Restoration Approach in a Tidally Influenced Tributary Floodplain: La Center Wetlands Modeling, Design & Outcomes

Lower Columbia Estuary Partnership

inter·fluve

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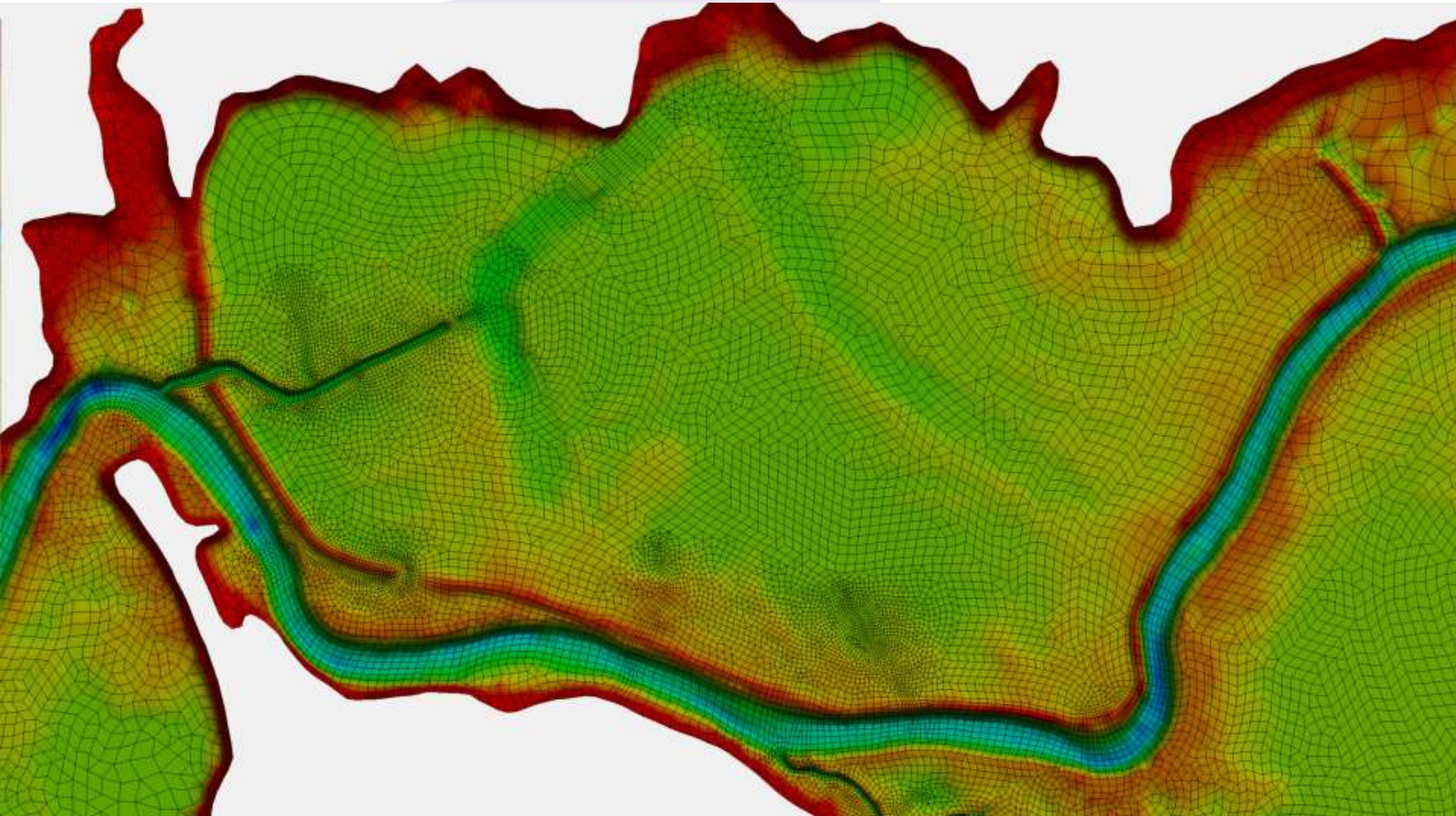
Caitlin Alcott: Inter-fluve

Focus of Presentation:

Role of hydrodynamic modeling in project feasibility & design.
Three general modeling questions:



1. *What controlling factors drive inundation of the site?*

2. How will restoration actions affect site hydrodynamics?

3. How can we mitigate potential risks of design elements?

- Flood risk on adjacent properties
- Erosion, head cutting, etc.?

1. Project Description

Project Overview

Site: 450 acre floodplain reconnection

- **Feasibility**: 2011-2012
- **Design**: 2014
- **Construction**: Fall 2015

Project Sponsor: Lower Columbia Estuary Partnership

Engineering & Design: Inter-Fluve

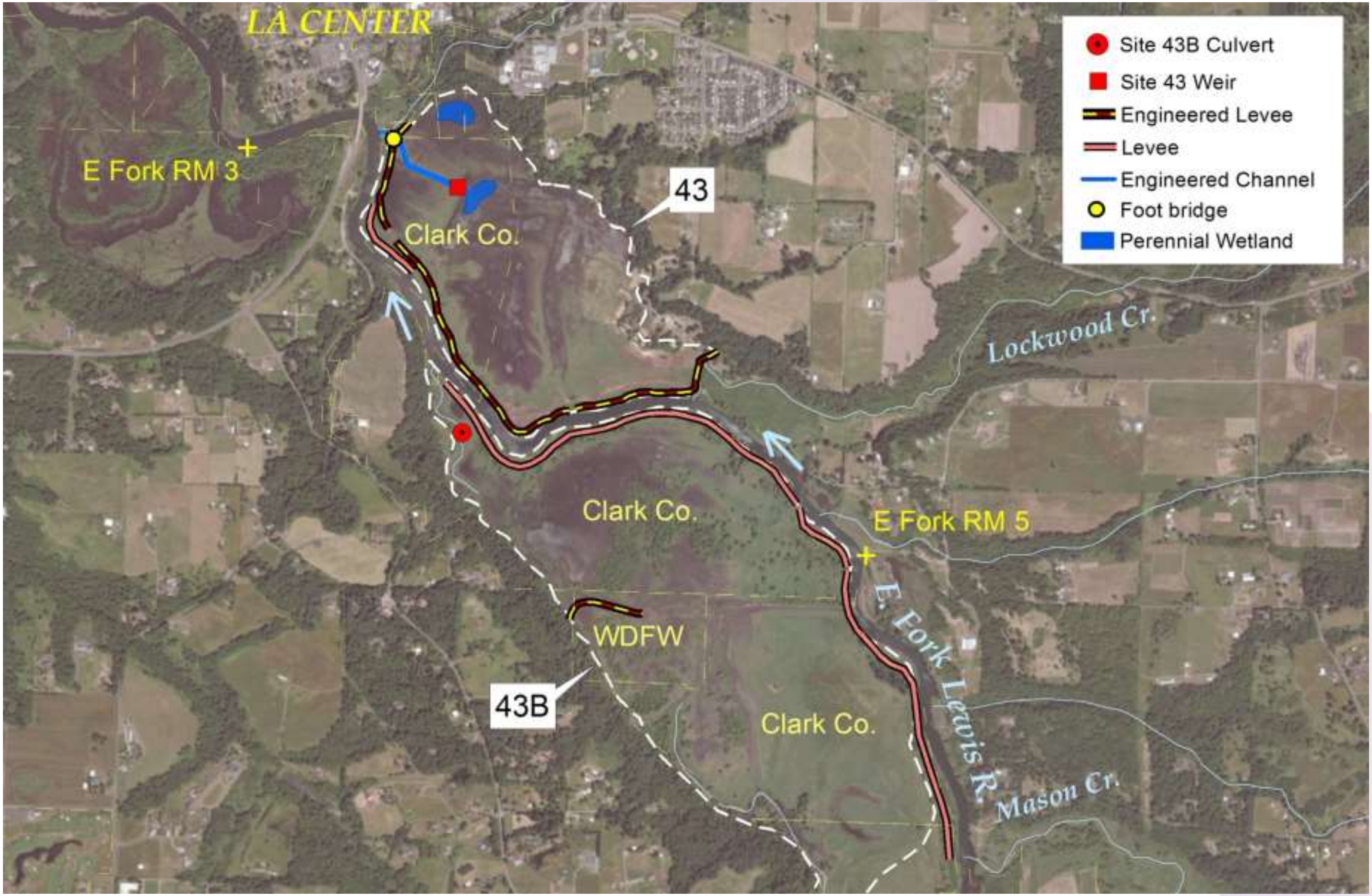
Construction: Aquatic Contracting

Funding: BPA/LCFRB

Partners: Clark County, WDFW, Private Landowners

La Center, WA

Existing Site Conditions (Pre-Restoration)



43 Engineered channel
from weir, looking downstream

43 Weir

from pond, looking downstream

43 Weir

43 Catfish/Weir Pond
from weir, looking upstream

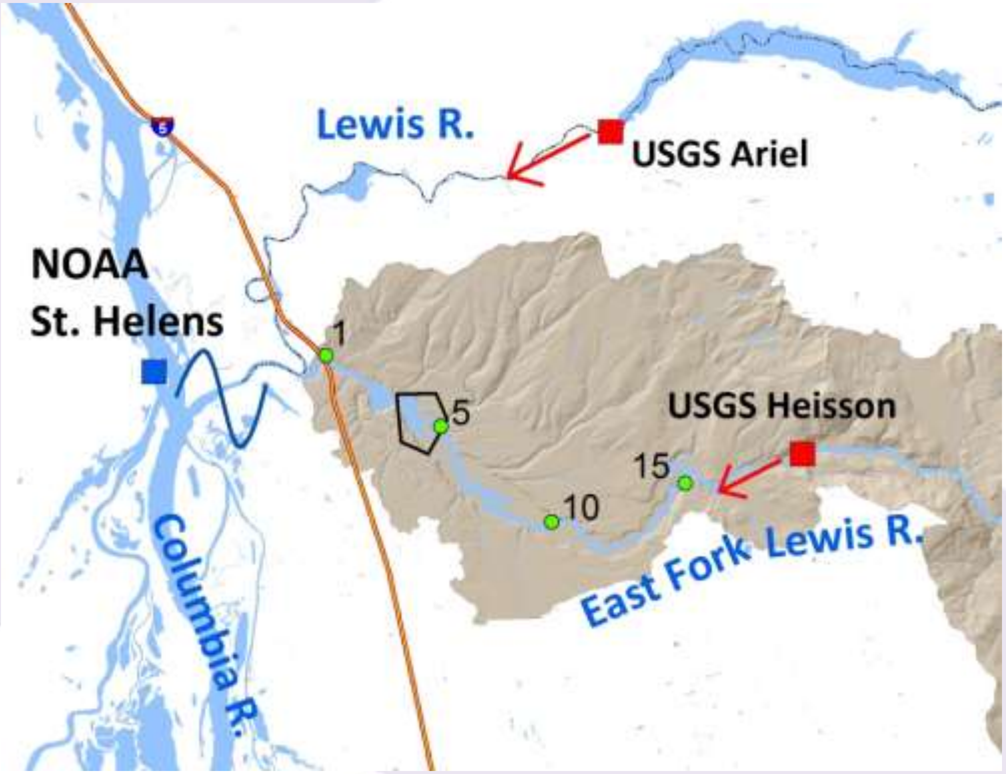
Levee along mainstem
Site 43, looking upstream

