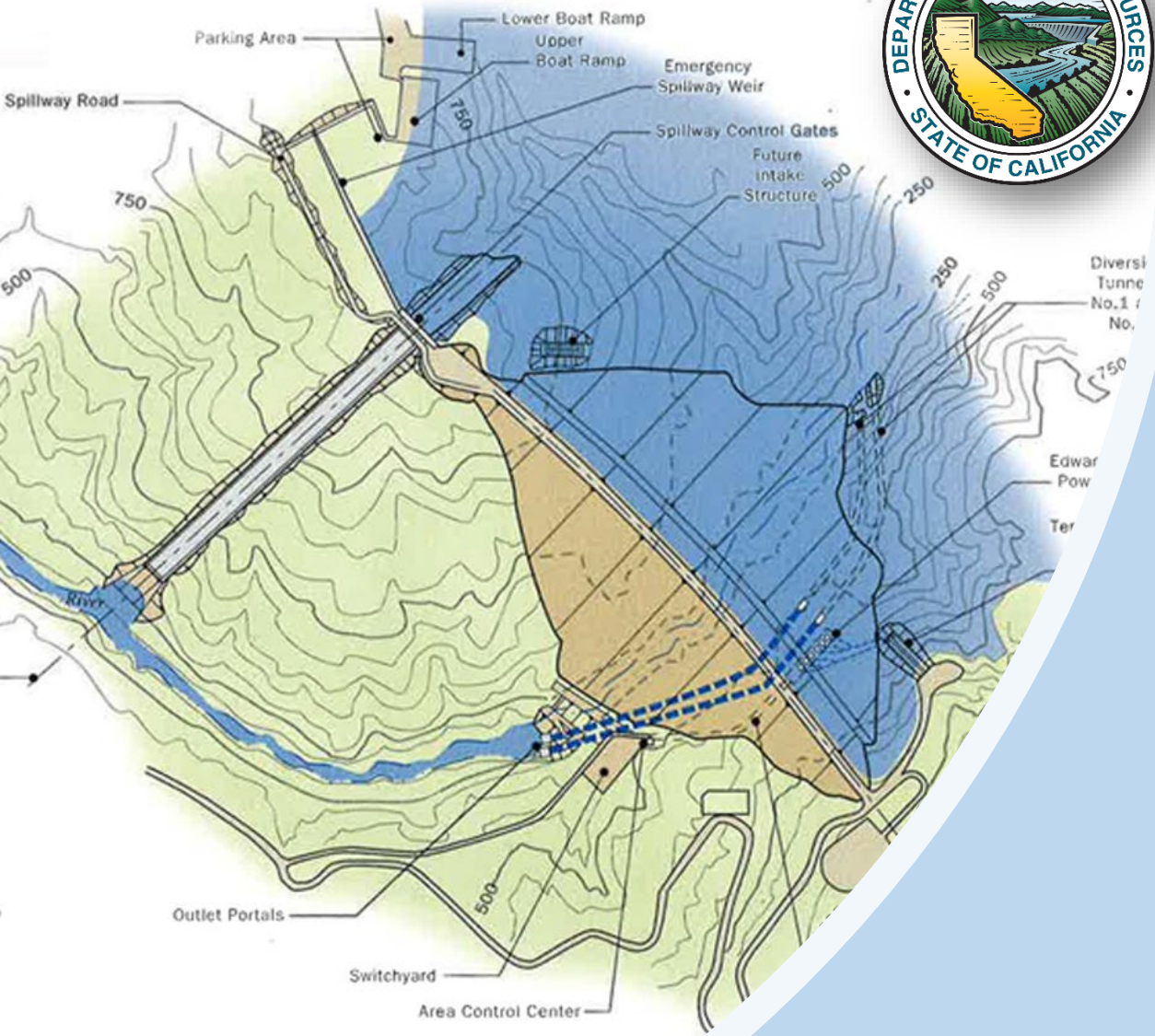


STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
OROVILLE DAM SAFETY
COMPREHENSIVE NEEDS ASSESSMENT

CNA Tasks 1, 2 & 6
Work Progress Briefing

Oroville Dam Safety Ad Hoc Committee – Meeting No. 3

January 10, 2019

Task 1 – Spillways

Objectives, Constraints

Task 1 Need Statement

What additional enhancements for spillway reliability, redundancy, and resiliency are needed at Oroville Dam?

Objective T1-1 – Determine what enhancements should be added to FCO Headworks and Chute to provide reliability and resiliency for spillway releases.

Objective T1-2 – Determine what new features or facilities should be added to provide redundancy to the FCO Headworks and Chute for spillway releases.

Objective T1-3 – Determine what new features or facilities should be added to provide reliability and resiliency to the Emergency Spillway monoliths for large spillway discharges.

