

Jun 20th, 5:00 PM - 5:15 PM

# Pushing and Pulling II: Survey of Two Behavioral Fish Guidance Systems (FGSs) Designed to Improve Safe Downstream Passage of Anadromous Salmonids

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**Survey of Two Behavioral  
*Fish Guidance Systems (FGSs)*  
Designed to Improve Safe  
Downstream Passage of  
Anadromous Salmonids**

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# Juvenile Fish Passage Behavior

**In general, juvenile anadromous salmonids and clupeids (herrings and shads):**

- **Follow bulk flow in the river thalweg**
- **Are surface oriented**
- **Cue on flow and turbulence**
- **May respond to changes in water quality**

**Migratory cues are disrupted in reservoirs**

# Problem

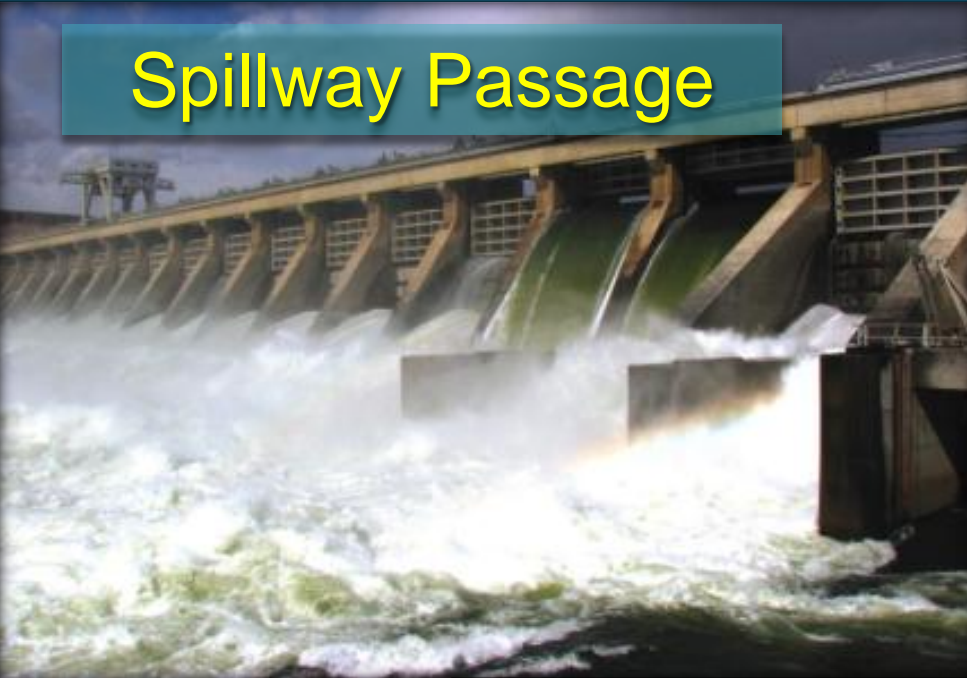
An aerial photograph of a dam structure. The dam is a long, narrow concrete wall with a spillway on the left side. To the right of the dam is a large reservoir of dark water. The surrounding landscape is a mix of brown, dry earth and some green vegetation. The sky is clear and blue.

How to get downstream migrants safely past a dam or intake???

