Bed Scour and Mobility

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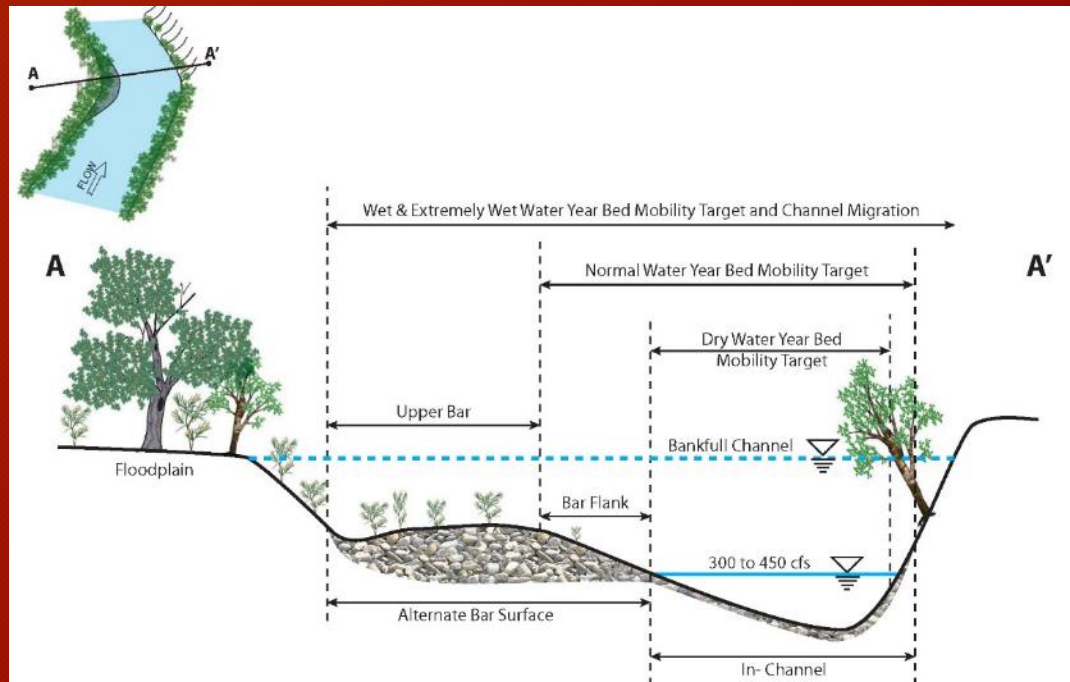
TRFE OBJECTIVES

- Mobilize cobbles (D84) on alternate bar surfaces during Normal and wetter water years >6,000 cfs)
- Mobilize subsurface cobbles (≥ 1D84 depth) during Wet and Extremely Wet years
- Mobilize subsurface cobbles (≥2D84 depth) during Extremely Wet years

PURPOSE

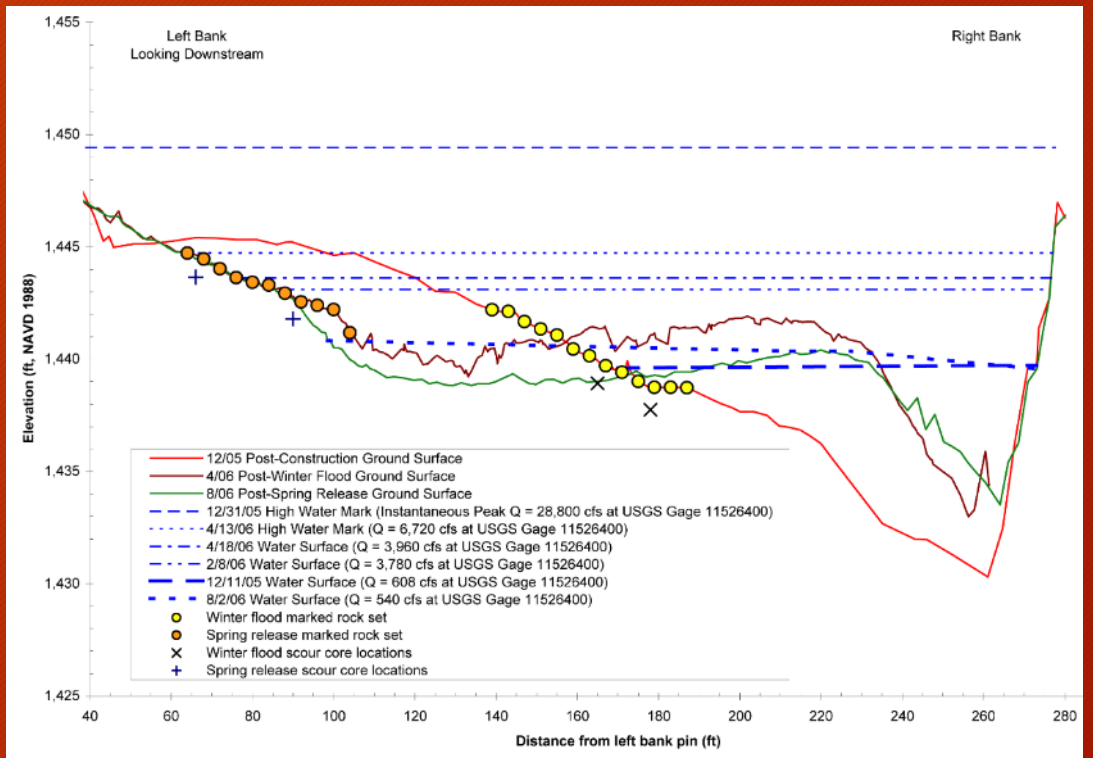
- Prevent detrimental encroachment of active bars
- Maintain complex channel morphology
- Scour fine sediments

