Strategies for Hydraulically Balancing Intake Screens for Fish Protection

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MWH

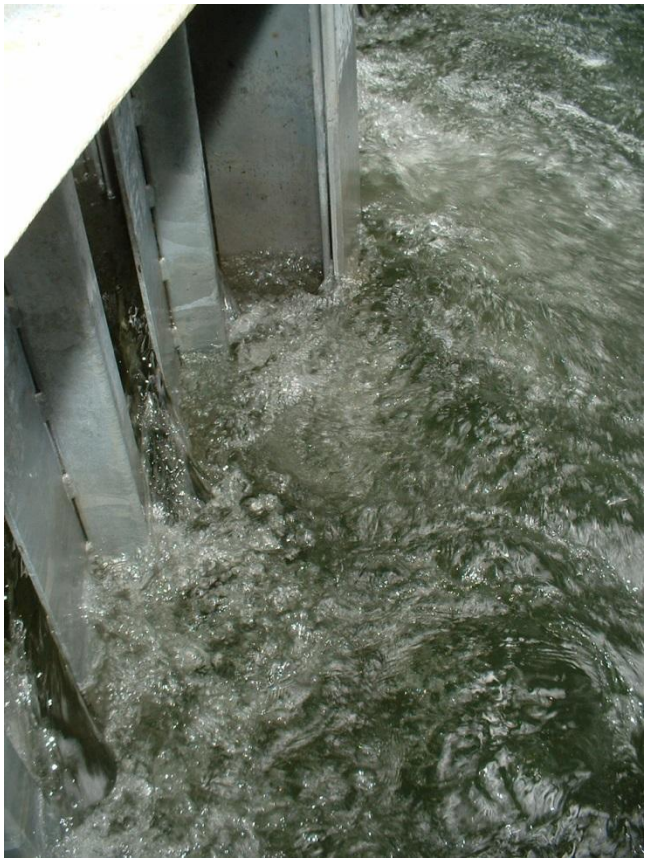
Overview

- Hydraulic balancing and how it is accomplished
- Agency Criteria and Guidelines
- Types of Baffling Systems
- Why Flow Control Baffling is Needed
- Common Issues with Design and Fabrication
- Project Example

Hydraulic Balancing

- Purpose = To Create uniform flow distribution along a series of intake screens.

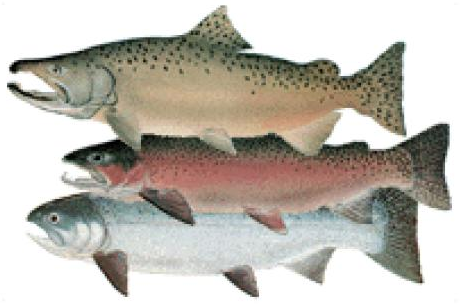
- How is this accomplished?
  - Increase head loss across the screens
  - Adjust Porosity



Regulatory Requirements

- In the Pacific Northwest, most river intakes require fish protection for anadromous fish such as salmon
  - Prevents fish impingement or entrapment

- NOAA's National Marine Fisheries Service (NMFS) is the primary regulatory agency
  - NMFS provides criteria and guidelines for design of fish passage facilities



Screen Design

- Many ways to screen, but for municipal facilities common screening configurations include:
  - Vertical or Inclined Screens
  - Rotating/Traveling Screens
  - Cylindrical Screens

