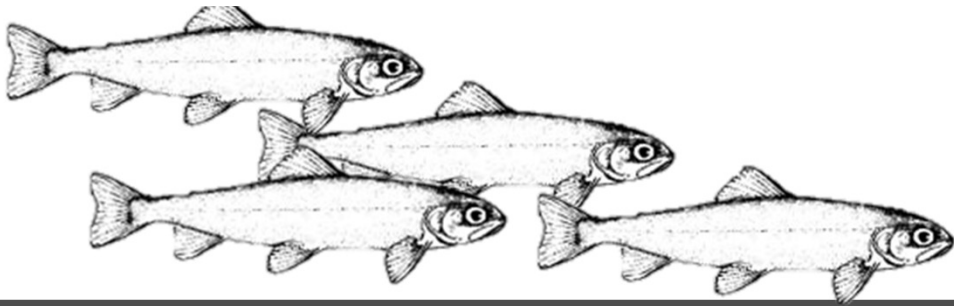




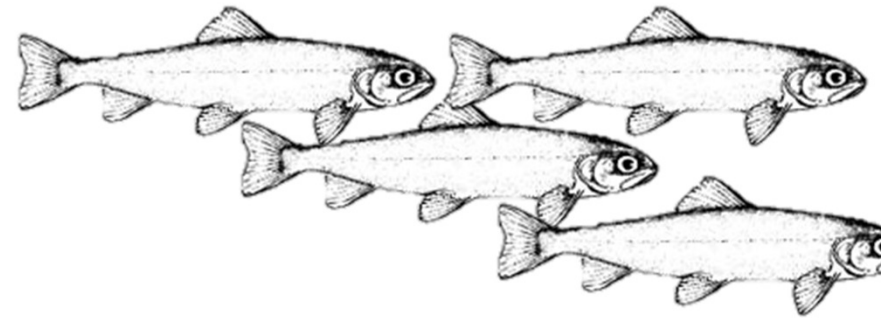
University of  
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## **Concurrent Sessions B: Case Studies of Passage at Dams - Innovative Fish Passage: A Cost-Effective Solution for High-Head Hydro**

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Authors	Greif, Ryan;Steimle, Kai;Brown, Richard
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# Innovative Fish Passage: A Cost-Effective Solution for High-Head Dams



Stephen Sullivan, PE  
Kai Steimle

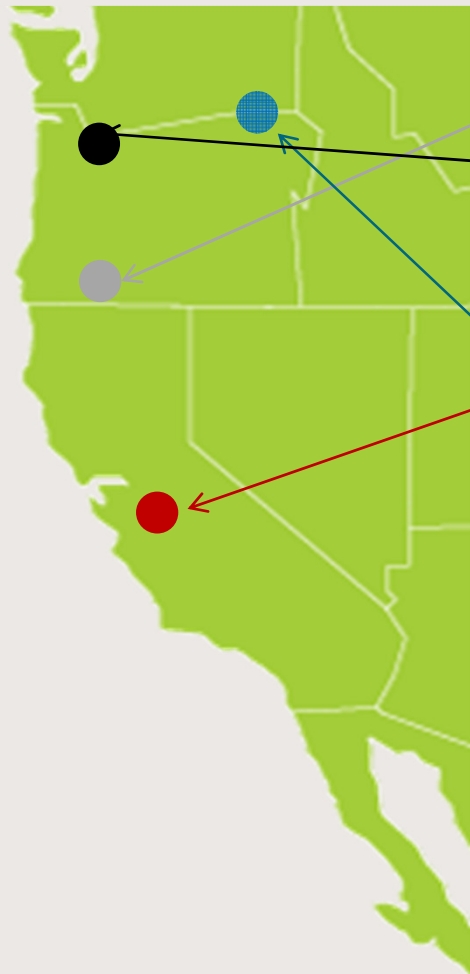
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# Acknowledgements



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Design by Mead & Hunt Inc.



