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Session A4- Lower Yellowstone River fish passage and entrainment prevention

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Lower Yellowstone River Fish Passage and Entrainment Prevention

28 June 2011

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Dan Pridal

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Omaha District Corps of Engineers

Lower Yellowstone River Diversion Dam Fish Passage and Entrainment Prevention Measures

US Army Corps of Engineers

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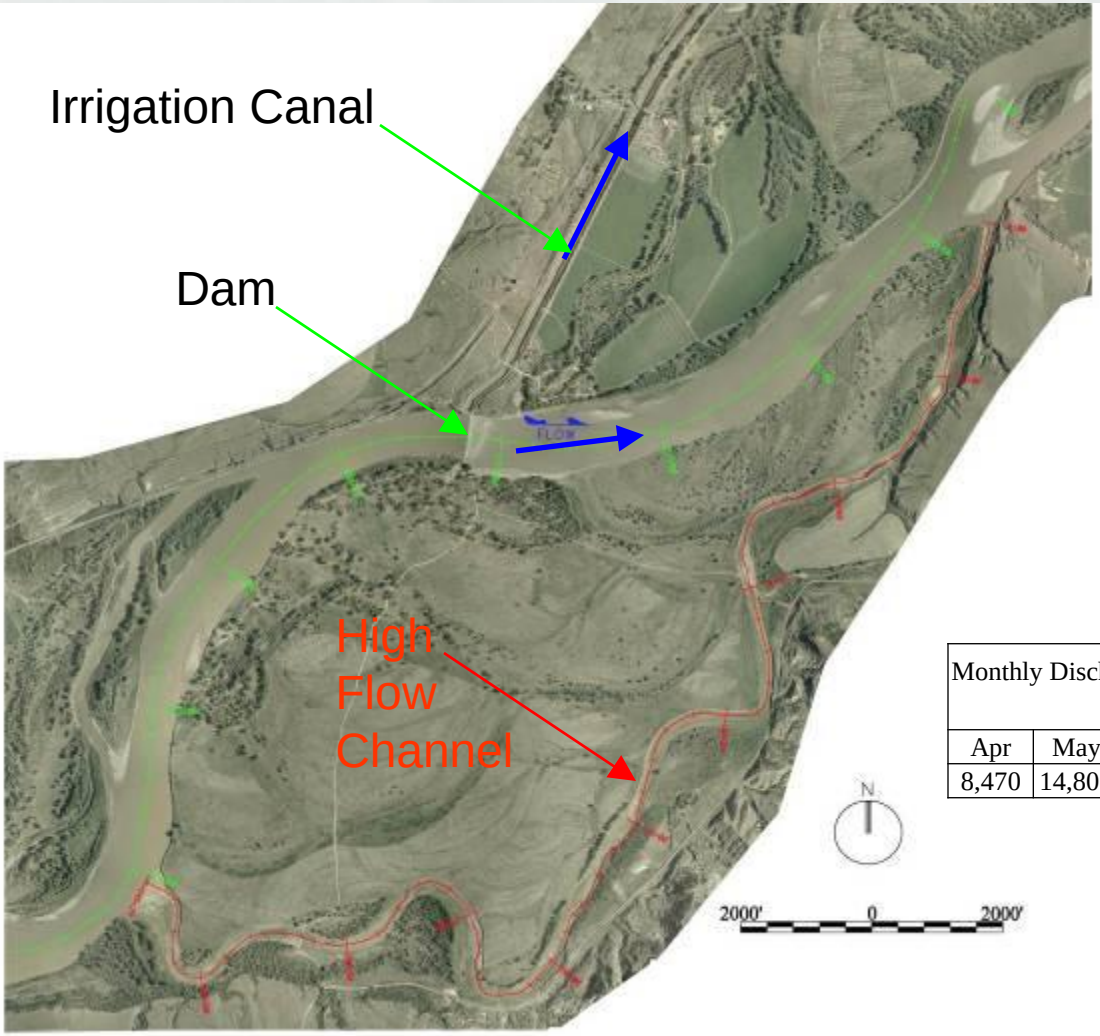
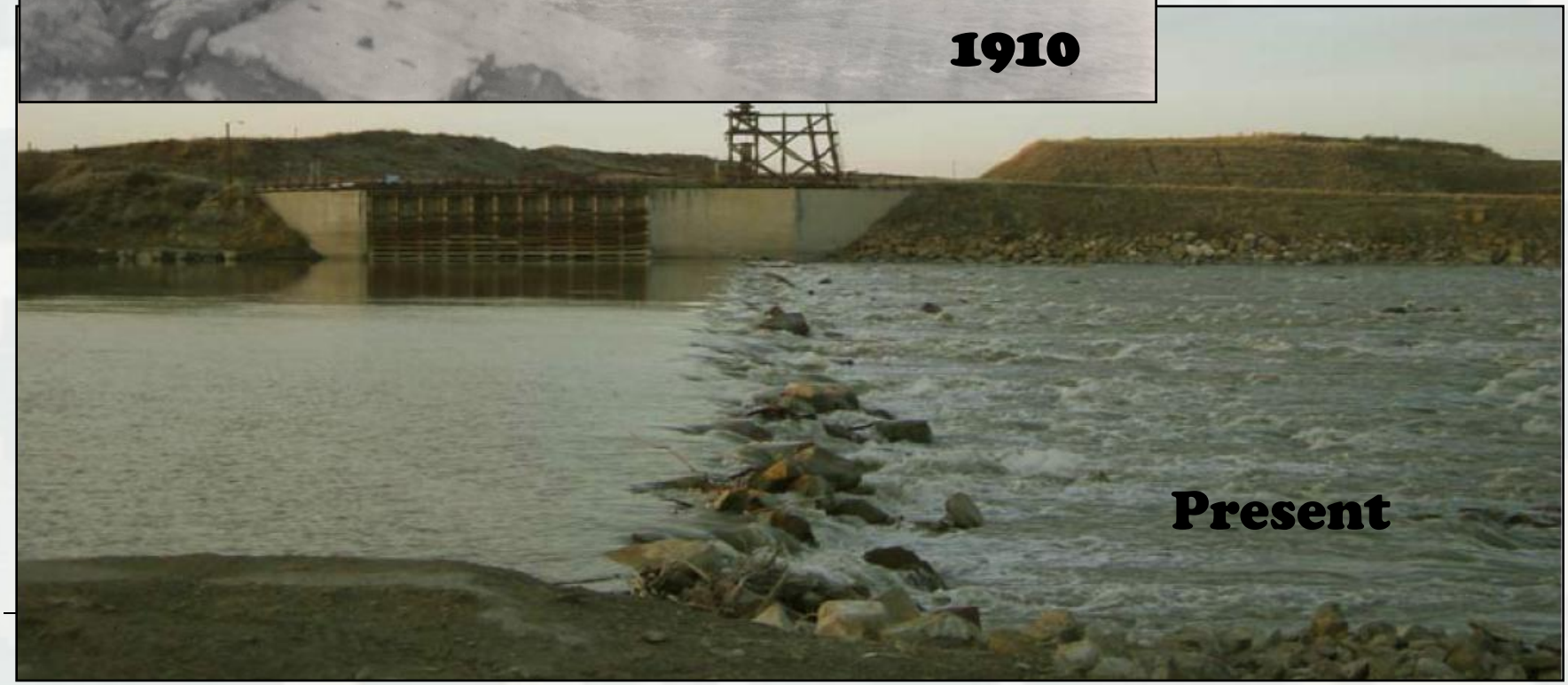
Lower Yellowstone River Irrigation Project (Intake Dam)



Monthly Discharges, equaled or exceeded 50% by duration (cfs)					
Apr	May	Jun	Jul	Aug	Sep
8,470	14,800	30,700	17,100	7,080	6,660

