NATURALIZED INSTREAM DIVERSION DESIGN IN AN AVULSING PLANFORM

1ST NATIONAL STREAM RESTORATION CONFERENCE

AUGUST 2, 2022

AECOM

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The Nature Conservancy

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GILA RIVER DIVERSION ENGINEERING

PRESENTATION OVERVIEW

- <u>GENERAL GILA RIVER DESCRIPTION</u>
  - General project site overview
  - Historical and current uses
  - Ecosystem characteristics
  - Sediment Characteristics
  - Hydrology
  - Geomorphology

- <u>IRRIGATION DIVERSION DESIGNS</u>
  - Existing push-up dam configurations
  - GBIC diversion improvement initiatives
- Diversion designs concepts:
  - Existing/proposed solutions review
    - Push-up dams
    - Hardened infrastructure approach
    - ‘Natural channel’ approach
  - Proposed diversion solution (design)
    - Site-specific
    - Constraint-based design
    - Quantitative modeling

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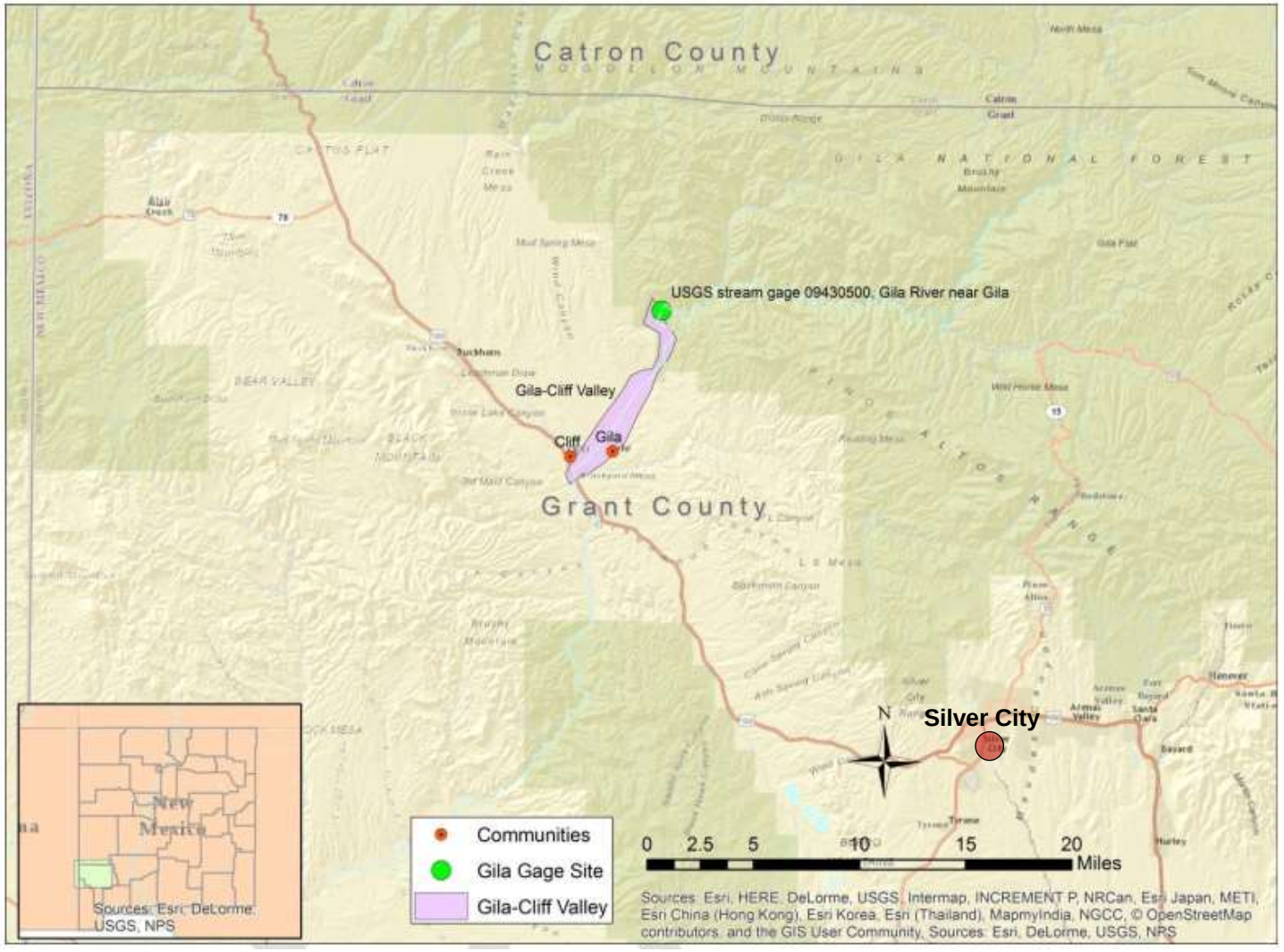
GILA RIVER OVERVIEW



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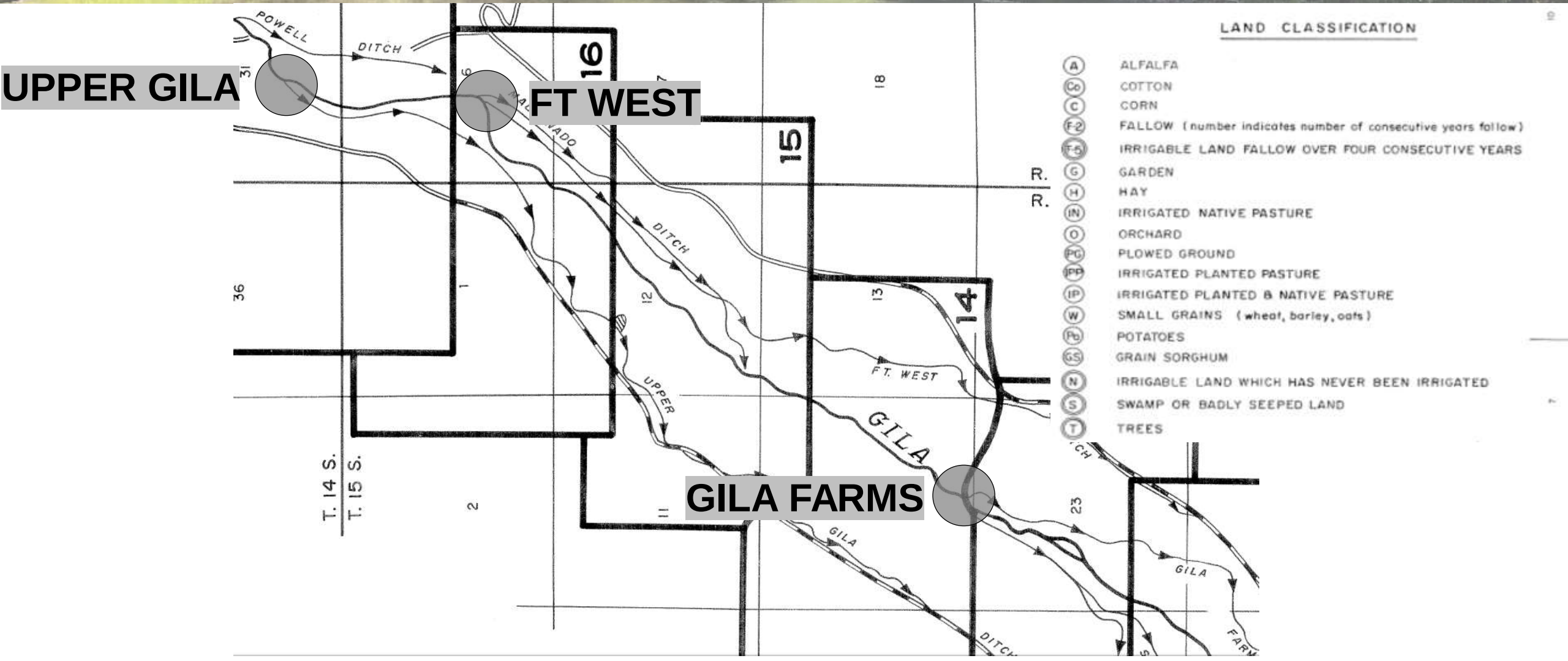
GILA RIVER OVERVIEW



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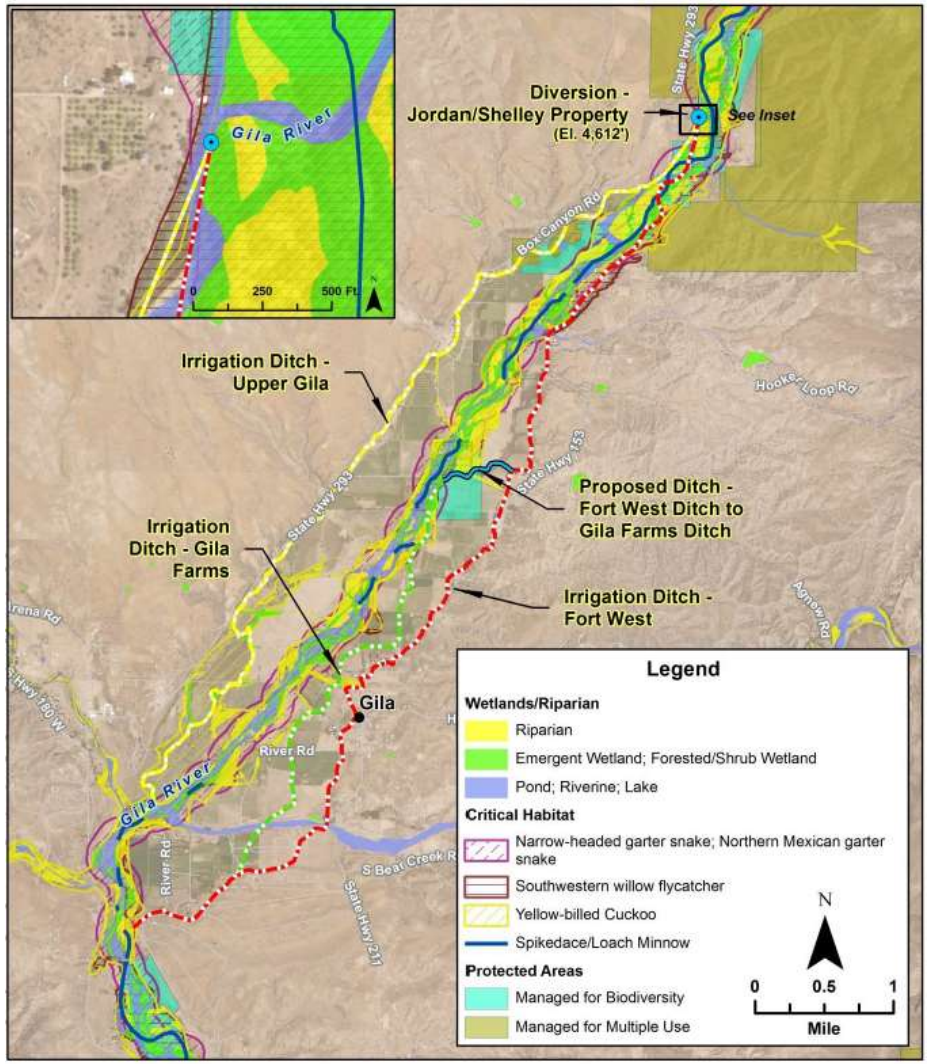
RIPARIAN & AQUATIC HABITAT



