Urban Riparian Restoration Program: Introduction to Stream Processes and Restoration

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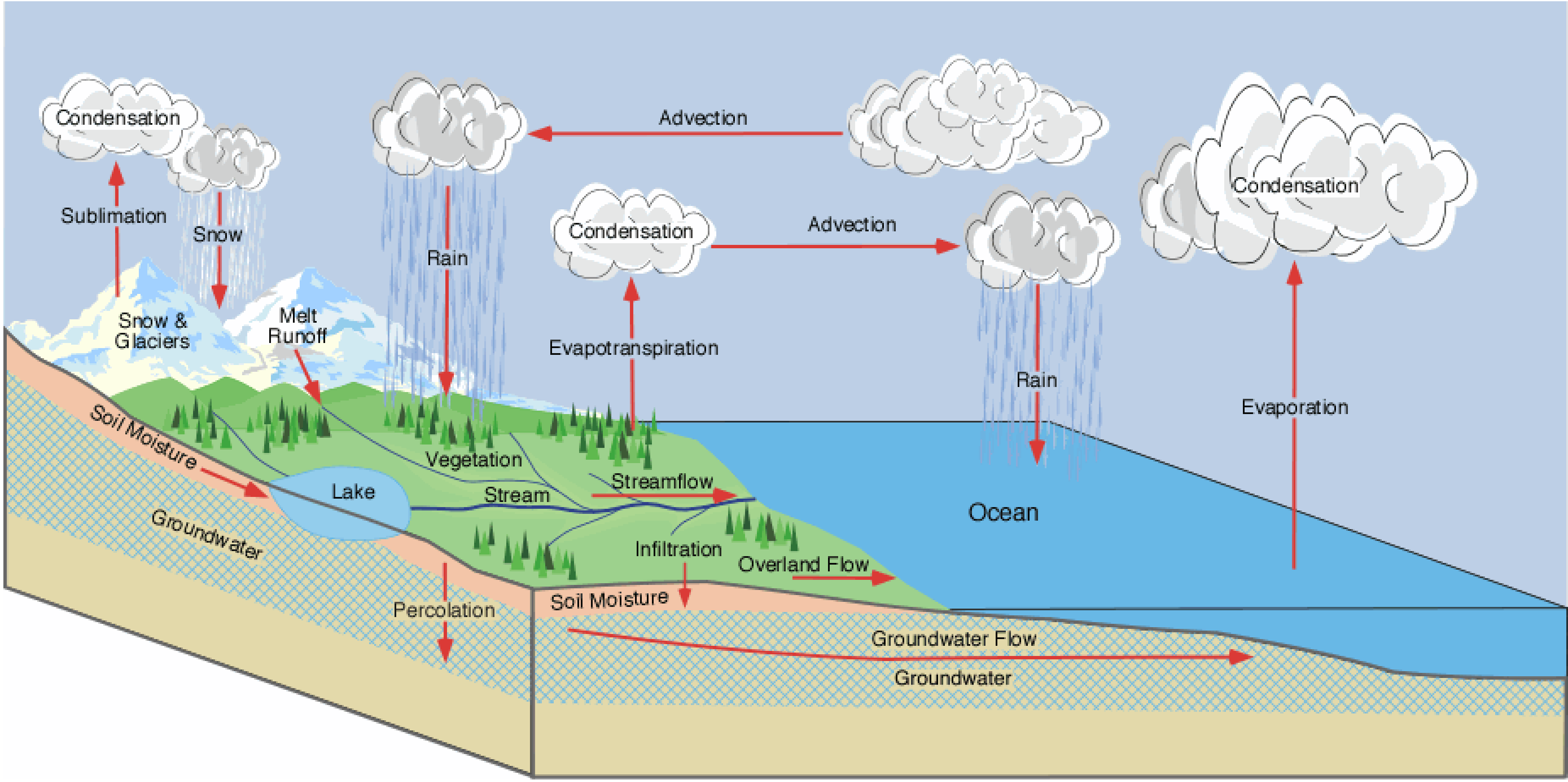
Outline

1. Hydrologic cycle
2. Introduction to stream morphology
    1. Bankfull Discharge
    2. Stability
    3. Channel measurements
3. Stream Classification
4. Stream Instability
5. Stream Restoration
6. Stabilization structures
7. Vegetation
8. Monitoring and evaluation