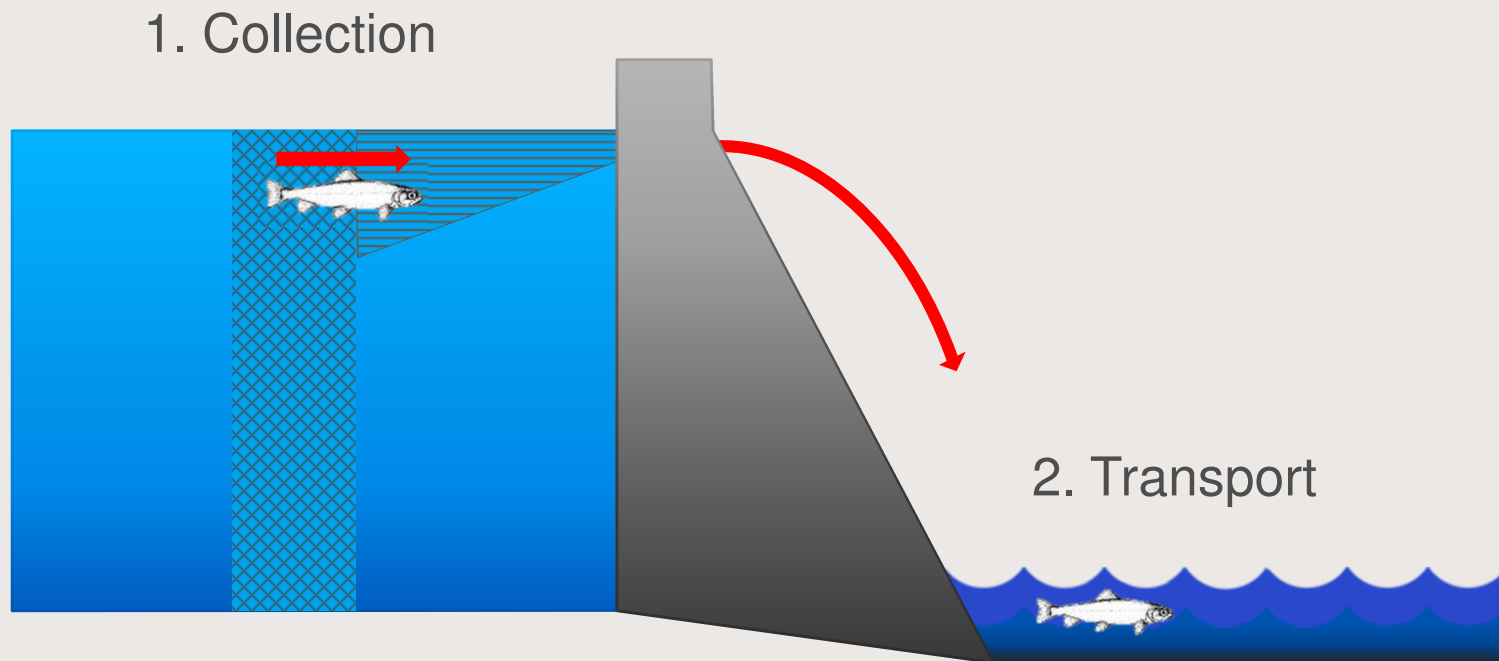
Fish pressure testing by Dr. Rich Brown at Battelle Labs

Review by the Applegate Fish Passage Technical Working Group with representatives from NMFS, ODFW, and USFWS



# Problem

- Downstream passage of juvenile fish
- How to dissipate energy?
- Control bypass flow and velocity?
- Prevent injury?

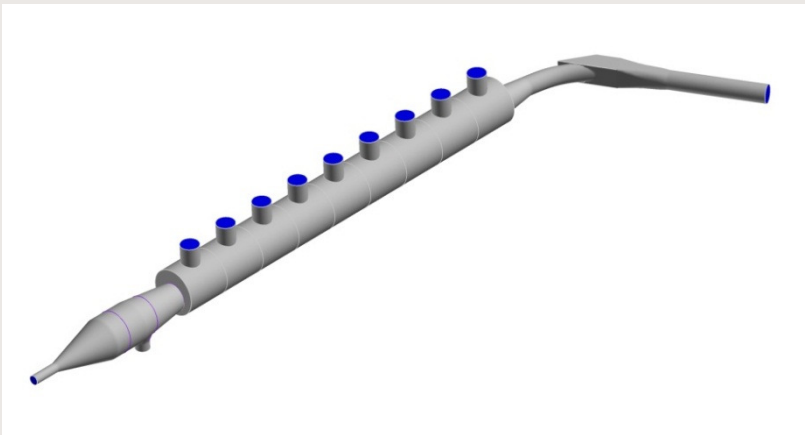


# Traditional Solutions

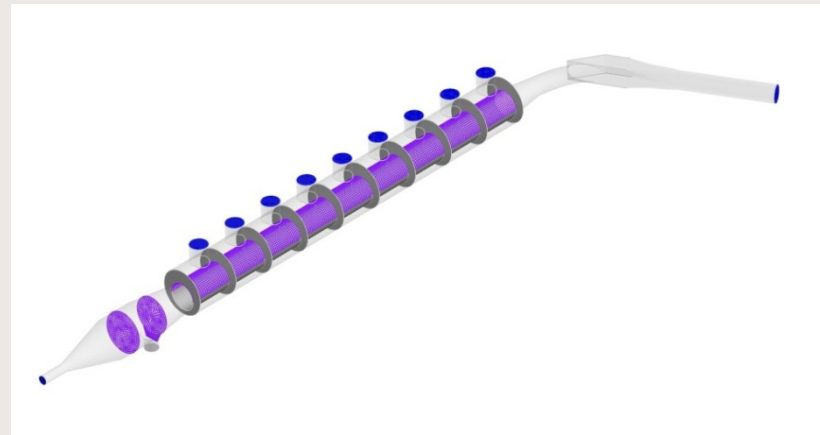


# Innovative Design

- Pressure vessel for fish collection and decompression
- Controlled decompression minimizes barotrauma
- Velocities within “fish-friendly” limits
- Precise bypass flow control
- Fish protected from valves by wedge-wire screens
- Patent-pending system

