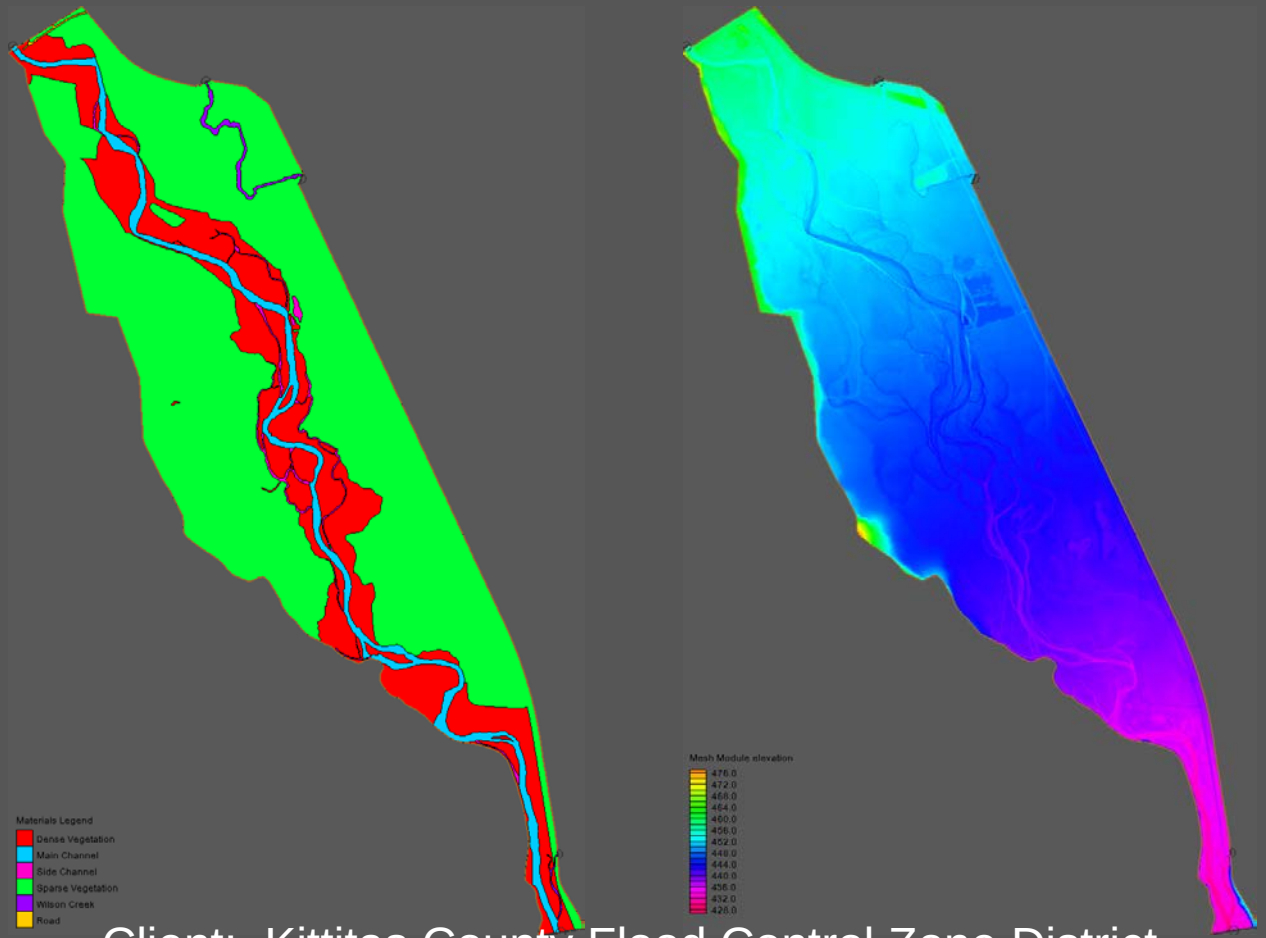
Two-Dimensional SRH-2D Modeling to Identify and Evaluate Habitat Enhancement and Flood Hazard Reduction Actions on a Reach of the Yakima River



Client: Kittitas County Flood Control Zone District

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August 20, 2014

by

Bob Elliot
&
Shaina Sabatine
(WSE)
Rob Hilldale
(USBR)

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SCIENCE & ENGINEERING

- Two projects: Schaake Levee (USBR) and Hansen Pits Reach (Kittitas County FCZD)
- Site Overview Including Existing Flood & Erosion Facilities
- Channel Migration and Avulsion Potential
- Identify Existing Flood Hazards
- Impacts / Benefits of Existing Flood & Erosion Facilities
- Flood & Erosion Hazard Reduction Opportunities
- Habitat Opportunities
- USBR Two-dimensional Modeling using SRH-2D and extended by WSE for Hansen study very beneficial

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Presentation Outline

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SRH-2D MODELING

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Develop focused strategy of viable alternatives for integrated floodplain management ("Floodplains by Design"), to preserve and/or enhance floodplain function along 7 miles of Yakima River near Ellensburg, WA.

USBR (Schaake levee) and Kittitas County (Hansen Pits, etc.) both primarily focused on left/east bank levees:

- Setting back existing levees will help reconnect cutoff side-channels and encourage channel migration
- Decreased flood depths reduce flood hazard and stress along existing revetments
- Increased channel/floodplain interaction and overall river habitat
- Right bank levees to remain, for now, but 2D model results show benefit of modifications to these levees and should be considered in the future

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Project Objectives

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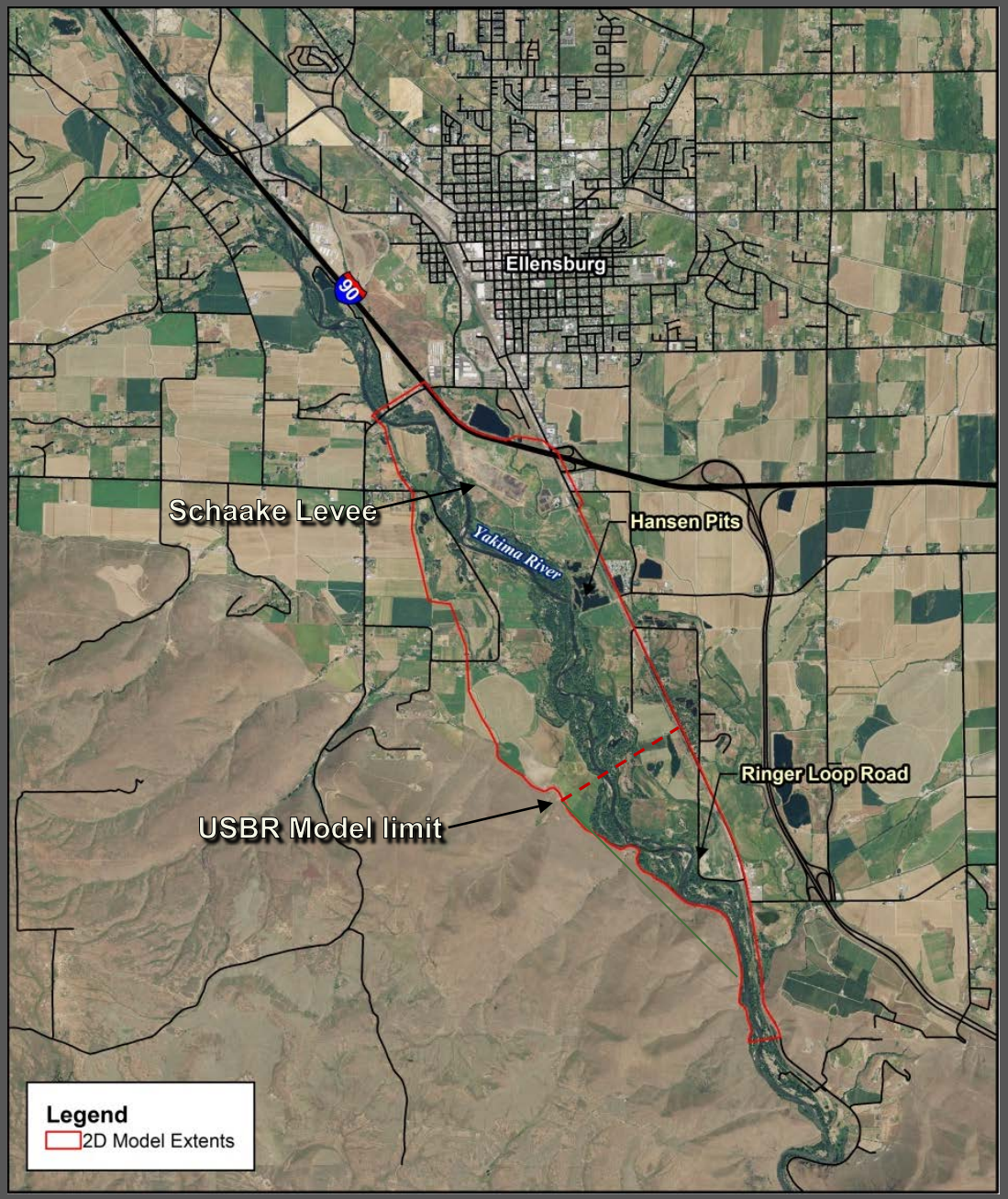

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Yakima River Project Reach

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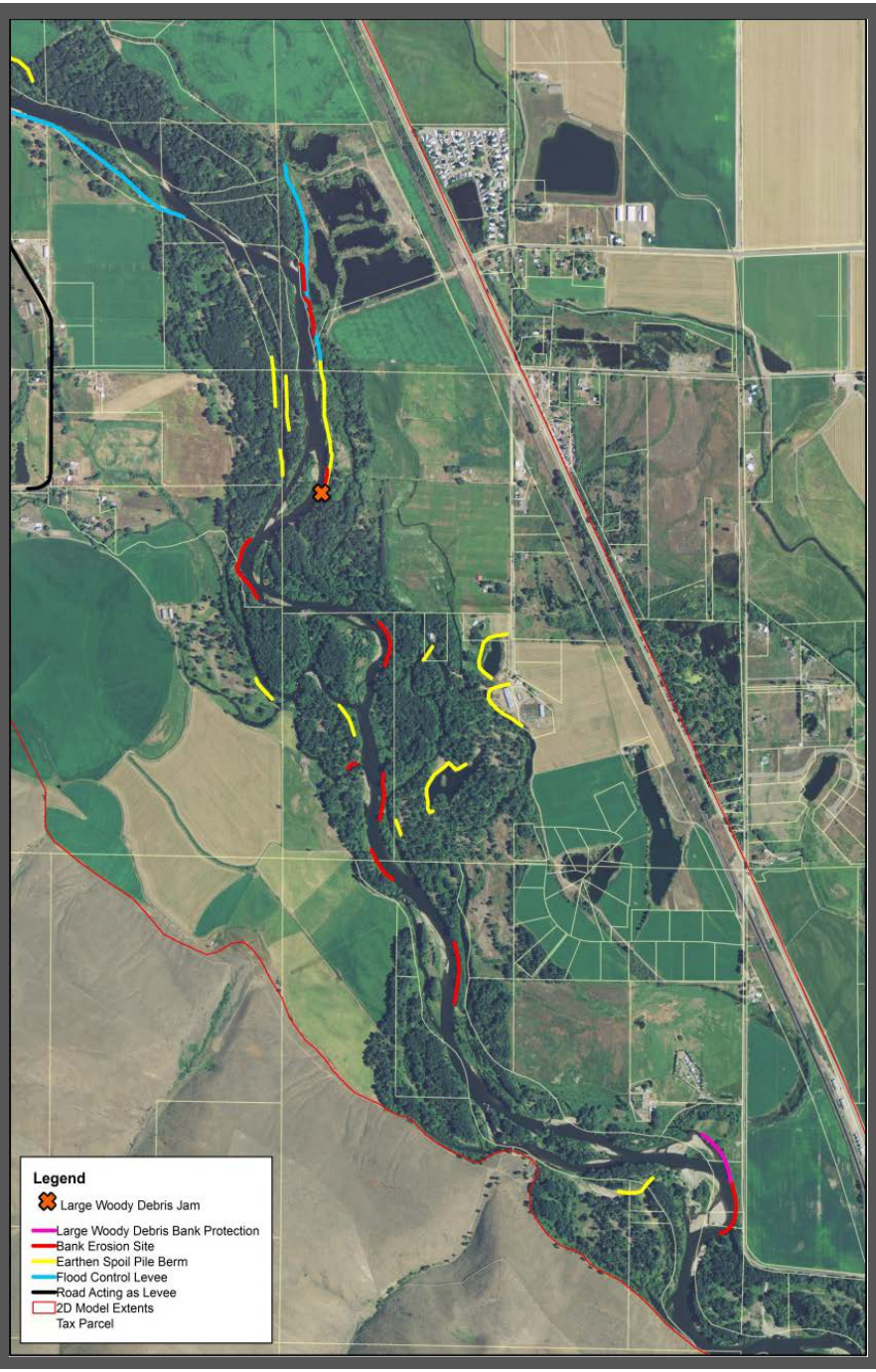