Traveling Screen Courtesy International Water Screens

Cylindrical Screen Courtesy Cook Legacy Screens

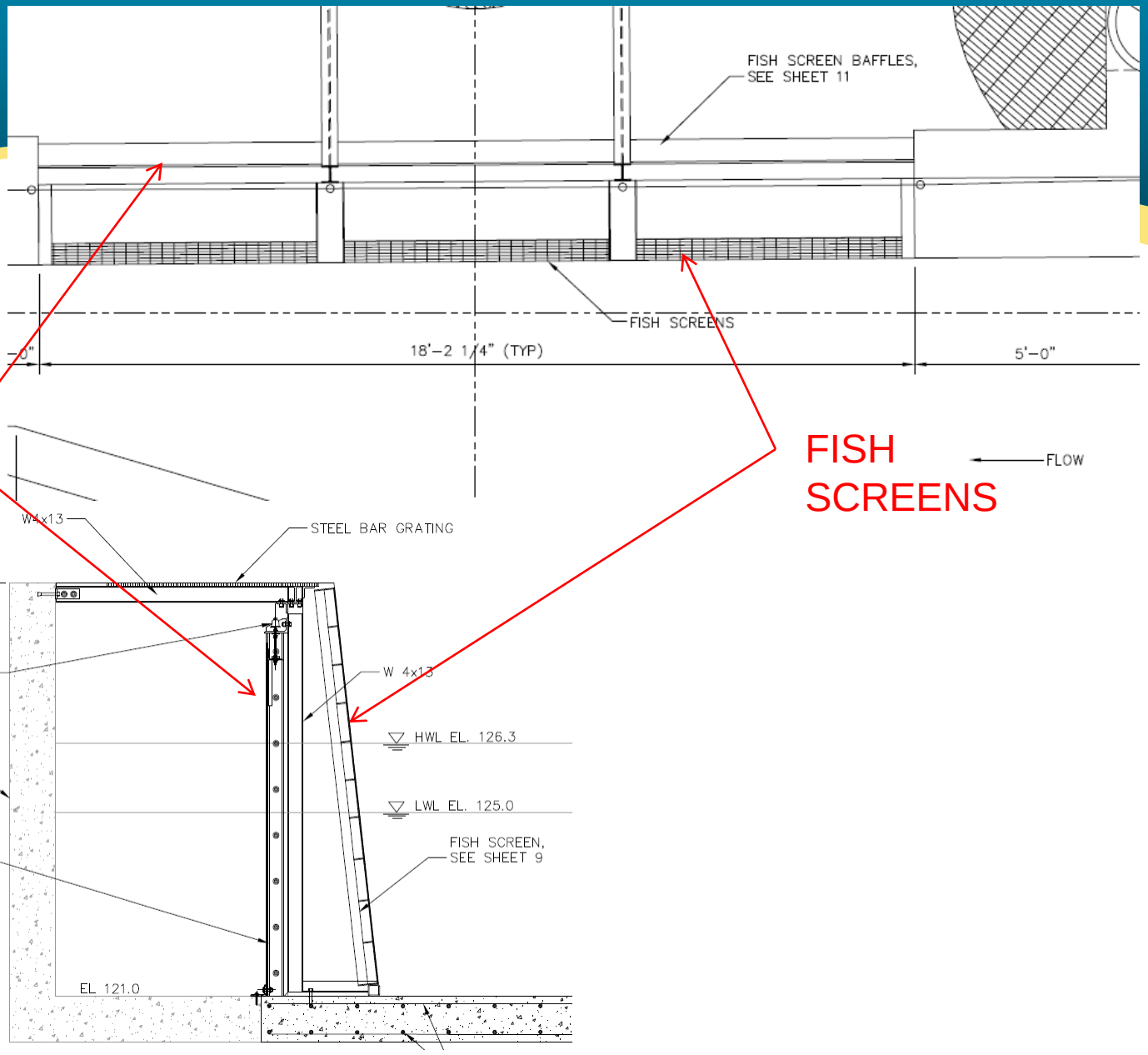
Vertical Screens along Logan River, UT

Screen Design

- NMFS provides design criteria for screen hydraulics includes:
  - Velocity (Sweeping and Approach)
    - 0.4 ft/s approach is most well-known
  - Effective Screen Area
  - Screen Submergence
  - Flow Distribution

Flow Distribution

- NMFS criteria reads, “the screen design must provide for nearly uniform flow distribution over the screen surface…”
- “Providing adjustable *porosity* control on the downstream side of the screens…may be required”
  - Porosity control = flow control baffles


FISH SCREEN BAFFLES,
SEE SHEET 11
FISH SCREENS
18'–2 1/4" (TYP)
5'–0"
FLOW CONTROL BAFFLES
FISH SCREENS
FLOW
W4x13
STEEL BAR GRATING
EL 130.0
BAFFLE ADJUSTMENT NUT
W 4x13
EXISTING CONCRETE RETAINING WALL
HWL EL. 126.3
LWL EL. 125.0
FISH SCREEN,
SEE SHEET 9
PERFORATED PLATE
FLOW CONTROL BAFFLES
SEE SHEET 11
EL 121.0

Why Uniform Flow Distribution?

