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Design and Development of Fish Passage Facilities for Shortnose Sturgeon at a Northeast Hydropower Project

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Design and Development of Fish Passage Facilities for Shortnose Sturgeon at a Northeast Hydropower Project





★ Hadley Falls Dam

Hadley Falls Dam



- 30-ft high, 985-ft long dam
- Located at RK 129
- 18-mile long impoundment
- Hadley Unit 1 installed in 1950, replaced in 2015
 - 15 MW Kaplan turbine
 - Hydraulic capacity of 4,520 cfs
- Hadley Unit 2 was installed in 1983
 - 15 MW fixed blade propeller turbine
 - Hydraulic capacity of 3,750 cfs
- Five 3.5 ft high automated Rubber Dam sections on the spillway crest
- Canal – Hydraulic capacity of 3,000 - 6,000 cfs

Existing Fish Passage



- Two Fish Lifts with entrances in the spillway and tailrace
- Bascule gate and rubber dam used as surface bypasses
- Louver guidance array in canal with bypass discharge into tailrace

Existing Fish Passage

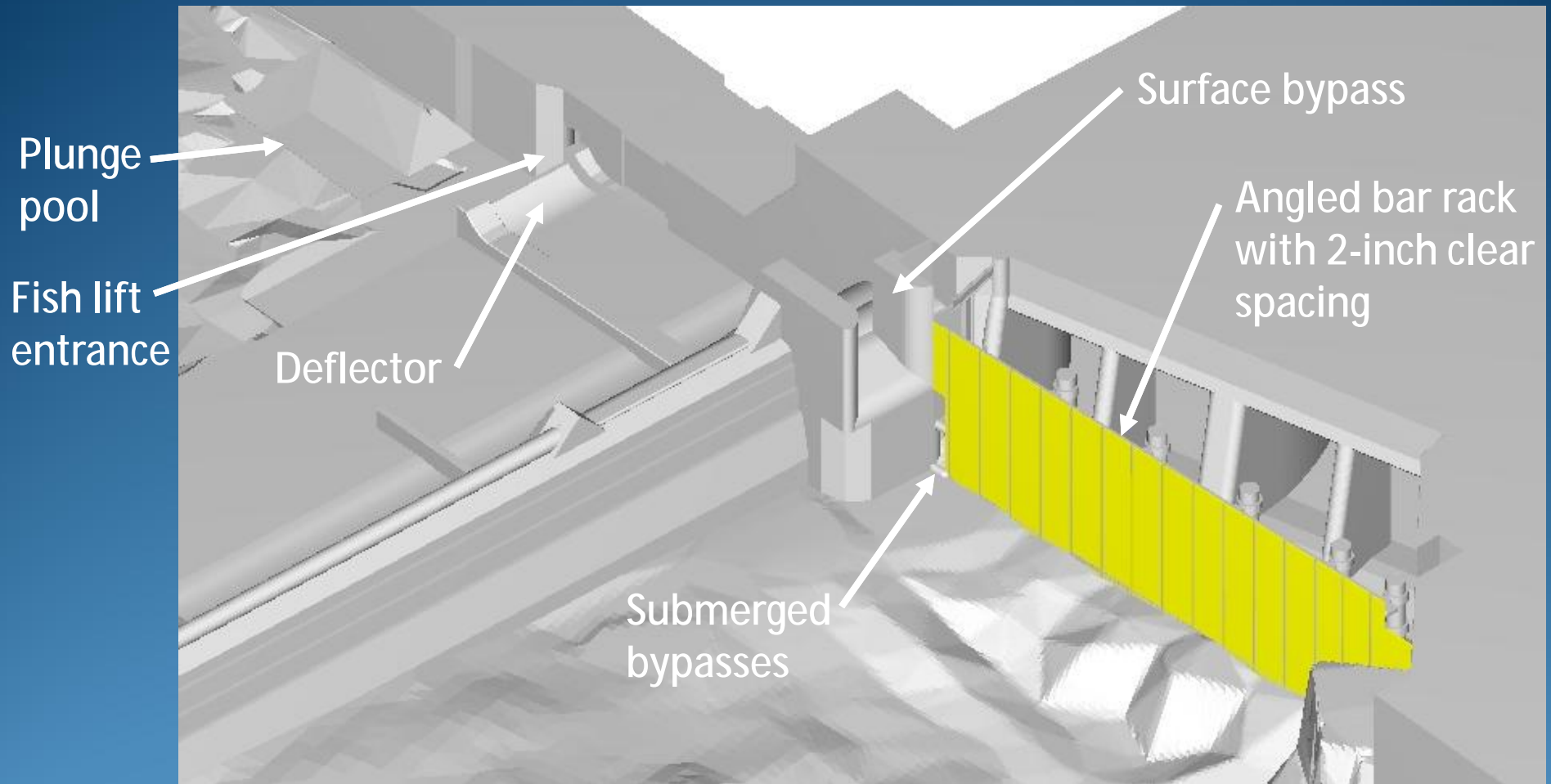


Downstream Fish Passage Background

- Holyoke Hydroelectric Project - New license 1999
- ESA-listed shortnose sturgeon
- Diadromous species (blueback herring, American shad, sea lamprey, and American eel)
- Settlement Agreement - March 12, 2004
- Cooperative Consultation Team - Multi-year program of research and analysis to address a permanent solution for downstream passage
- This research has included:
 - (i) 5 years of flume studies - Conte and Alden Labs;
 - (ii) 4 years of sturgeon radio tracking studies;
 - (iii) effectiveness testing of the 2-inch spaced full depth louvers;
 - (iv) analysis of the total river flows and desk-top I/E estimates;
 - (v) CFD analysis of flows that fish would experience with proposed enhancements.



