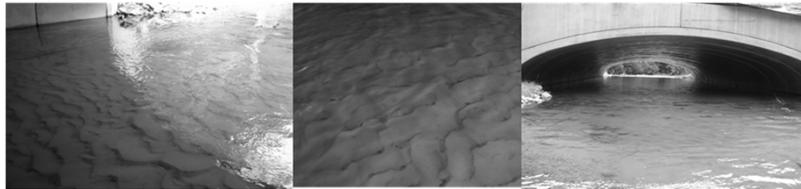


Some low gradient bed and bank design options

- BFW, tailwater control, no structure
- A few structural elements
- Rock bars for thalweg development
- Rock banks and bars

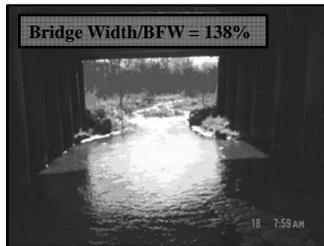
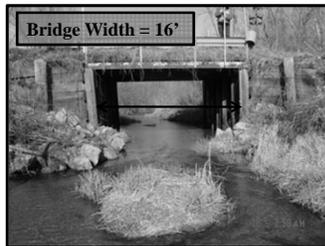
Can structures be too wide?

- Maybe - in sand bed streams with low flows
- Without structure to create banks or a thalweg
- Sand spreads out to create a flat, uniform bed
- Shallow water may impede passage of some sp.



Example of an open-bottom arch from Michigan.

Can structures be too wide?



Example of bridge on Spring Cr near Durango in SW WI.

BFW, tailwater control, no structure

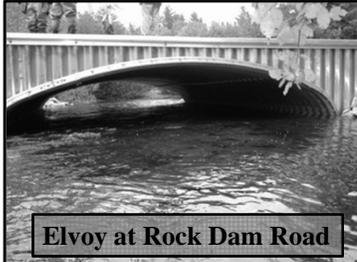




Brule at FR 2193



Simpson at FR 2386



Elvoy at Rock Dam Road

Drainage Area = 10.6 sq mi
BFW Est (E Reg) = 16.5'
Min BFW Graph = 12'

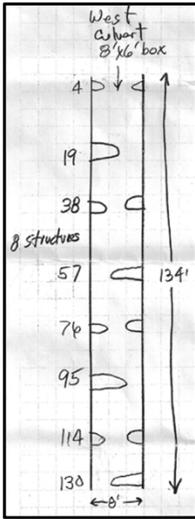
Rock bars for thalweg development NB Oconto W Trib at Hwy 64

- Culvert width = 8.0 ft
- BFW = 8 ft (ave)
- Culvert width/BFW = 100%
- Culvert length = 135 ft
- CL/BFW = 16.9

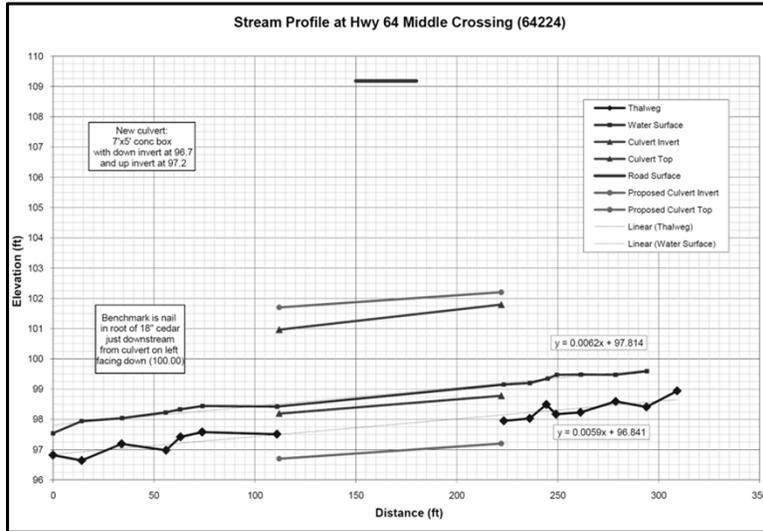
- 1 wavelength = 8'x10=80 ft
- 5 bars/wavelength
- Bar spacing=80/5=16 ft
- Total bars=135/16=8 bars
- Bar spacing adjusted slightly to fit culvert