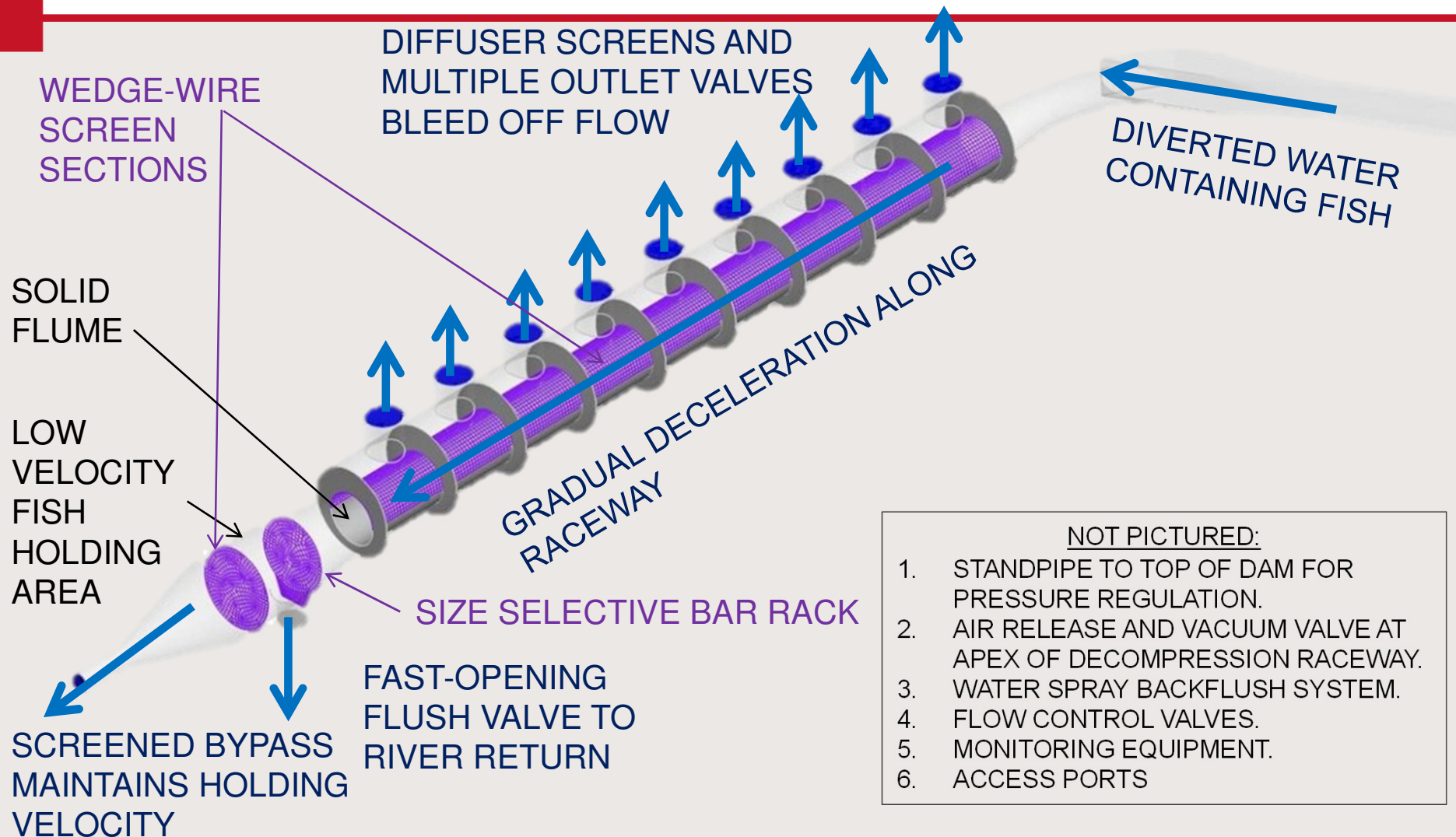


 Newhalen



Mead&Hunt

# Decompression Raceway

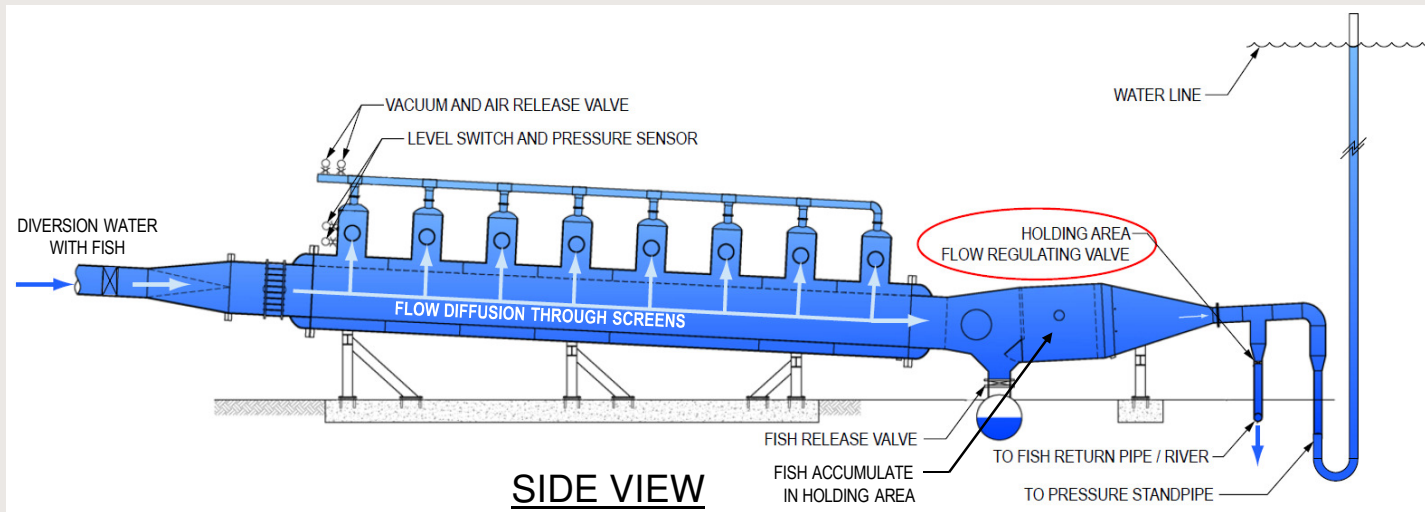


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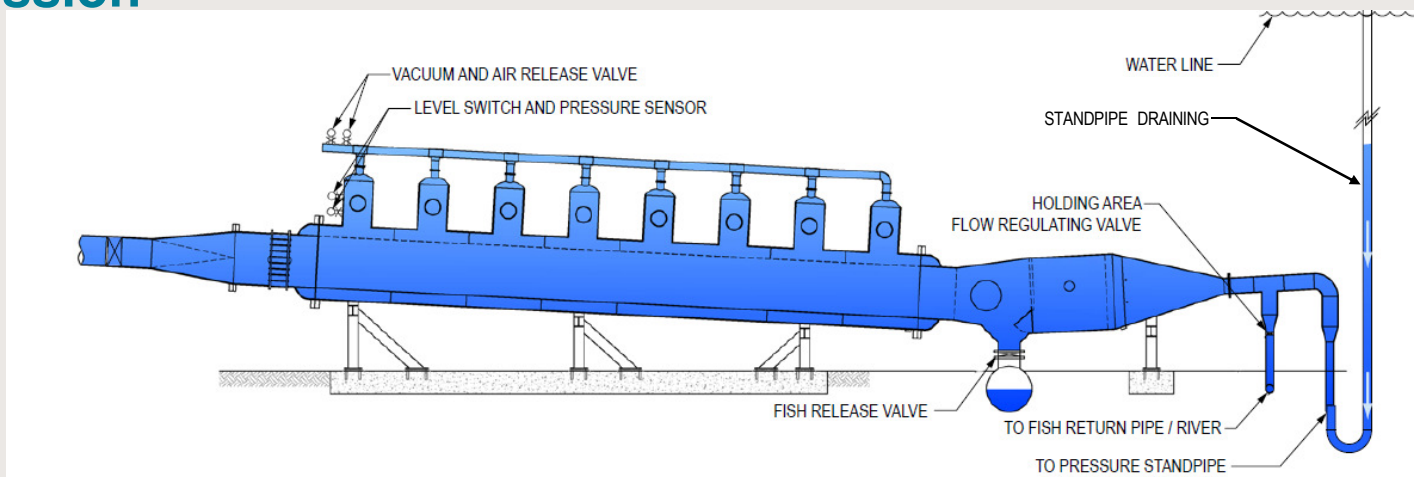
1. STANDPIPE TO TOP OF DAM FOR PRESSURE REGULATION.
2. AIR RELEASE AND VACUUM VALVE AT APEX OF DECOMPRESSION RACEWAY.
3. WATER SPRAY BACKFLUSH SYSTEM.
4. FLOW CONTROL VALVES.
5. MONITORING EQUIPMENT.
6. ACCESS PORTS