History

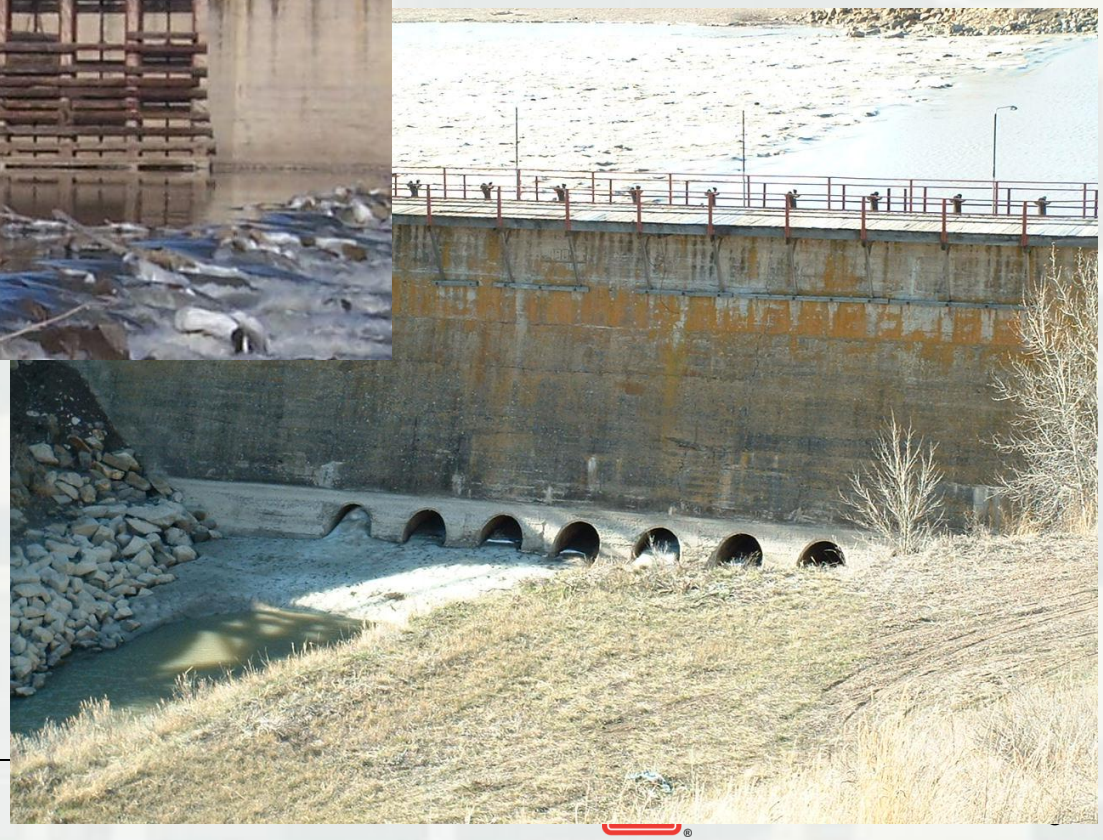


First Issue: Fish Passage

Current range of Pallid sturgeon in the Yellowstone basin.

Extended range of Pallid sturgeon with passage at Intake

Second Issue: Entrainment



Design Goals

- Allow passage under flow conditions to be experienced during spring and summer (BRT criteria)
- Reduce velocities experienced across crest and throughout ramp
- Maintain depths necessary for passage throughout the ramp
- Provide head for diversion at 3000 cfs (August 95% exceedance by duration flow rate)
- Prevent entrainment of sturgeon (and other species) in canal
- Provide design with minimal maintenance requirements at new headworks

Design Tools

- Site **data collection** (surveys, WS elev from several flows, sediment data, velocity data collection)
- **RAS 1D** model
  - Initial ramp configuration
  - Water surface elevation impacts
- **ADH 2D** modeling
  - Sediment transport evaluation
  - Debris protection evaluation
  - Velocity and depth evaluation for passage
- **Physical models** at Reclamation lab at Denver TSC (2 phases for headworks and ramp, include sediment)

Proposed Solutions

- Fish Passage
  - Rock ramp OR
  - Bypass channel
- Entrainment Prevention
  - Screened intakes (currently under construction)