Rock bars for thalweg development NB Oconto Middle Trib at Hwy 64



Rock banks and bars Torpee Cr at Hwy 32

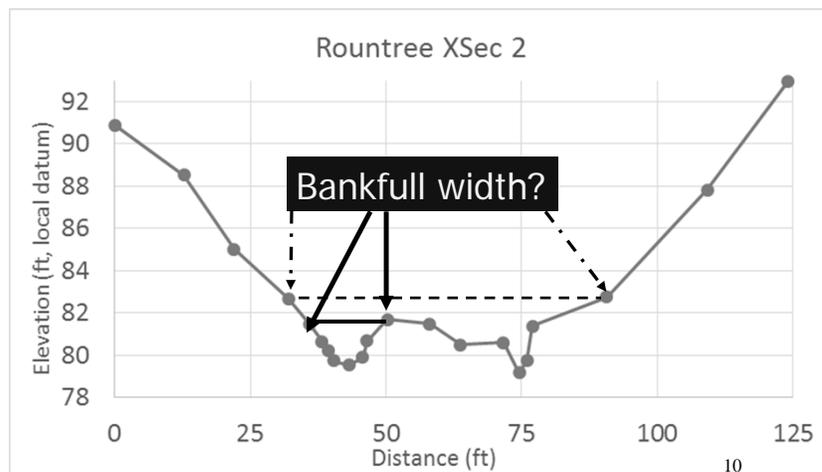


Bed design objectives

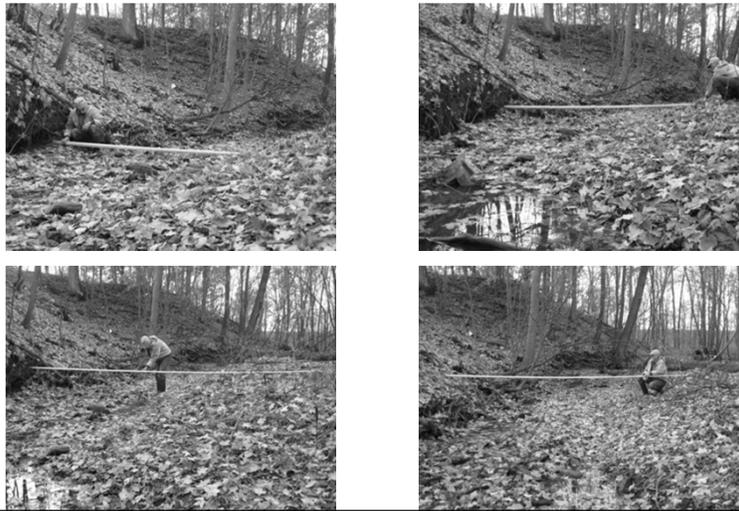
- Simulate natural bed
 - shape
 - diversity
 - roughness
 - mobility
 - permeability



