

OFMA 2025 Annual Conference

Navigating Floodplain & Drainage Challenges for Transportation Projects & Common Floodplain Issues

September 22nd, 2025
1:00 – 1:25



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We engineer solutions that improve communities.



Hank Amen, PE, CFM
CLIENT MANAGER – WATER

- 24 years H&H experience
- Major Projects:
 - LBJ East DB, TxDOT DAL
 - The Southern Gateway DB, TxDOT DAL
 - SH360 DB, TxDOT FW
 - 9 On & Off System Bridges, TxDOT
 - SH71 at Halfway Creek, TxDOT AUS
 - FW Naval Airforce Station - JRB – Joint Land-use Study (JLUS), NCTCOG
 - Kidd Springs, Drainage Study, COD/DWU



Andrew Schimenti,
PE, CFM, ENV SP
SENIOR ENGINEER – WATER

- 12 years H&H experience
- Major Projects:
 - Fort Worth Central City Flood Control Project
 - Customs and Border Protection Patrol Roads FY18 Program
 - Dallas/NCTCOG FEMA CTP FY14-FY19
 - TxDOT LBJ East
 - Dyess Air Force Base – Little Elm Creek Restoration
 - Denton Creek Master Plan, Coppell, TX



ABOUT US

Founded in 1956 on the very mindset that drives us today, we're here to improve communities by making them more sustainable, better connected, and more efficient. Simply put, we work to leave the world better than we found it.



Since 2018, we ranked in the **Top 100** on *Engineering News-Record's* national list of Top 500 Design Firms.

FOOTPRINT GROWTH

1956: Nebraska

1998: Missouri

1999: Arizona

2000: Colorado

2004: Iowa

2004: Kansas

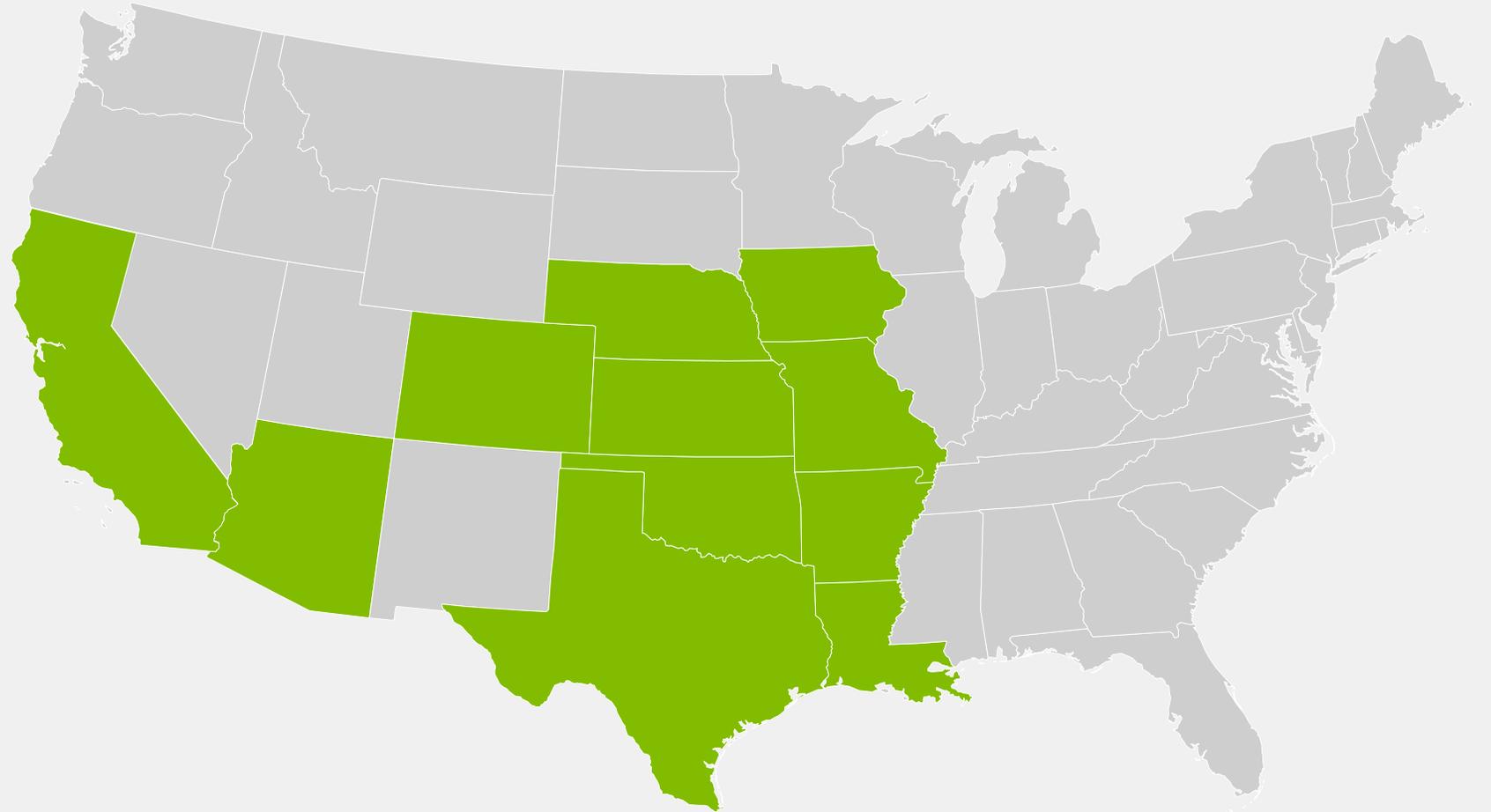
2013: Oklahoma

2018: Arkansas

2019: Texas

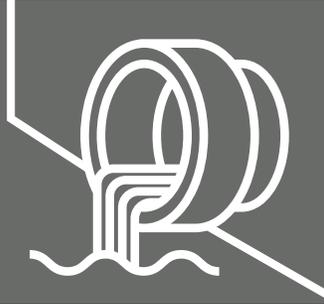
2025: California

2025: Louisiana



1

H&H Design Transportation



- Hydrology
- Common Hydraulic Software for Delivery of H&H projects
- Bridge Hydraulics
 - On & Off System Requirement
 - 1D vs. 2D
- Storm Drainage Evolution
- SH71 and Halfway Creek

2

STREAM STABILITY



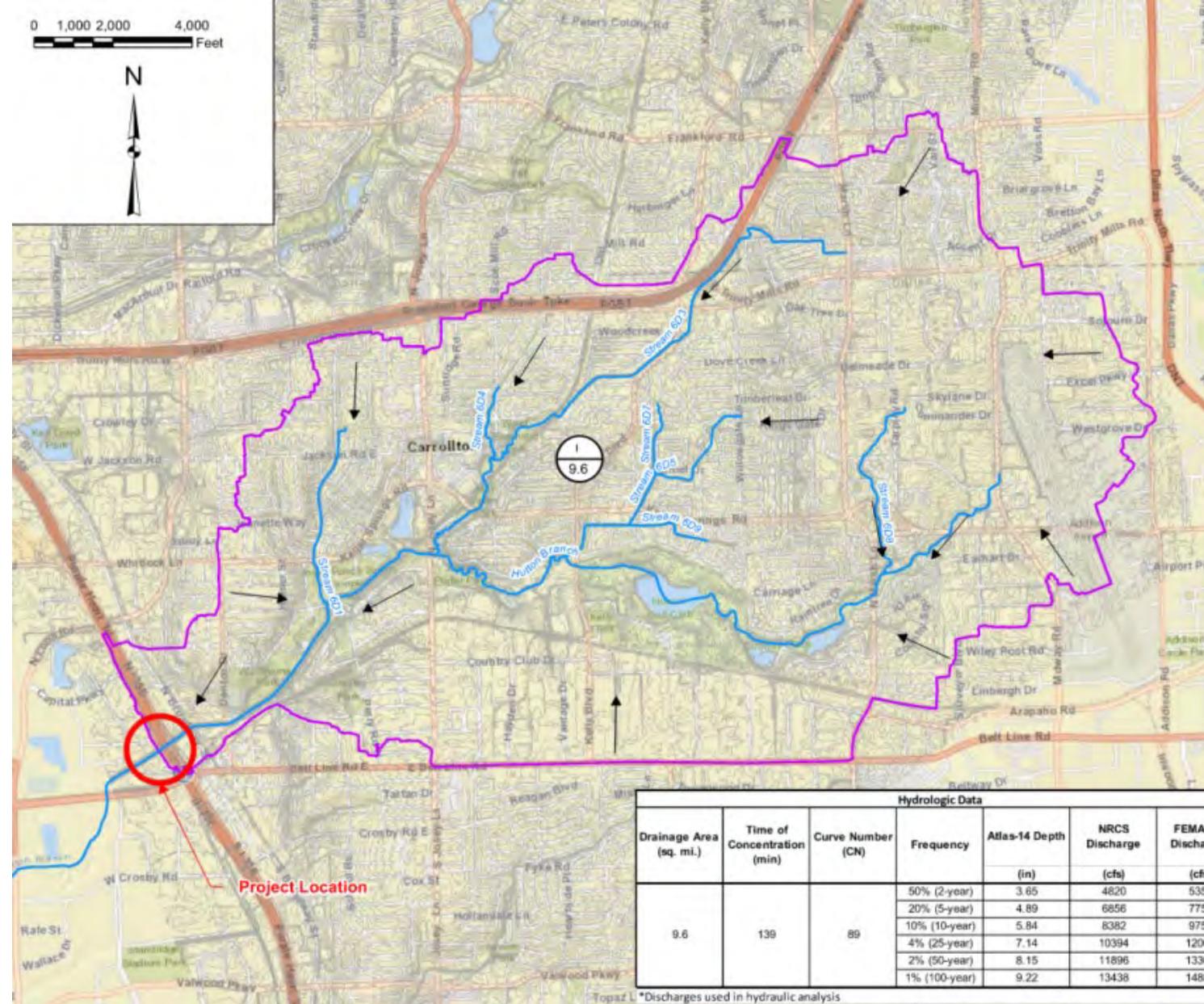
- Scour Analysis
- Channel Evolution Model
- Common Causes of Failure
- Hazards and Risks
- Geotechnical and Geomorphological investigation
- Stabilization techniques and applications



H&H Design Transportation

Hydrologic Analysis Methods

- Previous Studies/FEMA FIS Reports
- Rational Method <200ac
- Unit Hydrograph Method (HEC-HMS)
 - Drainage Area between 100-ac and 10 sq. mi.
 - Rainfall Source – NOAA Atlas-14
 - Storage, Losses and Timing
 - Rain - on - Grid
- USGS Gage Analysis (HEC-SSP, Peak FQ)
- Regional Regression Equations
 - DA > 10 sq. mi, not used for urban watershed with reservoirs



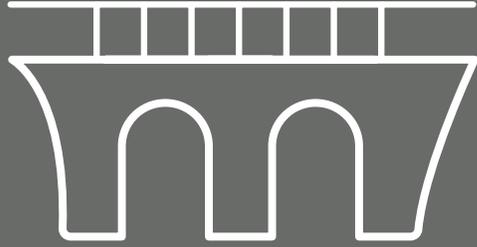
Common Hydraulic Software for Delivery of H&H projects

Application	Use	Value
USACE HEC-RAS	Models streams and bridge/culvert crossings. Traditional steady-state 1D models will be used for well-defined channels with connected floodplains that follow the stream planform.	Efficiently sizes culverts, bridges, and channels and performs scour calculations.
USACE HEC-SSP	Performs statistical analysis of hydrology using historical stream gage information. Uses Bulletin 17C procedures to estimate frequency discharges.	Calibrates hydrologic parameters to meet the expected range of storm frequencies. Validates city regulatory and FEMA effective discharges.
Innovyze XPSWMM/ CHI PCSWMM/ EPA SWMM	Provides continuous and event-based hydrologic analysis for runoff generation and water quality; includes finite volume, gridded 2D mesh, hydrology, hydraulics, and storm drainage.	Optimizes stormwater design and allows for evaluation of downstream impacts.
FHWA Hydraulic Toolbox	Performs channel lining material analysis, weir analysis, curb and gutter capacity, Rational Method runoff analysis, detention basin analysis, riprap analysis, rock sediment gradation analysis, median/ditch drop inlet capacity, bridge scour analysis, and horizontal grade inlet calculations.	Verifies culvert, bridge, and/or channels designed with HEC-RAS.
FHWA HY-8	Computes hydraulic data for culvert design.	Sizes small culvert crossings (clear opening width less than 20 feet) not located in studied streams.
Bluebeam Revu	Manages and stores documents for plan review and collaboration.	Facilitates internal QA/QC of construction plans, documents, and reports.
Microsoft Project	Tracks project milestones and deliverables and allows for easy scheduling of meetings.	Efficiently develops project schedules, tracks progress, and allows team members to manage budget and workload transparently.
Bentley ProjectWise, Microsoft Sharepoint, Microsoft OneDrive	Options for managing and sharing project data with various clients and team members.	Stores data in a centralized location to assist with versioning.

