4. Fluvial Processes and Channel Characteristics Important in Stream Simulation Design

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Acknowledgements

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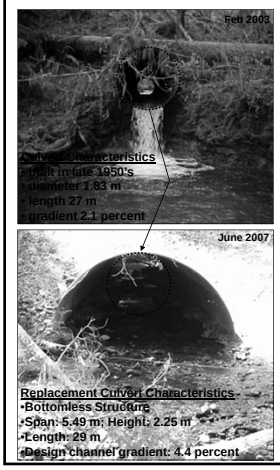


Presentation Objectives

- **A better understanding and appreciation of channel features, fluvial processes, and channel dynamics at a road-stream crossing.**
- **Understand the importance of integrating fluvial geomorphology with engineering principles to design a road-stream crossing that contains a natural and dynamic channel through the structure.**

Presentation Outline

- **Watershed Context**
- **Discharge and Channel Characteristics**
- **Channel Characteristics and Fluvial Processes**
  - **Channel slope**
  - **Channel cross section**
  - **Channel planform and bank patterns**
  - **Channel slope, shape, and planform**
  - **Channel bedforms**
  - **Channel-bed material**
  - **Flow hydraulics and sediment transport**
- **Predicting Channel Adjustments/Responses and Evaluating Potential Site Risk**

Linkages between Landscape Controls, Watershed Processes, and Channel Processes

Landscape Controls

-Geology -Climate

Watershed Processes/Characteristics

-runoff volume
-basin gradient
-drainage density
-large woody debris
-sediment supply
-basin shape
-vegetation types/density
-organic matter

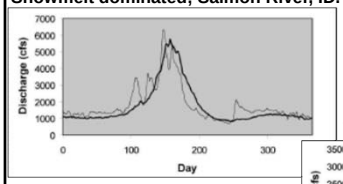
Land Use

Channel Processes/Characteristics

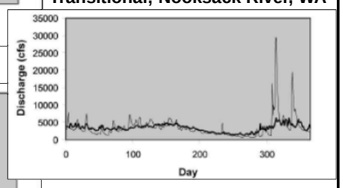
-Q magnitude, duration, frequency
-sediment transport and deposition
-channel gradient
-channel form (width and depth)
-channel-bed composition and bedforms

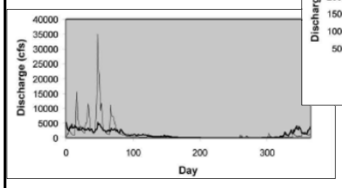
Influence of Climate on Flow Regimes

Snowmelt dominated; Salmon River, ID.



Transitional; Nooksack River, WA

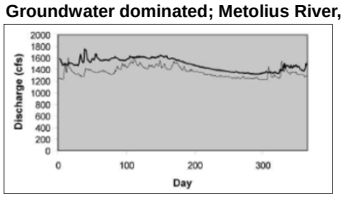




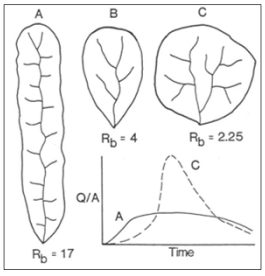
Rainfall dominated; Mattole River, CA. (From Skidmore et al., 2009)

Influence of Geology on Flow Regimes

Groundwater dominated; Metolius River, OR.

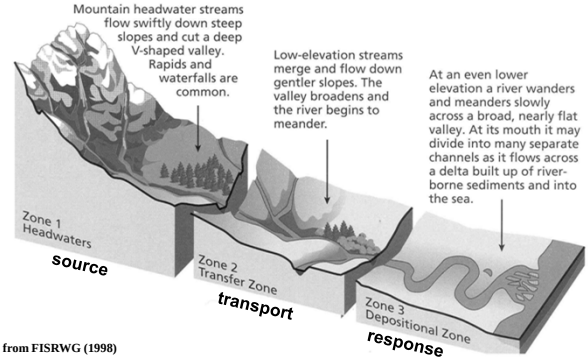


(From Skidmore et al., 2009)

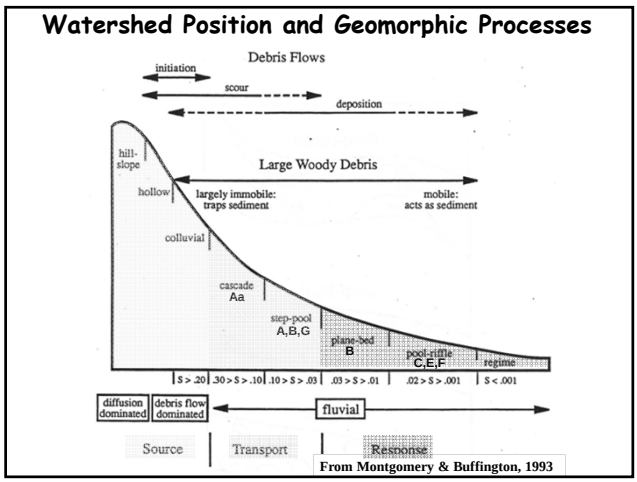


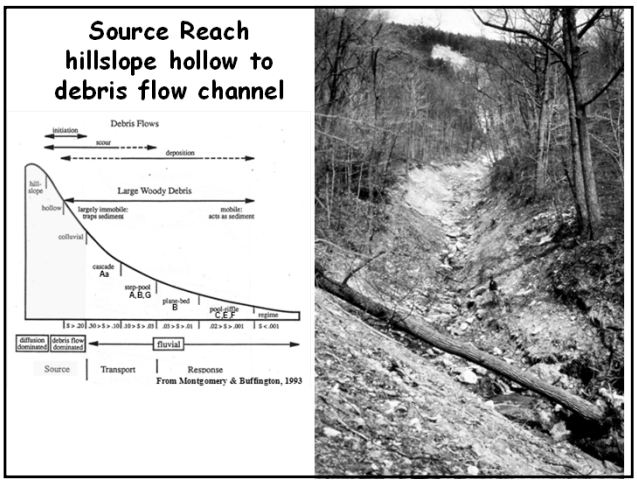
The timing, magnitude, and duration of peak discharge is influenced by drainage shape

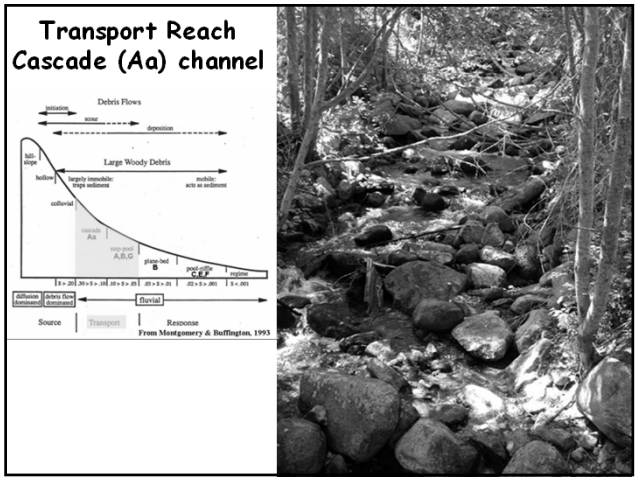
Channel Position in Watershed

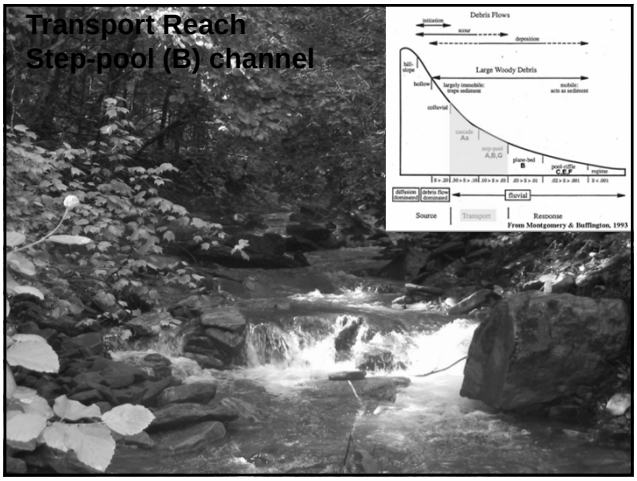


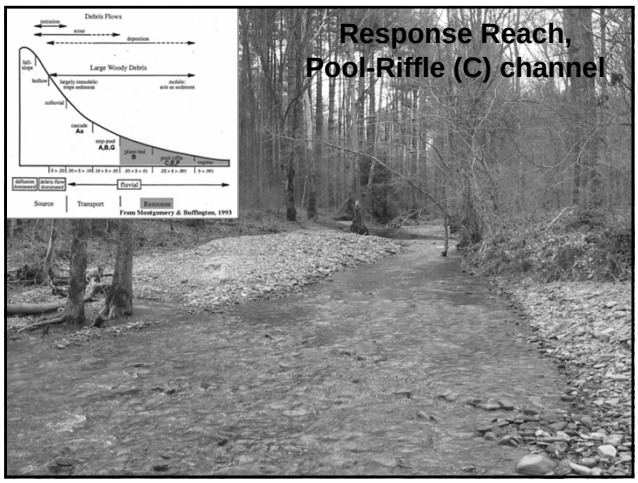
from FISRWG (1998)


Watershed Position and Geomorphic Processes
Debris Flows
initiation
scour
deposition
hill-slope
Large Woody Debris
hollow
largely immobile: traps sediment
mobile: acts as sediment
colluvial
cascade Aa
step-pool A,B,G
plane-bed B
pool-riffle C,E,F
regime
S > .20
.30 > S > .10
.10 > S > .03
.03 > S > .01
.02 > S > .001
S < .001
diffusion dominated
debris flow dominated
fluvial
Source
Transport
Response
From Montgomery & Buffington, 1993


Source Reach
hillslope hollow to
debris flow channel
Source
Transport
Response
From Montgomery & Buffington, 1993