- <u>BIRD SPECIES</u>
- Yellow-billed Cuckoo
- Southwestern willow flycatcher

- <u>HERPETOFAUNA</u>
- Narrow-headed garter snake
- Northern Mexican garter snake

- <u>FISH SPECIES</u>
- Spikedace
- Loach Minnow
- Gila Chub

- <u>FISH PASSAGE CONSIDERATIONS</u>
- Benthic swimming species
- Gradations with coarse materials to benthic turbulence layer
- Large roughness elements
- Average hydraulics characteristic to remaining river system

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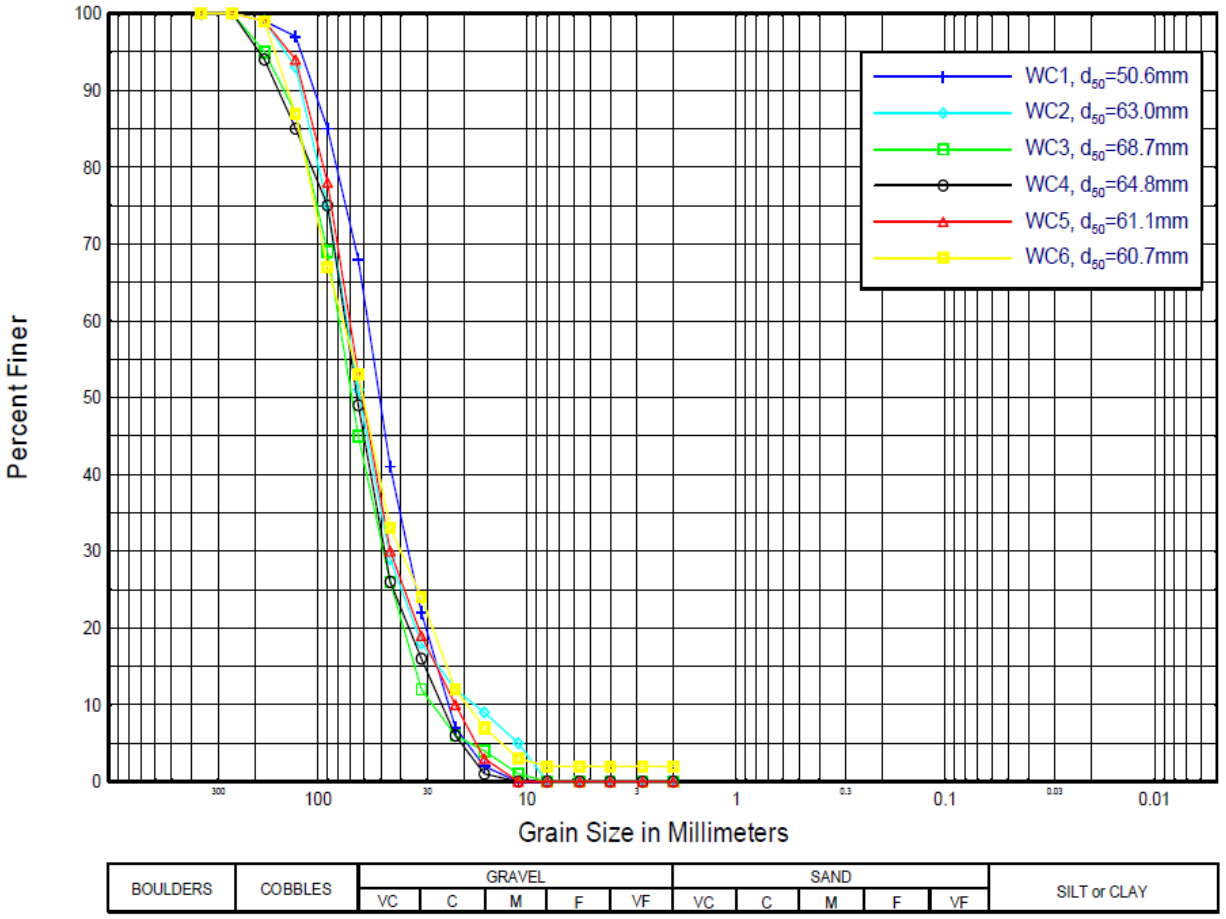
GENERAL SITE OVERVIEW – SEDIMENT DYNAMICS



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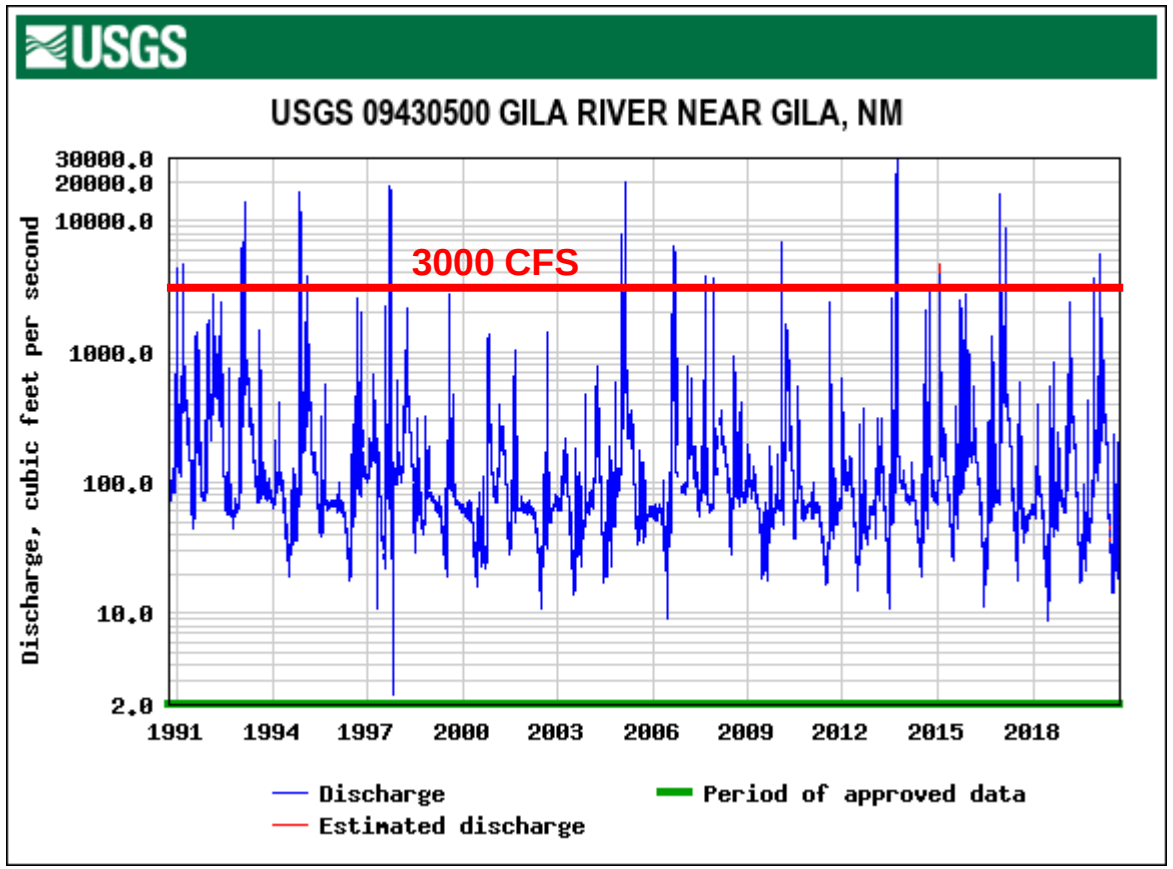
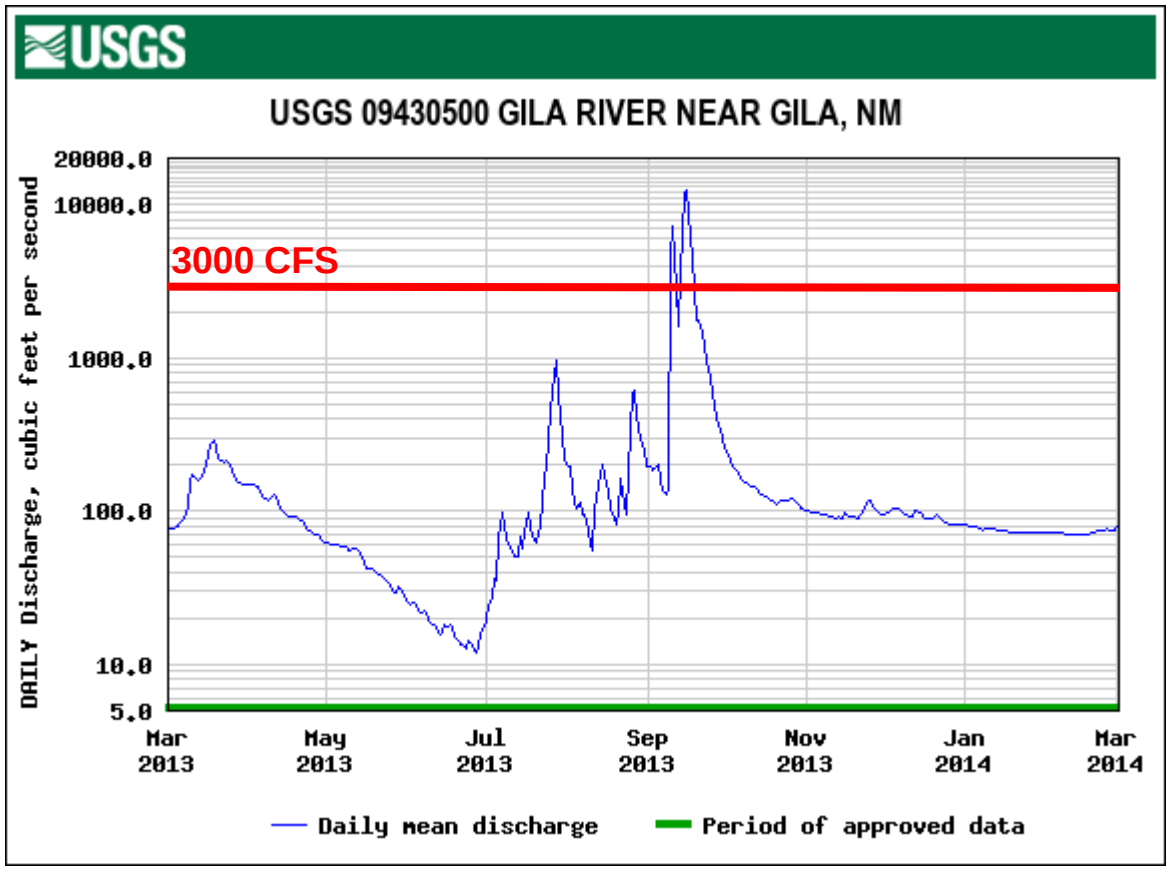
GENERAL SITE OVERVIEW - HYDROLOGY