Common Hydraulic Software for Delivery of H&H projects

Application	Use	Value
Bentley Microstation OpenRoads Designer with Drainage Utilities Extension	Creates existing and proposed surfaces, drainage designs and models, H&H computation flex tables, and plans. Preferred design software for DWU projects.	Optimizes alignment adjustment, surface contouring, and structural design. Additionally, the Drainage Utilities (DU) model extension allows for 3D modeling to identify utility conflicts, check cover depths, and ensure output protection while optimizing drainage design based on hydraulic requirements.
Autodesk AutoCAD Civil 3D	Provides surface modeling, site design, survey processing, and survey documentation.	Efficiently processes survey data and creates initial surfaces.
ESRI ArcGIS Pro	Pre-processes hydrologic parameters, including drainage area boundaries, land use, percent impervious surfaces, soil types, and longest flow paths. Delineates environmental constraints and prepares permitting documents.	Aids in communicating project plans and updates. Provides access to existing DWU storm drain networks, floodplain limits from Cooperating Technical Partners (CTP) models, and landowner information for property lines.
USACE HEC-HMS	Performs hydrologic simulations by defining sub-basin sizes and characteristics, routing reaches, reservoir and detention elements, and NOAA Atlas 14 depth-duration precipitation.	Compute SCS hydrology by leveraging the city's effective models or generating a new hydrologic modeling system (HMS) model following the City of Dallas Drainage Design Manual (September 2019).

BRIDGE HYDRAULICS



Off-system Bridges

- Typically, Un-studied A-Zone
- Less stringent hydraulic criteria
 - Free-board and 1' of rise
- May allow Overtopping at overbanks

On-system Bridges

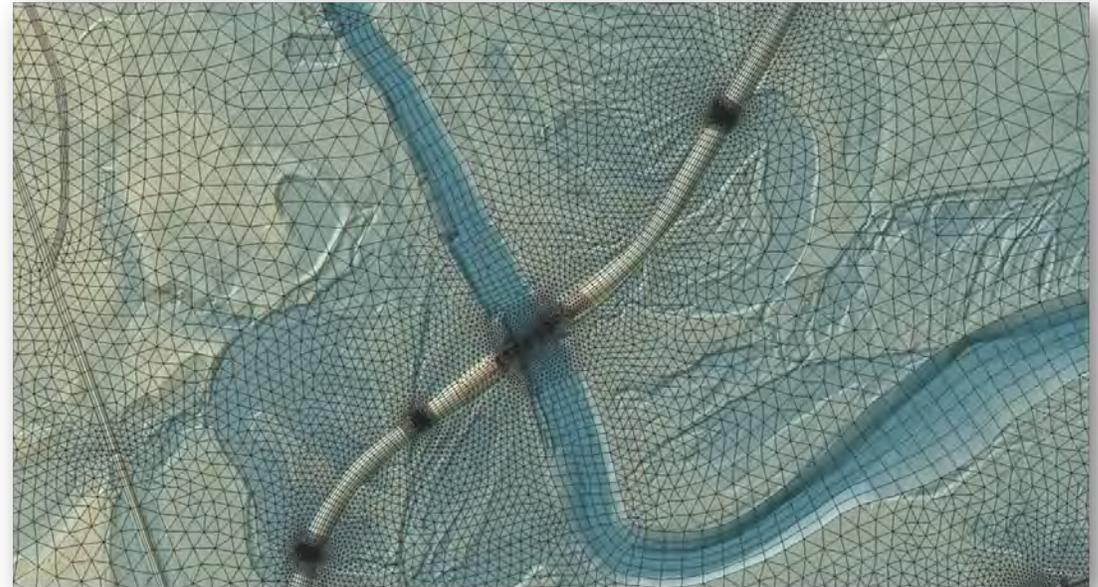
- Urban Conditions
- AE Zone, No-Rise Condition
- Split Flow Conditions wide floodplains
- Multiple Opening Hydraulics - Conveyance

Basic Modeling

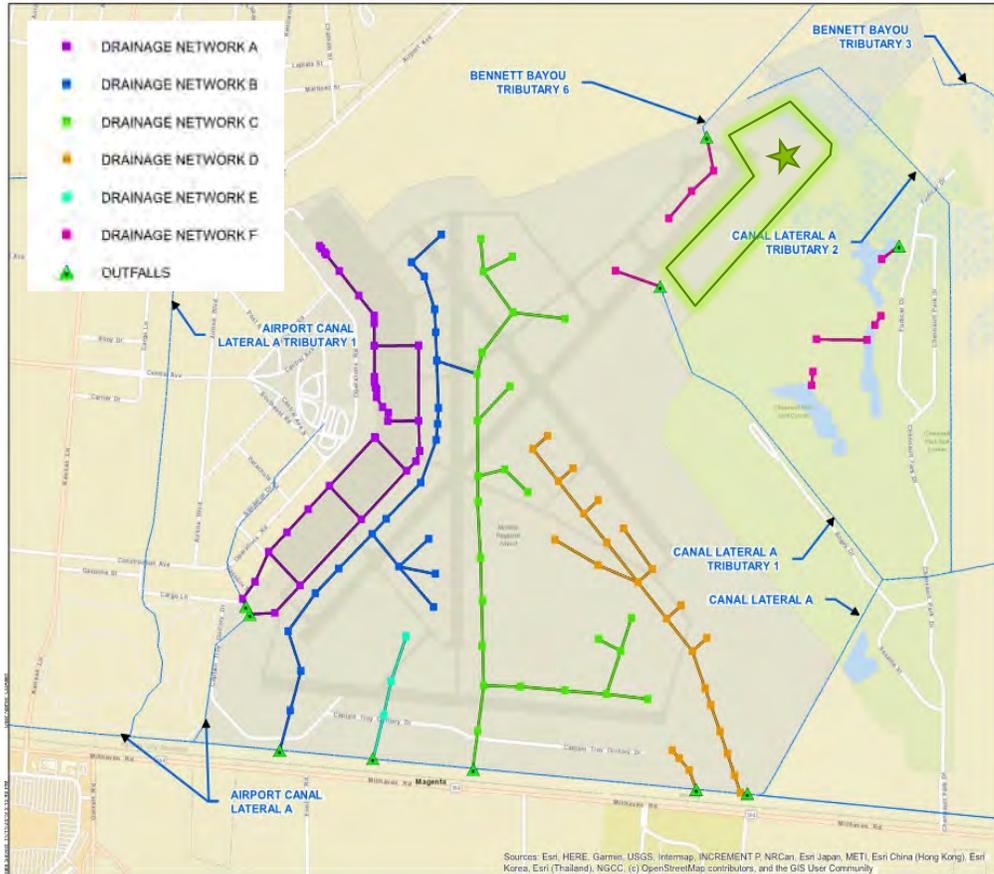
- 1D HEC-RAS Model
- (+) Utilize Cross-sections
- (+) Less data required
- (+) Easy and Quick to apply
- (+) Efficient and Familiar
- (-) Non-continuous terrain
- (-) Can't Simulate lateral Q
- (-) No variation in WSE

2D Modeling

- HEC-RAS 2D Model Unsteady
- (+) Continuous Terrain
- (+) Simulates Lateral Spreading
- (+) Momentum exchange
- (-) Requires more Data
- (-) More time and resources
- (-) Requires more experience
- (-) Challenges w/ 2D FEMA FW



STORM DRAINAGE



Storm-drainage Modeling for Transportation

- Traditional Geopak Drainage 1D Model
 - (+) Easy for production of plans and hydraulic data sheets
 - (+) Ties to Roadway geometry (.GPK) and COGO
 - (+) Utilizes Drainage Cell Library (.CELL)
 - (-) Outdated Software, no longer used on TxDOT
- Open Roads Drainage Utilities (DU) 3D Model
 - (+) Integrates with new Roadway ORD Model
 - (+) Conflicts can be avoided with utilities and bridges
 - (+) All hydraulic data is saved in cells not separate tables

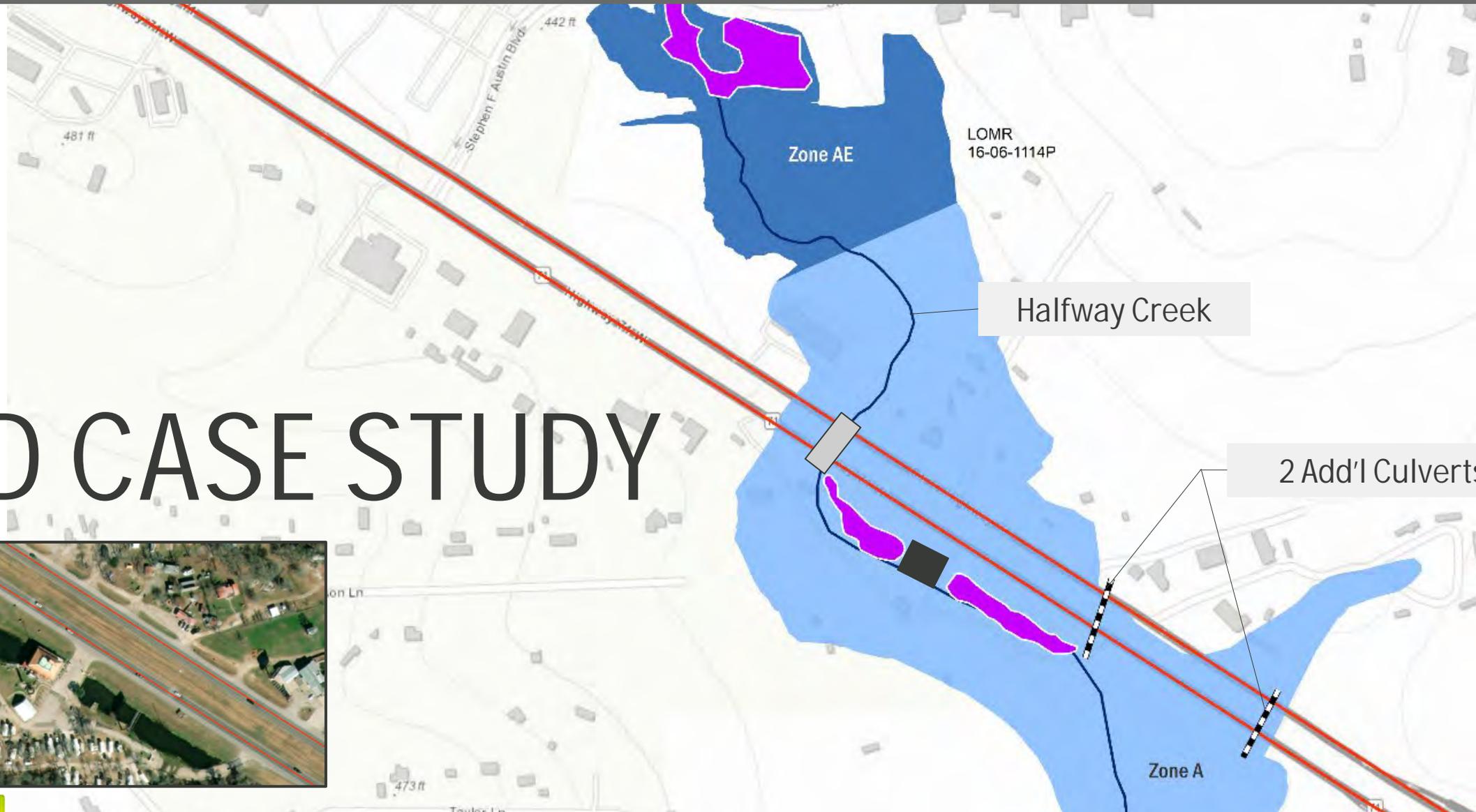
- (+) Geopak Reports are replaced by Flex-tables
- (-) Requires experience designer