Transport Reach
Cascade (Aa) channel
From Montgomery & Buffington, 1993


Transport Reach
Step-pool (B) channel



Watershed-Scale Processes

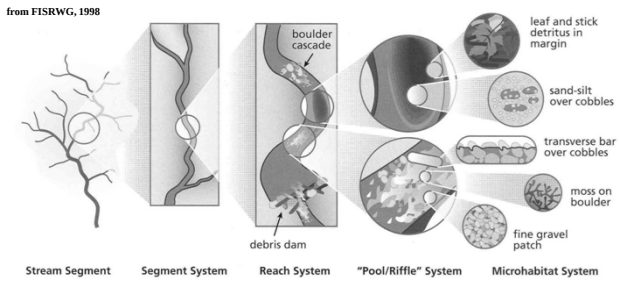
Watershed-Scale Processes

- Floods
- Fire
- Landslides/Debris Flows
- Debris Torrents
- Wind Throw
- Drought
- Anthropogenic Activities/ Impacts

What it means to the crossing design

- Water Transport
- Sediment Transport
- Wood Transport
- Organism Passage

Spatial Scale of Stream Channels



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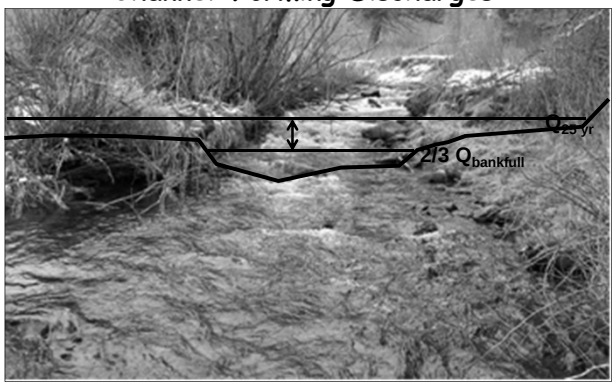
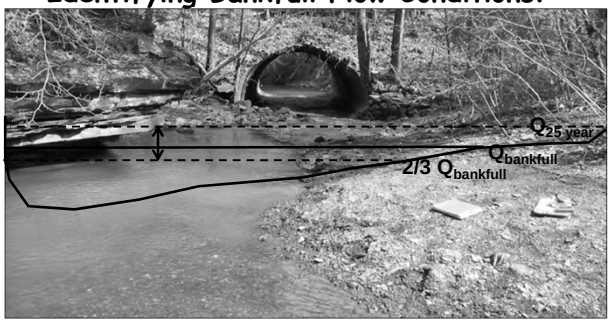
Channel-Forming Discharges



A range of flows (2/3 bankfull to the 25-year flood) are most influential in forming and maintaining the channel

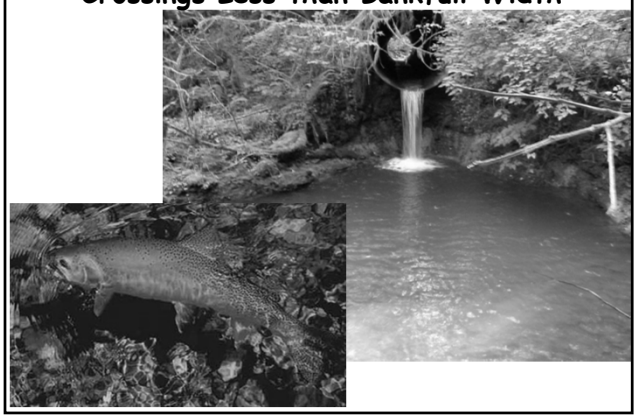
What is the Purpose/Significance of Identifying Bankfull Flow Conditions?



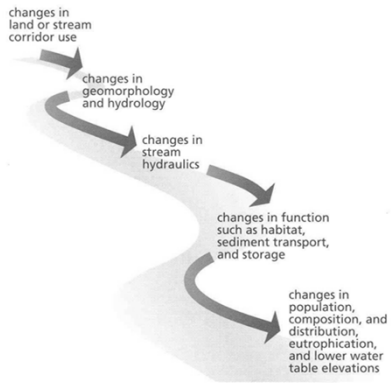
- **Index of range of flows that shape the channel/floodplain**
- **Transports more sediment over time than other discharges**
- **Typically occurs on average every 1 – 3 years**

Physical Effects of Road-Stream Crossings Less than Bankfull Width

Physical/Biological Effects of Road-Stream Crossings Less than Bankfull Width



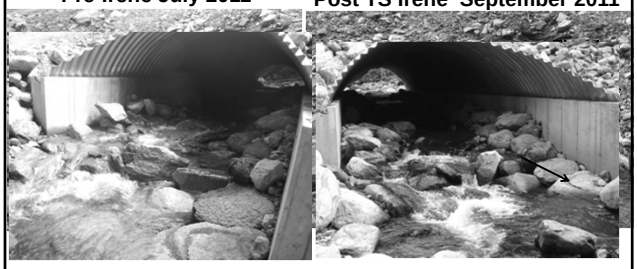
Channel Changes in Response to Undersized Culverts



from FISRWG, 1998

Properly Designed Structures Sized to Bankfull Flow Width or Greater

Pre-Irene July 2011 | Post TS Irene September 2011



- Long-term ecological /geomorphic continuity
- Minimal or no maintenance costs over life of structure
- Flood resiliency

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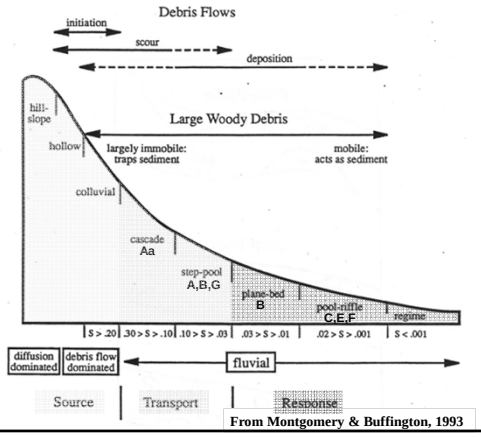
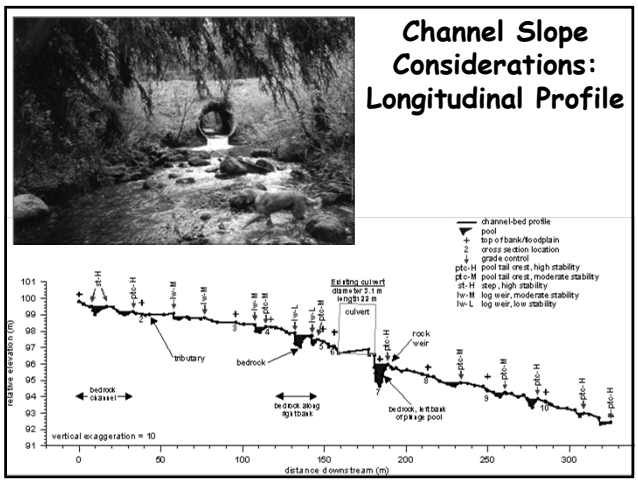
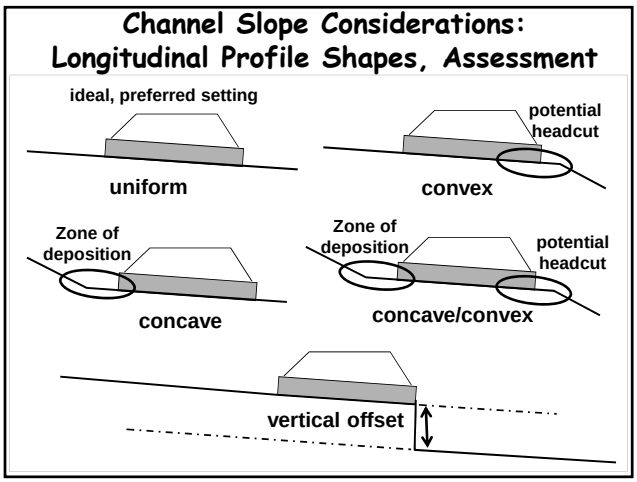
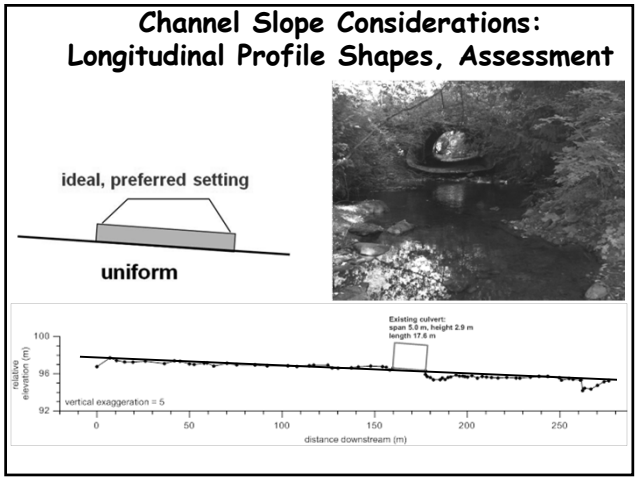
Channel Slope Considerations: Geomorphic Processes