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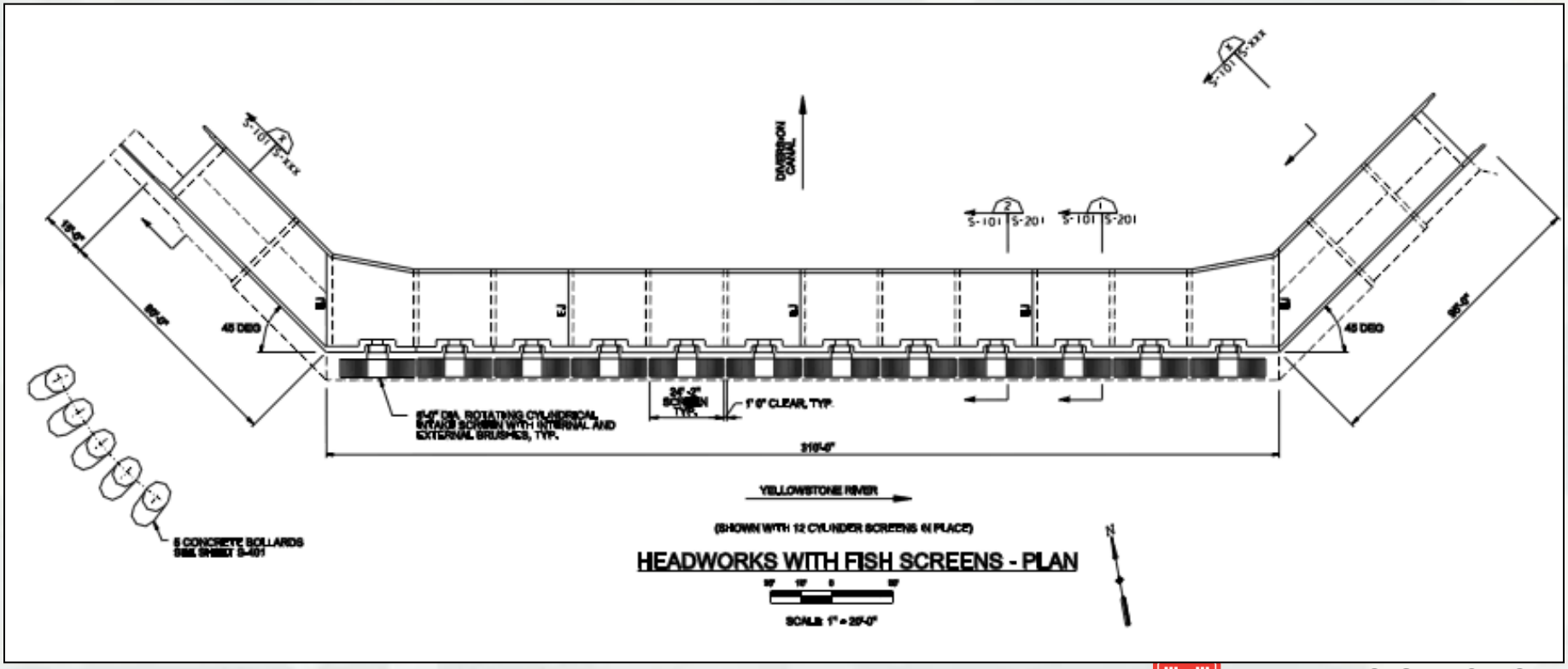
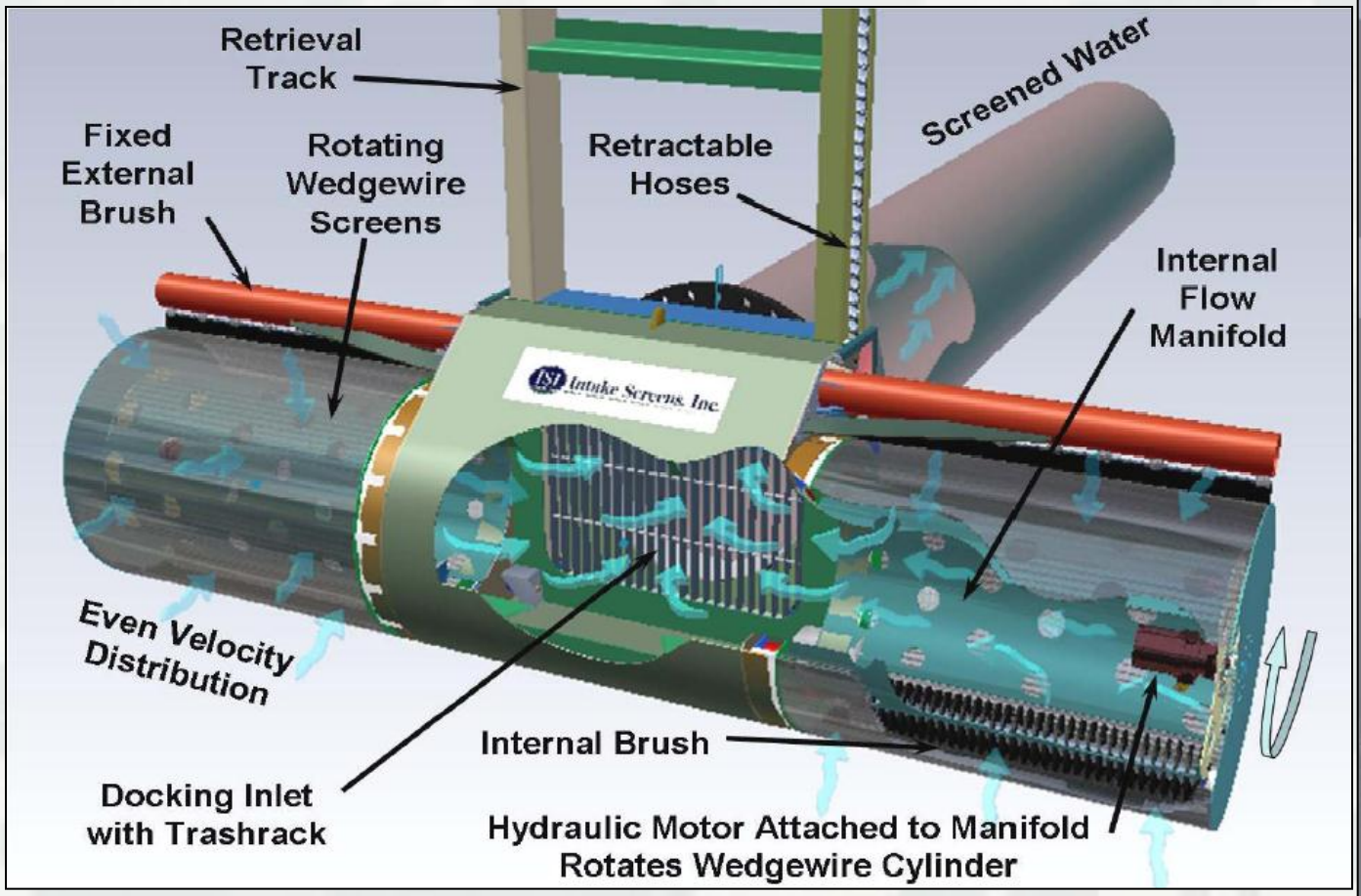
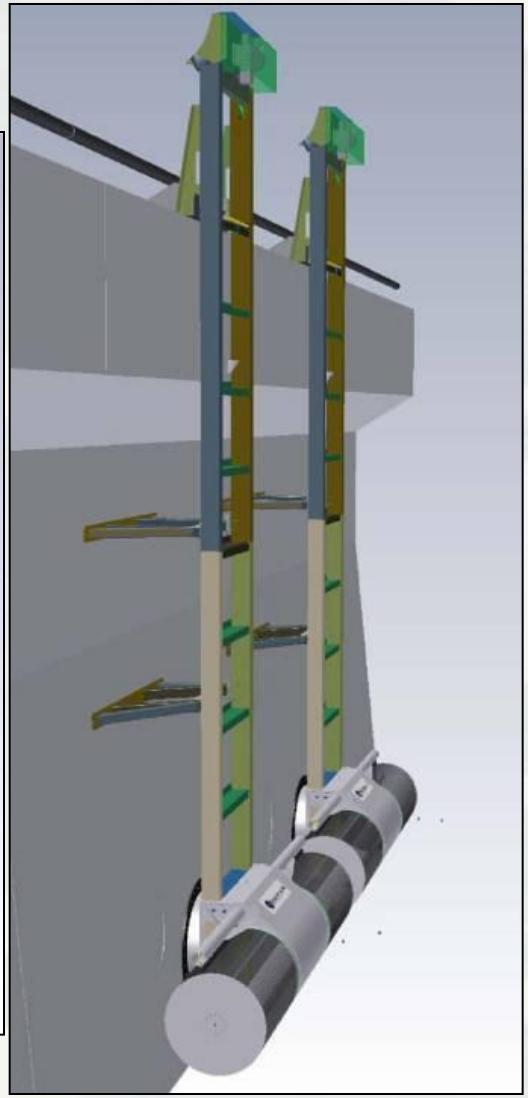
Fish Entrainment Prevention

- Rotating cylindrical screens
- NOAA passage criteria for Salmonids (0.4 fps approach velocity)
- Retrievable with winch and track system to prevent ice damage
- 12 screen units with a diameter of 78 inches and a 100 inch length of each screen cylinder (2 screen cylinders per unit)