(-) Plan production within the model

Storm-drainage Modeling for H&H Studies

- XPSWMM / PCSWMM / Storm CADD / ICM
- (+) Can Combine storm-sewer & surface water
- (+) Provide detailed information of inflow/outflow to and surcharge from storm sewer system
- (+) Surface water modeling can be 1D or 2D
- (-) Expensive

2D CASE STUDY



Model Review Findings (Schematic)



Hydrology – Update sub basins with storage/routing, move to HMS



Flow Increase Downstream, storage loss upstream of bridge



Hold current Base Flood Elevation within ROW, no rise 1% WSEL



Complex - split flow, multiple tributaries, hydrology/timing



Eliminate road overtopping of SH71 (flooding initiates at 10% AEP)

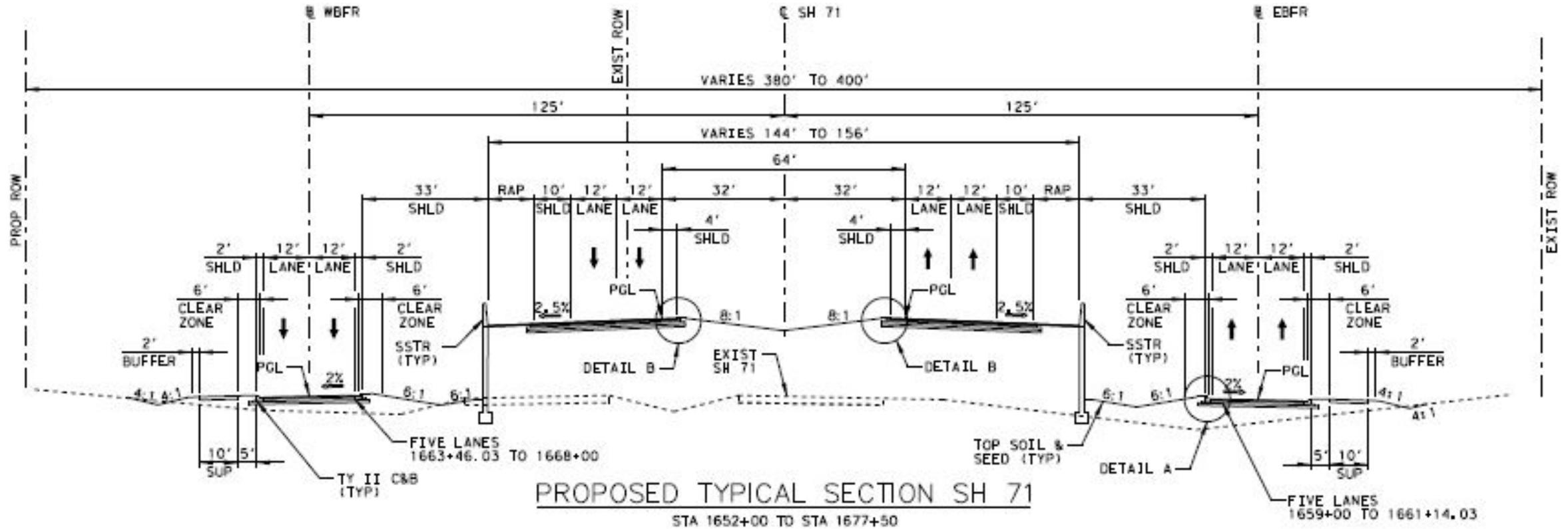


Flooding Complaints on both sides of SH71 – Hargis Memo



Existing Structure straddling creek banks – 5 culverts & weir

SH 71 at Halfway Creek | Bastrop, Tx

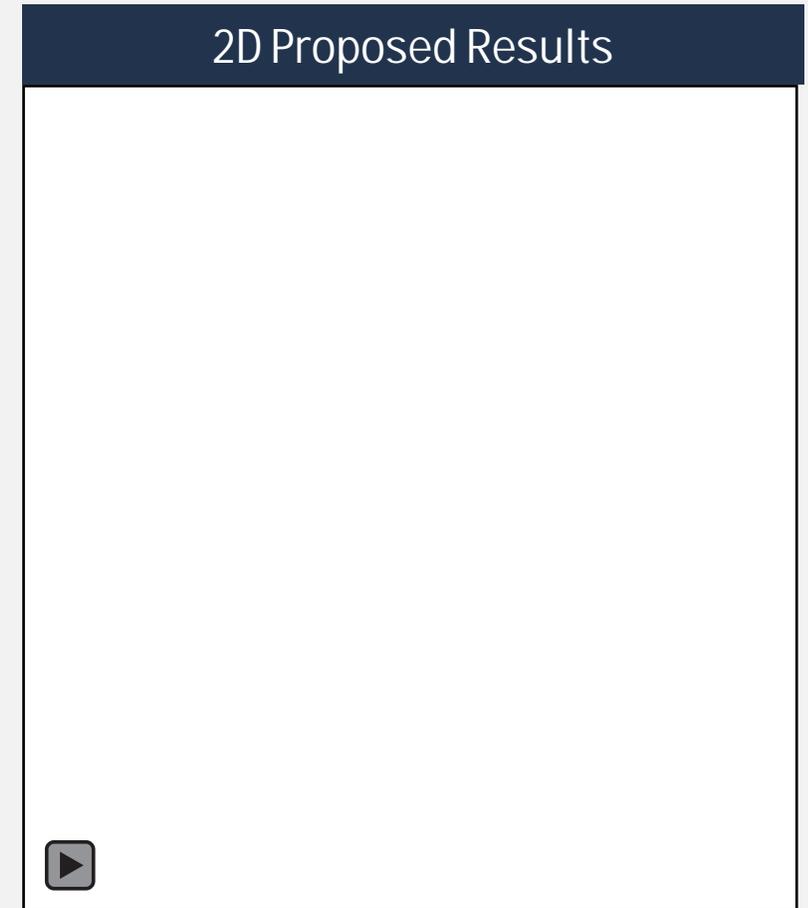
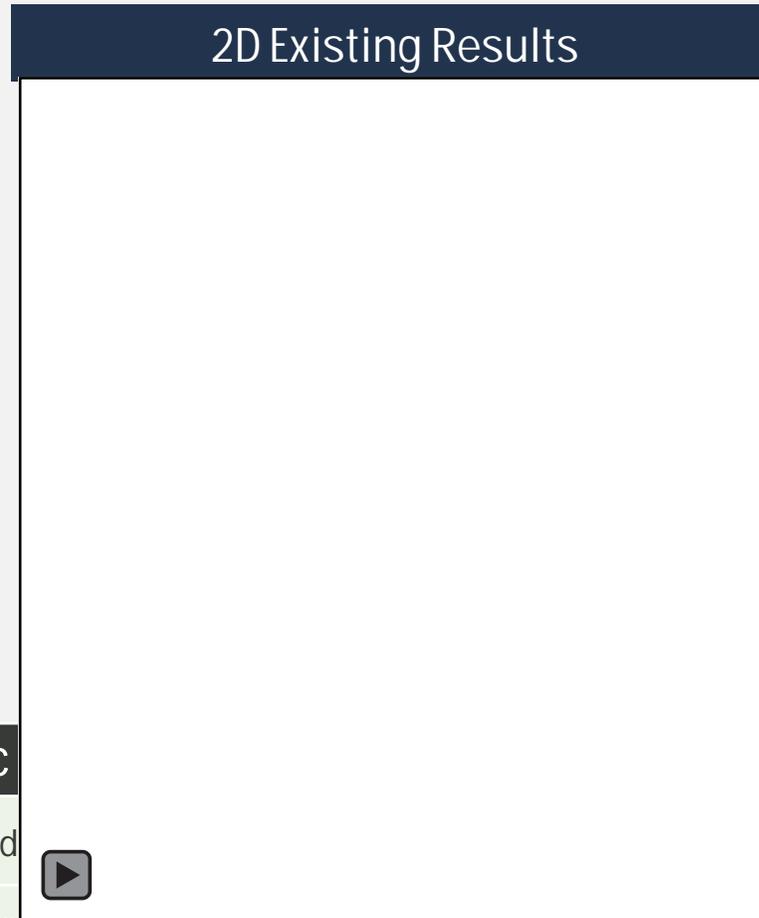


SH 71 at Halfway Creek | Bastrop, Tx

Utilized 2D modeling to:

- Solve a complex flooding issue of a Major Collector while still adding new Frontage and ML
- Optimized Bridge span lengths, Culvert size
- Minimize roadway embankment and retaining wall height.

Location	STRUCTURE	SCHEMATIC
1	Halfway Creek Bridge	35'-70'-35' Brid
2	Commercial Culvert 6	Extend exist 36" RCP (5) 10x5 MBC
3	Unnamed Tributary	(3) 9x5 MBC 70' Bridge



Scour & Stream Stability



Scour at Bridges

What is the most common cause of failure of bridges?

Scouring of material from bridge foundations

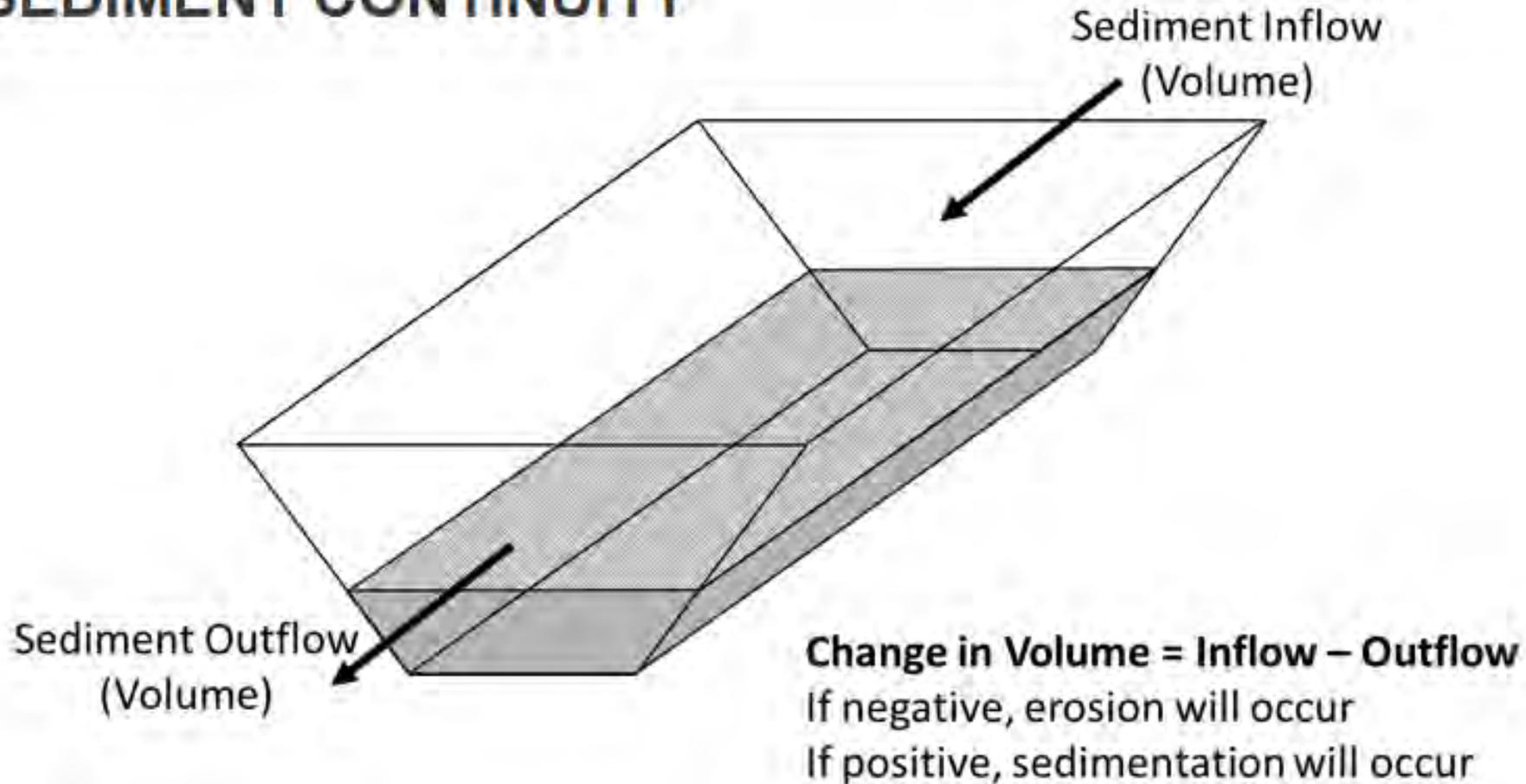
Scour Definition:

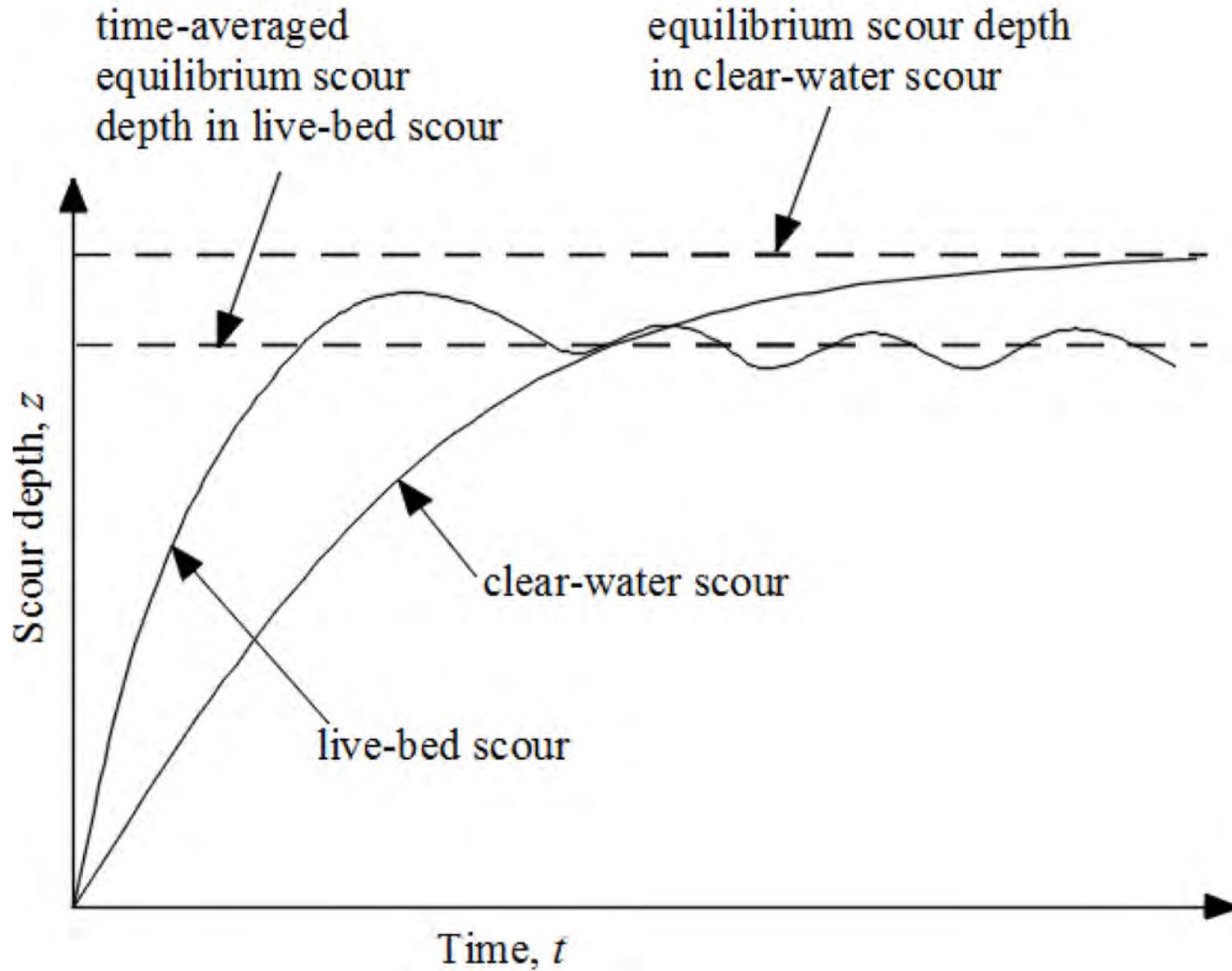
Scour is the result of erosive action of running water, excavating and carrying away materials from the bed and banks of streams



Scour is a Sediment Transport Problem

SEDIMENT CONTINUITY



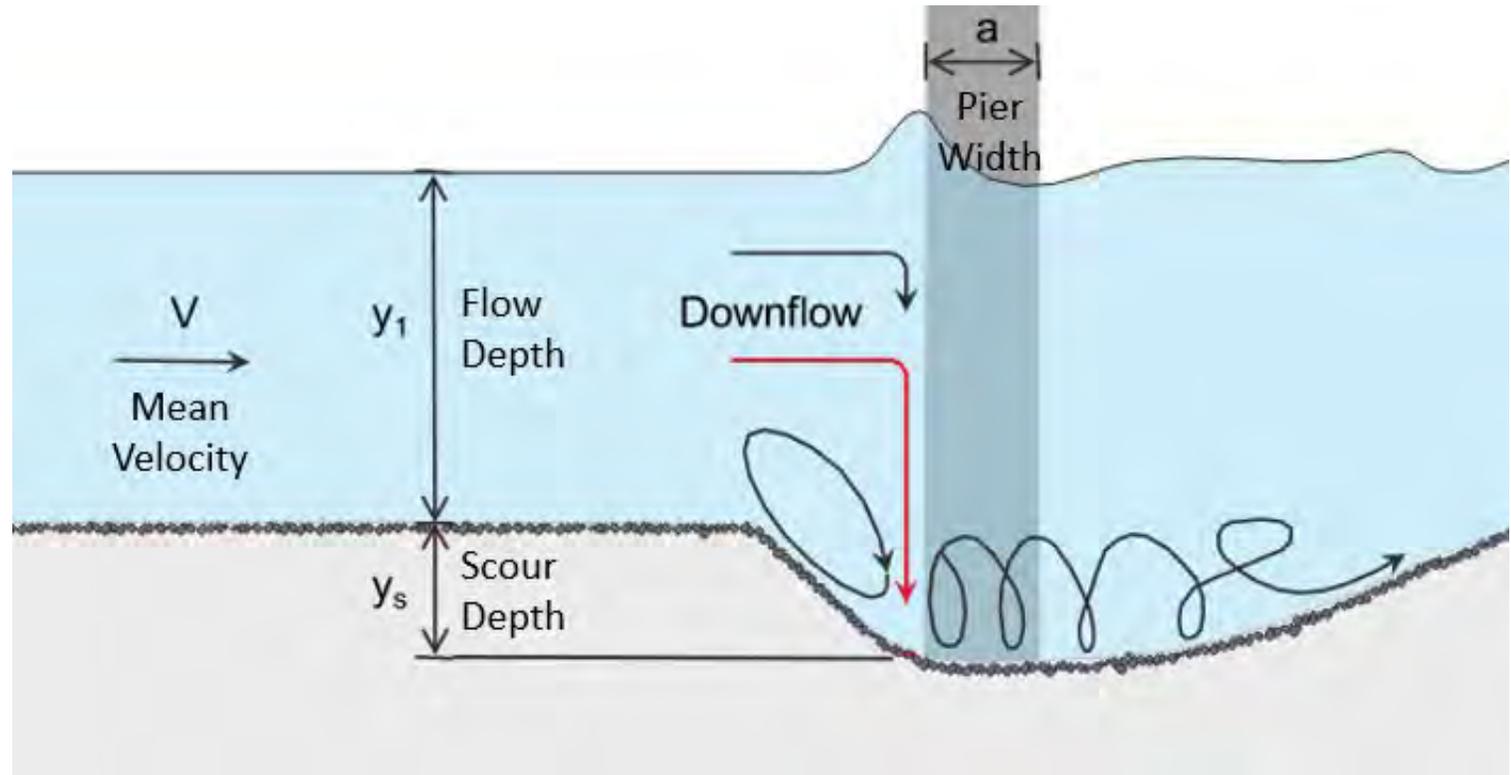


Contraction Scour Conditions

- Live-bed Scour
- Clear-water Scour

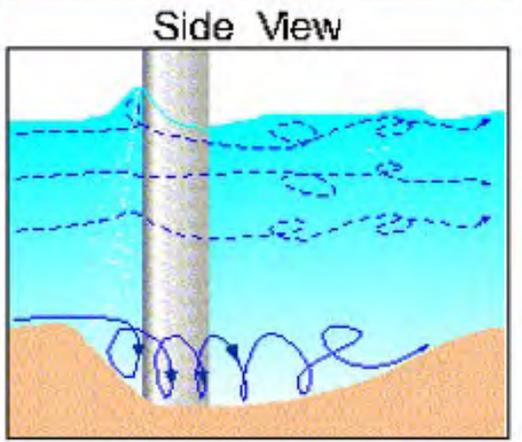
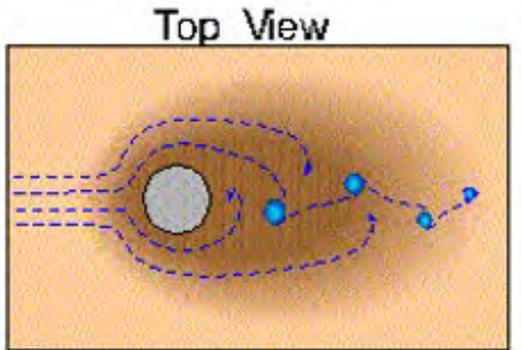
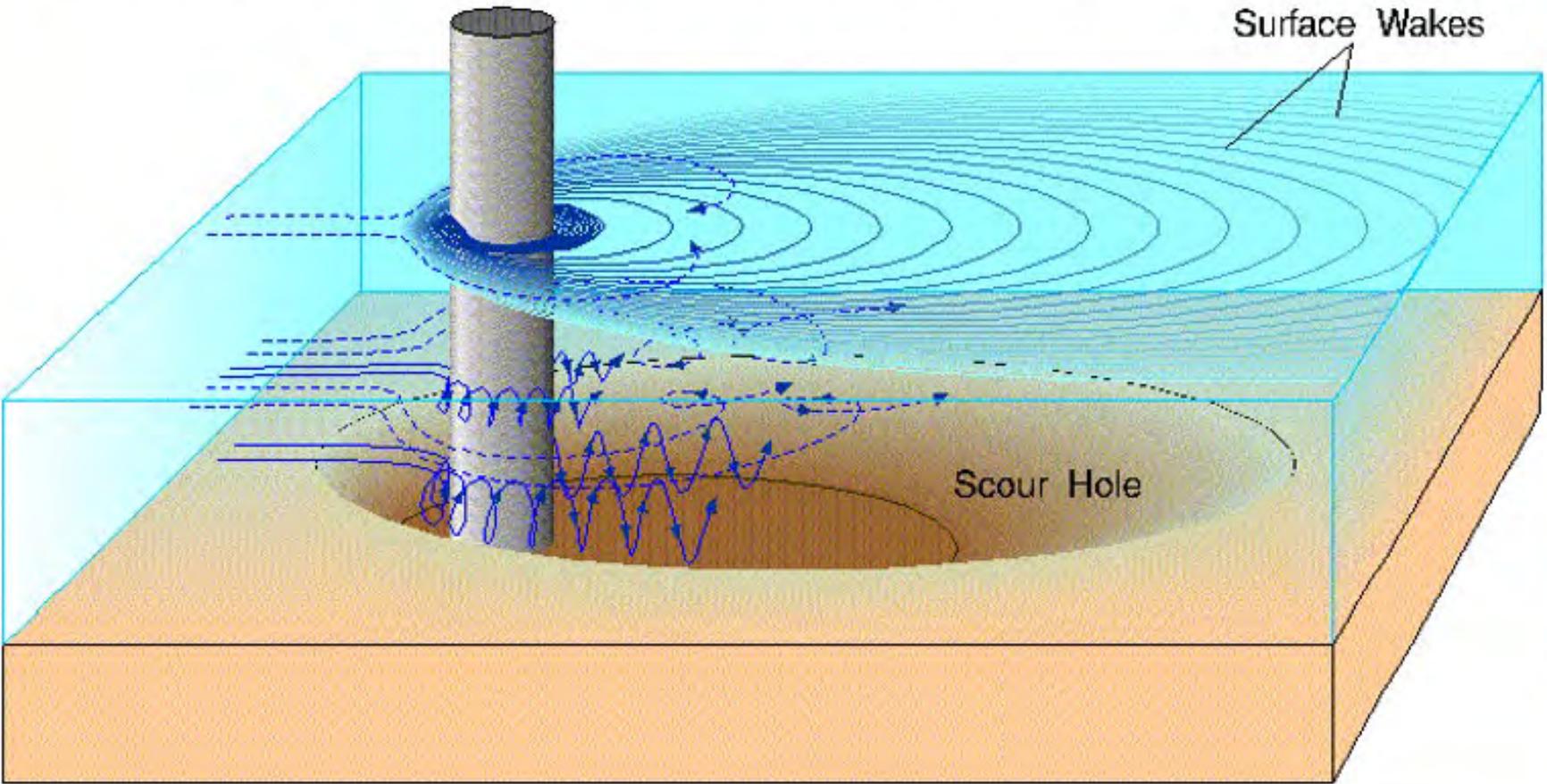
Pier Scour Conditions

