



Multidisciplinary Stream Restoration of North Clear Creek

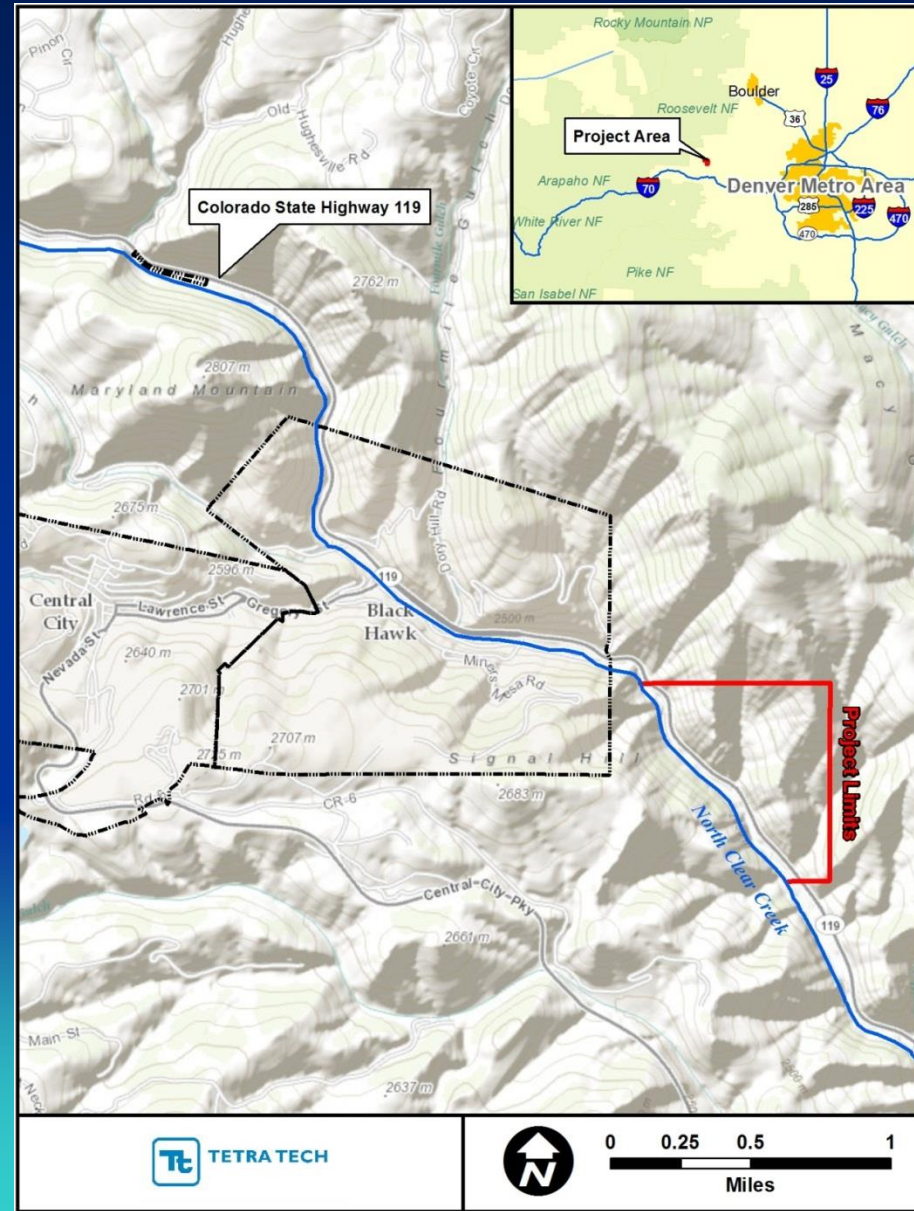
Stu Trabant
Tetra Tech



TETRA TECH

Background

- Blackhawk, CO
- Colorado Dept. of Transportation
- State Highway 119 Widening
- Team lead: HNTB



Project Team



History

- **Historical gold mining area**
 - Placer mining
 - Hard rock mining
- **Tailings and acid mine drainage**
- **US EPA Superfund Site**



Overall Project Objectives

- Highway widening and realignment
- Infrastructure scour protection
- Water quality improvements
- Habitat improvements
- Recreational and aesthetic improvements