Constraints

- Physical capacity limits of Existing Facilities
- Reliability of Existing Facilities
- Regulatory requirements
- Additional physical constraints:
  - Flood Inflows
  - Channel capacity
  - Geology
  - Scour potential
  - Existing facilities
  - Operations
  - Fishery impacts

Objectives, Constraints

Task 1 Need Statement

What additional enhancements for spillway reliability, redundancy, and resiliency are needed at Oroville Dam?

Objective T1-4 – Determine what new features or facilities should be added to the Emergency Spillway to provide reliability, and resiliency to the unlined spillway channel downstream of the Secant Pile Wall in order to preserve downstream conveyance.

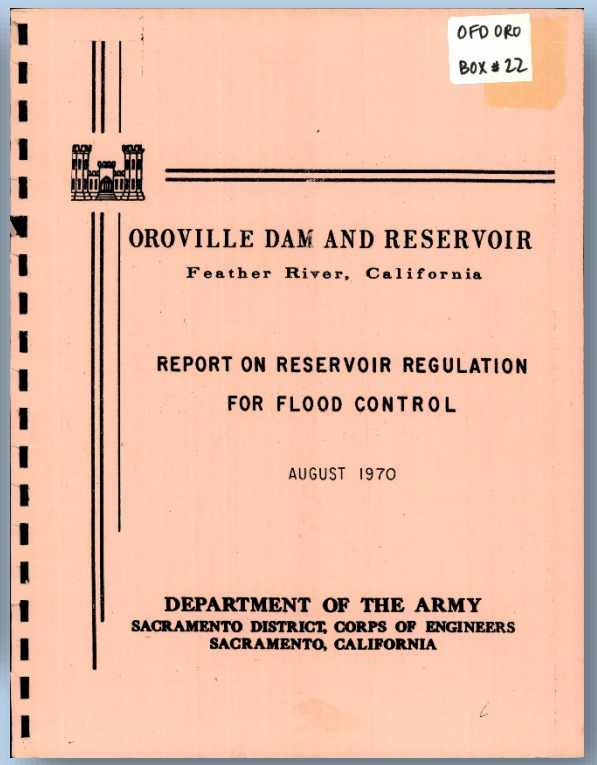
Objective T1-5 – Determine what new features or facilities should be added to the Emergency Spillway to provide reliability, and resiliency to the unlined spillway channel downstream of the Secant Pile Wall in order to protect the Hyatt PP from flooding.

Objective T1-6 – Determine what new features or facilities should be added Oroville Dam and its spillways (e.g. raising embankment crest, widening Emergency Spillway, lowering crest of Emergency Spillway) to provide reliability, and resiliency in passing current and future Inflow Design Floods.

Constraints

- Climate change
- Tolerable risk
- Allowable/tolerable damage to Oroville spillways
- Damage to Downstream SWP facilities
- Downstream levee capacities

Task 2 – Operations Needs Assessment



Standard Operating Procedures

Objectives, Constraints

Task 2 Need Statement

What candidate flood operations measures are appropriate for Oroville Dam?

Objective T2-1 – Incorporate relevant physical changes since 1970 WCM development in updated flood operations measures.

Objective T2-2 – Assess performance of operational measures for broad range of flood conditions to support risk-informed decision making.

Objective T2-3 – Develop candidate flood operation plan acceptable to USACE.

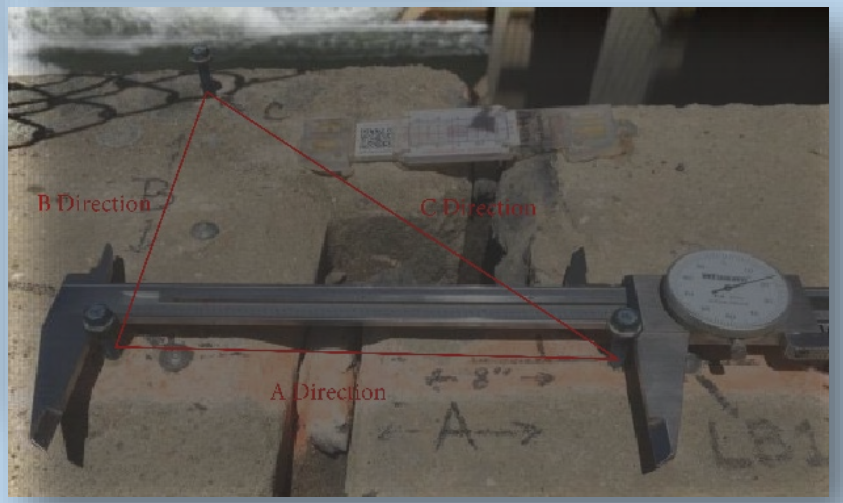
Objective T2-4 – Develop strategy that is sufficiently resilient and aligned with USACE guidelines to accommodate potential changes to climate.

Objective T2-5 – Develop operation plan that integrates with forecast-coordinated operation (F-CO) system created by DWR and Yuba Water Agency (YWA).