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EXISTING FLOOD AND EROSION PROTECTION FACILITIES & ACTIVE BANK EROSION

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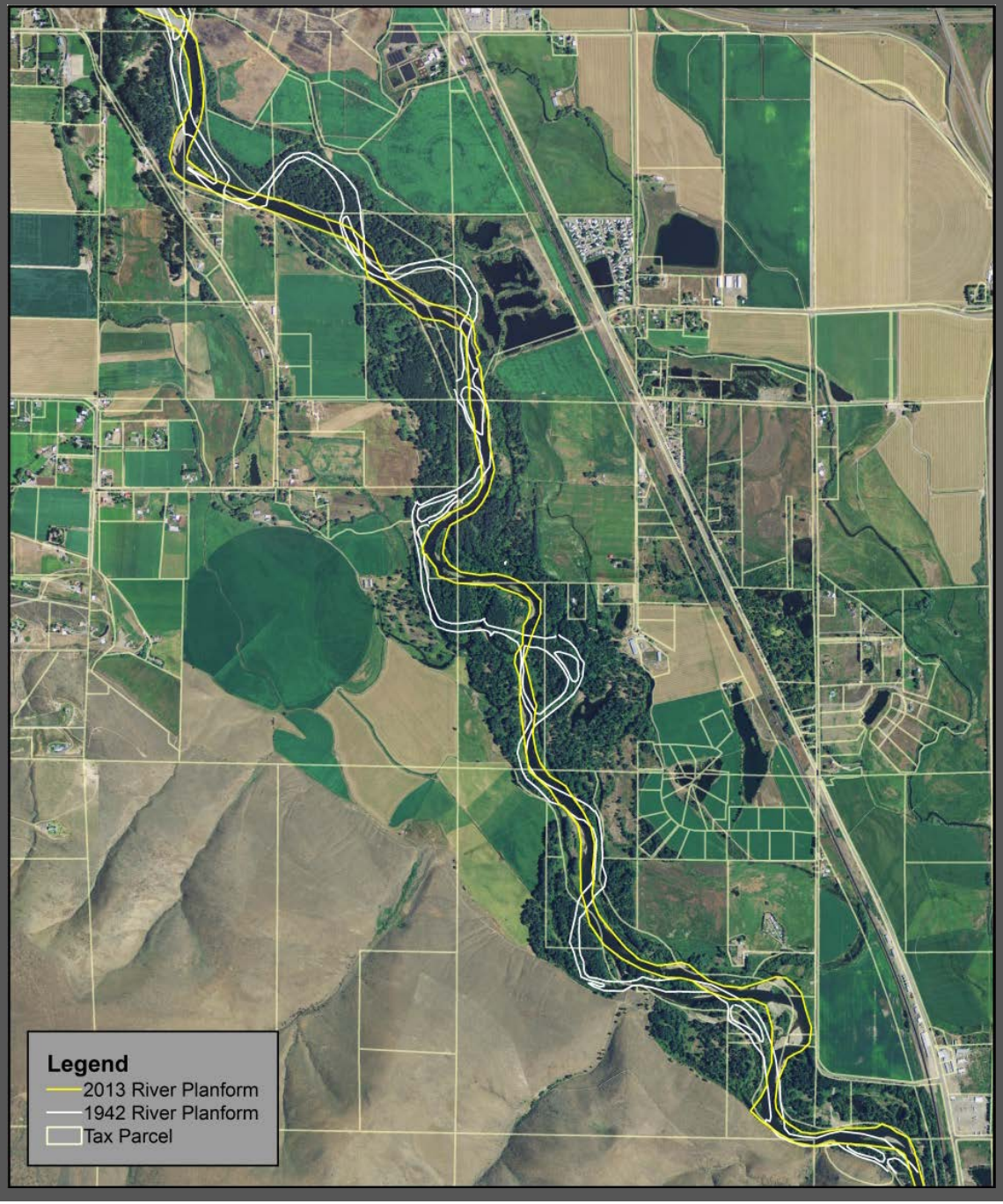

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CHANNEL MIGRATION

PLANFORM CHANGES 1942 TO 2013

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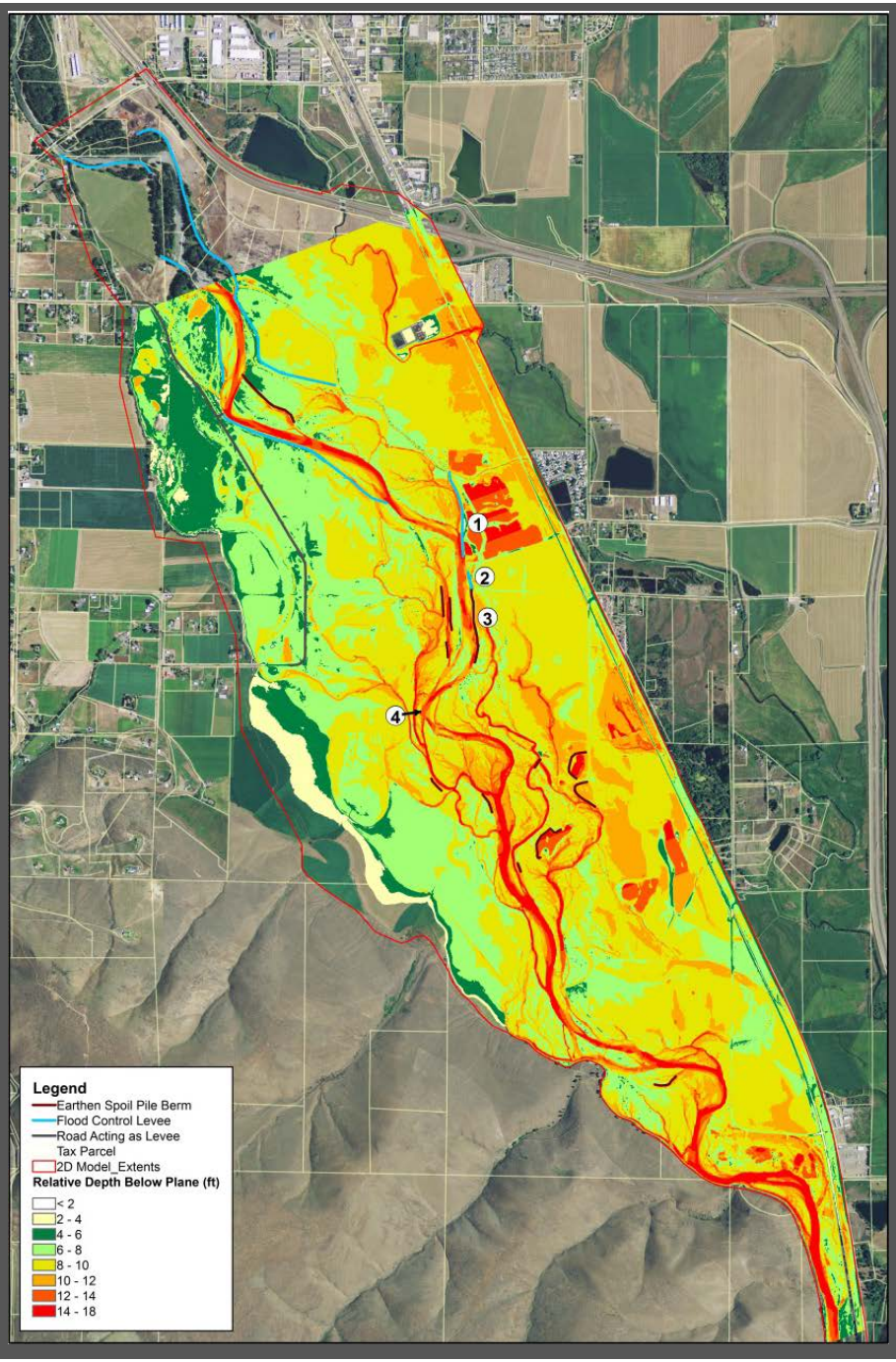

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AVULSION HAZARDS

REMNANT CHANNELS IDENTIFIED BY DEPTH

(SIDE CHANNEL HABITAT POTENTIAL)

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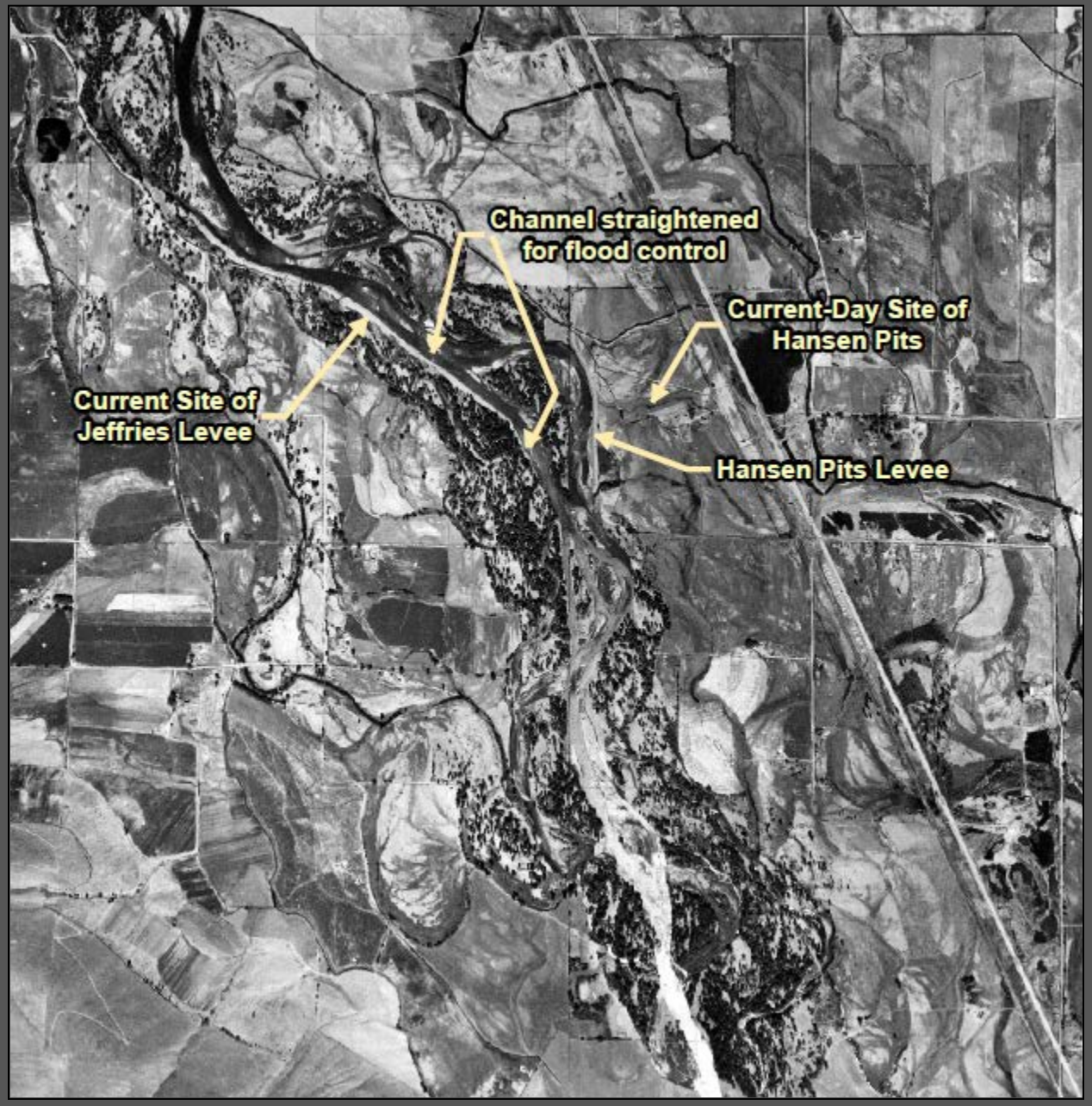