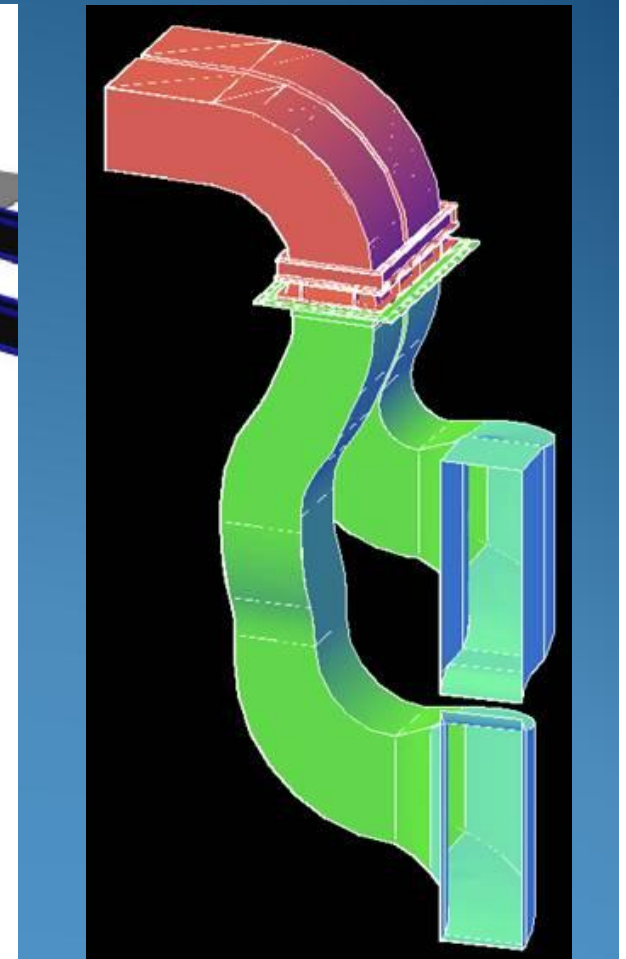
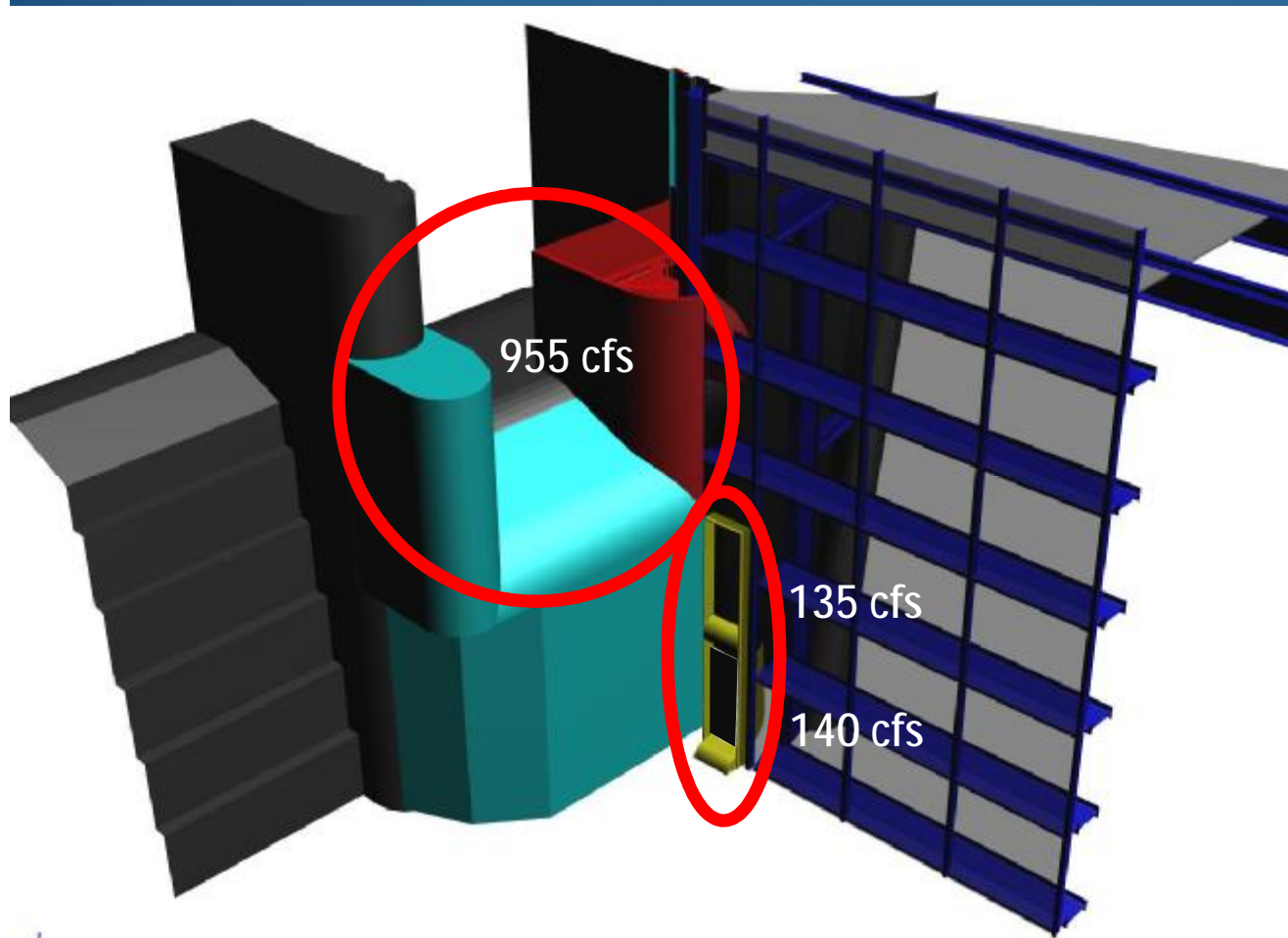
Components of Conceptual Design



