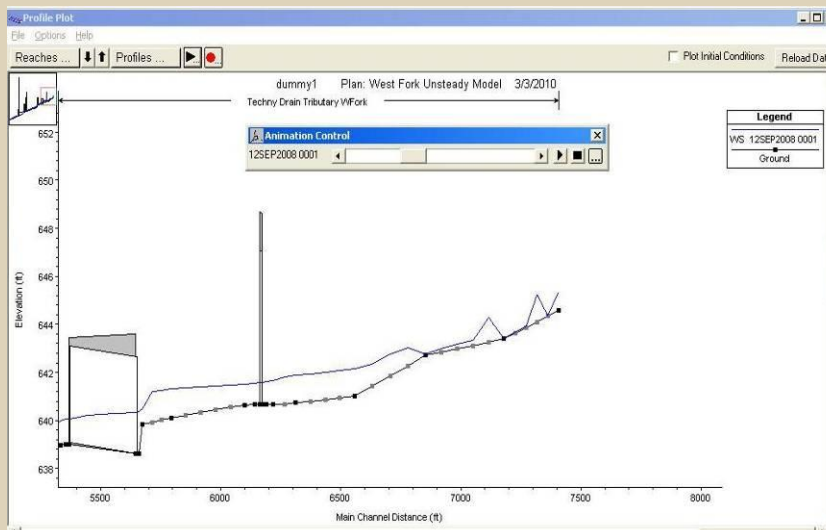
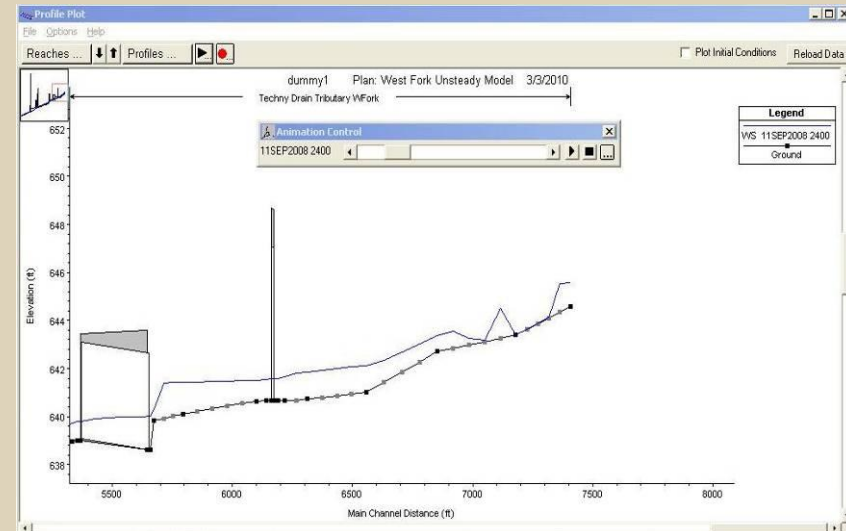
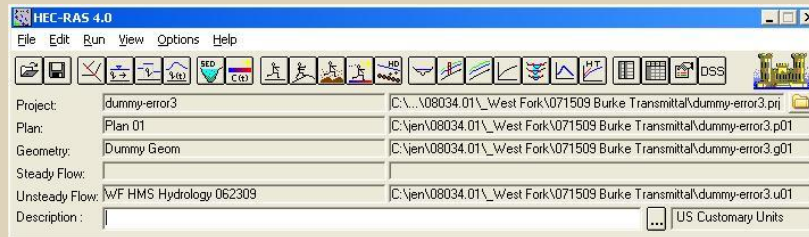
Computation Messages