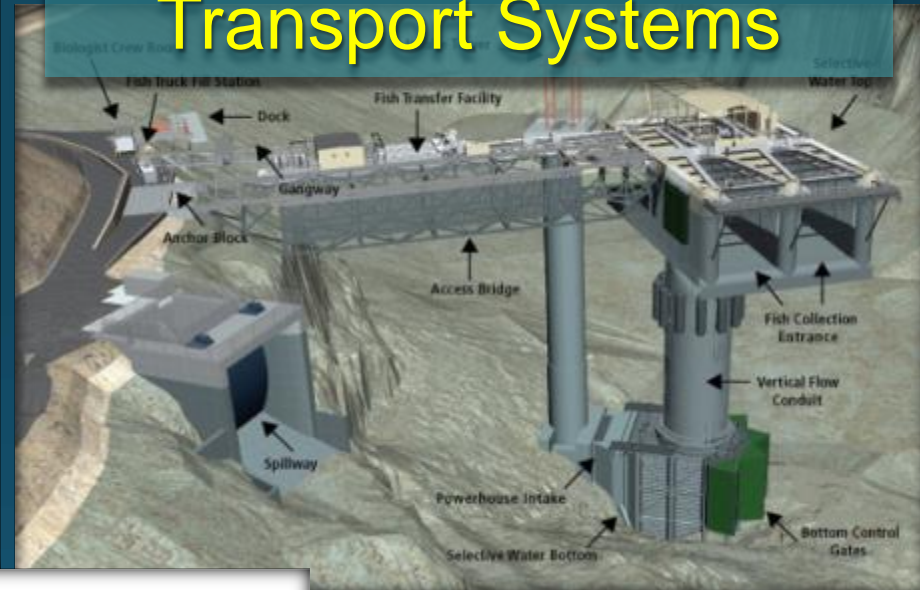


# Physical Bypass Systems

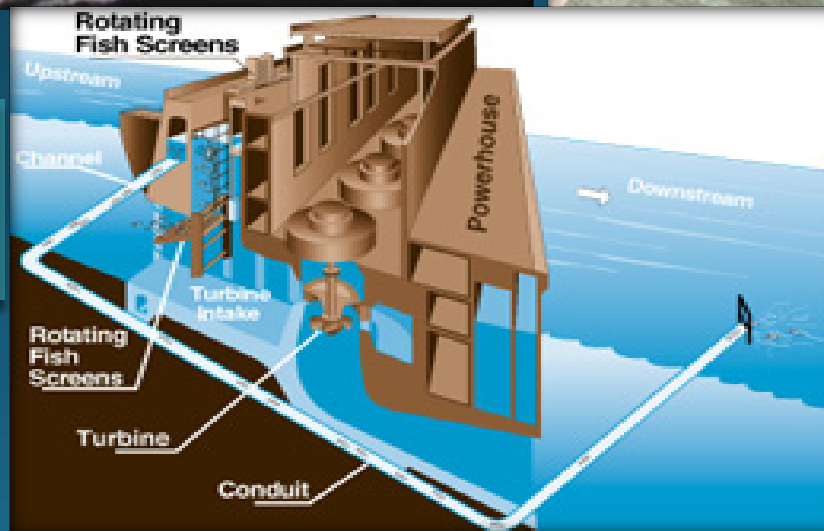
## Spillway Passage



## Collection and Transport Systems



## Turbine Passage



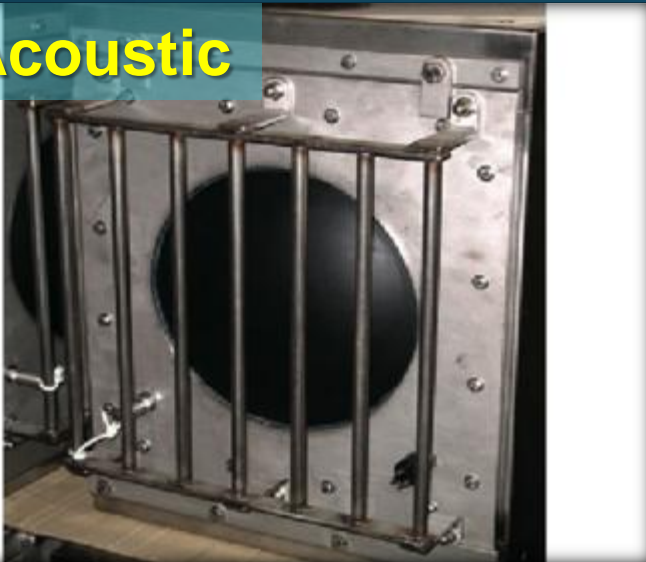
## Screened Intake and Bypass

# Non-Physical Guidance

Lights



Acoustic



Bubble Curtains





# Fish Guidance System (FGS)

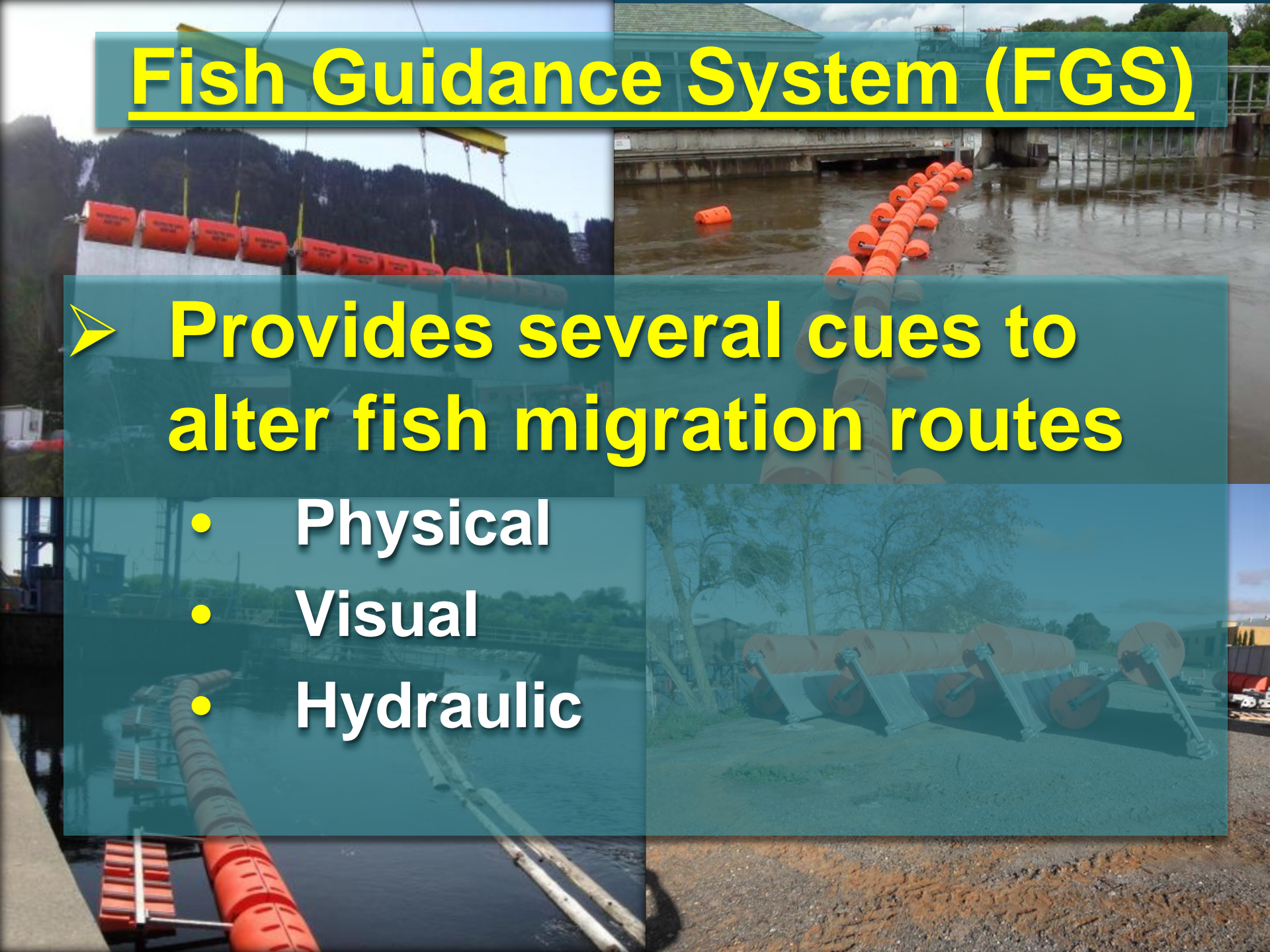




# Fish Guidance System (FGS)

➤ Provides several cues to alter fish migration routes

- Physical
- Visual
- Hydraulic





# Forebay Hydraulics and Fish Behavior

Spillway →

Powerhouse →

Image U.S. Geological Survey

©2010 Google

# Forebay Hydraulics and Fish Behavior

Spillway →

Powerhouse →

Bulk Flow ←

Image U.S. Geological Survey

©2010 Google



# Forebay Hydraulics and Fish Behavior

Spillway →

Powerhouse →

Intermediate  
Zone

Bulk  
Flow

Image U.S. Geological Survey

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# Forebay Hydraulics and Fish Behavior