# Decompression Raceway Operation: Phases 1 & 2

## 1. Fishing

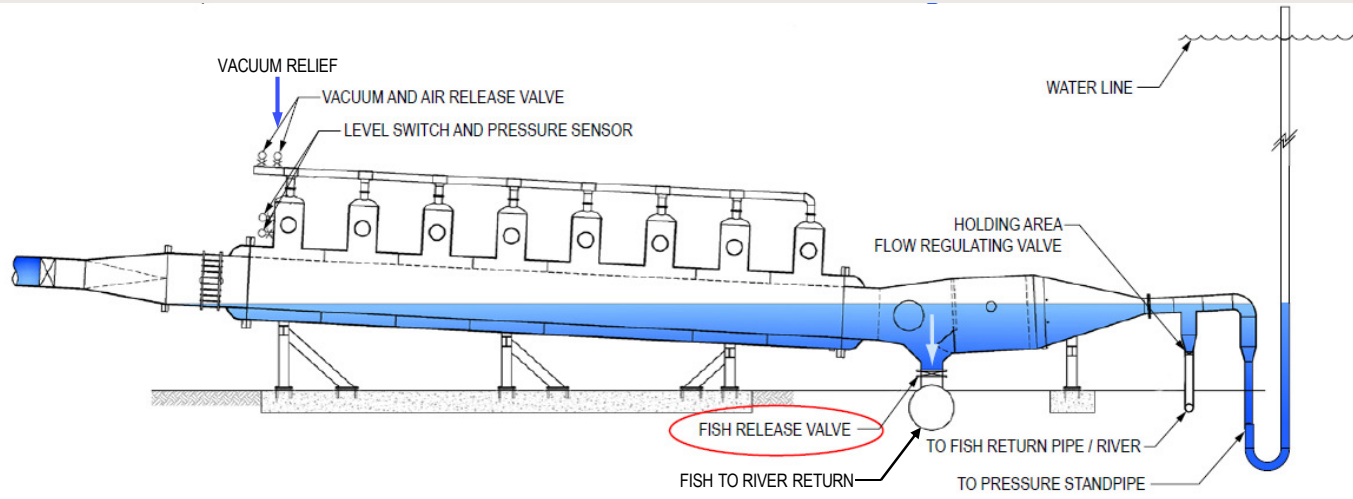


## 2. Decompression