Hydrologic Cycle

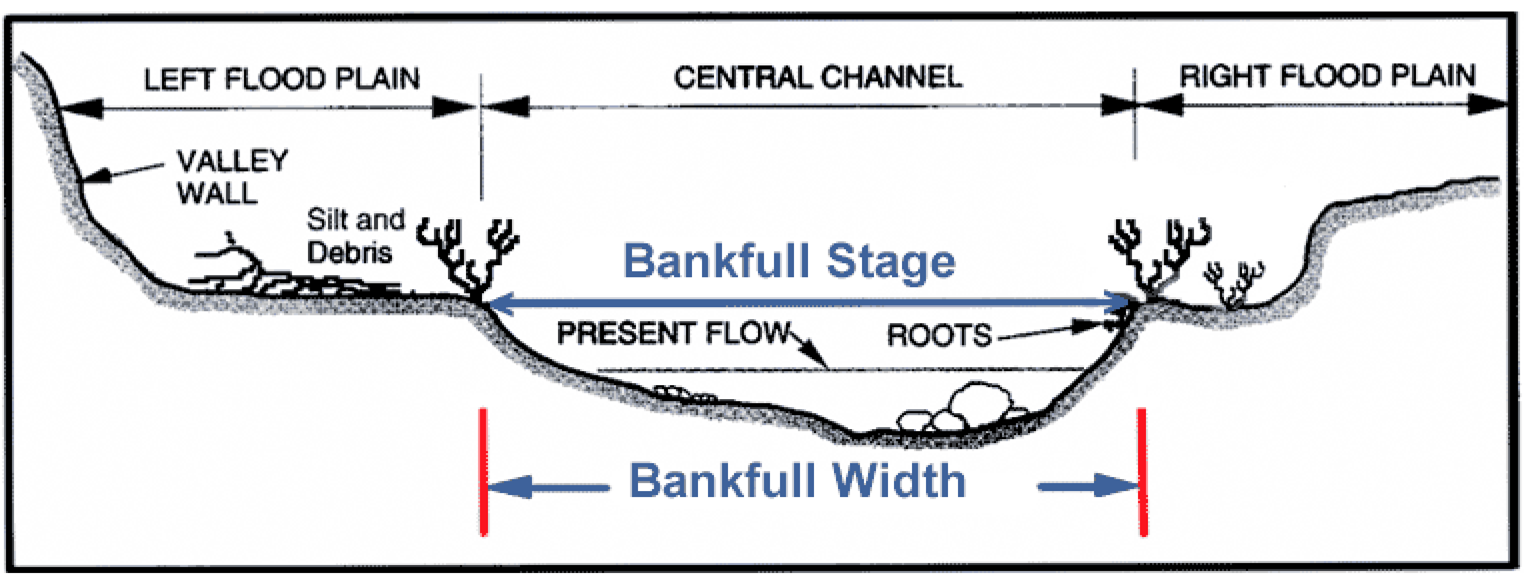


Stream Function

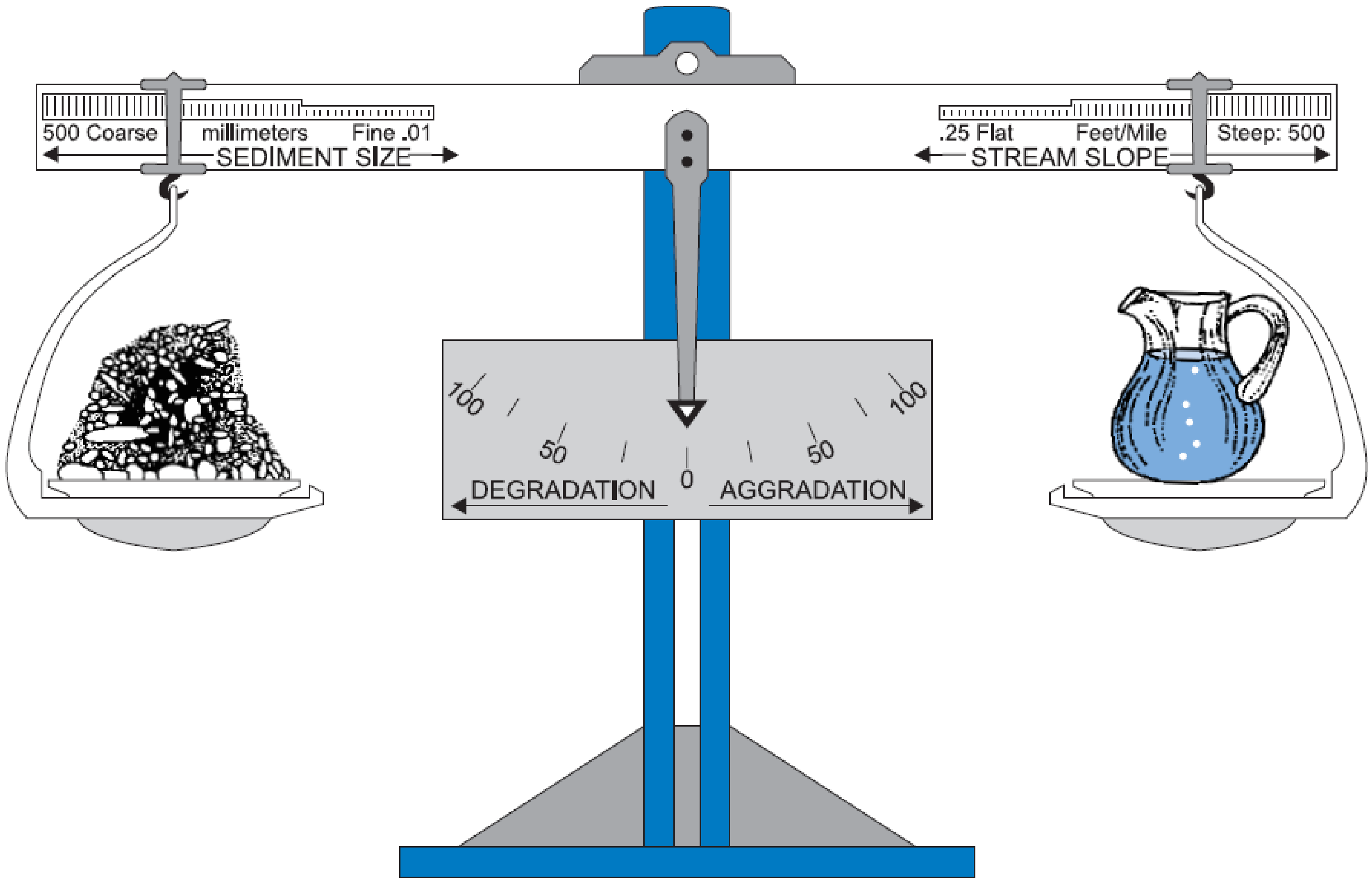
- Transporting water and sediments
- Habitat to aquatic organisms
- Trees and shrubs on banks provide food source and regulate temperatures
- Channel features such as pools, riffles and glides provide diversity
- Natural design important to maintain these features

Bankfull Discharge

- Most important process defining channel
- Effective (or dominant) discharge
- Transports majority of sediment load in stream
- Considered the insipient point of flooding



Natural Channel Stability

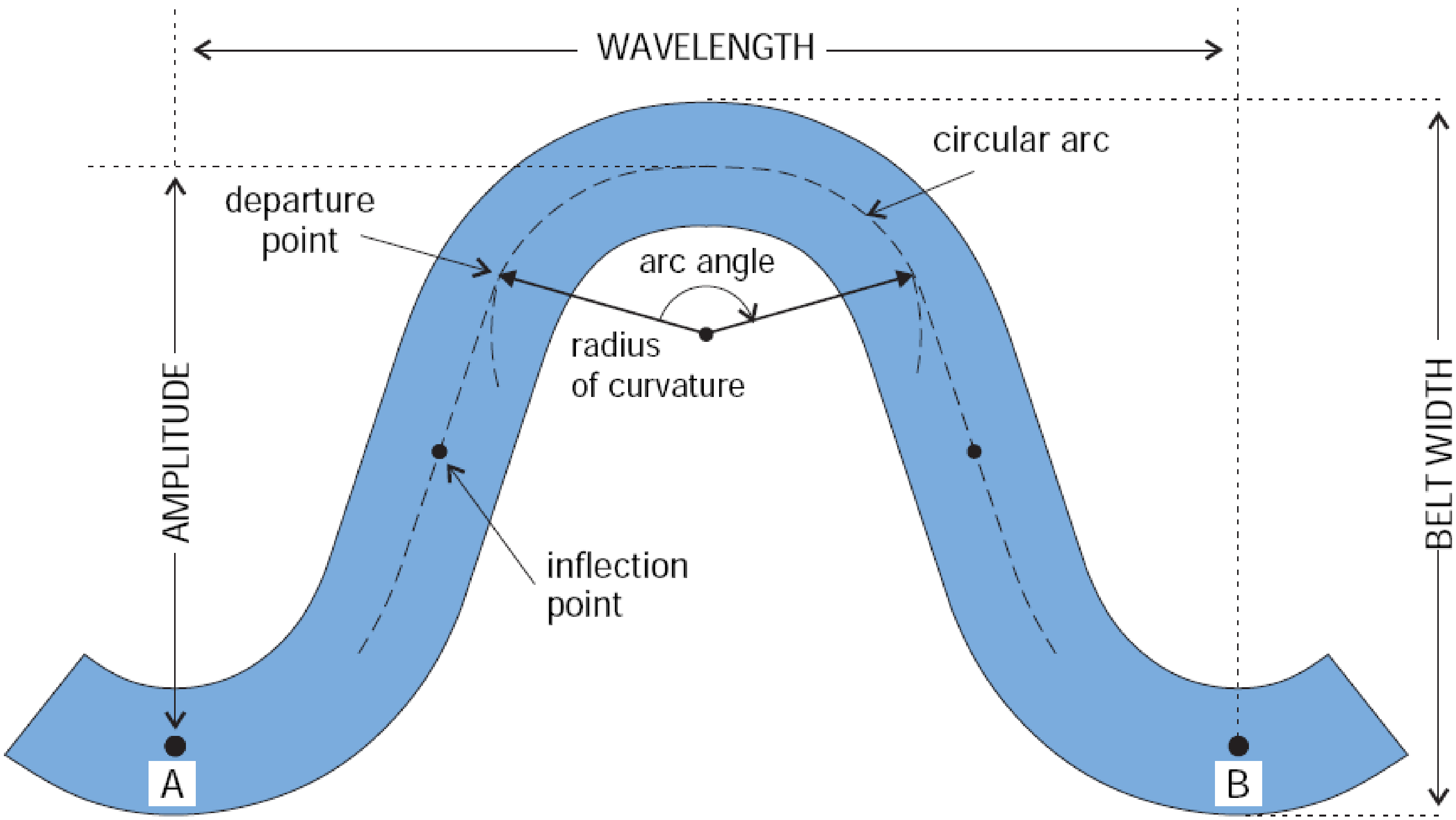


(Sediment LOAD) x (Sediment SIZE) $\propto$ (Stream SLOPE) x (Stream DISCHARGE)

Channel Dimension and Characteristics

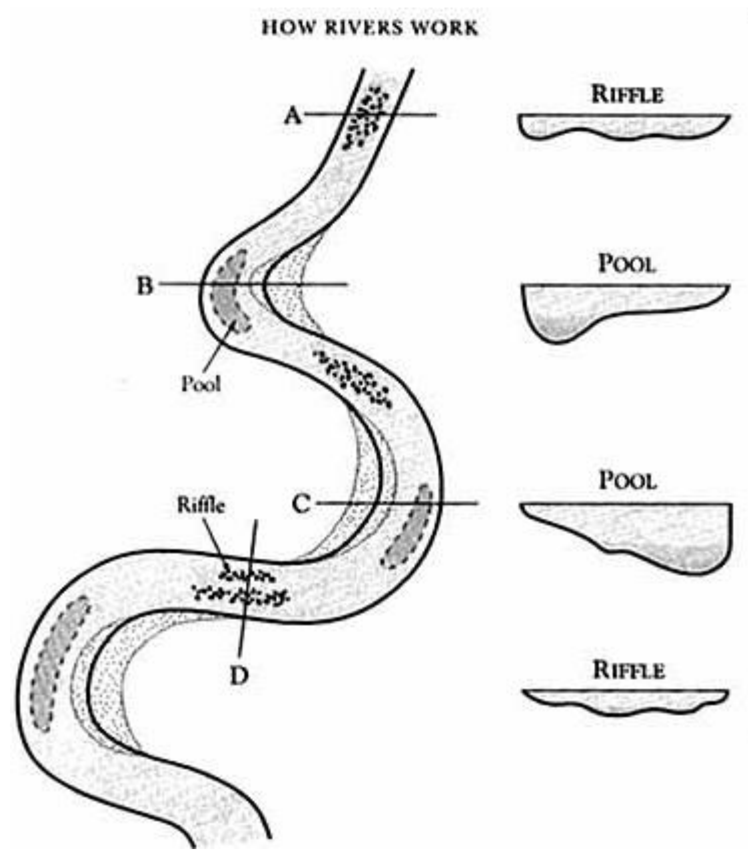
- It is the cross section of stream at bankfull measured at a stable riffle in stream
- Width of stream increases as you go downstream
- In arid regions, streams are wider due to lack of vegetation and erosion
- The mean depth of stream varies within stream depending on channel slope and riffle/pool spacing