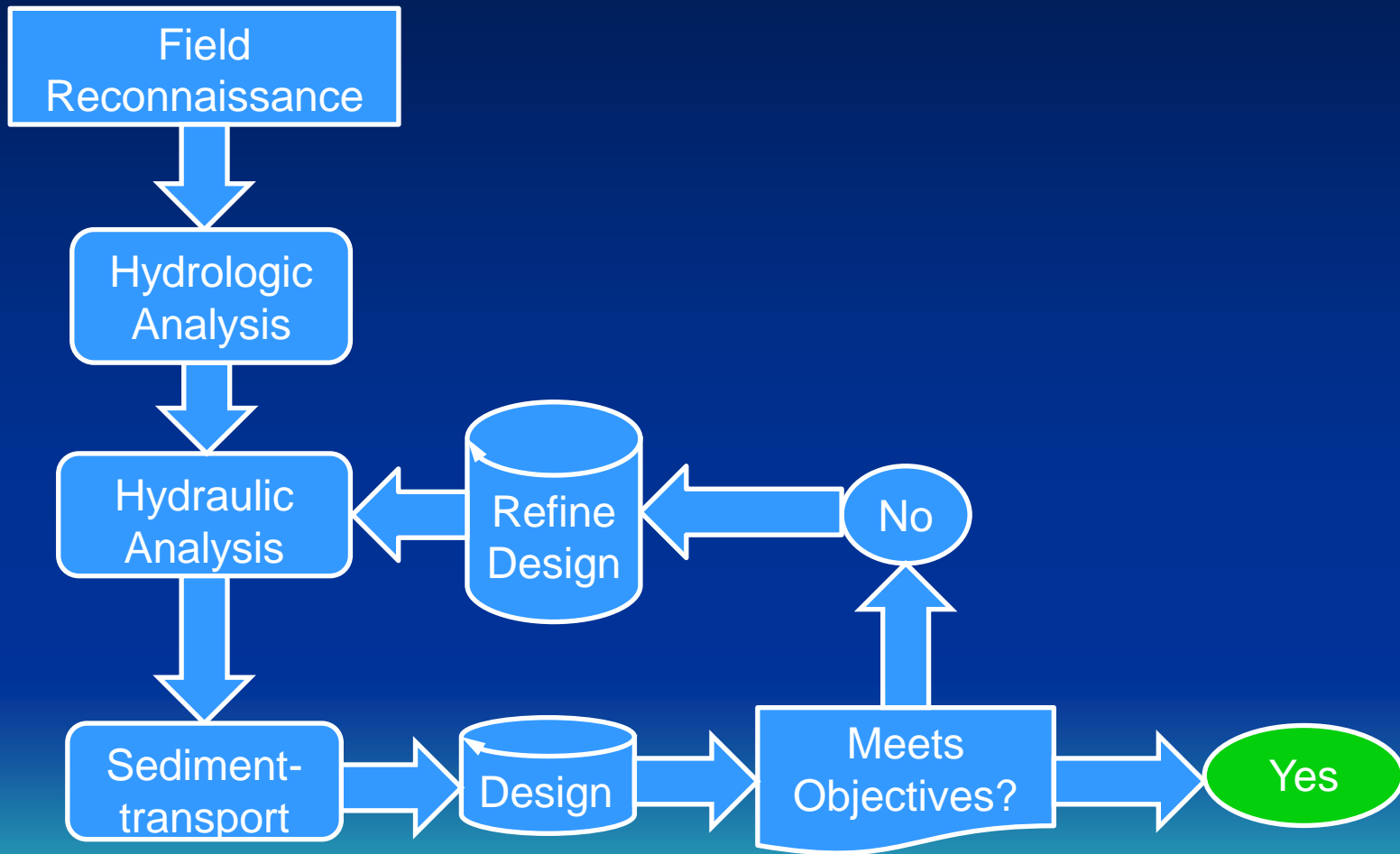


Stream Restoration Objectives

- **Coordinate with other project elements**
- **Aquatic and riparian habitat restoration (Brown Trout)**
- **Channel stability**
- **Sediment continuity**
- **Flood conveyance**



Basis of Design

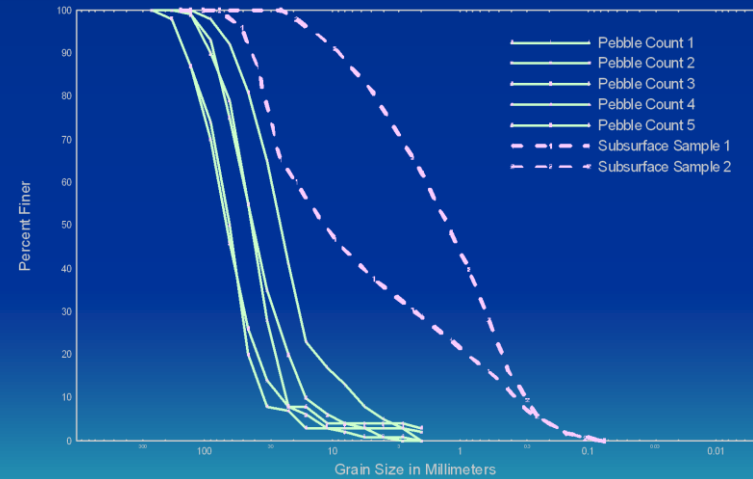


Field Reconnaissance

- Existing conditions
channel morphology
- Characterize boundary
materials
- Hydraulic conditions
- Design considerations



Sediment Sampling



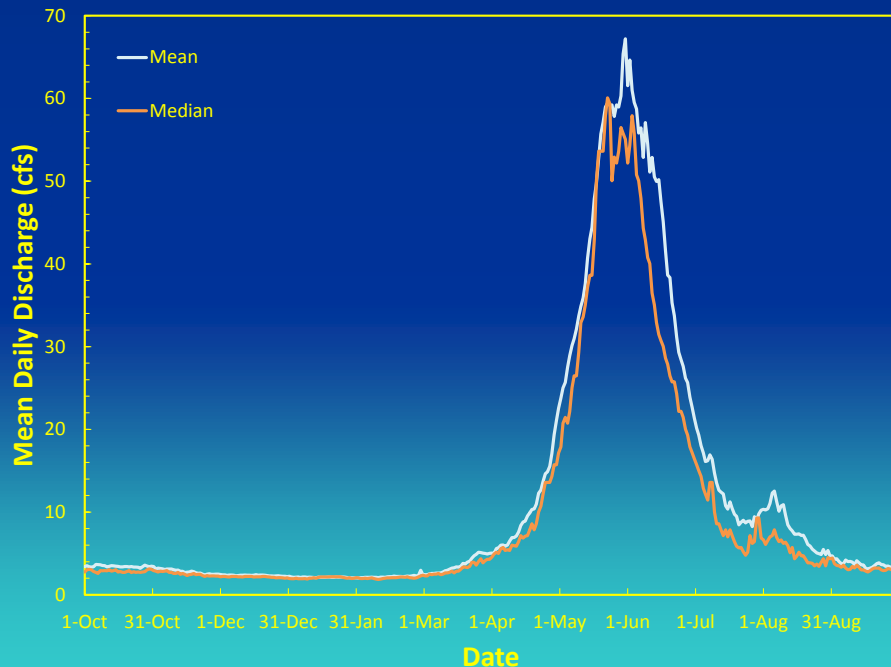
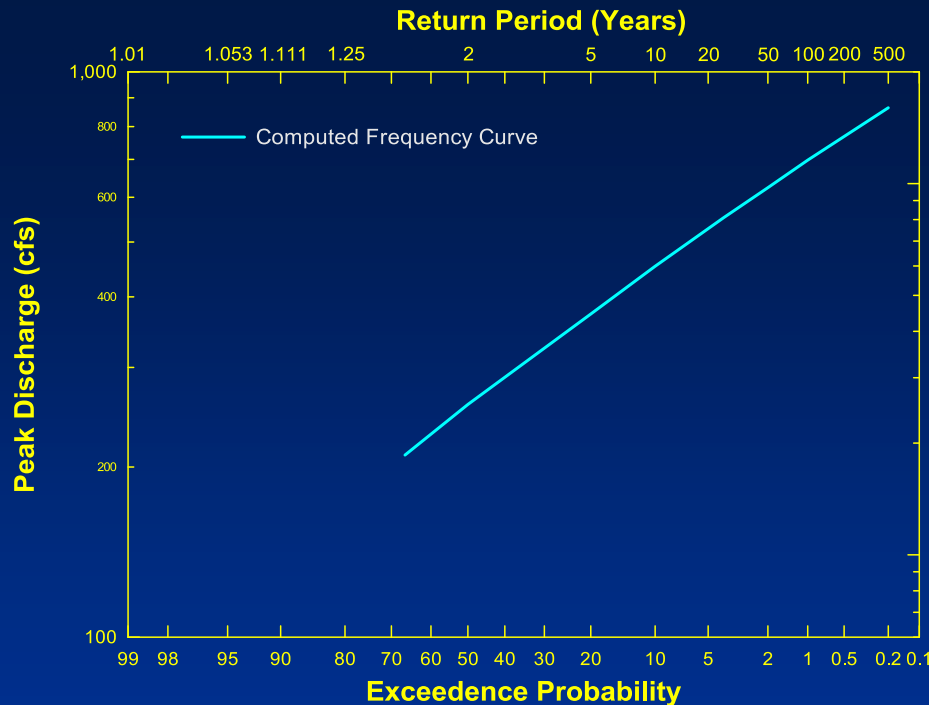
BOULDERS	COBBLES	GRAVEL					SAND					SILT or CLAY	
		VC	C	M	F	VF	VC	C	M	F	VF		