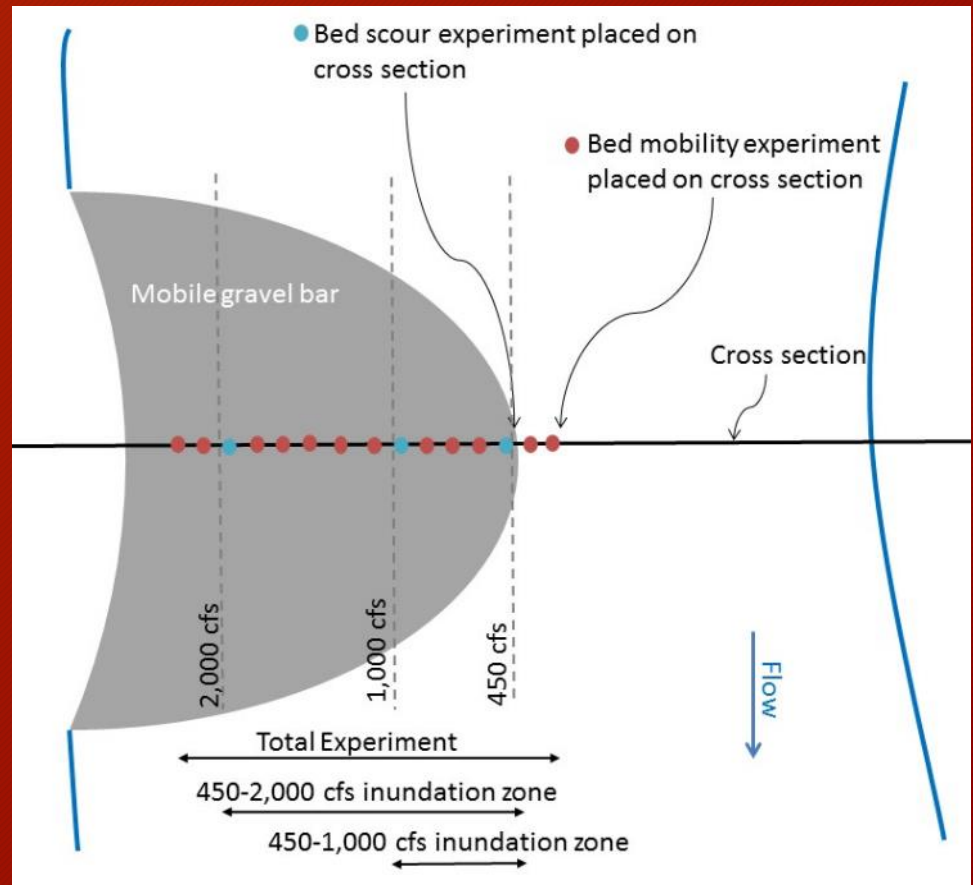


Bed Scour and Mobility Model

Empirical Model

- Marked rock and scour core experiments
- Draft statistical model of empirical results from 2009-2014