| | | | | | |
|---|--------------|------------------|----------|--------|--------|
| 12SEP2008 00:03:15 | Techny North | Tributary Techny | 486.2416 | 647.00 | 0.333 |
| Solution solver went unstable, iteration 12 at 12SEP2008 00:03:30 | | | | | |
| | Techny South | Tributary Techny | 306.292* | 649.84 | 2.262 |
| Solution solver went unstable, iteration 7 at 12SEP2008 00:03:45 | | | | | |
| | Techny South | Tributary Techny | 912.5332 | 651.43 | 0.343 |
| 12SEP2008 00:04:00 | Techny South | Tributary Techny | 682.35* | 651.19 | 0.161 |
| 12SEP2008 00:04:15 | Techny South | Tributary Techny | 50 | 645.38 | 0.253 |
| 12SEP2008 00:04:30 | Techny South | Tributary Techny | 437.7529 | 648.82 | 0.085 |
| 12SEP2008 00:04:45 | Techny South | Tributary Techny | 912.5332 | 650.51 | 3.673 |
| 12SEP2008 00:05:00 | Techny South | Tributary Techny | 50 | 645.38 | 1.263 |
| Solution solver went unstable, iteration 8 at 12SEP2008 00:05:15 | | | | | |
| | Techny Drain | Tributary WForK | 6693.42* | 641.45 | 14.284 |
| ***** Matrix Solution Failed ***** | | | | | |
| Minimum error exceeds allowable tolerance at 12SEP2008 0005 | | | | | |
| | Techny Drain | Tributary WForK | 7423.21* | | |
| WARNING! | | | | | |



De-bugging Initial Conditions

- Initial flow too low, reaches go “dry”
- Animate Profile





De-bugging Initial Conditions

- Keep Reaches “Wet”
 - Check Initial Flows
 - Check Minimum Flows
 - Add Dummy Flow to Emergency/Diversion Channels

Unsteady Flow Data - WF HMS Hydrology 062309

File Options Help

Boundary Conditions Initial Conditions | Apply Data

Initial Flow Distribution Method

☐ Use a Restart File Filename:

☒ Enter Initial flow distribution

Locations of Flow Data Changes

River: Add Multiple...

Reach: River Sta.: Add A Flow Change Location

| | River | Reach | RS | Initial Flow |
|----|------------------|------------------|----------|--------------|
| 1 | N Navy Ditch | Upper Reach | 2242.068 | 2 |
| 2 | N Navy Diversion | N Navy Diversion | 1056.009 | 0.1 |
| 3 | NBCR West Fork | US Underwriters | 50056.06 | 5 |
| 4 | NBCR West Fork | US Techny | 44505.76 | 5 |
| 5 | NBCR West Fork | DS Techny | 30891.70 | 20 |
| 6 | NBCR West Fork | US N Navy Div | 23552.81 | 20 |
| 7 | NBCR West Fork | US S Navy | 21471.09 | 20 |
| 8 | NBCR West Fork | DS S Navy | 17631.45 | 20 |
| 9 | S Navy | S Navy | 2228.927 | 2 |
| 10 | Techny Drain | Tributary W'Fork | 7468.671 | 20 |
| 11 | Techny North | Tributary Techny | 3808.565 | 20 |
| 12 | Techny South | Tributary Techny | 2899.544 | 20 |
| 13 | Underwriters | Trib West Fork | 1274.258 | 10 |

Uniform Lateral Inflow Hydrograph

River: N Navy Ditch Reach: Upper Reach RS: 1808.803

Inflow will be evenly distributed from RS: "1808.803" to RS:

☒ Read from DSS before simulation

File:
Path:

☒ Enter Table Data time interval:

Select/Enter the Data's Starting Time Reference

☒ Use Simulation Time: Date: Time:
☐ Fixed Start Time: Date: Time:

Hydrograph Data

| | Date | Simulation Time (hours) | Lateral Inflow (cfs) |
|---|----------------|-------------------------|----------------------|
| 1 | 11Sep2008 2400 | 00:00 | |
| 2 | 12Sep2008 0100 | 01:00 | |
| 3 | 12Sep2008 0200 | 02:00 | |
| 4 | 12Sep2008 0300 | 03:00 | |
| 5 | 12Sep2008 0400 | 04:00 | |
| 6 | 12Sep2008 0500 | 05:00 | |