- SEDIMENT MOBILIZATION: 1,300 CFS
- SEDIMENT FULL: 3,000 CFS

(MUSSETTER, 2006)

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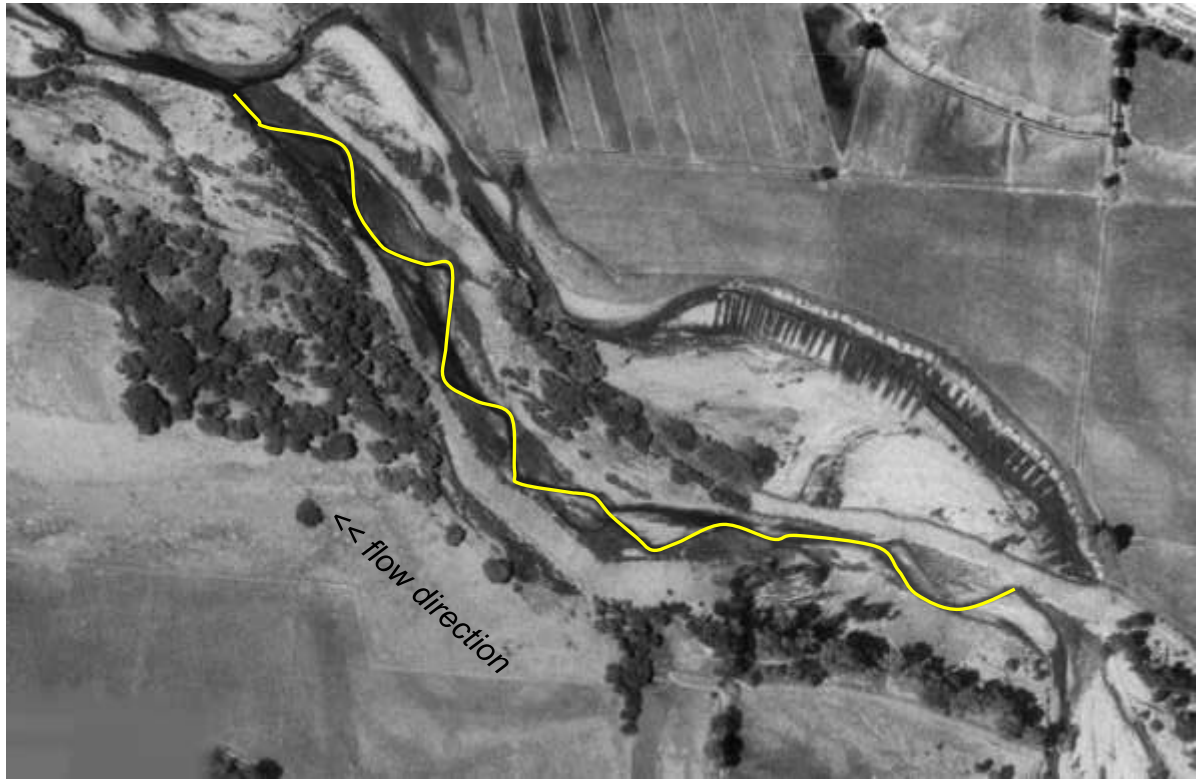
GENERAL SITE OVERVIEW – GEOMORPHOLOGY



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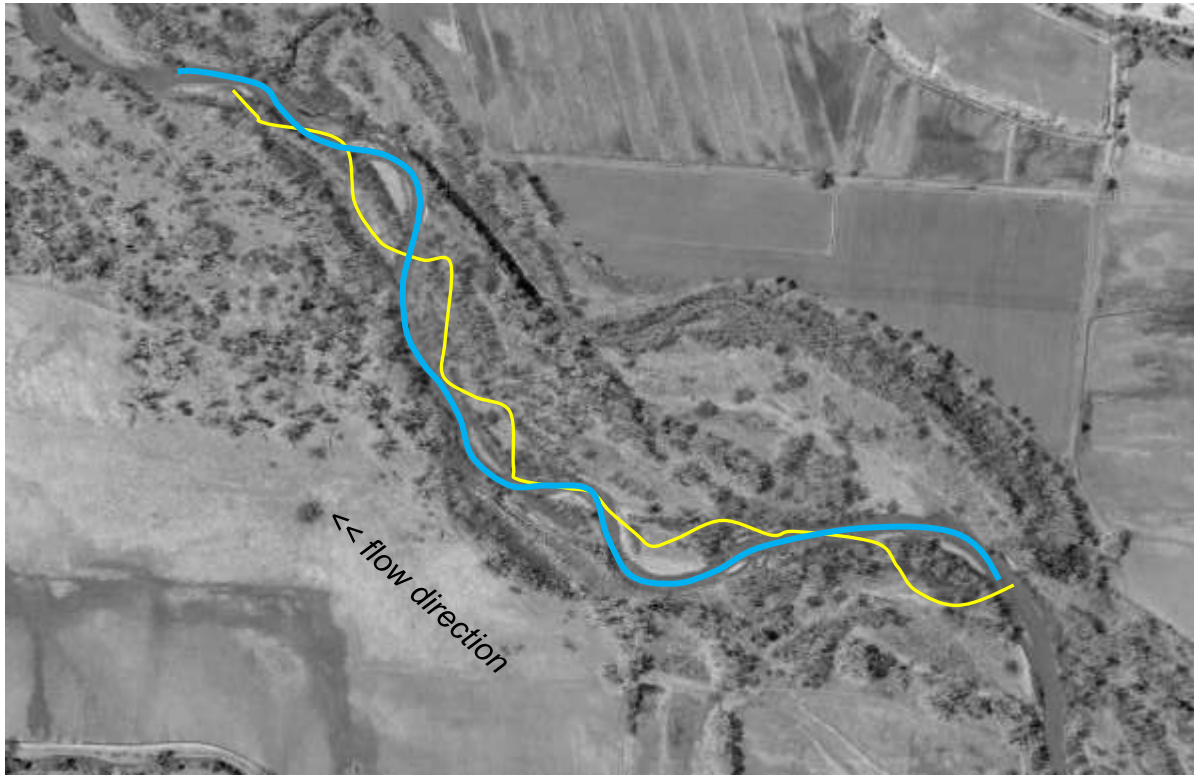

2016

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GILA RIVER OVERVIEW SUMMARY

- <u>DESIGN OBJECTIVES</u>
- Water delivery with instream diversions
- Maintenance minimization

- <u>DESIGN CONSTRAINTS</u>
- Sedimentation
- Geomorphic response
- Upstream flooding
- Upstream/downstream fish passage
- Cost
- Constructability
- Aesthetics

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EXISTING APPROACH – PUSH-UP DAMS

- PUSH-UP DAMS
- Constructed from native channel materials
- Fully mobilize with bedload transport
- Loss of irrigation water due on falling limb before rebuild possible/safe

EXISTING CONDITIONS – HARDENED INFRASTRUCTURE

- BILL EVANS RESERVOIR DIVERSION
- Counter-weight radial gates
- Rapid channel adjustment and sedimentation. Complete backfill of headgates.
- Downstream dredging and maintenance

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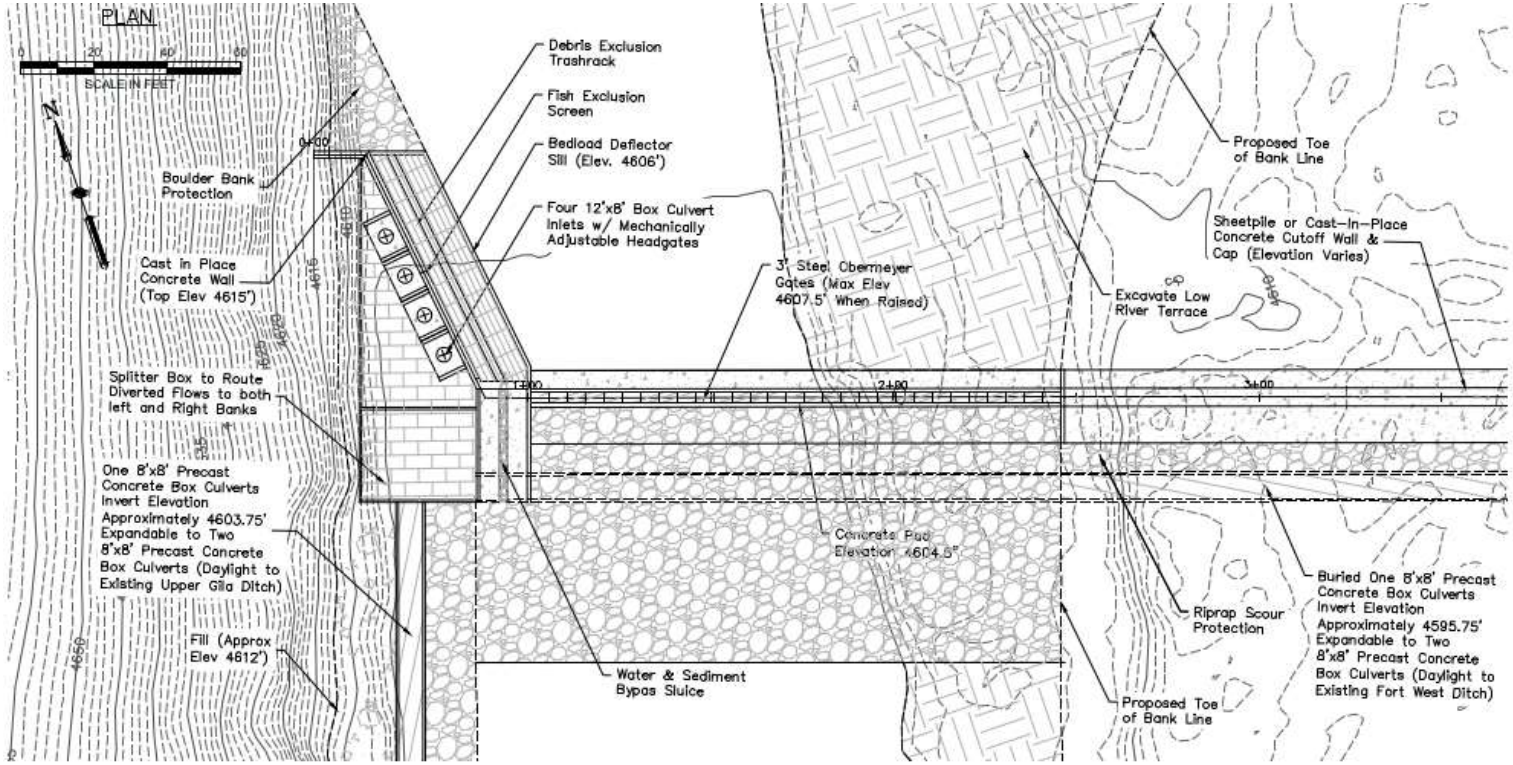
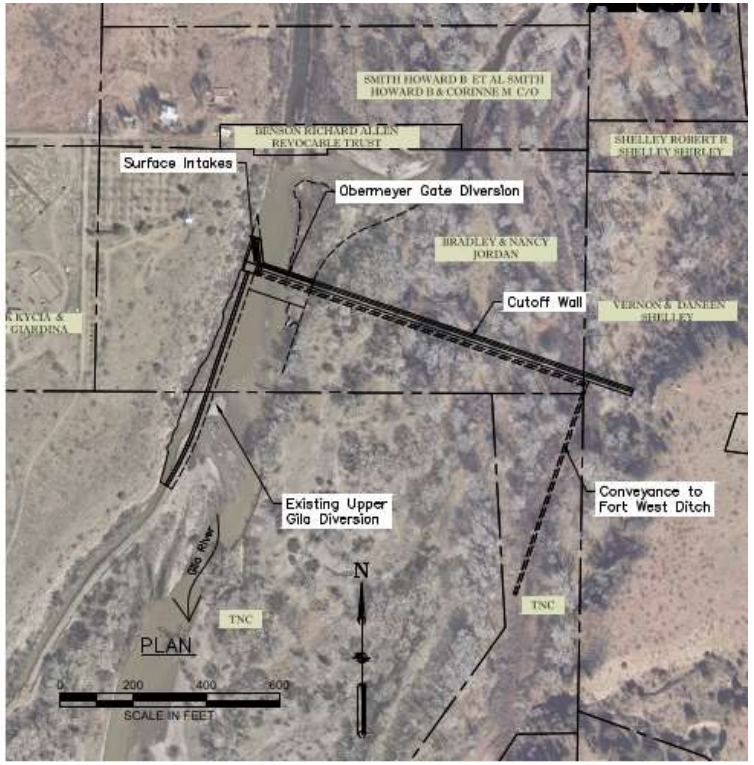
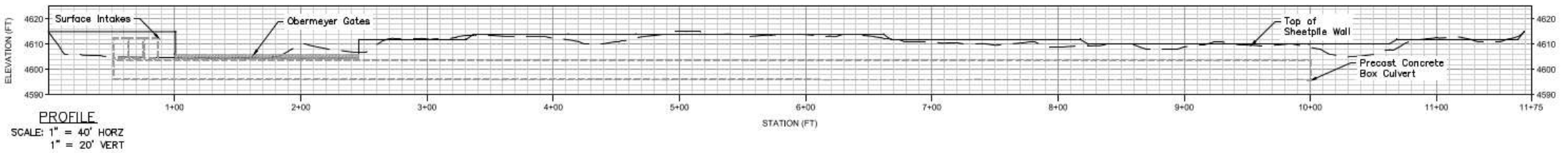
PROPOSED HARDENED INFRASTRUCTURE APPROACH