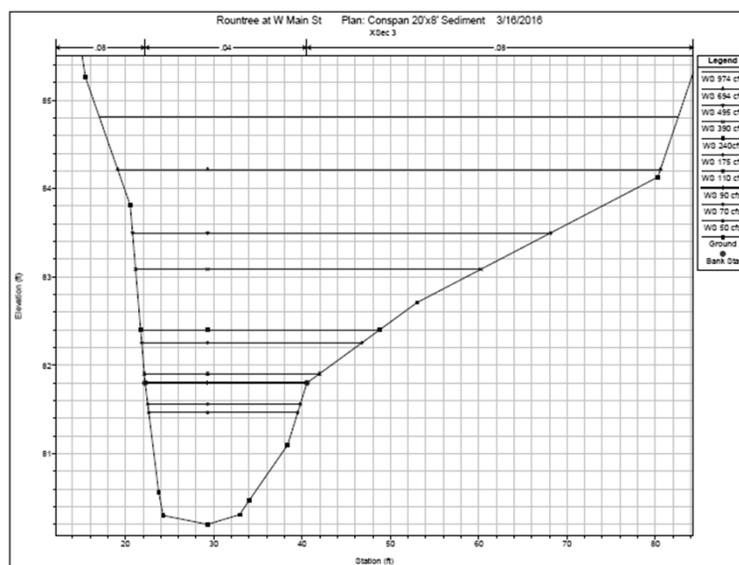
Bed shape

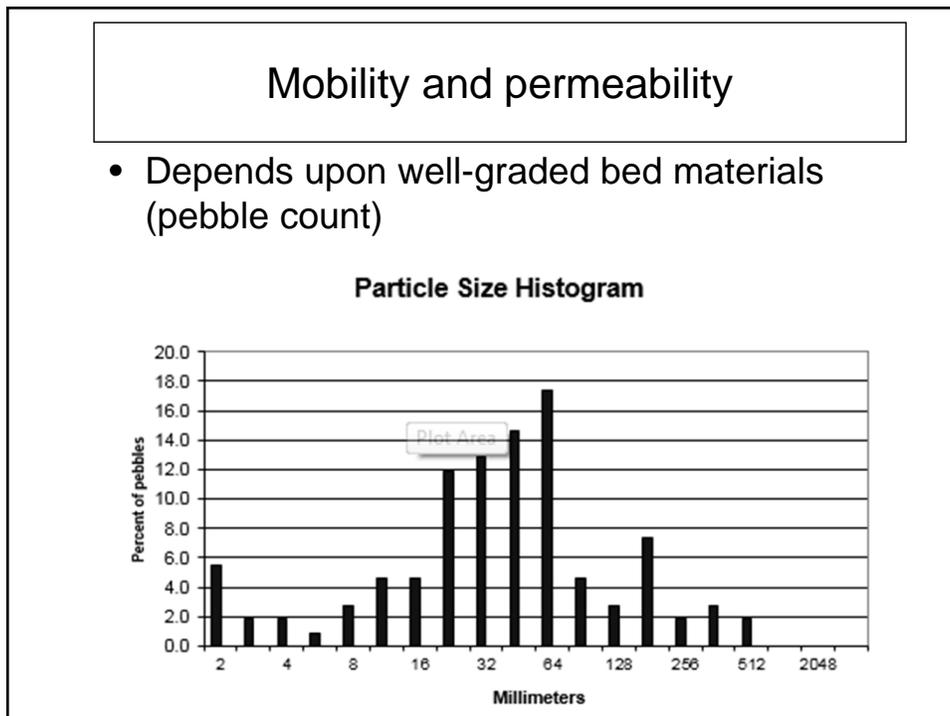
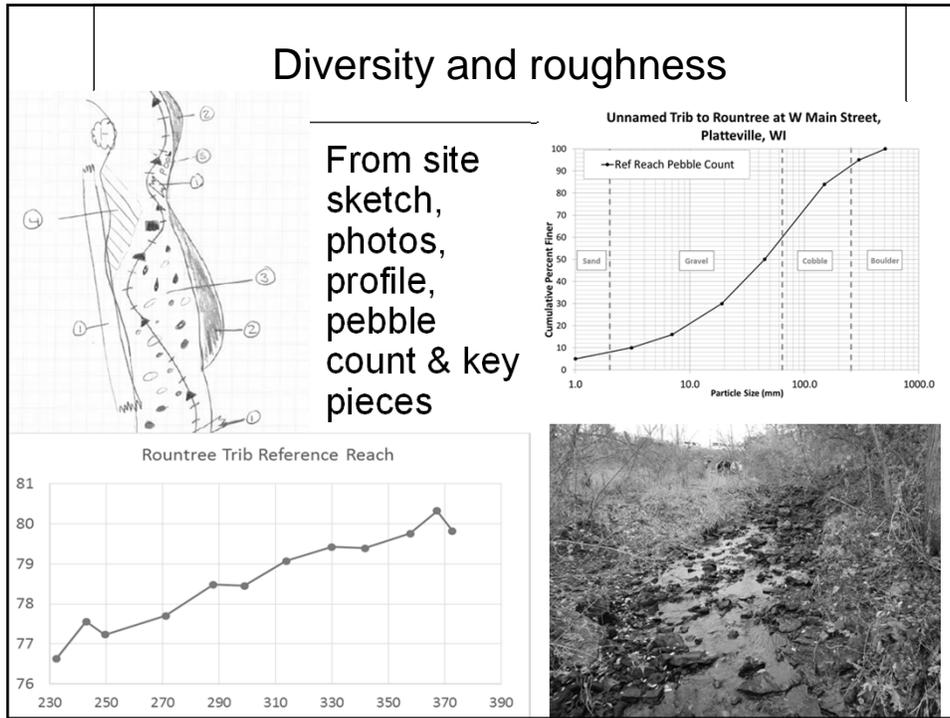