- Angled bar rack – 2-inch clear bar spacing; 2-3 ft/s approach velocity
- Surface bypass – modified version of existing uniform acceleration weir
- Submerged bypass – 5 ft/s entrance velocity

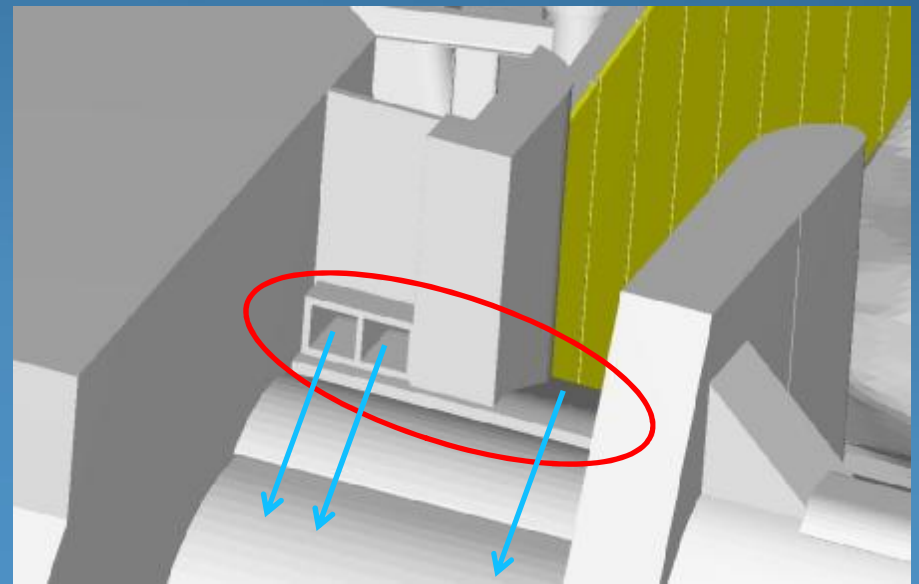
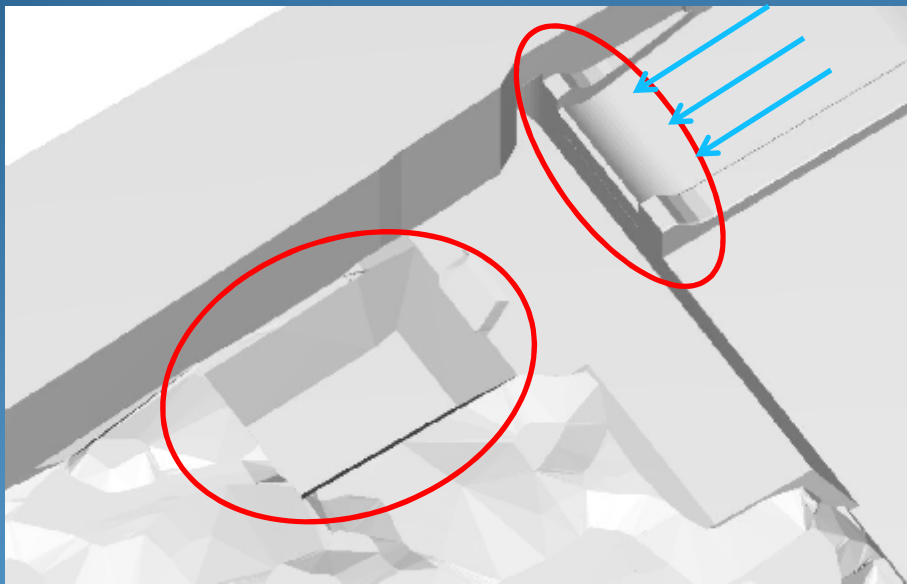
Bypass Details

- Surface bypass - bascule gate bay modified with new 12 ft wide uniform acceleration weir
- Submerged bypass - comprised of 3 ft wide by 18 ft high entrance with a 2 ft rounded partition at mid-height separating flow/fish into two separate 3 ft by 3 ft conduits