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HUMAN INFLUENCES

1954 AERIAL SHOWING 1940S CORPS FLOOD CONTROL PROJECT

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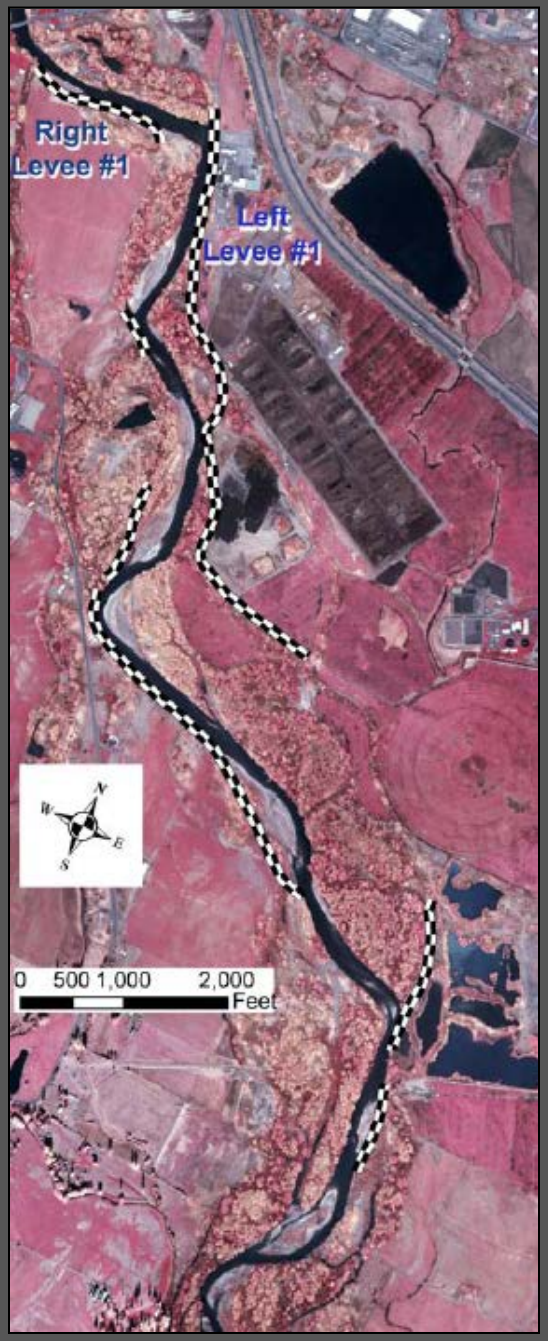

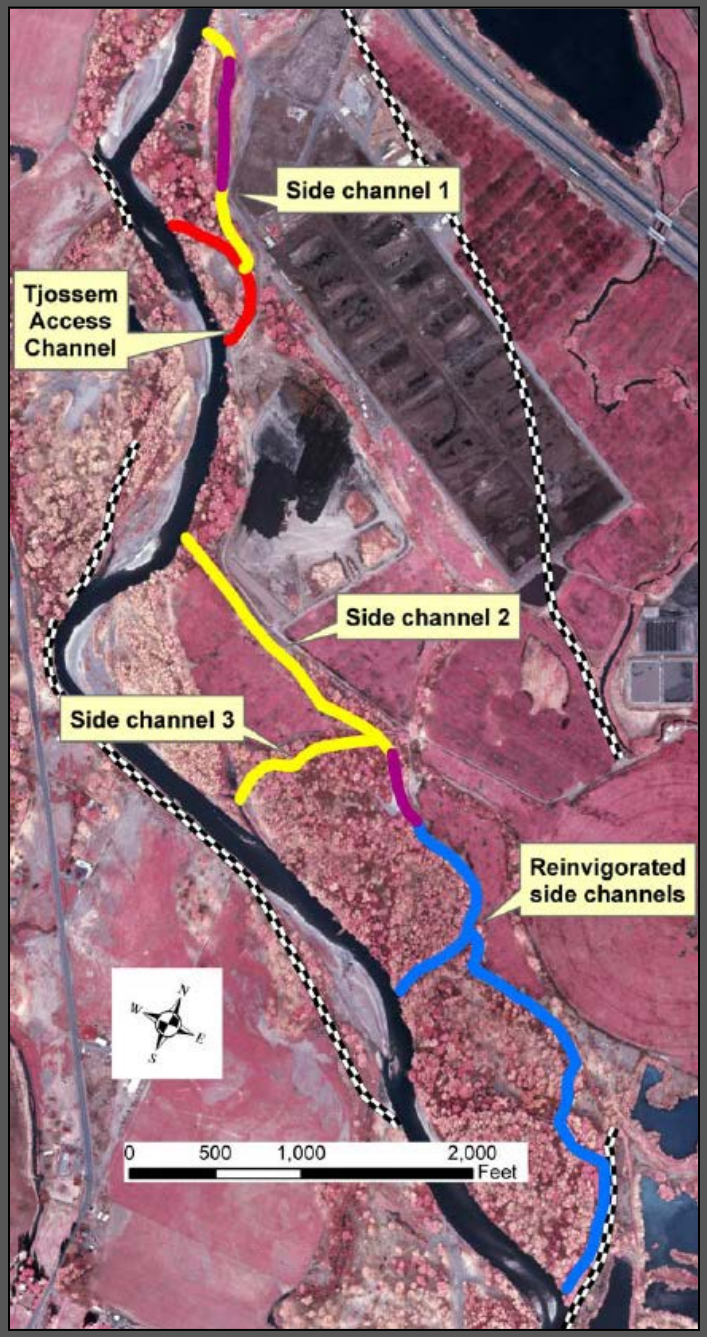

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USBR Project (Schaake Levee Reach)

Primarily focused upon channel and floodplain rehabilitation through levee setback and side channel re-creation

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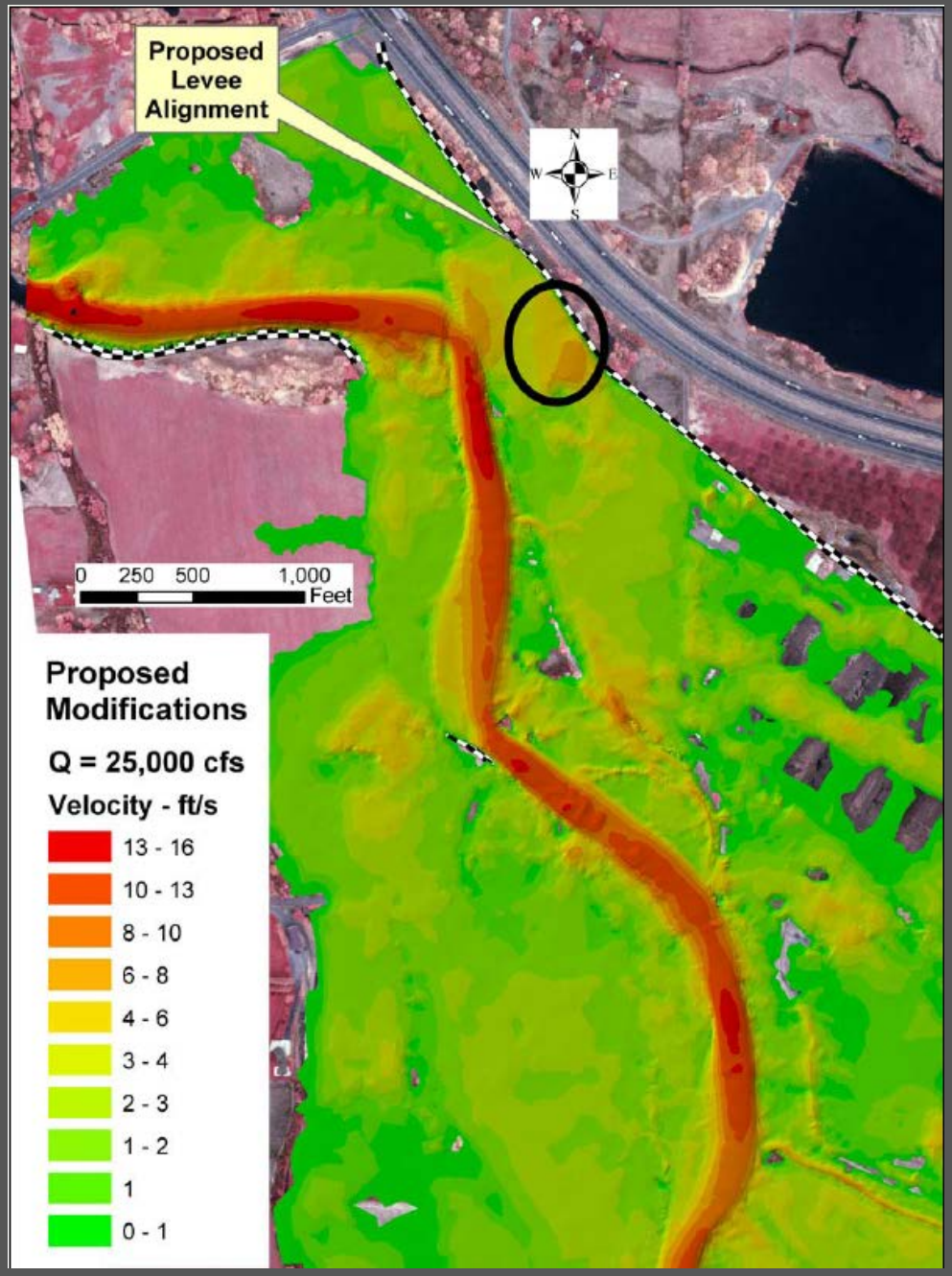

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SRH-2D Model Velocity Predictions with Proposed Levee Setback

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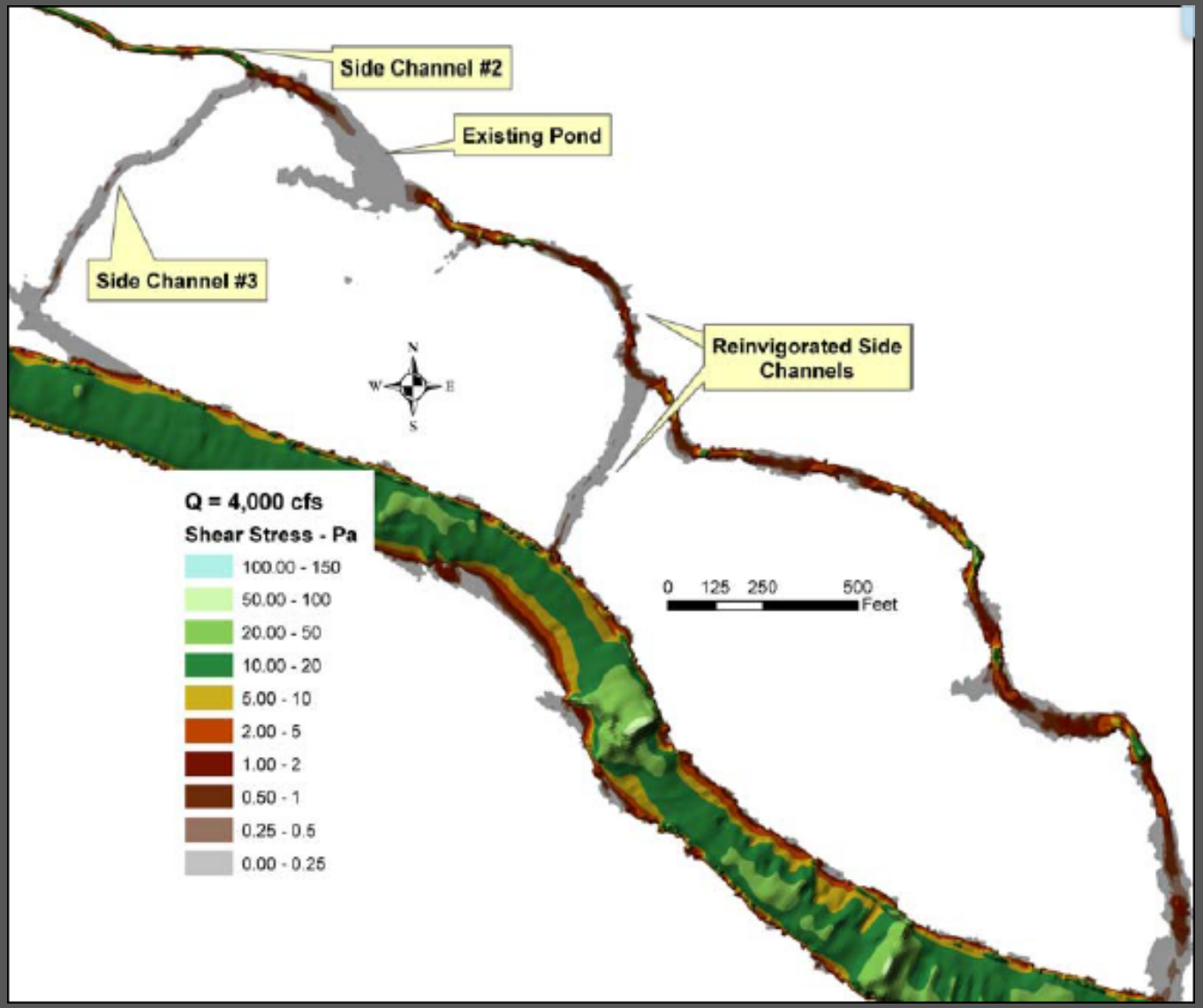

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SRH-2D Model Shear Stress Predictions along Lower Side Channels

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PHASE I: Assess Existing Conditions and Identify Alternatives:

- Improve and/or Maintain Flood Protection to Humans and Infrastructure (roads, buildings, farm land)
- Reduce Risk of Bank Erosion and Avulsion Potential (including at former gravel extraction site)
- Enhance Habitat and Restoration (subconsultant Herrera)
- Engage Multiple Agency and Private Stakeholders as Partners
- Use Defensible Tools that Easily Convey to Stakeholders and Public ➔ Extend USBR Two-dimensional SRH-2D modeling

PHASE II: Select and Implement Preferred Alternative(s) and Corridor Plan (future).

