Jun 21st, 3:10 PM - 3:30 PM

The Next Generation of Pool and Chute Fishways

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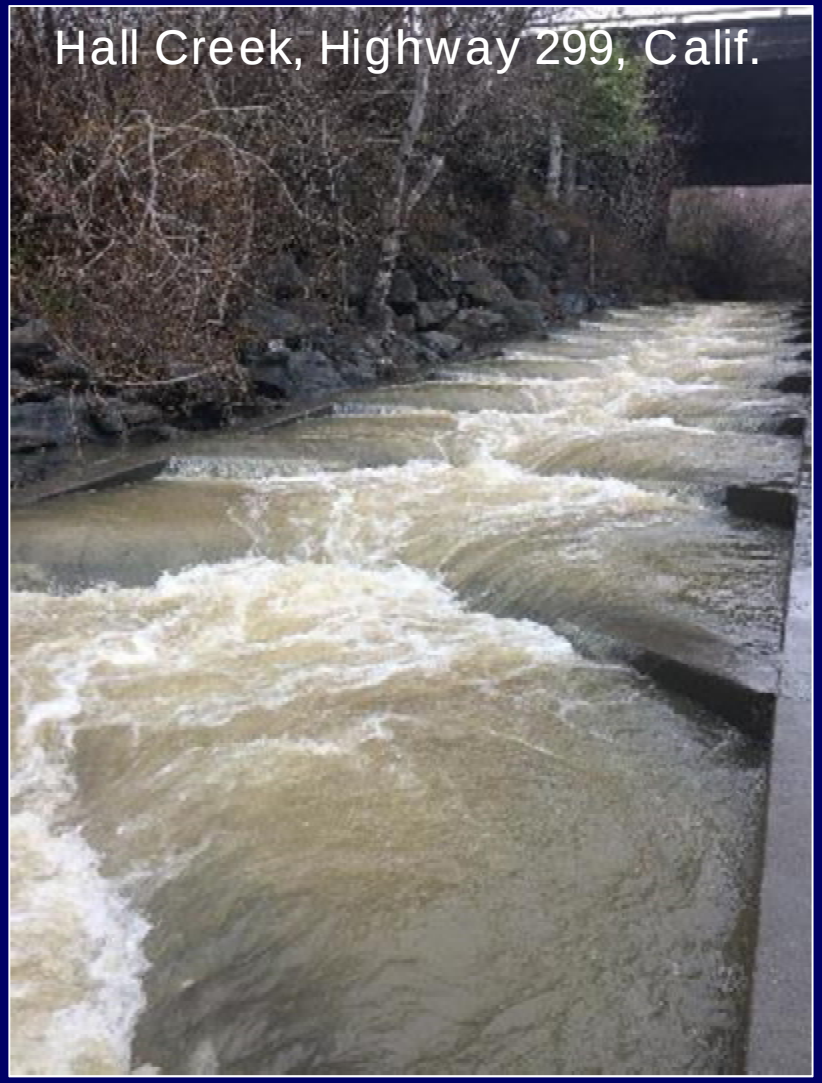

Photo: B. Foster

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Hydrologic Solutions

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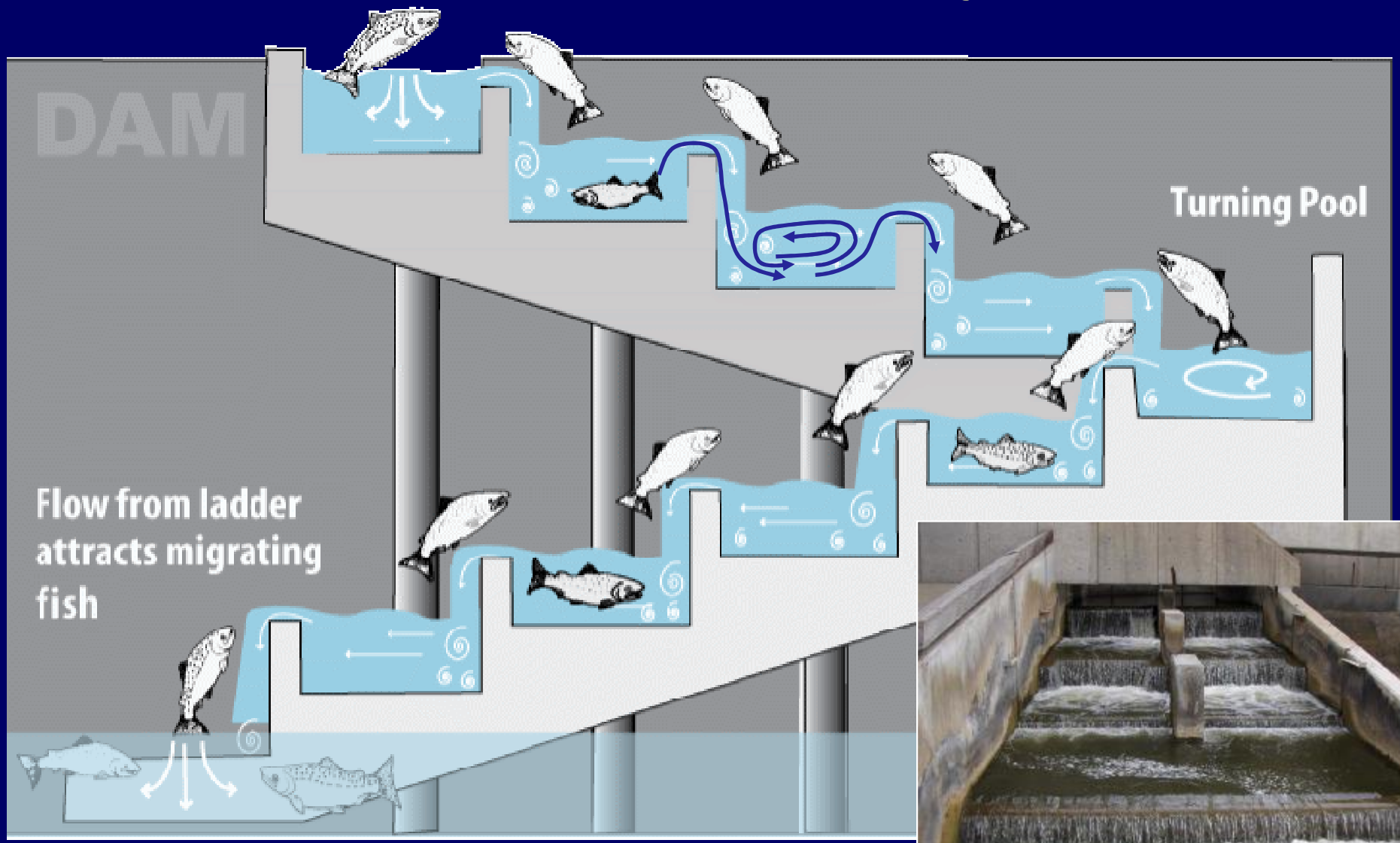
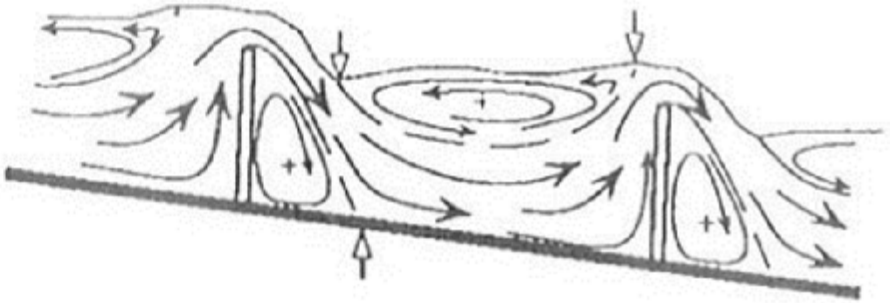
Pool and Weir Fishways