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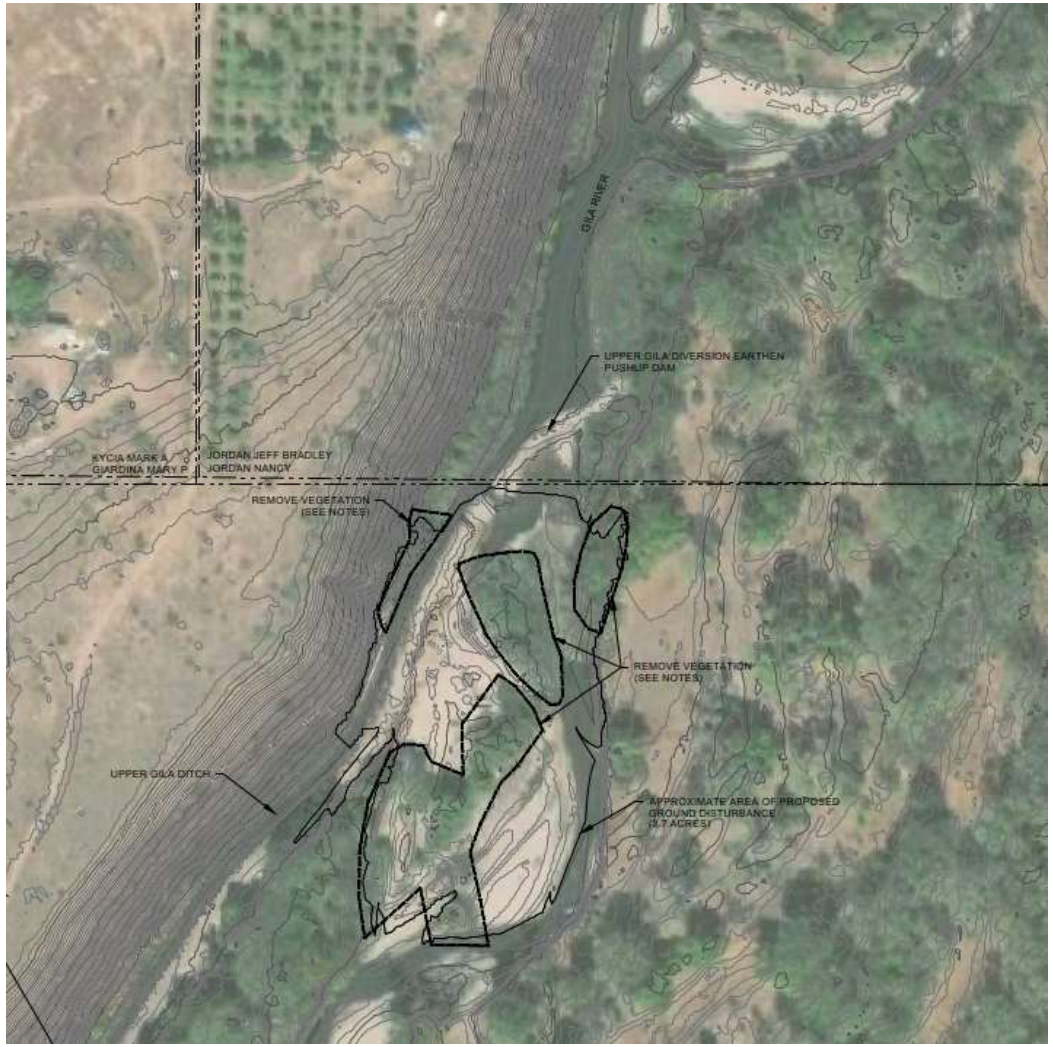
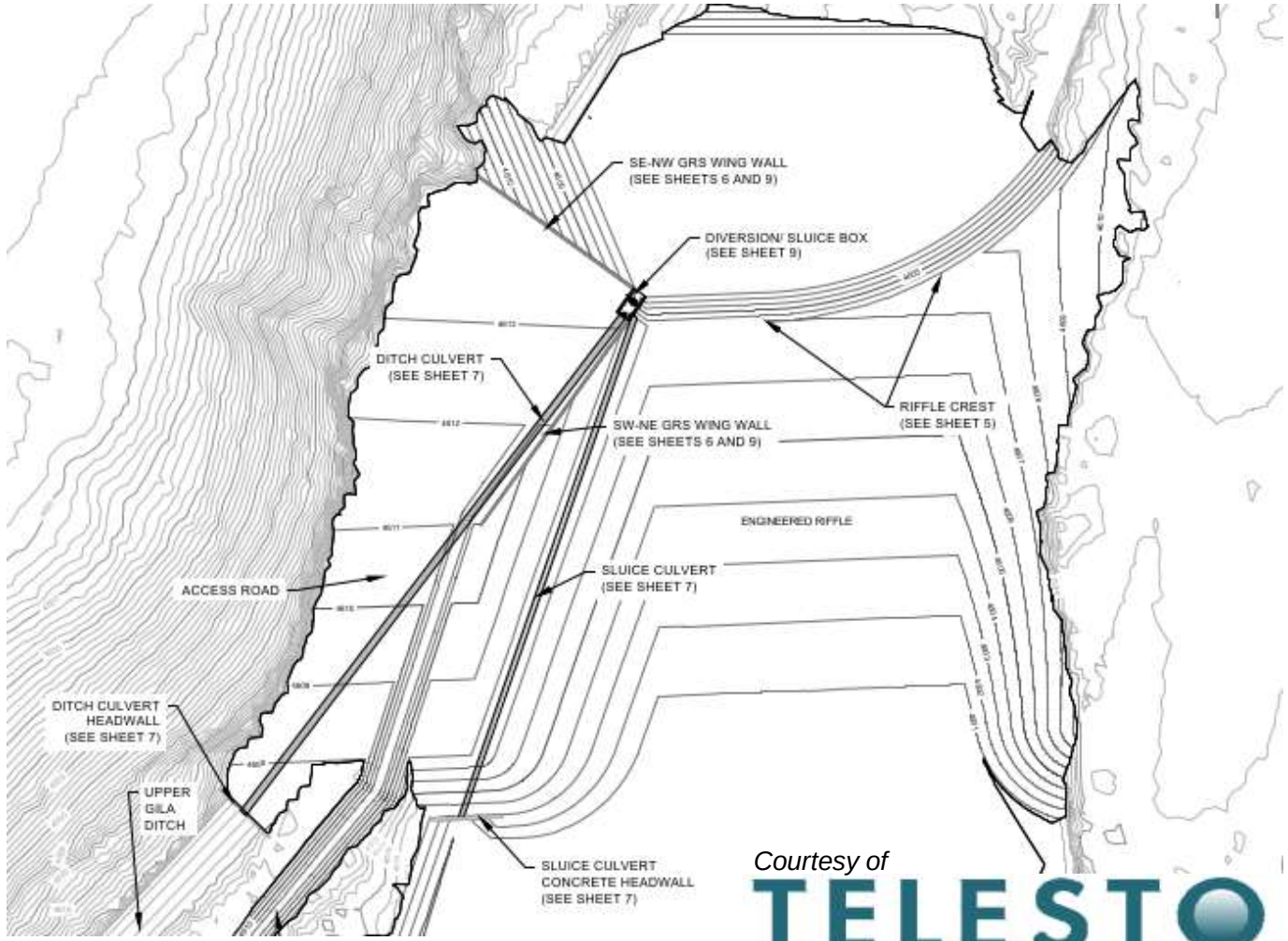
PROPOSED HARDENED INFRASTRUCTURE APPROACH