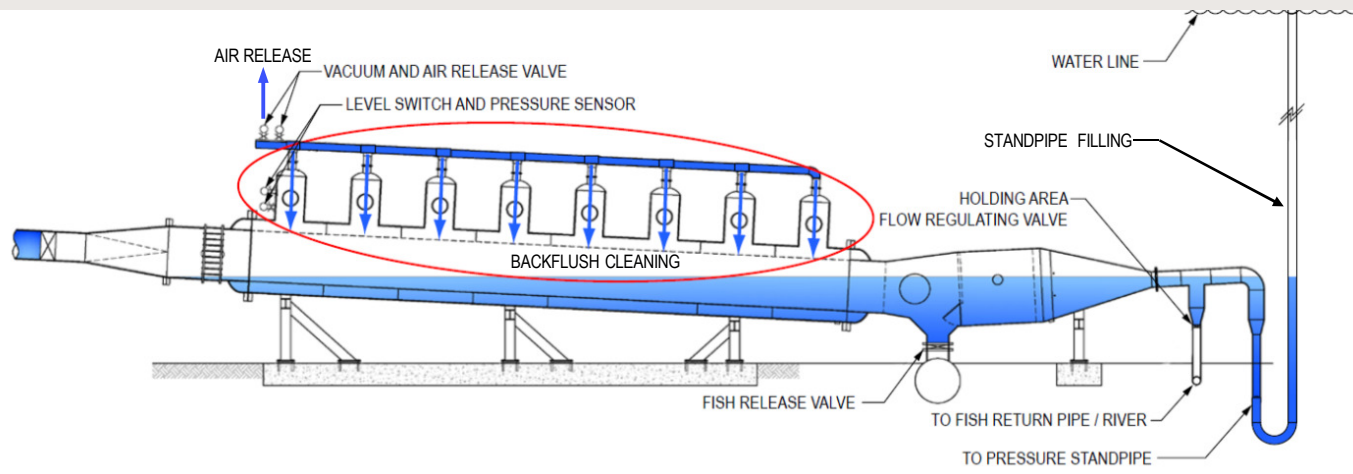


# Decompression Raceway Operation: Phases 3 & 4

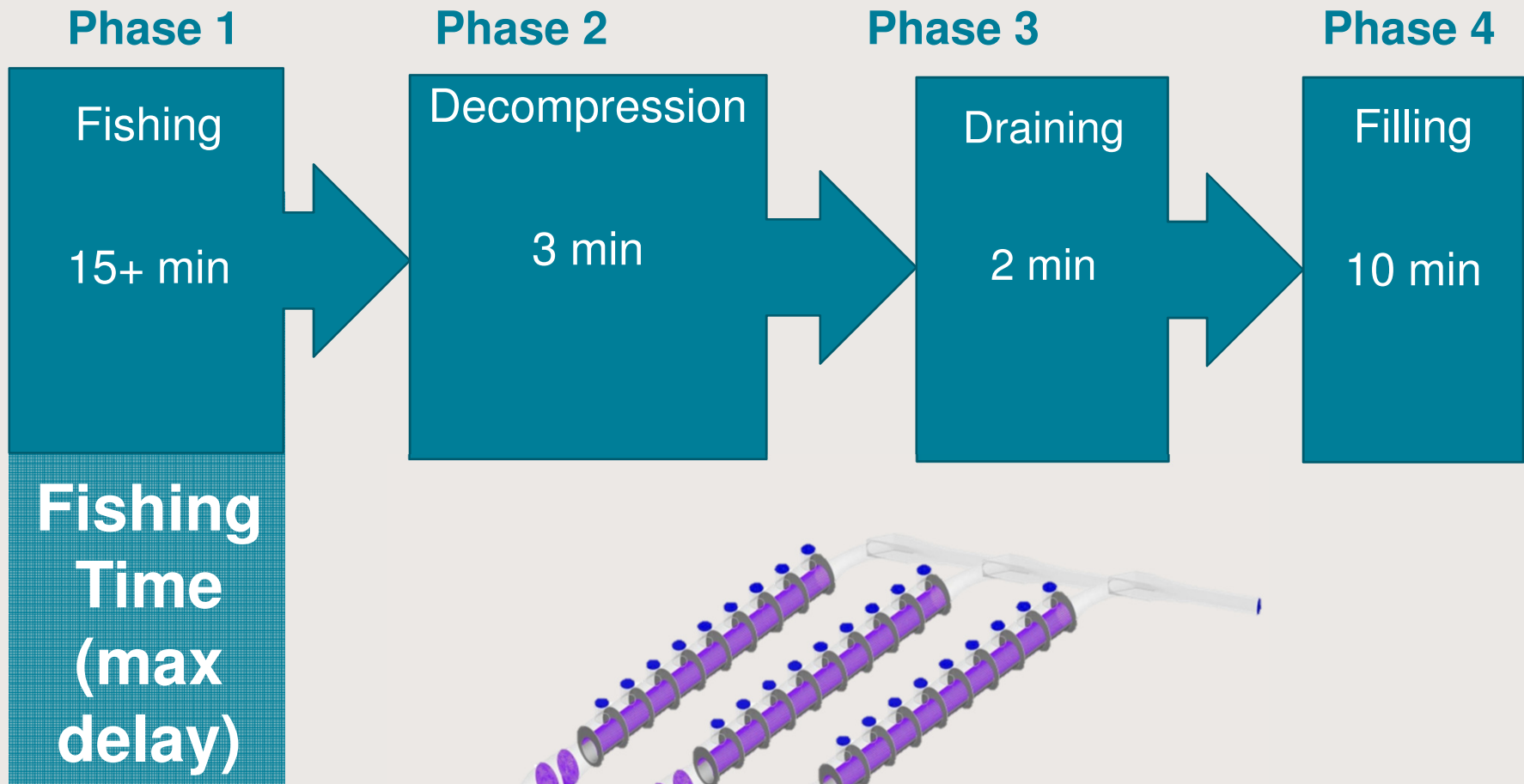
## 3. Draining