Nearfield Zone

Intermediate Zone

Bulk Flow

Spillway →

Spillway Flownet

Powerhouse →

Turbine Flownet

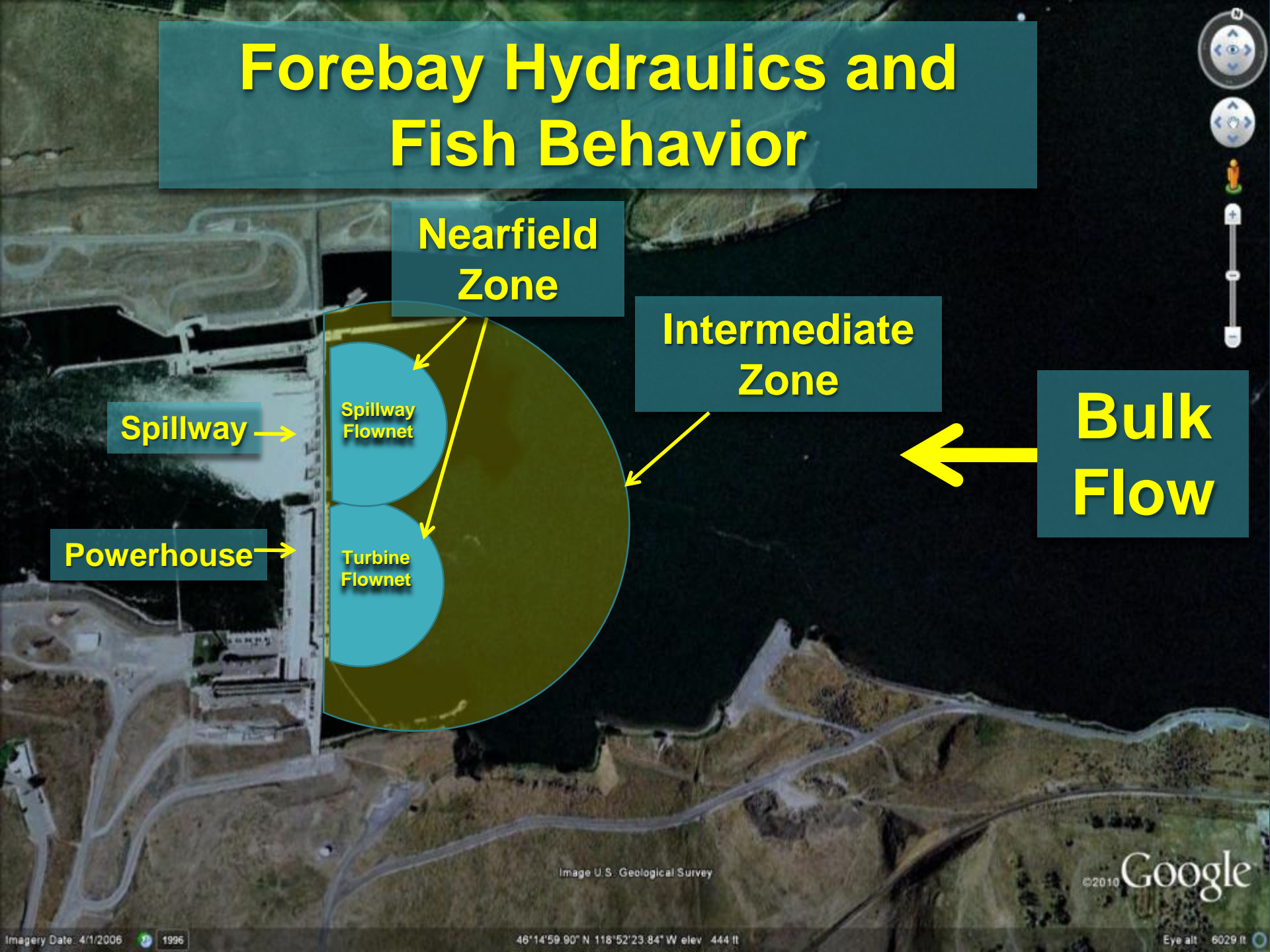


Image U.S. Geological Survey

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# Forebay Hydraulics and Fish Behavior