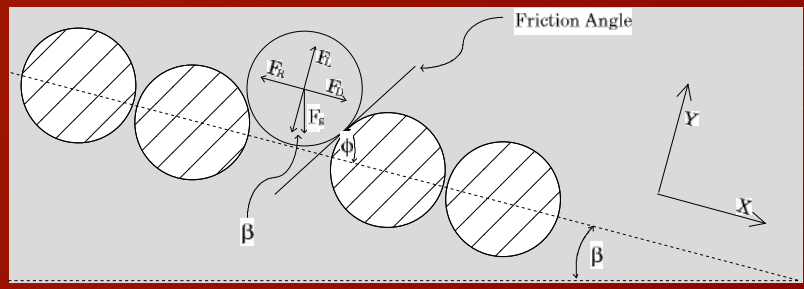




Bed Scour and Mobility Model

Deterministic Model

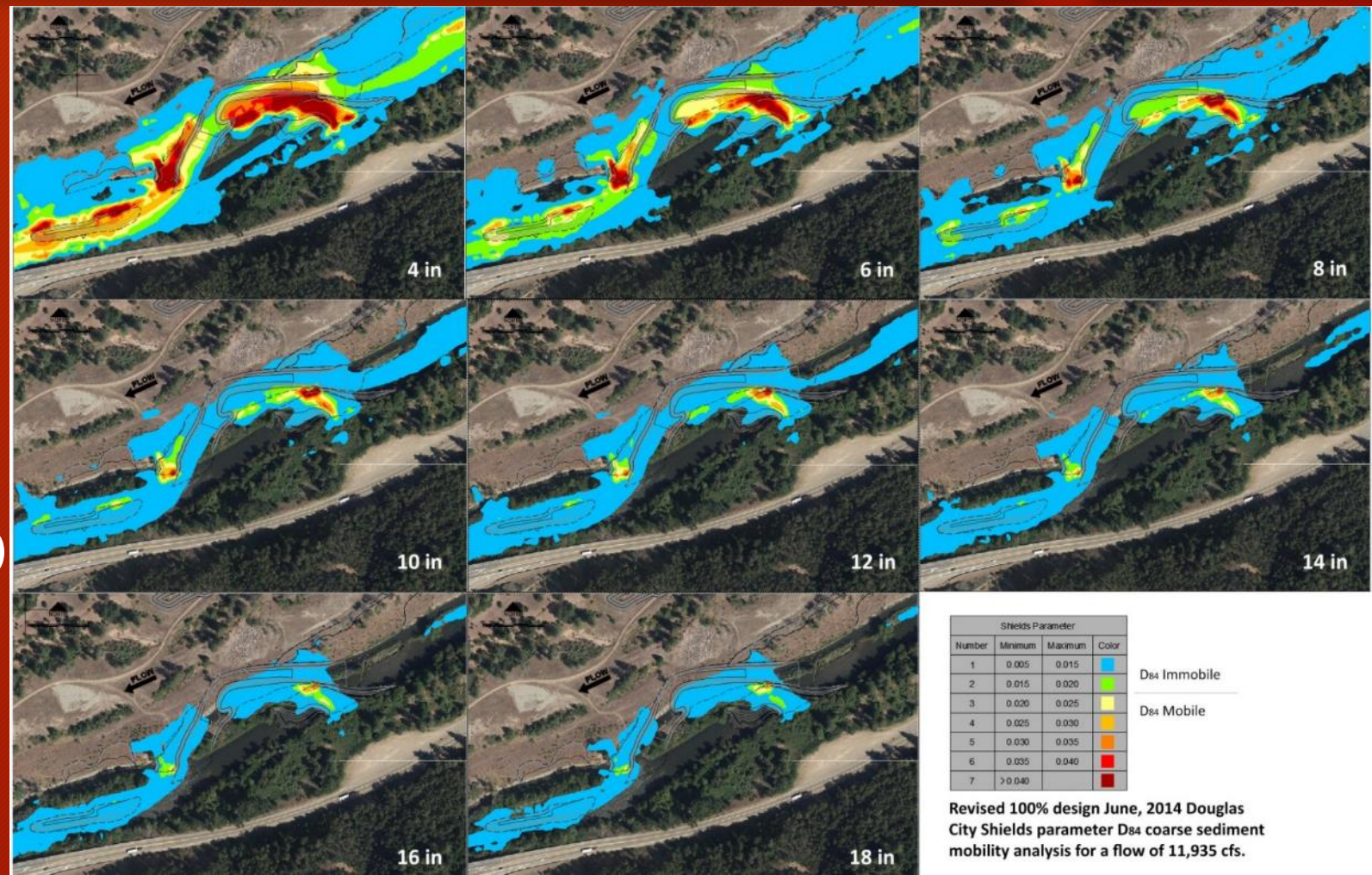
- Use 1-D or 2-D hydraulic models to predict boundary shear stress (force to move particle)
- Use bed mobility model to predict dimensionless critical shear stress to move D84 (force resisting movement)
- If ratio of force moving particle/force resisting movement is greater than 1, then movement
- If ratio of force moving particle/force resisting movement is greater than ~1.5, then scour