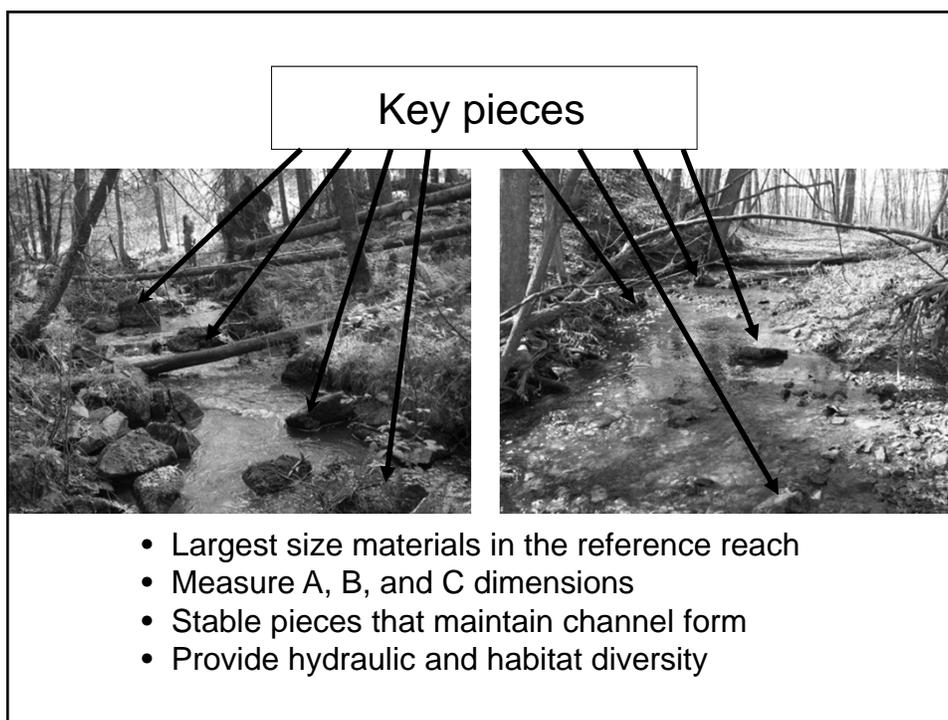
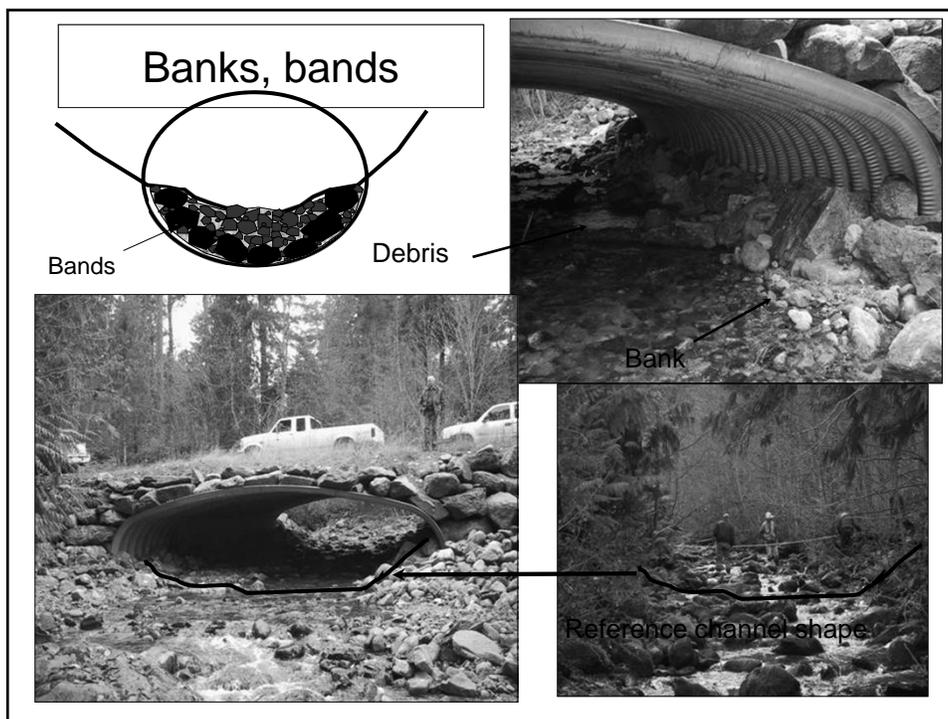
Bankfull?