43B Culvert
looking downstream

Site Hydrodynamics: Controlling Factors

East Fork Lewis R. flow:

- Dominant Nov. – Apr.
- Q1 approx. <u>4,000 cfs</u>
- Q2 approx. <u>9,000 cfs</u>



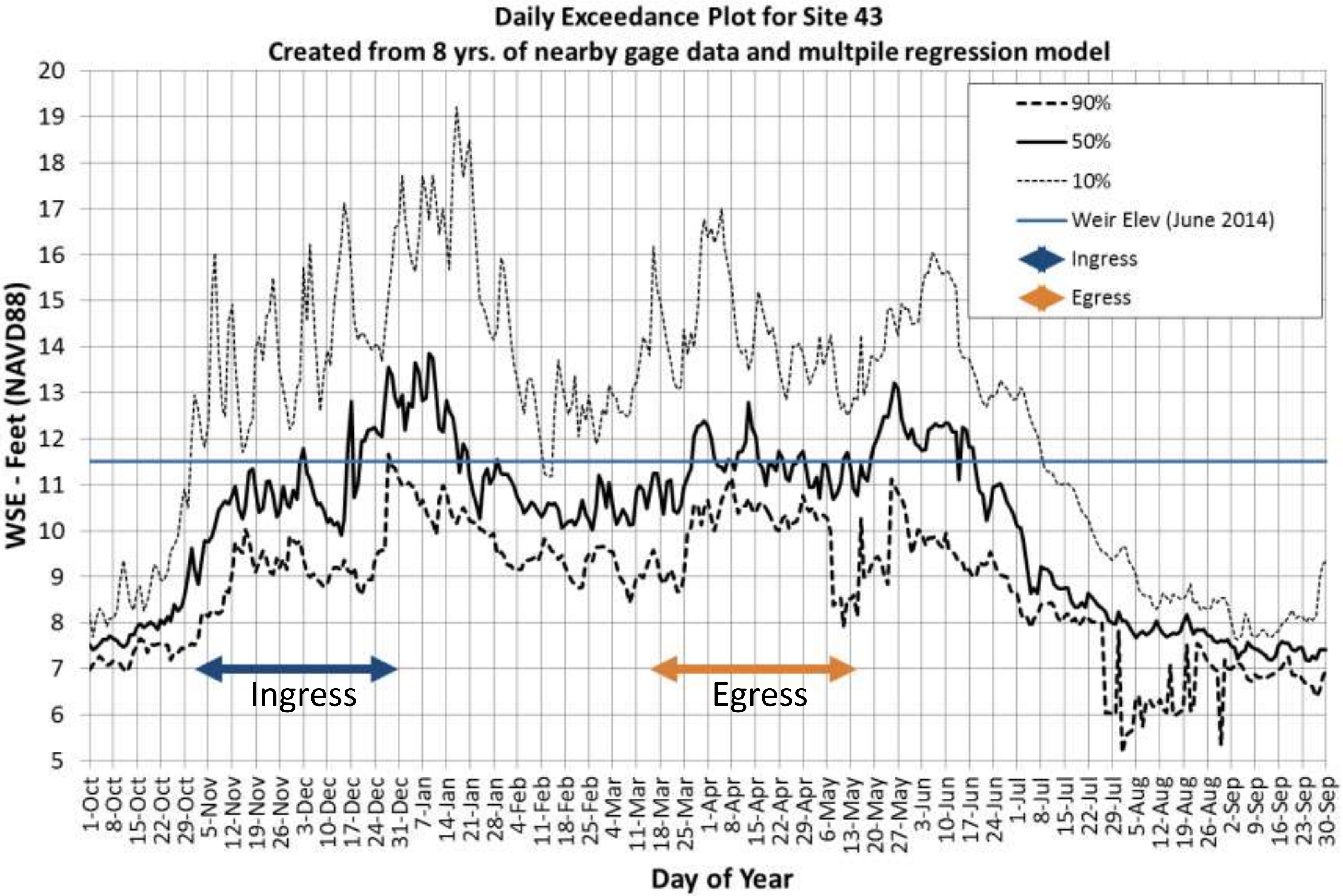
Columbia River tide:

- Dominant May – July
- Q2 stage approx <u>17.7’</u>

Lewis River flow:

- Dam controlled
- Can backwater site when E. Fork is low flow

Site 43 Weir limiting fish passage

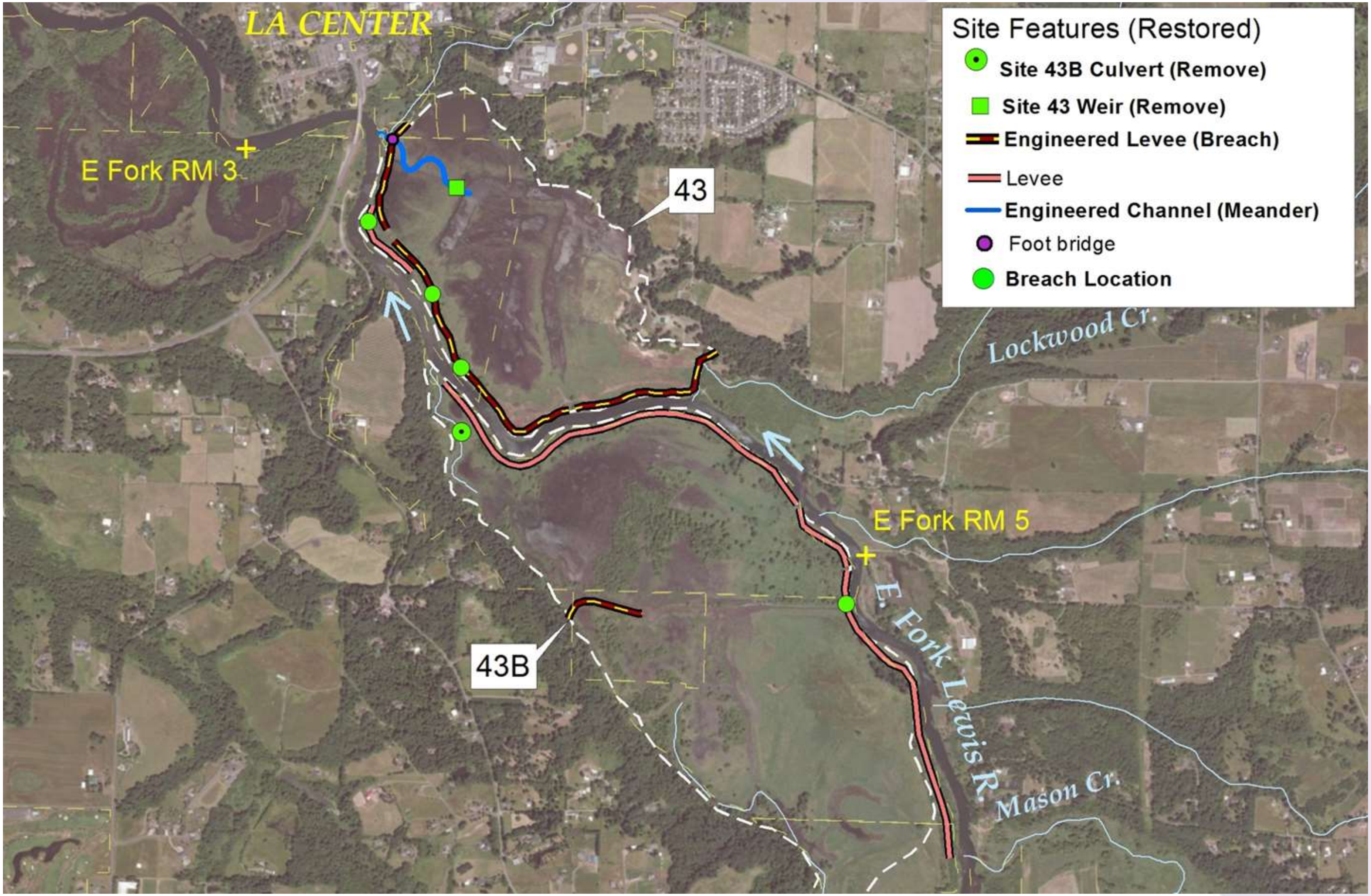


Design Objectives

- Increase inundation of wetlands and floodplains
- Improve/increase side-channel and off-channel habitat
- Improve fish passage

- **<u>Don't</u> drain the existing wetland & pond**
- **<u>Don't</u> flood the neighbors**