Conceptual Screen Configuration

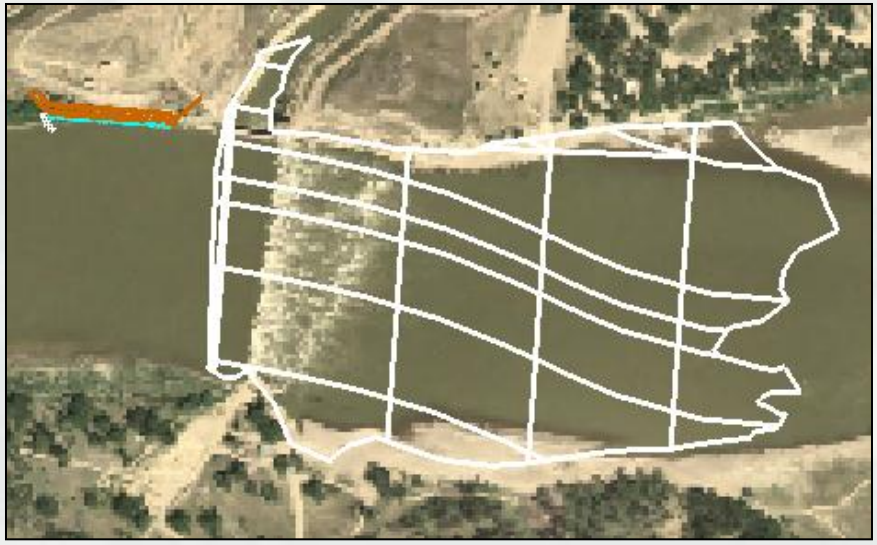


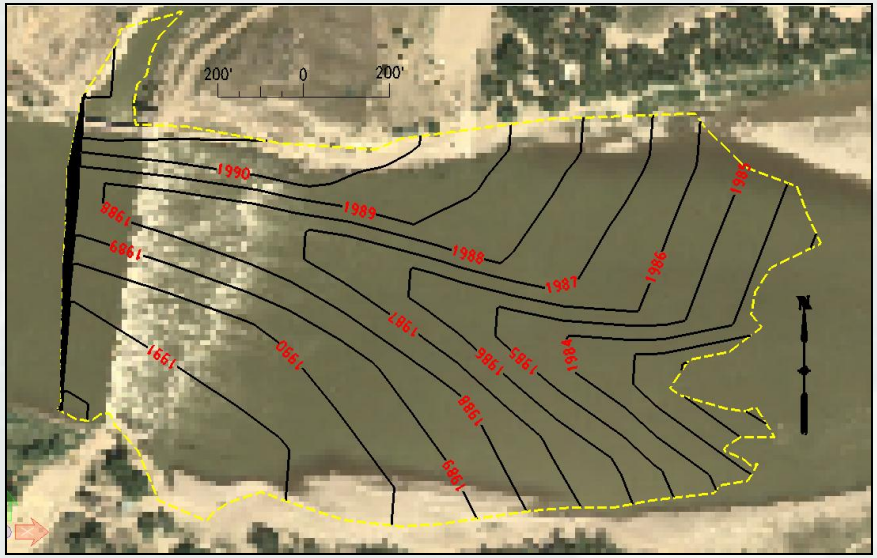


Fully functional screen and track system

Crest and Ramp Configuration

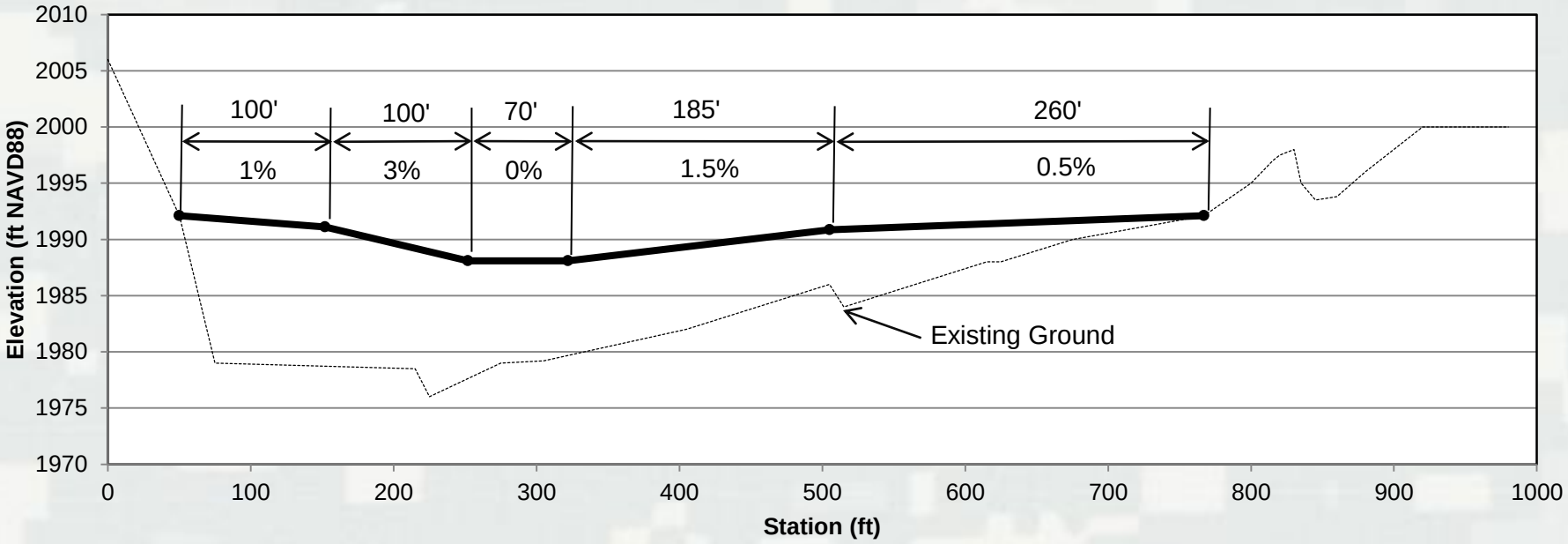
- Multiple iterations on configuration
- Full river width, gradually varying slopes.
- Proposed Ramp Configuration
  - ► Extends over 1500
    - 0-10 ft: 0.0 ft/ft
    - 10-500ft: 0.002 ft/ft
    - 500-900ft: 0.004 ft/ft
    - 900-1300ft: 0.006 ft/ft
    - 1300-ground: 0.008 ft/ft
  - ► Varying Crest from 1988.1 to 1992.1