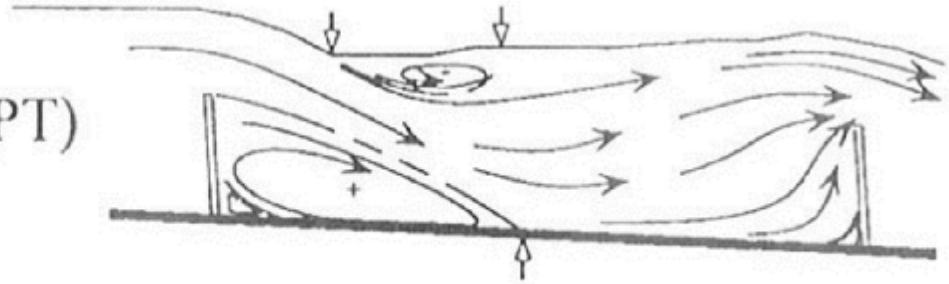
Operates Entirely in Plunging Regime over Limited Range of Flow

Plunging & Streaming Regimes

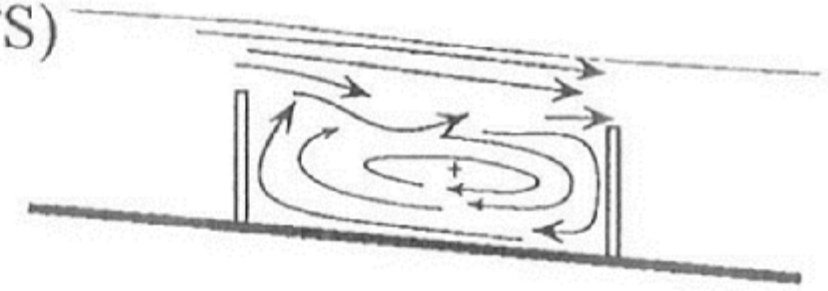
Plunging flow (P)
IWB15-005



Plunging transitional flow (PT)
IWA05-025



Transitional streaming flow (TS)
IWB10-035



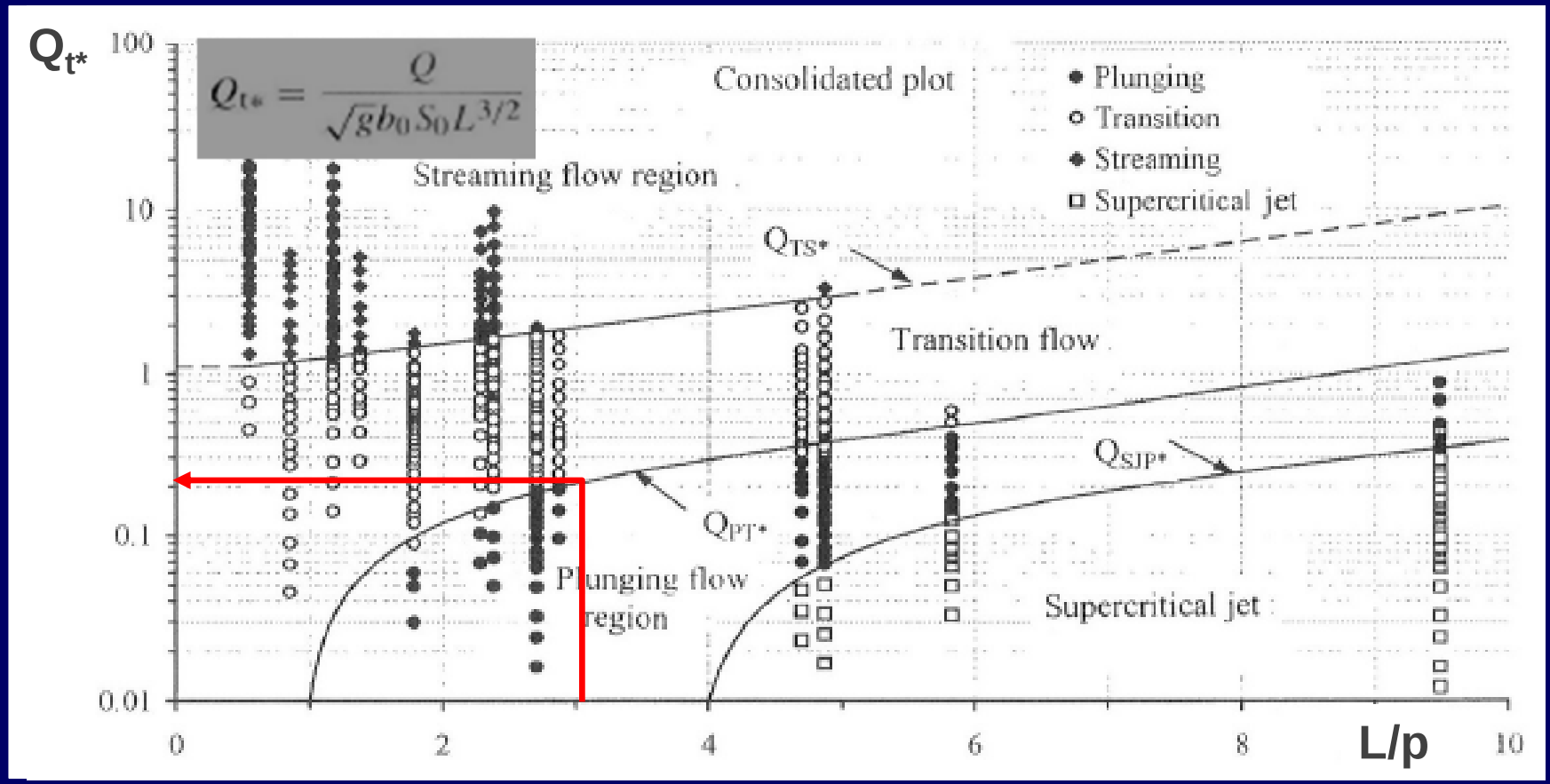
From Ead et al. 2004

Flow Regime Primarily Function of Weir Submergence.