Proposed Conditions

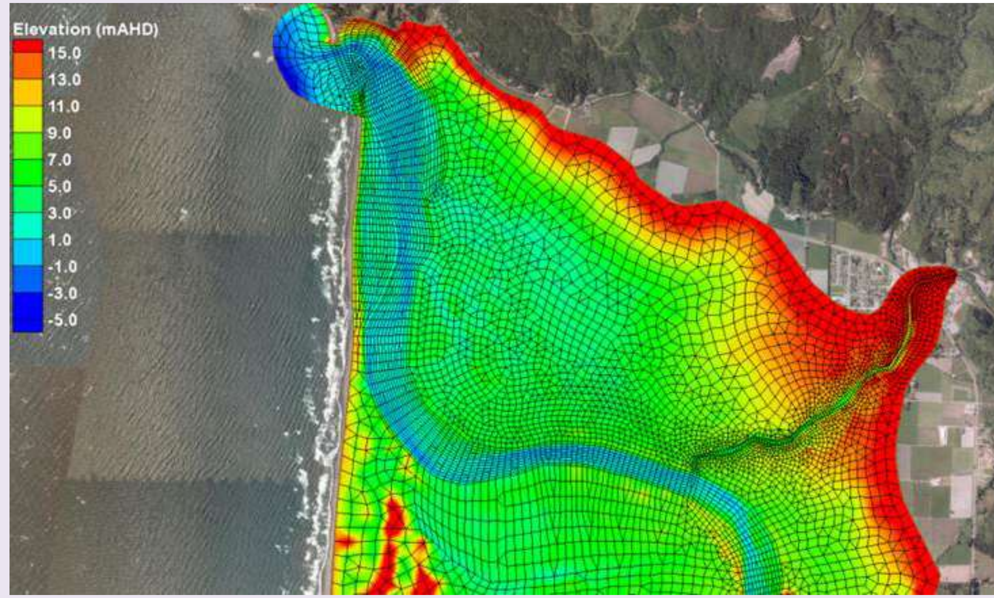


2. Model Background

Tuflow FV Hydrodynamic Model

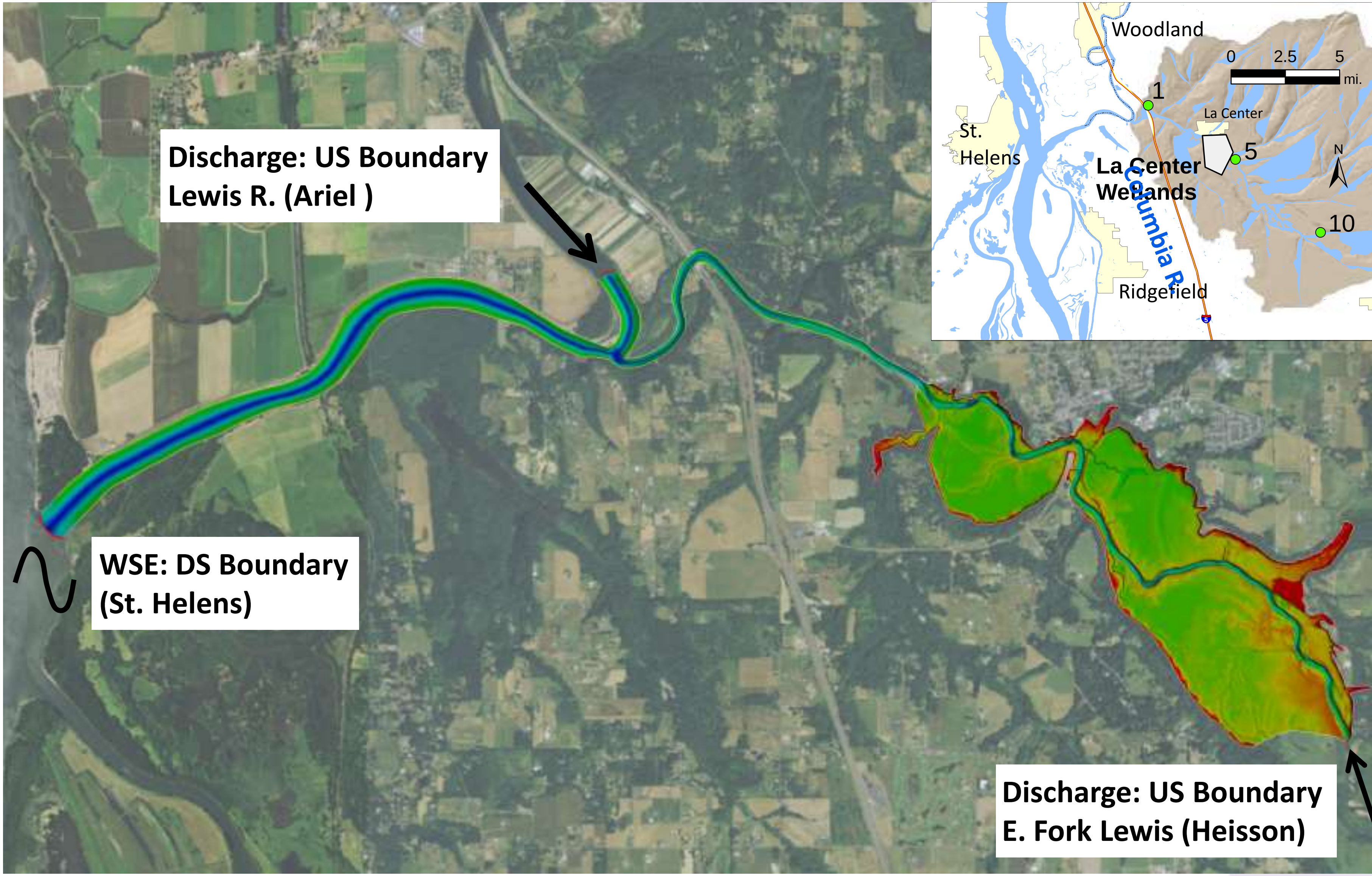
BMT WBM

"Where will our knowledge take you?"

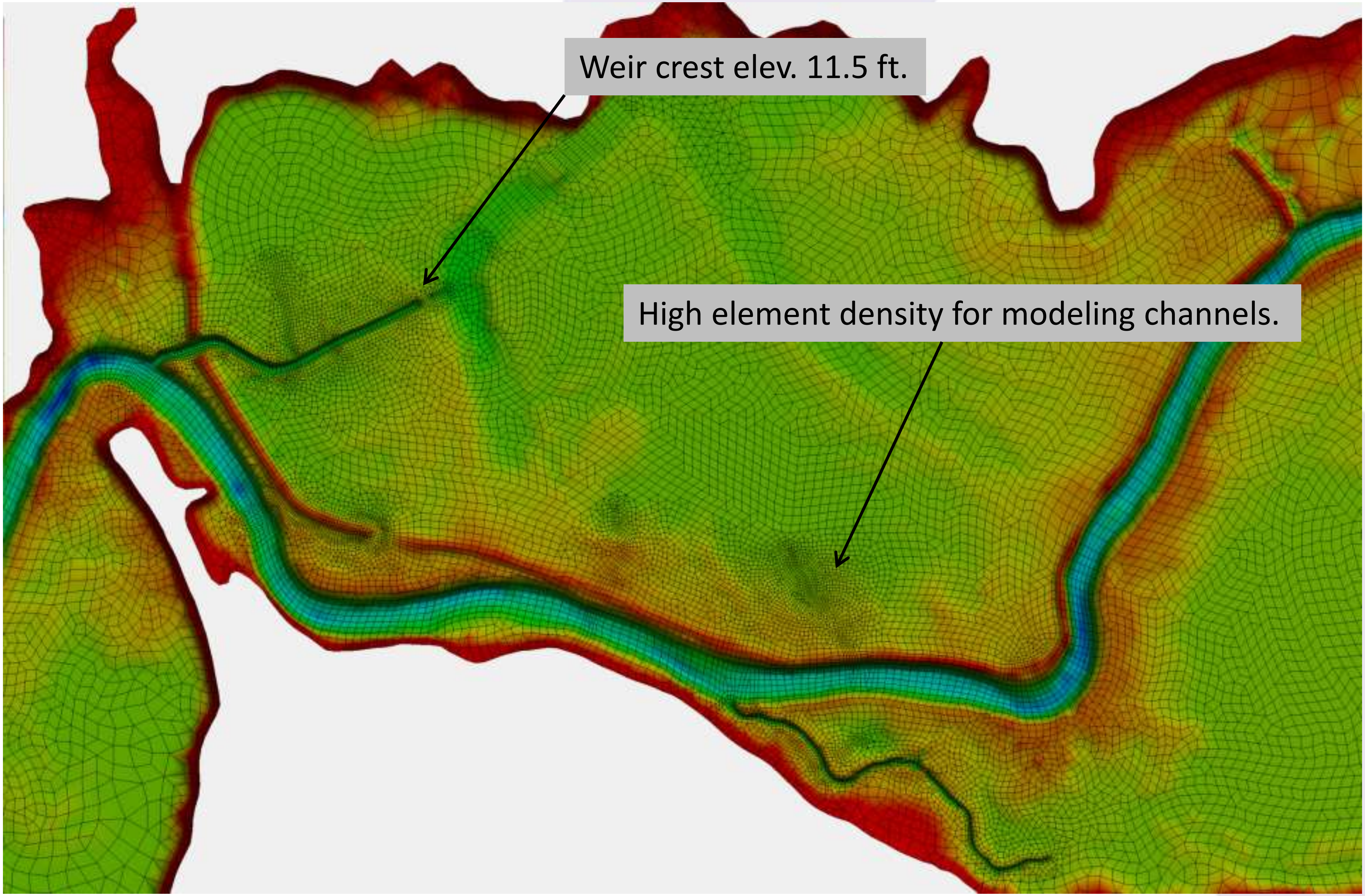


- Proprietary
- 2D numerical model (flexible time step, <u>stable</u>)
- Flexible bathymetric mesh