Nearfield Zone

Intermediate Zone

Bulk Flow

Spillway

Spillway Flownet

Powerhouse

Turbine Flownet

Zone of Separation

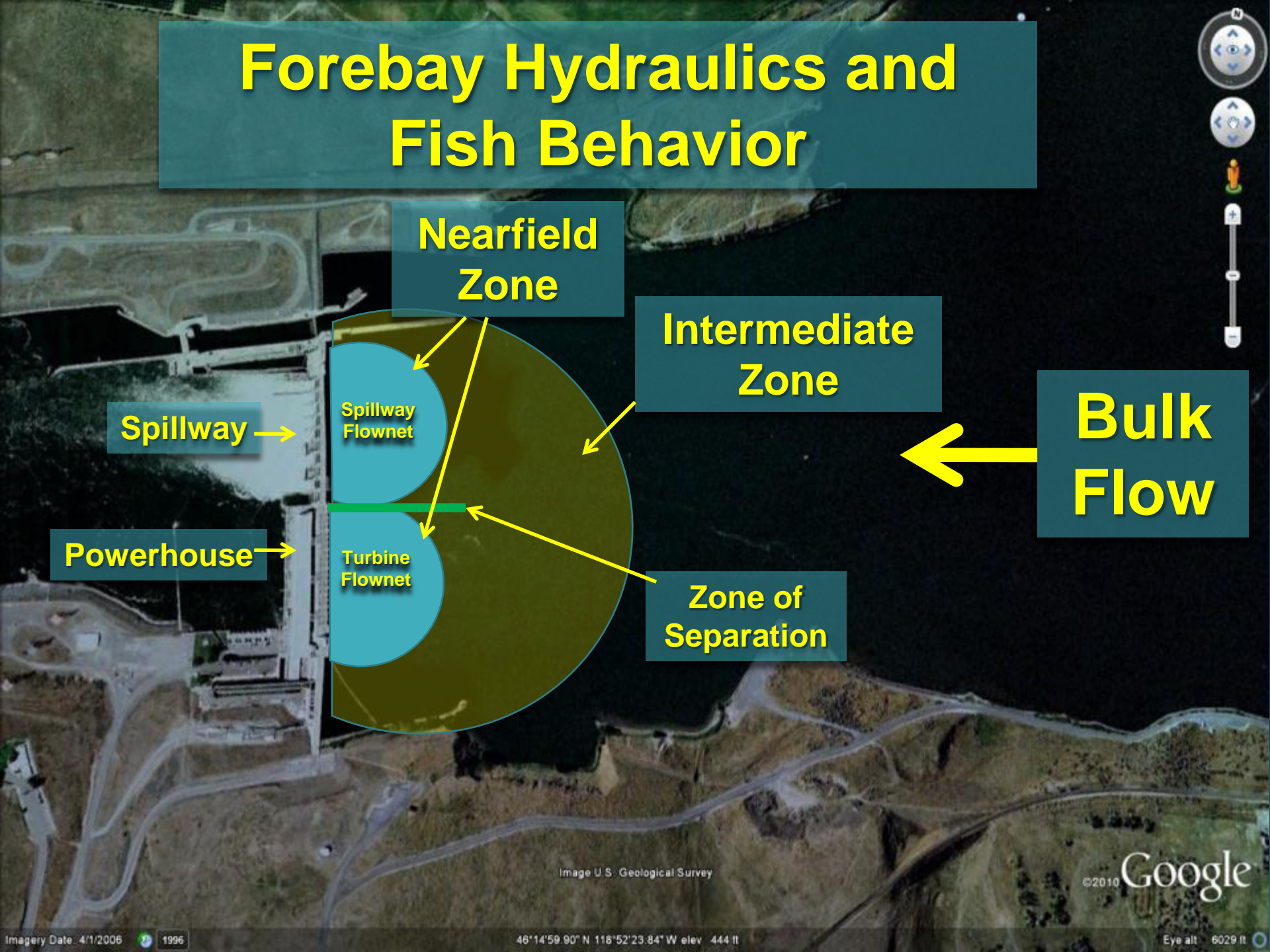


Image U.S. Geological Survey

©2010 Google



# Forebay Hydraulics and Fish Behavior

Nearfield Zone