- Function of:
 - Bed Material Characteristics
 - Bed Configuration
 - Flow Characteristics
 - Fluid Properties
 - Pier/foot Geometry



Local Scour - Pier

Horseshoe and Wake Vortices around a Cylindrical Element

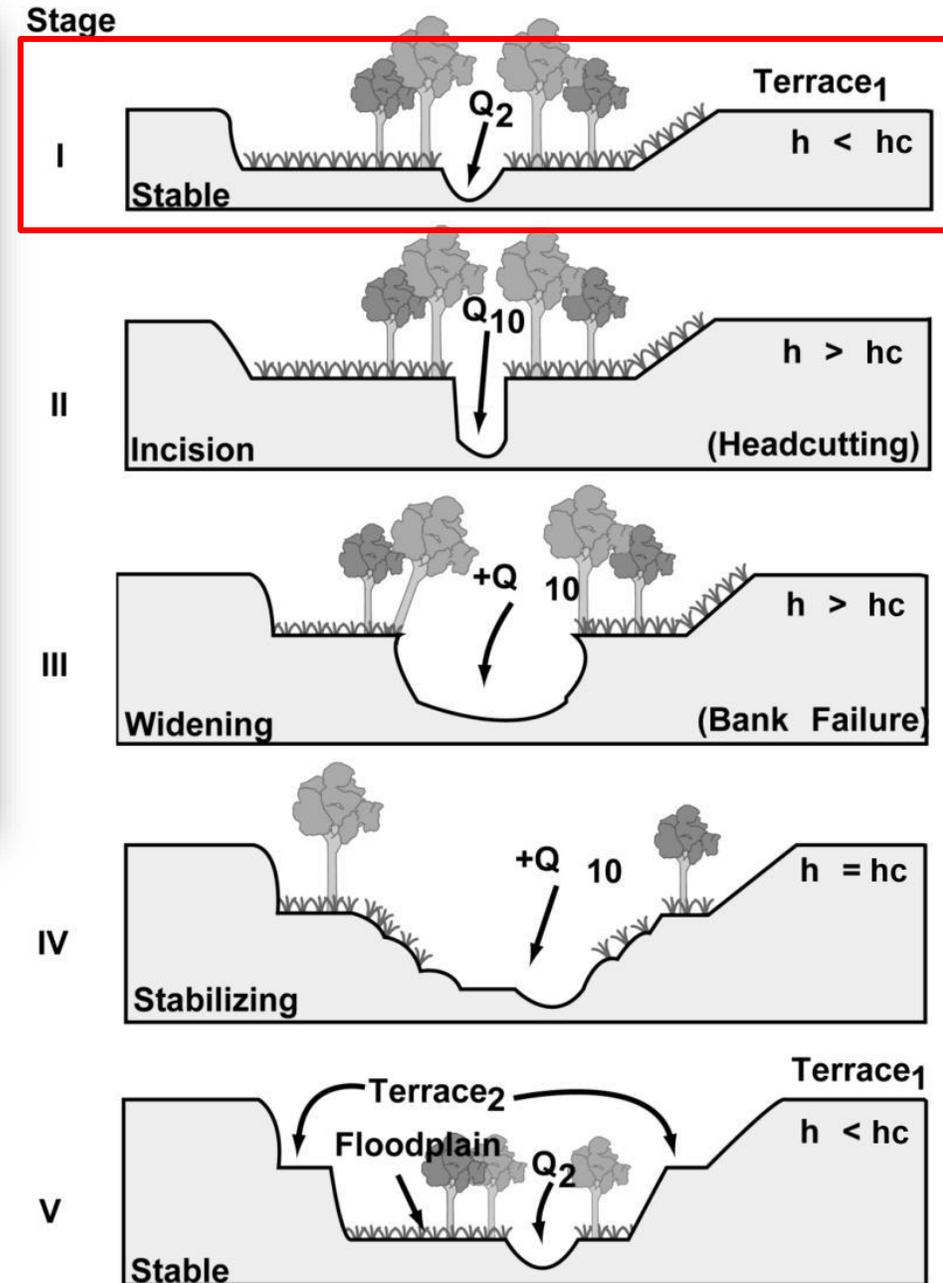


- Horseshoe Vortex
- - - Wake Vortex



East Fork Trinity River, Seagoville

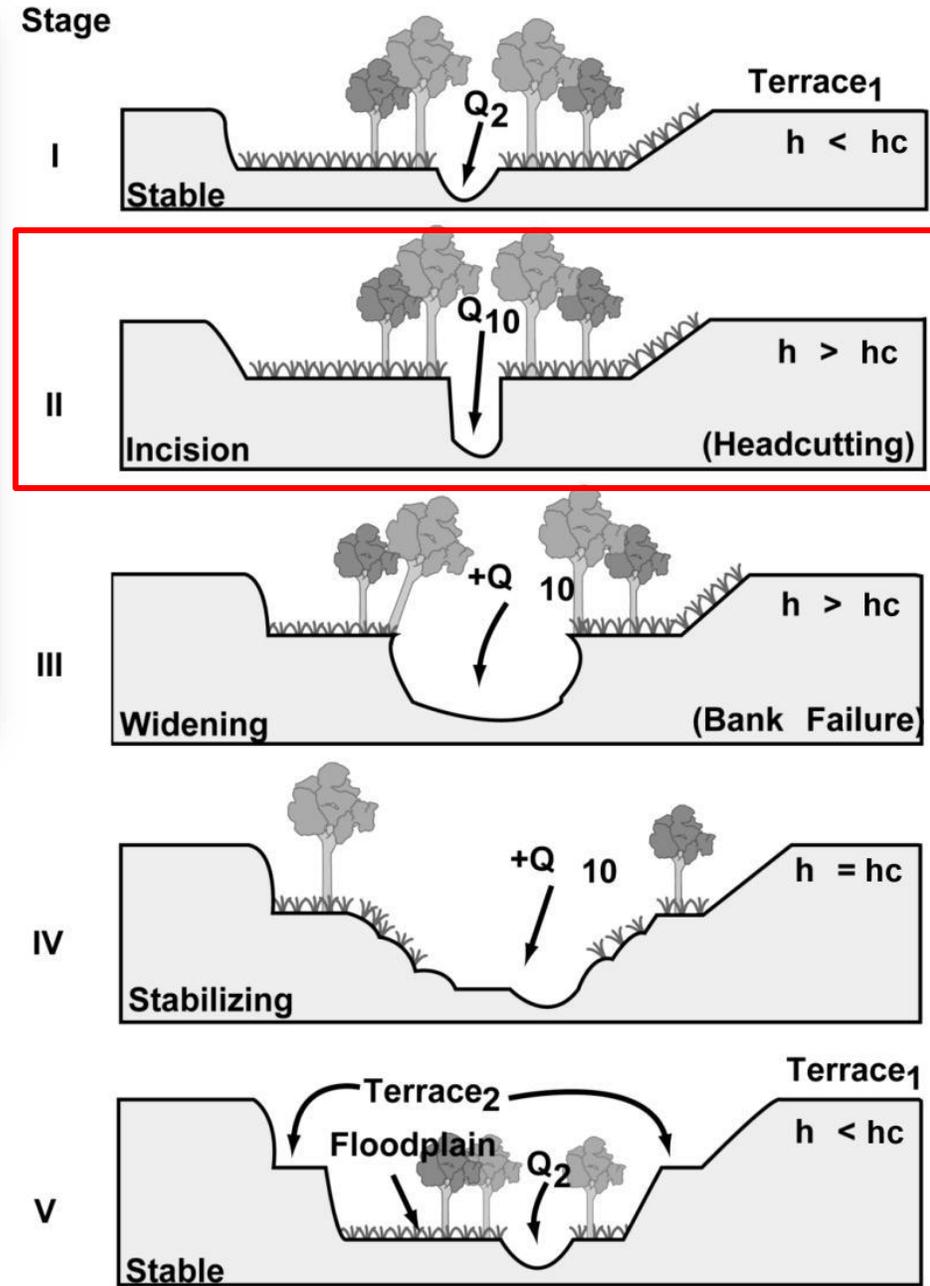
Channel Evolution Model





Denton Creek, Grapevine

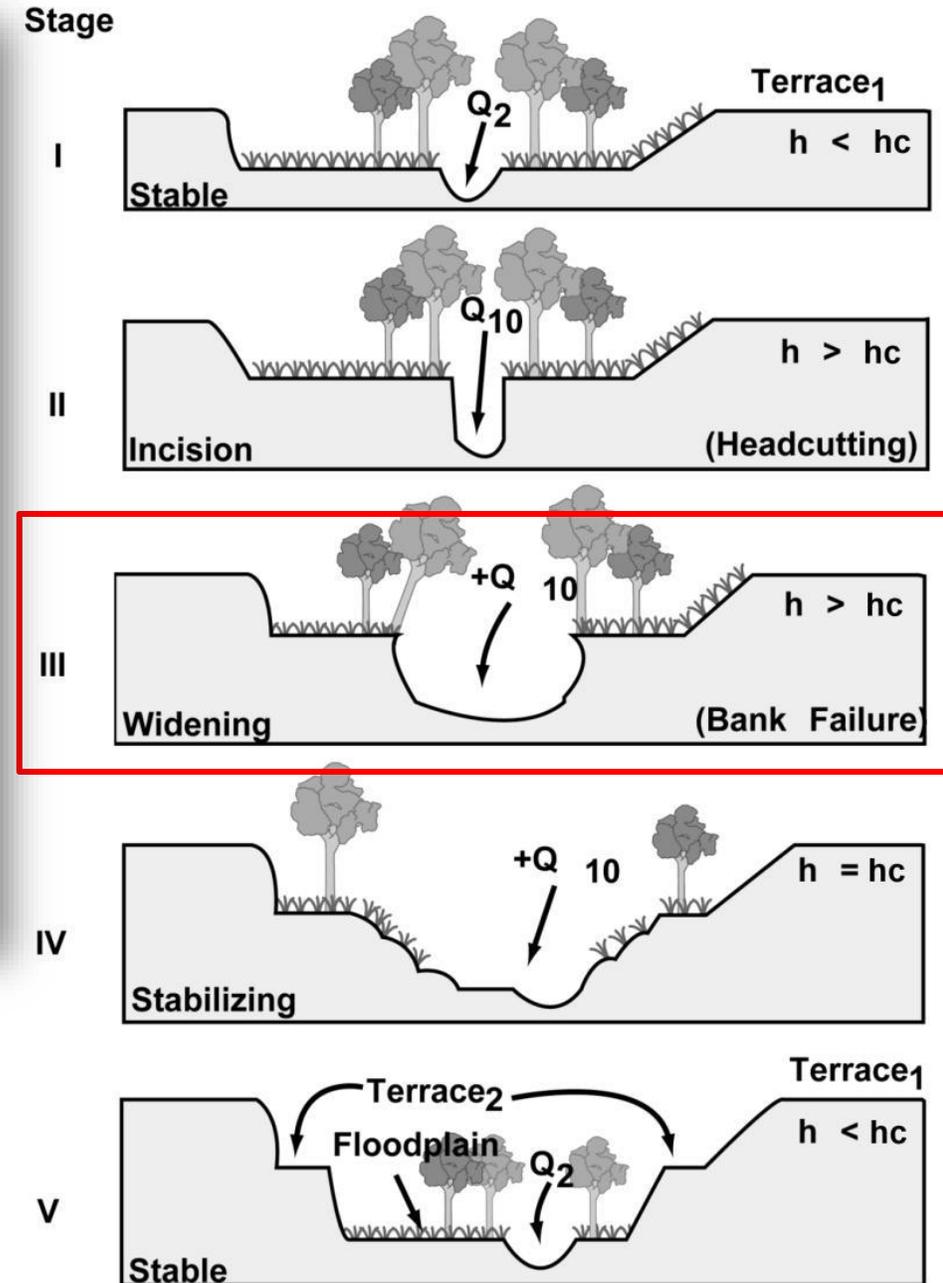