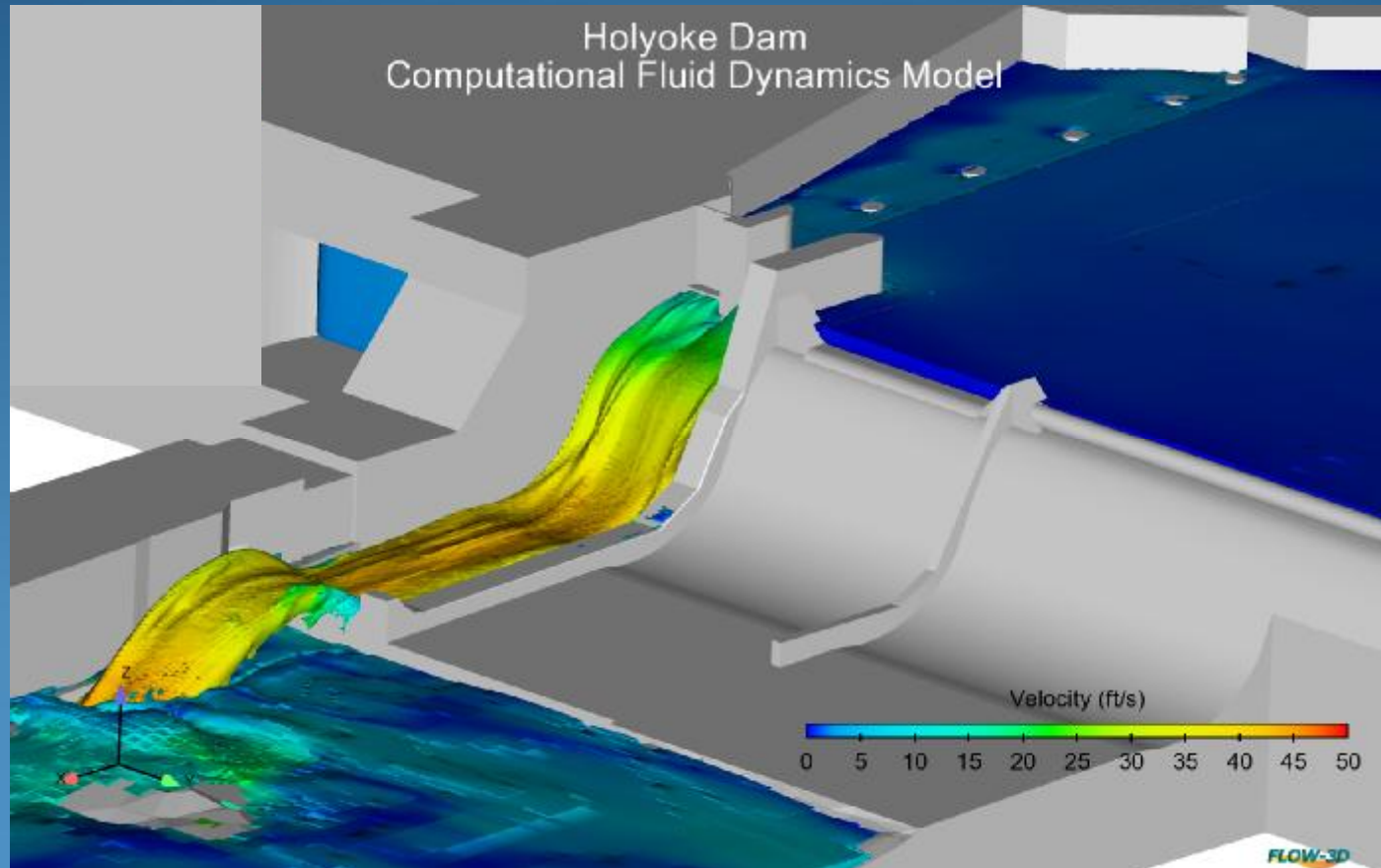
Bypass Discharge Details

- A new flow deflector was built at the downstream end of the apron below the Bascule Gate to direct the bypass discharge up and over the upstream entrance.
- A new plunge pool was built 2-ft from the flood wall and 24-ft from the dam apron.
- Plunge pool has sloped sides, bottom length of 35-ft, and bottom width average 15 -ft.
- Plunge pool depth at the normal tailwater elevation is 16-ft.
- Plunge pool is lined with concrete to provide scour protection.