HEC-RAS output

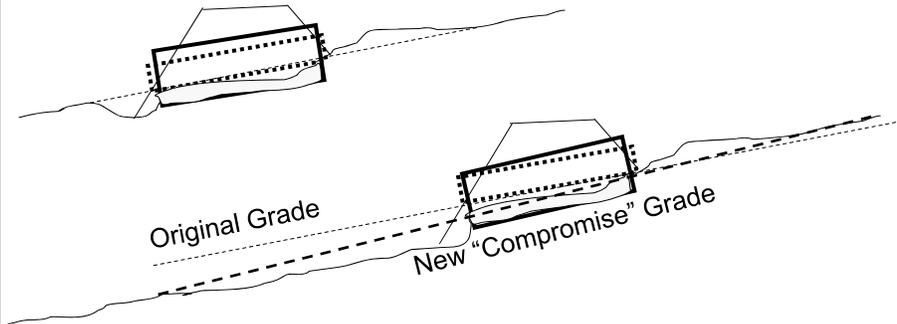






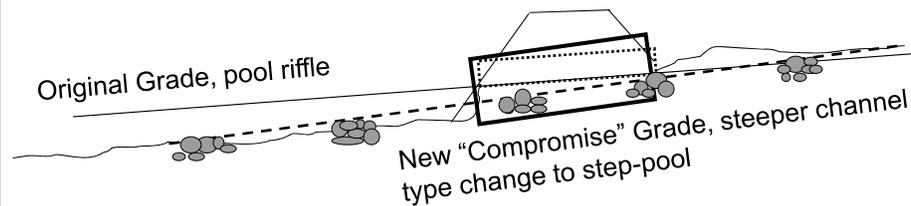
Profile control options

Move aggraded material to fill scoured area, then armor both surfaces.