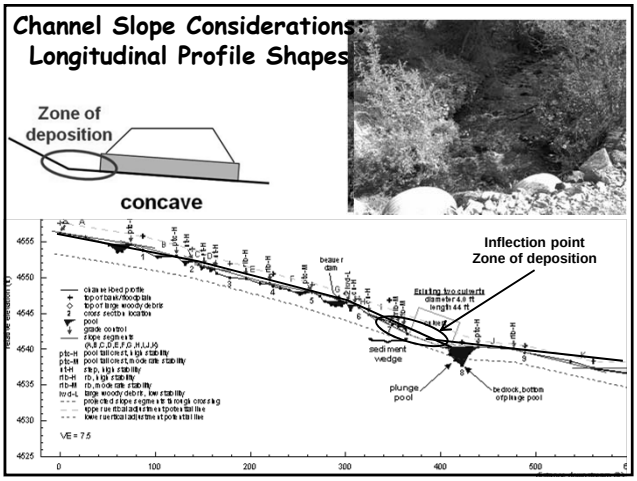


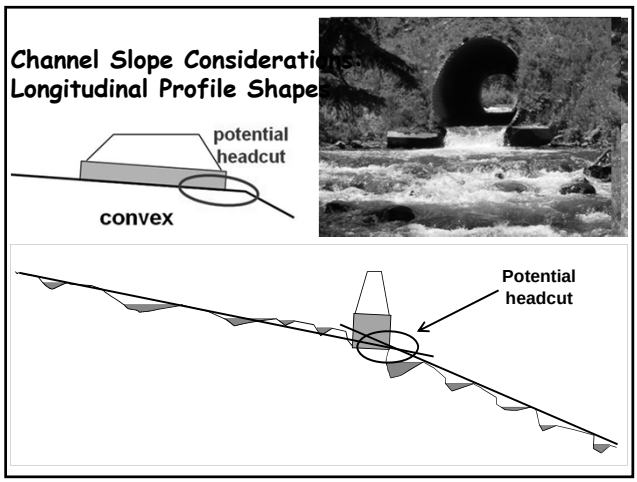
From Montgomery & Buffington, 1993

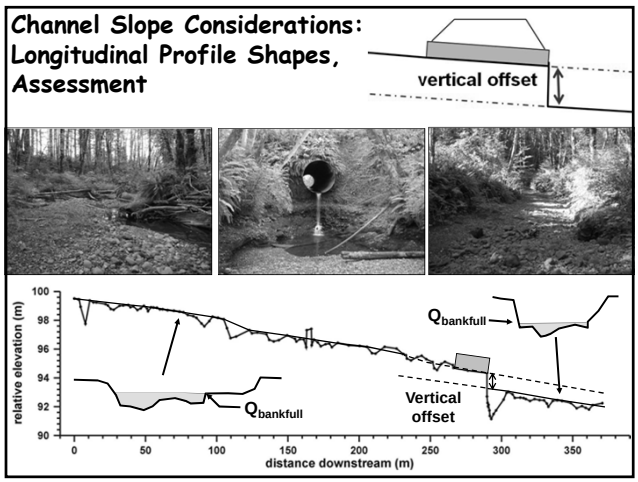

Channel Slope Considerations: Longitudinal Profile
channel-bed profile
pool
top of bank/floodplain
cross section location
grade control
pool tail crest, high stability
pool tail crest, moderate stability
step, high stability
log weir, moderate stability
log weir, low stability
Existing culvert
diameter 3.1 m
length 22 m
culvert
rock weir
tributary
bedrock
bedrock channel
bedrock along right bank
bedrock, left bank of plunge pool
vertical exaggeration = 10
relative elevation (m)
distance downstream (m)

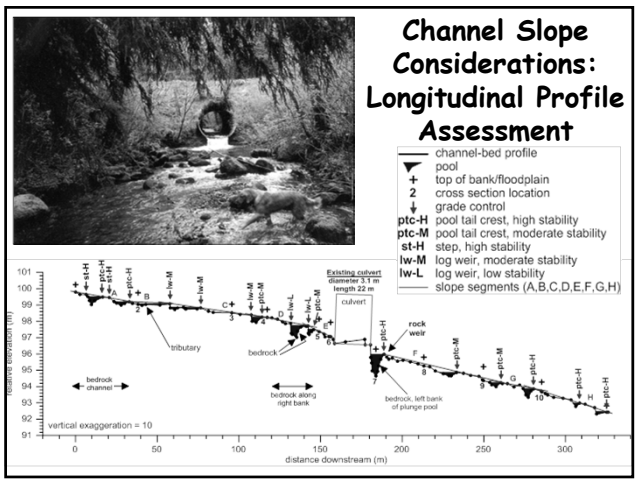

Channel Slope Considerations: Longitudinal Profile Shapes, Assessment
ideal, preferred setting
uniform
potential headcut
convex
Zone of deposition
concave
Zone of deposition
potential headcut
concave/convex
vertical offset

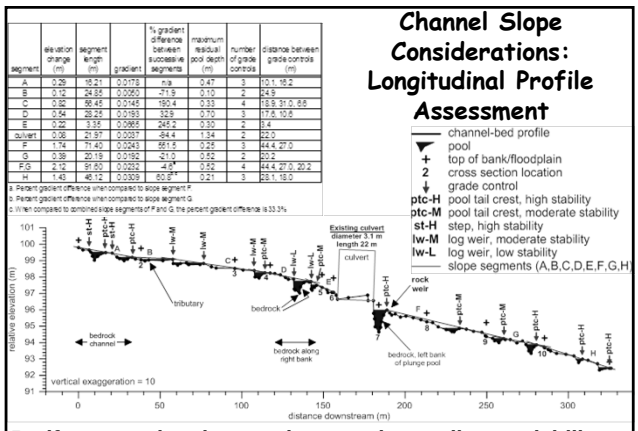

Channel Slope Considerations: Longitudinal Profile Shapes, Assessment
ideal, preferred setting
uniform
Existing culvert:
span 5.8 m, height 2.9 m
length 17.6 m
vertical exaggeration = 5
relative elevation (m)
distance downstream (m)


Channel Slope Considerations: Longitudinal Profile Shapes
Zone of deposition
concave
Inflection point
Zone of deposition
beaver dam
Existing two culverts
diameter 4.6 ft
length 44 ft
sediment wedge
plunge pool
bedrock, bottom of plunge pool
VE = 7.5







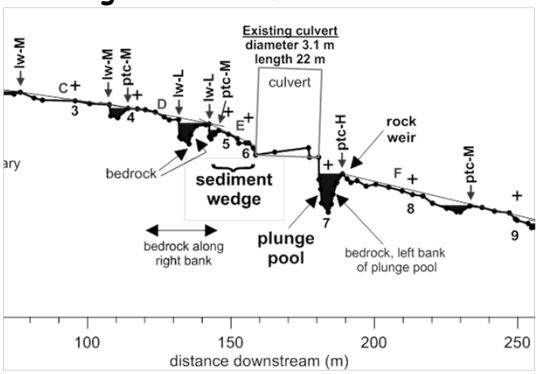


segment	elevation change (m)	segment length (m)	gradient	% gradient difference between successive segments	maximum residual pool depth (m)	number of grade controls	distance between grade controls (m)
A	0.29	16.21	0.0178	n/a	0.47	3	10.1, 16.2
B	0.12	24.85	0.0050	-71.9	0.10	2	24.9
C	0.92	56.45	0.0145	190.4	0.33	4	13.9, 31.0, 6.6
D	0.54	28.25	0.0193	32.9	0.70	3	17.6, 10.6
E	0.22	3.55	0.0665	245.2	0.30	2	3.4
culvert	0.06	21.97	0.0027	-84.4	1.34	2	22.0
F	1.74	71.40	0.0243	661.5	0.25	3	44.4, 27.0
G	0.38	20.19	0.0192	-21.0	0.52	2	20.2
F/G	2.12	91.60	0.0232	-4.6[a]	0.52	4	44.4, 27.0, 20.2
H	1.43	46.12	0.0309	60.8[b]	0.21	3	28.1, 18.0

a. Percent gradient difference when compared to slope segment F
b. Percent gradient difference when compared to slope segment G
c. When compared to combined slope segments of F and G, the percent gradient difference is 33.3%

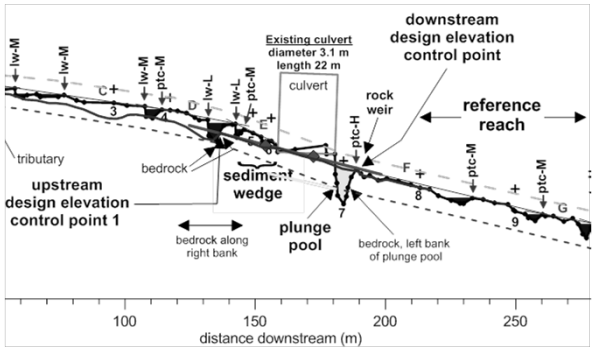
Bedform spacing, key grade controls, gradient variability, range of scour depths

Channel Slope Considerations: Longitudinal Profile Assessment



Local degradation and aggradation

Channel Slope Considerations: Longitudinal Profile, Design



The longitudinal profile is used to develop the design channel profile and spacing of bedforms through the structure.

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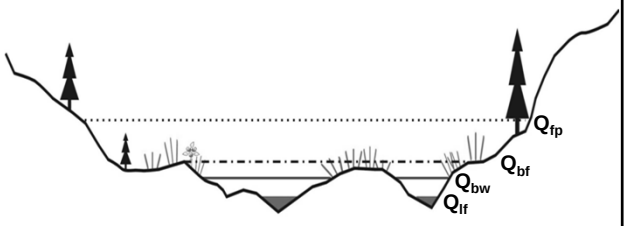
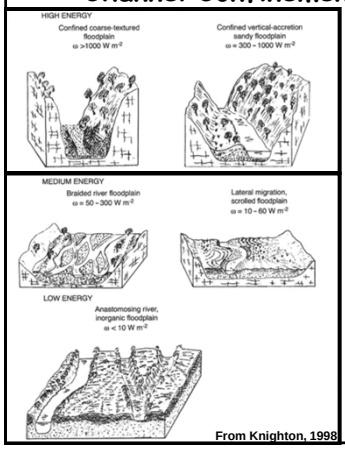
Channel Shape Considerations



- **Establishes the natural dimensions of the channel**
- **Delineates the width and depth of low flow, the streambed, bankfull flow, floodplain inundation, and channel/slope interactions**