1. Reduces fish injury
2. Reduces debris concentration at hot spots
   - Makes the screens easier to clean
   - Lowers risk of failure
3. Reduces required head loss across screens, therefore saving pumping costs or increasing generation potential

Flow Control Baffle Systems

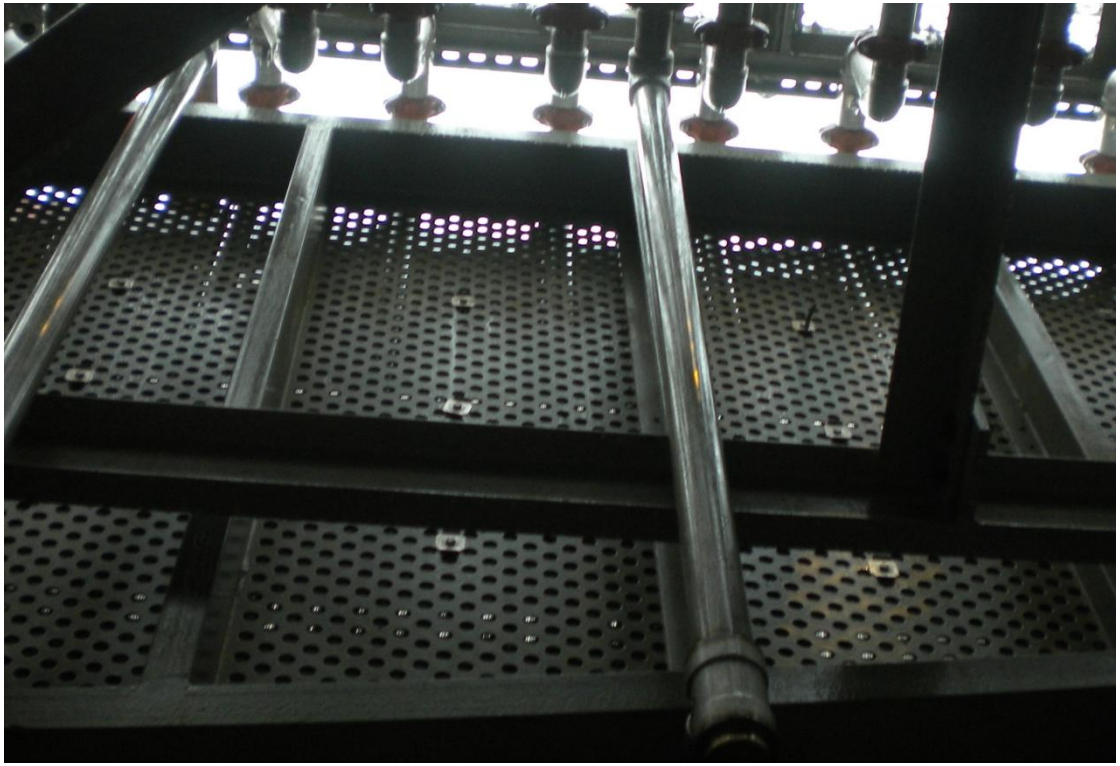
- Two primary types of baffling systems:
  1. Louvers