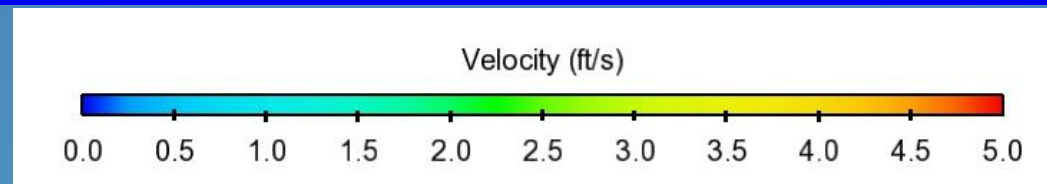
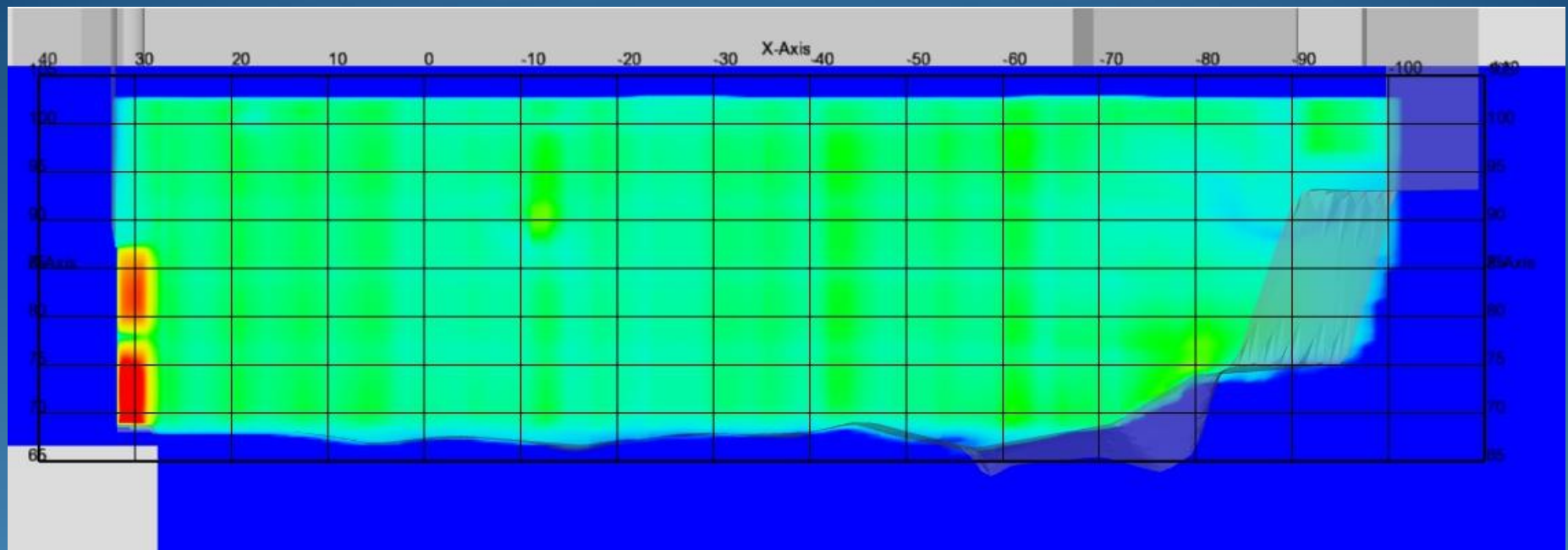
CFD Modeling

A 3D Computational Fluid Dynamics (CFD) model was used to evaluate hydraulic conditions with respect to agency criteria and develop the final design of the fish passage facilities.