Channel Evolution Model





Denton Creek, Coppel

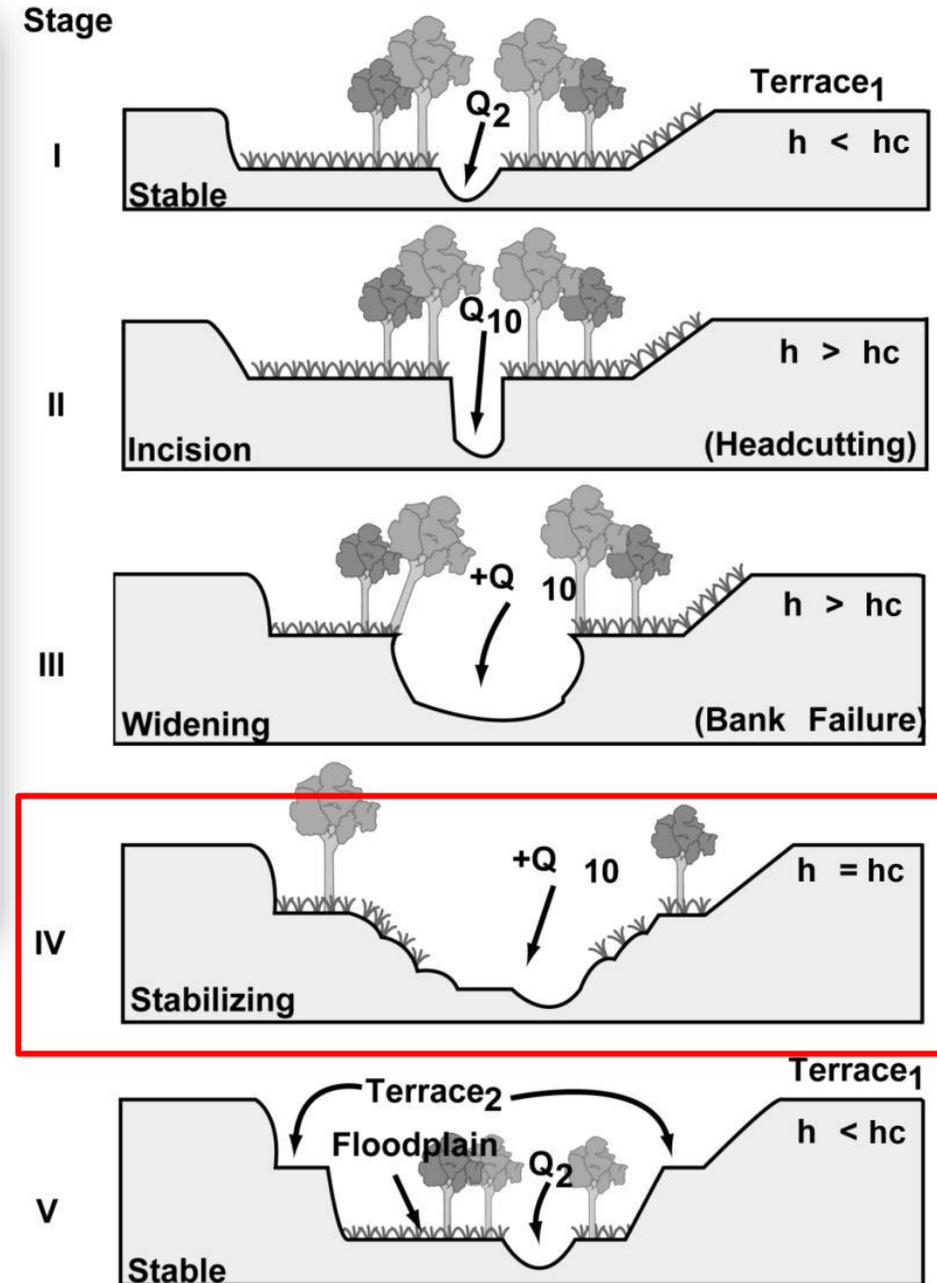
Channel Evolution Model





Hickory Creek, Balch Springs

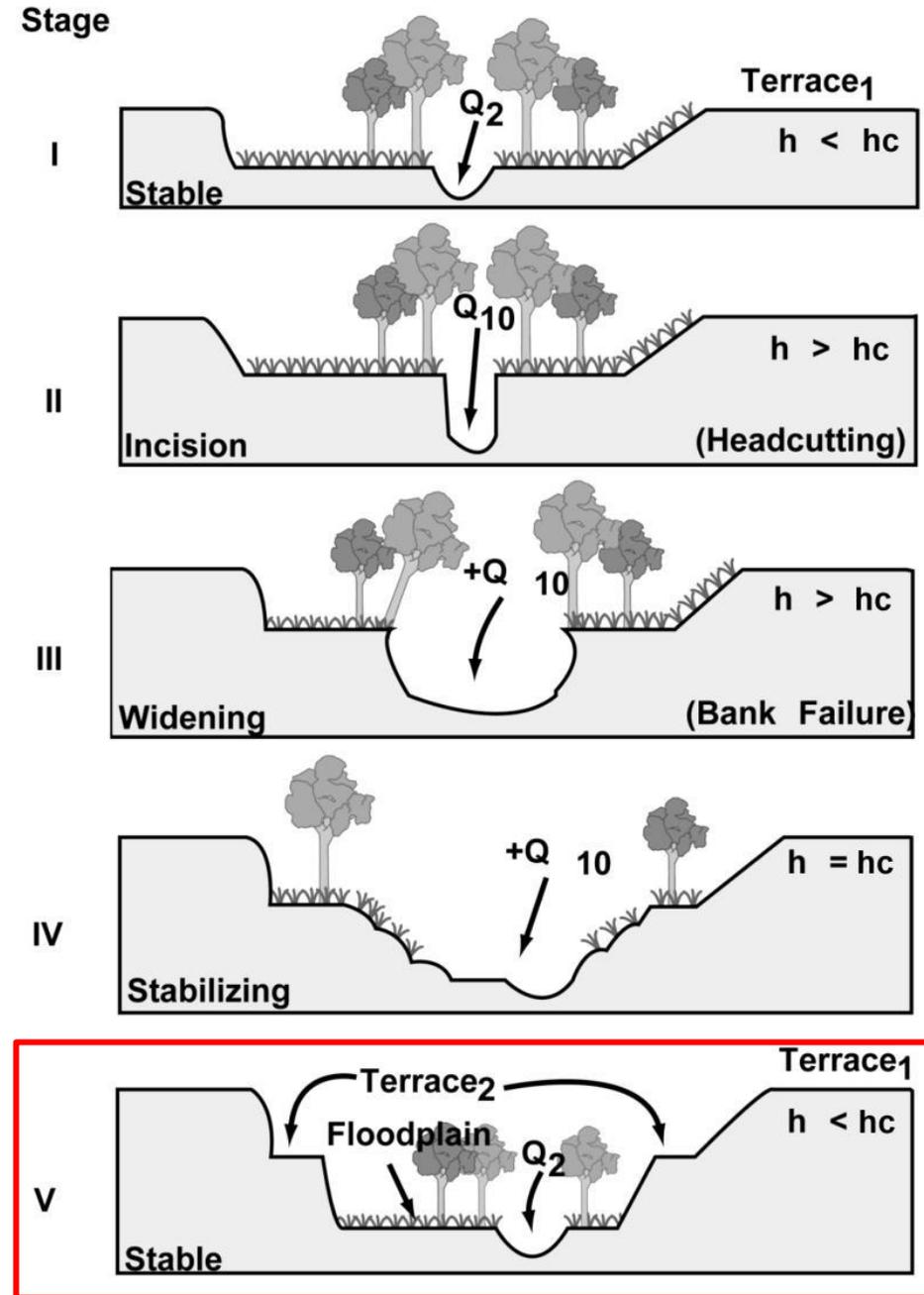
Channel Evolution Model

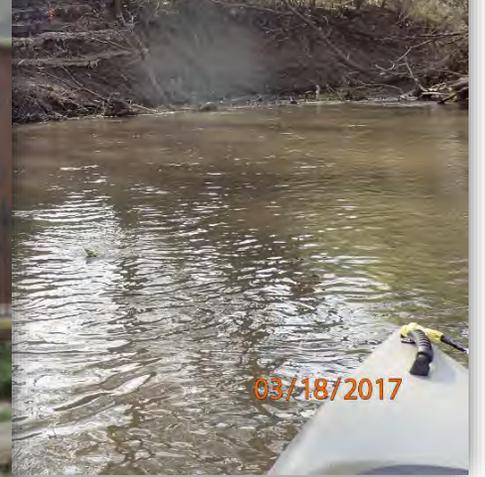




South Mesquite Creek, Mesquite

Channel Evolution Model

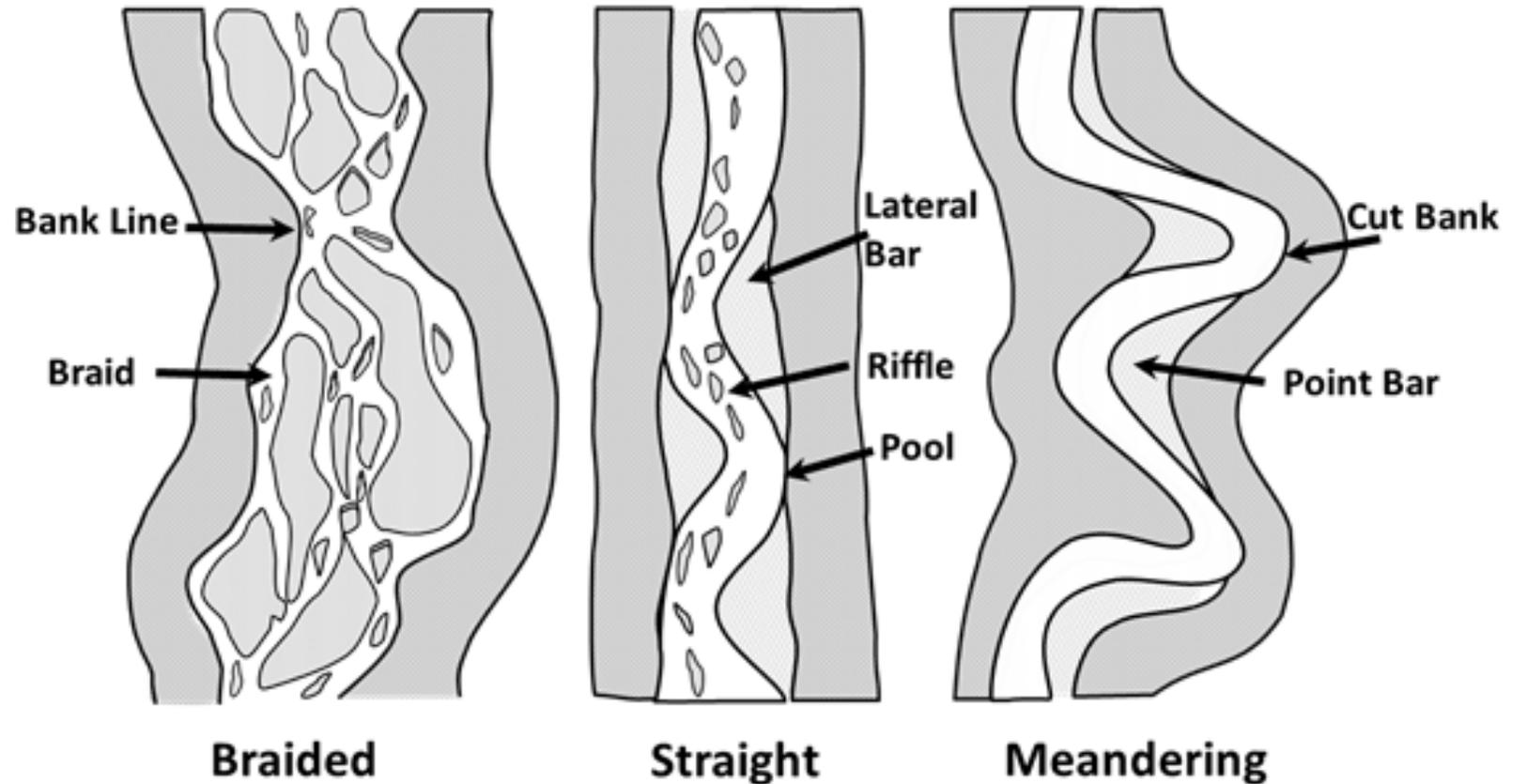




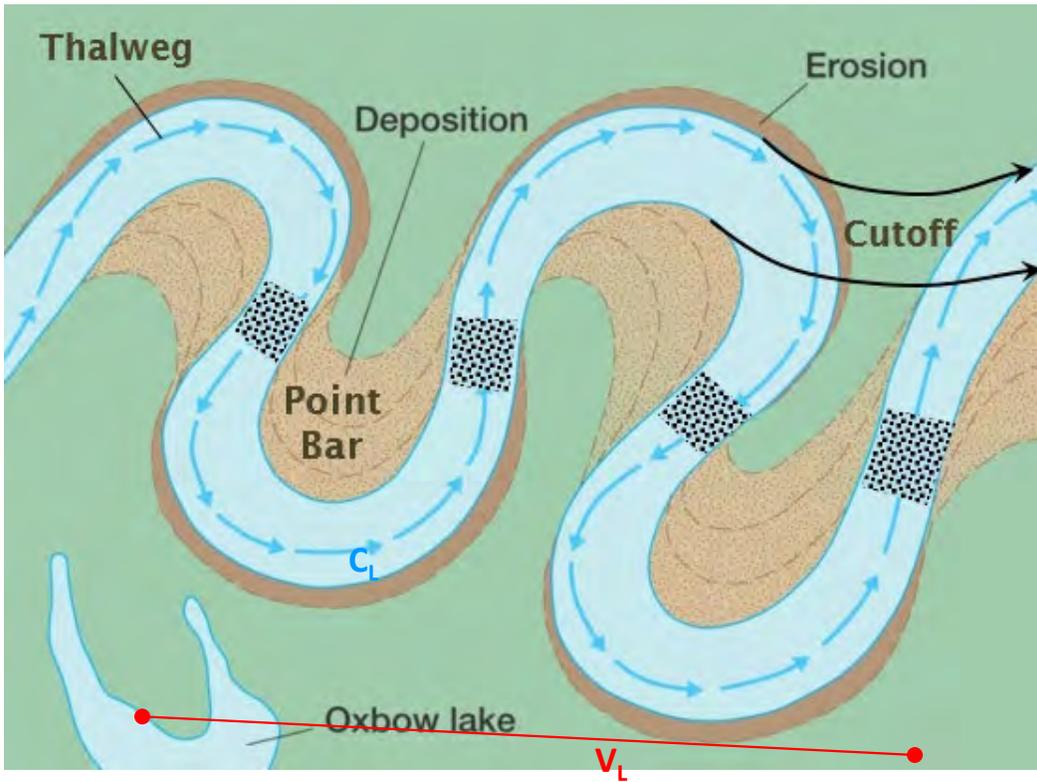
Instability and Stream Planform

Stream planform is:

- the shape of a stream when viewed from above
- useful in understanding stream morphology and potential stream response to change

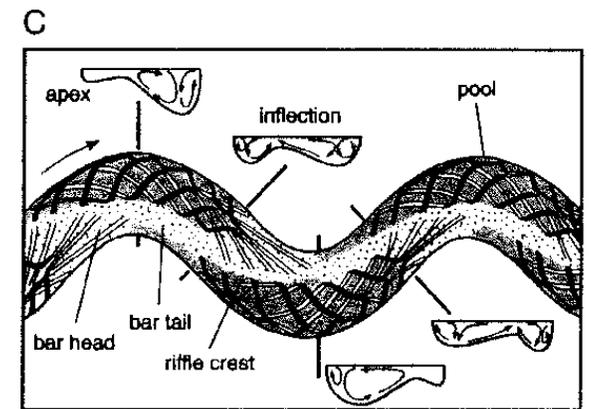
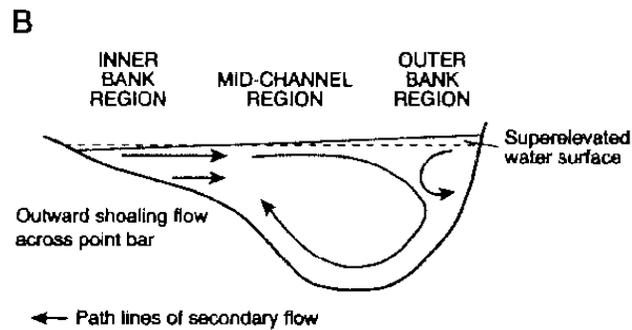
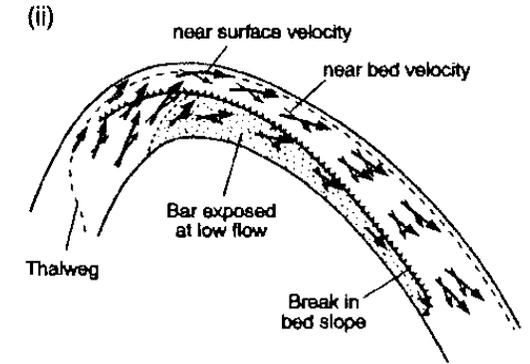
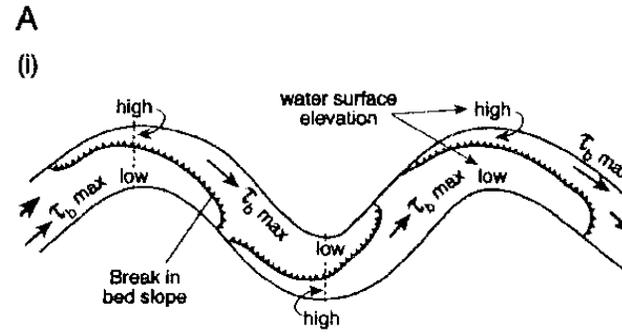


Meandering Streams



Features

- Thalweg
- Sinuosity (CL/VL)
- Point bar
- Cutoffs and oxbows



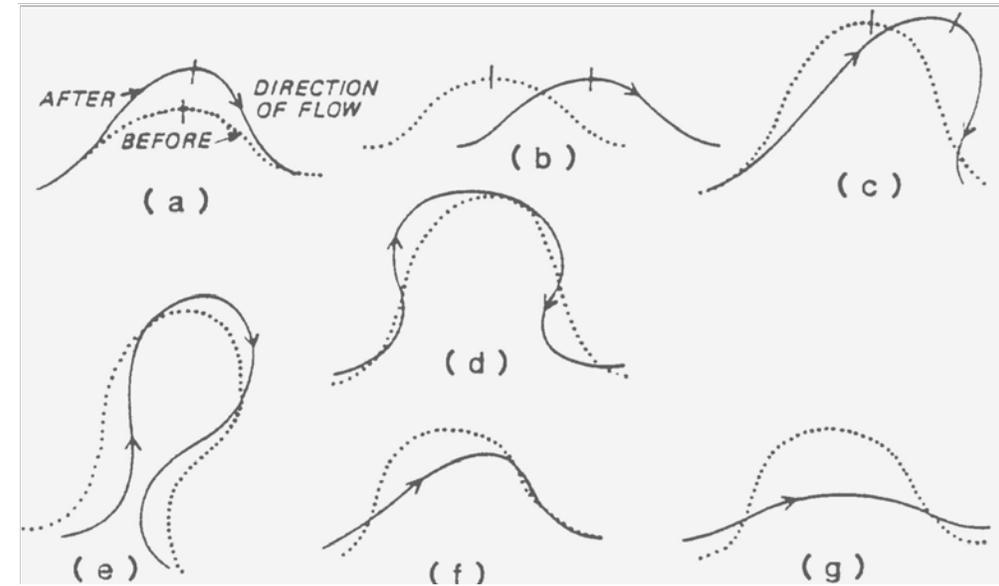
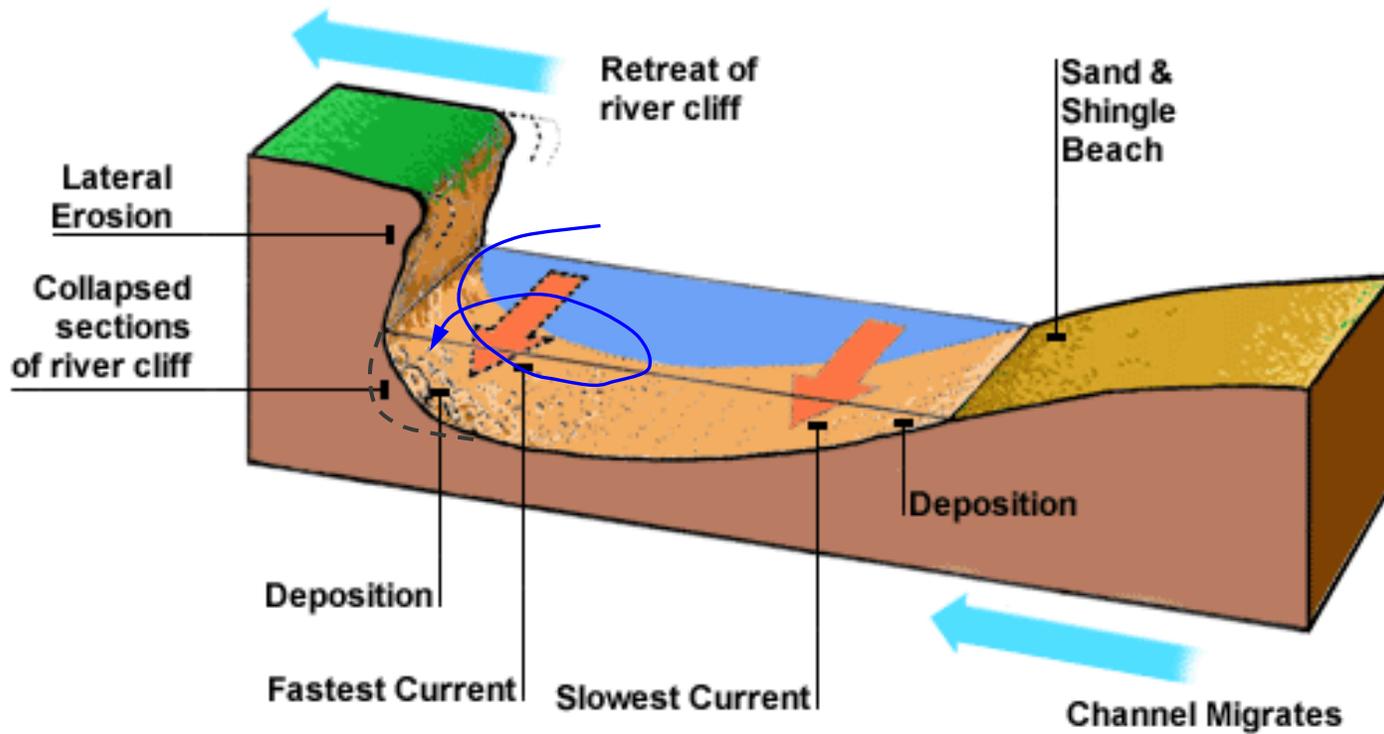
Flow Patterns