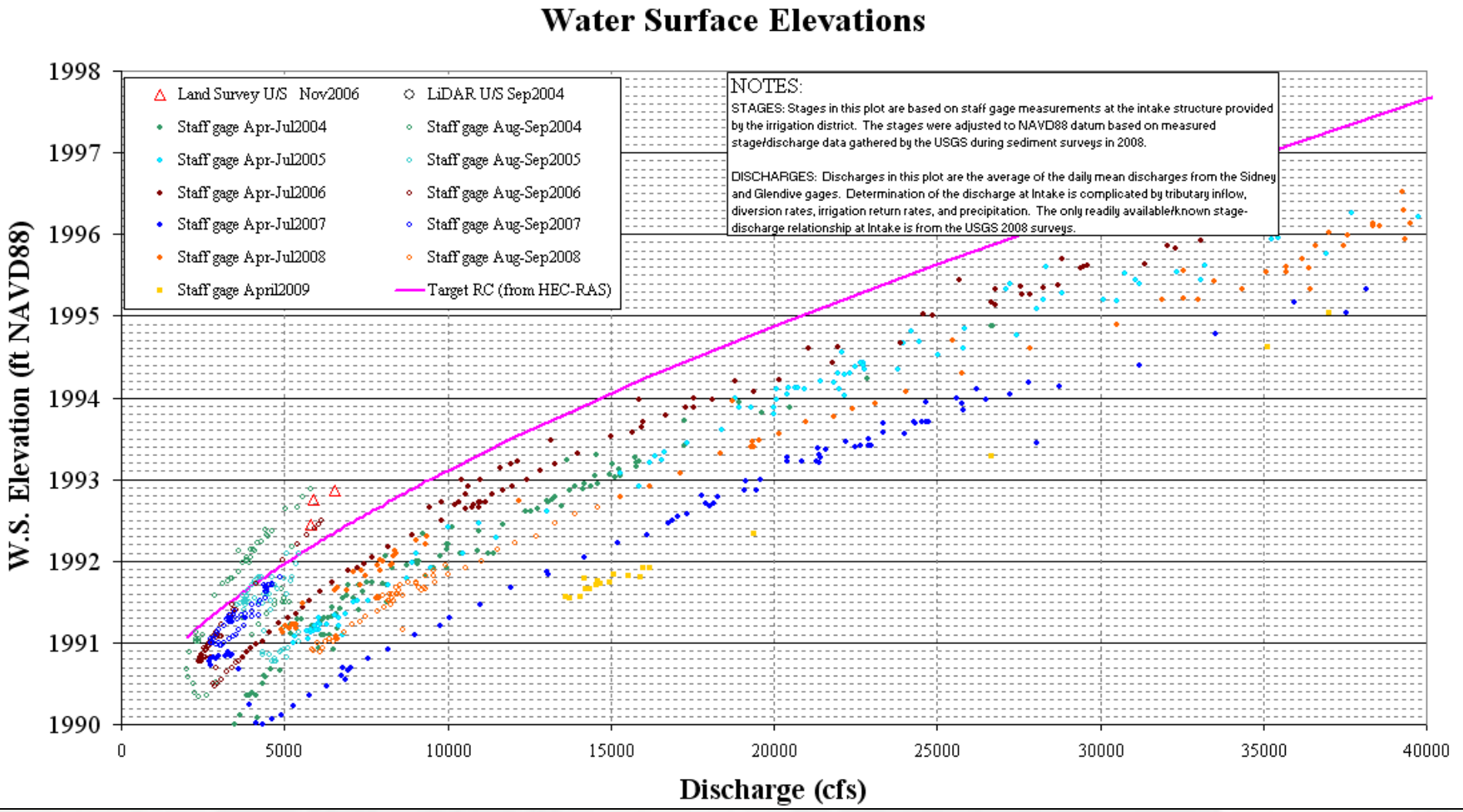
Design Geometry

Ramp Crest



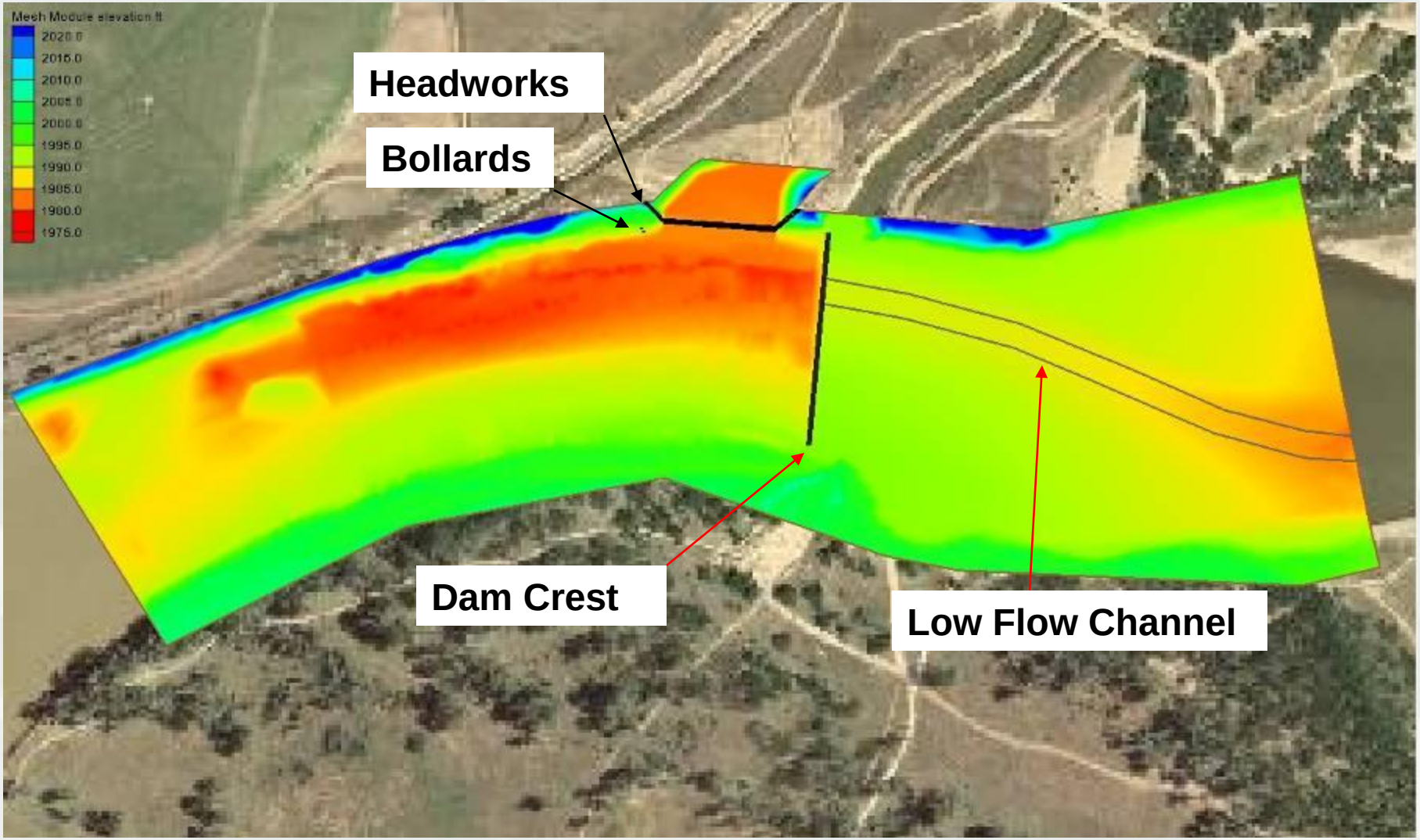
1D HEC-RAS Hydraulic Modeling

Initial Ramp Crest Configuration, Selection of Diversion Rating Curve, Design of Diversion Structure



2-D (ADH) Model Geometry

Bed Elevations



Physical Model

(for Headworks)