Other Factors: Fishway Slope, Weir Spacing and Height

Transitional Streaming Flow
Poor Fish Passage Conditions

Streaming-Plunging Transition



$$Q = Q_{t*}\sqrt{g}b_o S_o L^{3/2}$$

From Ead et al, 2004

b = Weir Top Width
So = Fishway Slope
L = Spacing between Weirs
p = Weir Height above Floor

Hybrid Fishway Type: Pool & Chute Fishway

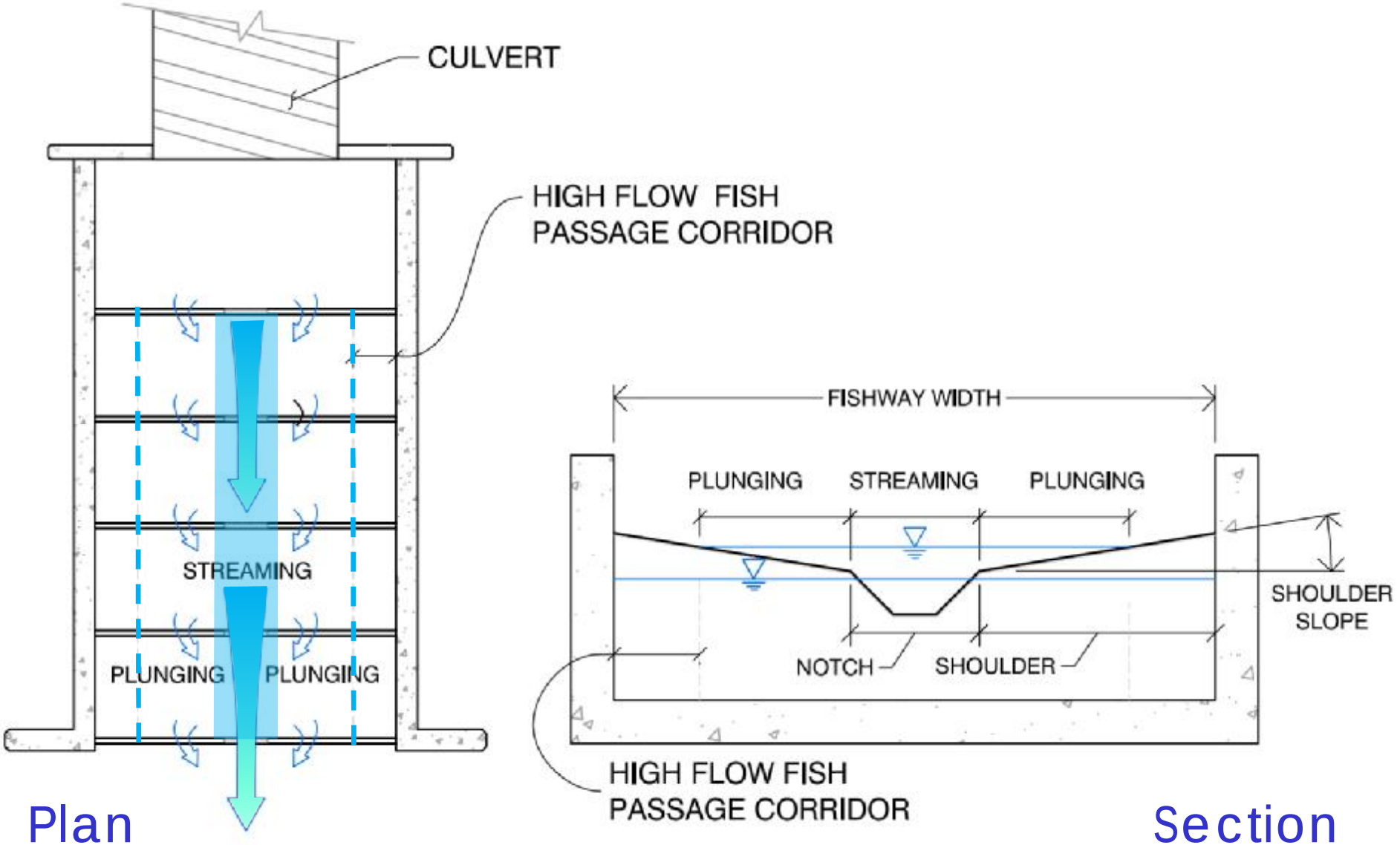
Plunging at Low Flow

Streaming & Plunging at High Passage Flow

Photos: Kozmo Bates

Pool and Chute Fishways

Simultaneous Plunging and Streaming



Fishway Types: Pool & Weir

Sloping Weir Crest (V-weir) Creates Good Passage Conditions along Edge

$$Q_{v-weir} = \frac{8}{15} C_{dt} \sqrt{2g} \tan\left(\frac{\theta}{2}\right) H_{v-weir}^{2.5}$$

Where:

$$C_d = 0.6072 - 0.000874\theta + 6.1 \times 10^{-5}\theta^2$$

Pool & Chute Fishway

Big Sulphur Creek
Culvert Retrofit

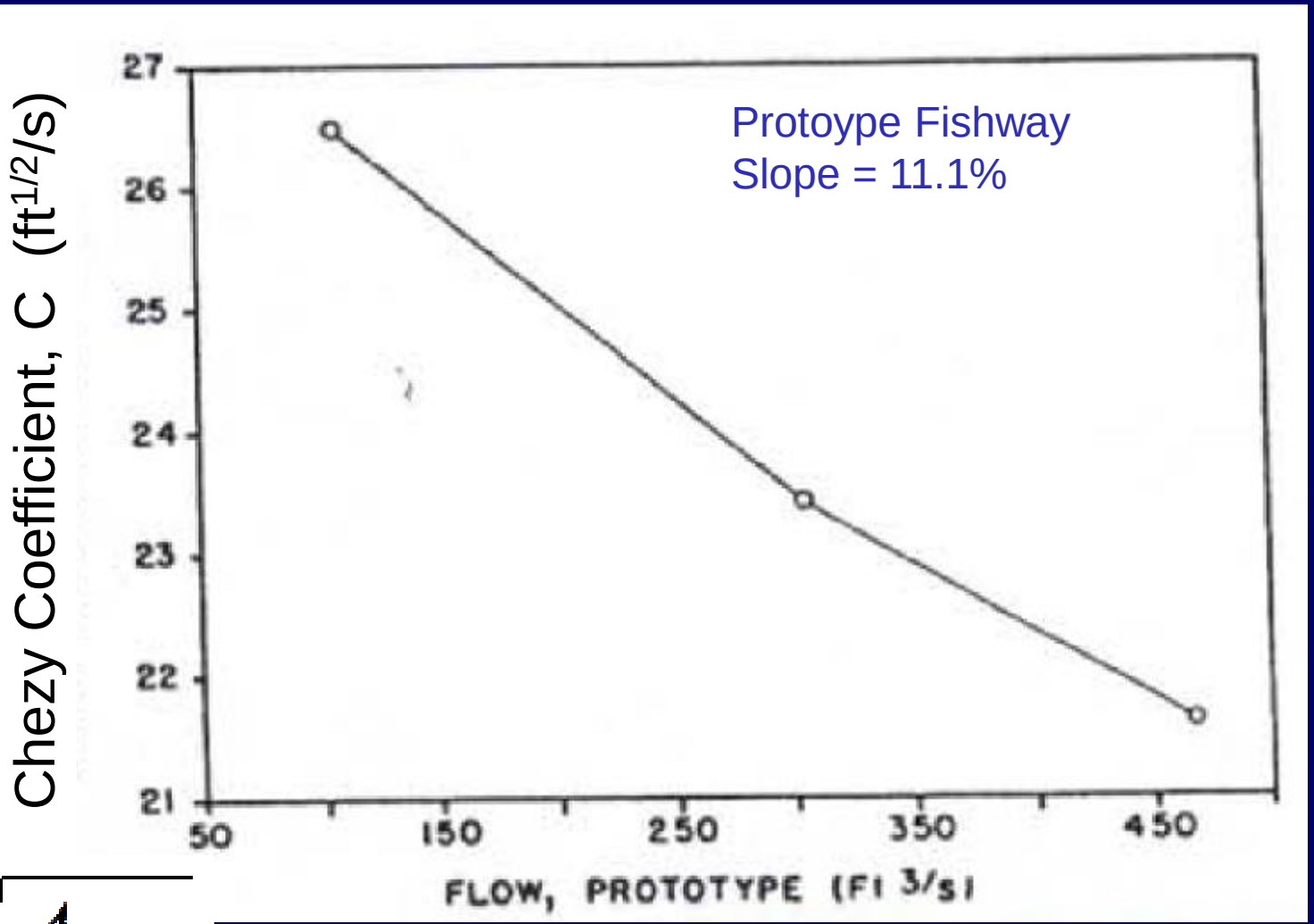

Low Passage
Design Flow


High Passage Design Flow

Taditional Pool & Chute Guidance:

- Best built at slopes ≤ 10%
- Avoid overall drop greater than approximately +/- 7 feet
- 2-feet of Dry Shoulder at Qhp

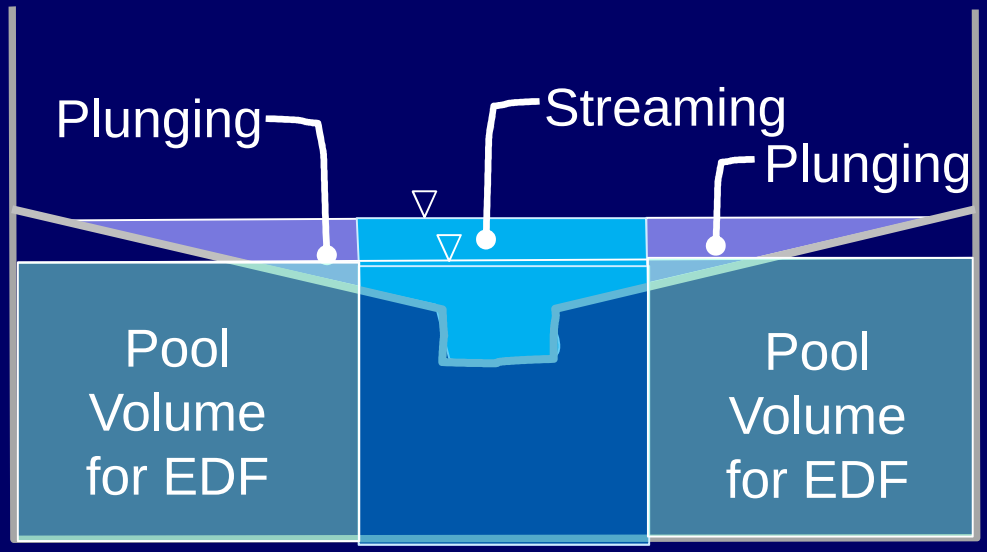
Pool & Chute Fishway Steaming Hydraulics