Channel Confinement Considerations

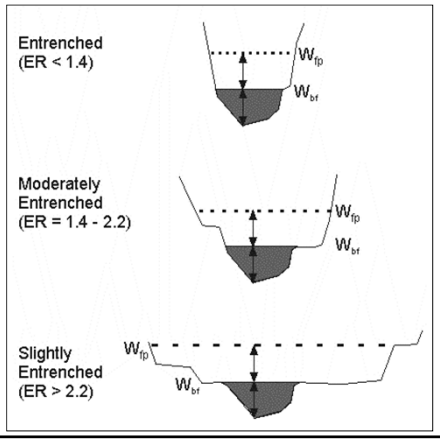


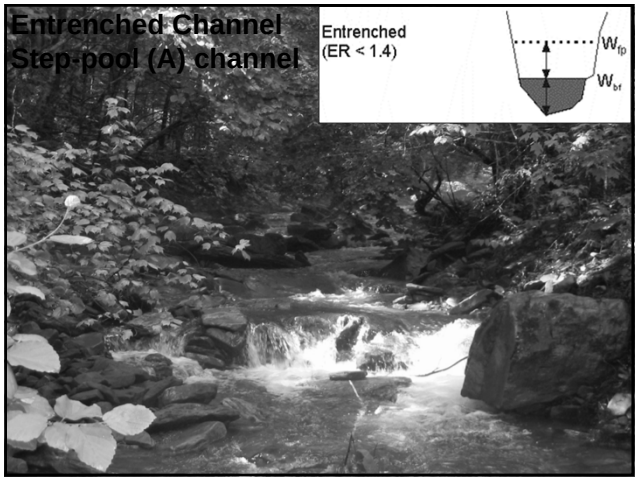
From Knighton, 1998

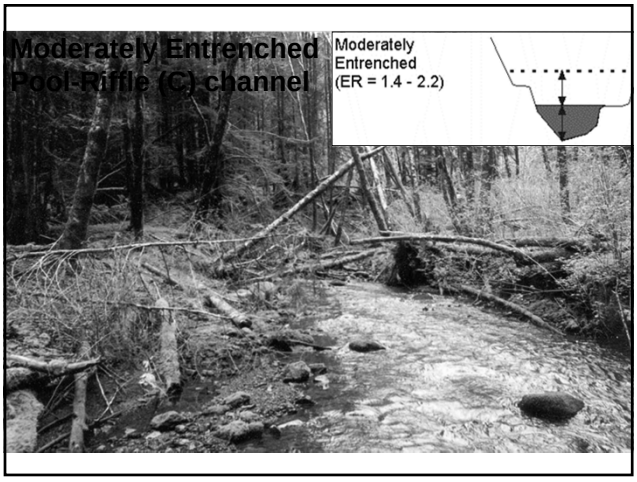
Confined channels
- High energy
- Straight, high gradient channels
- minimal floodplain development
- Channel migration low
- Slope/channel interactions high

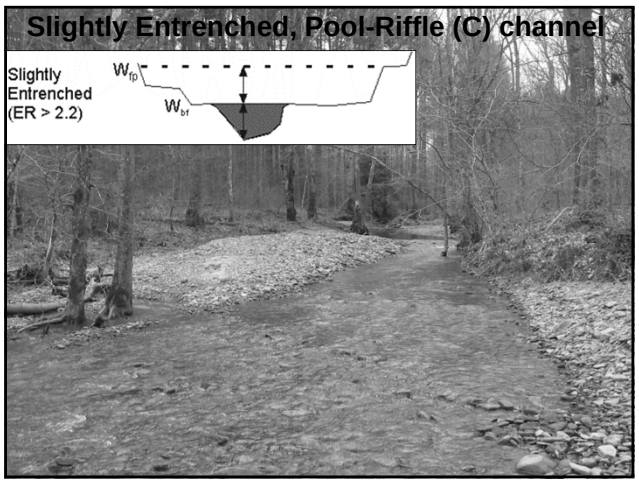
Unconfined channels
- low energy
- Sinuous, low-gradient channels
- Well-developed floodplain
- Channel migration high
- Slope/channel interactions low

Channel Entrenchment Considerations









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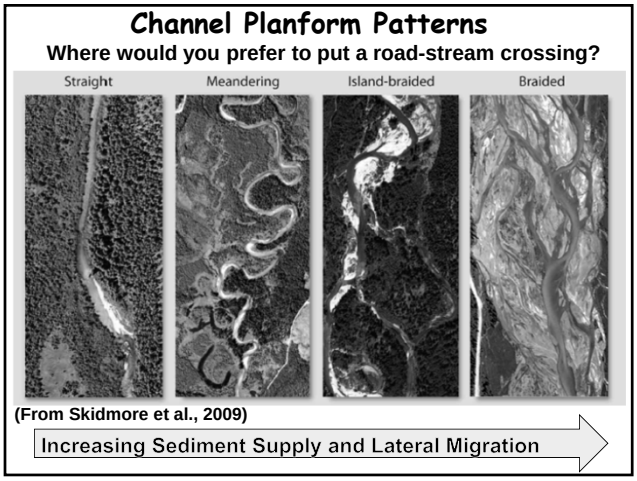
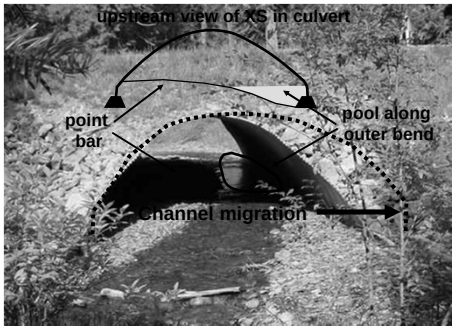


Channel Planform Considerations

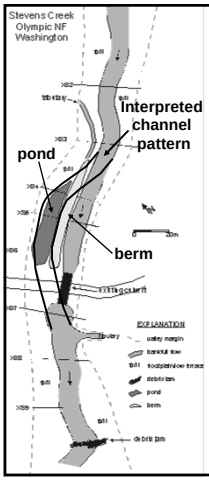
- If possible, locate crossings on straight channel segments
- Accept small skews in channel-road alignment and reinforce banks if necessary
- Interpret and predict the natural planform pattern at the crossing
- May need to perform channel restoration to recreate natural geometries

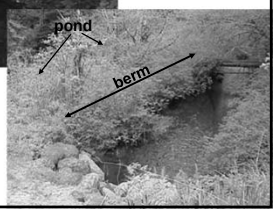
Channel Planform Considerations

Channel Planform Considerations



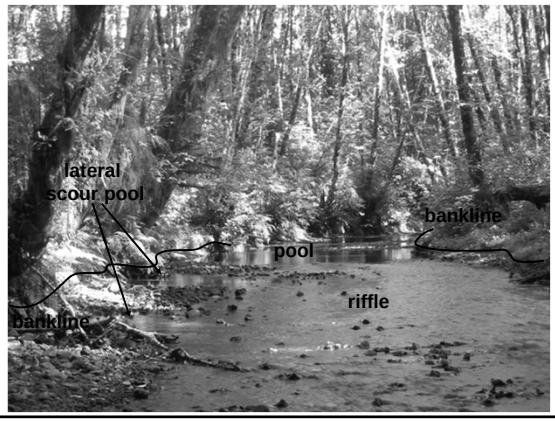
Channel Planform Considerations





Channel-Bank Patterns

Channel-Bank Patterns



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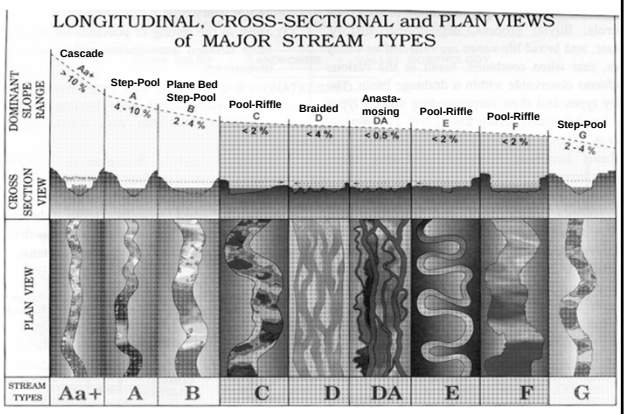
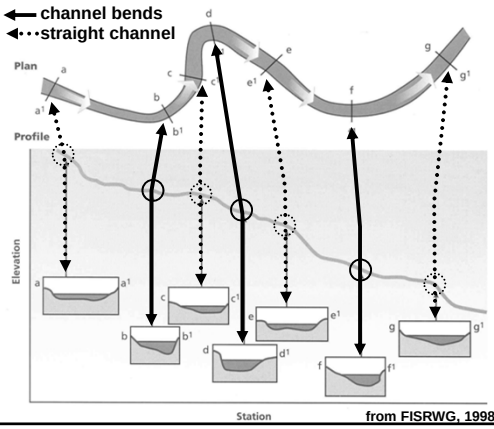
- **Predicting Channel Adjustments/Responses and Evaluating Potential Site Risk**

Channel Slope, Shape, and Planform



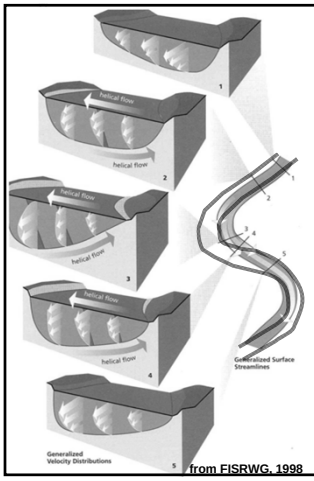
From Rosgen 1996

Channel Slope, Shape, and Planform



from FISRWG, 1998

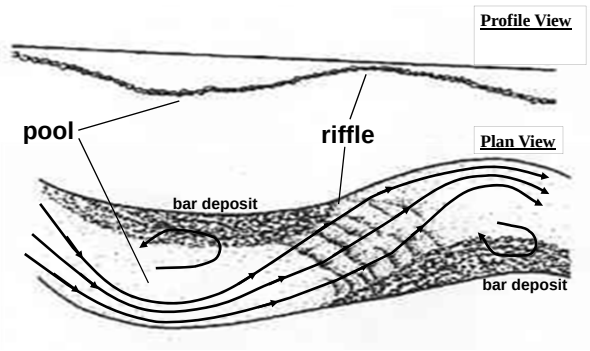
Channel Slope, Shape, and Planform



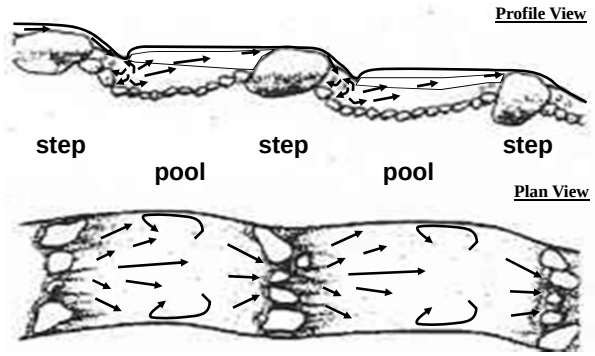
- **Fluvial processes in meandering, pool-riffle channels**

from FISRWG, 1998

Pool-Riffle Channel Flow Patterns and Energy Dissipation



Step-Pool Channel Flow Patterns and Energy Dissipation



Presentation Outline

- **Watershed Context**
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  - **Channel slope**
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  - **Channel slope, shape, and planform**
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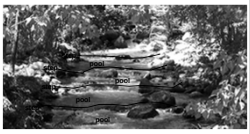
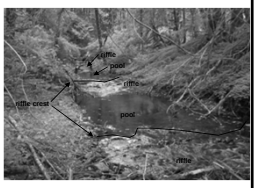
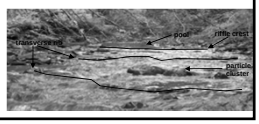
  - **Channel-bed material**
  - **Flow hydraulics and sediment transport**
- **Predicting Channel Adjustments/Responses and Evaluating Potential Site Risk**