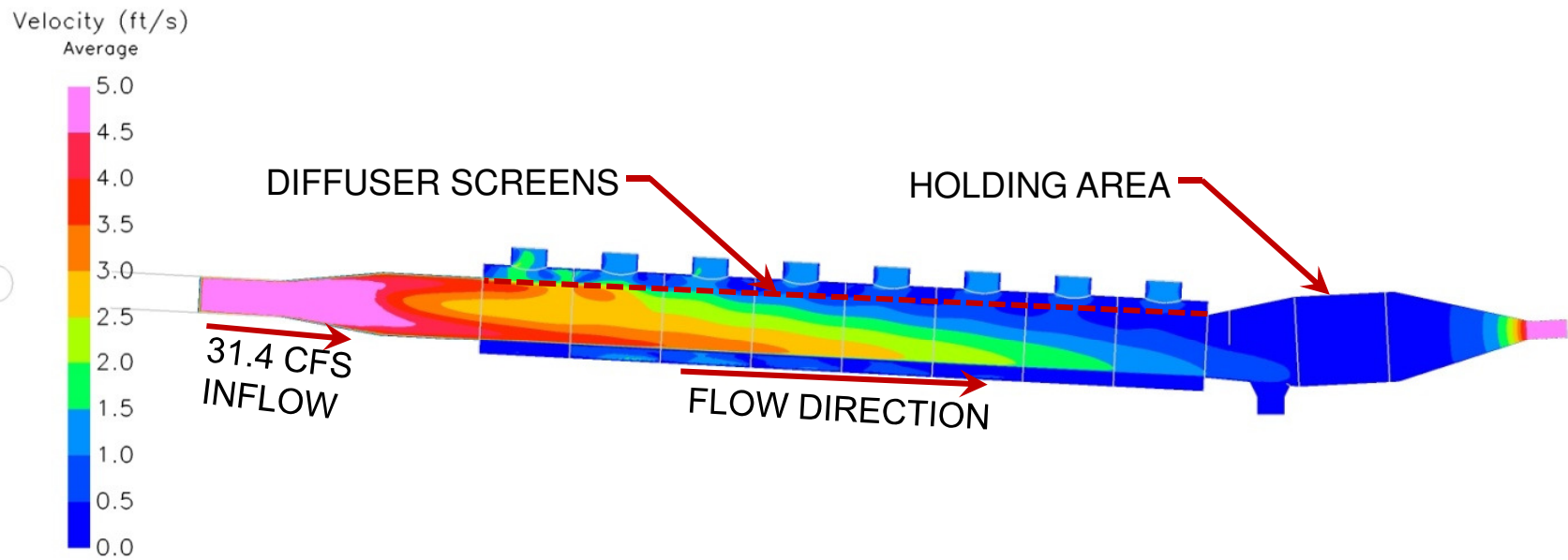
## 4. Filling



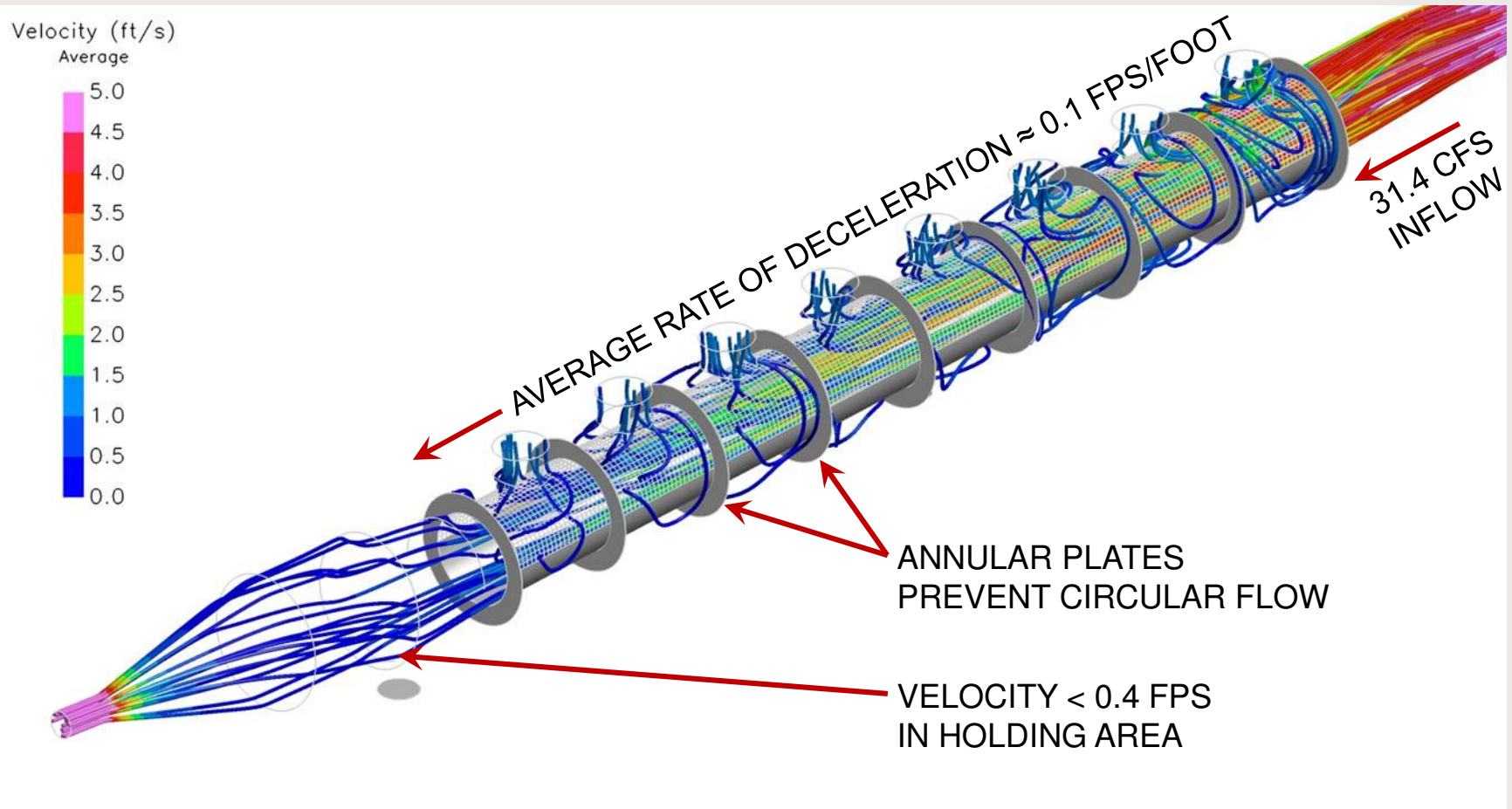
# Decompression Raceway Operation: Overview