Meander Geometry



Channel features

- Sequences of riffles and pools
- Riffles: larger rock particles, shallower, and steeper
- Pools: flat surfaces, deep
- Run: between riffles and pools
- Glide: between pools and riffles



Natural Stream Restoration

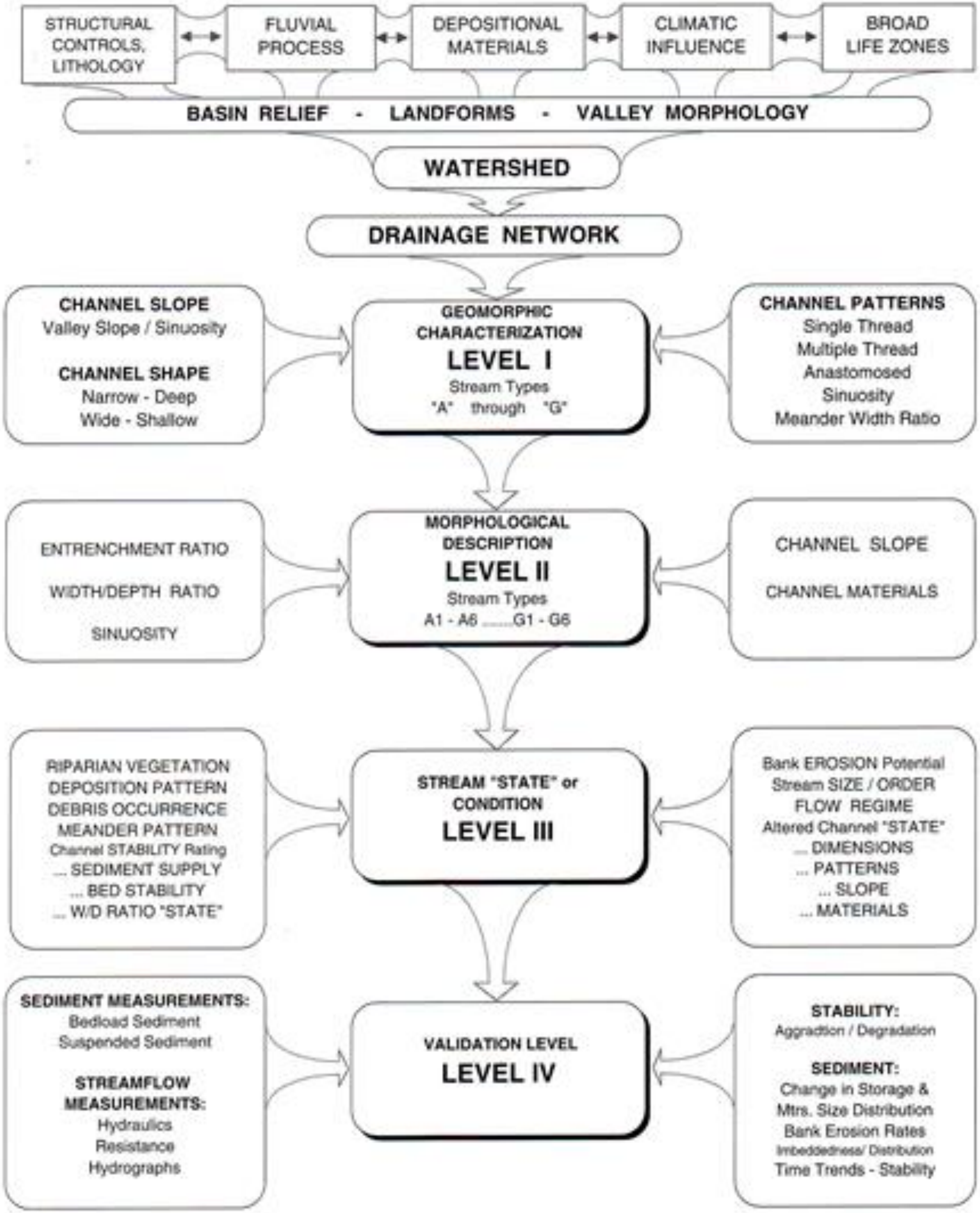
- Utilizes reference reach
- Includes bankfull and floodplain areas
- Restoration should result in water and sediment movement without degradation or aggradation
- Improves habitat and promotes diversity
- Promotes riparian vegetation

Stream Assessment

- Determine watershed drainage area (GIS)
- Determine land use (map or survey)
- Determine bankfull (field observation)
- Determine channel dimension (survey)
- Determine stream pattern: sinuosity, radius of curvature, belt width and meander wavelength (1:24000 maps)
- Channel profile

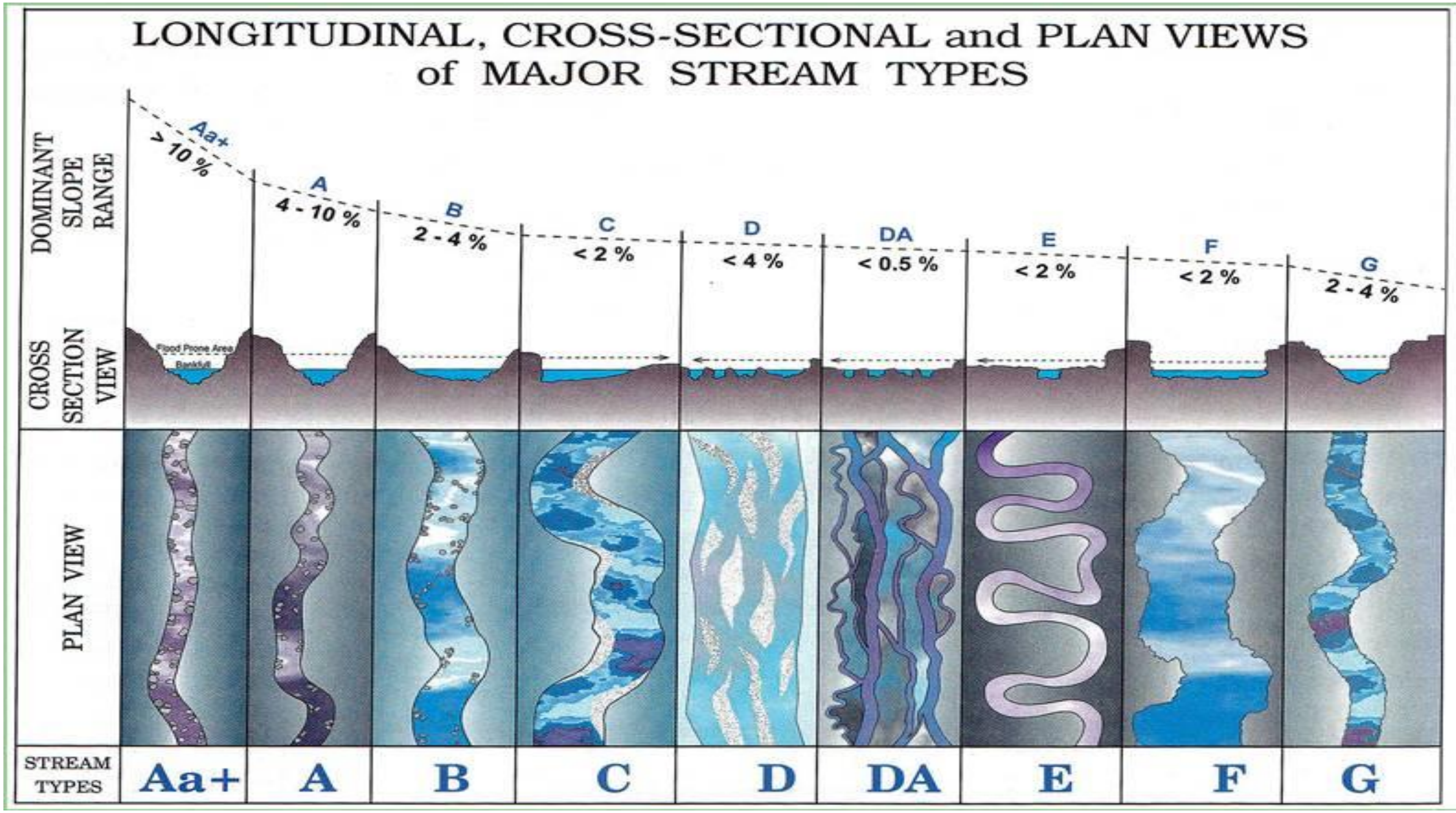
Stream Assessment

- Substrate Analysis
- Estimate bankfull discharge and velocity (Manning's equation)
- Assess riparian condition: topography of floodplain, constraints in urban settings, soil fertility, plant inventory