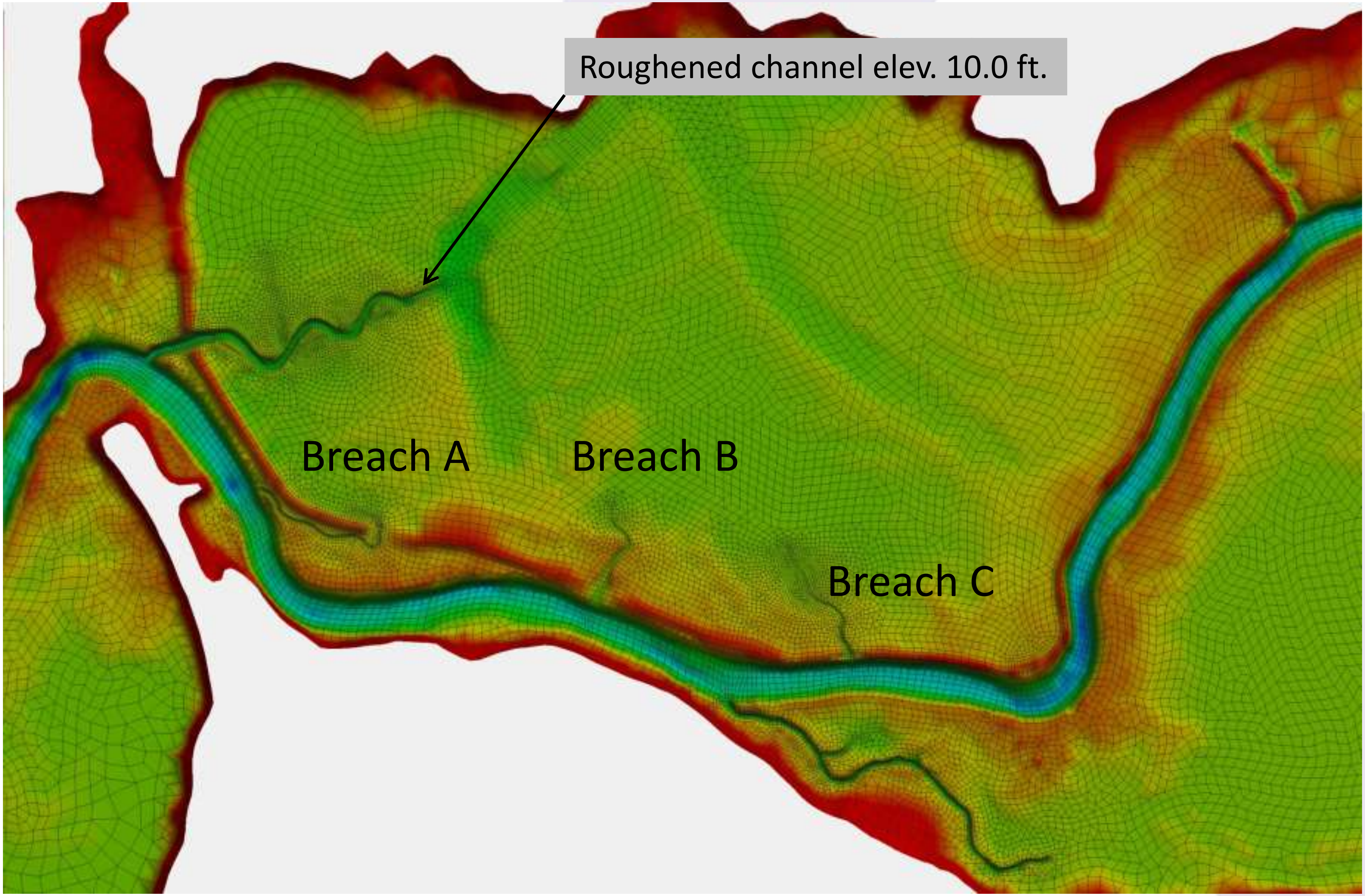
Model Physical Overview



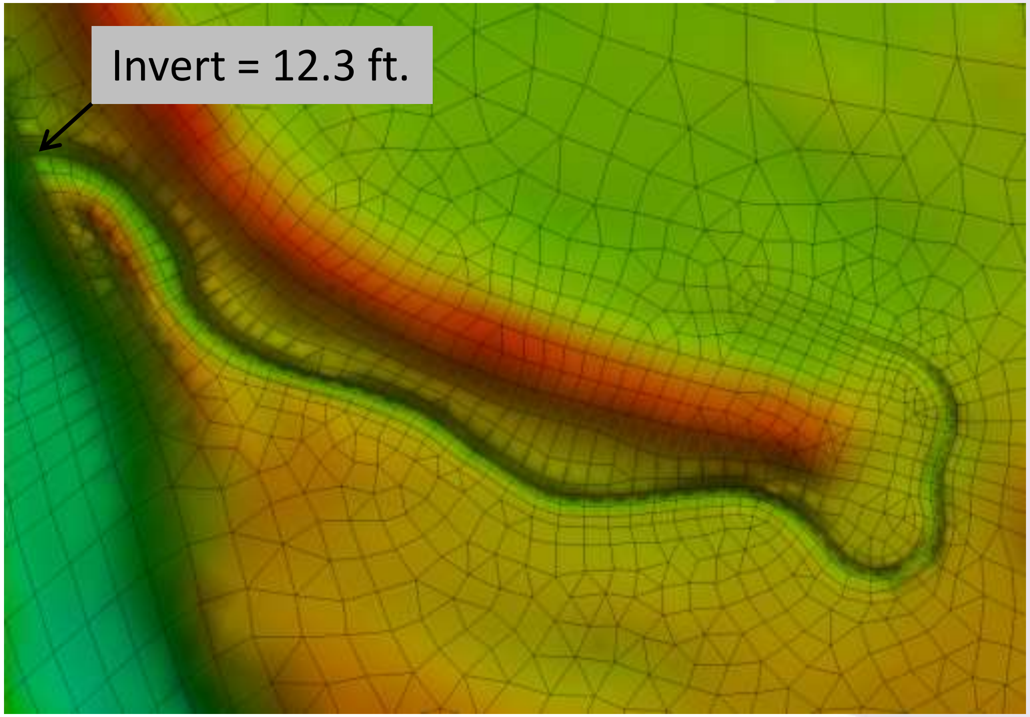
Model Mesh (Existing Condition)



Model Mesh (Restored Condition)

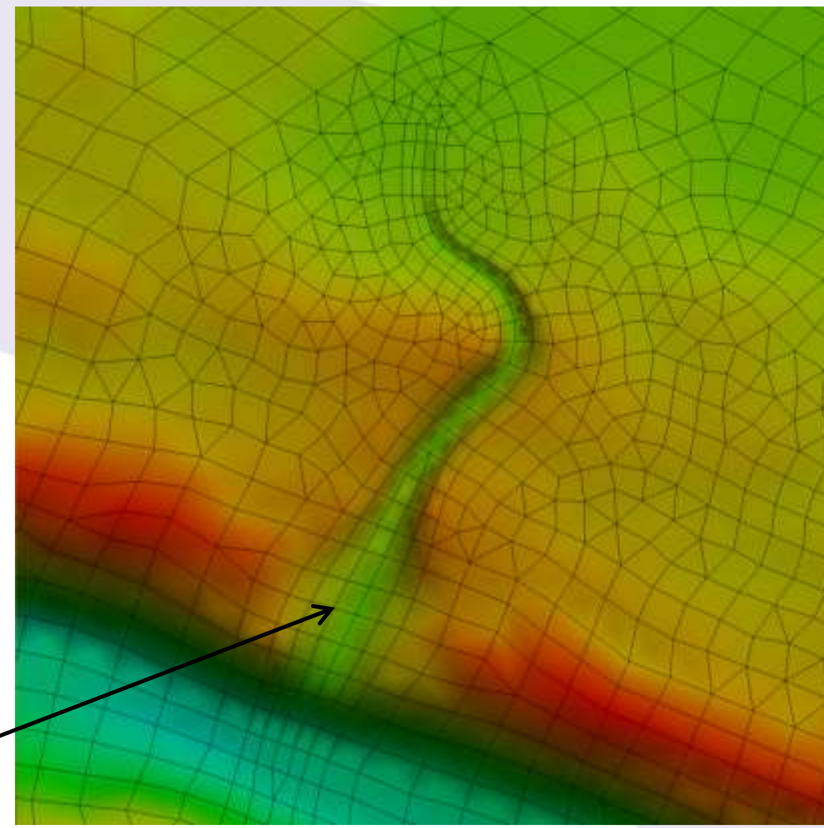


Model Mesh (Restored Condition)