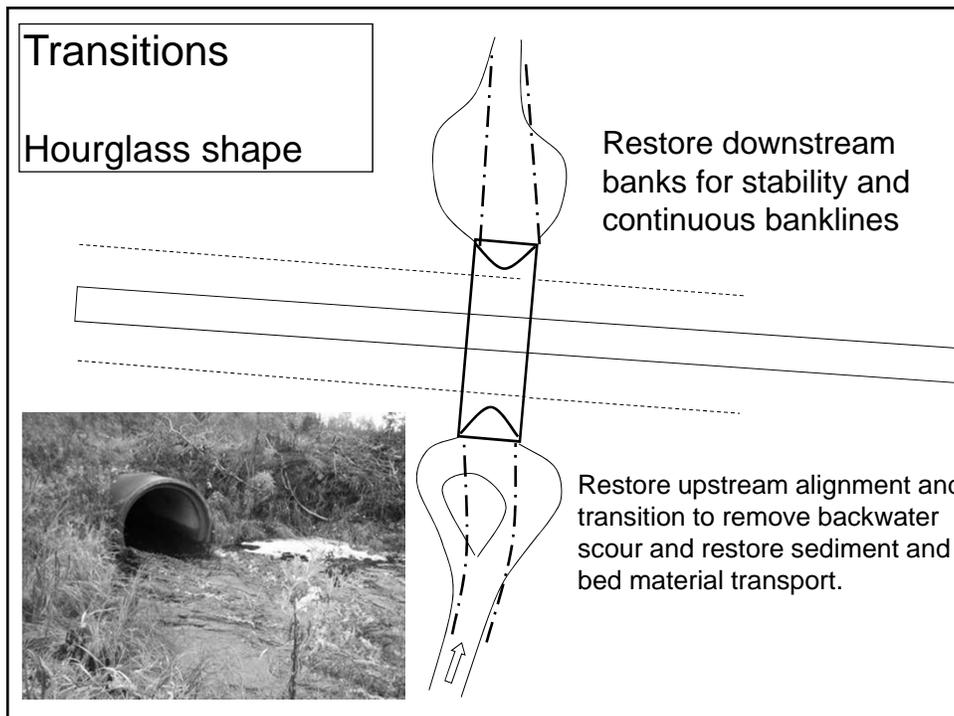
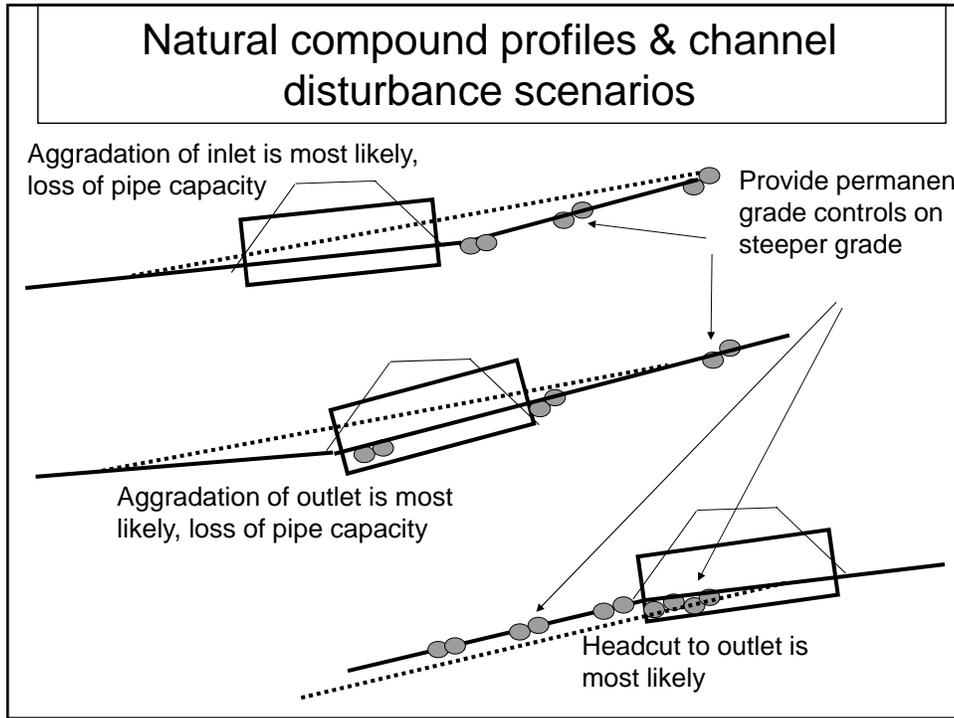


- For an insiced channel, a steeper connecting channel can be used
- A stability analysis is required

Profile control options grade controls – rock bands



- Riffle or riffle/step structures
- Constructed with a band of primarily larger (D84-D100) size unsorted rocks.
- They help form channel cross-section and profile shape.