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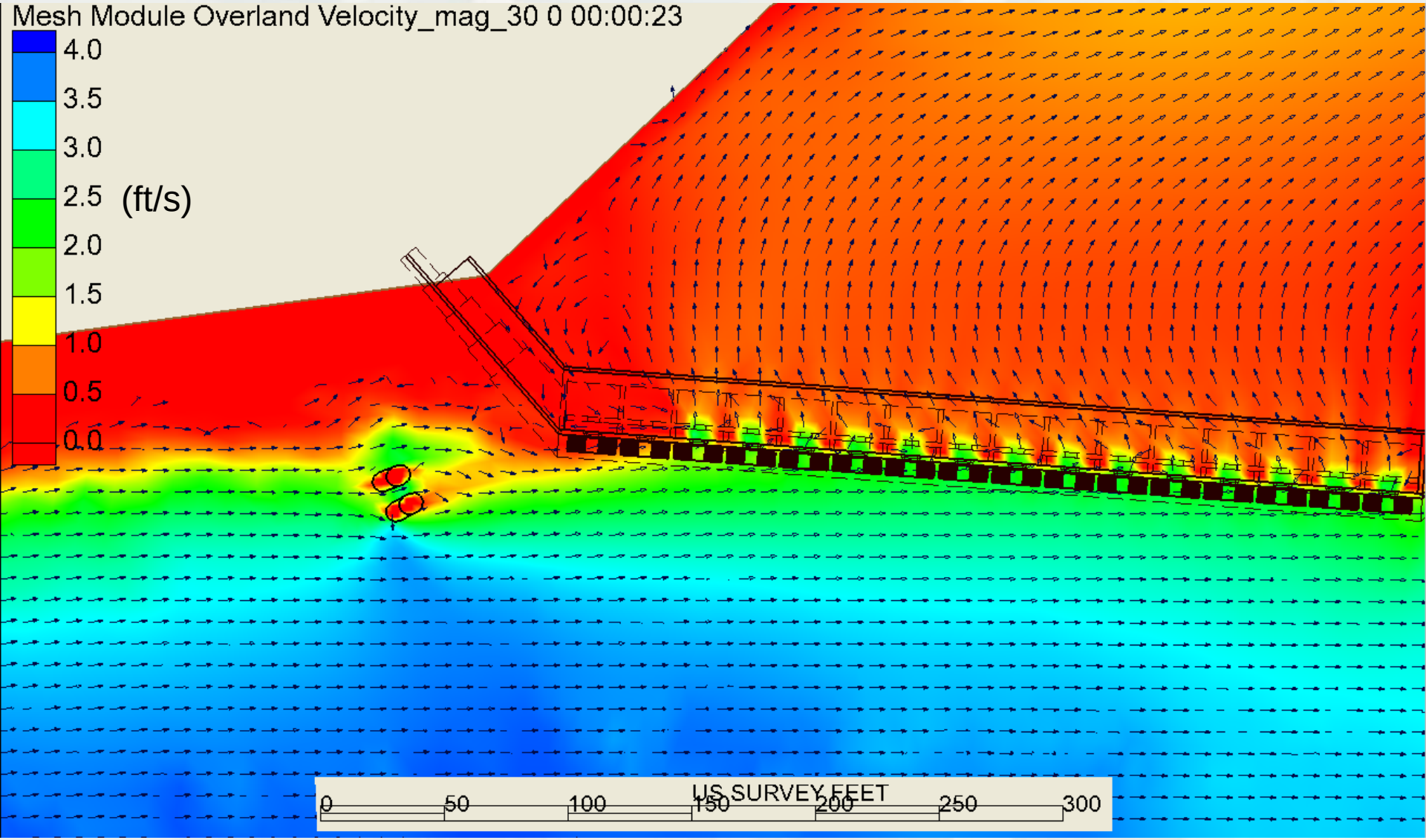
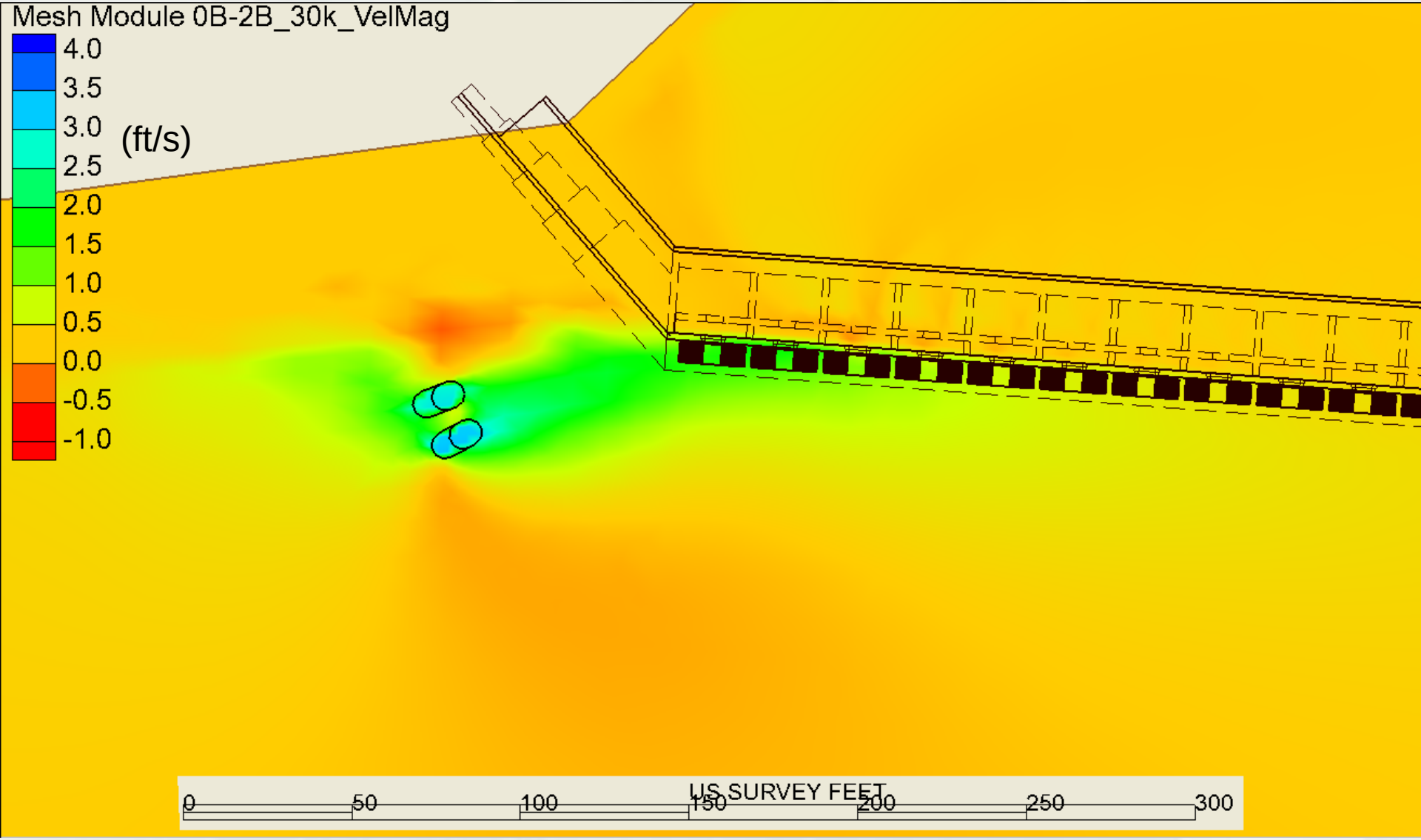
30,000 cfs velocity