Shields parameter ~ $\frac{\text{mobility force}}{\text{grain resisting force}}$ → $\tau *_{D_i} = \frac{\tau_b}{(\rho_s - \rho_w) g D_i}$

Bed Scour and Mobility Model Output: 2-D modeling example of site design elements

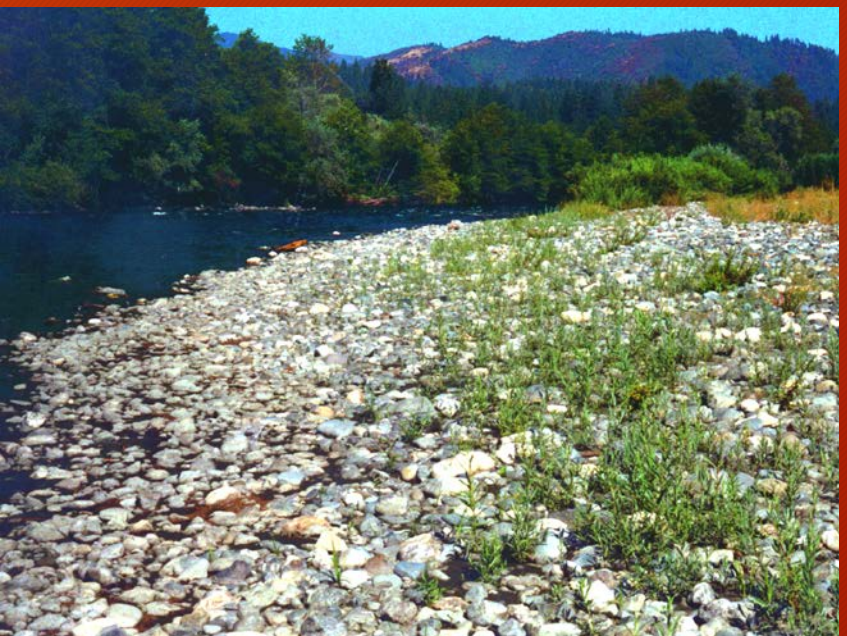
- Identify areas of high shear stress at design flows
- Identify areas of particle mobility and scour at a given flow for grain size X, Y, Z
- Informs selection of grain size for various areas in planform for objectives of:
  - Mobility (bars, channel migration)
  - Stability (flow splits)