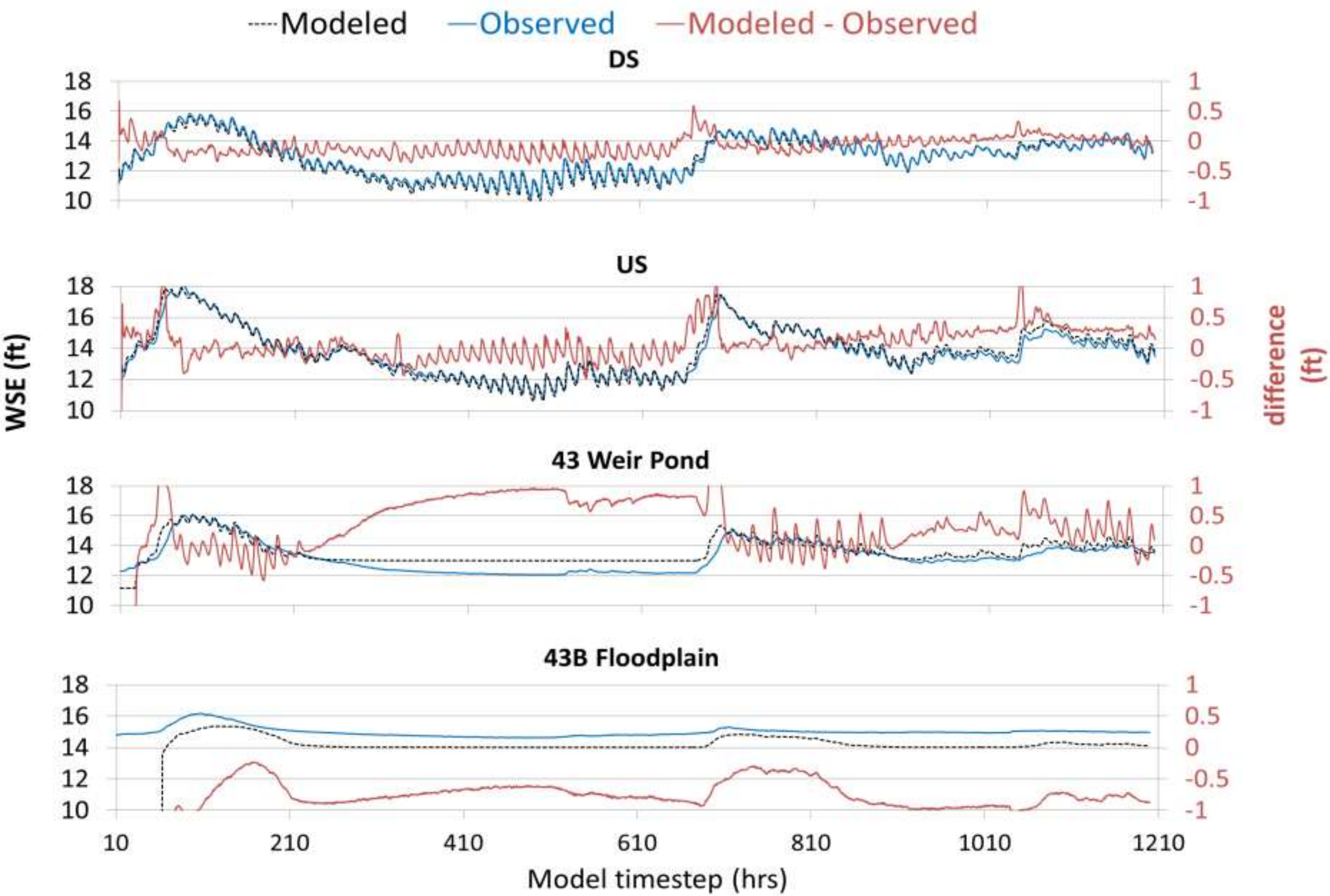


Breach A

Breach B



Model Calibration/Verification: Results



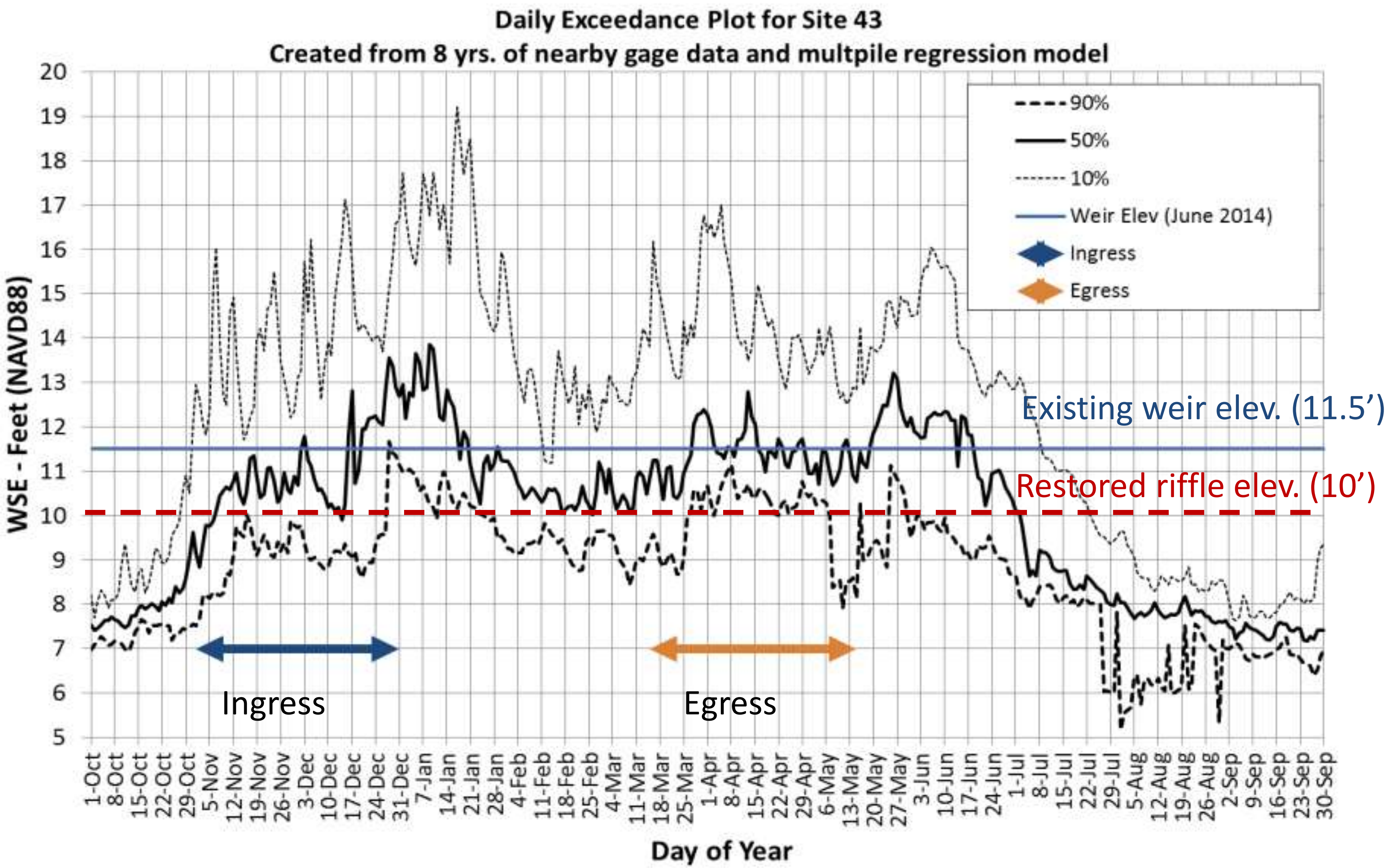
3. Model Results

Restoration Impacts

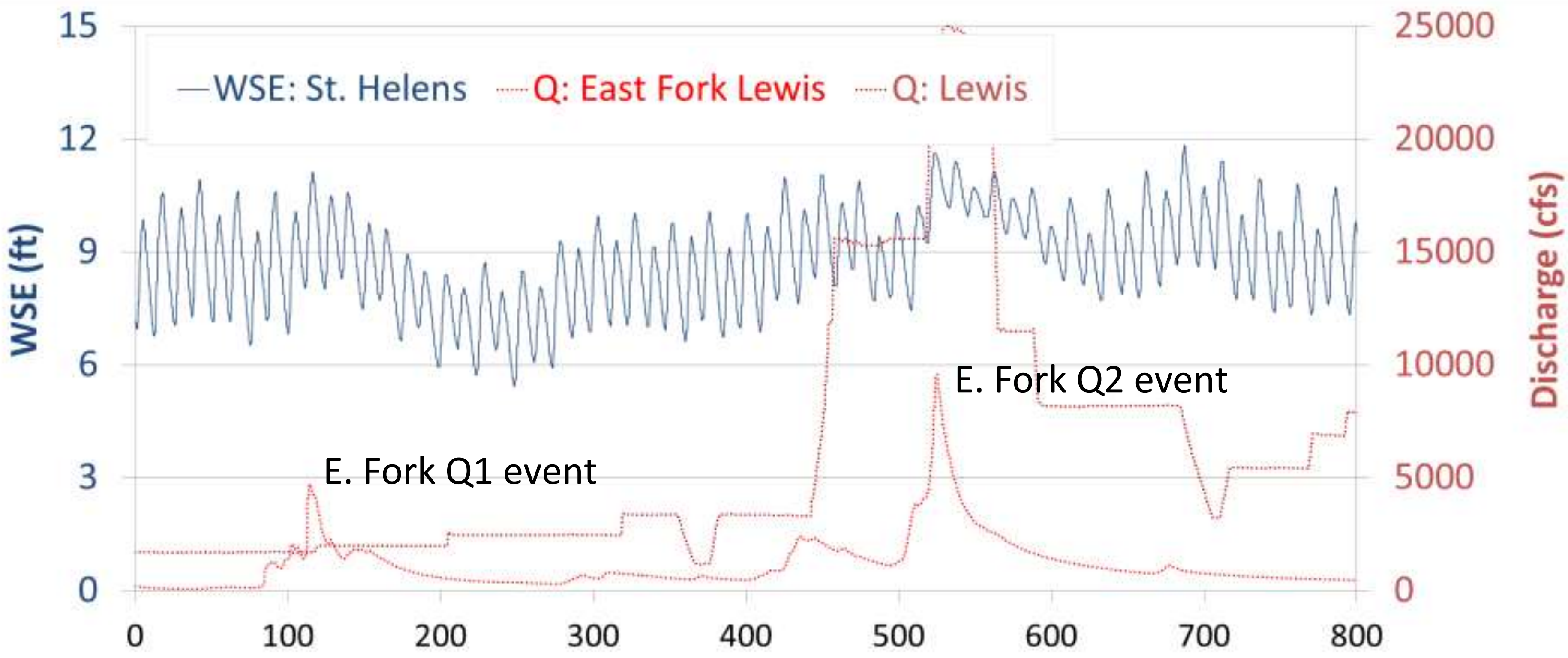
Restoration scenarios modeled at feasibility stage:

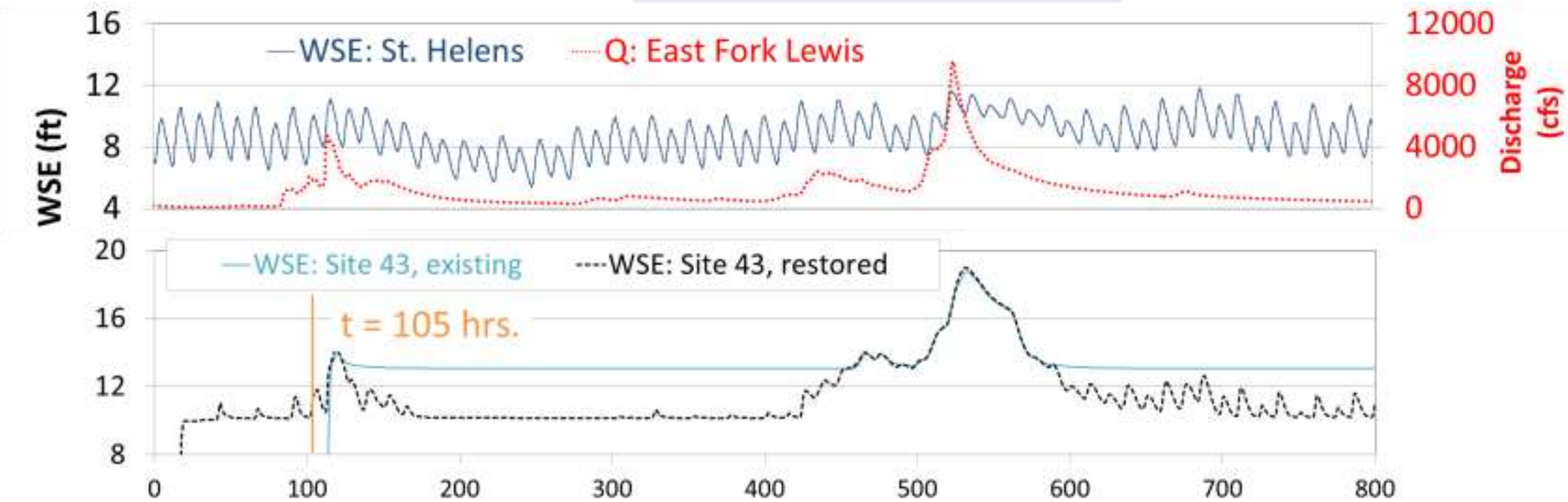
	Modeled Restoration Actions					
Scenario	43: Breach levee	43: Remove Weir	43: Lower Weir to 10’	43: Meander channel	43B: Remove culvert	43B: Breach levee
1	X			X	X	N/A
2	X	X				N/A
3	**X**		**X**	**X**	**X**	**X**
all	X	X		X	X	X

Proposed: replace weir w/ with constructed riffle to increase fish access and reduce potential fish stranding