# CFD Modeling

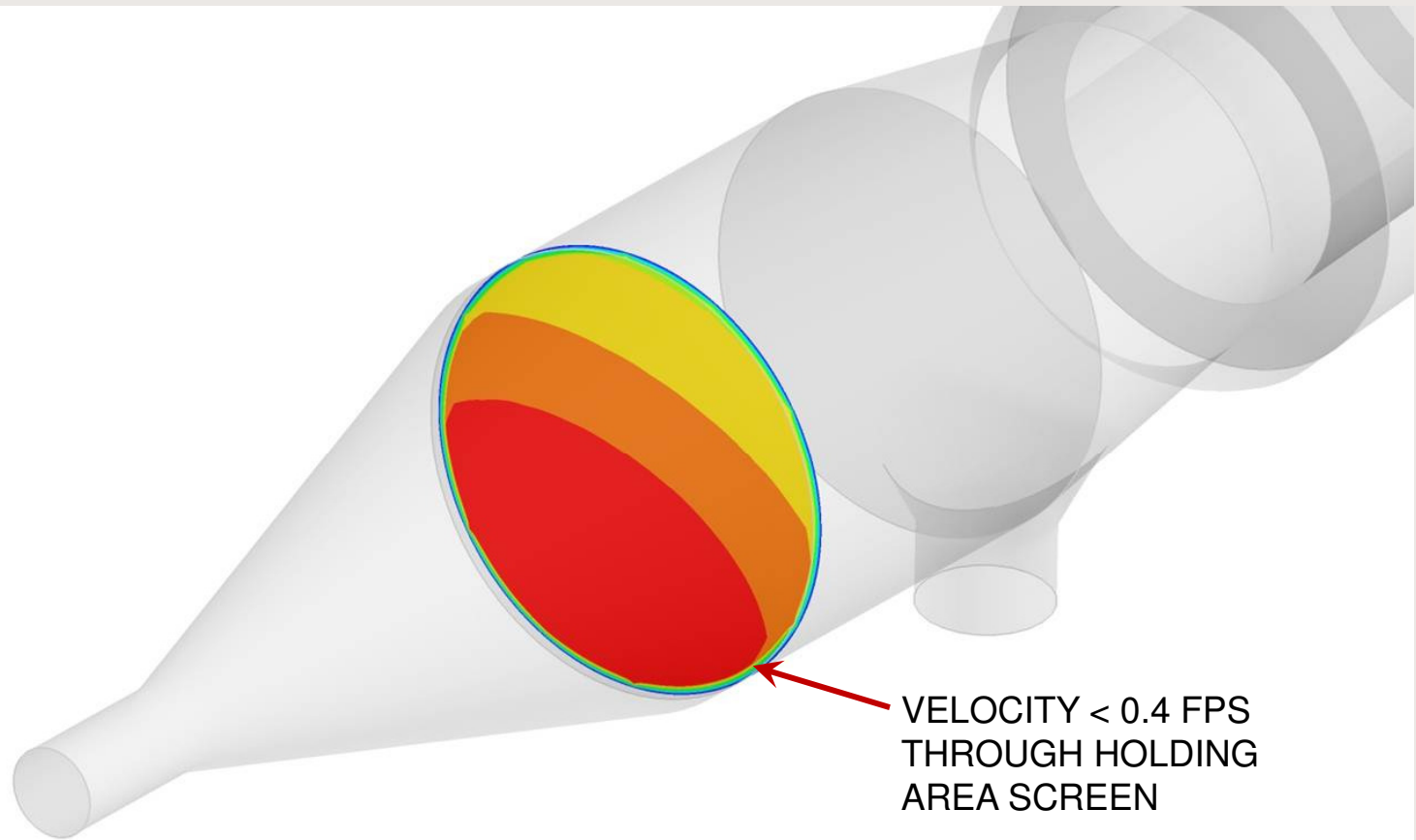
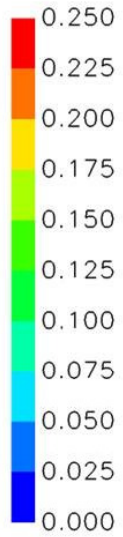