Channel Bedforms Considerations

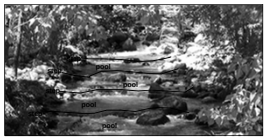
- **Are the bedforms significant along the longitudinal profile?**
- **Are the bedforms stable, permanent features or are they temporary features?**
- **Do the bedforms form step-pool or riffle-pool sequences along the channel?**
- **How do the bedforms affect channel roughness?**
- **Are the bedforms important for dissipating flow energy during floods?**

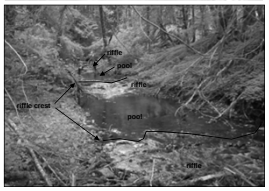


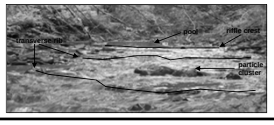




Channel Bedforms

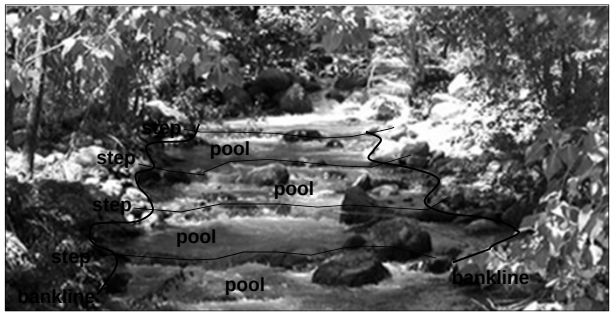




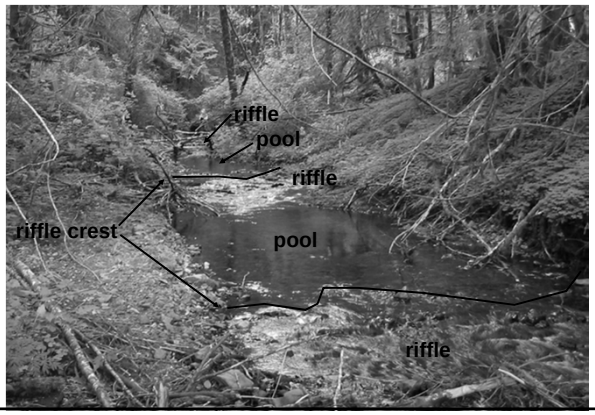


- **Steps and Pools**
- **Riffles and Pools**
- **Large Woody Debris**
- **Transverse Ribs**
- **Particle Clusters**
- **Gravel Bars**

Channel Bedforms: Steps and Pools



Channel Bedforms: Riffles and Pools



Channel Bedforms: Steep Riffles, Transverse Ribs, and Particle Clusters

Channel Bedforms: Large Woody Debris

Channel Bedforms: Gravel Bars, Riffles, Pools

Presentation Outline

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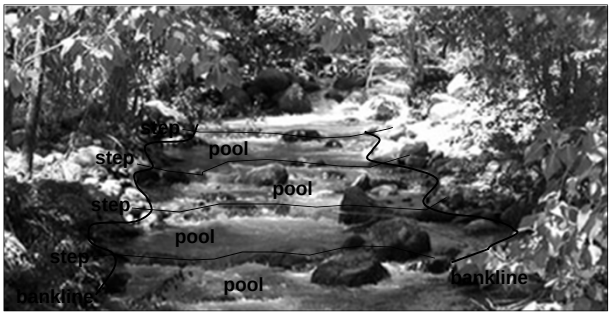
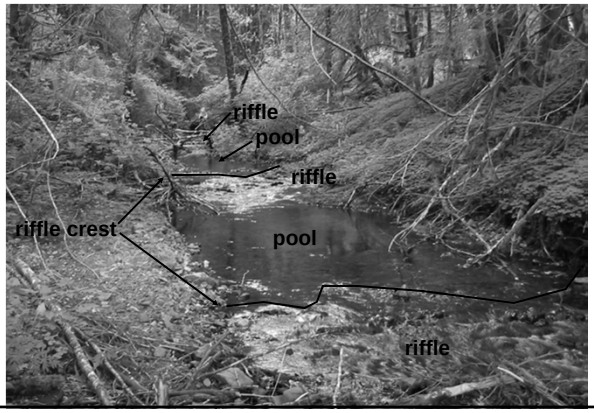
Channel-Bed Material Considerations

- **Does channel-bed substrate size vary spatially between and within channel units (i.e., pools versus steps, riffles versus pools, within riffles)?**
- **Is the channel-bed substrate well sorted or poorly sorted (uniformly or non-uniformly graded)?**
- **Does the channel-bed substrate vary vertically (i.e., surface layer versus the subsurface layer)?**

Channel-Bed Material: Steps and Pools



Channel-Bed Material: Riffles and Pools

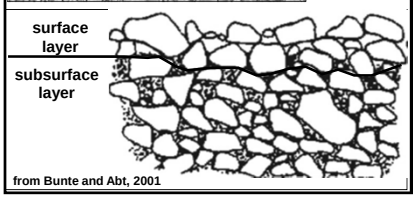


Channel-Bed Material: Transverse Ribs and Particle Clusters

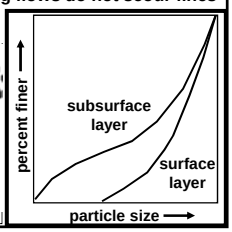
Channel-Bed Material: Vertical Variability

Surface layer
- Typically coarser than the subsurface layer because of the scour of fines between the larger particles

Subsurface layer
- Finer than the surface layer because fines are present in the voids between the larger particles
- Winnowing flows do not scour fines



from Bunte and Abt, 2001



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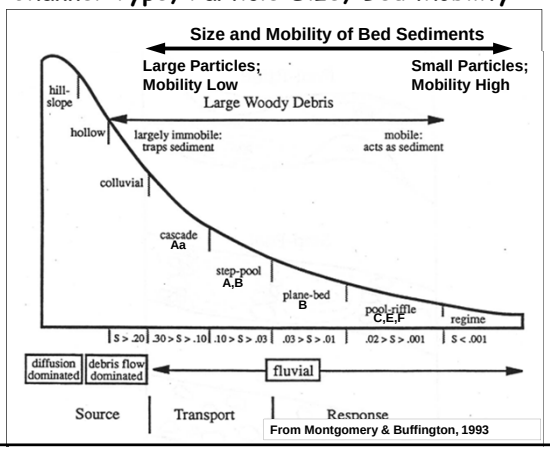
Flow Hydraulics and Sediment Transport

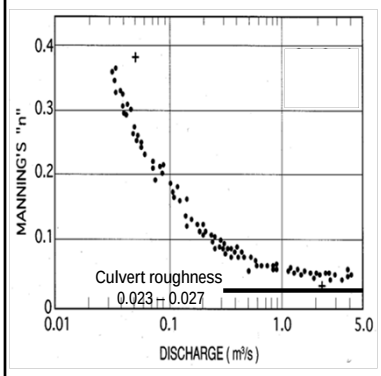
- Boundary Resistance
  - Particle roughness (particle size, sorting, etc.)
  - Vegetation roughness
- Channel Resistance
  - Slope variability
  - Bedform sequences
  - (step-pool, pool-riffle, etc.)
  - Bank irregularity
  - Channel alignment
- Free Surface Resistance
  - Surface waves
  - Hydraulic jumps

Channel Type, Particle Size, Bed Mobility

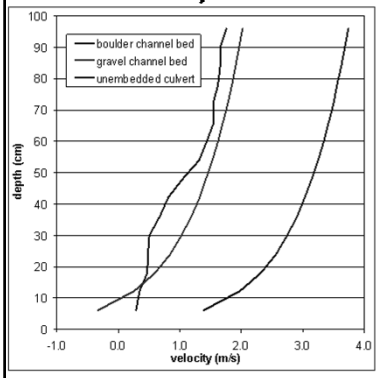


From Montgomery & Buffington, 1993

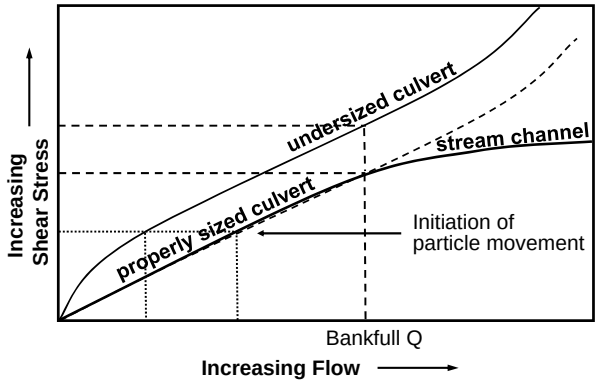
Flow Hydraulics and Sediment Transport: Channel Roughness versus Culvert Roughness



Flow Hydraulics and Sediment Transport: Velocity Profiles



Flow Hydraulics and Sediment Transport: Natural Channels and Culverts



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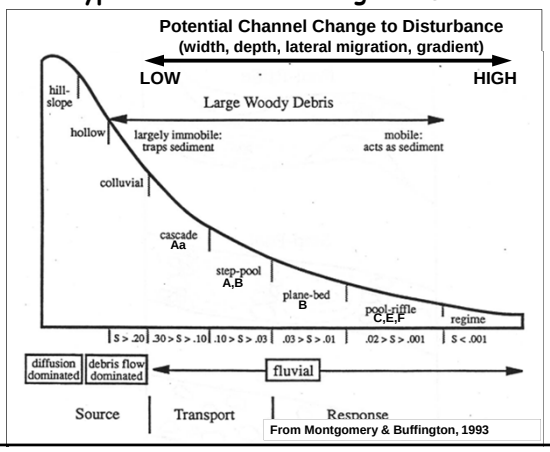
Channel Adjustments and Responses