Intermediate Zone

Bulk Flow

Spillway →

Spillway Flownet

Powerhouse →

Turbine Flownet

Zone of Separation

Fish Guidance System

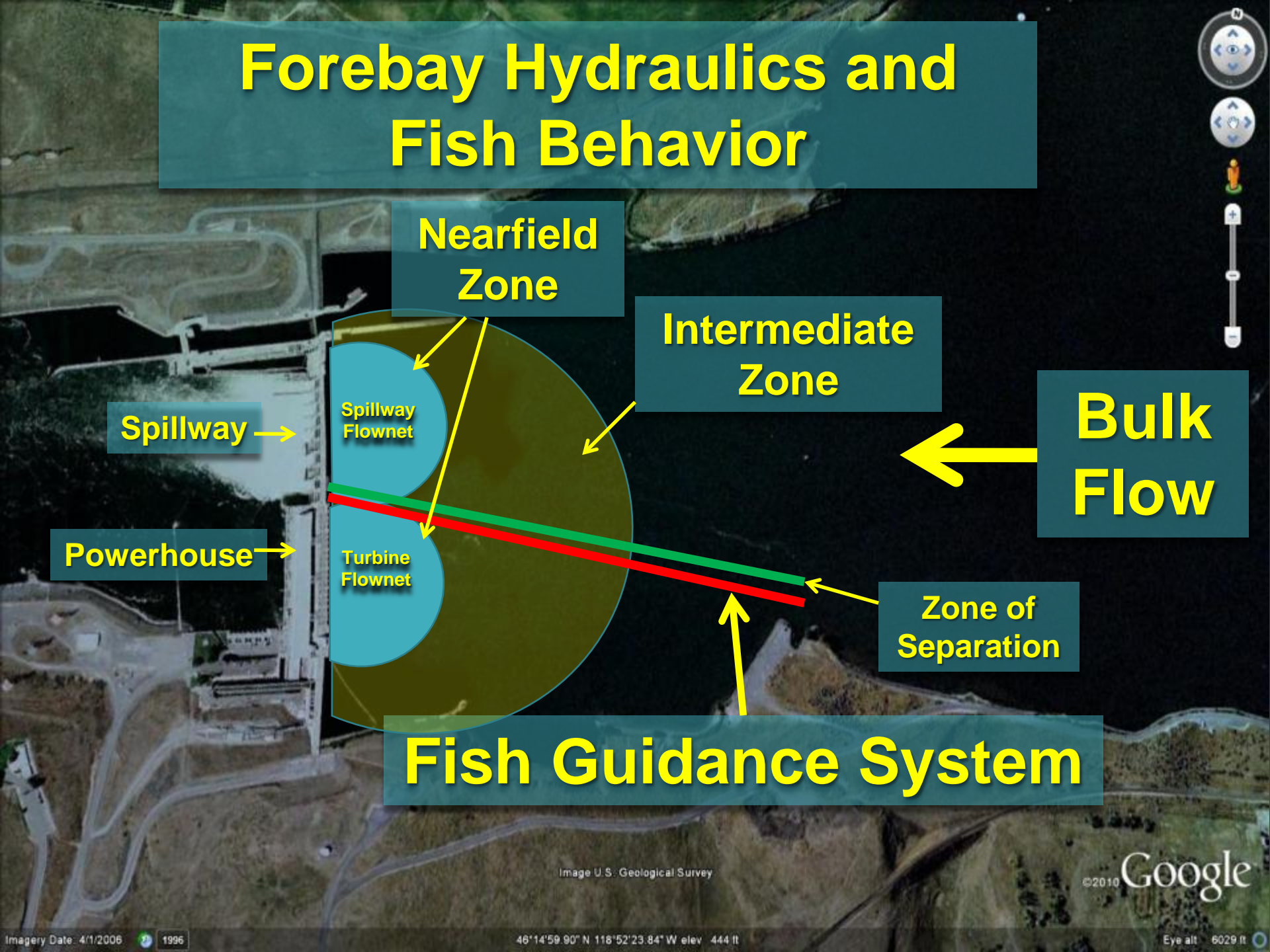
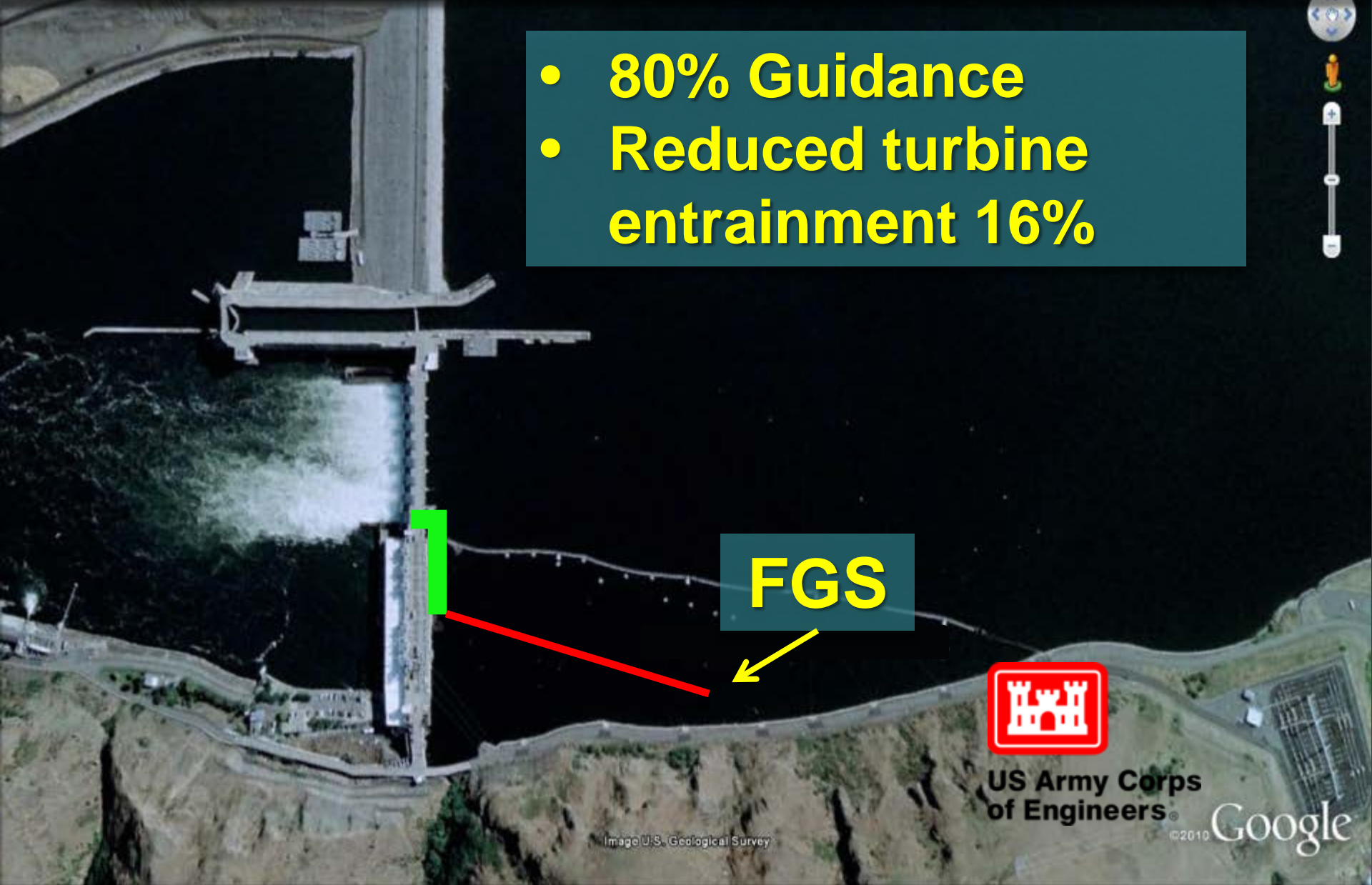