A Louver Adjustment System

Louver Baffles

Flow Control Baffle Systems

2. Perforated Plates
   - Fixed
   - Adjustable

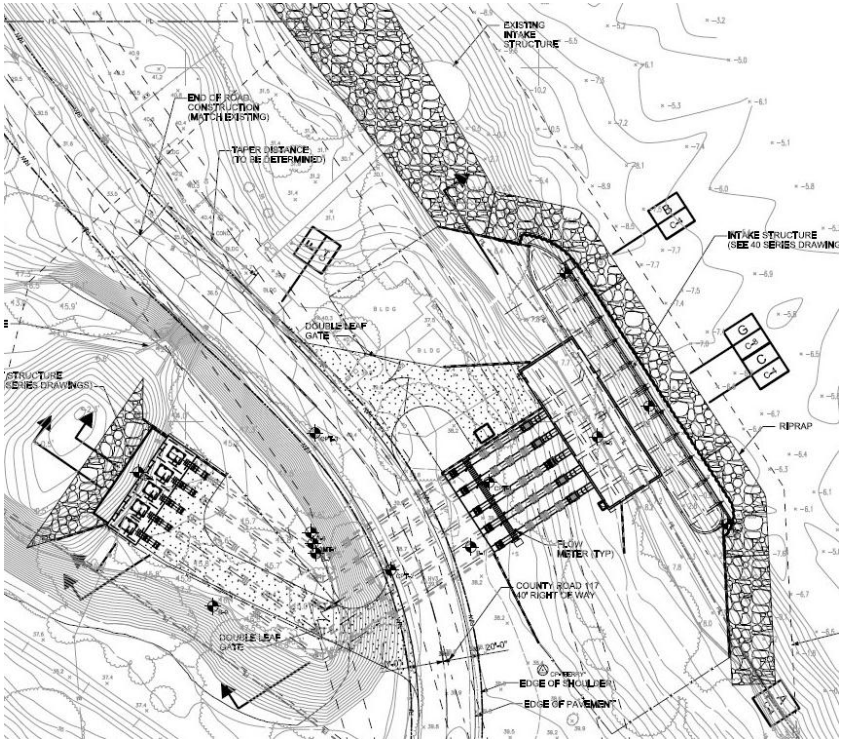


- More head loss = more uniform flow distribution

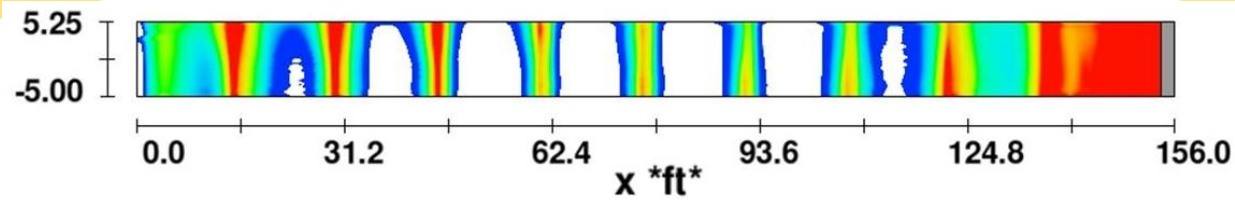
➢A challenge for many installations!

Why is Flow Baffling Needed?

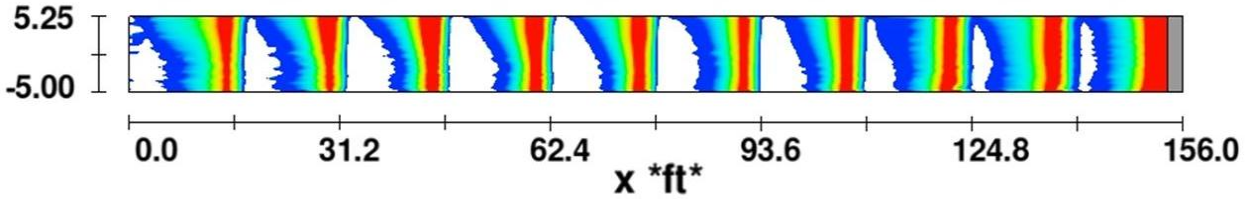
- Reclamation District 2035 fish screens (Woodland, CA) along Sacramento River
  - Installed a 400 cfs pumping station with fish screens and baffles
- During design, used CFD modeling to evaluate flow control baffling