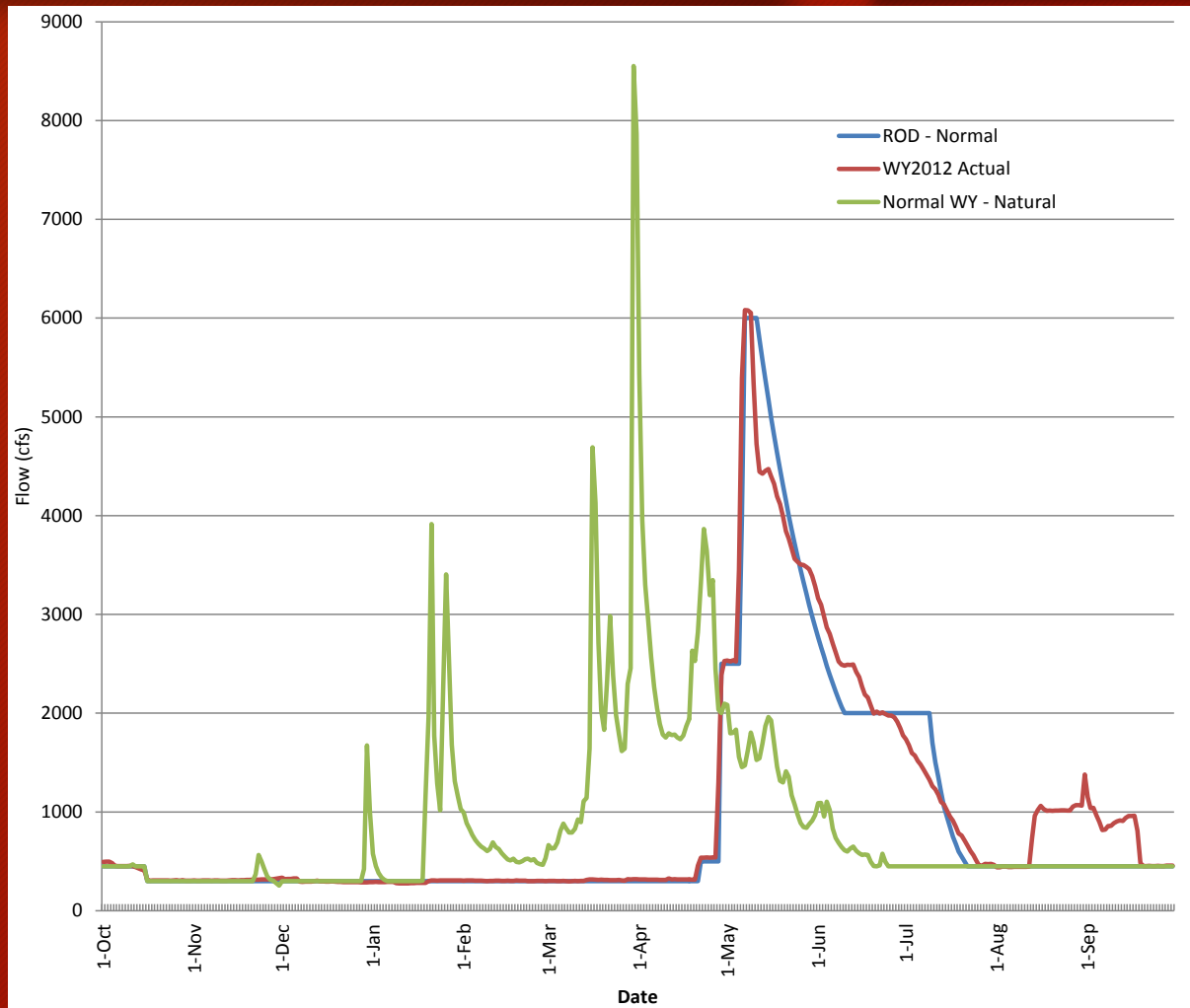


Revised 100% design June, 2014 Douglas City Shields parameter D_{84} coarse sediment mobility analysis for a flow of 11,935 cfs.

Bed Scour and Mobility Model-Hydrology

- Qpeak=6,000 cfs for ROD and WY2012 Actual
- Qpeak=8,500 cfs for Natural
- Assume no tributary accretion, but is easily added