Hydrologic Analysis

➤ **By Ayres**

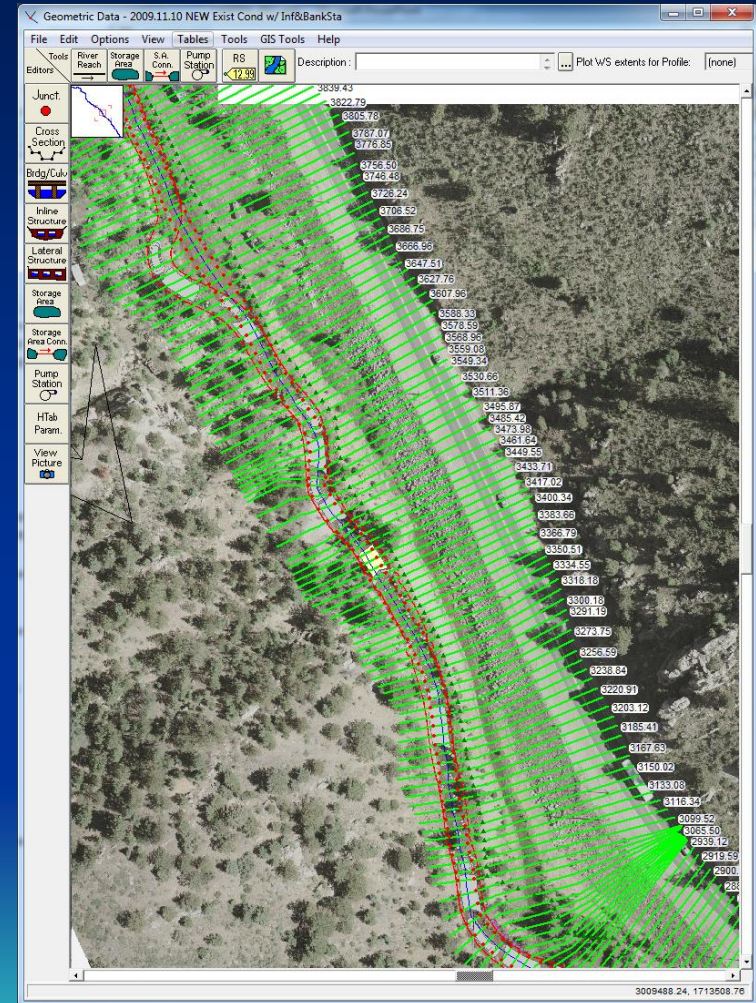
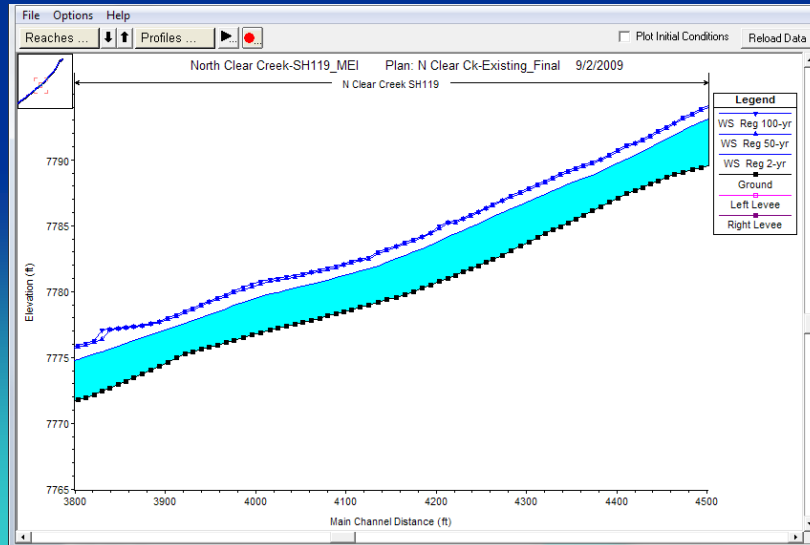
➤ **Use of results:**

- **Scour protection and channel stability**
- **Channel geometry**
- **Sediment-transport balance**