Image U.S. Geological Survey

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# Lower Granite Dam FGS Results

- 80% Guidance
- Reduced turbine entrainment 16%



**FGS**



**US Army Corps of Engineers**

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# Bonneville Dam, Powerhouse 2 Fish Guidance System

Powerhouse



US Army Corps  
of Engineers

Juvenile  
Bypass  
Channel

Fish  
Guidance  
System

© 2011 Google  
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Image © 2011 GeoEye

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# FGS Results



US Army Corps  
of Engineers®

- **15% guidance improvement for juvenile spring chinook passage**
- **Guided fish entered the bypass at 2 times the rate of unguided fish**

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Imagery ©2011 GeoEye



# FGS Installations



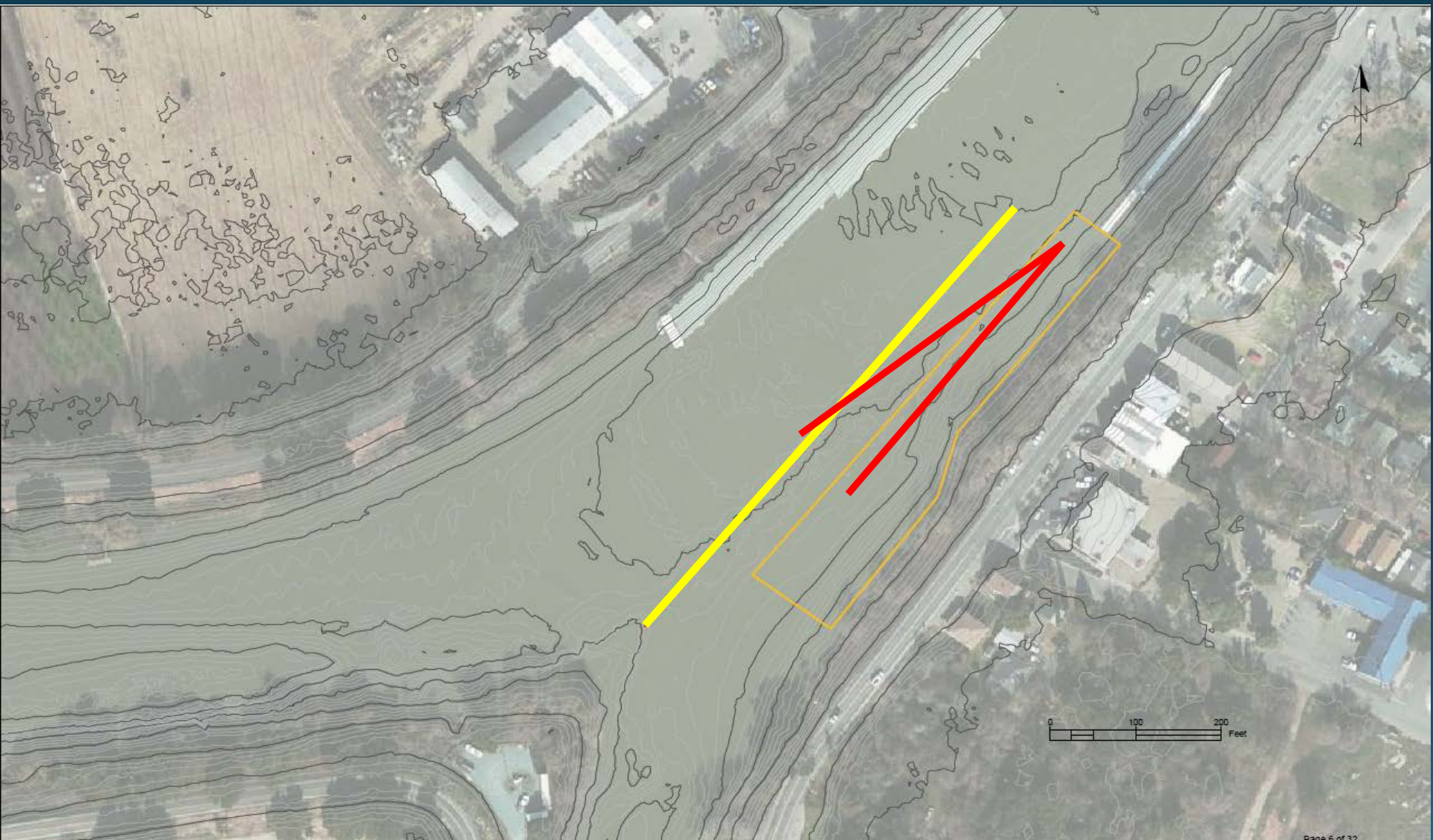


# Georgiana Slough Sacramento River, CA



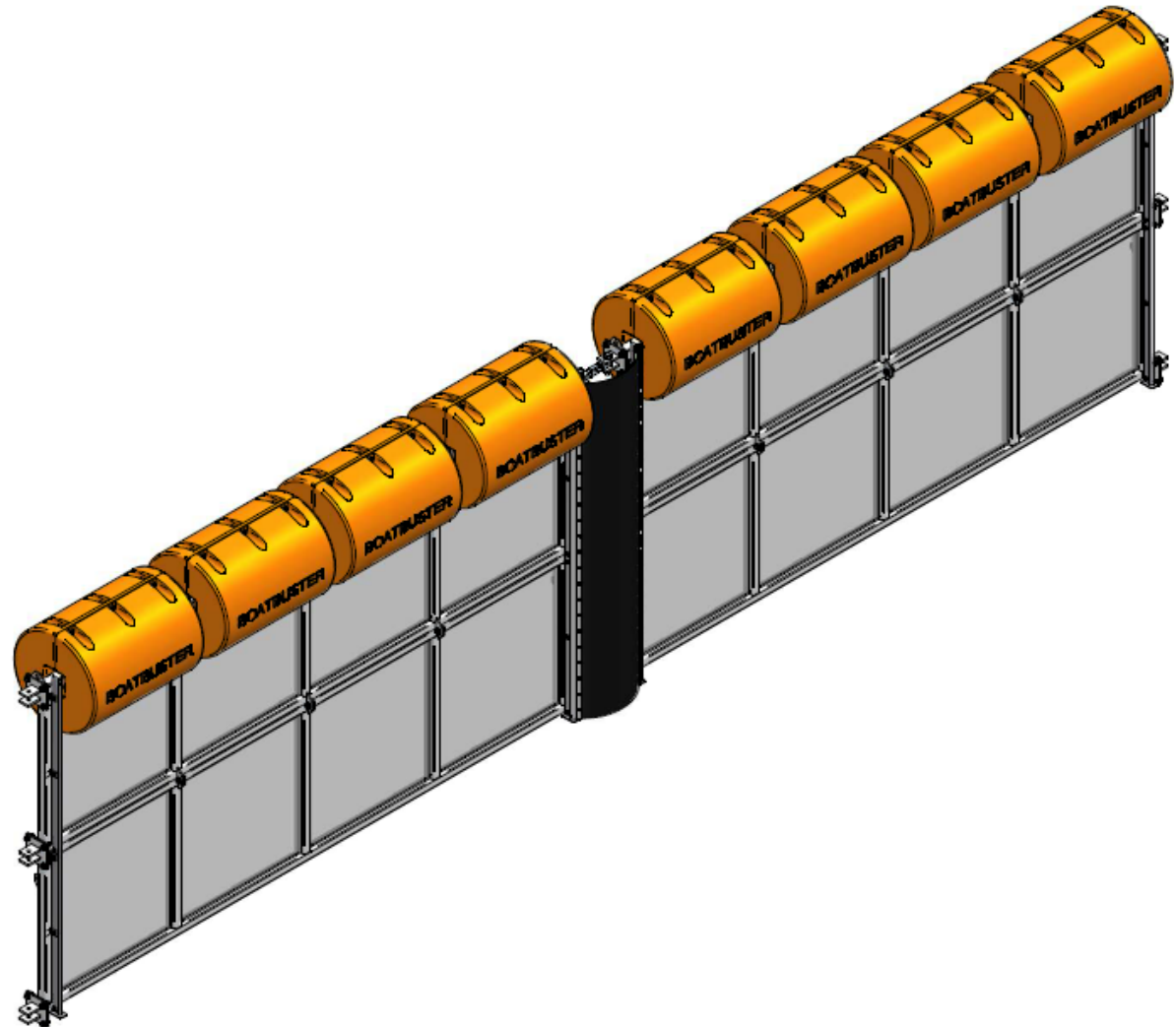


# Georgiana Slough Sacramento River, CA





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# Georgiana Slough Sacramento River, CA