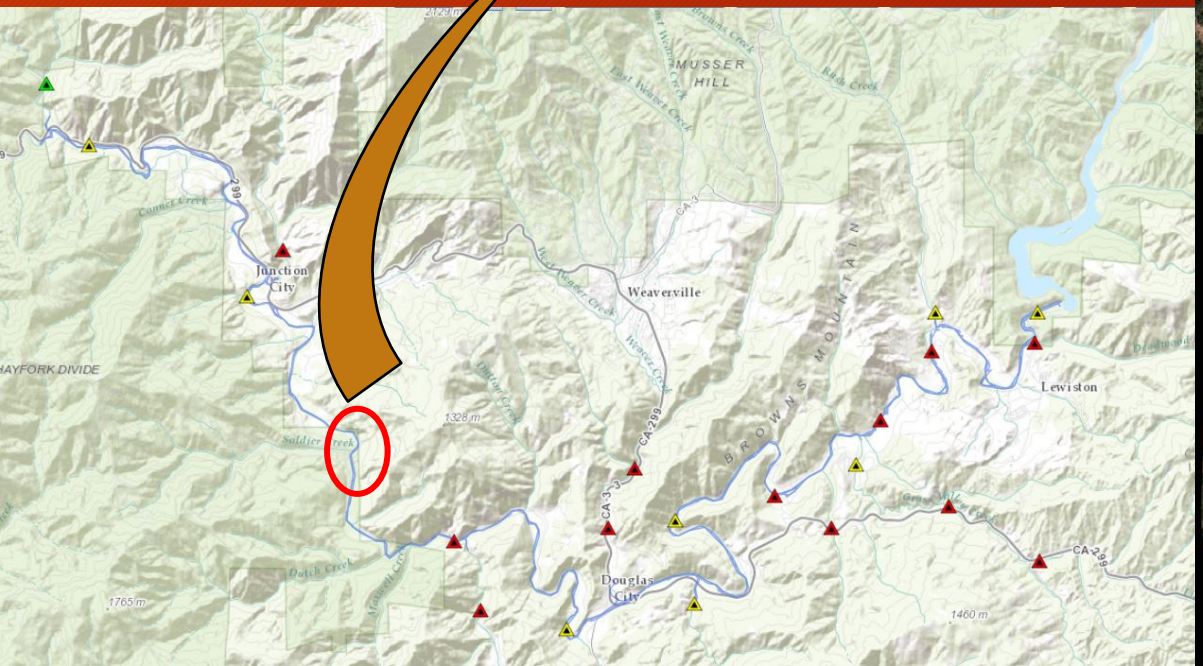


Bed Scour and Mobility Model Output: 2-D modeling example of hydrographs

- 3 mile reach just downstream of Dutch Creek
- Uses 2014 MA active bar polygons
- Uses 2014 USFWS/YT/HVT D84 grain size mapping
- Uses Reclamation SRH 2-D shear stress output for 6,000 cfs and 8,500 cfs
- No tributary accretion assumed for this model run
- Assume Critical Shield Parameter for D84=0.020 for mobility
- Assume Critical Shield Parameter for D84=0.025 for >1D84 scour
- Assume Critical Shield Parameter for D84=0.030 for >2D84 scour
- Can refine numbers based on empirical observations and/or conduct sensitivity analysis

$$\tau *_{D_i} = \frac{\tau_b}{(\rho_s - \rho_w) g D_i}$$

Example 3-mile modeling site below Dutch Creek



Bed Scour and Mobility Model Output: 6,000 cfs and 8,500 cfs on mid-channel bar

Predicted D84 Bed Mobility

Predicted >1D84 Bed Scour

Predicted >2D84 Bed Scour

Bed Scour and Mobility Model Output: 6,000 cfs and 8,500 cfs on point bar

Predicted D84 Bed Mobility

Predicted >1D84 Bed Scour

Predicted >2D84 Bed Scour

Bed Scour and Mobility Model Output: Comparison of Results for all Active Bars in 3-mile reach

Total Active Bar Area (sq ft)	Peak Flow	Predicted Active Bar area mobilized by peak flow, D84 Shields parameter>0.02 (sq ft)	Percent of total Active Bar area mobilized by peak flow	Predicted Active Bar area with shallow scour (>1D84) by peak flow, D84 Shields parameter>0.025 (sq ft)	Percent of total Active Bar area scoured by peak flow	Predicted Active Bar area with deeper scour (>2D84) by peak flow, D84 Shields parameter>0.030 (sq ft)	Percent of total Active Bar area scoured by peak flow
33,480	6,000 cfs	16,229	48.5%	5,828	17.4%	3,297	9.8%
33,480	8,500 cfs	20,169	60.2%	9,090	27.2%	5,617	16.8%

- Model predicts bed mobility objective are partially met during Normal year release (6,000 cfs) and shallow bed scour objective not met for Wet year (8,500 cfs) release
- Portion of bar area mobilized increases by 24% between 6,000 and 8,500 cfs
- Portion of bar area with shallow scour increases by 56% between 6,000 and 8,500 cfs
- Portion of bar area with deeper scour increases by 70% between 6,000 and 8,500 cfs
- Critical Shields parameter values used needs further review/calibration/discussion

Bed Scour and Mobility Model

- How outputs fit in DSS
  - Summaries performed, if any Example done for 3-mile reach, could easily be done for 40 miles
  - Description of output metrics and where they fit in DSS Would allow predictions of bed mobility and scour for a variety of flows, could compare to empirical model and monitoring results
- Model logistics
  - Who runs the model? Individual practitioners
  - How long is required to analyze and compare management alternatives? A day or two
- Model development and application
  - Is the model complete? If not, when? Is can be complete soon, but would need to agree on assumptions/parameters
  - Are there any roadblocks that keep it from being done? Not really, just need collaboration