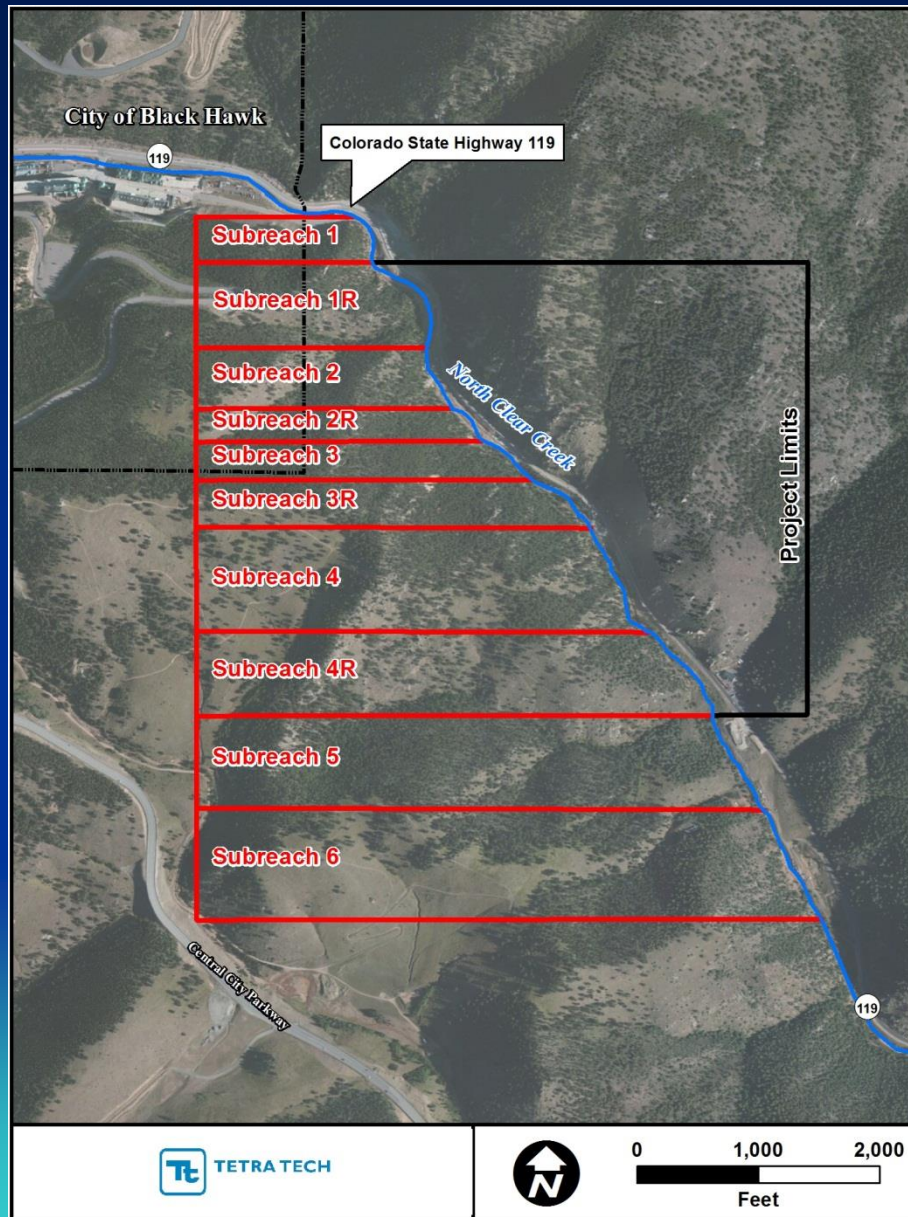


Hydraulic Analysis

- HEC-RAS computer software
- Range of flows to 100-yr Peak Q
- Existing and with-project conditions

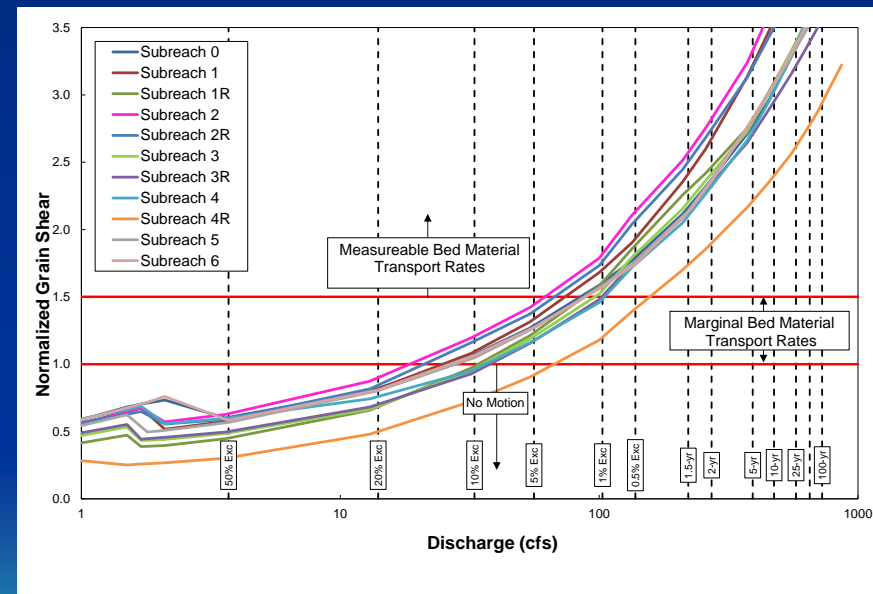


Subreach-averaged Hydraulics



Sediment-transport Analysis

- Input: bed material gradations and subreach-averaged hydraulics
- Incipient motion analysis
- Bed material loads
 - Sediment rating curves
 - Annual bed material volumes
 - Sediment-continuity analysis