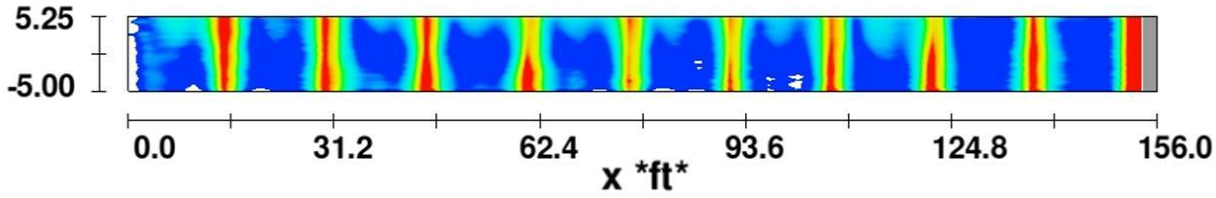
Fish Screen Flow Distribution



Case 1 – No Baffles



Case 2 – Baffles Wide Open



Case 3 – Baffles In Variable Positions

Color Scale: 0.0 ft/s (blue) to 0.33 ft/s (red), White = Greater than 20% above OAV

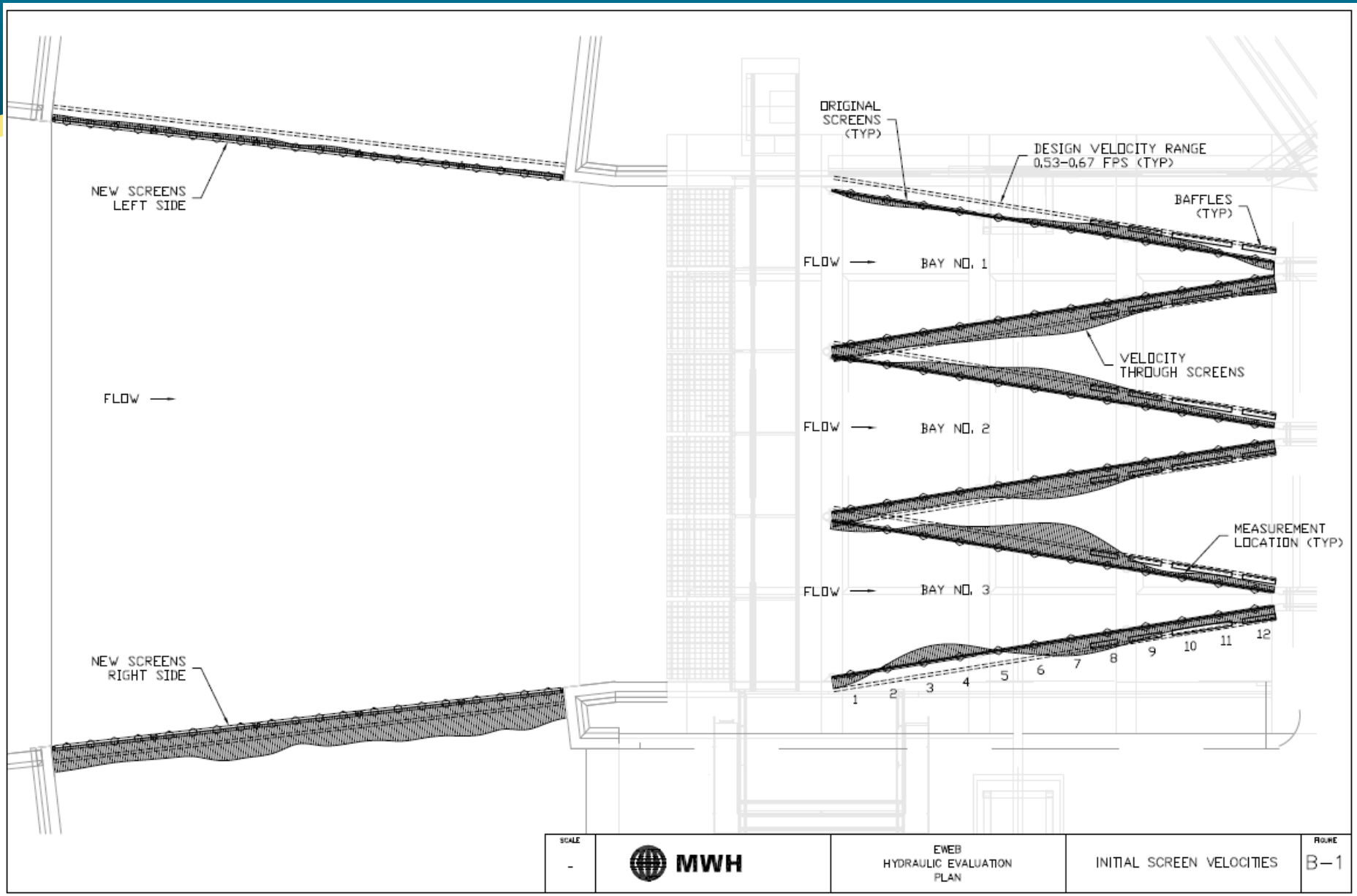
WhyFlow Baffling is Necessary

- Hydraulic Evaluation at Leaburg Dam Fish Screens – Spring 2009
- Owner: Eugene Water & Electric Board (Eugene, OR)

Facility Facts:

- 2,500 cfs Capacity
- 4,675 SF Total Screen Area

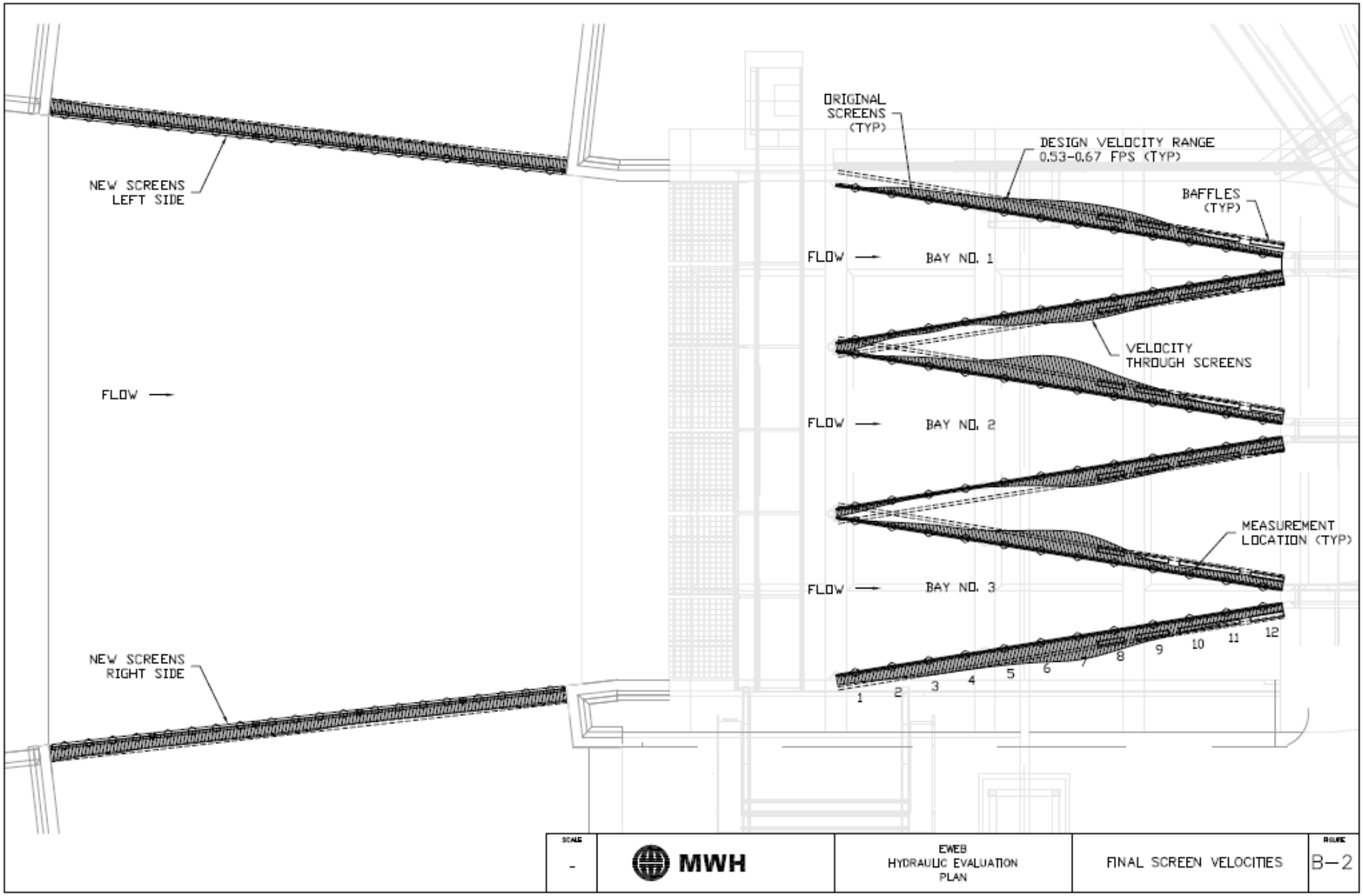
Leaburg Hydraulic Evaluation



Leaburg Hydraulic Evaluation

- What we did:
  1. Field Measurements of screen approach velocities
  2. Adjusted baffles to create more uniform flow distribution
  3. Iterated until screens achieved NMFS guidelines for the facility

Leaburg Hydraulic Evaluation



Flow Control Baffling: What can go Wrong?

- Common issues with flow baffling systems:
  - Operation:
    - Leakage around, above, or below the baffles
    - Leakage between perforations (in sliding plates)
  - Maintenance:
    - Difficult to access
    - Difficult to adjust or not adjustable

Common Issues

Fabrication

Holes do not align

Common Issues

Warped Perforated Plates

Common Issues

- Leakage around baffles can cause hot spots!

Design Recommendations

- Ensure that all flow paths above, below, or around the baffles are closed off.
- Consider specifying tight fabrication tolerances.
  - A shop inspection can be extremely helpful.
  - Need to follow up to insure tolerances are achieved!
- Consider how the baffles will be adjusted
  - NMFS requires a hydraulic evaluation for most installations
  - Saves the client time and money

Project Example

- Lower Baker Floating Surface Collector
  - Owner: Puget Sound Energy

  - Location: Concrete, WA