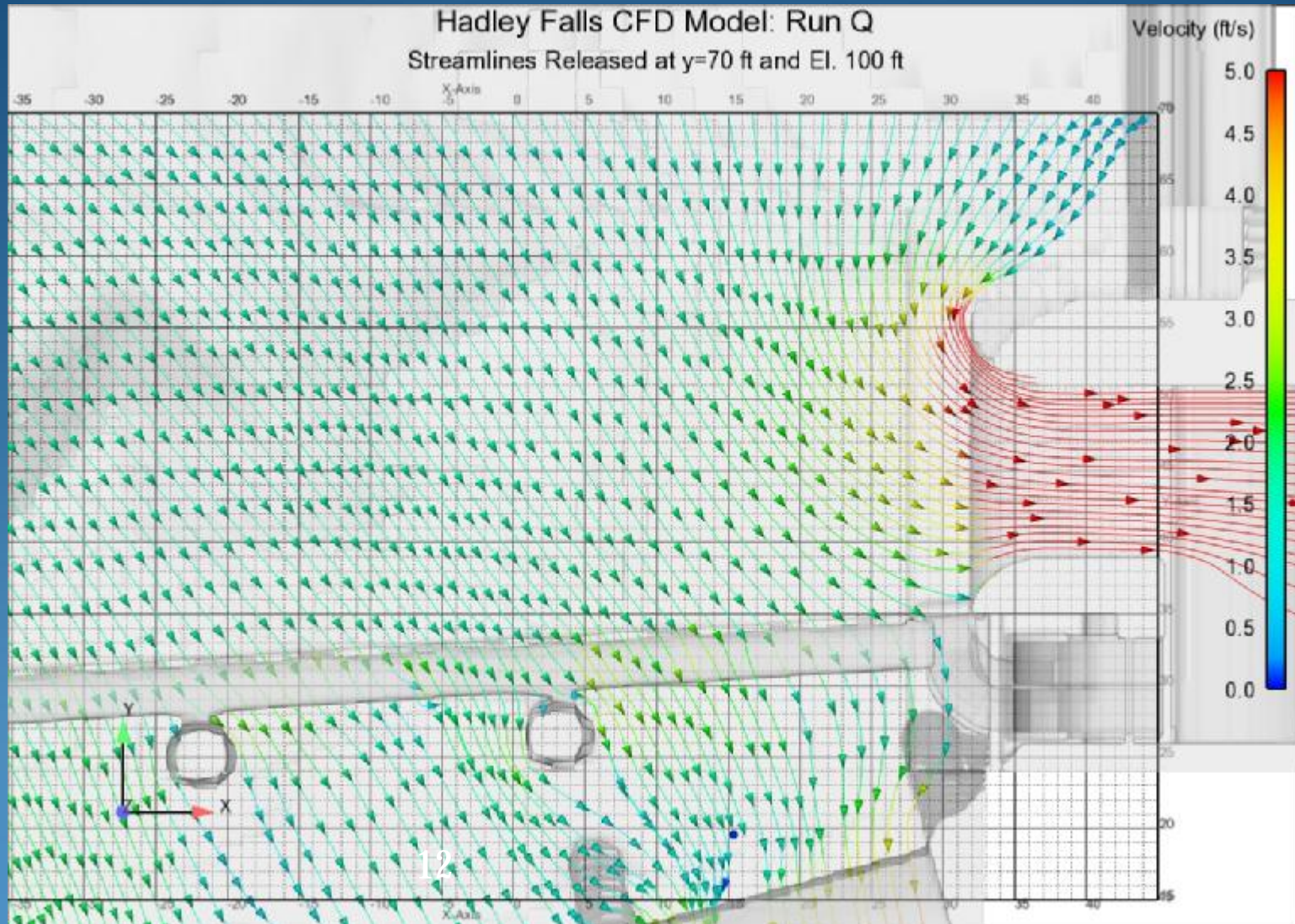


CFD Modeling – Rack and Bypasses

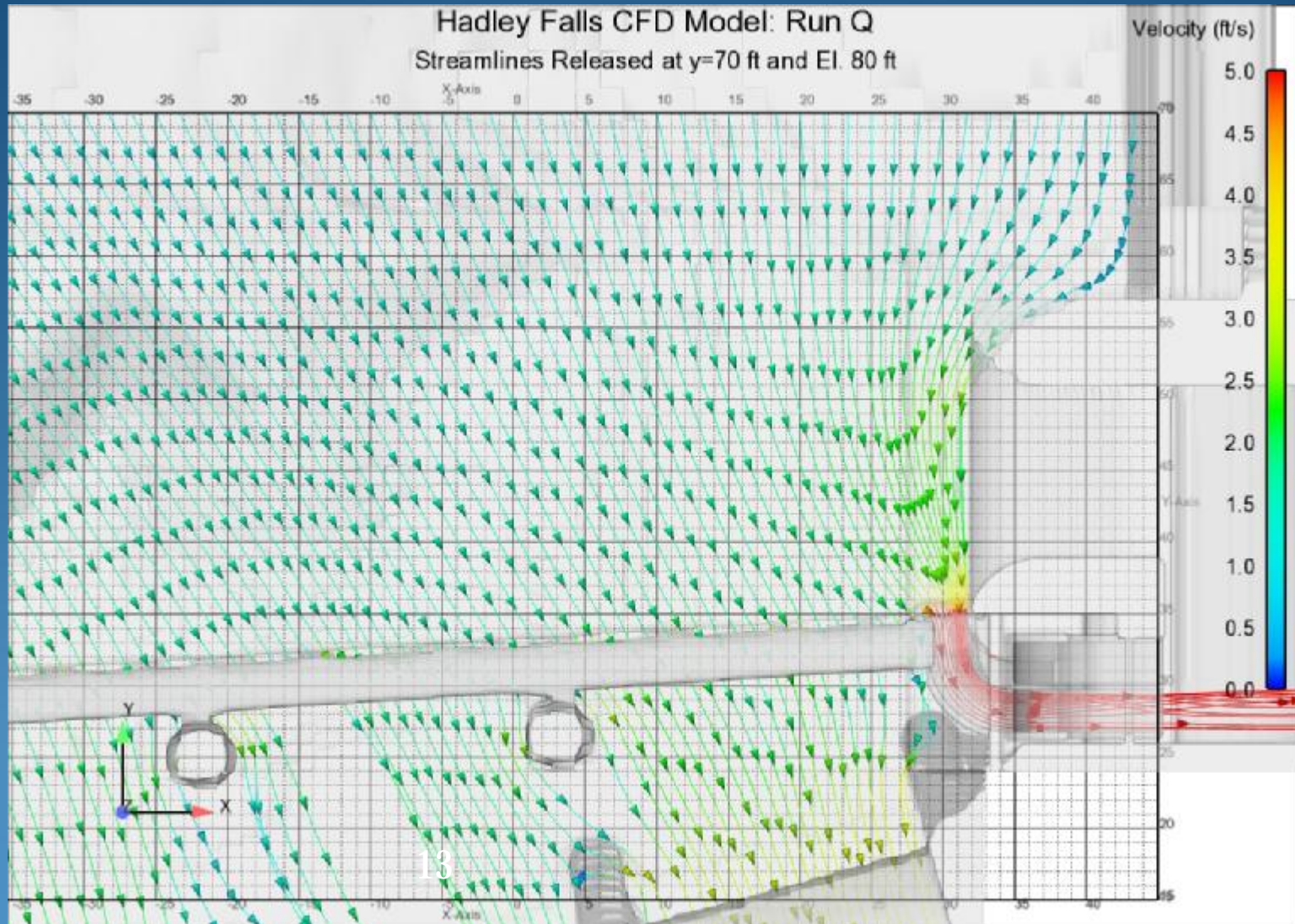
Approach velocities 0.5 ft upstream of angled bar rack