Courtesy of

TELESTO SOLUTIONS INCORPORATED

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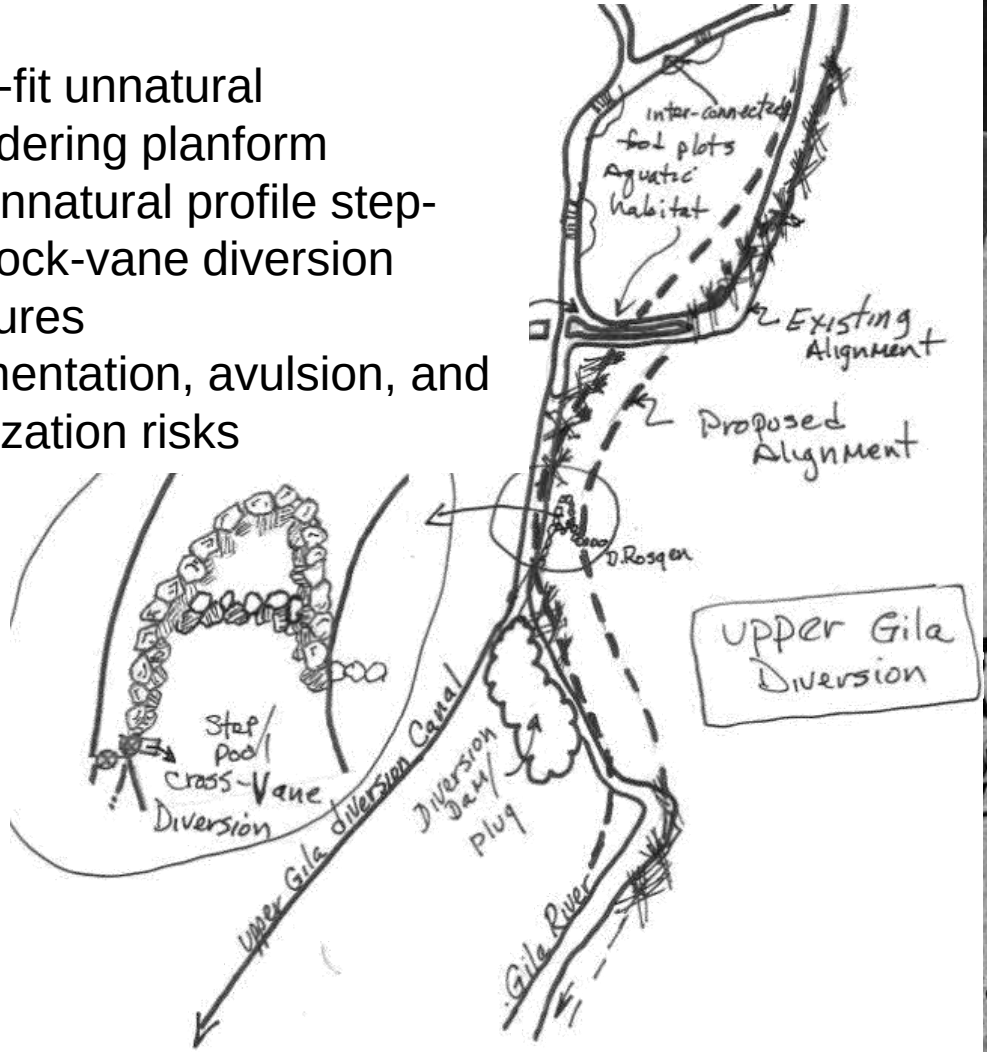
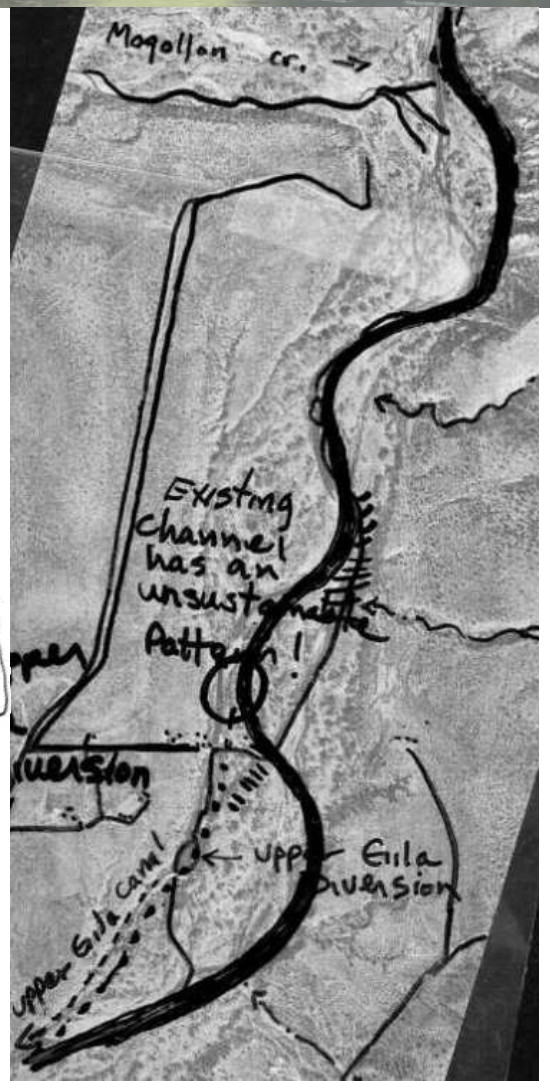
PROPOSED NATURAL RIVER APPROACH

- Force-fit unnatural meandering planform
- Add unnatural profile step-pool rock-vane diversion structures
- Sedimentation, avulsion, and mobilization risks





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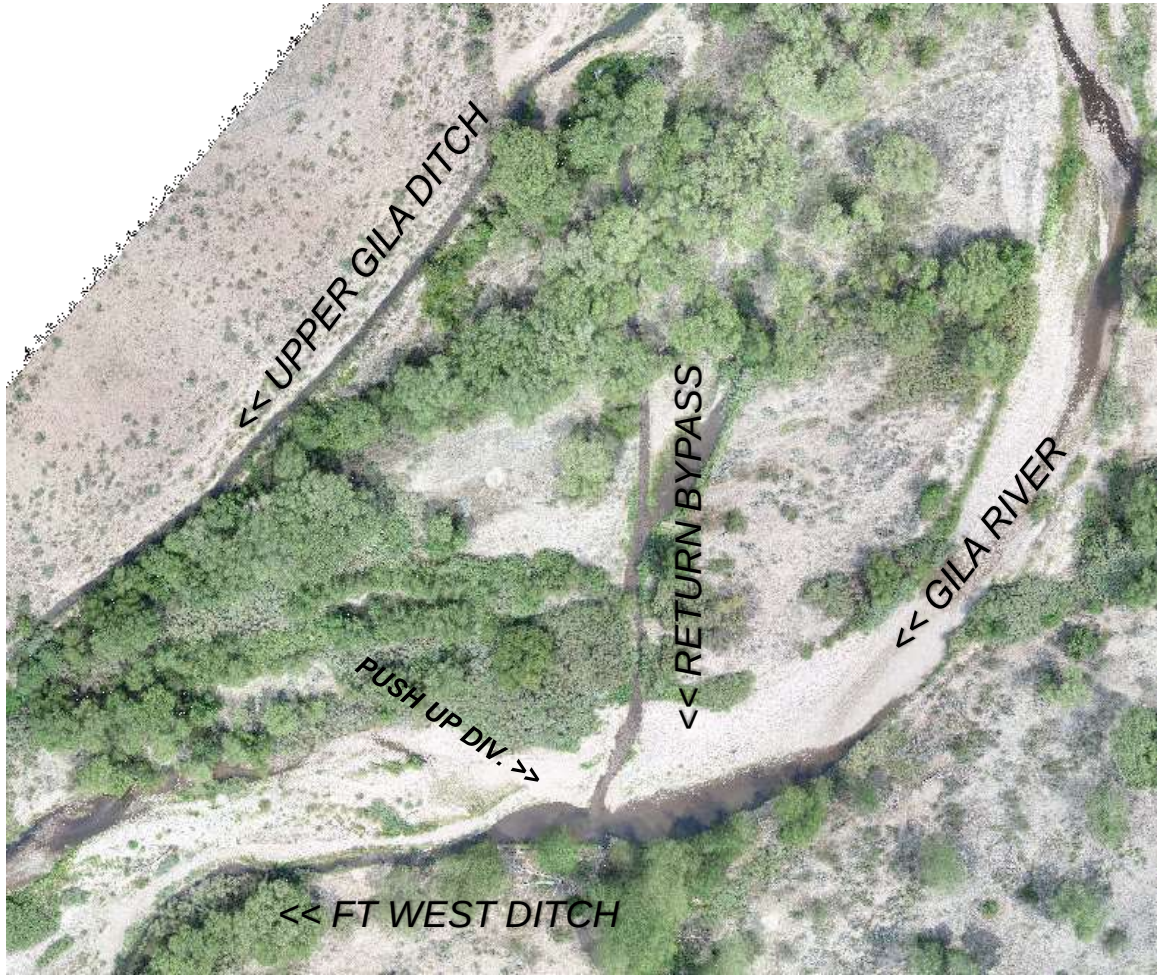
PROPOSED DIVERSION DESIGN

- <u>DESIGN STEPS</u>
- Quantify *Q* (channel/diversion) and *Qs* inputs, local distributions
- Determine geomorphic responses and sensitivities
- Site-specific design alternative development to natural process