Time Step Adjustment Options ("Critical" boundary conditions)

☐ Monitor this hydrograph for adjustments to computational time step

Max Change in Flow (without changing time step):

Min Flow: Multiplier:



De-bugging Initial Conditions

- Flow upstream of confluence not equal to flow downstream of confluence

Unsteady Flow Data - WF HMS Hydrology 062309

File Options Help

Boundary Conditions Initial Conditions Apply Data

Initial Flow Distribution Method

☐ Use a Restart File Filename:

☒ Enter Initial flow distribution

Locations of Flow Data Changes

River: Add Multiple...

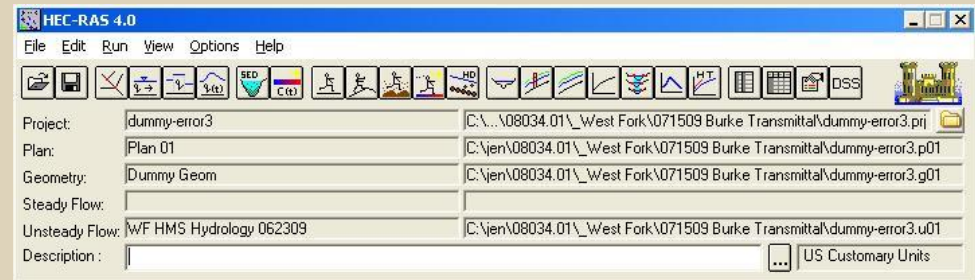
Reach: River Sta.: Add A Flow Change Location

| | River | Reach | RS | Initial Flow |
|----|------------------|------------------|----------|--------------|
| 1 | N Navy Ditch | Upper Reach | 2242.068 | 2 |
| 2 | N Navy Diversion | N Navy Diversion | 1056.009 | 0.1 |
| 3 | NBCR West Fork | US Underwriters | 50056.06 | 5 |
| 4 | NBCR West Fork | US Techny | 44505.76 | 5 |
| 5 | NBCR West Fork | DS Techny | 30891.70 | 20 |
| 6 | NBCR West Fork | US N Navy Div | 23552.81 | 20 |
| 7 | NBCR West Fork | US S Navy | 21471.09 | 20 |
| 8 | NBCR West Fork | DS S Navy | 17631.45 | 20 |
| 9 | S Navy | S Navy | 2228.927 | 2 |
| 10 | Techny Drain | Tributary Wfork | 7468.671 | 20 |
| 11 | Techny North | Tributary Techny | 3808.565 | 20 |
| 12 | Techny South | Tributary Techny | 2899.544 | 20 |
| 13 | Underwriters | Trib West Fork | 1274.258 | 10 |



De-bugging Initial Conditions

- Supercritical Flow, Model Unable To Converge To Solution
- Review Summary Output Tables