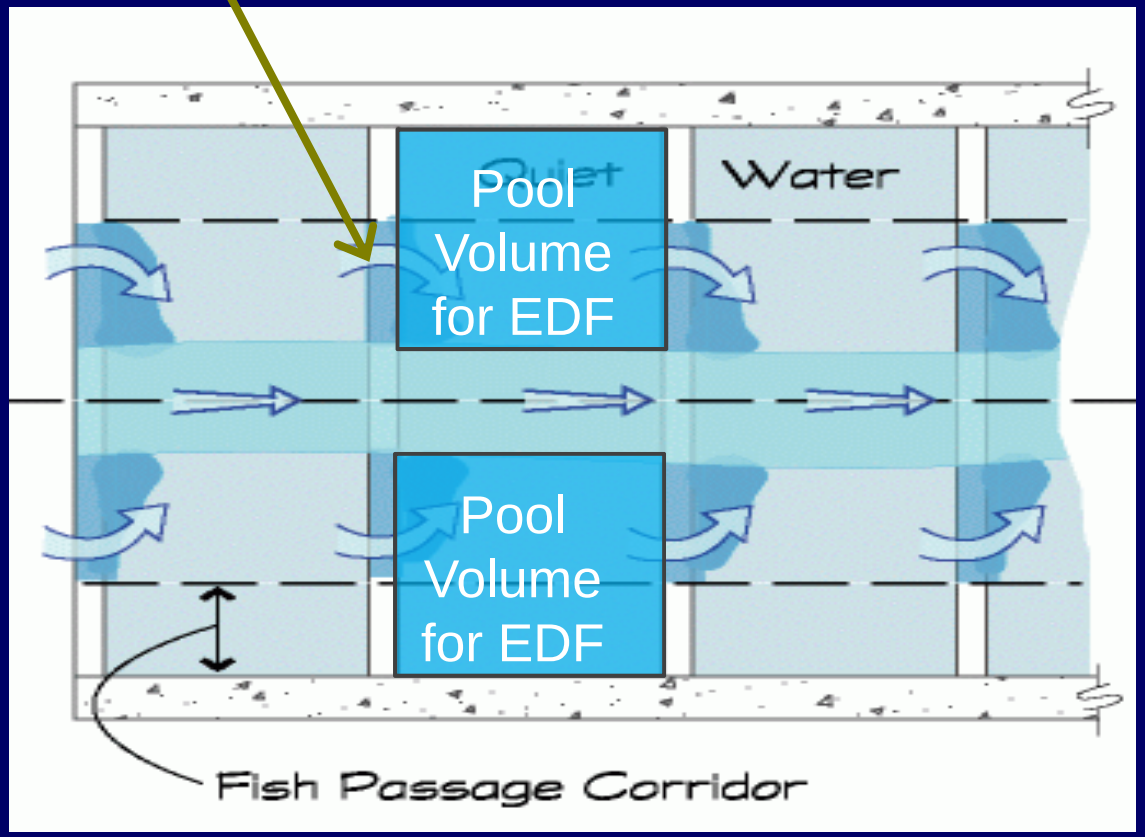
$$Q = CA\sqrt{\frac{A}{P}S_o}$$

Bates, K, 1991, Pool-and-Chute Fishways, American Fisheries Society Symposium 10:268-277.