Stream Restoration Design

1. Planform

- Space limitations
- Habitat considerations

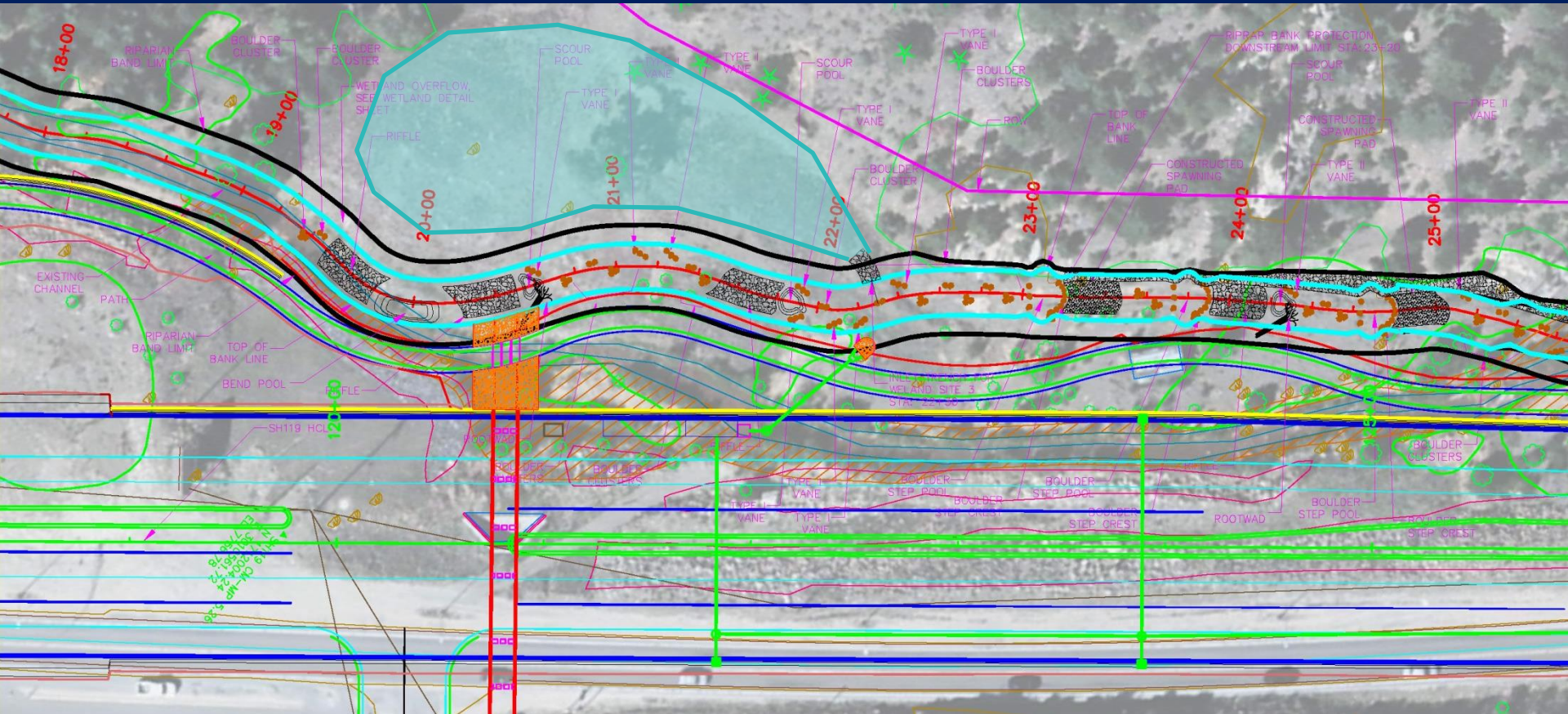
2. Channel geometry

- Channel capacity for 1.5- to 2-yr event

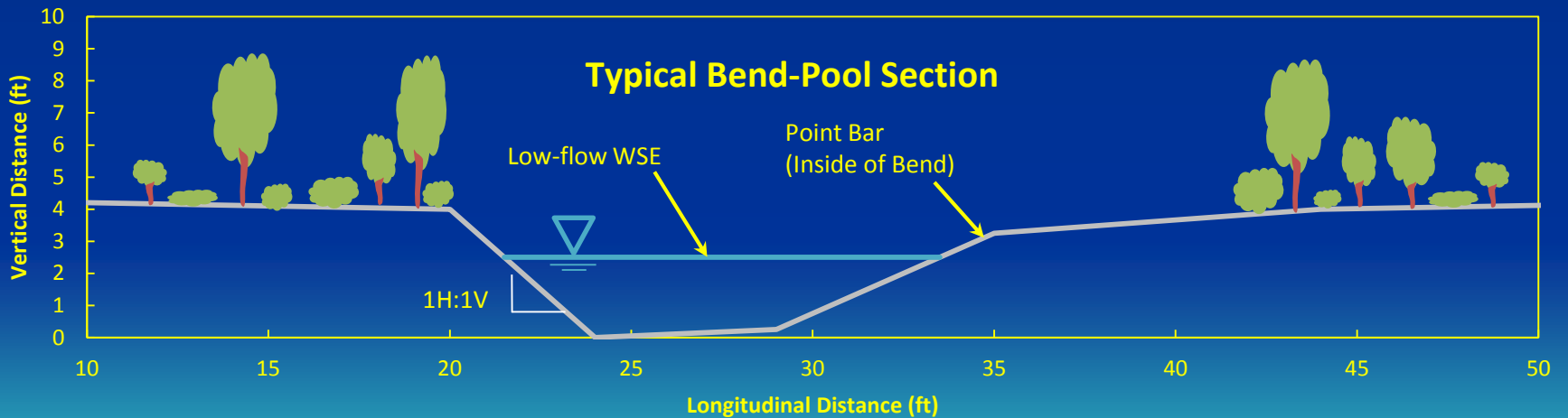
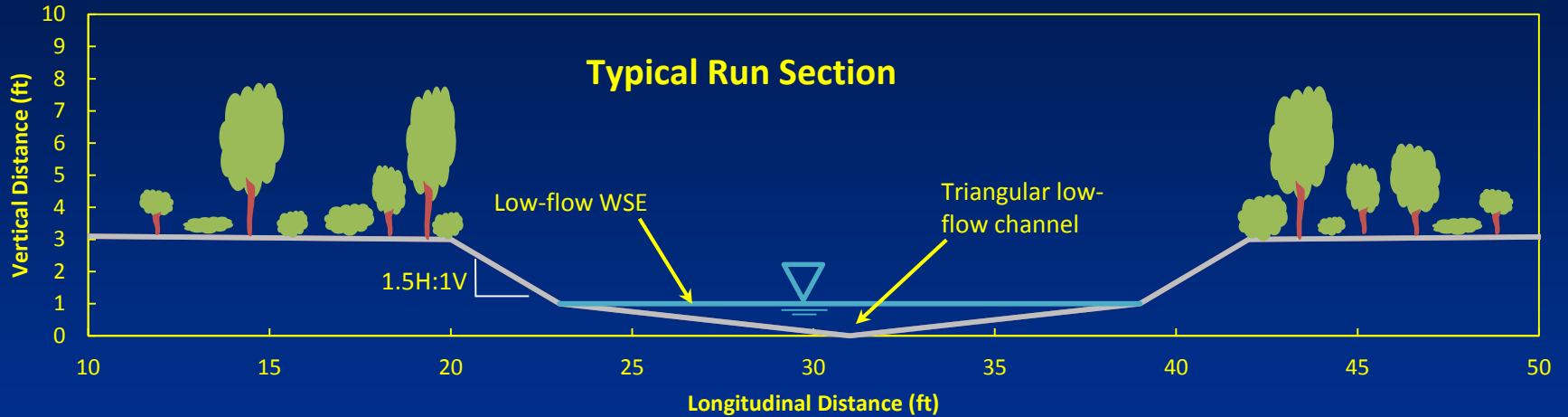
3. Channel gradient