STRUCTURAL CONTROLS, LITHOLOGY
FLUVIAL PROCESS
DEPOSITIONAL MATERIALS
CLIMATIC INFLUENCE
BROAD LIFE ZONES
BASIN RELIEF - LANDFORMS - VALLEY MORPHOLOGY
WATERSHED
DRAINAGE NETWORK
CHANNEL SLOPE
Valley Slope / Sinuosity
CHANNEL SHAPE
Narrow - Deep
Wide - Shallow
GEOMORPHIC CHARACTERIZATION
LEVEL I
Stream Types
"A" through "G"
CHANNEL PATTERNS
Single Thread
Multiple Thread
Anastomosed
Sinuosity
Meander Width Ratio
ENTRENCHMENT RATIO
WIDTH/DEPTH RATIO
SINUOSITY
MORPHOLOGICAL DESCRIPTION
LEVEL II
Stream Types
A1 - A6 ......G1 - G6
CHANNEL SLOPE
CHANNEL MATERIALS
RIPARIAN VEGETATION
DEPOSITION PATTERN
DEBRIS OCCURRENCE
MEANDER PATTERN
Channel STABILITY Rating
... SEDIMENT SUPPLY
... BED STABILITY
... W/D RATIO "STATE"
STREAM "STATE" or CONDITION
LEVEL III
Bank EROSION Potential
Stream SIZE / ORDER
FLOW REGIME
Altered Channel "STATE"
... DIMENSIONS
... PATTERNS
... SLOPE
... MATERIALS
SEDIMENT MEASUREMENTS:
Bedload Sediment
Suspended Sediment
STREAMFLOW MEASUREMENTS:
Hydraulics
Resistance
Hydrographs
VALIDATION LEVEL
LEVEL IV
STABILITY:
Aggradation / Degradation
SEDIMENT:
Change in Storage &
Mtrs. Size Distribution
Bank Erosion Rates
Imbeddedness/ Distribution
Time Trends - Stability

Level I Assesment



Level II: Key terms

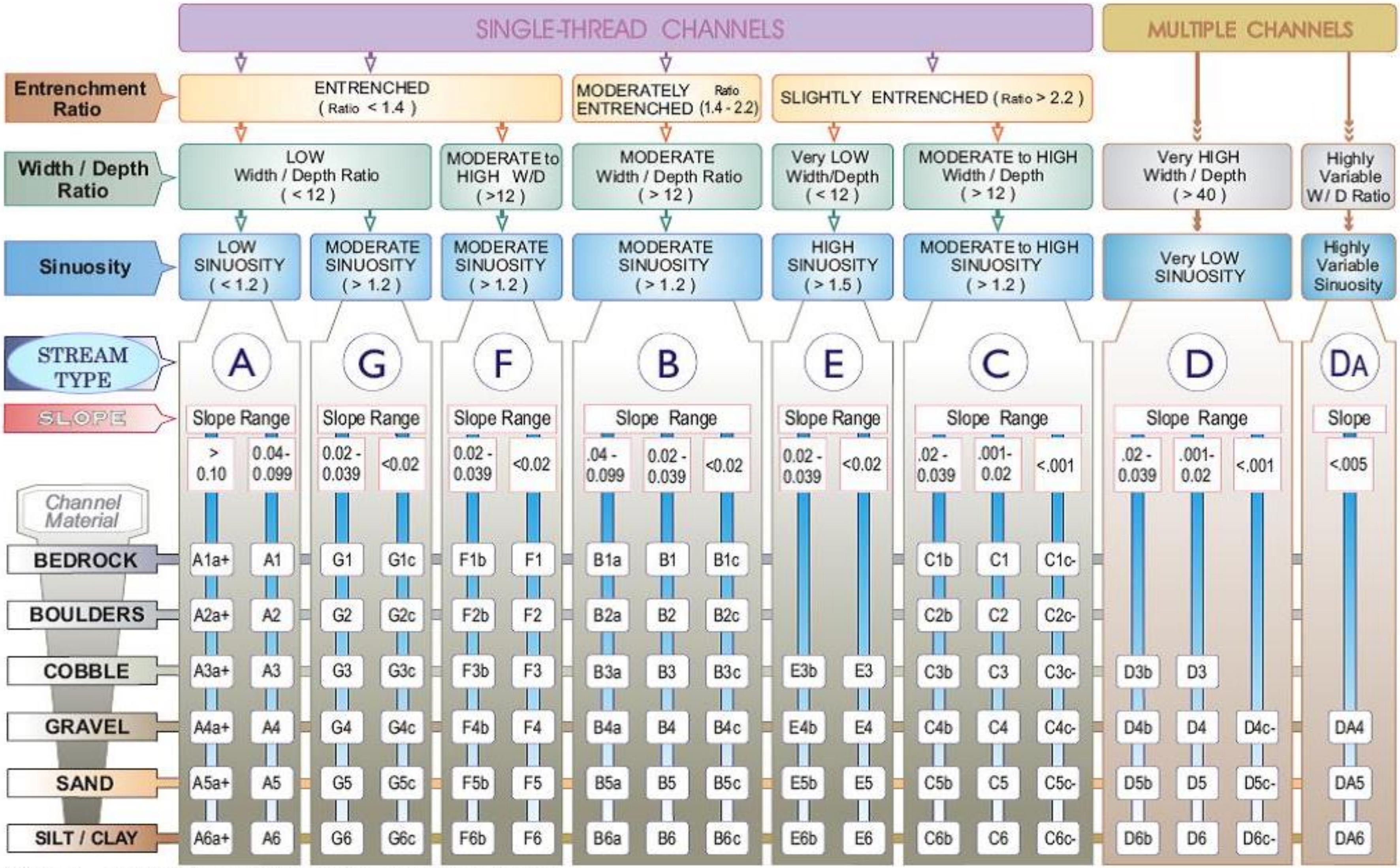
- Entrenchment ratio:

Width of the flood prone area/bankfull surface width

- Sinuosity:

Stream Length/Valley Length

The Key to the Rosgen Classification of Natural Rivers



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the "*continuum of physical variables*" within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