- **Channels adjust their bedform configuration, width, depth, slope, and meander pattern in response to changes in discharge, sediment supply, and/or base level changes**
- **Channel adjustments occur in response to naturally occurring events such as floods, landslides, etc. or land-use activities such as logging/road building, mining, urbanization, dam building, etc.**
- **The rate of channel adjustment varies spatially and temporally along the channel in response to a disturbance; this reflects watershed- and local-scale differences in geomorphic setting, fluvial processes, channel characteristics, and past disturbances**

Channel Type and Potential Change to Disturbance

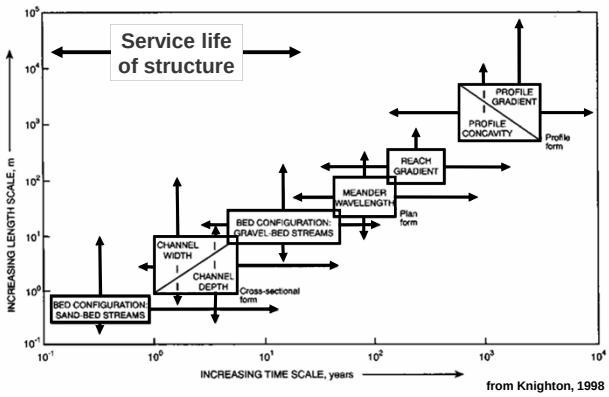


From Montgomery & Buffington, 1993

Relationship Between Channel Type, Bed Mobility, and Potential Changes to Disturbance

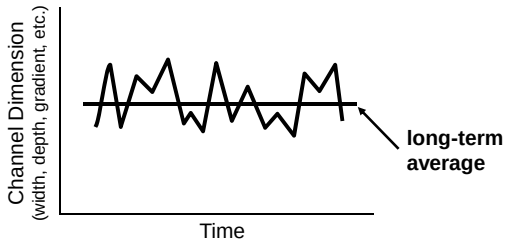
Size of Bed Sediment	Relative Mobility of Bed Material	Potential Channel Changes to Disturbance (width, depth, lateral migration, gradient)	Channel Type
Boulder Cobble	LOW	LOW	Rosgen A Cascade Step Pool
Gravel Cobble			Rosgen B C Plane Bed Pool Riffle
Sand	HIGH	HIGH	Rosgen C E Regime

Timescales of adjustment



from Knighton, 1998

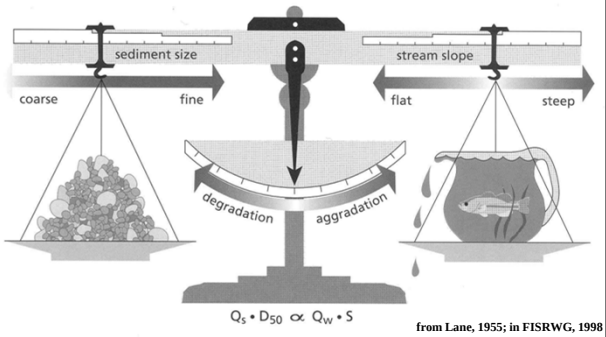
Understanding and Predicting Channel Responses/Adjustments



Dynamic, Stable Channels: Steady State Equilibrium

Channel Adjustments and Responses

Sediment (LOAD) X (SIZE) α **Stream (SLOPE) X (DISCHARGE)**



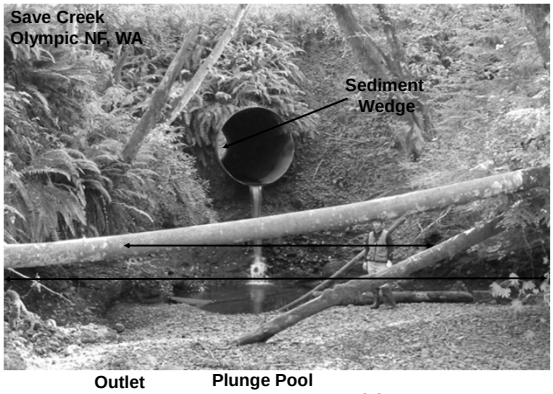
$Q_s \cdot D_{50} \propto Q_w \cdot S$

from Lane, 1955; in FISRWG, 1998

Channel Responses to an Undersized Culvert

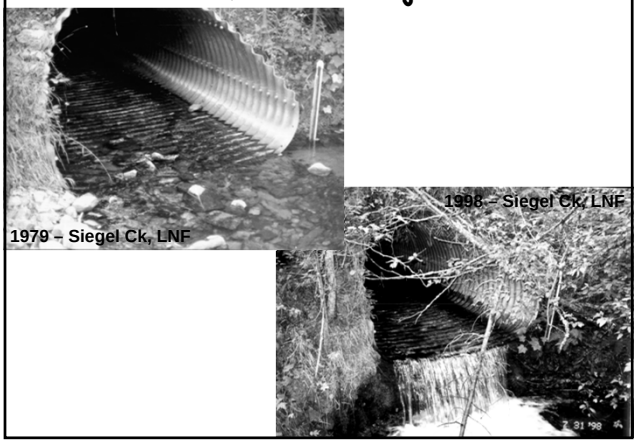
$$\text{Inlet Constriction Ratio} = \frac{\text{Culvert Span}}{\text{Bankfull Width}} = \frac{2.1\text{ m}}{9.7\text{ m}} = 0.22$$

Channel Responses to an Undersized Culvert

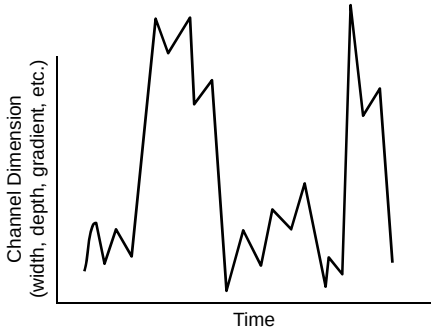


$$\text{Outlet Expansion Ratio} = \frac{\text{Plunge Pool Scour Width}}{\text{Bankfull Width}} = \frac{12.8\text{ m}}{9.7\text{ m}} = 1.3$$

Rate of Channel Adjustment



Recognizing Channel Instability and Disequilibrium

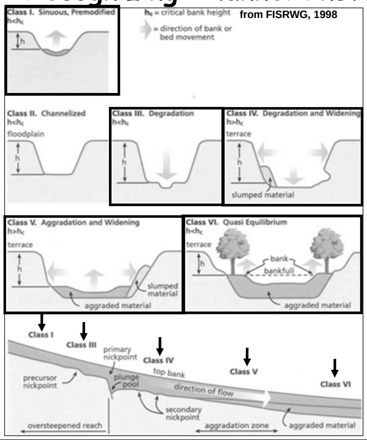


Unstable Channels: Disequilibrium

Recognizing Channel Instability

- **Important to recognize channel instability and disequilibrium**
- **Climate change, base-level changes, land-use practices, etc. can cause local and system-wide channel degradation and aggradation**

Recognizing Channel Instability



- Channel Evolution Model

Recognizing Channel Instability

- Channel Evolution Model

Class No.	Class Name	Dominant Processes: Fluvial	Dominant Processes: Hillslope	Characteristic Forms	Geobotanical Evidence
I	Premodified	Sediment transport - mild aggradation; basal erosion on outside bends; deposition on inside bends.		Stable, alternate channel bars; convex top-bank shape; flow line high relative to top bank; channel straight or meandering.	Vegetated banks to flow line.
II	Constructed			Trapezoidal cross section; linear bank surfaces; flow line lower relative to top bank.	Removal of vegetation.
III	Degradation	Degradation; basal erosion on banks.	Pop-out failures.	Heightening and steepening of banks; alternate bars eroded; flow line lower relative to top bank.	Riparian vegetation high relative to flow line and may lean toward channel.
IV	Threshold	Degradation; basal erosion on banks.	Slab, rotational and pop-out failures.	Large scallops and bank retreat; vertical face and upper-bank surfaces; failure blocks on upper bank; some reduction in bank angles; flow line very low relative to top bank.	Riparian vegetation high relative to flow line and may lean toward channel.
V	Aggradation	Aggradation; development of meandering thalweg; initial deposition of alternate bars; reworking of failed material on lower banks.	Slab, rotational and pop-out failures; low-angle slides of previously failed material.	Large scallops and bank retreat; vertical face, upper bank, and slough line; flattening of bank angles; flow line low relative to top bank; development of new floodplain.	Tilted and fallen riparian vegetation; reestablishing vegetation on slough line; deposition of material above root collars of slough line vegetation.
VI	Restabilization	Aggradation; further development of meandering thalweg; further deposition of alternate bars; reworking of failed material; some basal erosion on outside bends deposition of flood-plain and bank surfaces.	Low-angle slides; some pop-out failures near flow line.	Stable, alternate channel bars; convex-short vertical face on top bank; flattening of bank angles; development of new floodplain; flow line high relative to top bank.	Reestablishing vegetation extends up slough line and upper bank; deposition of material above root collars of slough-line and upper-bank vegetation; some vegetation establishing on bars.

from FISRWG, 1998

Recognizing Channel Instability

- Johnson et al. (1999)