  - 500/1000 cfs capacity downstream passage facility
  - Construction Completed: March 2013
  - Contractor: Skanska USA

Lower Baker FSC

- Facility Details
  - 1,700 SF (approx) Total Screen Area, including vertical screens and horizontal floor screens
  - Flow can switch automatically between 500 and 1,000 cfs
  - Fish are captured and hauled by boat to the shore for transport downstream of the dam.

Lower Baker FSC

- Perforated Plate flow control baffles
  - Fixed: Stainless Steel
  - Sliding: Steel or UHMW PE (Ultra-High Molecular Weight Polyethylene)
    - UHMW used to conform to the shape of the fixed plate once under pressure
- Rectangular perforations
  - To provide linear adjustability during the hydraulic evaluation

A baffle set up in the Shop

Lower Baker FSC

Sliding Plates in their Guides

Painted Steel Baffles - Consider materials of Construction!

Lower Baker FSC

- Pneumatic cylinders are used to drive the baffle openings between two set points
  - Automatically switches the baffle configuration when the facility flow switches from 500 to 1,000 cfs

Summary

- Selection of a flow control baffling method requires consideration of:
  - Available Head
  - Materials of Construction
  - Access and Ease of Adjustment
- For good practice, carefully consider
  - Leakage paths around the baffles
  - Fabrication tolerances to improve final product

Questions