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Level III

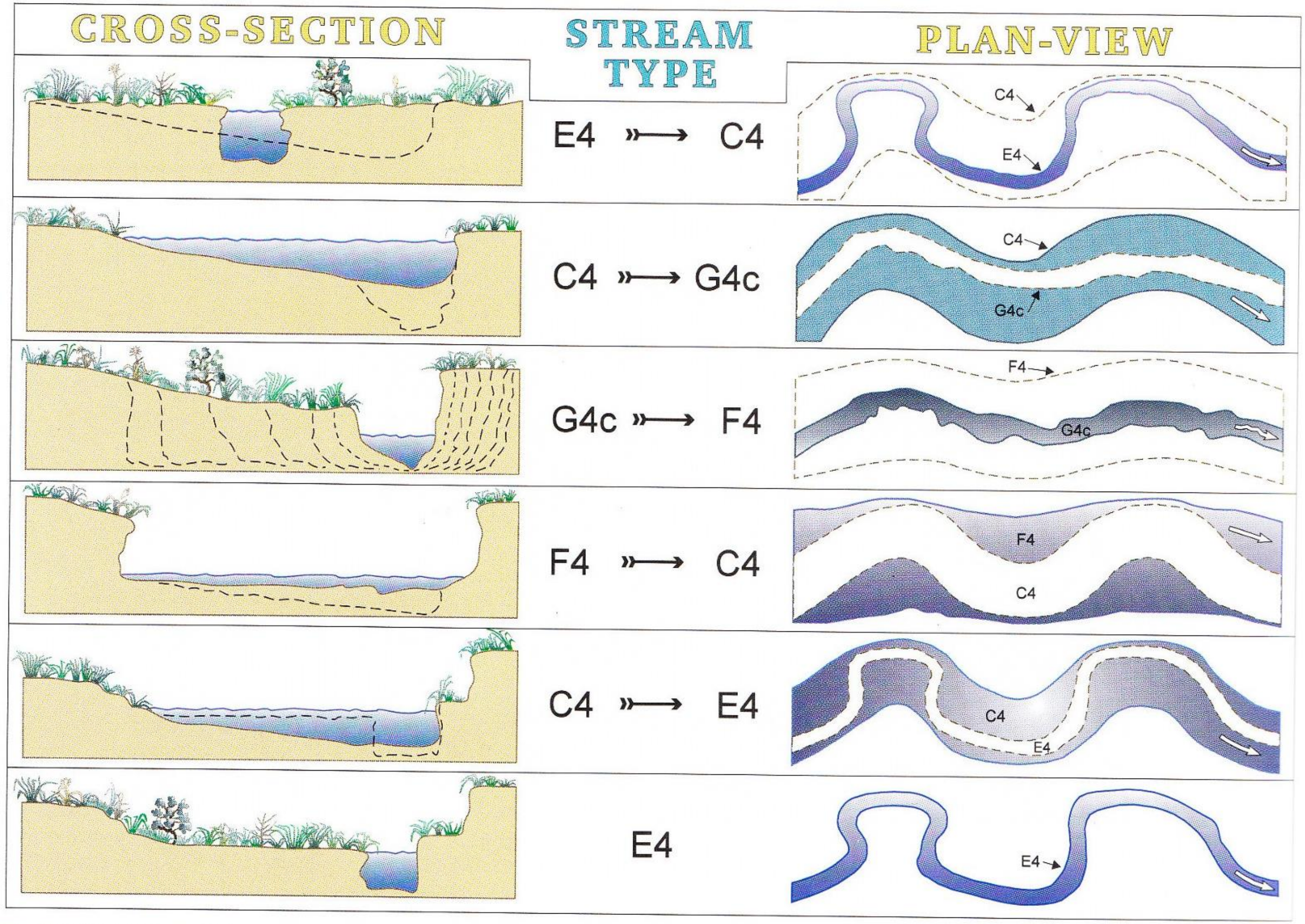
- Watershed scale instability
  - Channelization
  - Development
- Local (reach) instability
  - Outside bank of meander bend
  - Channel constrictions
- Channel stability assessment
  - Channel evolution
  - Streambank erosion