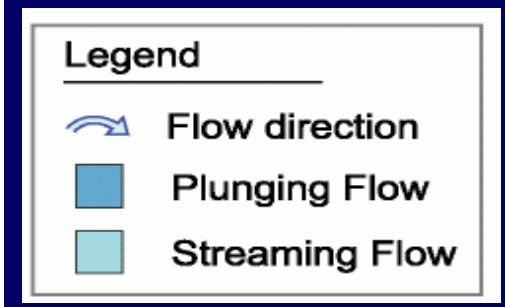
Pool & Chute Fishway EDF Calculations



$Q_{plunging}$ = Q for EDF

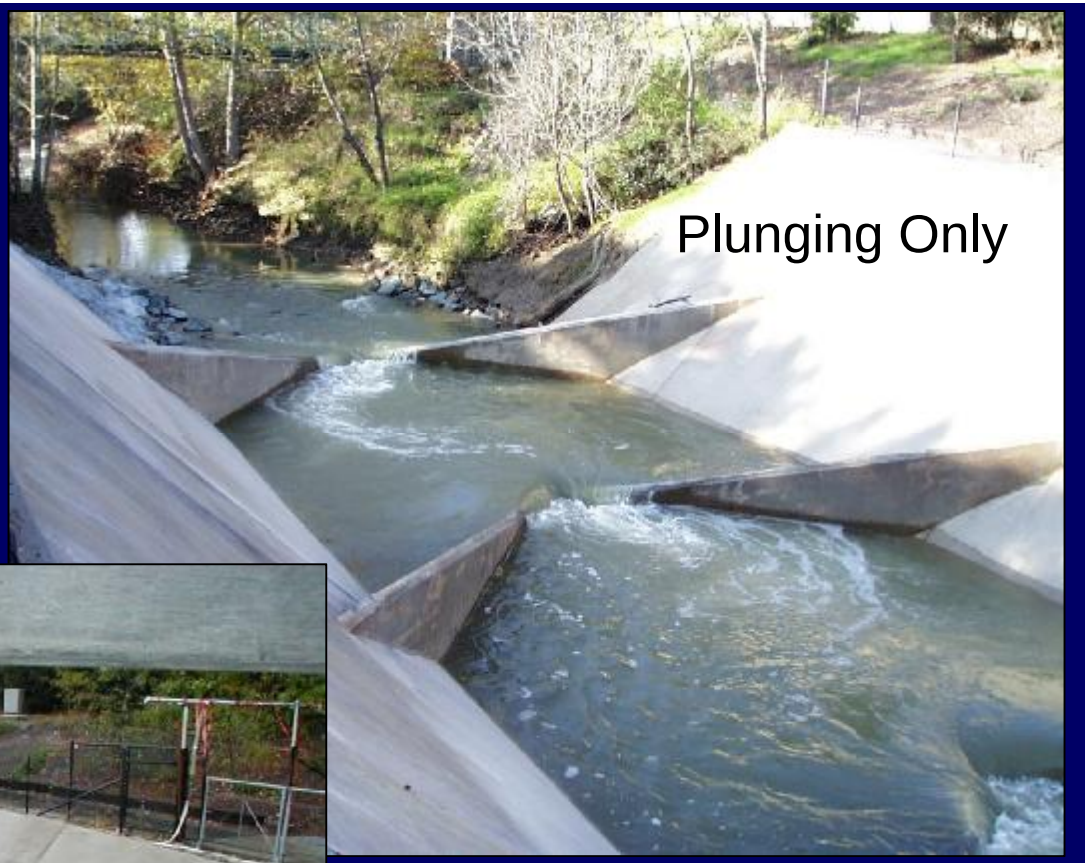


$$EDF = \frac{gQh}{V}$$



Vortex Pool & Chute Fishway

Stevens Creek,
Mountain View, CA
Built 2002



photos from Jon Mann

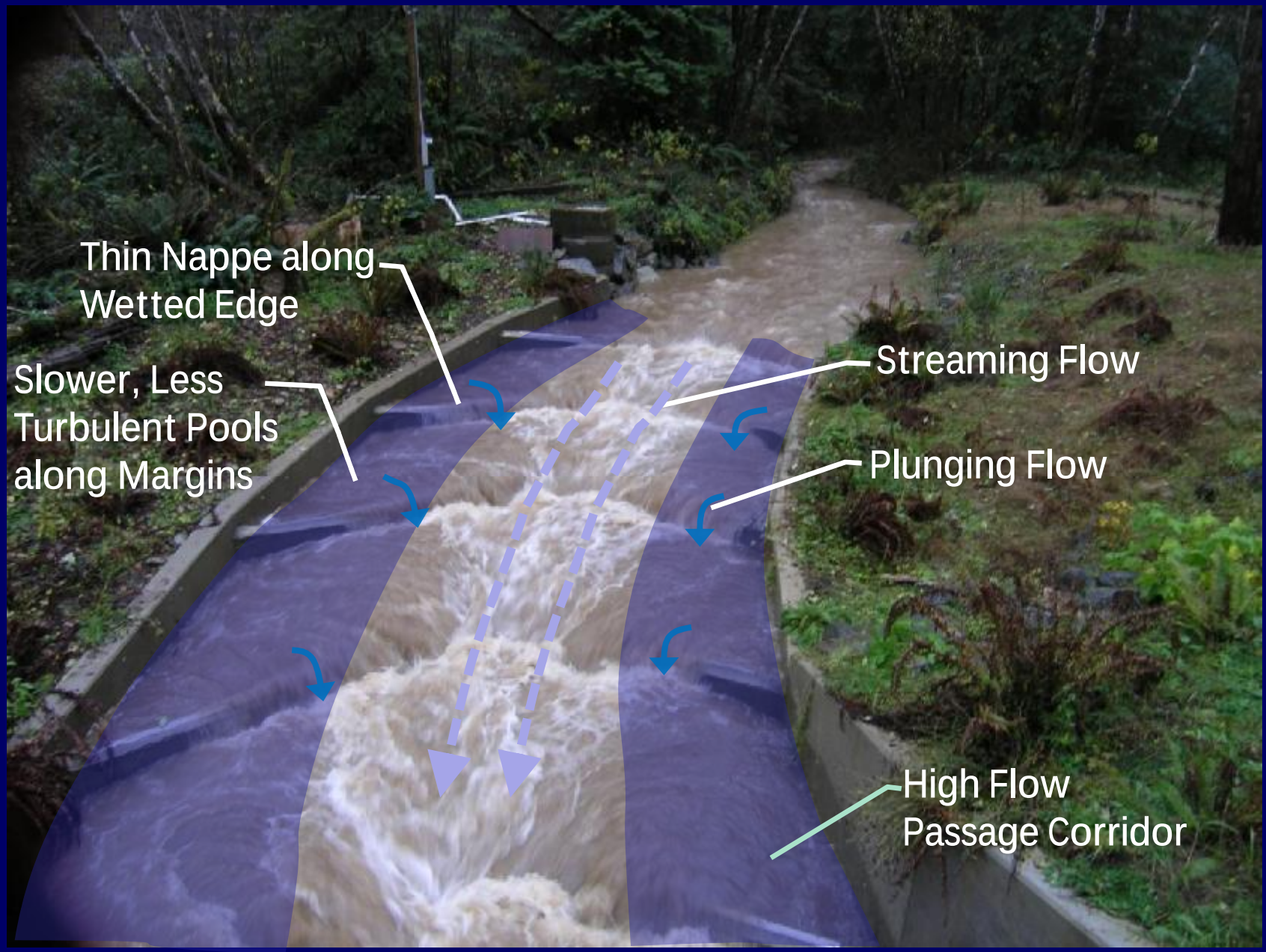
Vortex Pool & Chute Fishway

Peacock Creek
Smith River, California
Built, 2005

Fishway Dimensions:

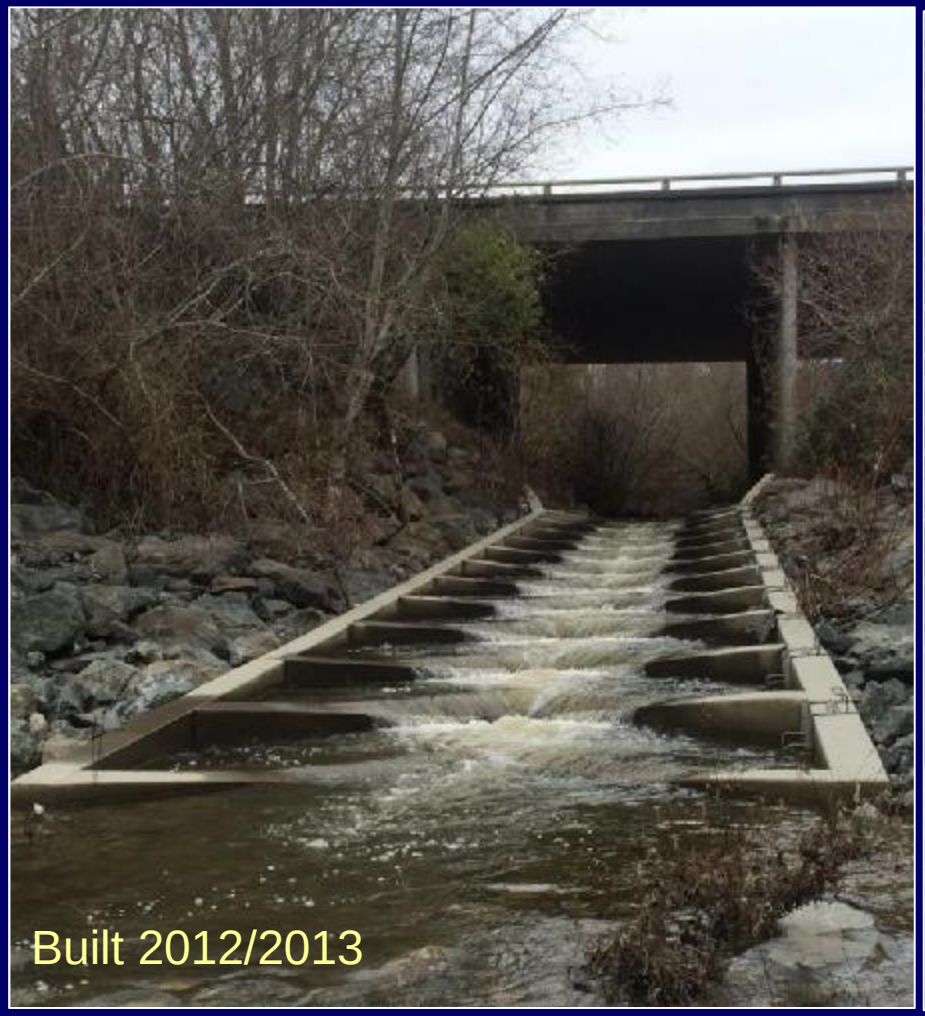
Width = 20 feet
Slope = 7%
Shoulder Slope: 5H:1V
Vortex Angle: 45 deg.
Drops = 8 inches
Overall Fall = 7 feet