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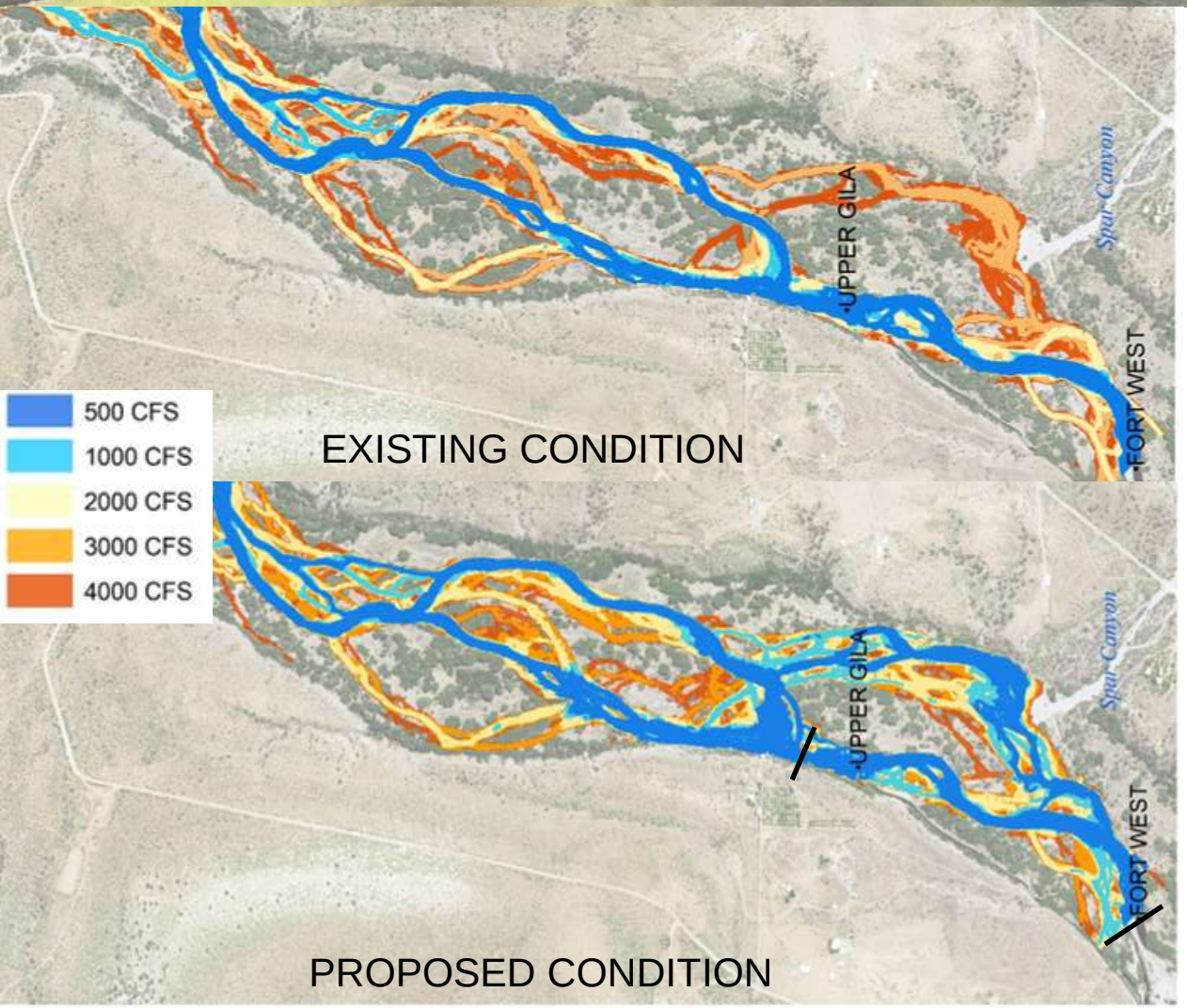
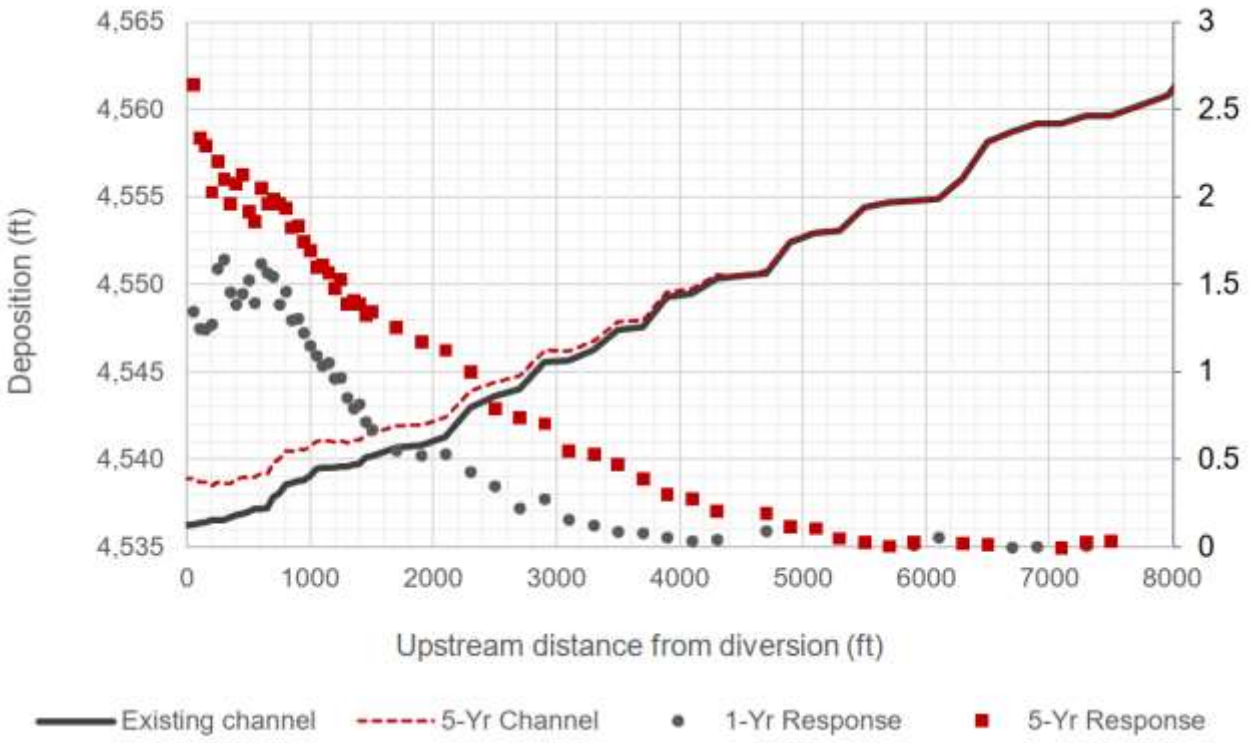
GEOMORPHIC CHANNEL RESPONSE POTENTIAL





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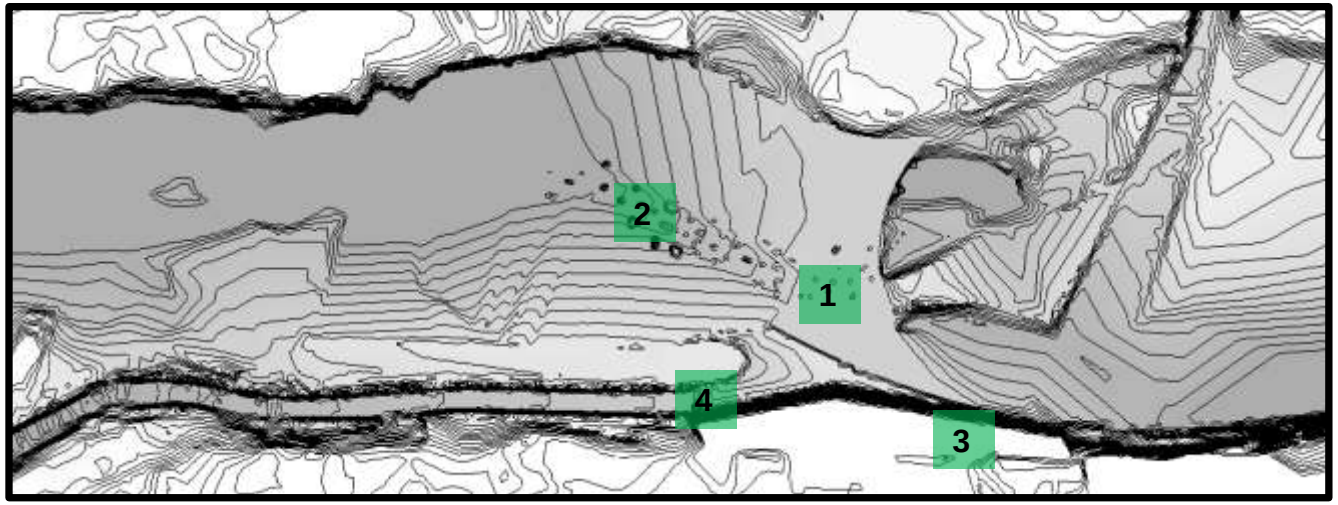
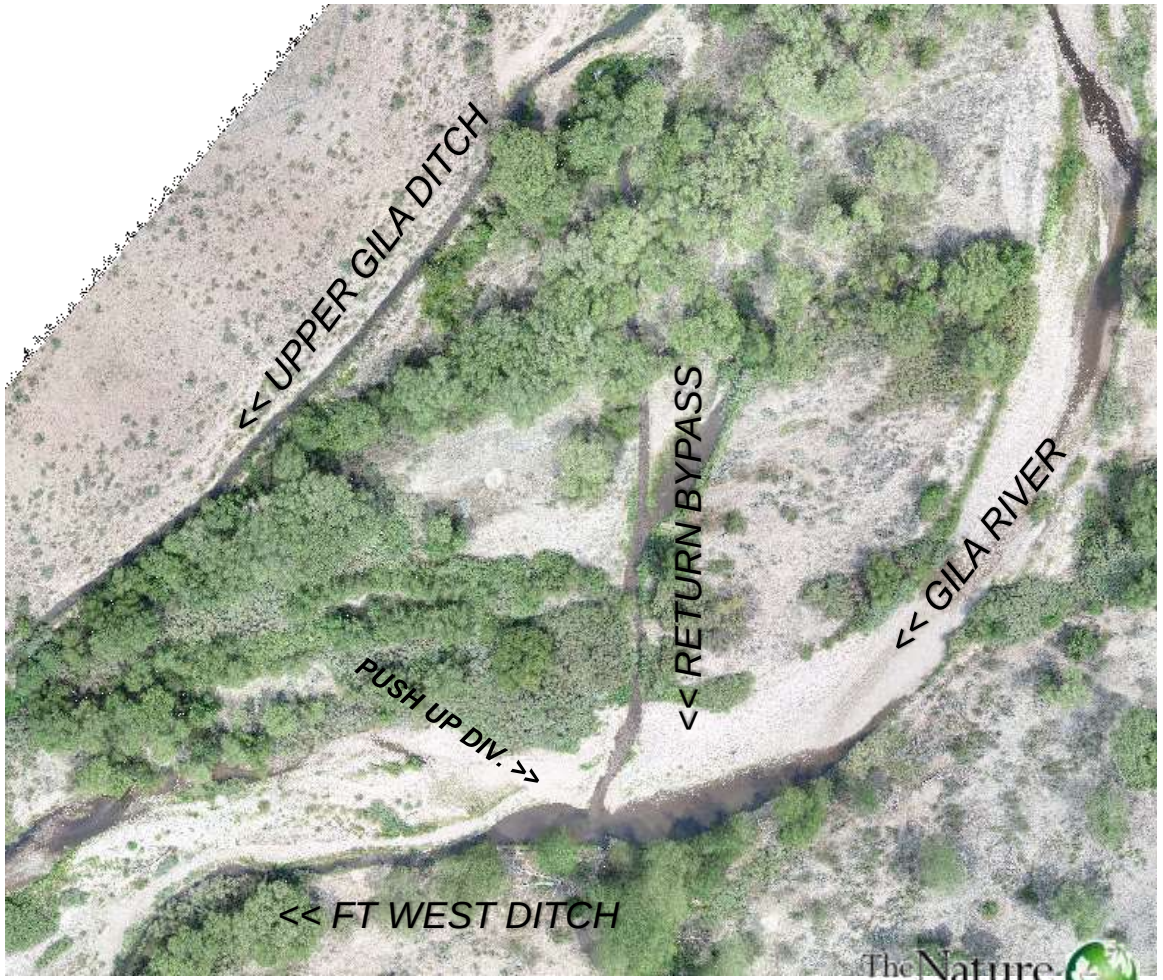
PROPOSED DIVERSION DESIGN

- <u>DESIGN COMPONENTS</u>
- **Hardened boulder “saltation” invert (1)**
  - Invert below ditch invert
- Engineered ramp – 2% grade; LRE (2)
- Outer-bank flow guide structure (3)
- Hardened ditch invert works (4)
  - Prescribed maintenance access