Watershed Scale Instability

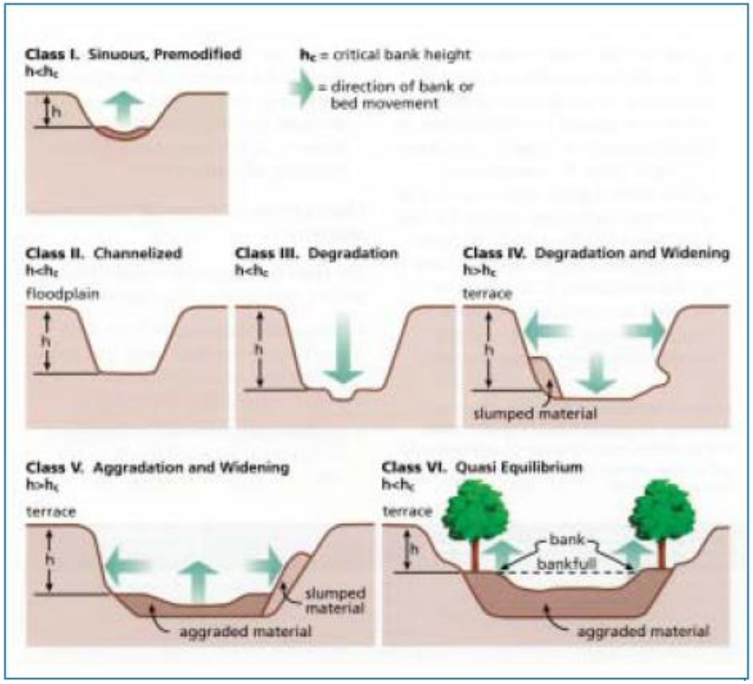
Local Scale: Outside Bend Erosion

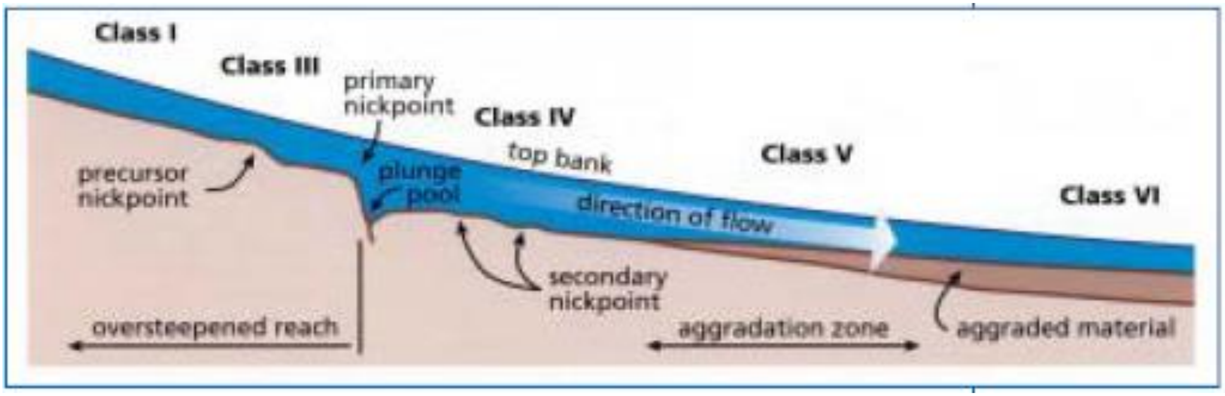
Local Scale: Channel Constrictions

Channel Evolution



Channel Evolution



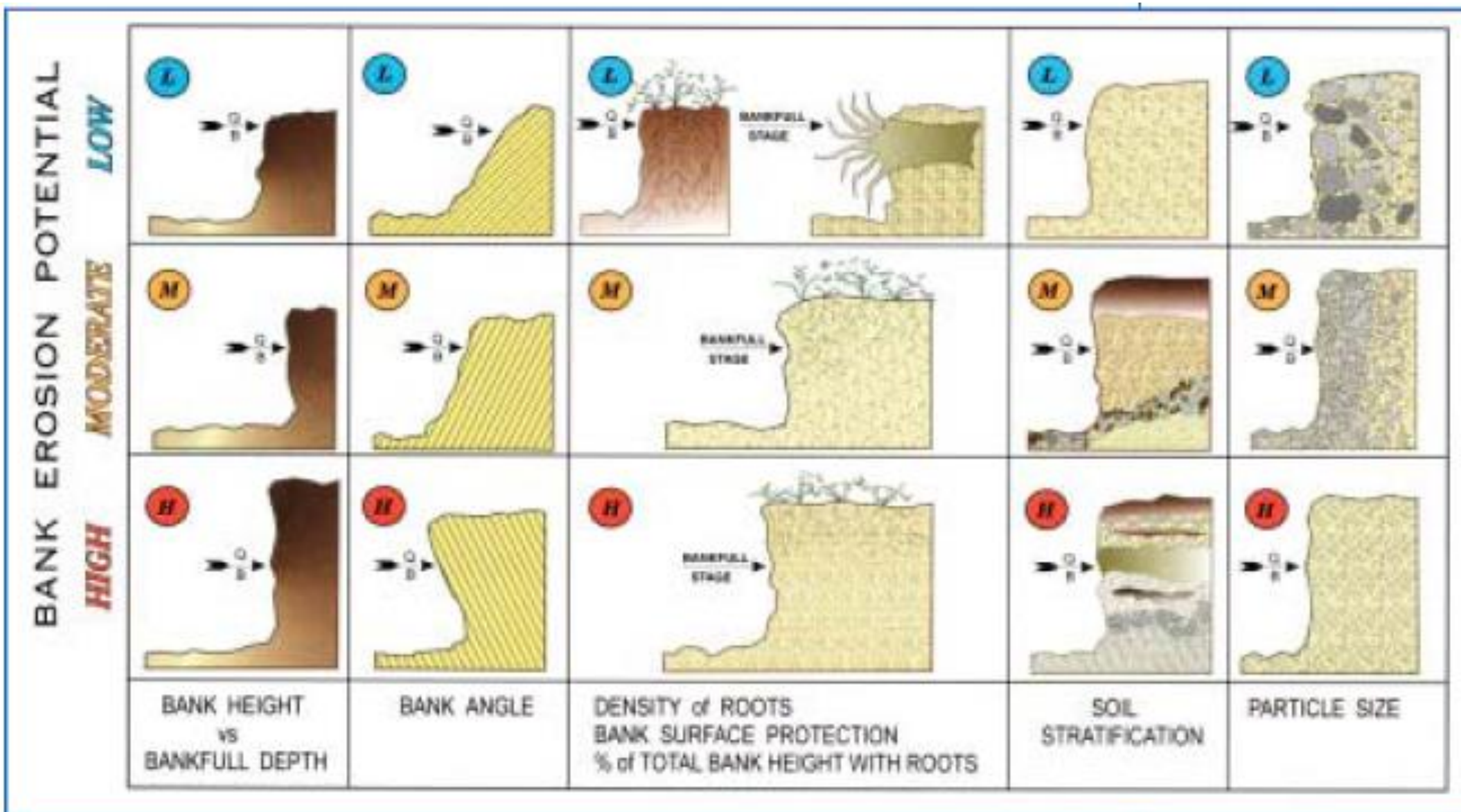


Degradation and Widening

Channel Evolution

Stream Evolution: F4 Channel

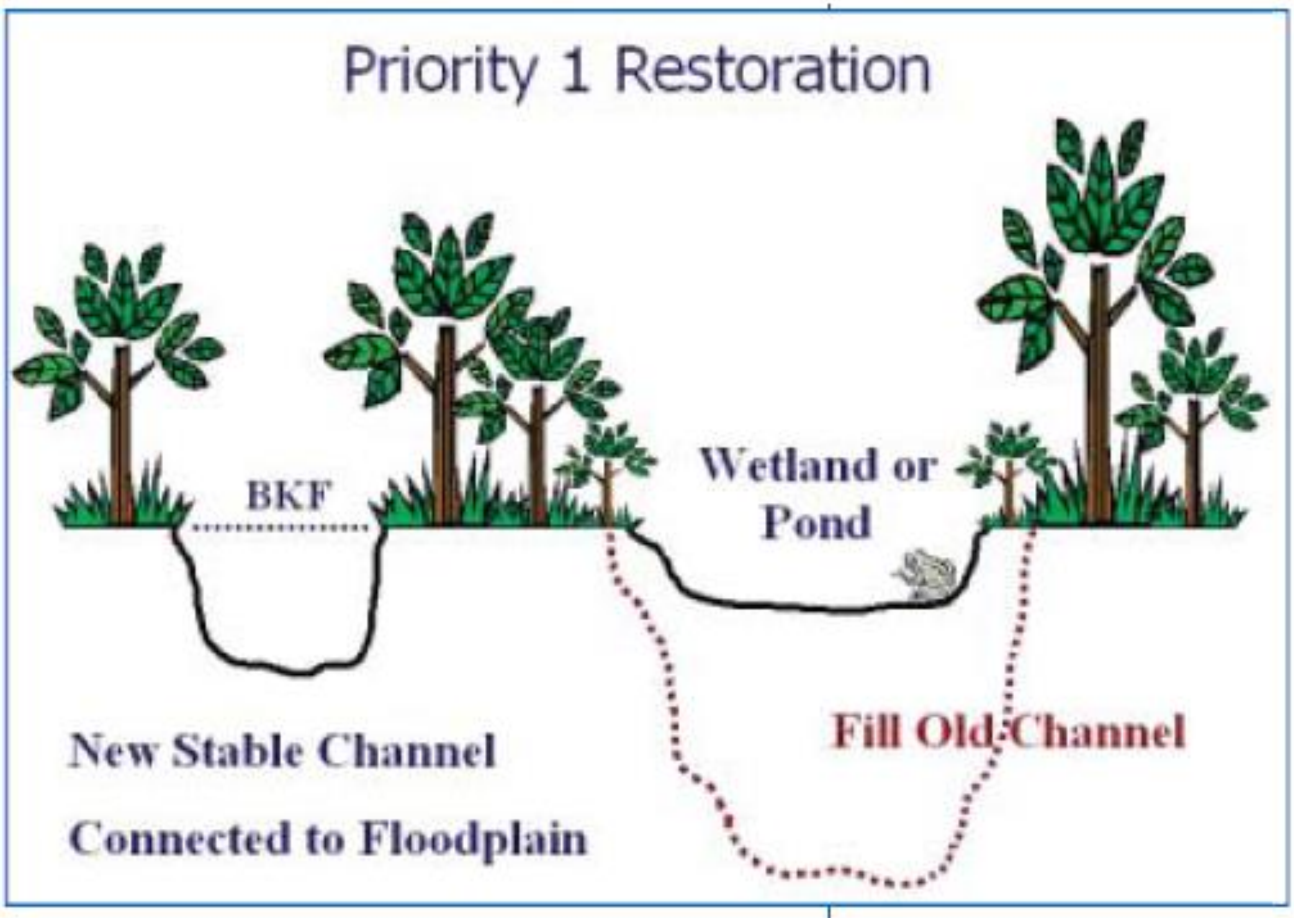
Bank Erodibility Factors



Erodibility

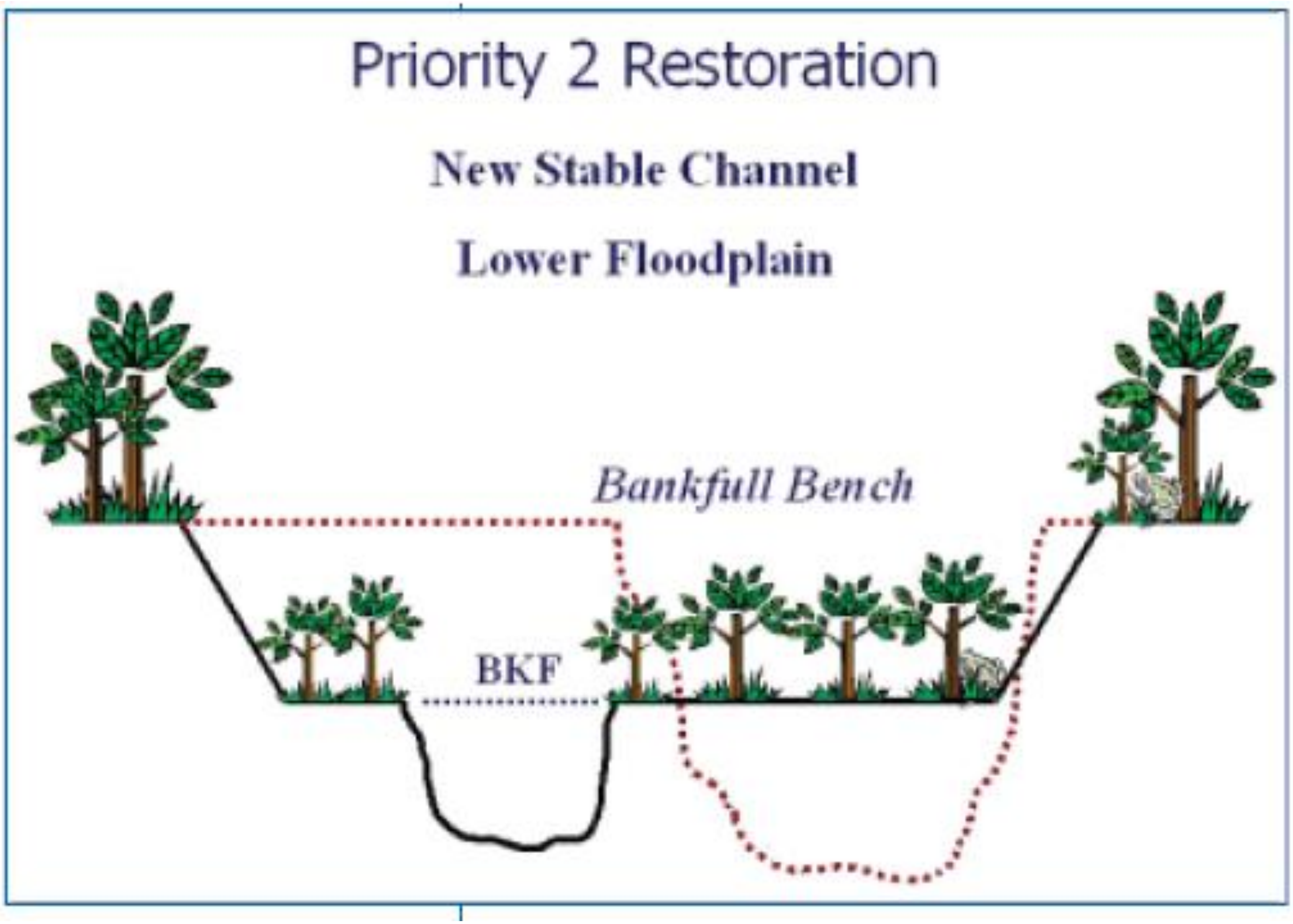
Stream Restoration Options

- I- Establish bankfull at historical floodplain elevation: E, C



Civitan Park Stream
Restoration and

II- Create new floodplain at present elevation: E, C



Priority 2

Before

After

III- Widen floodplain B, Bc

Priority 3

Before

After

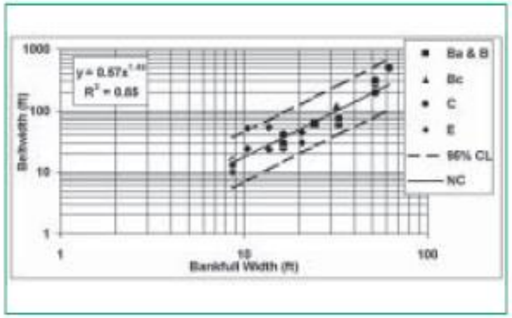


Figure 6.5

Belt width as a function of bankfull width
Clinton et al., 1999