- Transport sediment supply
- Bed material mobilization

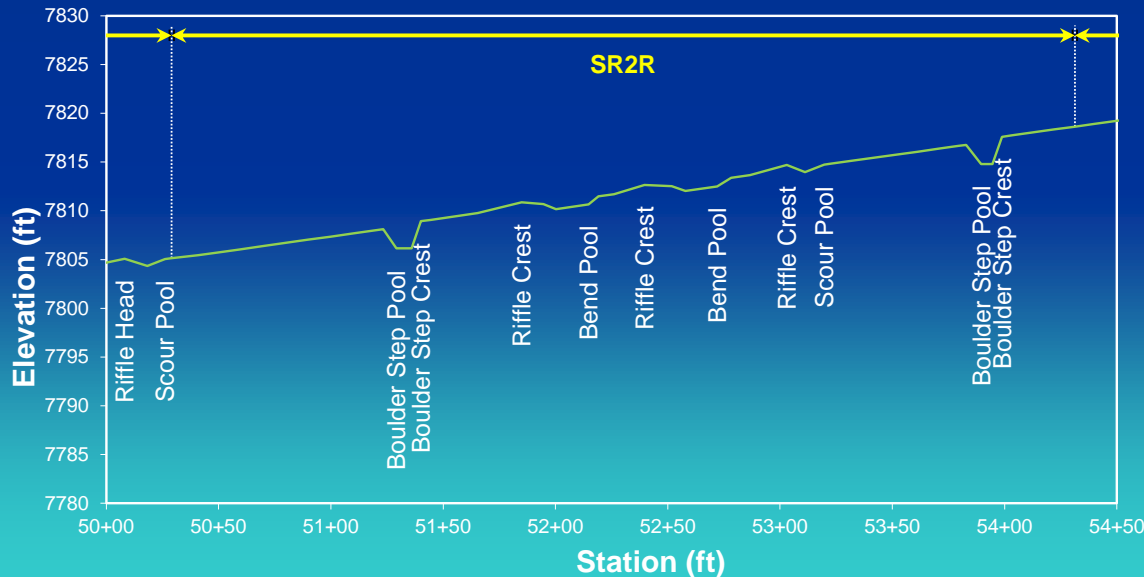
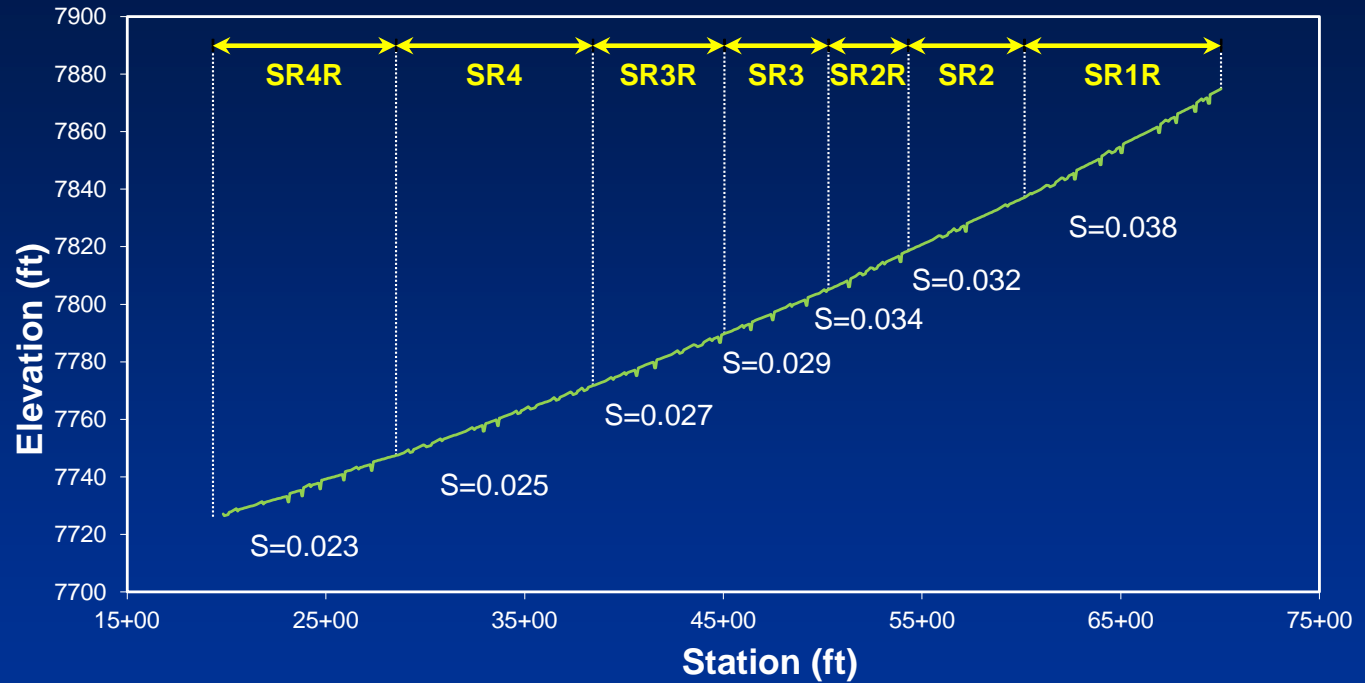
1. Planform