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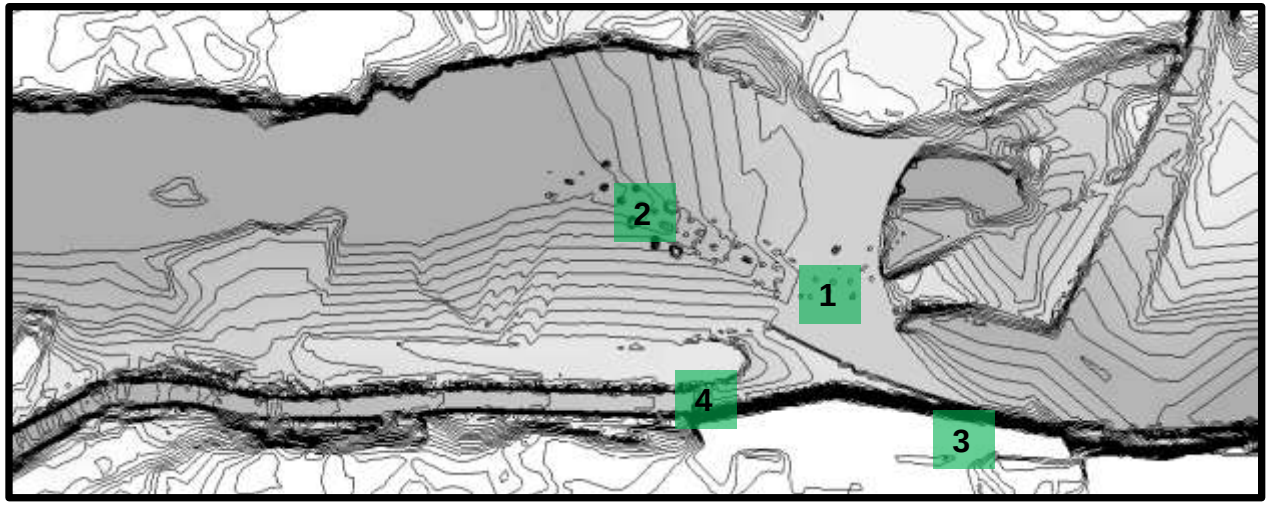

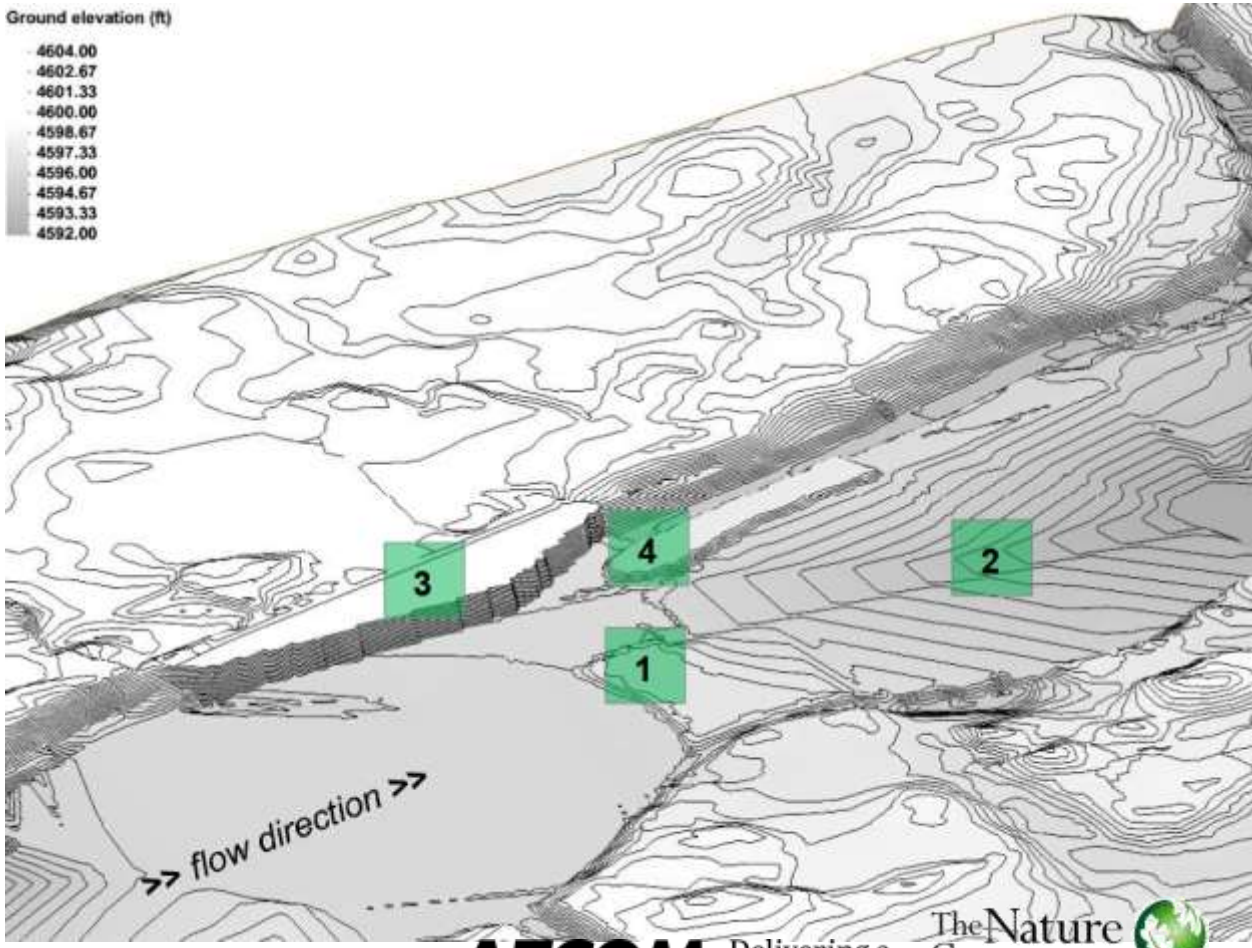

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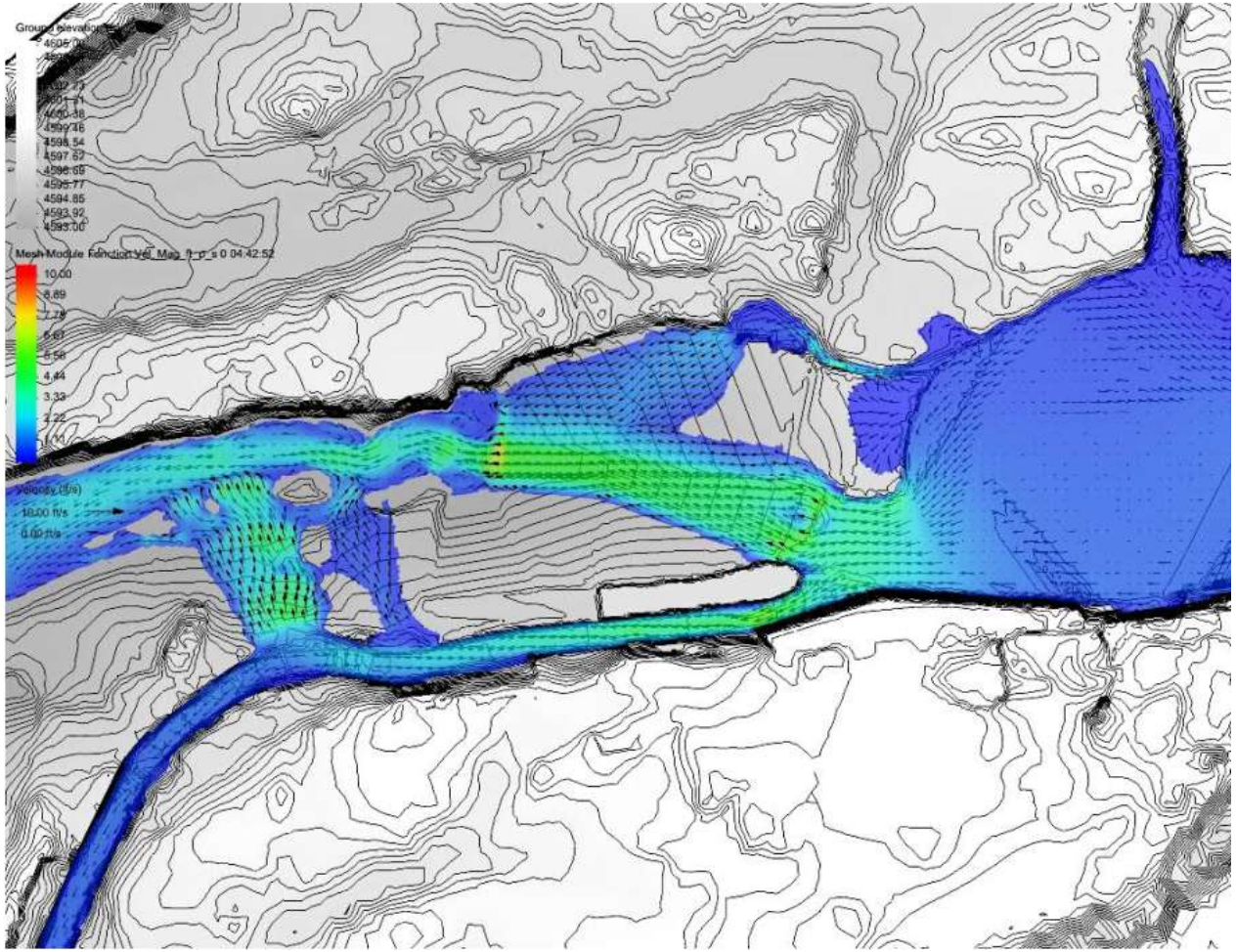
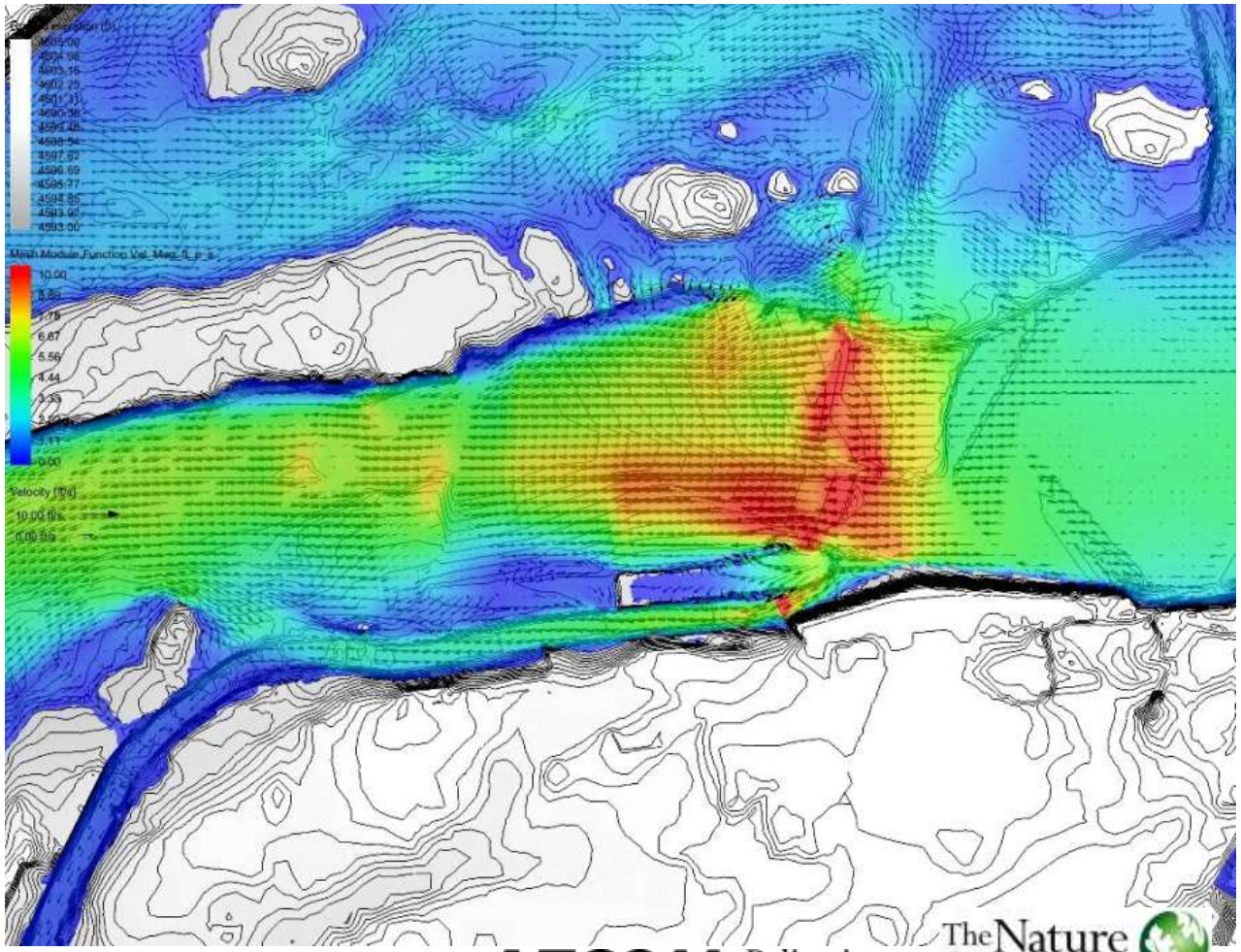
PROPOSED DIVERSION DESIGN