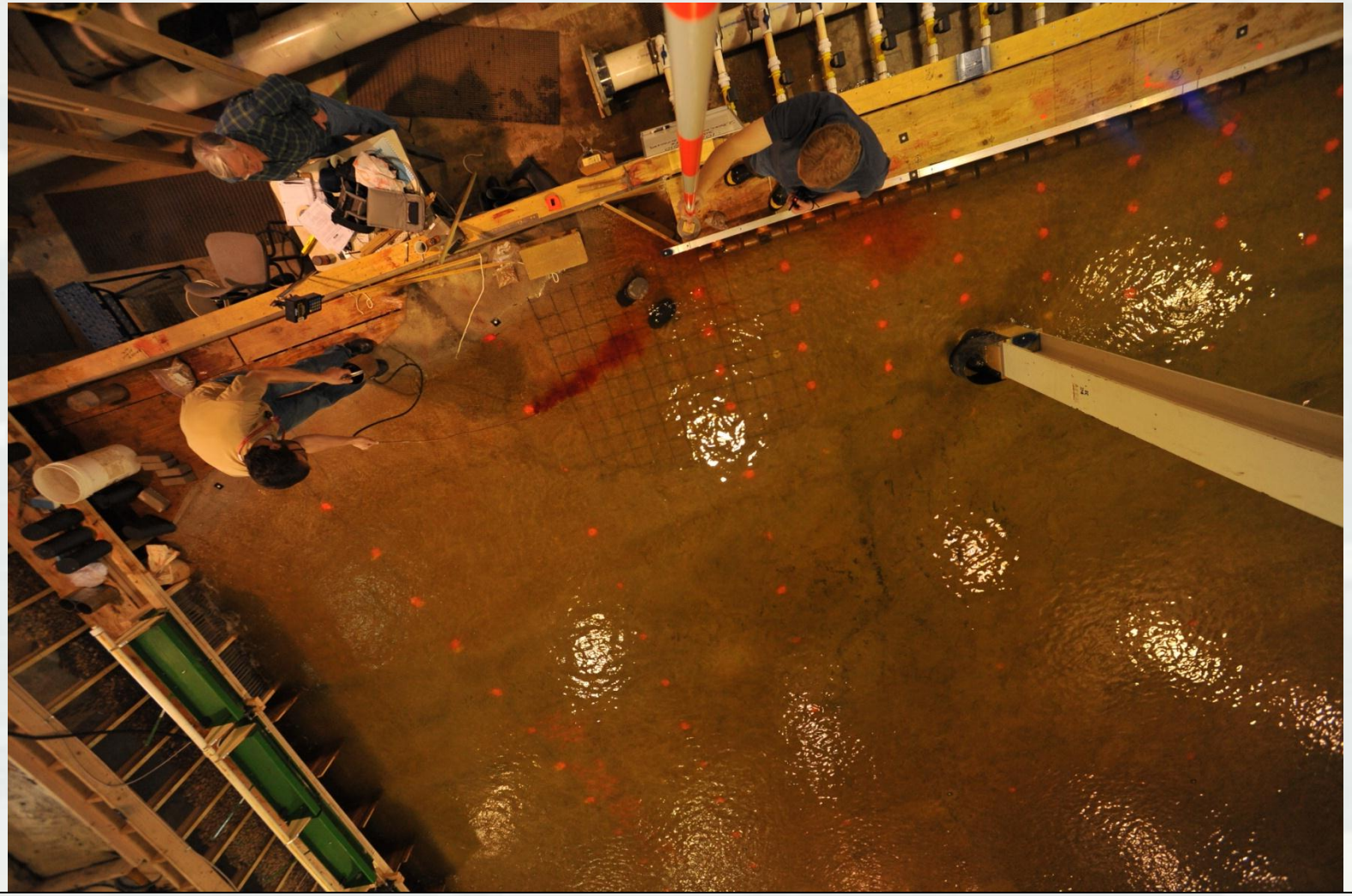


Debris Protection

- Velocity magnitude comparison: zero bollards minus two bollards



30,000cfs, 2 bollards



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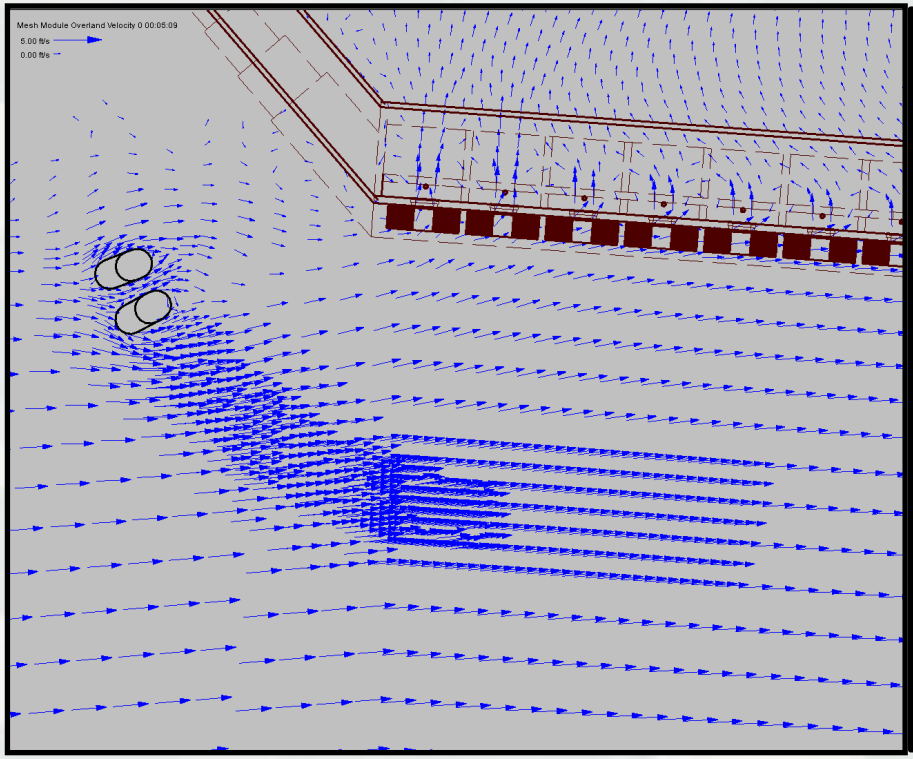
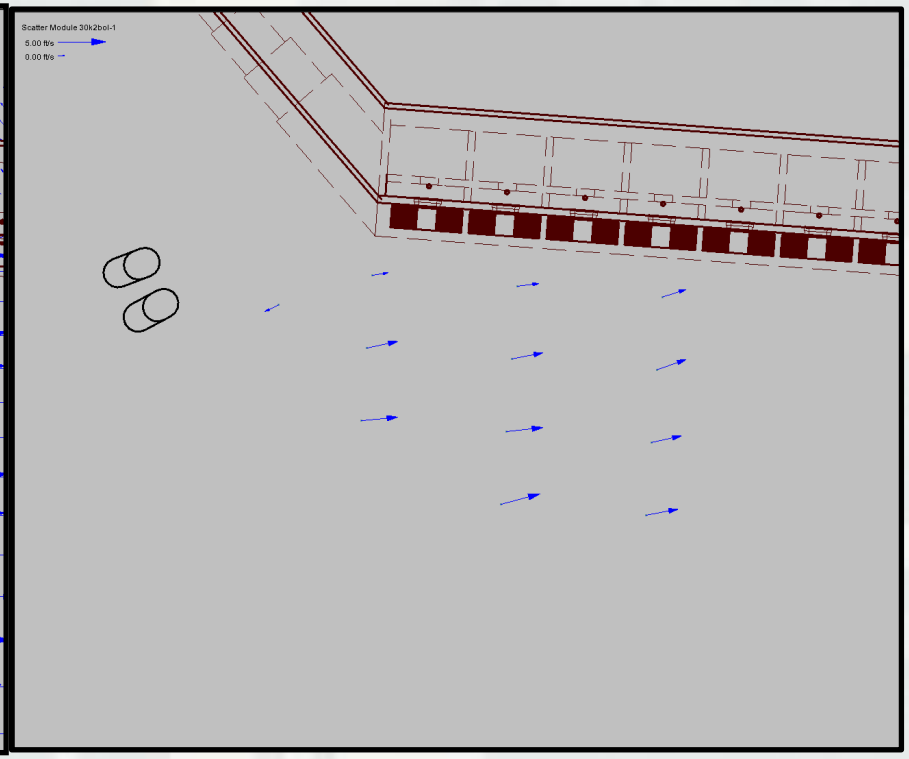
2D vs. Physical Model