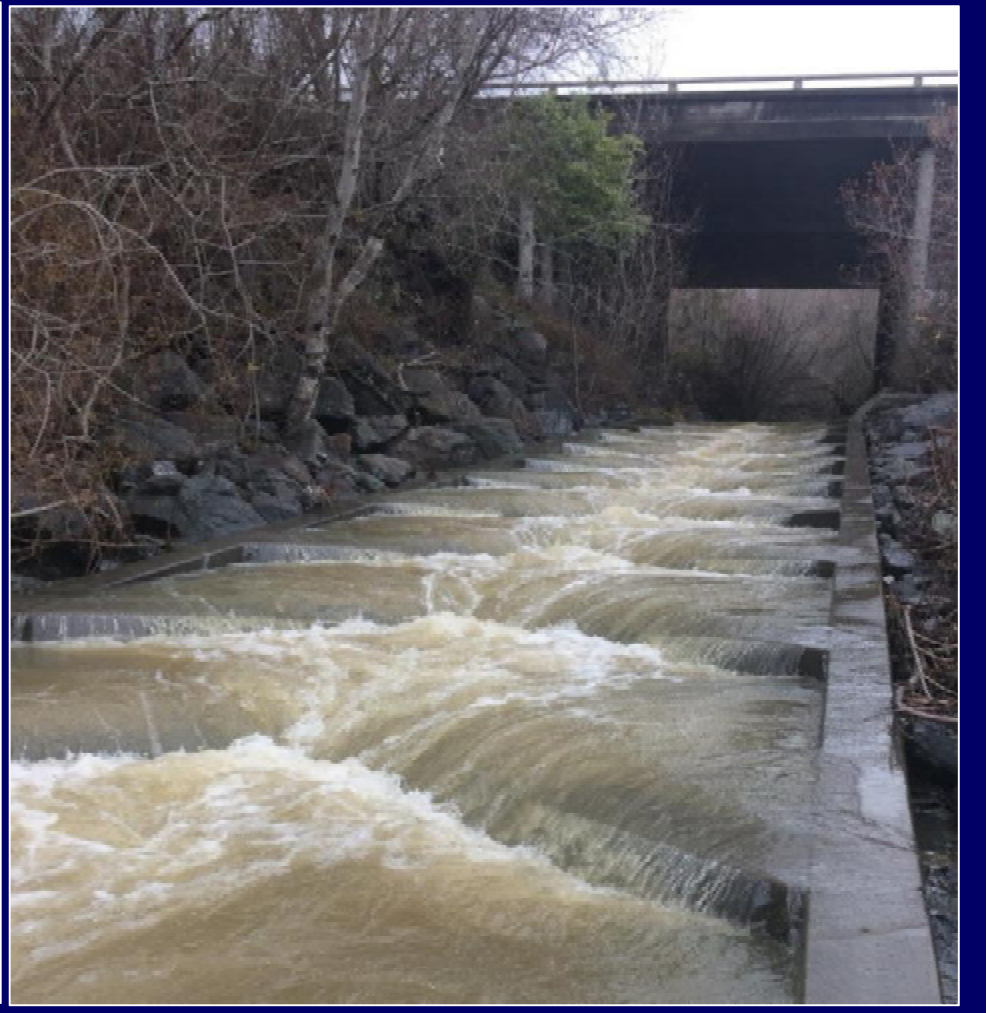
Vortex Pool and Chute Fishway Hydraulics



Vortex Pool & Chute Fishway

Hall Creek under US 299 Bridge Scour Apron Retrofit





Fishway: Width = 15 feet, Slope = 7%, Drops = 8 inches,
Vortex Angle = 45 deg, Shoulder Slope = 5H:1V

Overall Fall = 7.4 feet

Photos: Brendan Foster

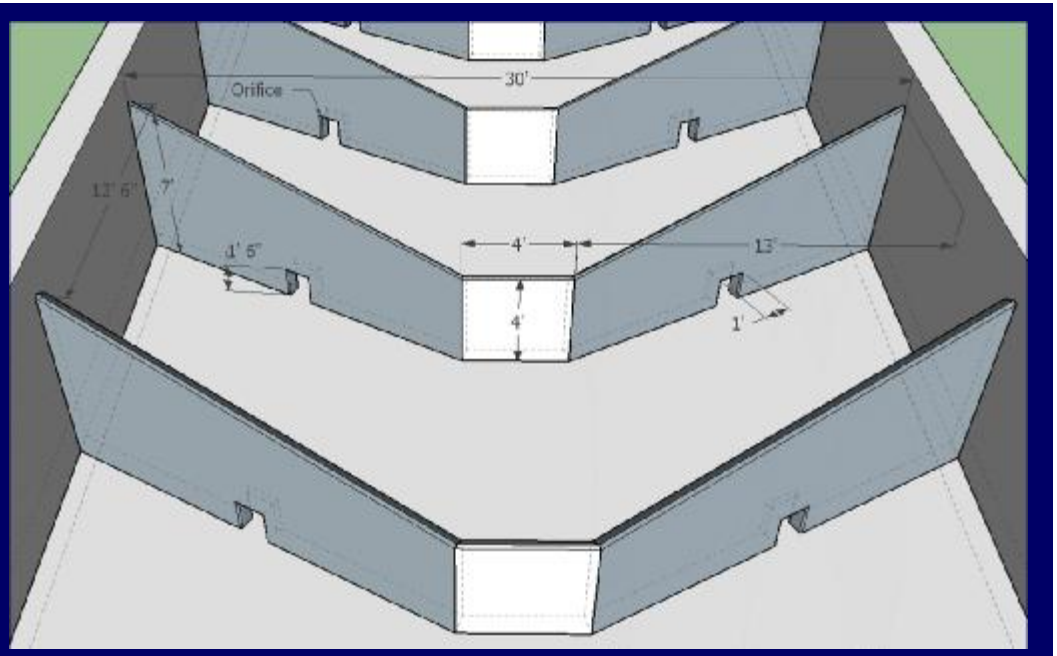
Physical Model of Vortex Pool and Chute Fishway