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Kittitas County Project (Hansen Pits, etc. Reach Study)

Multi-Objective (flood, fluvial, habitat)

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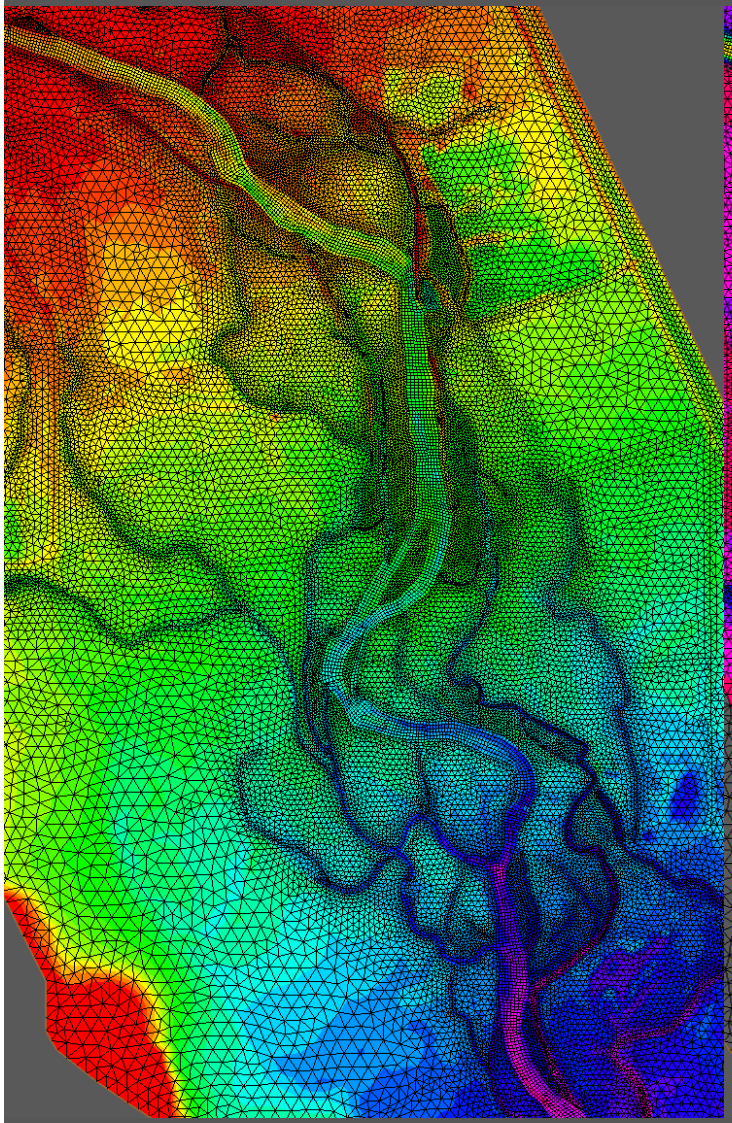
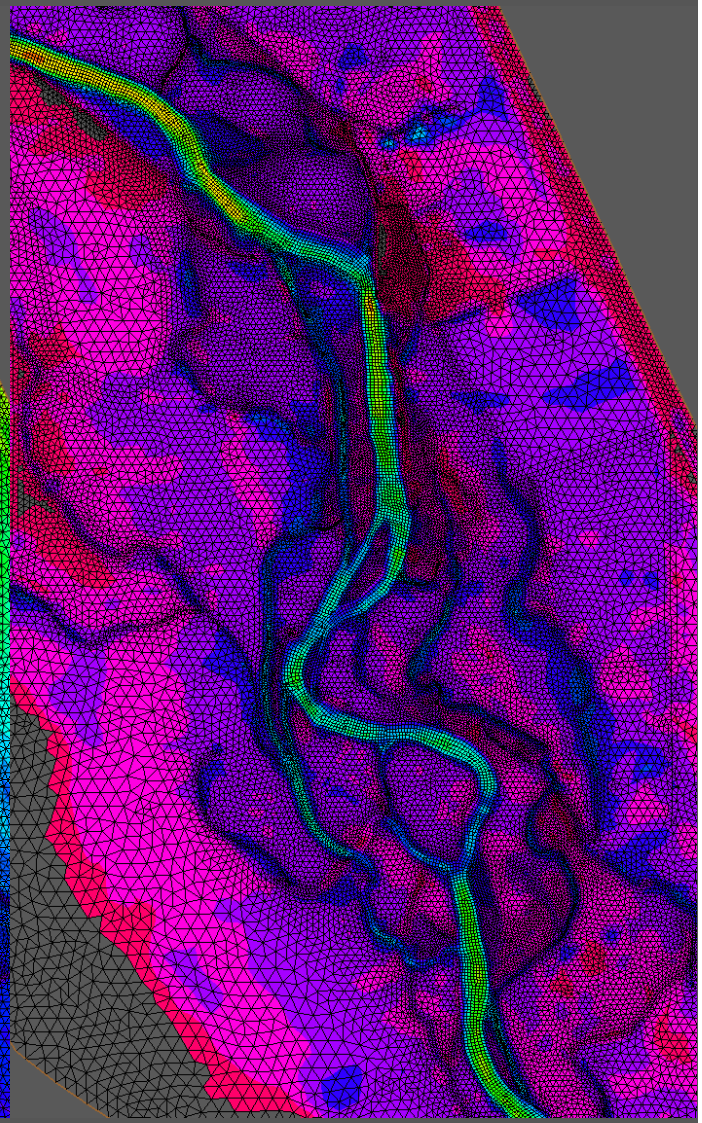
Bed Elevation:



100-yr Velocity:



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SRH-2D MODEL MESH

(OVERLAPPING 4000 FT REACH OF USBR & WSE STUDIES)

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Original USBR Model:	Modified WSE Model:	
TOTAL:	TOTAL:	RIVER:
330,111 nodes 383,006 elements (~10 foot channel) 2,150 acres ~4 miles long	77,527 nodes 142,342 elements (~25 foot channel) 2,900 acres ~7 miles long	Channel width= 150-225 feet Floodplain width= 1 mile or greater

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SRH-2D MODEL MESH DATA

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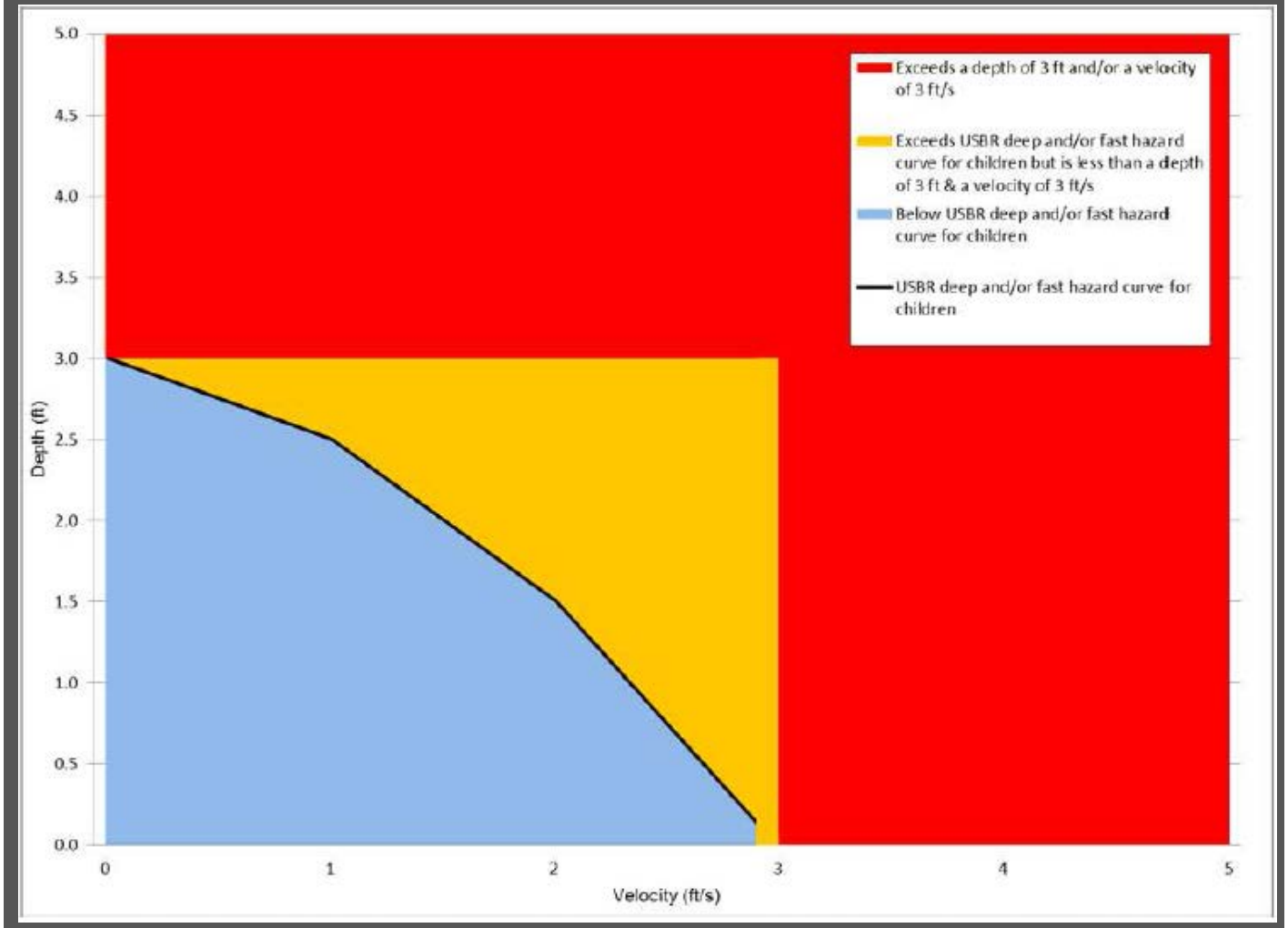

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USBR MODIFIED DEEP & FAST FLOOD HAZARD CURVE FOR CHILDREN (USBR 1988)

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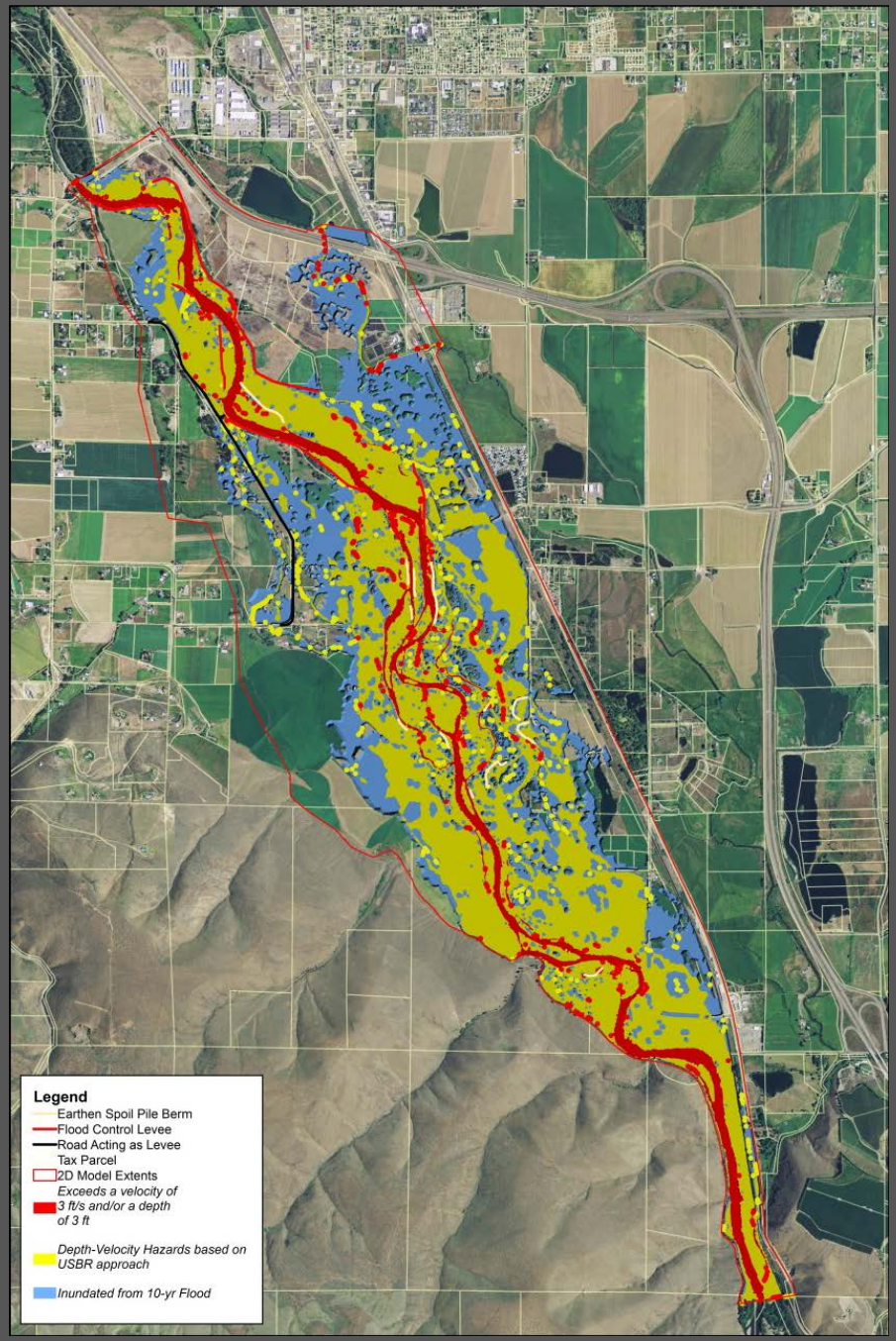