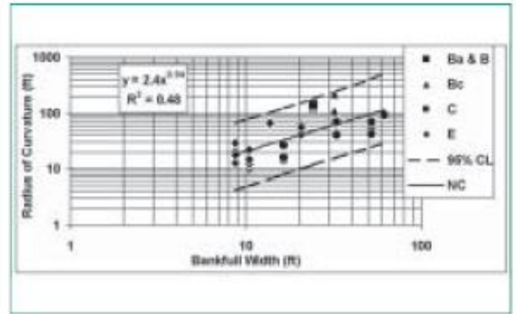


Figure 6.6

Radius of curvature as a function of bankfull width
Clinton et al., 1999

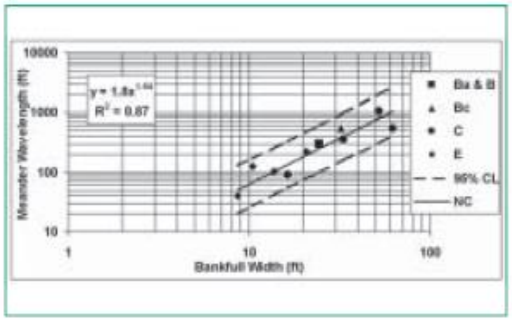


Figure 6.7

Meander wavelength as a function of bankfull width
Clinton et al., 1999

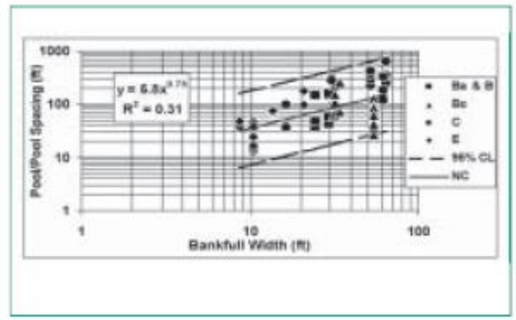


Figure 6.8

Pool-to-pool spacing as a function of bankfull width
Clinton et al., 1999

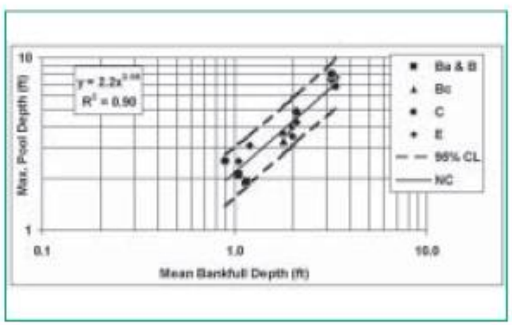


Figure 6.9

Max pool depth as a function of riffle mean bankfull depth
Clinton et al., 1999

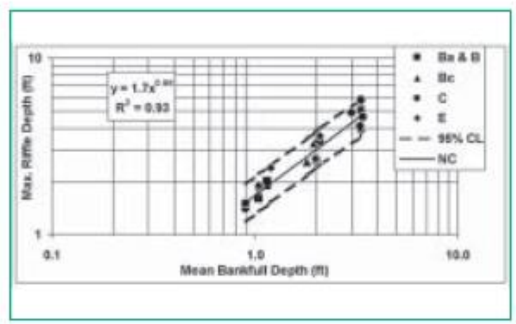


Figure 6.10

Max riffle depth as a function of mean bankfull depth
Clinton et al., 1999

IV- Stabilize Existing Streambanks in place

- Use in-stream structures
- Riprap?
- Gabions?
- Concrete?
- Bioengineering
- Study upstream and downstream impacts

Stream Stabilization?