| Profile Output Table - Standard Table 1 | | | | | | | | | | | | | |
|--|-----------|----------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|----------|-----|
| HEC-RAS Plan: WestForkUnsteady River: Techny Drain Reach: Tributary W/Fork Profile: 12SEP2008 0005 | | | | | | | | | | | | | |
| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # | Chl |
| Tributary W/Fork | 7468.671 | 12SEP2008 0005 | -8.45 | 644.590 | 644.76 | 645 | 645 | 0 | -4 | 2 | 18 | 2.37 | |
| Tributary W/Fork | 7423.21* | 12SEP2008 0005 | -28.06 | 644.350 | 645.60 | | 646 | 0 | 1 | 29 | 35 | 0.19 | |
| Tributary W/Fork | 7377.75* | 12SEP2008 0005 | 26.67 | 644.110 | 645.11 | | 645 | 0 | 2 | 16 | 27 | 0.37 | |
| Tributary W/Fork | 7332.28* | 12SEP2008 0005 | -2.91 | 643.870 | 643.91 | 644 | 966 | 4430 | -144 | 0 | 1 | 180.65 | |
| Tributary W/Fork | 7286.82* | 12SEP2008 0005 | -2.08 | 643.630 | 643.65 | 644 | 3866 | 97357 | -456 | 0 | 0 | 765.95 | |
| Tributary W/Fork | 7241.367 | 12SEP2008 0005 | -0.81 | 643.390 | 643.41 | 644 | 1846 | 36848 | -278 | 0 | 0 | 467.87 | |
| Tributary W/Fork | 7176.16* | 12SEP2008 0005 | -1.68 | 643.250 | 643.48 | 644 | 644 | 1 | -5 | 0 | 3 | 2.74 | |
| Tributary W/Fork | 7110.95* | 12SEP2008 0005 | -2.64 | 643.120 | 643.14 | 644 | 10859 | 364456 | -811 | 0 | 0 | 1361.85 | |
| Tributary W/Fork | 7045.75* | 12SEP2008 0005 | 0.57 | 642.980 | 643.00 | 643 | 1059 | 15973 | 164 | 0 | 0 | 274.82 | |
| Tributary W/Fork | 6980.54* | 12SEP2008 0005 | 3.95 | 642.850 | 643.47 | | 644 | 0 | 2 | 2 | 8 | 0.53 | |
| Tributary W/Fork | 6915.343 | 12SEP2008 0005 | 4.46 | 642.710 | 643.57 | | 644 | 0 | 1 | 5 | 10 | 0.26 | |
| Tributary W/Fork | 6841.37* | 12SEP2008 0005 | 5.63 | 642.280 | 643.51 | | 644 | 0 | 1 | 6 | 10 | 0.22 | |
| Tributary W/Fork | 6767.39* | 12SEP2008 0005 | 4.50 | 641.850 | 642.68 | | 643 | 0 | 2 | 2 | 5 | 0.56 | |
| Tributary W/Fork | 6693.42* | 12SEP2008 0005 | -5.23 | 641.430 | 642.48 | | 643 | 0 | -2 | 3 | 6 | 0.40 | |
| Tributary W/Fork | 6619.455 | 12SEP2008 0005 | -8.29 | 641.000 | 641.68 | 642 | 642 | 0 | -6 | 1 | 4 | 1.94 | |
| Tributary W/Fork | 6557.86* | 12SEP2008 0005 | -0.35 | 640.930 | 640.95 | 641 | 1421 | 32297 | -224 | 0 | 0 | 376.36 | |
| Tributary W/Fork | 6496.26* | 12SEP2008 0005 | 3.22 | 640.860 | 642.04 | | 642 | 0 | 1 | 4 | 7 | 0.20 | |
| Tributary W/Fork | 6434.67* | 12SEP2008 0005 | 2.39 | 640.800 | 641.94 | | 642 | 0 | 1 | 4 | 8 | 0.16 | |
| Tributary W/Fork | 6373.082 | 12SEP2008 0005 | 2.36 | 640.730 | 641.89 | | 642 | 0 | 1 | 4 | 10 | 0.15 | |
| Tributary W/Fork | 6326.95* | 12SEP2008 0005 | 2.43 | 640.690 | 641.84 | | 642 | 0 | 1 | 4 | 9 | 0.18 | |
| Tributary W/Fork | 6280.837 | 12SEP2008 0005 | 2.52 | 640.660 | 641.66 | | 642 | 0 | 1 | 3 | 10 | 0.32 | |



De-bugging Initial Conditions

- Computational Parameters

- May need shorter computational time step to allow HEC-RAS to converge
- May need shorter output time step to enable user to see results at time of failure

Unsteady Flow Analysis

File Options Help

Plan: Plan 01 Short ID: Plan 01

Geometry File: Dummy Geom

Unsteady Flow File: WF HMS Hydrology 062309

Plan Description: Dummy Model

Programs to Run:

- ☒ Geometry Preprocessor
- ☒ Unsteady Flow Simulation
- ☒ Post Processor

Simulation Time Window

Starting Date: 12Sep2008 Starting Time: 0000

Ending Date: 17SEP2008 Ending Time: 0000

Computation Settings

Computation Interval: 15 Secor Hydrograph Output Interval: 30 Minute

☐ Computation Level Output Detailed Output Interval: 30 Minute

DSS Output Filename: C:\jen\08034.01_West Fork\071509 Burke Transmitt

☐ Mixed Flow Regime (see menu: "Options/Mixed Flow Options ...")


Compute




De-bugging Runtime Errors

- De-bugging Runtime Errors
- Identify Source of Model Crashes
 - Note time and location of model crash
 - Find problematic XS and consider HEC-RAS suggestions
- Heed Model Extrapolation Warnings



Geometry Processor

River: NBCR West Fork RS: 17.76965
Reach: DS S Navy Node Type: Cross Section
IB Curve: 

Unsteady Flow Simulation

Simulation: 
Time: 120.0000 17SEP2008 00:00:00 Iteration: 0
Writing Profiles: 400

Post Process

River: NBCR West Fork RS: 26523.93
Reach: US N Navy Node Type: Cross Section
Profile: 12SEP2008 0200 
Simulation: 3/3 

Computation Messages

| At River | S Navy | Reach | S Navy | R.S. | 195.7806 |
|----------|----------------|-------|-----------|------|----------|
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 15392.18 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 12756.26 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 11870.73 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 11359.11 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 6664.061 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 4060.731 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 2319.75 |

Finished Unsteady Flow Simulation

Writing Results to DSS
Finished Writing Results to DSS

Reading Data for Post Process
Simulation went unstable at: 12Sep2008 02:15:00
Resetting post process profiles to end at: 12SEP2008 0200

Running Post Processor Version 4.0.0 March 2008

Finished Post Processing

| Task | Time |
|----------------------------|-----------|
| Preprocessing Geometry | 0.44 sec |
| Unsteady Flow Computations | 9.02 sec |
| Writing to DSS | 1.45 sec |
| Post-Processing | 2.31 sec |
| Complete Process | 13.27 sec |

Computation messages written to: C:\jen\08034.01\dummyfor\AFSM.p18.comp_msgs.txt

Close



De-bugging Runtime Errors

- Identify Source of Model Crashes
 - Note time and location of model crash

```
***** Matrix Solution Failed *****  
Minimum error exceeds allowable tolerance at 12SEP2008 0214  
NBCR West Fork US N Navy 23529.47
```

- Review detailed output tables
- Find problematic cross section and consider HEC-RAS suggestions
- Often, just need more cross sections

Cross Section Output

File Type Options Help

River: NBCR West Fork Profile: 12SEP2008 0200

Reach: US N Navy RS: 23529.47 Plan: ust4 trunc half

| Plan: ust4 trunc half NBCR West Fork US N Navy RS: 23529.47 Profile: 12SEP2008 0200 | | | | | |
|---|----------|------------------------|---------|---------|----------|
| E.G. Elev (ft) | 620.58 | Element | Left OB | Channel | Right OB |
| Vel Head (ft) | 0.03 | Wt. n-Val. | | 0.035 | |
| W.S. Elev (ft) | 620.55 | Reach Len. (ft) | 0.50 | 80.00 | 82.70 |
| Crit W.S. (ft) | | Flow Area (sq ft) | | 3.38 | |
| E.G. Slope (ft/ft) | 0.011402 | Area (sq ft) | | 3.38 | |
| Q Total (cfs) | -4.69 | Flow (cfs) | | -4.69 | |
| Top Width (ft) | 19.91 | Top Width (ft) | | 19.91 | |
| Vel Total (ft/s) | -1.39 | Avg. Vel. (ft/s) | | -1.39 | |
| Max Chl Dpth (ft) | 0.23 | Hydr. Depth (ft) | | 0.17 | |
| Conv. Total (cfs) | 44.0 | Conv. (cfs) | | 44.0 | |
| Length Wtd. (ft) | 80.00 | Wetted Per. (ft) | | 19.92 | |
| Min Ch El (ft) | 620.32 | Shear (lb/sq ft) | | 0.12 | |
| Alpha | 1.00 | Stream Power (lb/ft s) | | -0.17 | |
| Froth Loss (ft) | 3.51 | Cum Volume (acre-ft) | 0.00 | 0.33 | |
| C & E Loss (ft) | | Cum SA (acres) | 0.00 | 1.37 | |