# CFD Modeling



# CFD Modeling

Velocity(ft/s)  
Normal component



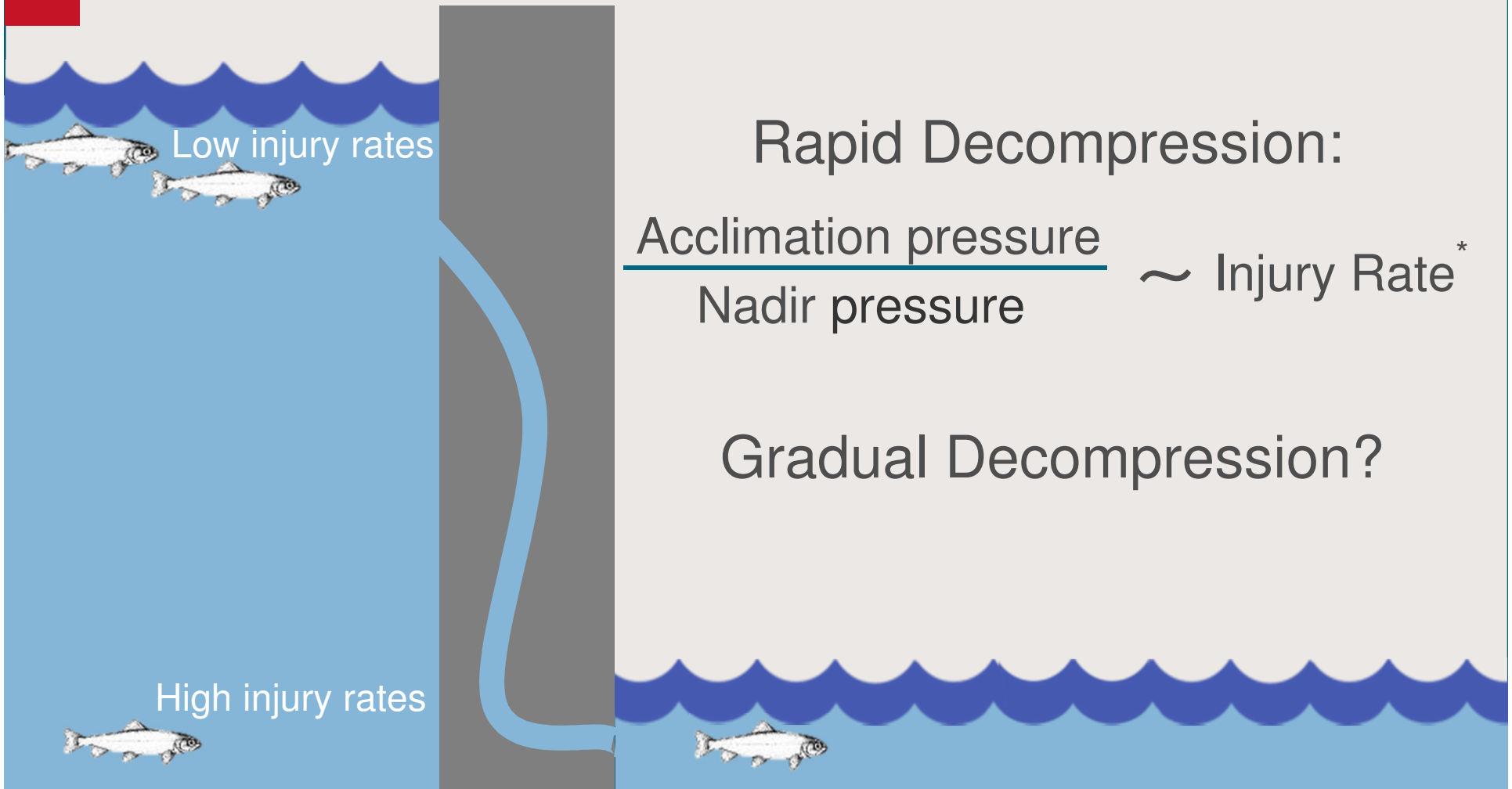
## CFD Modeling Results

- Uniform deceleration from 10 fps to less than 0.4 fps
- No flow separation or eddies
- Protective screen approach velocities

# Hyperbaric Pressure Tests



# Fish Testing: Barotrauma



# Hyperbaric Pressure Tests

- Conducted by Pacific Northwest National Laboratory (Battelle)
- Juvenile Chinook salmon and steelhead
- Pressures increased/decreased to simulate passage through system
- Site-specific scenario: acclimated to 24 psia
  - No injuries in 70 Chinook, 72 steelhead
- Worst-case scenario: acclimated to 90 psia
  - No injuries in 70 Chinook, 60<sup>th</sup> steelhead was injured
  - Decompression time increased from 1.7 to 3 minutes
  - No injuries in 72 additional steelhead

**Conclusion:** 3 minute decompression protective for fish acclimated to depths up to 200 feet

# Decompression Raceway Advantages

- Continuous passage with minimal delay
- Well-regulated bypass flow
- Passively adapts to variable reservoir levels
- Small facility footprint
- Possible cost savings
- Adaptable to different:
  - Dam heights
  - Intake designs
  - Screening or collection technologies
  - Fish evaluation or tag detection

# Discussion



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