- Shear Stress
- Velocity

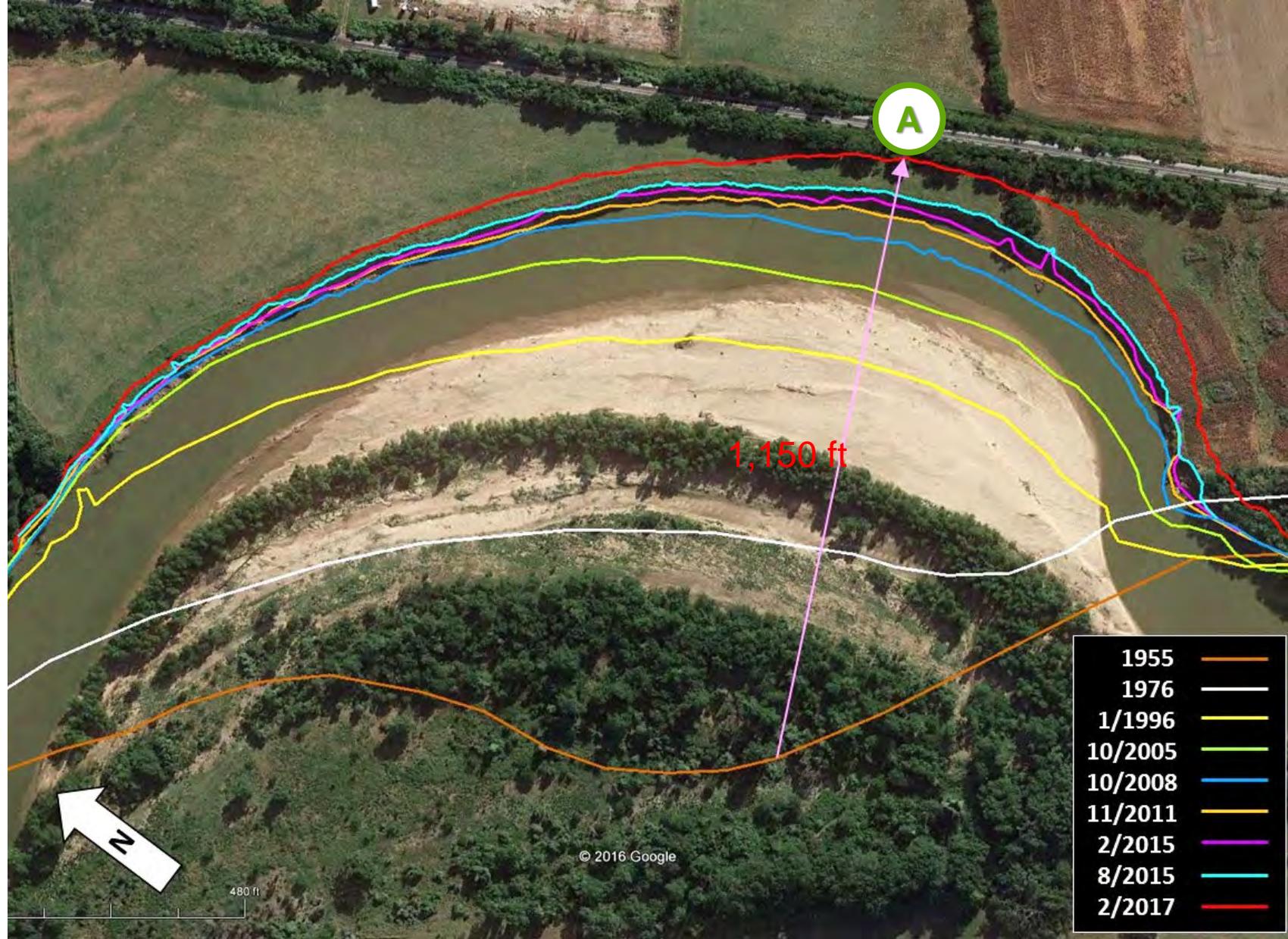
- Helicoidal Flow

Channel Migration

Defined as the **lateral shift** (perpendicular to the channel centerline) and **down-valley migration** of an alluvial river.



- a) Extension
- b) Translation
- c) Rotation
- d) Conversion to a compound loop
- e) Neck cutoff by closure
- f) Diagonal cutoff by chute
- g) Neck cutoff by chute



Brazos River near
Highbank, TX

2018



Brazos River near
Highbank, TX



Straight Streams

- Considered a transitional stage
- Many straight streams/reaches are man-made/modified
- Even in straight channels, the thalweg will meander

Walla Walla River, OR

1964

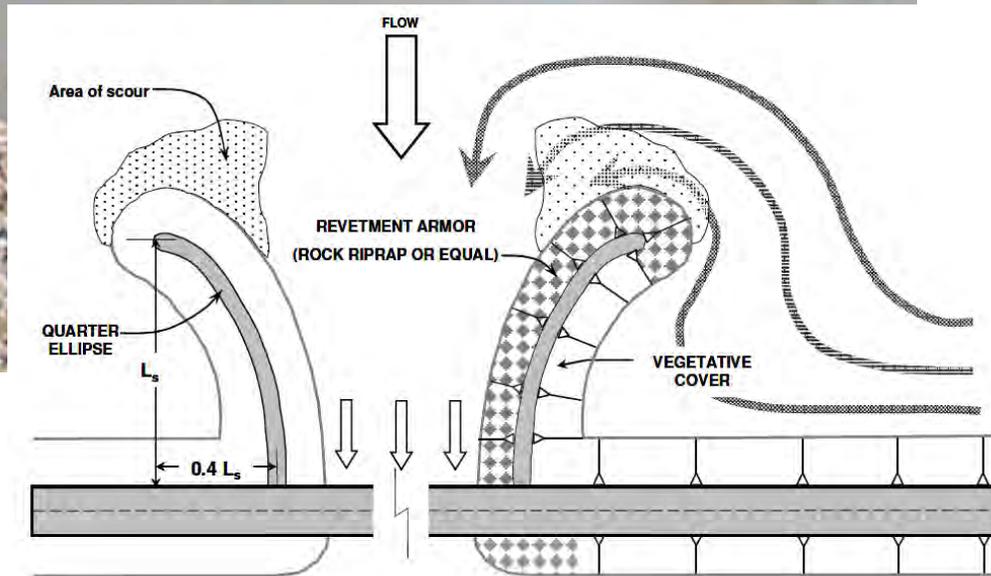


2015





HYDRAULIC COUNTERMEASURES: RIVER TRAINING STRUCTURES

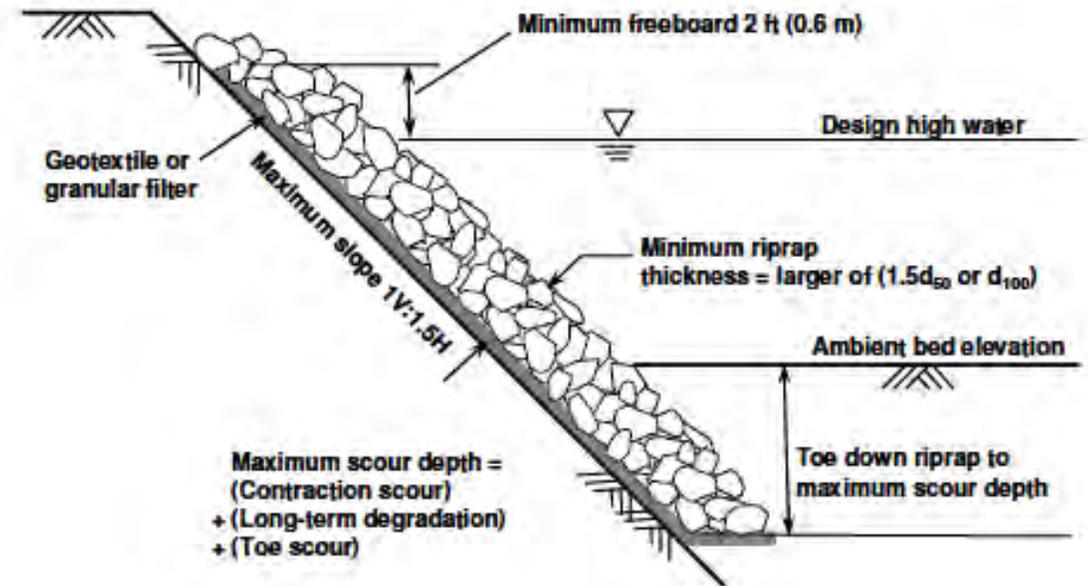
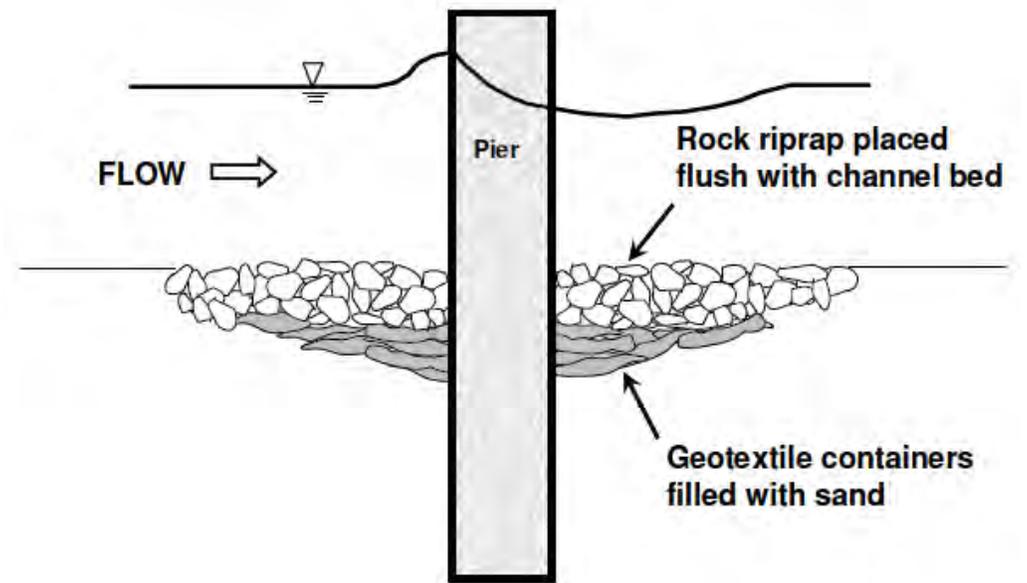


TRANSVERSE STRUCTURES
Impermeable spurs (jetties, groins, wing dams)
Permeable spurs (fences, netting)
Transverse dikes
Bendway weirs/Stream barbs ¹
Hardpoints
Drop structures (check dams, grade control)
Embankment Spurs
LONGITUDINAL STRUCTURES
Longitudinal dikes (crib/rock toe/embankments)
Retards
Bulkheads
Guide banks
AREAL STRUCTURES/TREATMENTS
Jacks/tetrahedron jetty fields
Vanes
Channelization
Flow relief (overflow, relief bridge)
Sediment detention basin

HYDRAULIC COUNTERMEASURES:

Armoring

REVTMENTS AND BED ARMOR
Rigid
Soil cement
Roller compacted concrete
Concrete pavement
Rigid grout filled mattress/concrete fabric mat
Fully grouted riprap
Flexible/articulating
Riprap
Self launching riprap (windrow)
Riprap fill-trench
Gabions/gabion mattress ²
Wire enclosed riprap mattress (rail bank/sausage)
Articulated blocks (interlocking and/or cable tied)
Concrete/grout mattress (fabric-formed)
Partially grouted riprap
LOCAL SCOUR ARMORING
Riprap (fill/apron)
Fully grouted riprap
Concrete armor units (Toskanes, tetrapods, etc.) ³
Grout filled bags/sand cement bags
Gabions/gabion mattress ²
Articulated blocks (interlocking and/or cable tied)
Sheet pile/cofferdam
Partially grouted riprap



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