Errors, Warnings and Notes

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m) between the current and previous cross section. This may indicate the need for additional cross sections.


Select Profile






De-bugging Runtime Errors

- Heed Model Extrapolation Warnings
 - Adjust Hydraulic Table (HTab) Parameters
 - Adjust Storage Ratings

HEC-RAS Finished Computations

Geometry Processor
River: NBCR West Fork RS: 17.76965
Reach: DS S Navy Node Type: Cross Section
IB Curve: 

Unsteady Flow Simulation
Simulation: 
Time: 120.0000 17SEP2008 00:00:00 Iteration: 0
Writing Profiles 400

Post Process
River: NBCR West Fork RS: 26523.93
Reach: US N Navy Node Type: Cross Section
Profile: 12SEP2008 0200 
Simulation: 3/3 

Computation Messages

WARNING!

***** Extrapolated above/beyond Rating Curve (Bridge/Culvert/etc.) *****

| | | | | | |
|----------|----------------|-------|-----------|------|----------|
| At River | NBCR West Fork | Reach | US N Navy | R.S. | 21960.49 |
| At River | NBCR West Fork | Reach | US N Navy | R.S. | 18626.96 |
| At River | S Navy | Reach | S Navy | R.S. | 1080.941 |
| At River | S Navy | Reach | S Navy | R.S. | 195.7806 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 15392.18 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 12756.26 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 11870.73 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 11359.11 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 6664.061 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 4060.731 |
| At River | NBCR West Fork | Reach | DS S Navy | R.S. | 2319.75 |

Finished Unsteady Flow Simulation



Summary

- Start with Good XS Locations, Good Unsteady Flow Input Locations
- Use HEC-RAS Graphical & Tabular Tools
 - Review .txt file to find time & location of error
 - Animate Profile
 - Review Summary Output Tables
 - Review Detailed Output Tables
- Pay Attention to:
 - Initial Flows
 - Supercritical Flow
 - Cross Section Spacing
- Consider HEC-RAS Warnings



Resources for Help

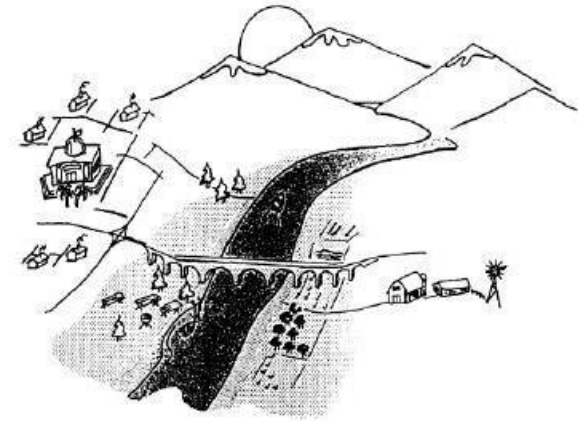
- Resources for Help
 - HEC-RAS Help
 - ASCE HEC-RAS Unsteady Flow Class and/or Class Manual