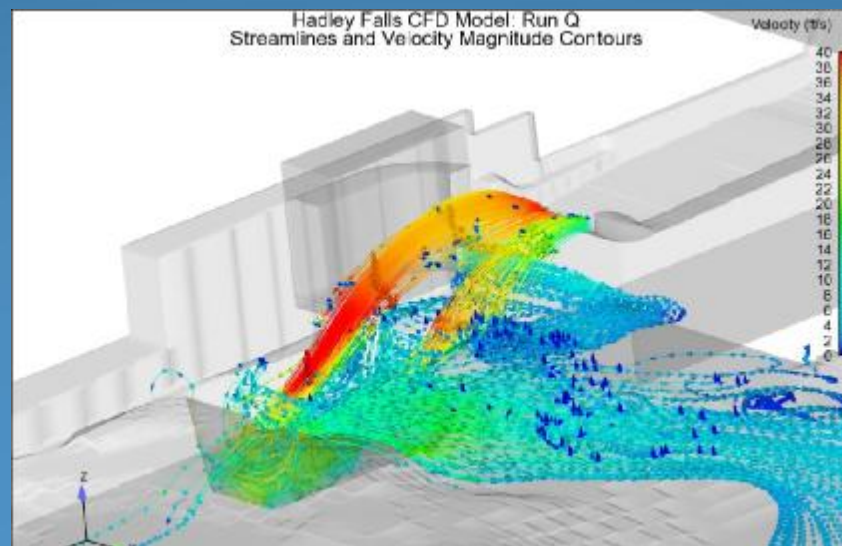
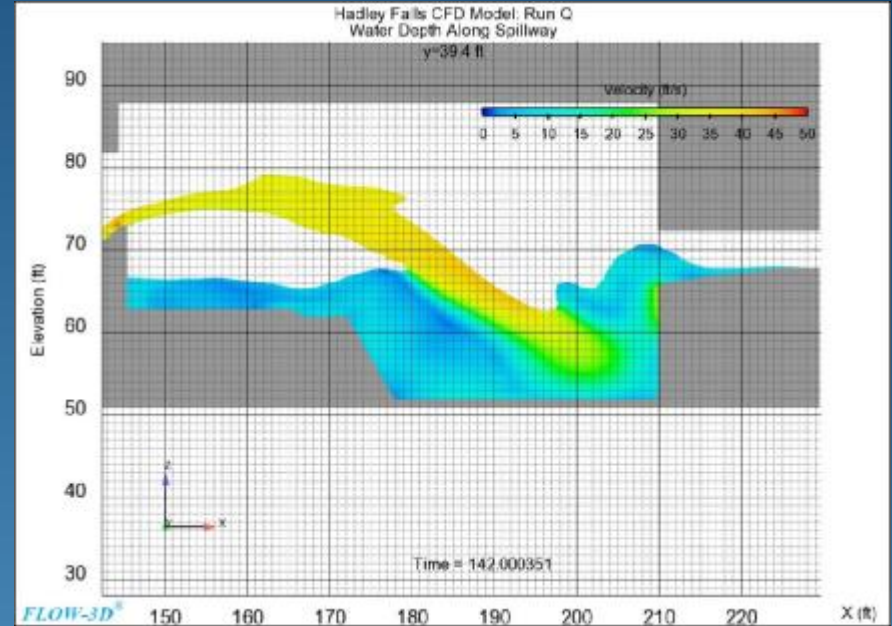
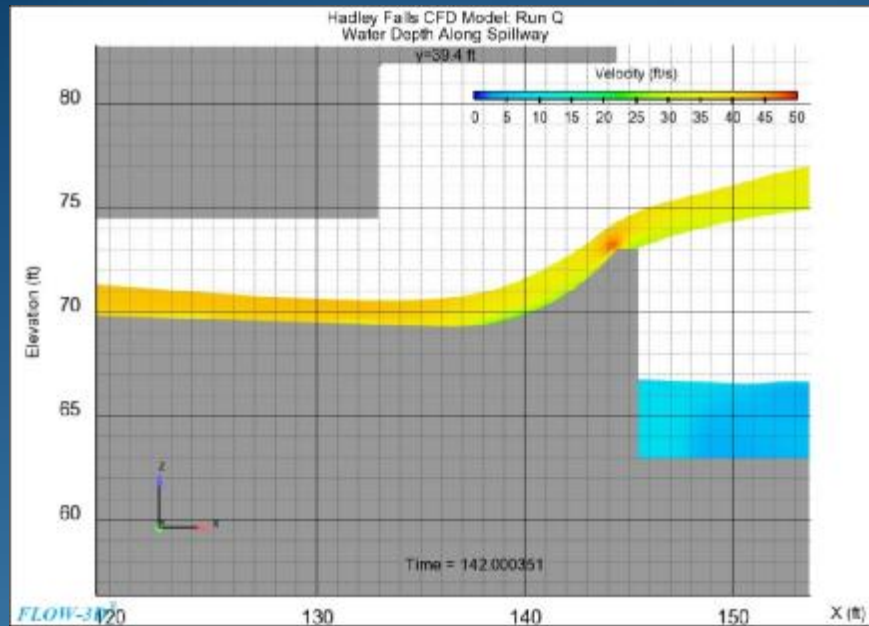
CFD Modeling – Flow Streamlines Surface Bypass