Tie channel edges to stream



Bed material design

Use reference reach gradation

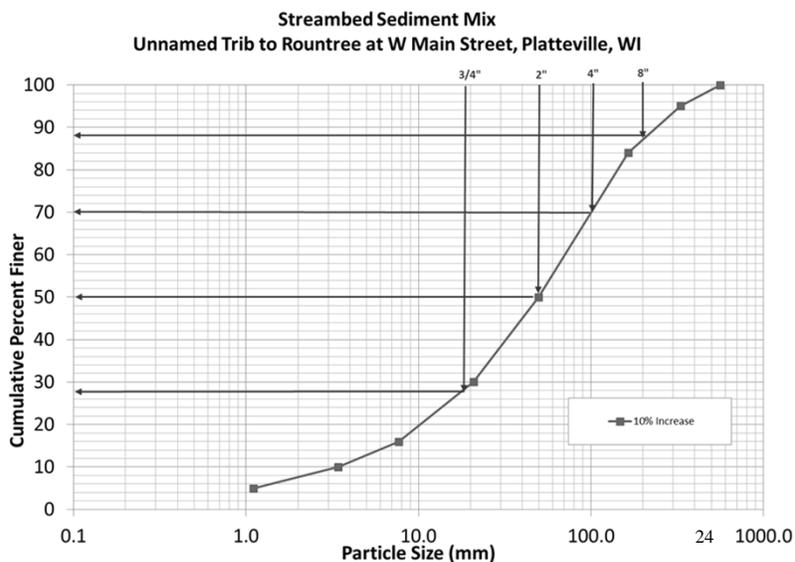
- Pebble count of reference channel for D_{100} , D_{84} and D_{50}
- Account for large roughness features
- Make sure you have at least 5% fine materials
- Can use Fuller-Thompson equations to adjust fine portion of the bed mix (see Stream Sim. Manual)



Pebble count interpretation exercise

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Rountree Trib. pebble-count



Bed material example

Trout Creek

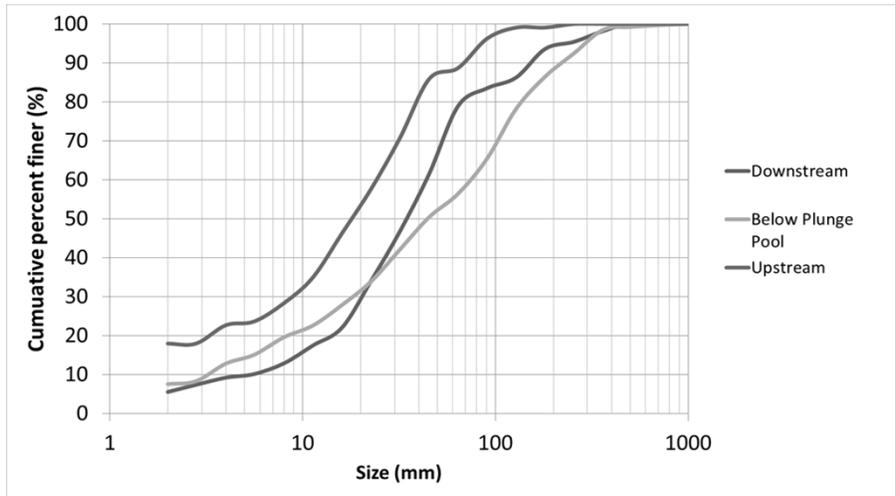
Size class	Reference (in)
D100	22
D84	6.5
D50	2.0
D16	0.3
D5	sand



Bed mix composition

% Composition	Nominal Category
7	Boulder (8-20 in)
17	Large Cobble (4-8 in)
20	Sm. Cobble (2-4 in)
22	Gravel (3/4-2 in)
28	Sand and finer (<3/4 in)

Rountree Trib. pebble count



Bed material examples

- Walk-behind Bobcat to install materials
- Fan for air quality in confined space
- Sheet piling to divert water



Example, continued



Substrate volume exercise