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HAZARDS

10-YEAR FLOOD

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SRH-2D MODELING

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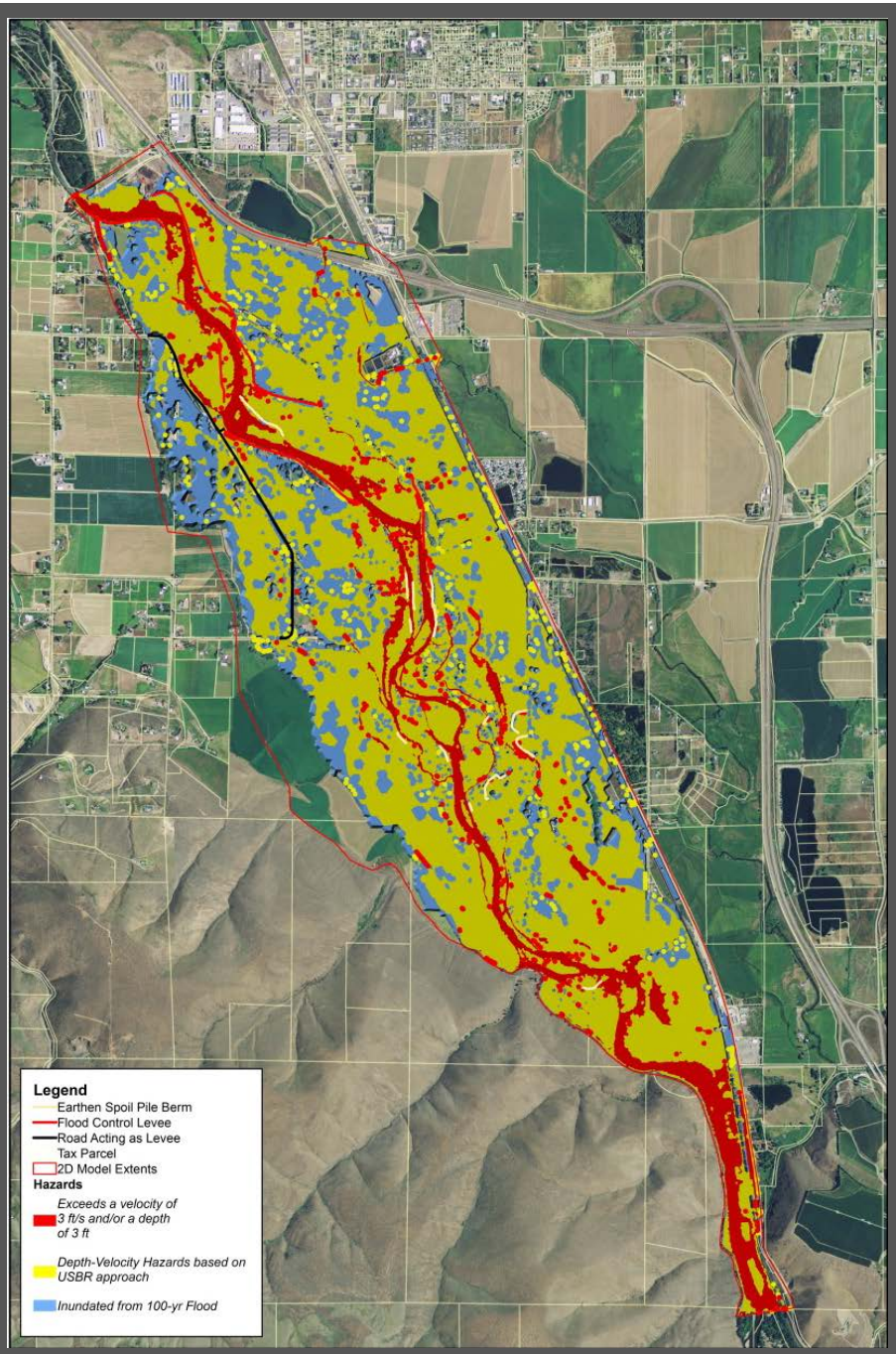

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HAZARDS

100-YEAR FLOOD

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WATERSHED
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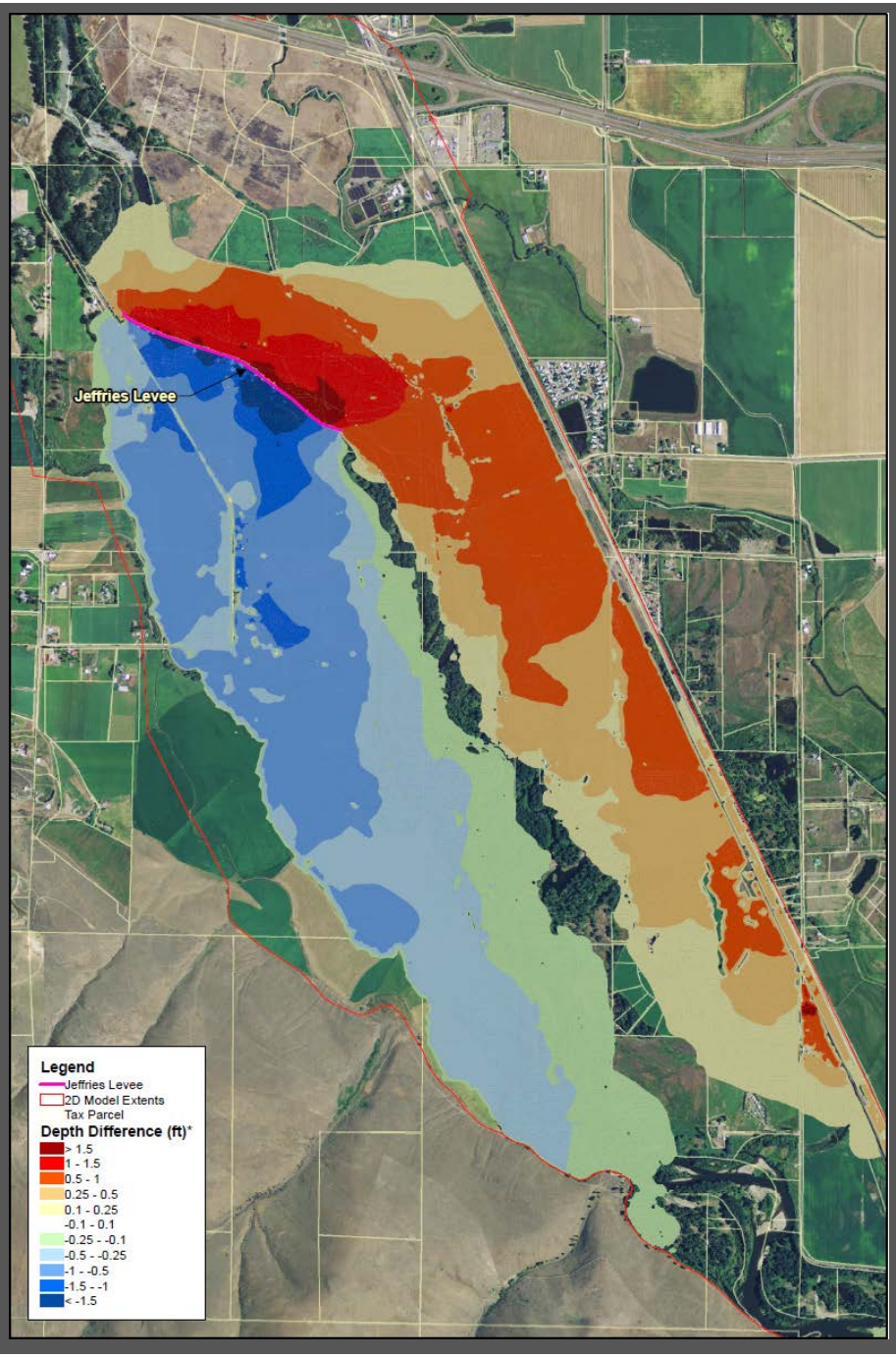

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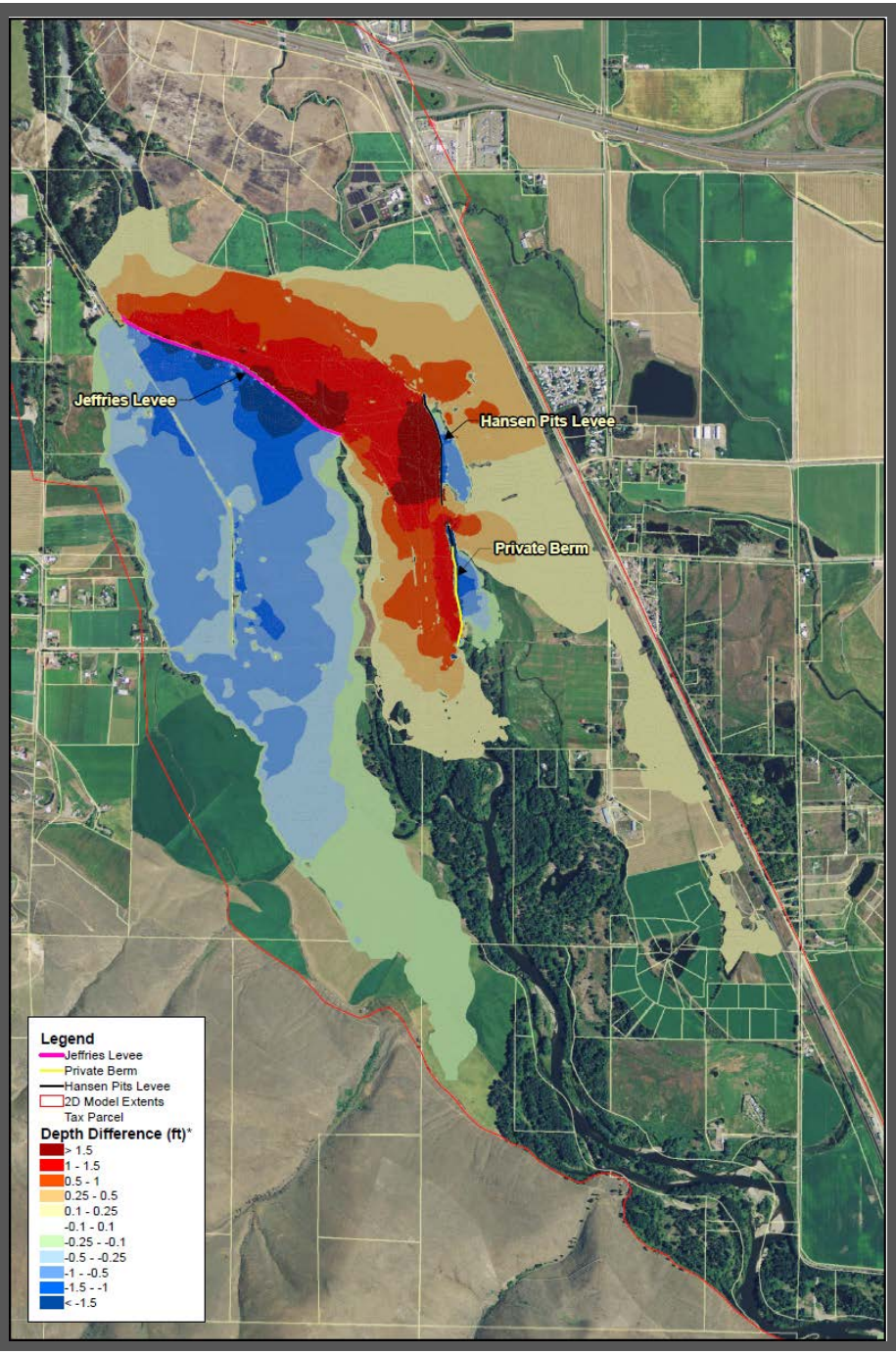
WATER DEPTH CHANGES CAUSED BY JEFFRIES LEVEE ALONE ASSUMING NO HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER

SRH-2D MODELING

WATERSHED
SCIENCE & ENGINEERING



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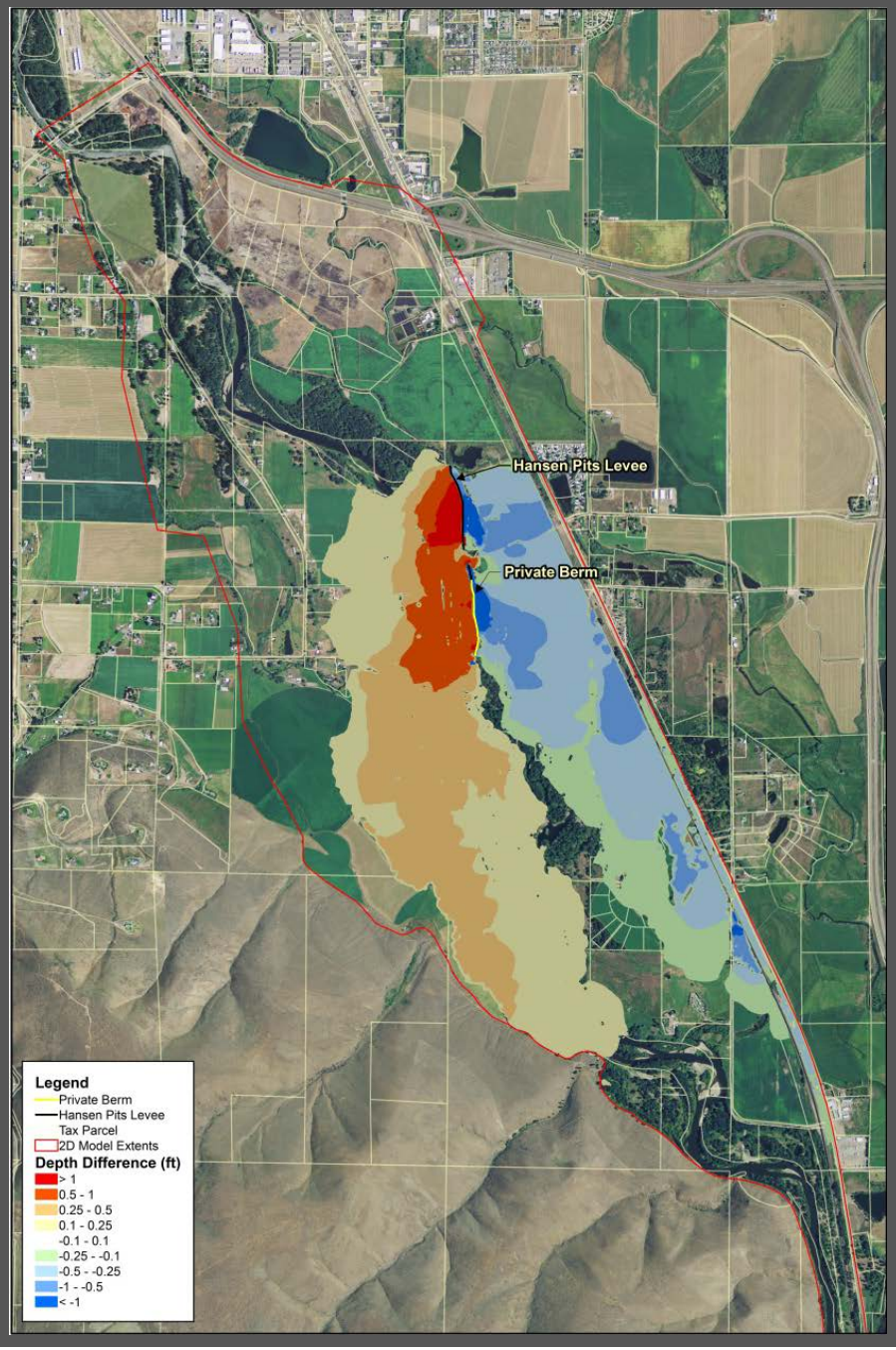
WATER DEPTH CHANGES CAUSED BY JEFFRIES LEVEE ALONG WITH THE HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER

SRH-2D MODELING

WATERSHED
SCIENCE & ENGINEERING



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WATER DEPTH CHANGES CAUSED ONLY BY HANSEN PITS LEVEE & DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

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SRH-2D MODELING

WATERSHED
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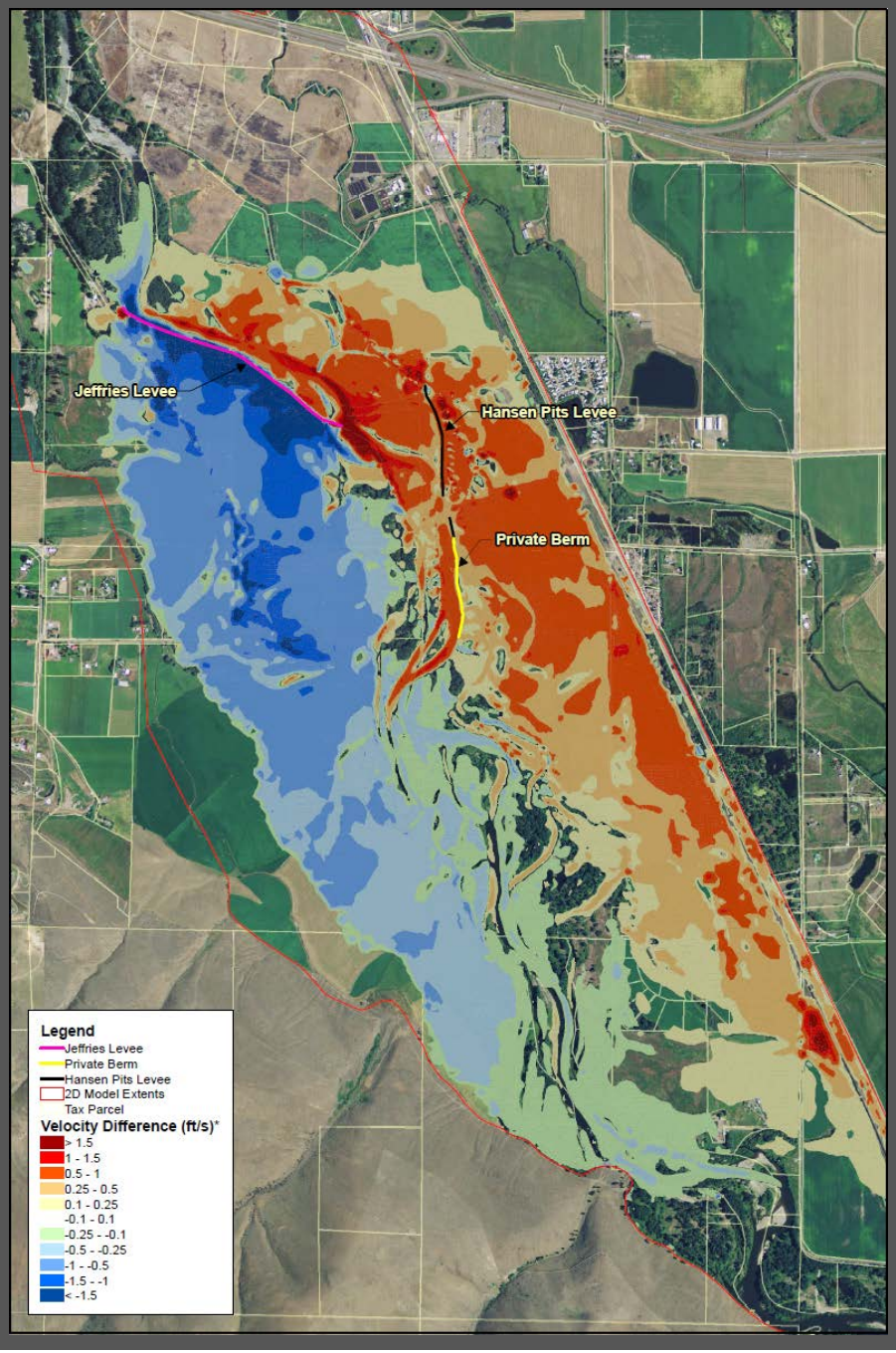

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VELOCITY CHANGES CAUSED BY JEFFRIES LEVEE ALONE ASSUMING NO HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

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SRH-2D MODELING

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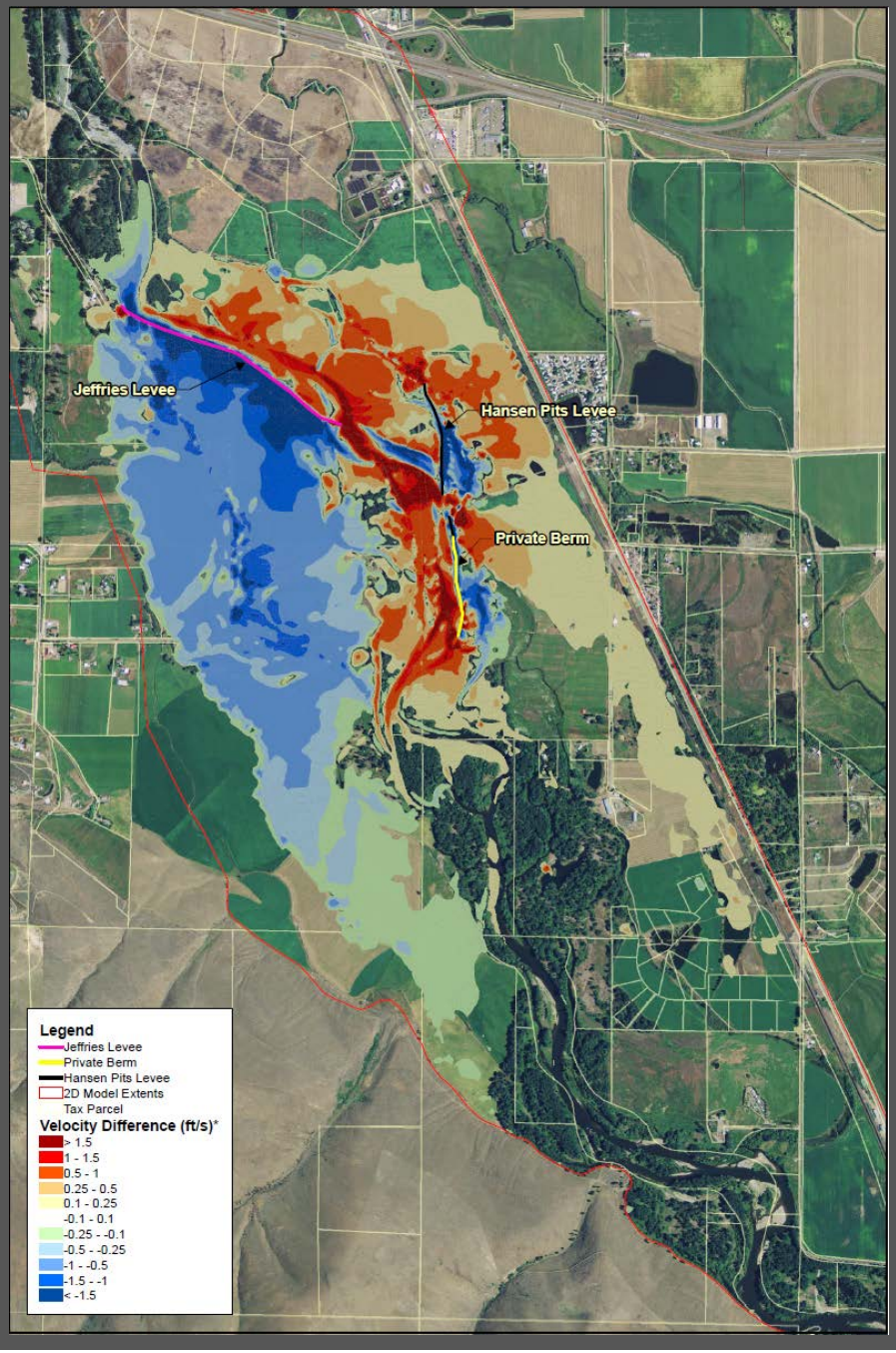

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VELOCITY CHANGES CAUSED BY JEFFRIES LEVEE ALONG WITH THE HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