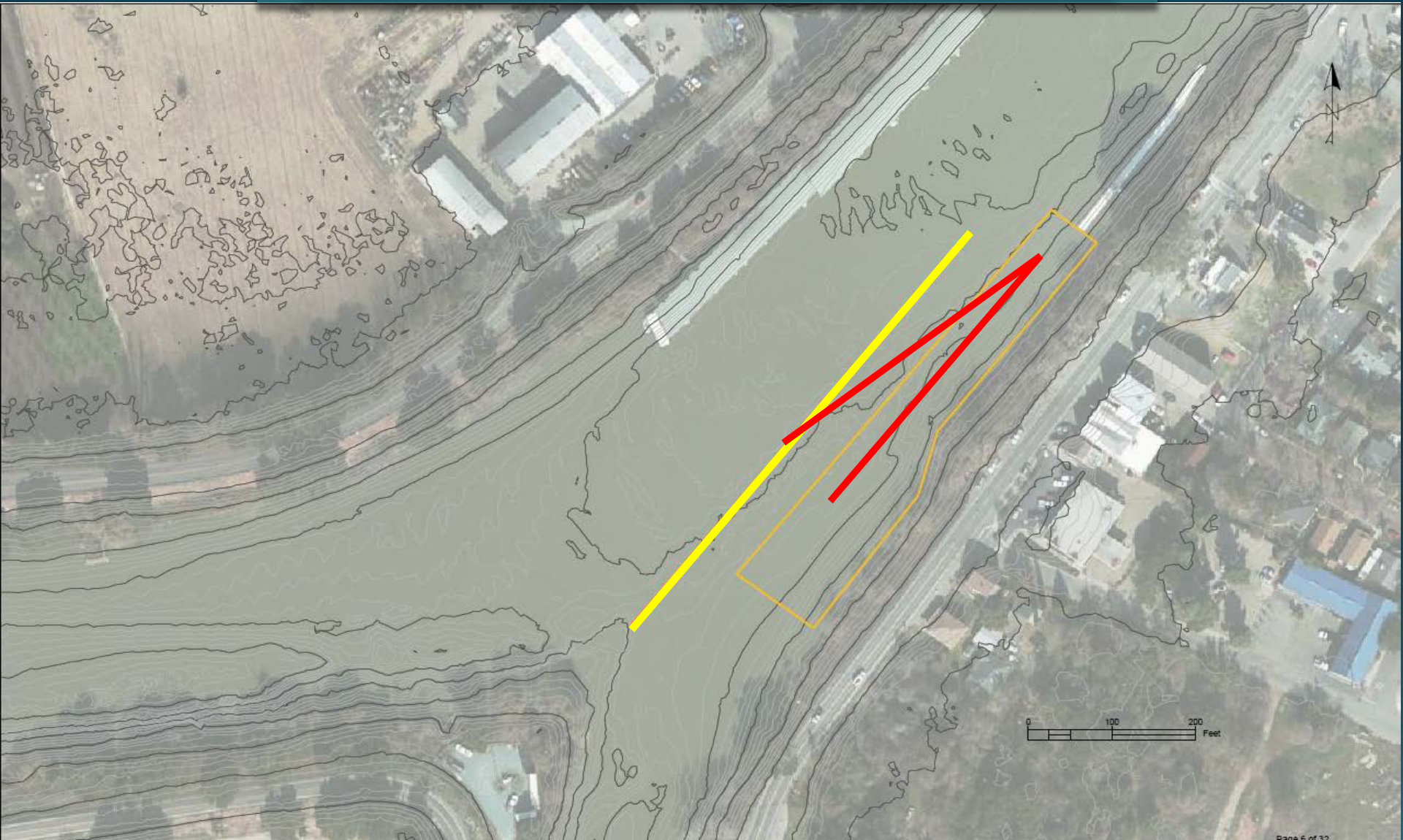


# Georgiana Slough Sacramento River, CA





# Georgiana Slough Sacramento River, CA



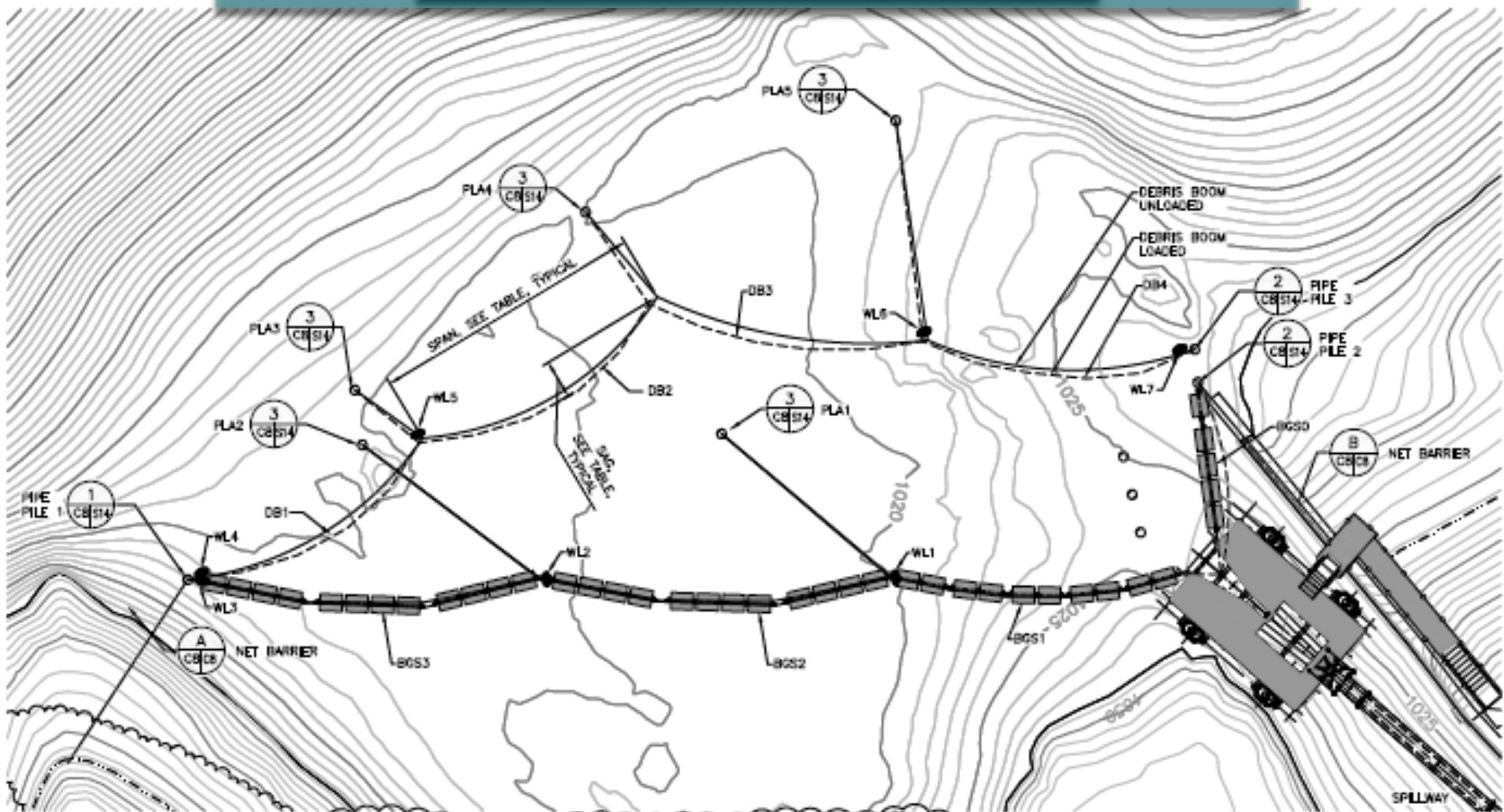


# Los Padres Reservoir Carmel River, CA





# Los Padres Reservoir Carmel River, CA



PLAN

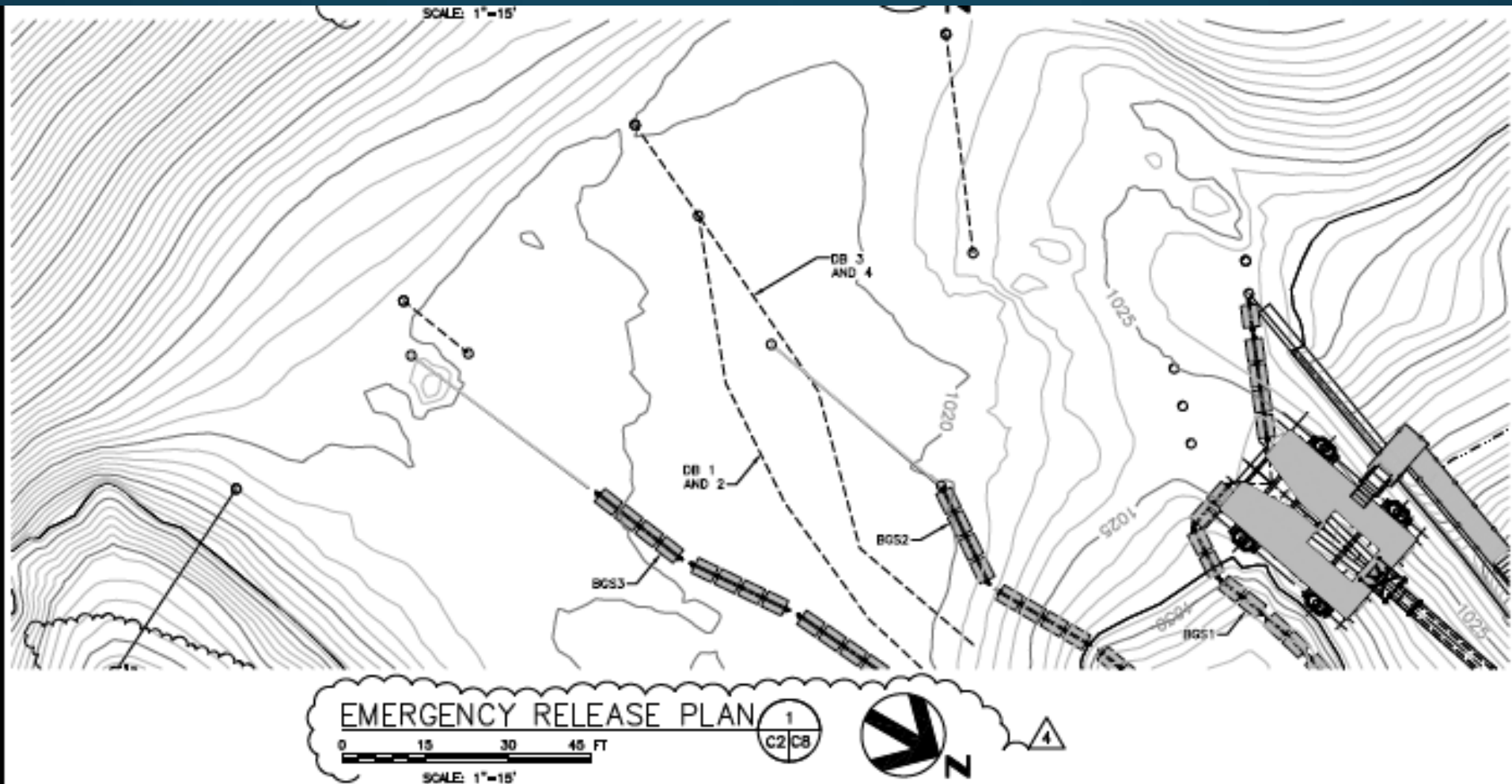
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4

# Los Padres Reservoir Carmel River, CA





# Los Padres Reservoir Carmel River, CA





# Los Padres Reservoir Carmel River, CA





# Los Padres Reservoir Carmel River, CA





# Los Padres Reservoir Carmel River, CA





# **Summary**

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- **Permanent Physical Structure**
- **Significantly Improves Juvenile Fish Guidance and Survival**
- **Flexible Configuration to Allow Improvements**
- **Can Reduce Operations Costs**

# Recommendations

- **Know Site Specific Conditions**
- **Provide Adequate Bypass**
- **Address Debris**
- **Work With Manufacturer**
- **Be Flexible – Modifications Will Further Improve FGS Performance**



# Fish Guidance System



## QUESTIONS?