CFD Modeling – Flow Streamlines Submerged Bypass



CFD Modeling – Bypass Discharge





Construction



Construction



Angled Bar Rack Construction





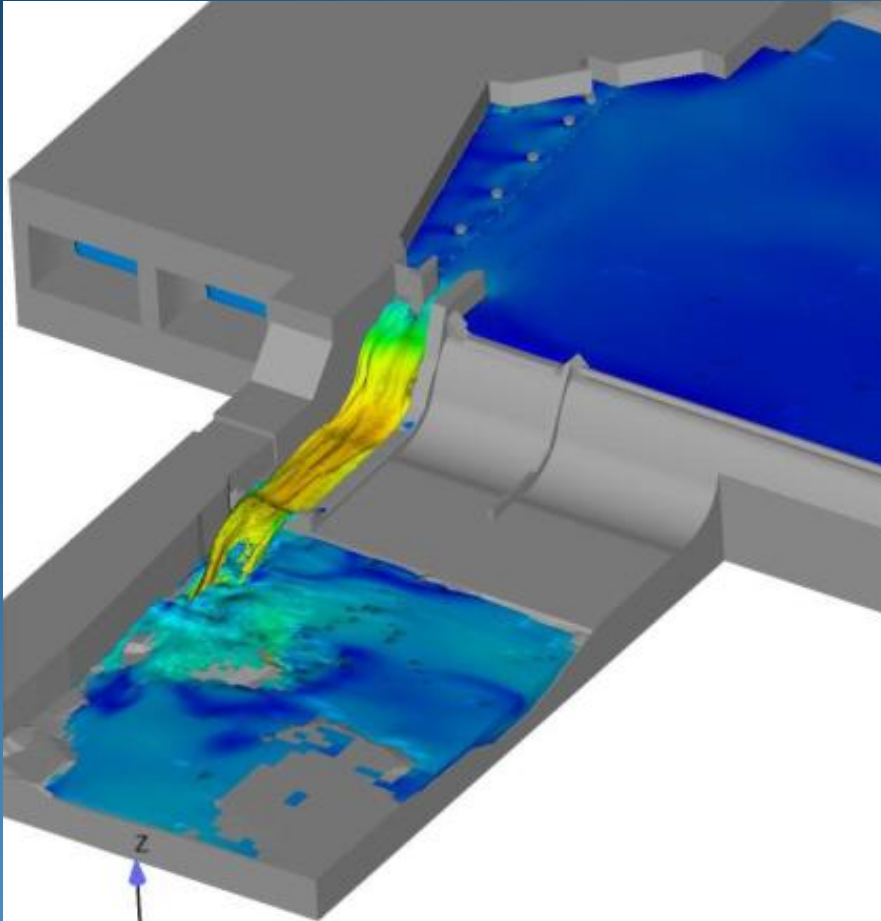
Fish Lift Entrance Enhancements



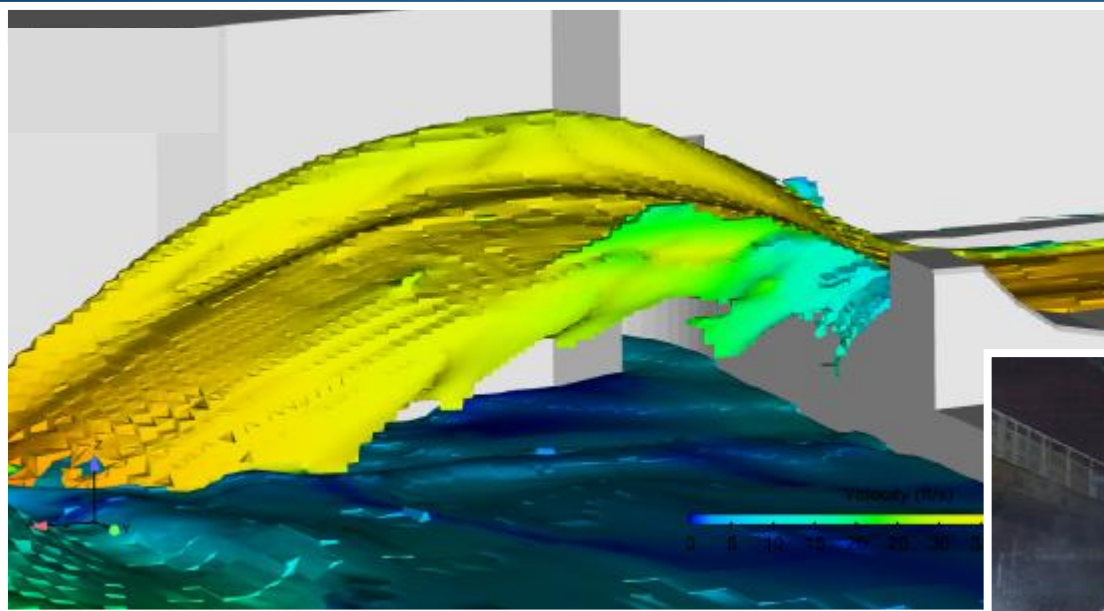
Construction



CFD Model and Post-Installation



CFD Model and Post-Installation



Results to Date

- Studies to determine downstream passage efficiency are ongoing.
- In 2016, 94 shortnose sturgeon were lifted before being returned downstream.
 - 79 unique shortnose sturgeon entered the fish lift (15 repeats).
 - 11 previously tagged shortnose sturgeon
 - There were 5 times more shortnose sturgeon entering the fish lift in 2016 than any previous year (Maximum number lifted was 16 in 1996).
- In 2016, 385,930 adult American shad were lifted upstream at Holyoke Dam.
 - This was higher than the 60-year (1955 to 2015) annual mean of 309,119 shad.
 - It was the eighth highest annual count during the 60-year period.





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Thank you!



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