2. Channel Geometry



3. Channel Gradient

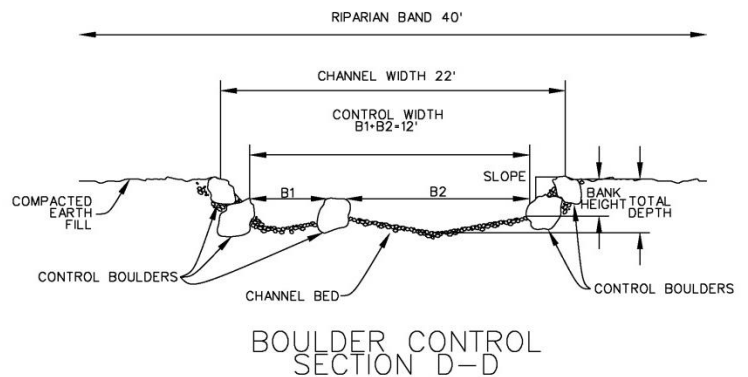
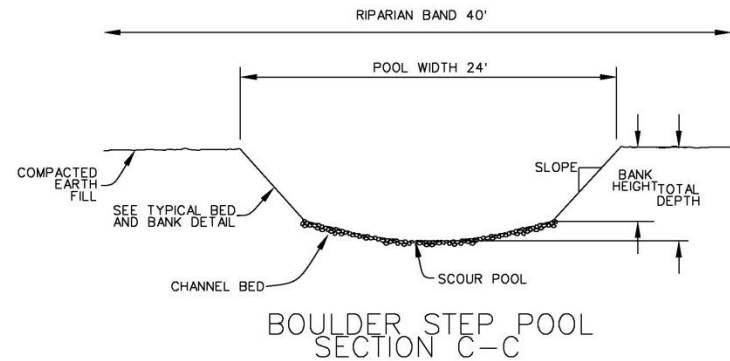
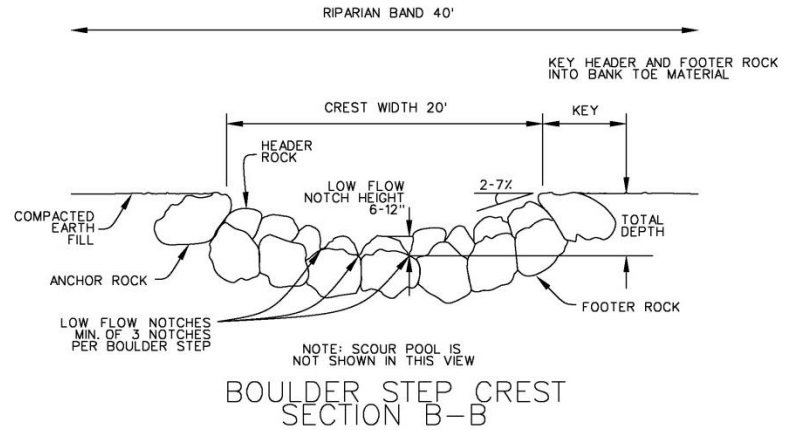
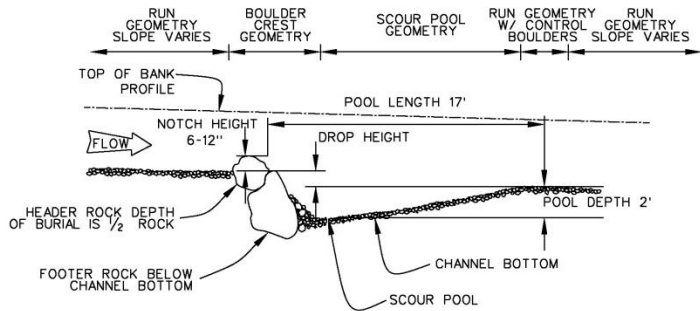
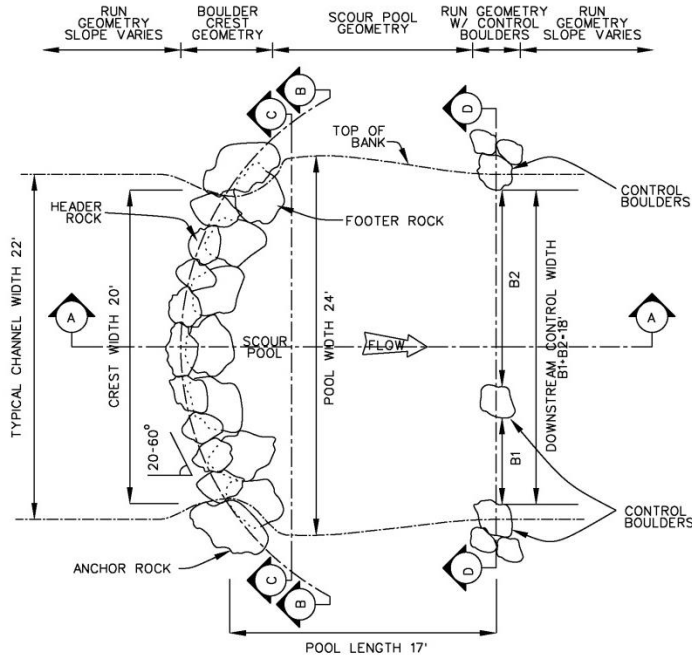