TABLE 1. Stability Indicators, Descriptions, and Ratings

Stability indicator (1)	Ratings: Excellent (1–3) (2)	Good (4–6) (3)	Fair (7–9) (4)	Poor (10–12) (5)
1. Bank soil texture and coherence	Clay and silty clay; cohesive material	Clay loam to sandy clay loam	Sandy clay to sandy loam	Loamy sand to sand; noncohesive material
2. Average bank slope angle (Pfankuch 1978)	Bank slopes <3H:1V (18° or 33%) on both sides.	Bank slopes up to 2H:1V (27° or 50%) on one or occasionally both banks.	Bank slopes to 1.7H:1V (31° or 60%) common on one or both banks.	Bank slopes over 60% common on one or both banks.
3. Vegetative bank protection (Pfankuch 1978; Thorne et al. 1996)	Wide band of woody vegetation with at least 90% density and cover. Primarily hard wood, leafy, deciduous trees with mature, healthy, and diverse vegetation located on the bank. Woody vegetation oriented vertically.	Medium band of woody vegetation with 70–90% plant density and cover. A majority of hard wood, leafy, deciduous trees with maturing, diverse vegetation located on the bank. Woody vegetation oriented 80–90° from horizontal with minimal root exposure.	Small band of woody vegetation with 50–70% plant density and cover. A majority of soft wood, piney, coniferous trees with young or old vegetation lacking in diversity located on or near the top of bank. Woody vegetation oriented at 70–80° from horizontal often with evident root exposure.	Woody vegetation band may vary depending on age and health with less than 50% plant density and cover. Primarily soft wood, piney, coniferous trees with very young, old and dying, and/or monostand vegetation located off of the bank. Woody vegetation oriented at less than 70° from horizontal with extensive root exposure.
4. Bank cutting (Pfankuch 1978)	Little or none evident. Infrequent raw banks less than 15 cm high generally.	Some intermittently along channel bends and at prominent constrictions. Raw banks may be up to 30 cm.	Significant and frequent. Cuts 30–60 cm high. Root mat overhangs.	Almost continuous cuts, some over 60 cm high. Undercutting, sod-root overhangs, and side failures frequent.
5. Mass wasting or bank failure (Pfankuch 1978)	No or little evidence of potential or very small amounts of mass wasting. Uniform channel width over the entire reach.	Evidence of infrequent and/or minor mass wasting. Mostly healed over with vegetation. Relatively constant channel width and minimal scalloping of banks.	Evidence of frequent and/or significant occurrences of mass wasting that can be aggravated by higher flows, which may cause undercutting and mass wasting of unstable banks. Channel width quite irregular and scalloping of banks is evident.	Frequent and extensive mass wasting. The potential for bank failure, as evidenced by tension cracks, massive undercuttings, and bank slumping, is considerable. Channel width is highly irregular and banks are scalloped.
6. Bar development (Lagasse et al. 1995)	Bars are mature, narrow relative to stream width at low flow, well vegetated, and composed of coarse gravel to cobbles.	Bars may have vegetation and/or be composed of coarse gravel to cobbles, but minimal recent growth of bar evident by lack of vegetation on portions of the bar.	Bar widths tend to be wide and composed of newly deposited coarse sand to small cobbles and/or may be sparsely vegetated.	Bar widths are generally greater than 1/2 the stream width at low flow. Bars are composed of extensive deposits of fine particles up to coarse gravel with little to no vegetation.
7. Debris jam potential (Pfankuch 1978)	Debris or potential for debris in channel is negligible.	Small amounts of debris present. Small jams could be formed.	Noticeable accumulation of all sizes. Moderate downstream debris jam potential possible.	Moderate to heavy accumulations of various size debris present. Debris jam potential significant.
8. Obstructions, flow deflectors, and sediment traps (Pfankuch 1978)	Rare or not present.	Present, causing cross currents and minor bank and bottom erosion.	Moderately frequent and occasionally unstable obstructions, cause noticeable erosion of the channel. Considerable sediment accumulation behind obstructions.	Frequent and often unstable causing a continual shift of sediment and flow. Traps are easily filled causing channel to migrate and/or widen.
9. Channel bed material consolidation and armoring (Pfankuch 1978)	assorted sizes tightly packed, overlapping, and possibly imbricated. Most material >4 mm	Moderately packed with some overlapping. Very small amounts of material <4 mm	Loose assortment with no apparent overlap. Small to medium amounts of material <4 mm	Very loose assortment with no packing. Large amounts of material <4 mm
10. Shear stress ratio [Eqs. (3)–(4)]	$\tau_o/\tau_c < 1.0$	$1.0 \le \tau_o/\tau_c < 1.5$	$1.5 \le \tau_o/\tau_c < 2.5$	$\tau_o/\tau_c \ge 2.5$
11. High flow angle of approach to bridge or culvert (Simon and Downs 1995)[a]	$0° \le \alpha \le 5°$	$5° < \alpha \le 10°$	$10° < \alpha \le 30°$	$\alpha > 30°$
12. Bridge or culvert distance from meander impact point (Simon and Downs 1995)[b]	$D_m > 35$ m	$20 < D_m \le 35$ m	$10 < D_m \le 20$ m	$0 < D_m \le 10$ m
13. Percentage of channel constriction (Simon and Downs 1995)	0–5%	6–25%	26–50%	>50%

Note: Ranges of values in ratings columns provide possible rating values for each factor.
[a] α = approach flow angle to bridge or culvert.
[b] D_m = distance from bridge or culvert upstream to meander impact point.

TABLE 2. Stability Indicators and Weights for Stability Assessment Scheme

Stability indicator (1)	Weight (2)
1. Bank soil texture and coherence	0.6
2. Average bank slope angle	0.6
3. Vegetative bank protection	0.8
4. Bank cutting	0.4
5. Mass wasting or bank failure	0.8
6. Bar development	0.6
7. Debris jam potential	0.2
8. Obstructions, deflectors, and sediment traps	0.2
9. Bed material consolidation and armoring	0.8
10. Shear stress ratios	1.0
11. High flow angle of approach to bridge	0.8
12. Distance from meander impact point	0.8
13. Percentage of channel constriction	0.8

TABLE 3. Overall Rating Ranges

Description (1)	Rating, R (2)
Excellent	$R < 32$
Good	$32 \le R < 55$
Fair	$55 \le R < 78$
Poor	$R \ge 78$

Site Risk Assessment: Channel Responses to Consider at road-stream crossings

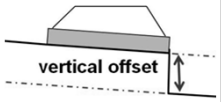
- **Channel stability:** Is the overall channel stable or unstable because of system-wide degradation and aggradation?
- **Vertical adjustment potential:** What is the potential range of channel-bed elevations over the service life of the structure from scour and fill processes during floods, sediment and wood inputs from debris flows and/or debris torrents, loss or formation of debris jams, land-use changes, etc.?
- **Headcut potential:** What are the ecological implications for allowing headcutting to occur as the channel adjusts to establish a new equilibrium condition?
- **Lateral adjustment potential:** Can channel migration or lateral shifting over the service life of the structure affect stream/culvert alignment?
- **Floodplain conveyance/connectivity:** Is floodplain function and connectivity ecologically important? What is the depth and extent of flow in floodplain above bankfull conditions?

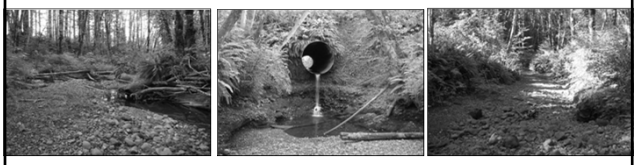
Site Risk Assessment: Channel Responses to Consider at road-stream crossings

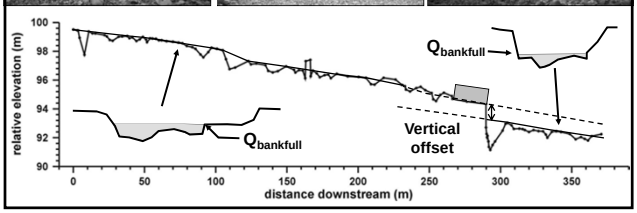
- **Channel stability:** Is the overall channel stable or unstable because of system-wide degradation and aggradation?
  - Longitudinal Profile Shape
    - Vertical offset
  - Channel Entrenchment / Floodplain Disconnect
    - Entrenchment ratio differences
  - Bank Instability
    - Channel evolution model, other rapid channel/bed stability assessments
  - Sediment deposition on floodplains
  - NEED TO DETERMINE WHAT IS CAUSING INSTABILITY

Site Risk Assessment

CHANNEL STABILITY: Save Creek, Olympic NF, WA Example

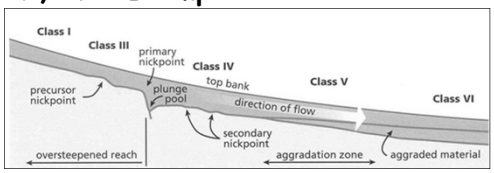


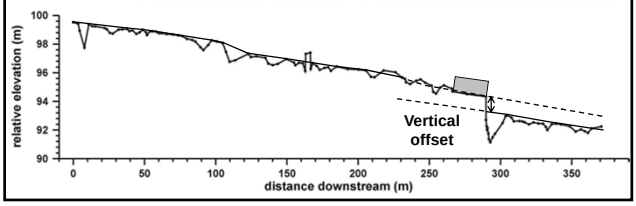




Site Risk Assessment

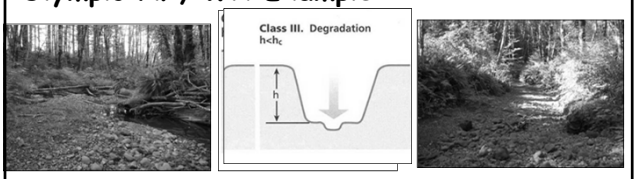
CHANNEL STABILITY: Save Creek, Olympic NF, WA Example

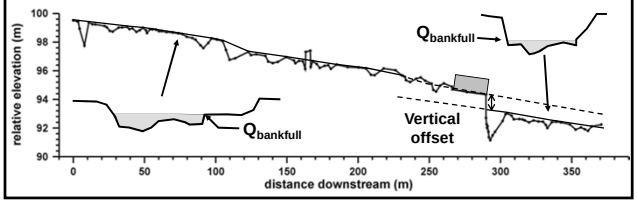




Site Risk Assessment

CHANNEL STABILITY: Save Creek, Olympic NF, WA Example





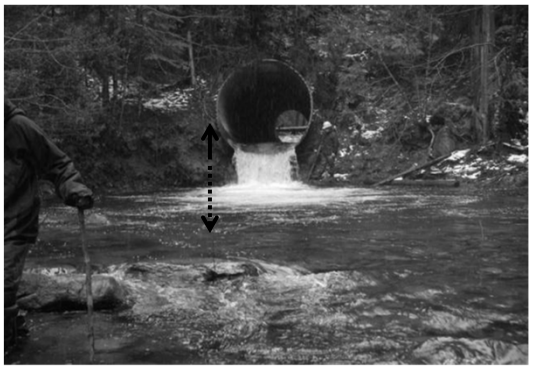
Site Risk Assessment: Channel Responses to Consider at road-stream crossings

Vertical adjustment potential: What is the potential range of channel-bed elevations over the service life of the structure from scour and fill processes during floods, sediment and wood inputs from debris flows and/or debris torrents, loss or formation of debris jams, land-use changes, etc.?