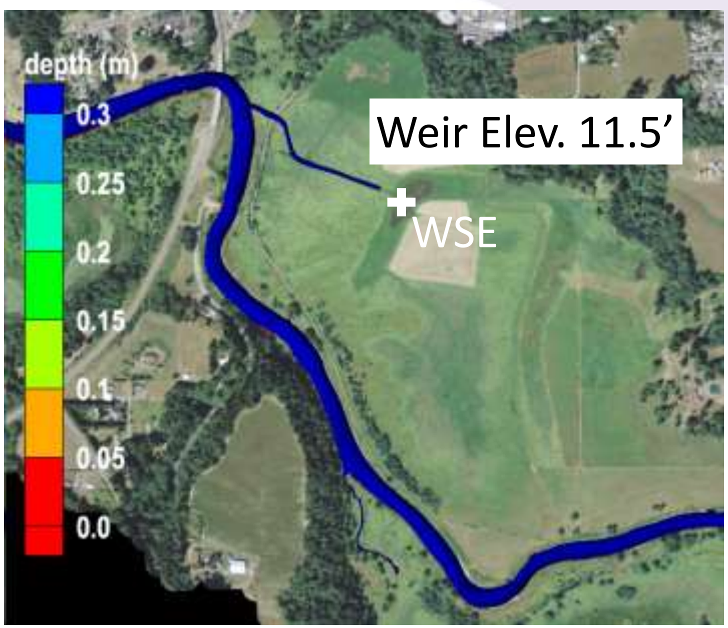


Boundary Conditions to evaluate restoration benefits

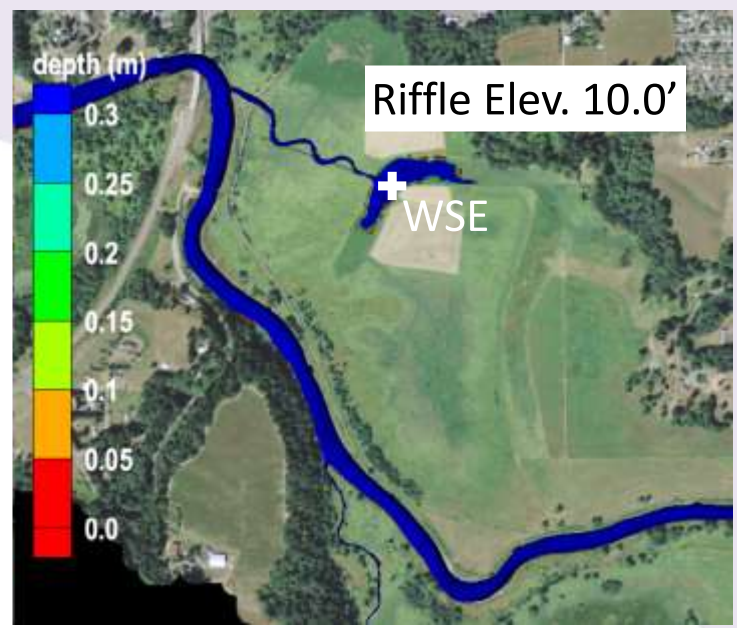


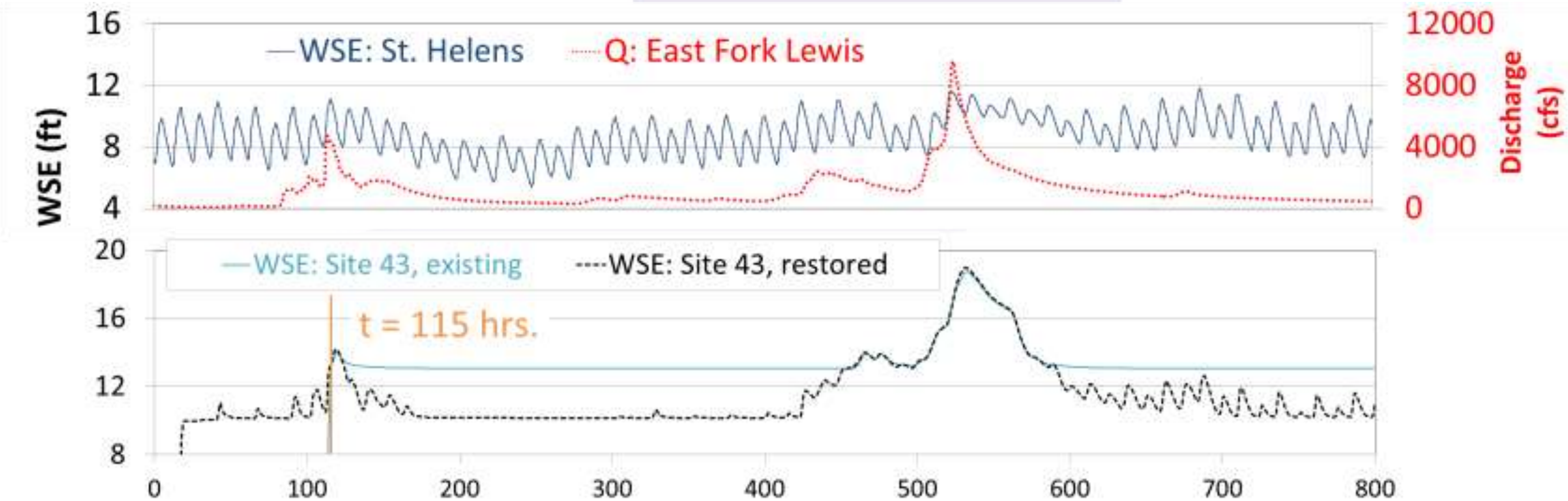


Modeled Water Depth, Existing Condition:

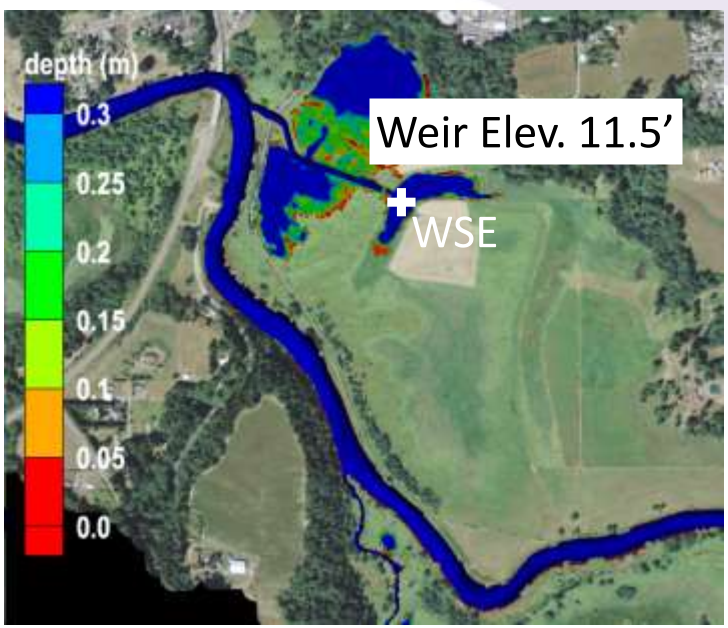


Modeled Water Depth, Restored Condition:

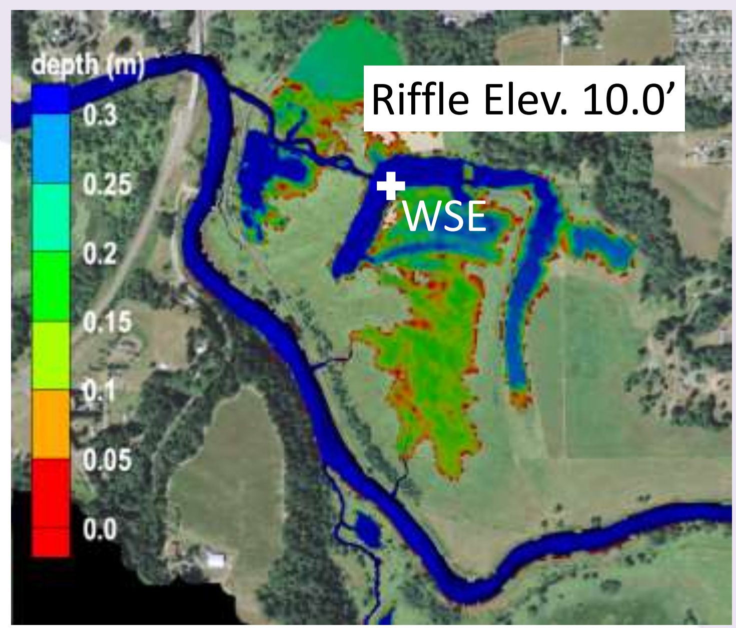


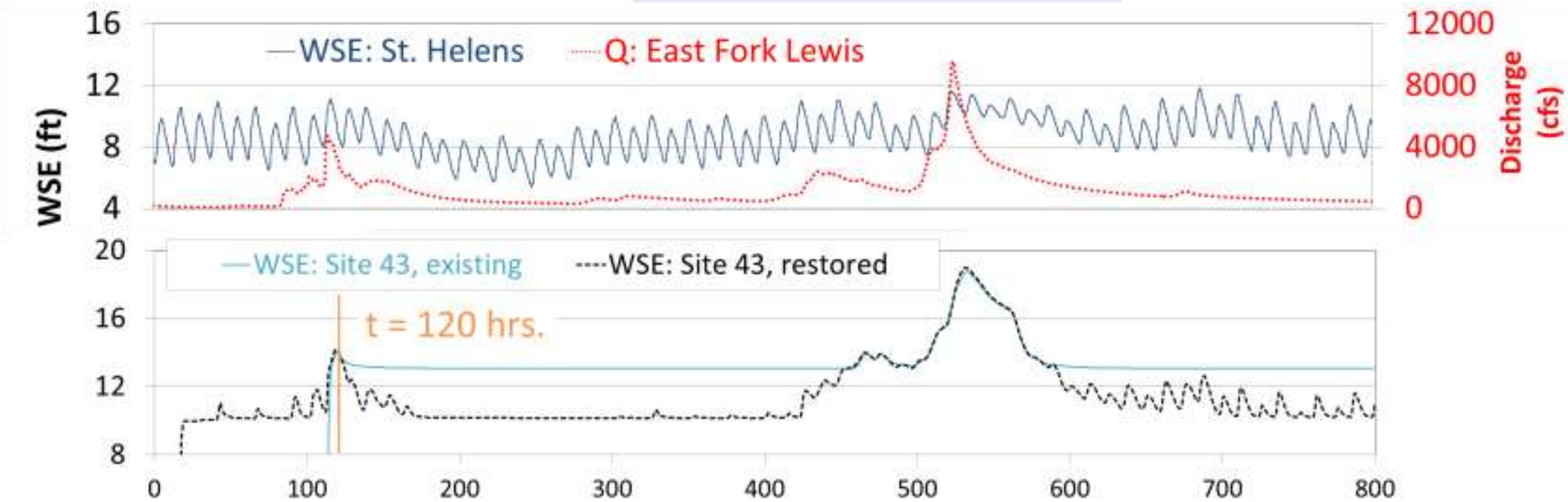


Modeled Water Depth, Existing Condition:



Modeled Water Depth, Restored Condition:





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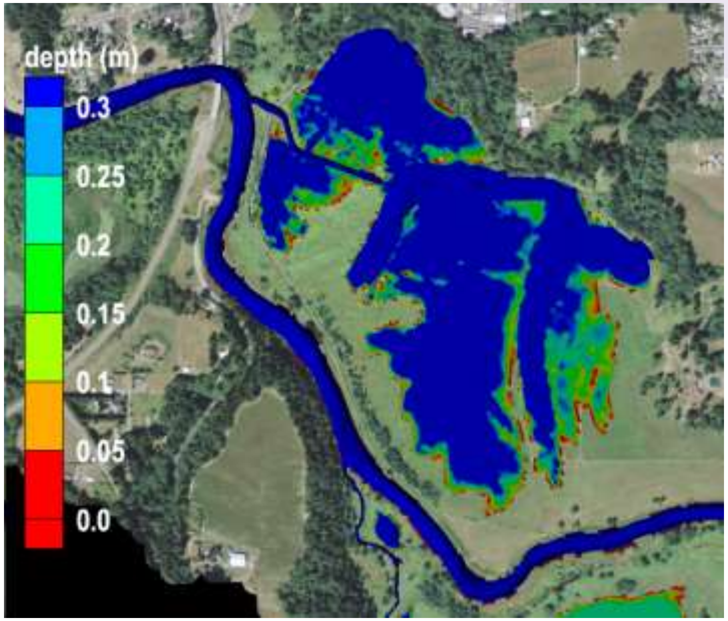

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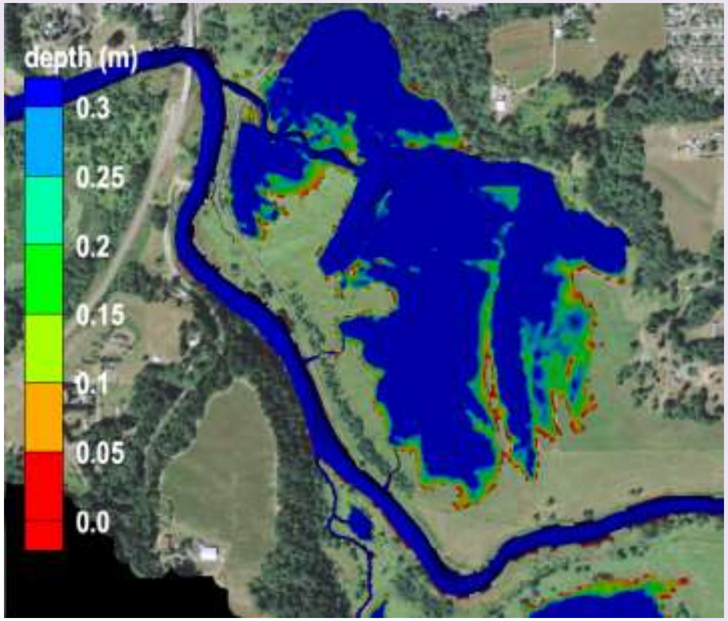
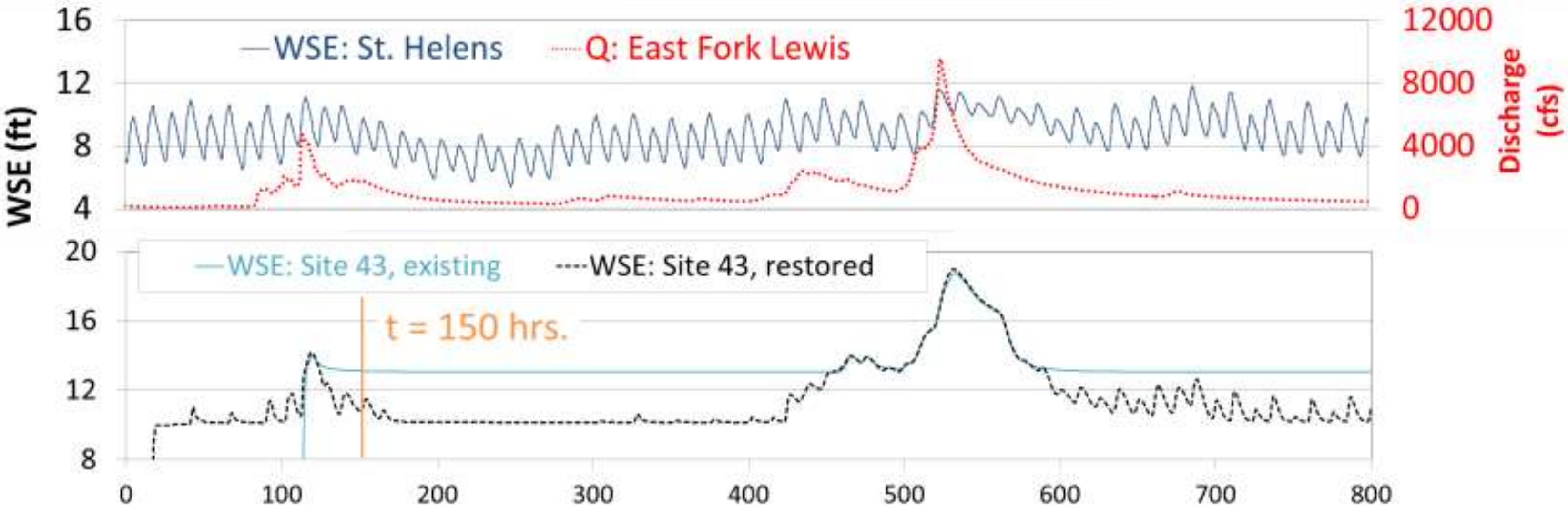
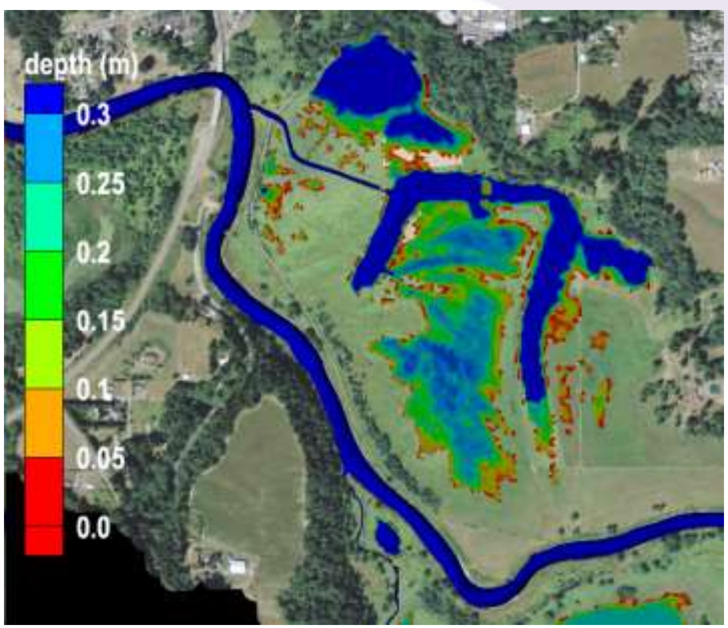
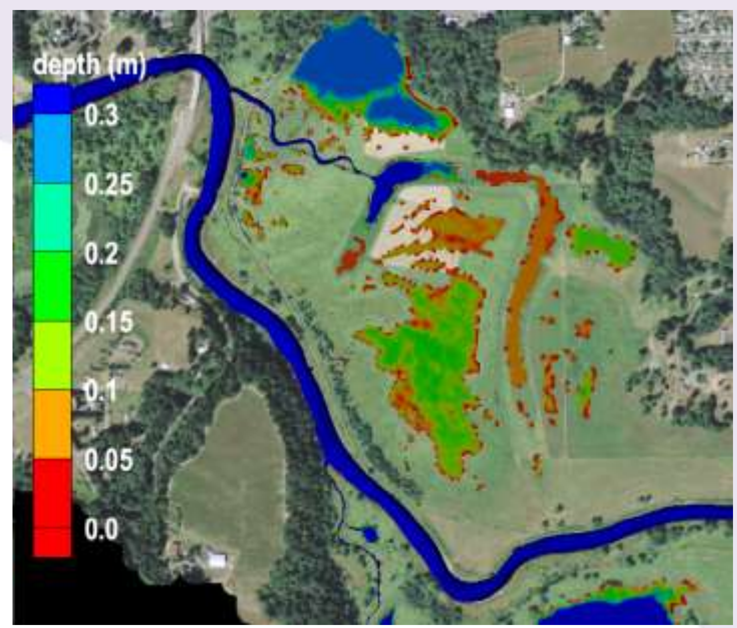




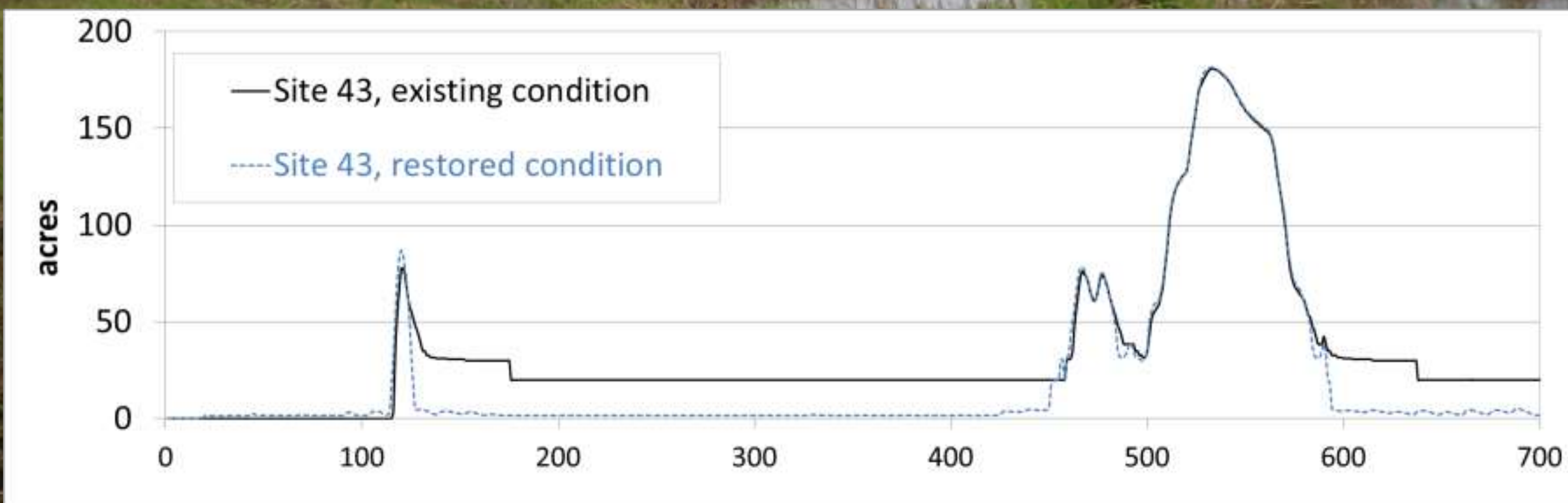
Modeled Water Depth, Existing Condition:



Modeled Water Depth, Restored Condition:



Acres inundated to > 1 ft. depth



Summary of results for simulated Q1 flood:

Site Condition	Max. acres >1 ft. depth Site 43	Max. acres > 1 ft. depth Site 43B	Total Hours that 1 ft. depth is exceeded				
			Site 43			Site 43B	
			Weir Pond	Wapato Pond	43 Floodplain	43B Wetland	43B Floodplain
Existing	174	180	385	1450	230	145	125
Restored	175	186	290	1644	226	151	150

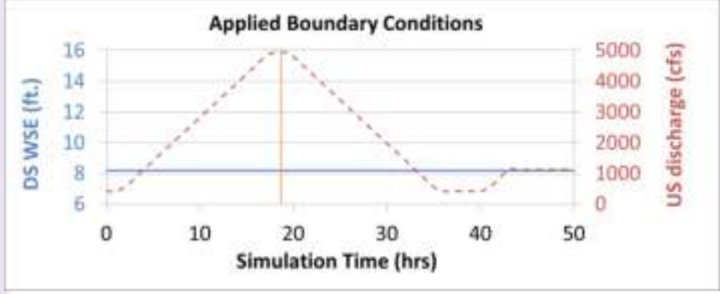
- primary benefit of restoration is a more natural flow regime (decreased stranding, increased water quality)
- Increased duration/extent of inundation is limited.
- Landowner concerns are addressed (pond retains water, flooding times similar)
- Q2 is similar

Question:

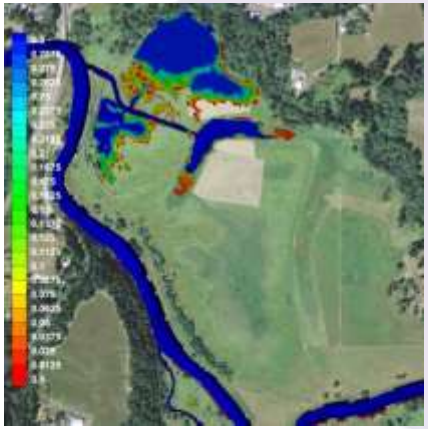
Does duration/extent of inundation improve under certain hydrologic conditions?

To answer:
Simulate regular flow event (Q1) on East Fork Lewis during lower Columbia River flow. Removes backwatering effect.

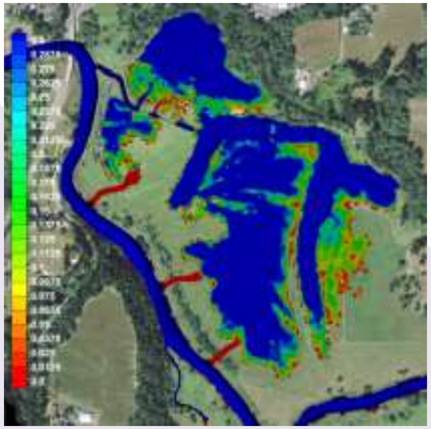
Low Columbia Flow Scenario Results:



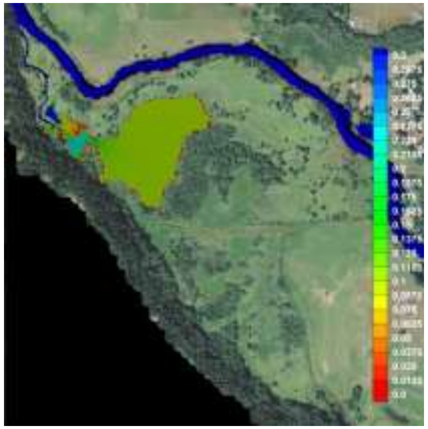
Site 43 Existing: **14 acres > 1 ft. depth**



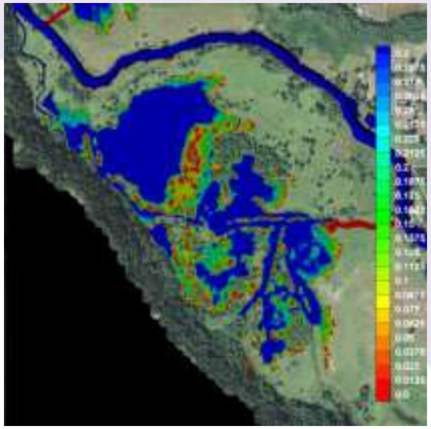
Site 43 Restored: **60 acres > 1 ft. depth**



Site 43B Existing: **1 acre > 1 ft. depth**

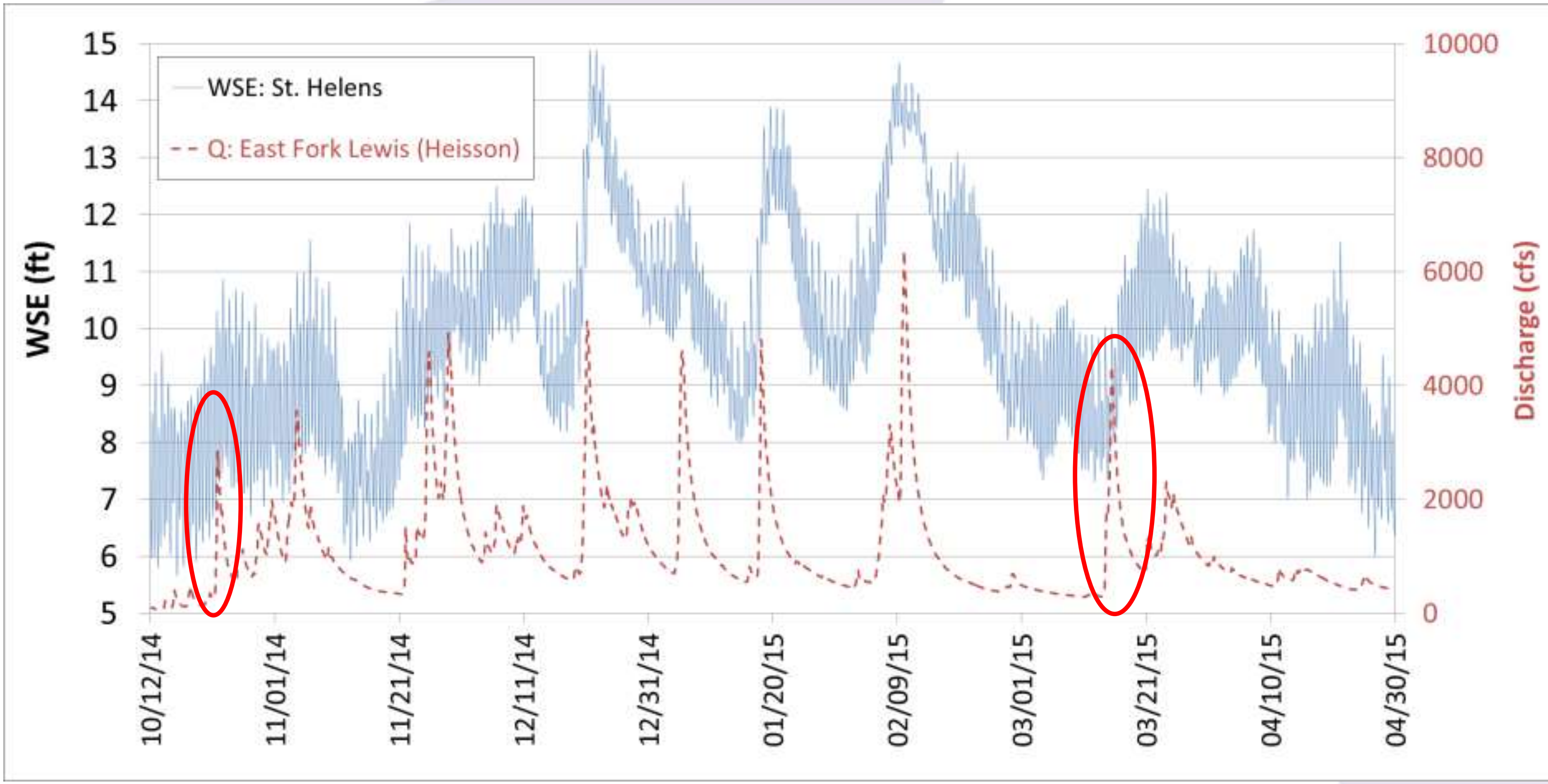


Site 43B Restored: **67 acres > 1 ft. depth**



Low Columbia Flow Scenario

A look at existing hydrographs shows when this condition occurred:

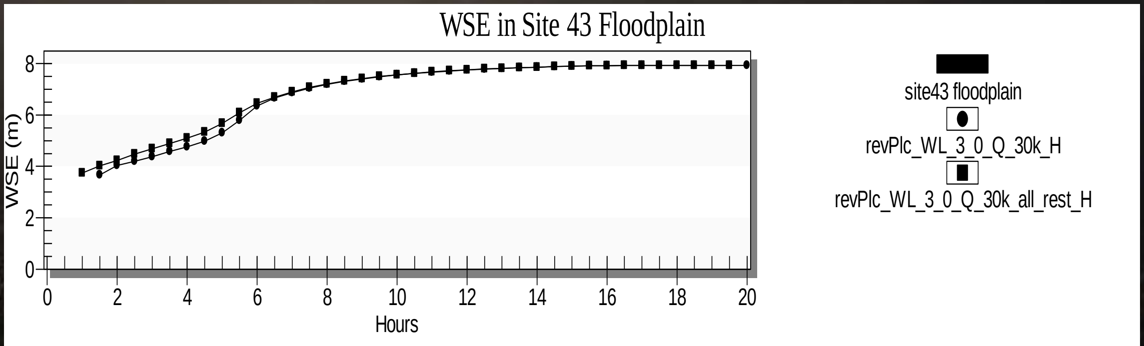


C. Current Velocities

Evaluate erosional/head-cutting risks and design requirements in breach channels for restored conditions

D. Flood Risk Analysis

Compare Q_{100} stage/discharge for existing and restored conditions



Modeling Conclusions for Design:

- Project will provide significant restoration benefits while addressing landowner concerns:
  - Optimized riffle elev. maintains pond year-round while allowing increased inundation when E. Fork flow > ≈1,800 cfs and Columbia R. stage is below 11.5’
  - Breaches/barrier removal at both sites allow increased inundation and fish access, and decrease potential fish stranding
- Minimal risk of erosion in constructed channels due to velocity/elevation gradients and vegetation
- Minimize additional flood risk to adjacent landowners

Lessons Learned:

- In complex tidal/fluvial systems, hydrodynamic modeling is essential for evaluating restoration impacts if site hydrology is not known.
- Collaboration in the modeling process allows for a much more thorough investigation if project feasibility and design funding is limited.

Thanks, Questions?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