2D (ADH) Results

Physical Model Results

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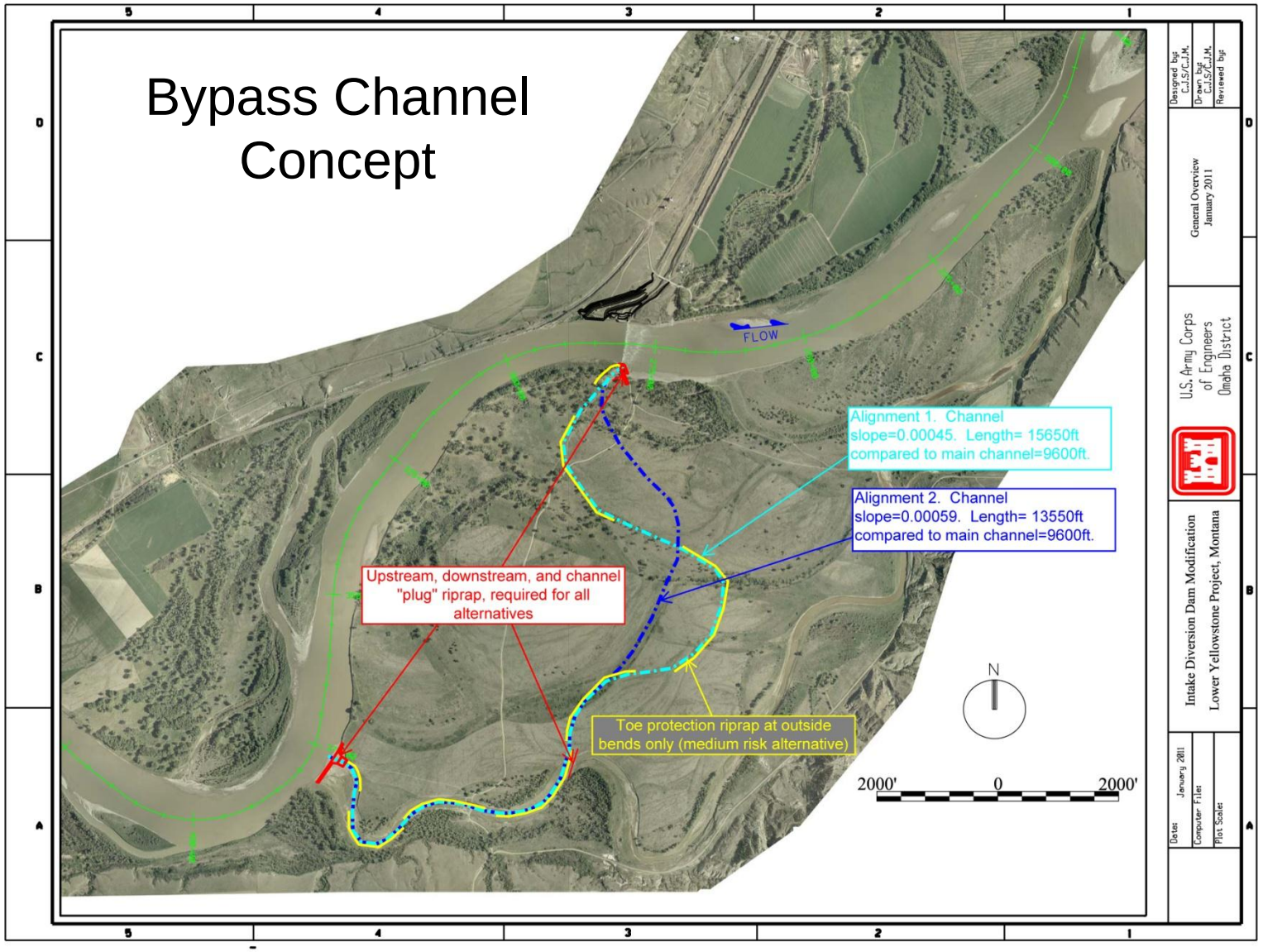
Bypass Channel Concept

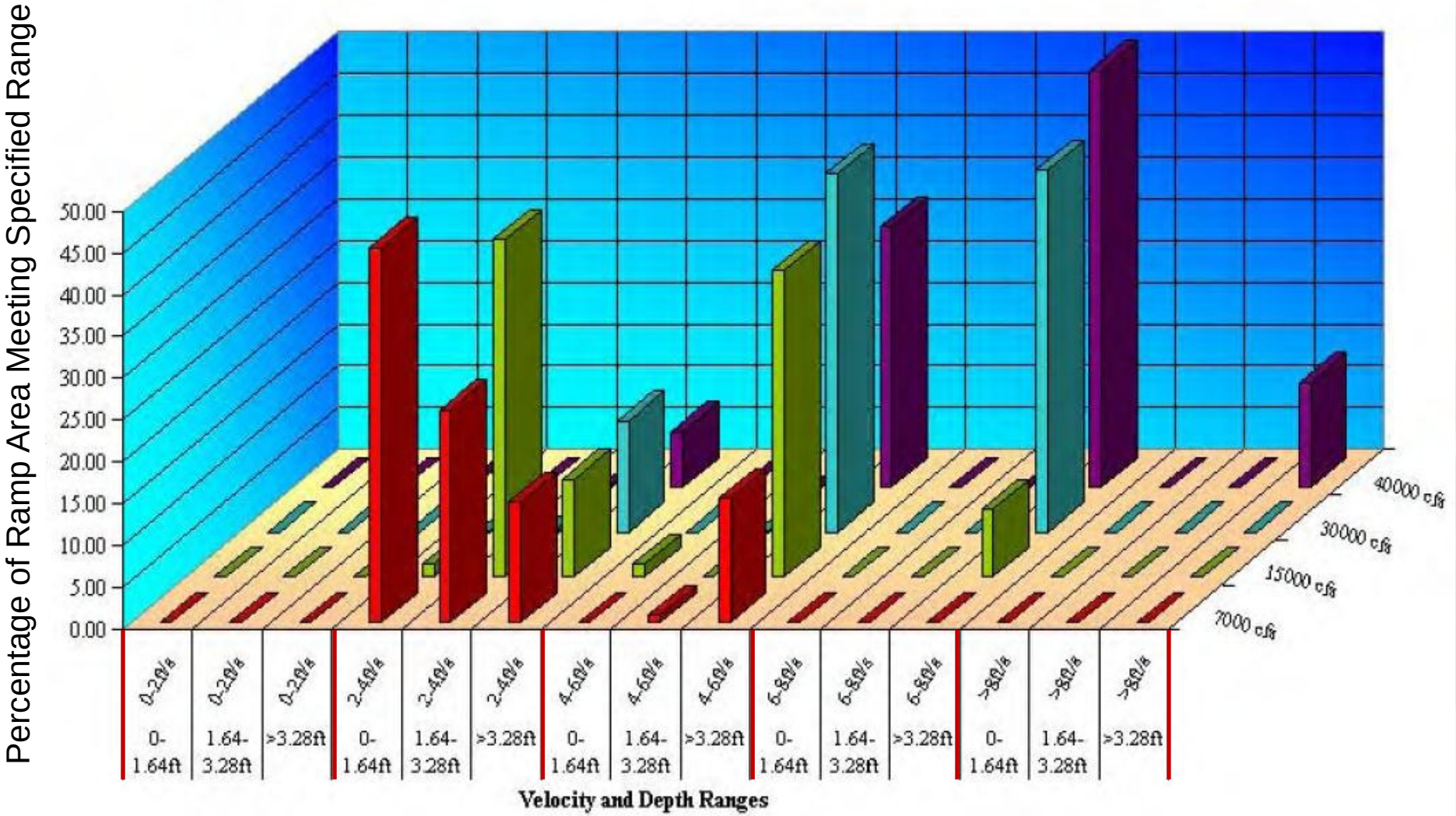


Conceptual Bypass Details

		Flow Splits for Base and Alternatives							
Recurrence interval (annual, post-Yellowtail flows)	Total Yellowstone River discharge	**BASE** (existing right bank chute assuming new headworks with existing dam)		**10% Diversion**		**15% Diversion**		**30% Diversion**	
	(cfs)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)
<2-yr	3000	0	0	210	7	570	19	830	28
<2-yr	7000	0	0	750	11	1260	18	2540	36
<2-yr	15000	0	0	1600	11	2280	15	5280	35
<2-yr	20000	0	0	2120	11	2850	14	6930	35
<2-yr	30000	790	3	3170	11	3990	13	9840	33
5-yr	60600	4050	7	7190	12	7920	13	18540	31

Pertinent Bypass Channel Parameters	**10% Diversion**	**15% Diversion**	**30% Diversion**
Alignment	2	1	2
Bypass Channel Length (ft)	13550	15650	13550
Bypass Channel Longitudinal Slope	0.00059	0.00045	0.00059
Low Flow Channel Depth (ft)	2	N/A	2
Low Flow Channel Bottom Width (ft)	10	N/A	10
Low Flow Channel Side Slopes	1V:3H	N/A	1V:3H
Main Bypass Channel Bottom Width	50	61	300
Main Bypass Channel Side Slopes	1V:5H	1V:4H	1V:5H
Approximate Excavation Quantity (cubic yards)	650,000	950,000	2,460,000

Results-Ramp Depth & Velocity



Passage Delineations: >1m, <***6*** fps

Discussion