- **Longitudinal Profile Shape**
  - **Concave (deposition and erosion cycles)**
  - **Convex (potential headcutting)**
  - **Vertical offset (potential headcutting)**
- **Large Woody Debris, Debris Torrents**
- **Mass Wasting Potential**
- **Presence of Bedrock**

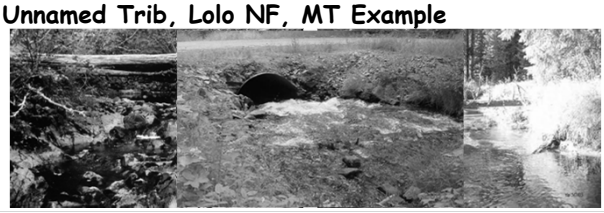
Site Risk Assessment

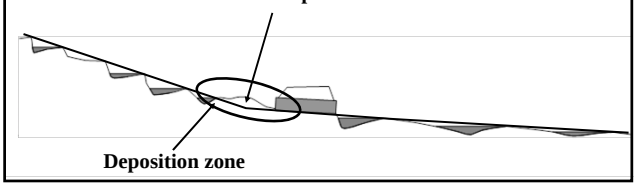
VERTICAL ADJUSTMENT POTENTIAL:
Tahoe NF, California Example



Site Risk Assessment

VERTICAL ADJUSTMENT POTENTIAL:
Unnamed Trib, Lolo NF, MT Example





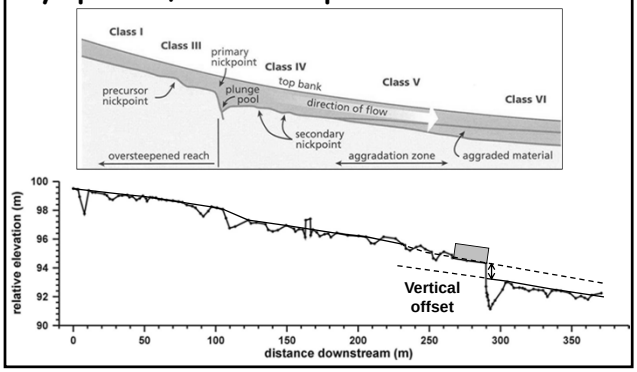
Site Risk Assessment

VERTICAL ADJUSTMENT POTENTIAL:
Siuslaw NF, Oregon Example

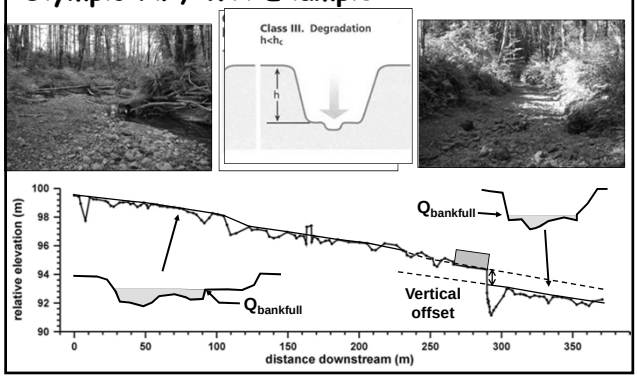
Site Risk Assessment: Channel Responses to Consider at road-stream crossings

- **Headcut potential:** What are the ecological implications for allowing headcutting to occur as the channel adjusts to establish a new equilibrium condition?
  - Almost always have headcutting through the sediment that has accumulated at the inlet
  - Longitudinal Profile Shape
    - Extent of vertical offset and size of bed material in the upstream channel will control the depth and upstream extent of headcutting/channel incision

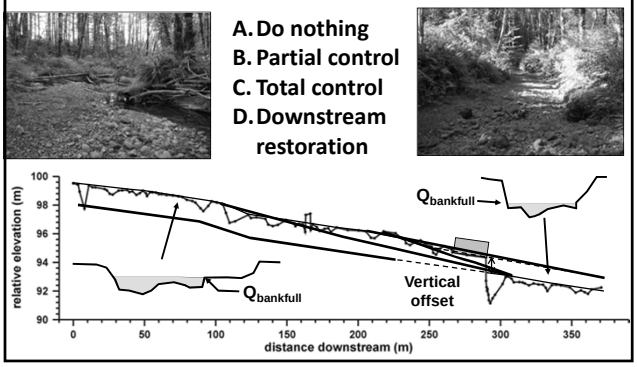
Site Risk Assessment
HEADCUT POTENTIAL: Save Creek, Olympic NF, WA Example



Site Risk Assessment
HEADCUT POTENTIAL: Save Creek, Olympic NF, WA Example



Site Risk Assessment
HEADCUT POTENTIAL: Save Creek, Olympic NF, WA Example



Site Risk Assessment: Channel Responses to Consider at road-stream crossings

- **Lateral adjustment potential: Can channel migration or lateral shifting over the service life of the structure affect stream/culvert alignment?**
  - **Unconfined channels**
  - **Sinuous channels**
  - **Existing channel/structure alignment is already skewed**
  - **Composition and stability of bed and bank material**
  - **Can potential sediment/debris inputs from floods/mass wasting processes force lateral channel shifting**

Site Risk Assessment

LATERAL ADJUSTMENT POTENTIAL:
Unnamed Stream, Mississippi

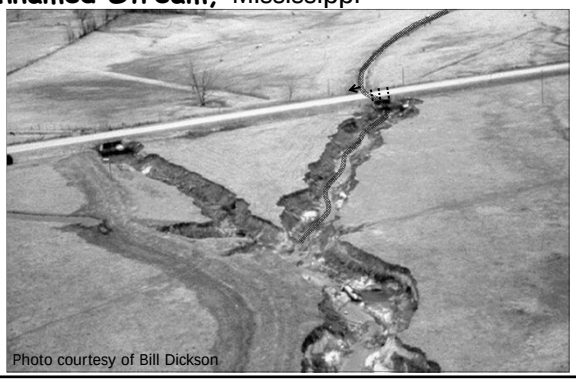
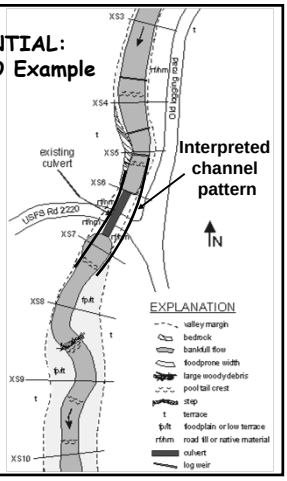


Photo courtesy of Bill Dickson

Site Risk Assessment

LATERAL ADJUSTMENT POTENTIAL:
Newbury Creek, Olympic NF, CO Example

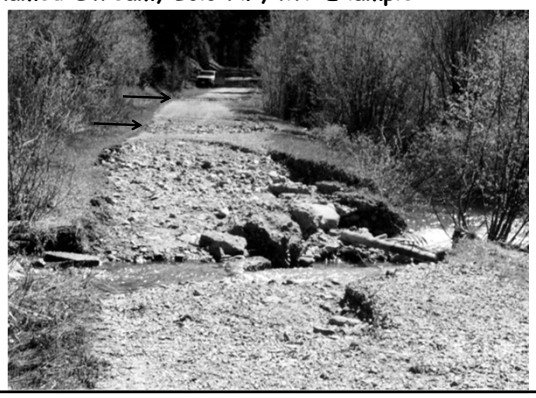


Site Risk Assessment

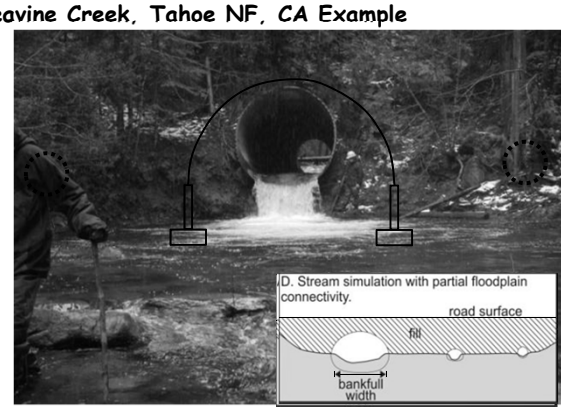
Channel Responses to Consider at road-stream crossings

- **Floodplain conveyance/connectivity: Is floodplain function and connectivity ecologically important? What is the depth and extent of flow in floodplain above bankfull conditions?**
  - **Is the floodplain/riparian migration corridor important for terrestrial animals?**
  - **Unconfined channels with large floodplains**
  - **Flashy flow regimes that can cause floodwaters to pond behind the roadfill**
  - **Any evidence of past large floods?**

Site Risk Assessment
FLOODPLAIN CONVEYANCE/CONNECTIVITY:
Unnamed Stream, Lolo NF, MT Example



Site Risk Assessment
FLOODPLAIN CONVEYANCE/CONNECTIVITY:
Peavine Creek, Tahoe NF, CA Example



Summary

- **Watershed-scale and local-scale processes influence channel conditions at the crossing; consideration of these processes at both scales are needed for understanding channel conditions, fluvial processes, and channel responses at the road-stream crossing.**
- **The gradient, planform pattern, dimensions, bedforms, and sediment size of the natural channel must be evaluated at the road-stream crossing in order to design a structure that contains a natural and dynamic channel.**
- **A road-stream crossing channel design that has dimensions and characteristics similar to those in the natural channel will ensure that the design channel will be able to laterally and vertically adjust its form to a wide range of floods and sediment/debris inputs without compromising the movement and habitat needs of fish and other aquatic organisms.**

Selected References and Recommended Readings

- **Federal Interagency Stream Restoration Working Group (FISRWG)**. 1998. Stream Corridor Restoration: Principles, Processes, and Practices. Federal Interagency Stream Restoration Working Group (15 Federal agencies of the United States Government). ISBN-0-934213-59-3.
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