**US Army Corps
of Engineers**

Hydrologic Engineering Center

HEC-RAS River Analysis System



User's Manual

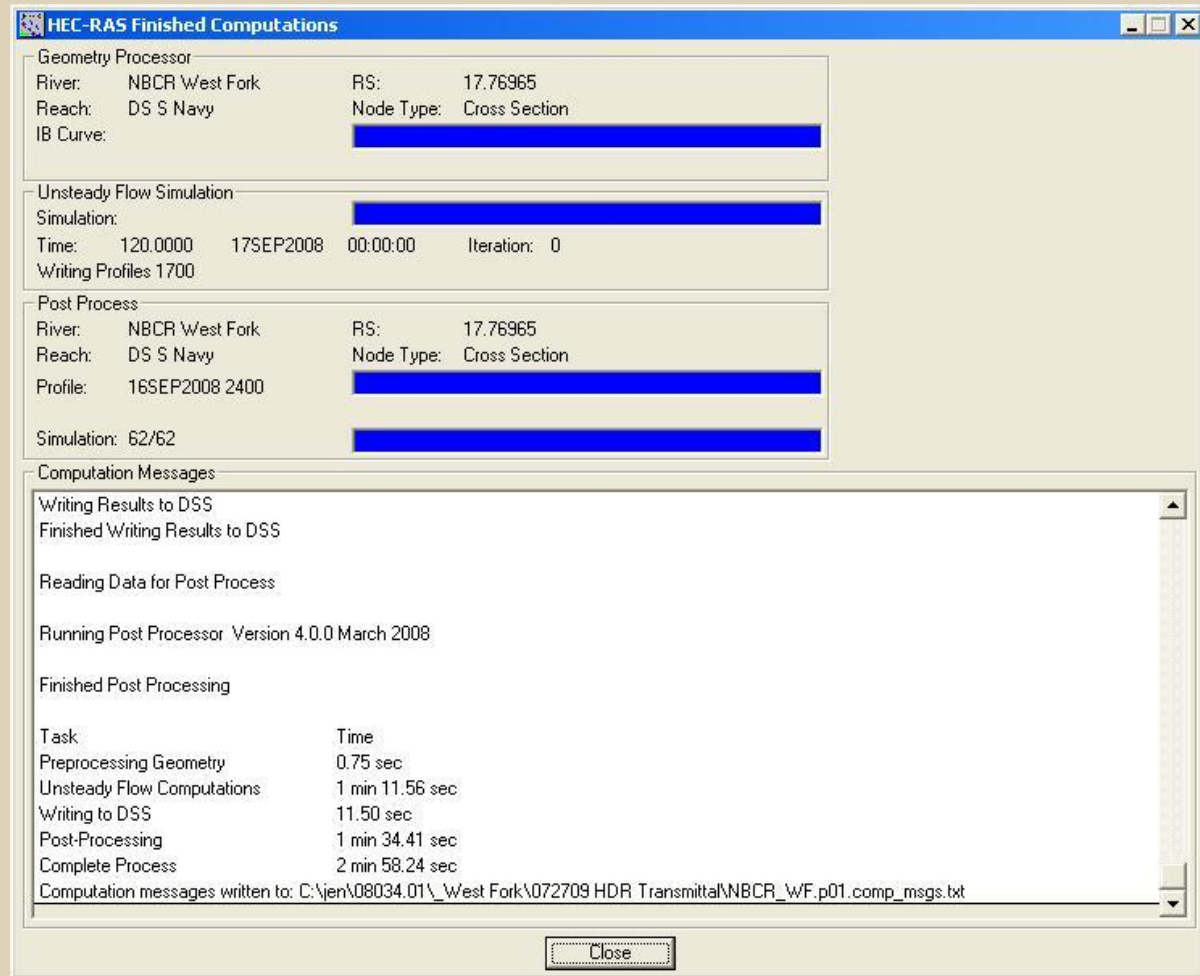
Version 4.0
March 2008

Approved for Public Release. Distribution Unlimited.

CPD-68



Model Runs! Success!



Questions?