100 CFS



2000 CFS

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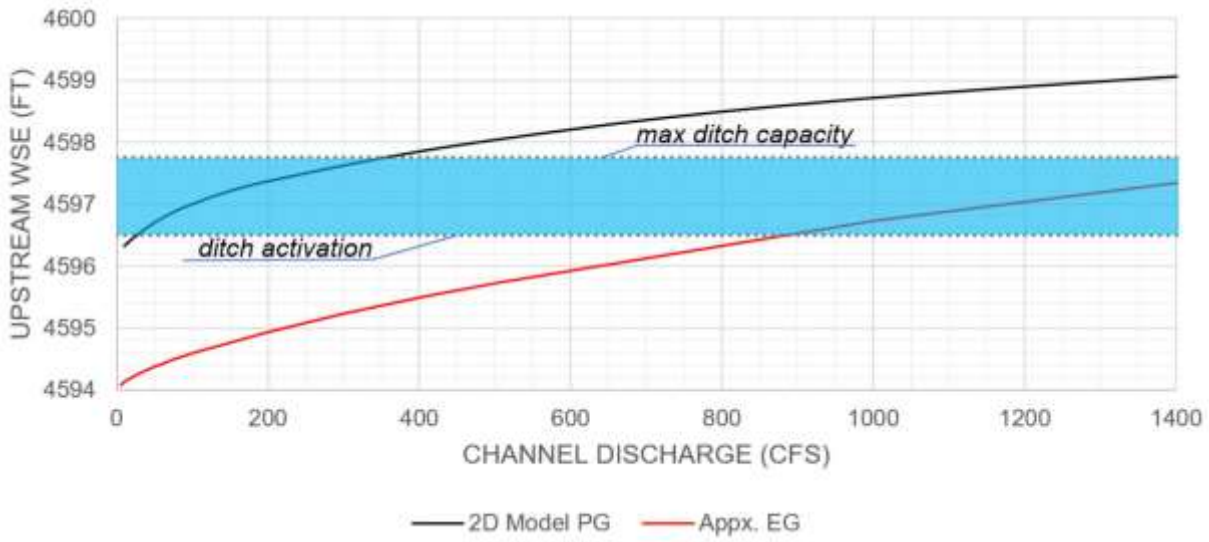
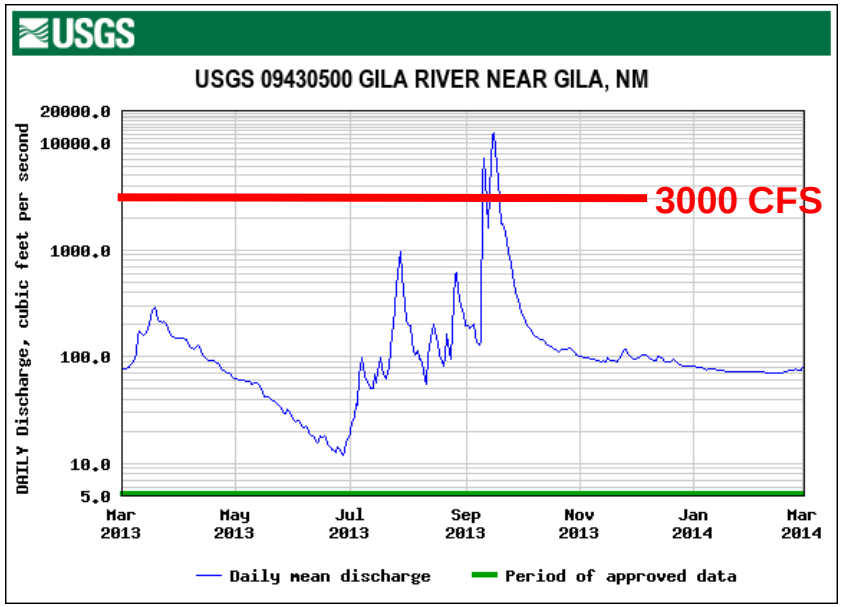
PROPOSED DIVERSION DESIGN

- EX MOBILIZED CONFIGURATION
  - Ditch active near 850 cfs (10 cfs ditch)
  - Ditch maxed above 1400 cfs (> 60 cfs ditch)

- PR CONFIGURATION
  - Ditch active near 50 cfs (10 cfs ditch)
  - Ditch maxed above 300 cfs (> 60 cfs ditch)





Approx. 1000 ac-ft of water diversion potential saved with proposed design each mobilization event

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PROPOSED DIVERSION DESIGN SUMMARY

- DESIGN OBJECTIVES
- Deliver water to irrigation ditch **– increased capacity over longer duration of hydrograph**
- Long-term sedimentation and maintenance **– predictable and routine maintenance to *build up* rather than *excavate and remove. Improvement* over existing push-up dams**

- DESIGN CONSTRAINTS
- Upstream/downstream fish passage **– velocities and depths within passable ranges**
- Sedimentation **– designed aggradation with channel transport dynamics**
- Upstream flooding **– no spatial impact**
- Geomorphic **– Avulsion risk relatively low at Ft West**
- Cost **– $870K**
- Aesthetic **– local and natural materials**

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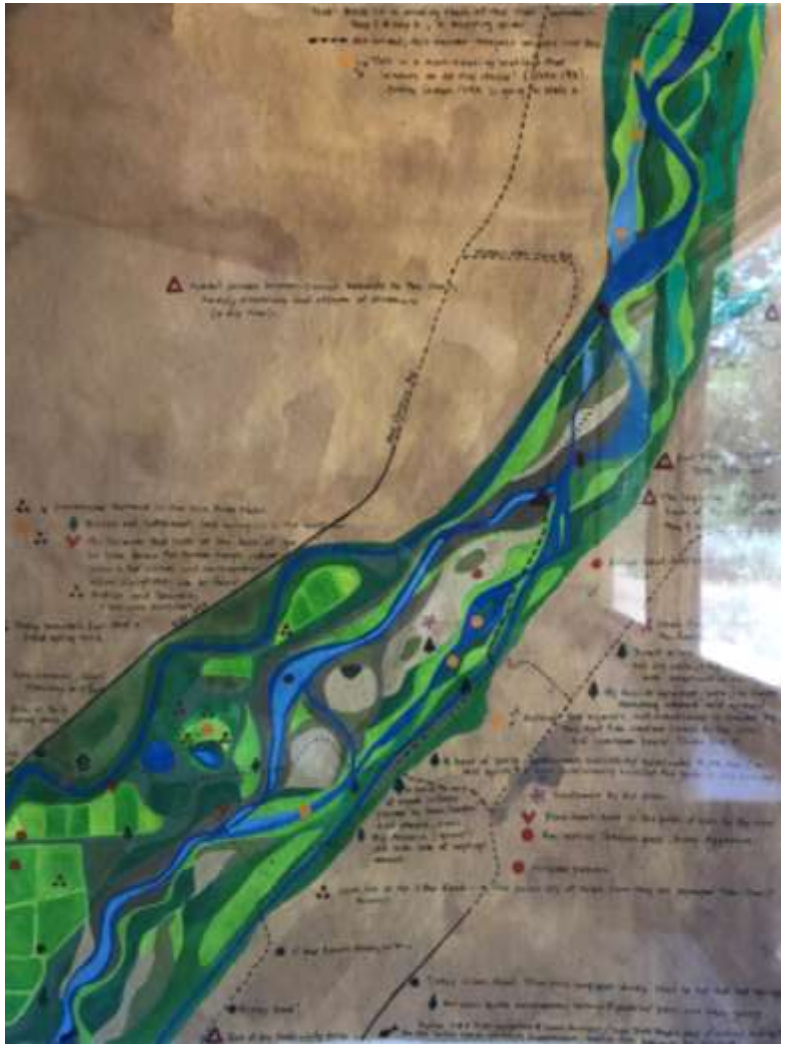
PRESENTATION SUMMARY

- Gila River may remain ‘free-flowing’ and ‘wild’ for a reason
- Design a diversion structure to a river environment, not a river to a diversion structure
- Sediment, fluvial geomorphology, local hydraulics are always unique
- Few one-size-fits-all solutions for river engineering; generalizations can cause problems
- All the tools are available to quantifiably design river structures for a variety of applications/scenarios
  - Sedimentation and scour
  - Geomorphic system response
  - 2D/CFD modeling
  - Fish passage biomechanics modeling



QUESTIONS

THANK YOU!

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