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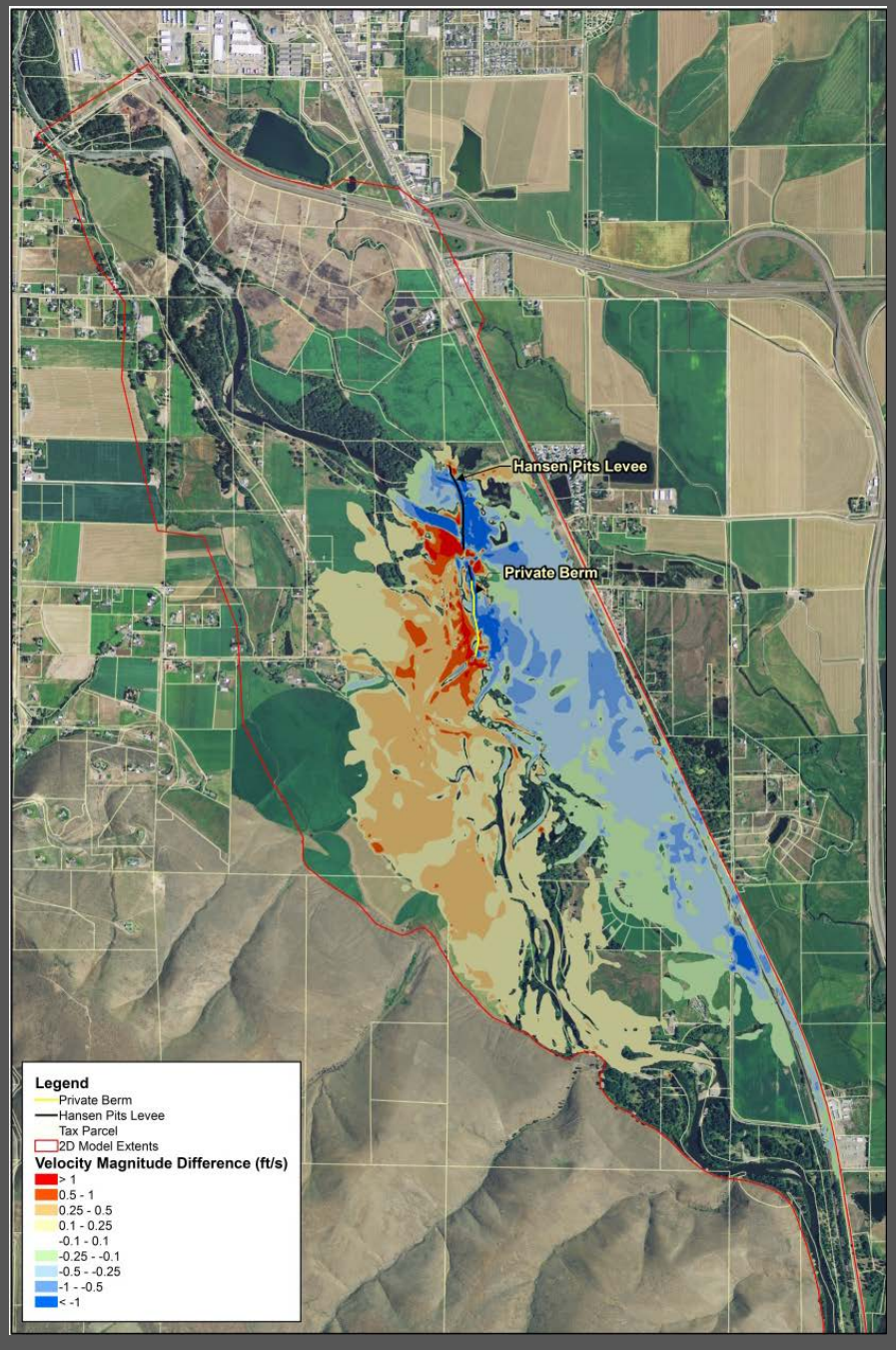

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VELOCITY CHANGES CAUSED ONLY BY HANSEN PITS LEVEE & DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

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Flood Observations and Bank Erosion and Avulsion Potential Confirmed by Model Results:

- Velocities and depths
- Corps flood control project (Jeffries Levee)

Benefits and Unintended Impacts of Flood Control Levees and Berms:

- Upstream Jeffries project protects right floodplain by deflecting flow to downstream left floodplain, resulting in increased depths and velocities
- Hansen Pits levee and downstream berm offset Jeffries impacts and provide flood hazard benefit, but further confine the flow

Flood and Erosion Reduction at Hansen Pits Needs to Consider Modifications to Upstream Levee:

- Improved angle of attack to reduce bank erosion
- Setback of each levee/berm

Geomorphic and Habitat Impact of Levee Confinement

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CONCLUSIONS FROM 2D MODELING

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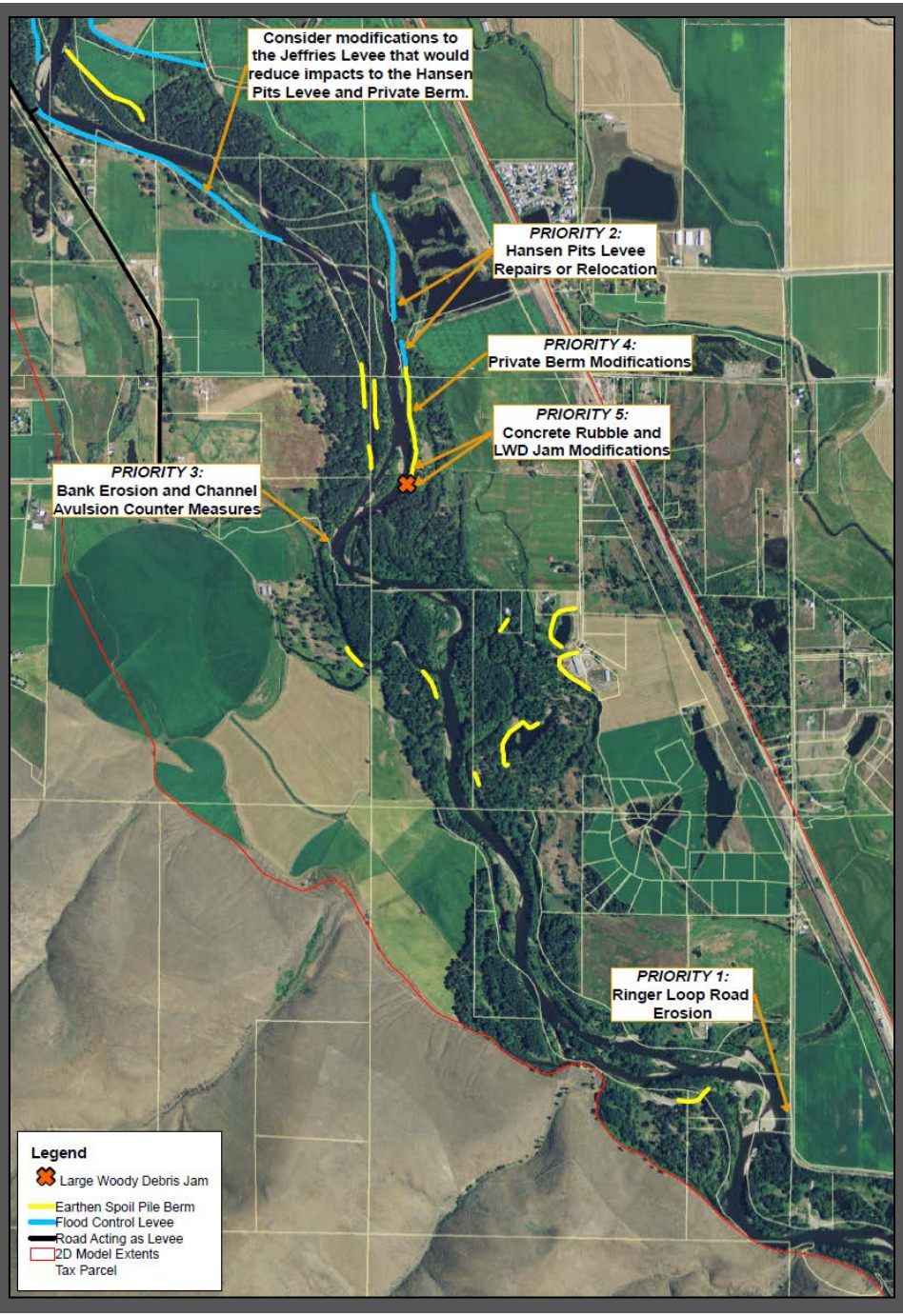

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Flood & Erosion Hazard Reduction Opportunities & Priorities

ADDITIONAL MEASURES:

- **PREPARE FOR THE NEXT BIG FLOOD**
- **LIMIT DEVELOPMENT**
- **FLOOD PROOFING**
- **EVACUATION PLAN**
- **CRITTER PADS**
- **ETC.**

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SRH-2D MODELING

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Low Flow Fish Runs:

- Base flow for typical habitat conditions
- September – February low flow period (1000 cfs)
- May – August higher flow period (3000 cfs)
- “flip-flop” due to upstream reservoir storage in upper watershed and summer releases for irrigation

SRH-2D Modeling of Existing Conditions:

- Identify key edge habitat and side-channel habitat
- Less than 3 ft deep and under 1.5 fps requirement for juvenile salmonid refuge

Propose Habitat Project Opportunities:

- Based upon site reconnaissance, habitat evaluation, 2D model results, and stakeholder input
- Future 2D modeling of specific alternatives, due to modified geometry (e.g. opening cut off side channel inlet), roughness (LWD protection), etc.

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Approach for Habitat Evaluation

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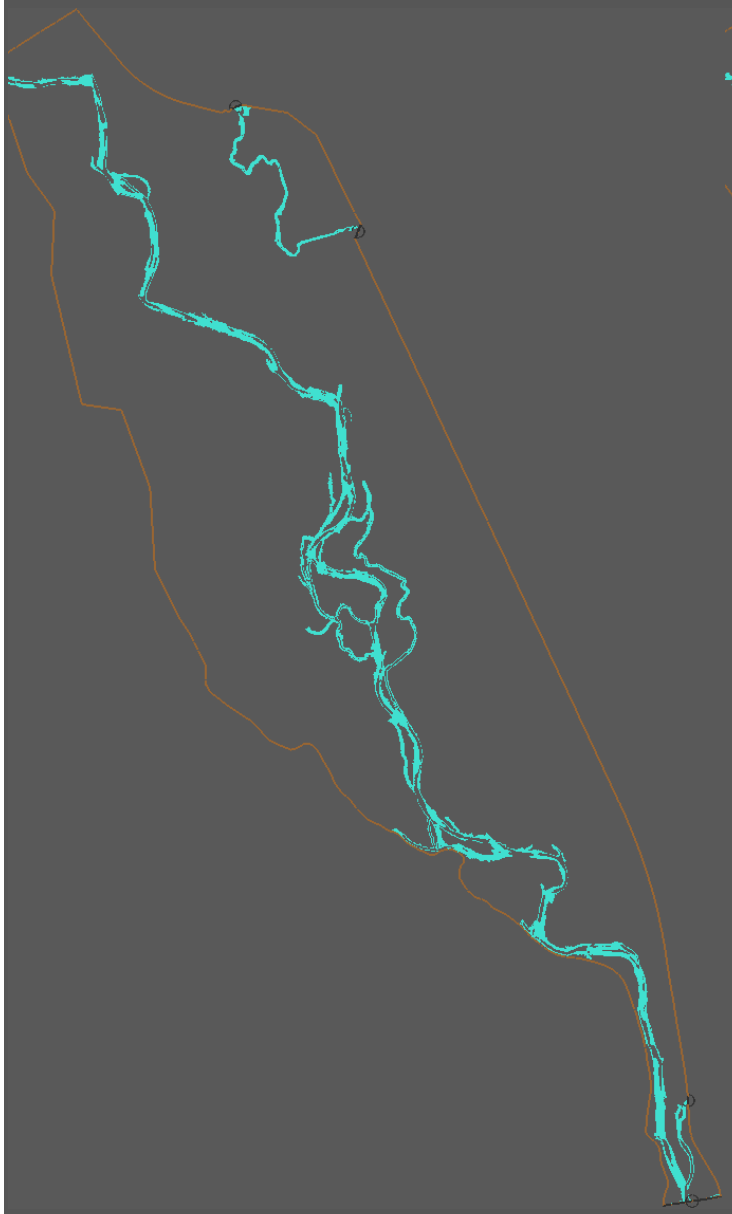
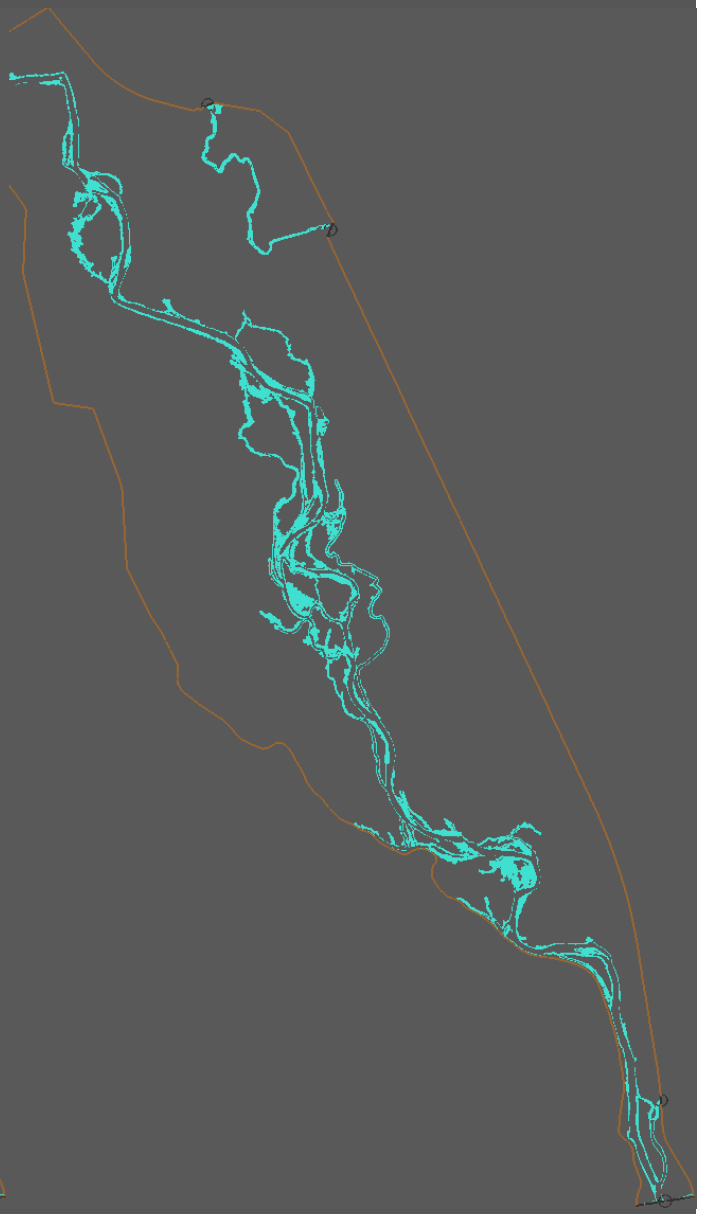
1000 cfs:



3000 cfs:



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Low (Fish) Flow Depth Plots

0 ft – 3 ft

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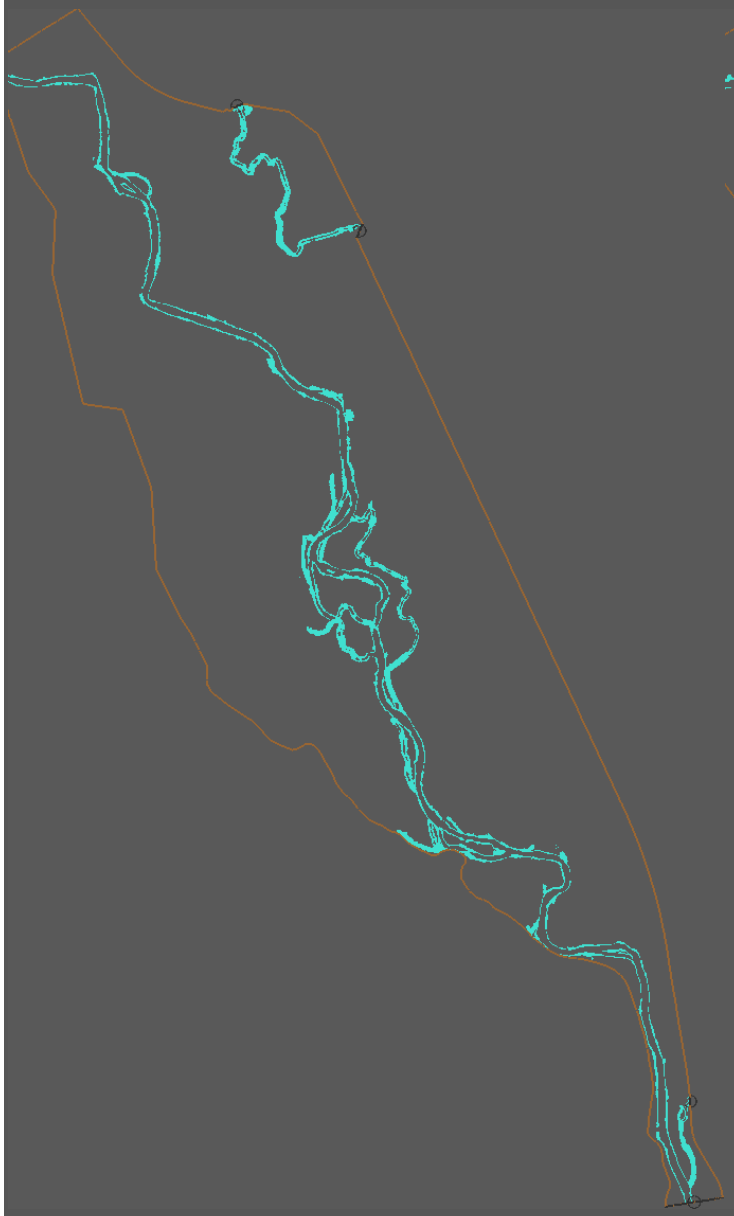
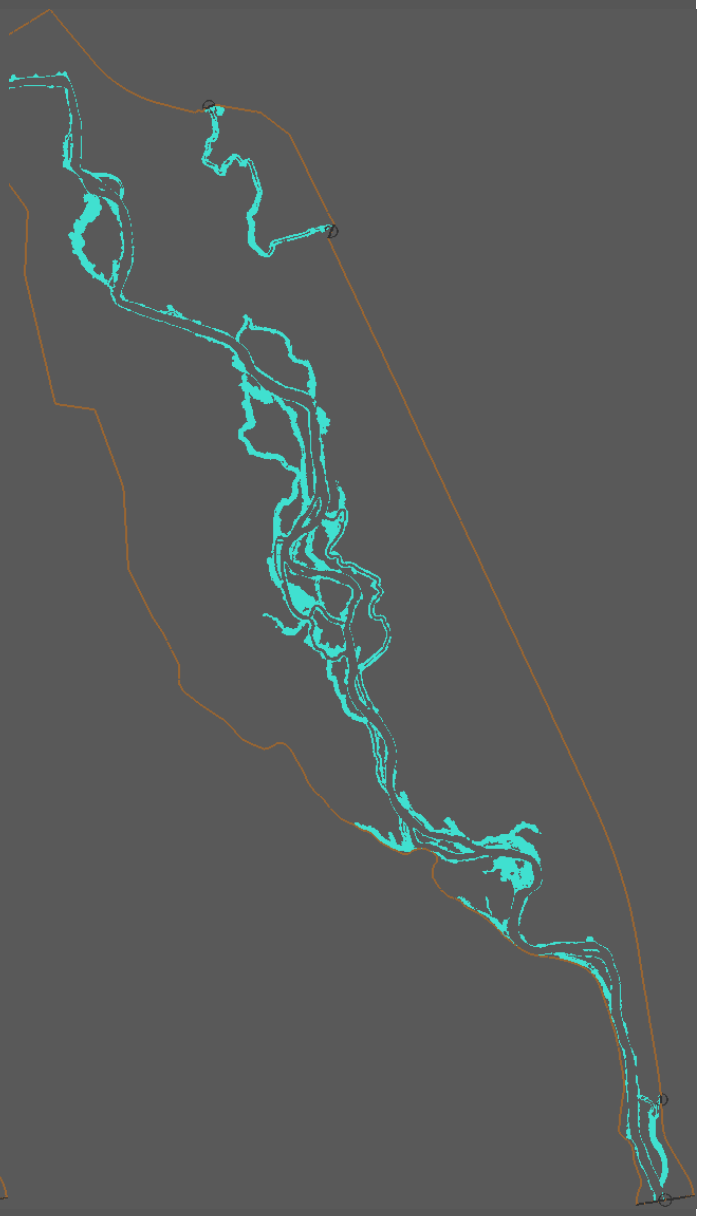
1000 cfs:



3000 cfs:



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Low (Fish) Flow Velocity Plots

0 fps – 1.5 fps

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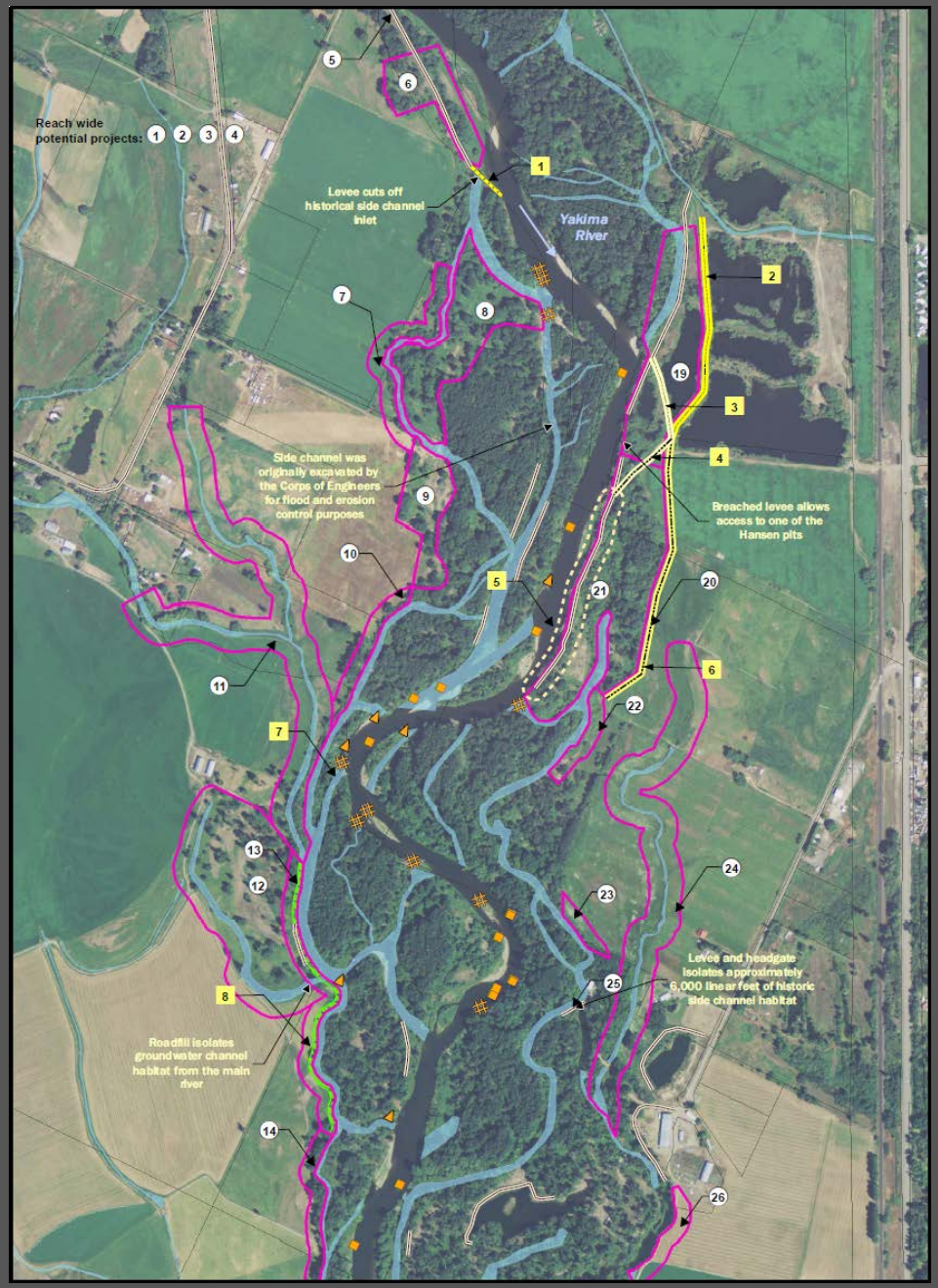

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Identified Habitat Opportunities (proposed alternatives)

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Benefits of SRH-2D Modeling:

- Ease of use, SMS for pre- and post-processing
- Very stable robust model, handles dry beds & wetting/drying
- Gives realistic & defensible results to characterize existing conditions & to formulate alternatives
- Results easy to understand by public/stakeholders

Specifically to Yakima project:

- Used to identify flood hazard areas (e.g. deep/fast)
- Used to identify erosion/avulsion hazards & future problem areas (e.g. high velocities)
- Simulated low flow events to help Habitat team identify sites for proposed edge habitat and side channel restoration
- Will be used to test specific alternatives for flood & erosion hazard protection, combined with proposed Schaake setback

CONCLUSIONS

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SRH-2D MODELING

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