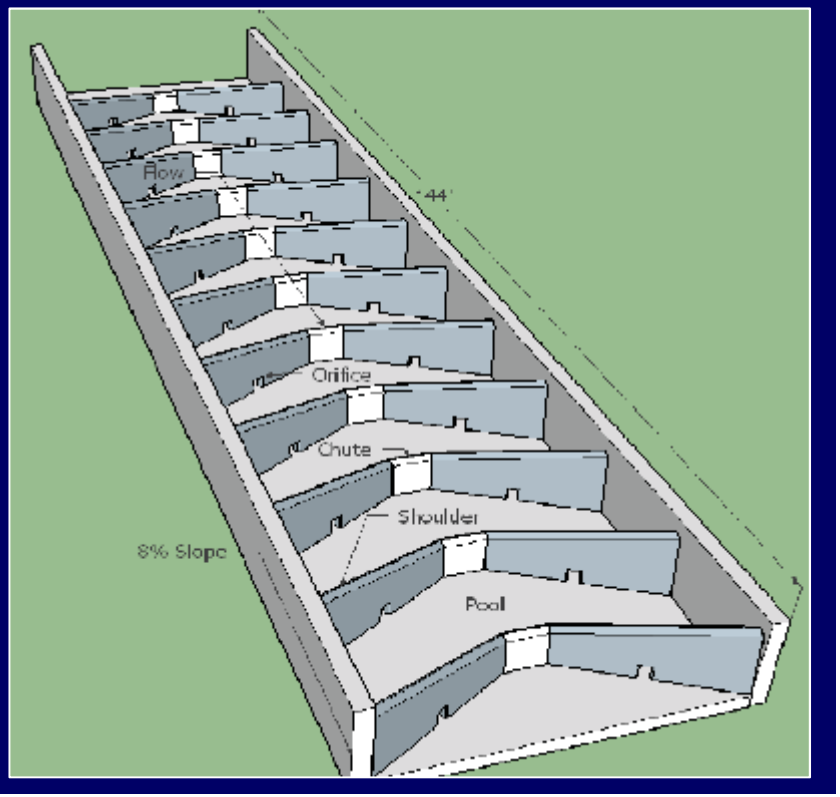
Prototype:

- Width = 30 feet
- Length = 144 feet
- Slope = 8%
- ***Overall Drop = 11 feet***

- No. Weirs = 11
- Drop per Weir = 1-foot
- Orifices (1.5'H x 1'W)

- Vortex Angle = 60 deg
- Center Width = 4 feet
- Shoulder Slope: 5H:1V



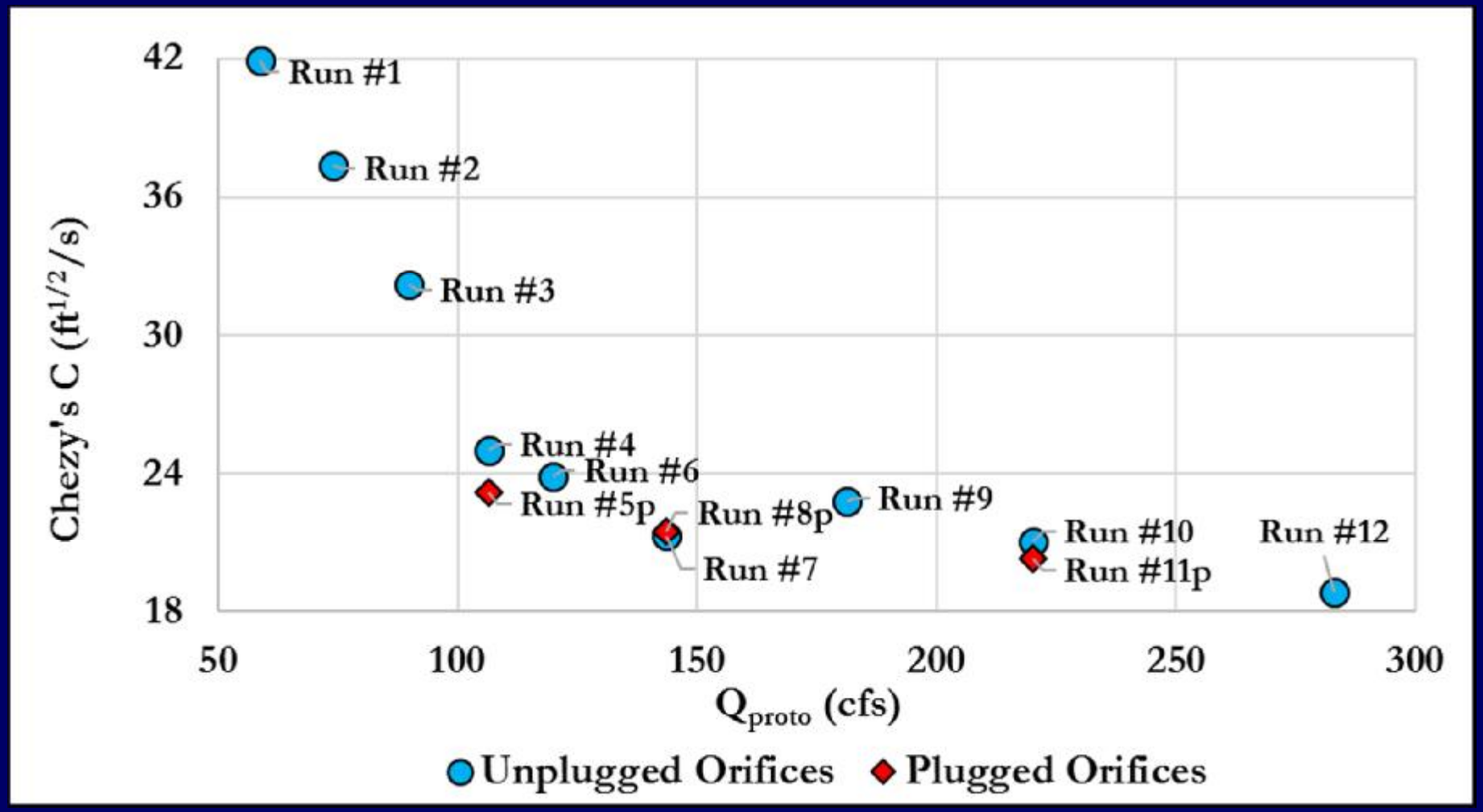


1:15 Scale Model of Vortex Pool and Chute Fishway

Humboldt State University Flume

Model hydraulics showed no limitations on fishway length or overall drop

Chezy Coefficient for Streaming Flow in Prototype Pool-and-Chute Fishway



Nyberg, Mathew, Brian Draeger, Brian Weekly, Eileen Cashman, Michael Love. 2016. Analysis of Vortex Pool-and-Chute Fishway. American Journal of Undergraduate Research. 13:4:37-57.

Conclusions

- Vortex weir shape provides less turbulent passage corridors along fishway edges than traditional style pool and chute fishways
  - Maintains low turbulence when shoulder is fully wetted
- At slopes up to 8 percent, no undesirable hydraulics formed with total drop up to 11 feet
- More research is needed for performance at steeper slopes

Acknowledgments

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