Vertical Channel Stability

- Boulder step-pool structures
- Thomas, et al (1999)
- Fish leap height considerations

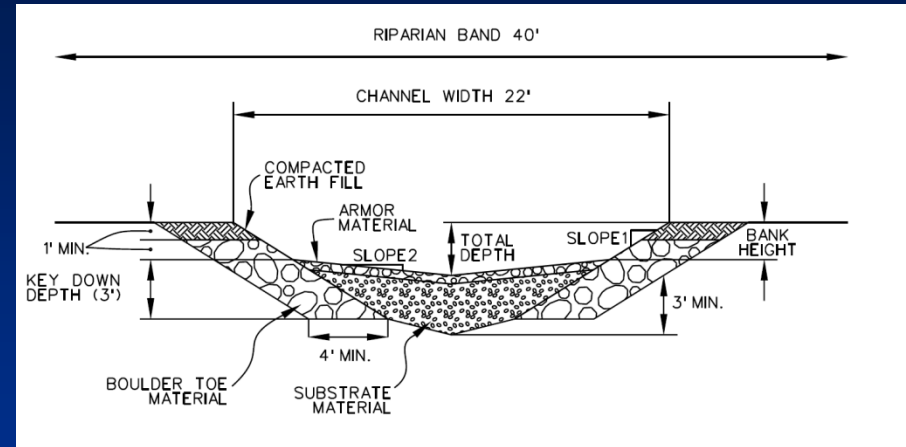


Boulder Step-pool Design



Lateral Channel Stability

- Boulder toe material
- Bio-engineered upper banks*
- Riprap sensitive slopes

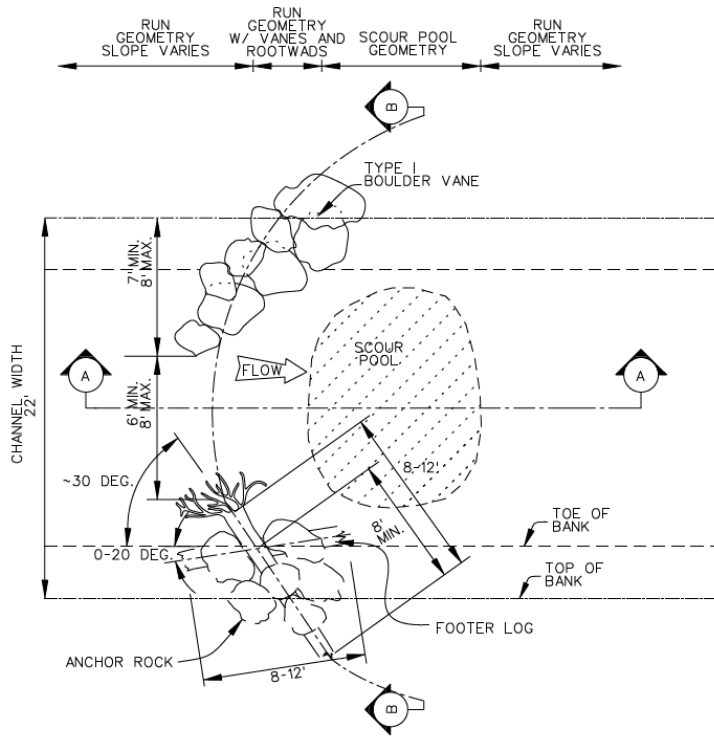


*Banks re-vegetated as part of Landscape Architecture Plan

Micro-habitat Features

- **Holding, rearing and spawning areas**
- **Create hydraulic diversity**
- **May provide additional channel stability**
- **Types**
 - **Boulder features**
 - **Rootwads**
 - **Gravel spawning pads**

Rootwads



Boulder Features



Other Design Considerations

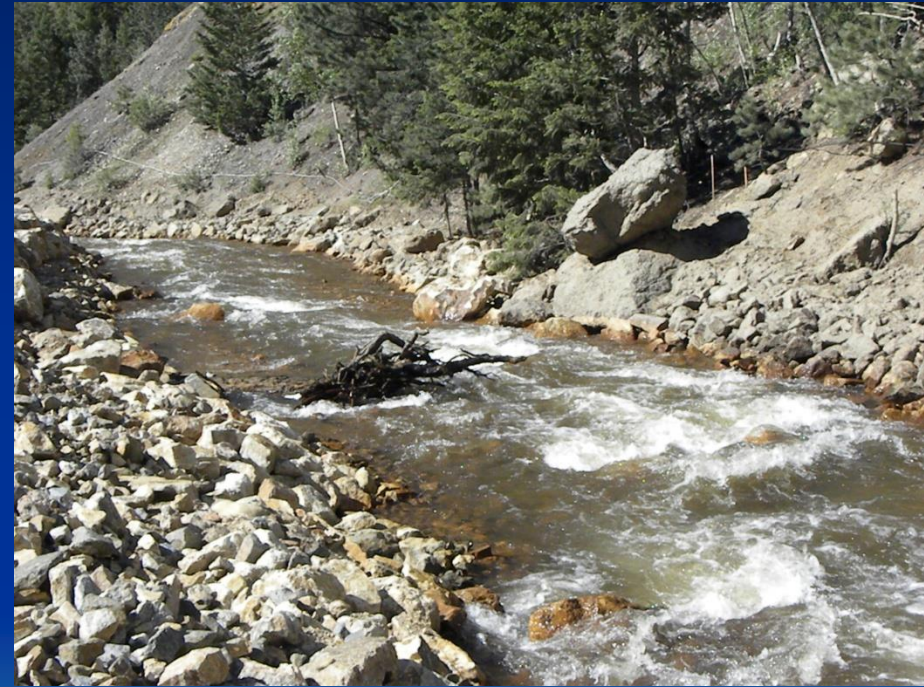
- **Coordinate with:**
 - **Scour protection design**
 - **Landscape architecture**
 - **Highway drainage system**
- **Wetland connectivity**
- **Constructability and BMPs**



Pre-Construction (August, 2009)



Post-Construction (June, 2011*)



*Prior to landscaping/revegetation
and final grading

Questions?