Structures: Root Wad

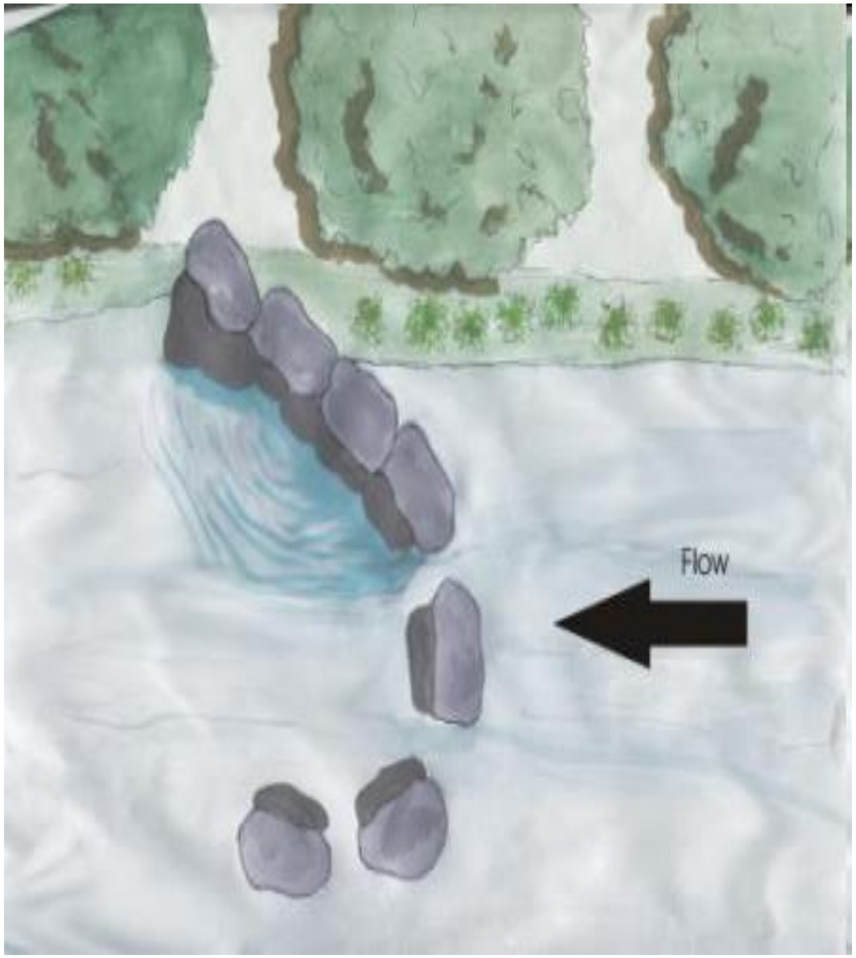
Figure 8.1

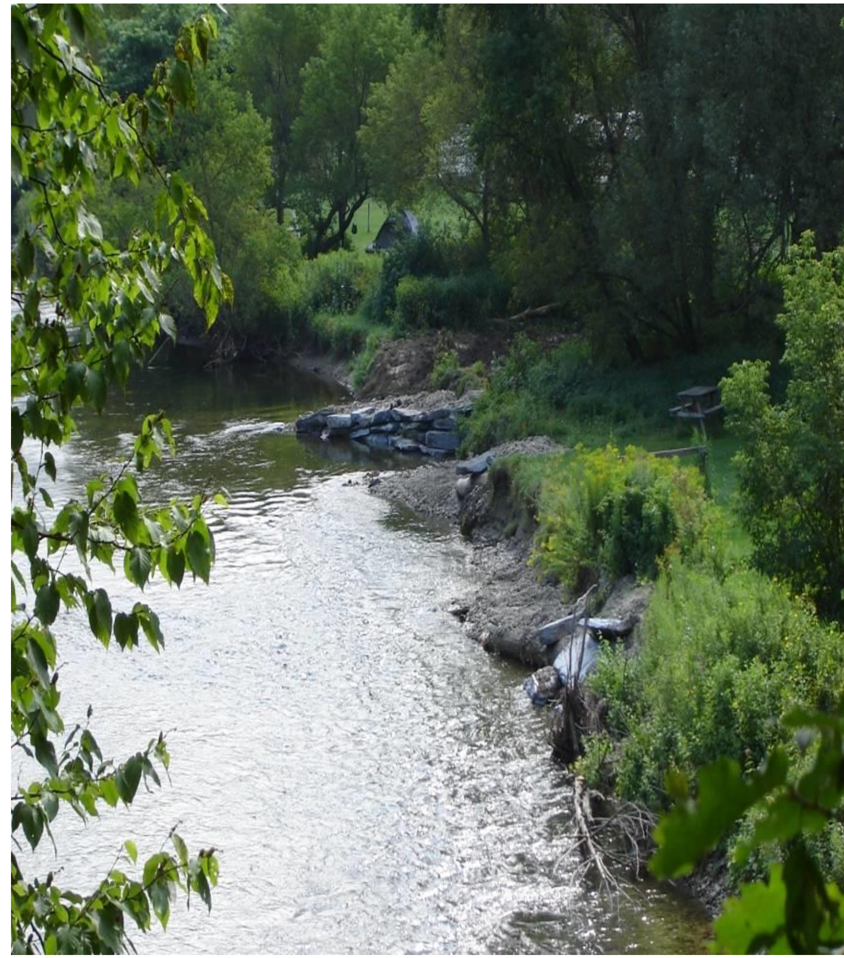
Root wad placed on outside of meander bend

Figure 8.2

Track hoe with hydraulic thumb inserting root wad into streambank

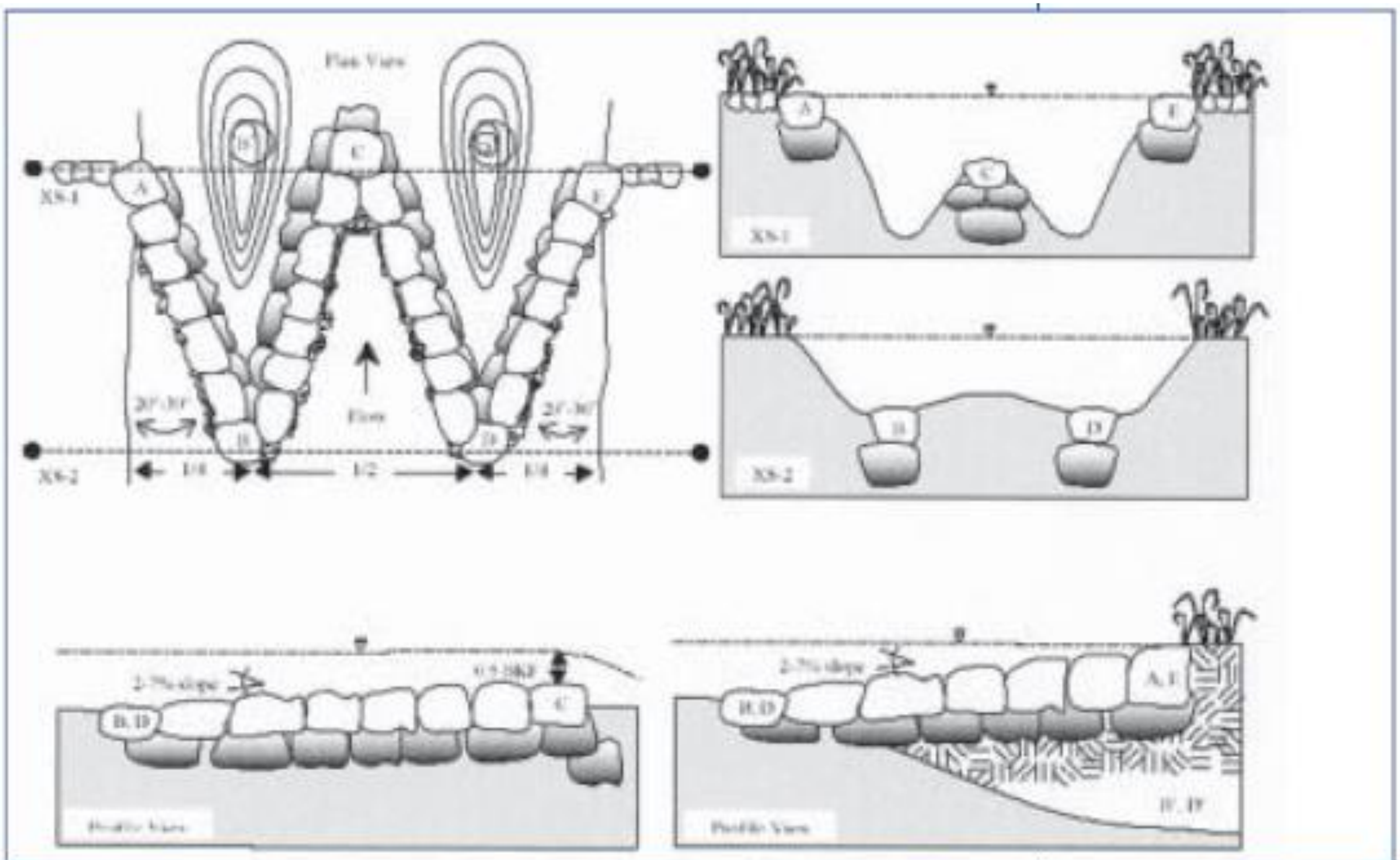
Structures: J-Hook Vanes






CAT
CAT

Structures: W-weir



Stream Crossings

Vegetation: Assessments are Needed Prior to Construction

- Determine if existing vegetation is a good template for revegetation
- Discover problematic issues to plan for before construction
- Identify special features to enhance or protect
- Gather ecological data for restoration planning

Plant inventory

- Use local guides
- Check for natural resource publications
- Contact plant professionals

Soils

- Nutrients
- Compactedness
- Composition
- Plans for tilling, mulching, liming

AgriLIFE EXTENSION
Texas A&M System

Soil, Water and Forage Testing Laboratory
Department of Soil and Crop Sciences
Texas AgriLife Extension Service

D-494

S 11

SOIL SAMPLE INFORMATION FORM

Please submit this completed form and payment with samples. Mark each sample bag with your sample identification and ensure that It corresponds with the sample identification written on this form. *See sampling and mailing instructions on the back of this form.

(PLEASE DO NOT SEND CASH)

SUBMITTAL AND INVOICE INFORMATION: This information will be used for all official invoicing and communication.

Name ____ County where sampled ____________________

Address ____ Phone _____________________________

City ______________________________ State______ Zip ______ _____________________________

CLIENT NAME: Client name will only be included with information above on result reports.

Name ____

Lab Use only

Payment (DO NOT SEND CASH)
- ☐ Check
- ☐ Money Order
- ☐ Credit Card – requires additional form*

Amount Paid $______________________
Make Checks Payable to: **Soil Testing Laboratory**
*Credit card payment forms can be downloaded at http://soiltesting.tamu.edu

Problematic and Invasive Plants

http://www.texasinvasives.org/invasives_database/

Vegetation

- Salvage on-site vegetation
- Live staking (2-4 feet apart)
- Bare-root planting
- Container plant material
- Permanent seeding

Do Not Mow Streambanks

- Promotes bank stability
- Flood flow reduction
- Water quality
- Reduction of mosquito habitat
- Wildlife habitat

Evaluation and Monitoring

- Morphology
- Photo documentation
- Vegetation
- Bank stability
- Shading and temperature
- Fish and invertebrate data

Links and Resources

- USDA Stream Restoration Design: https://directives.sc.egov.usda.gov/viewerFS.aspx?id=3491
- Wildland Hydrology Resources: https://wildlandhydrology.com/resources/
- NC State University Dept. of Biological and Agricultural Engineering Extension Publications: https://www.bae.ncsu.edu/extension/extension-publications/
- Texas Stream Team at The Meadows Center for Water and the Environment: http://txstreamteam.rivers.txstate.edu/
- Invasives Database: http://www.texasinvasives.org/invasives_database/
- Texas A&M AgriLife Ecological Engineering Group: www.facebook.com/agrilifeecoeng/
- The Dallas Center's Urban Ecological Engineering Program: http://dallas.tamu.edu/extension/engineering/

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