Constraints

- Existing infrastructure.
- Infrastructure modification measures.
- Availability of flexible reservoir-river system models.
- Inflow event probability information.
- USACE decision-making at local (Sacramento District) and regional (South Pacific Division) and national (HQUSACE) offices.
- Future climate changes are not known with certainty.
- Multi-agency coordination and collaboration between DWR, USACE, YWA, National Weather Service, California Nevada River Forecast Center (NWS CNRFC), and leading experts in the field of forecast based flood operations.

Task 6 – Instrumentation and Monitoring



Task 6 Objectives, Constraints

Task 6 Need Statement

What performance instrumentation and monitoring measures are needed for dam safety, reliability, redundancy and resiliency?

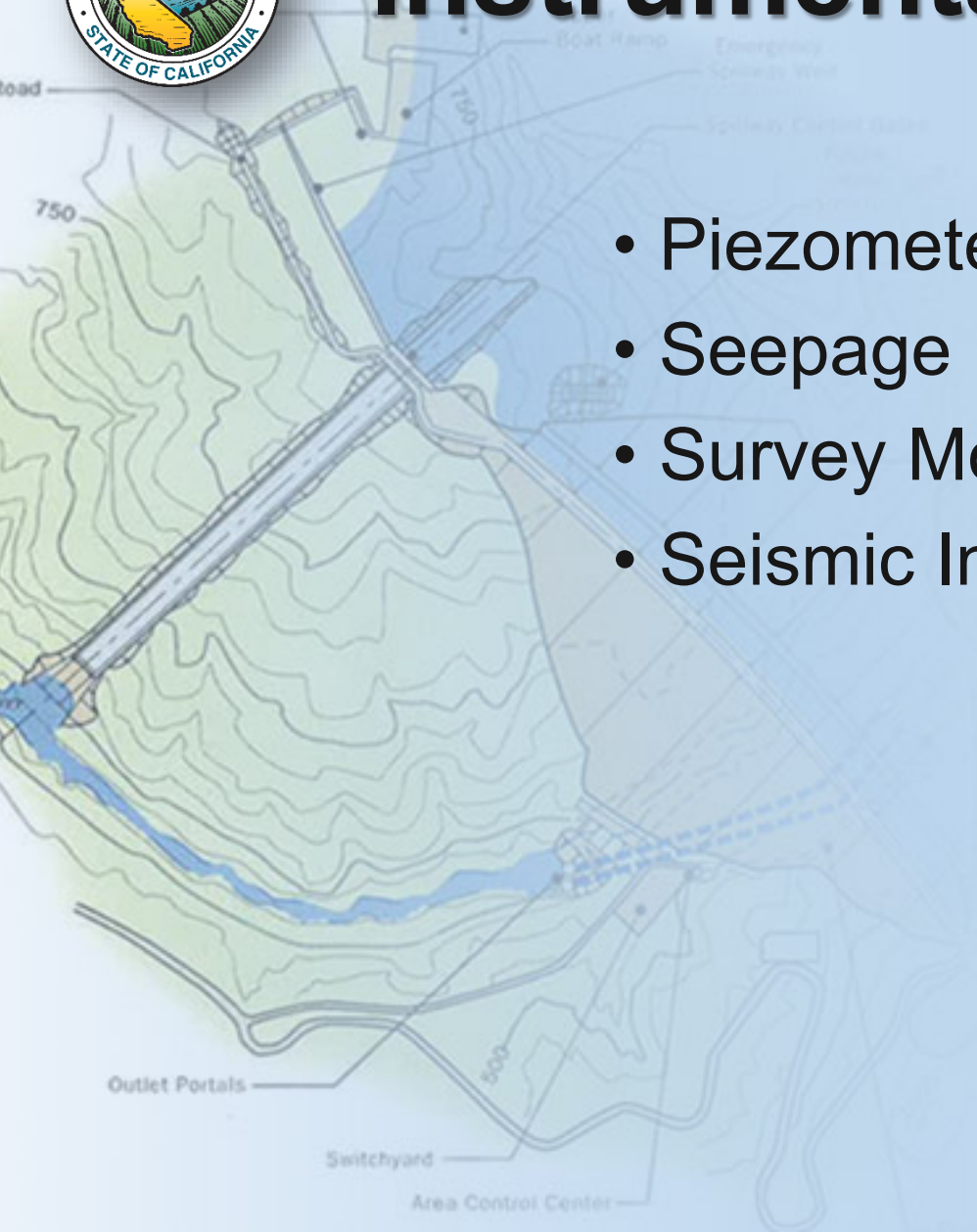
Objective T6-1 – Review instrumentation and monitoring equipment and procedures from pre-construction through present day. Validate previous conclusions.

Objective T6-2 – Identify opportunities for improvements to instrumentation that will support dam safety and improve regulatory compliance.

Constraints

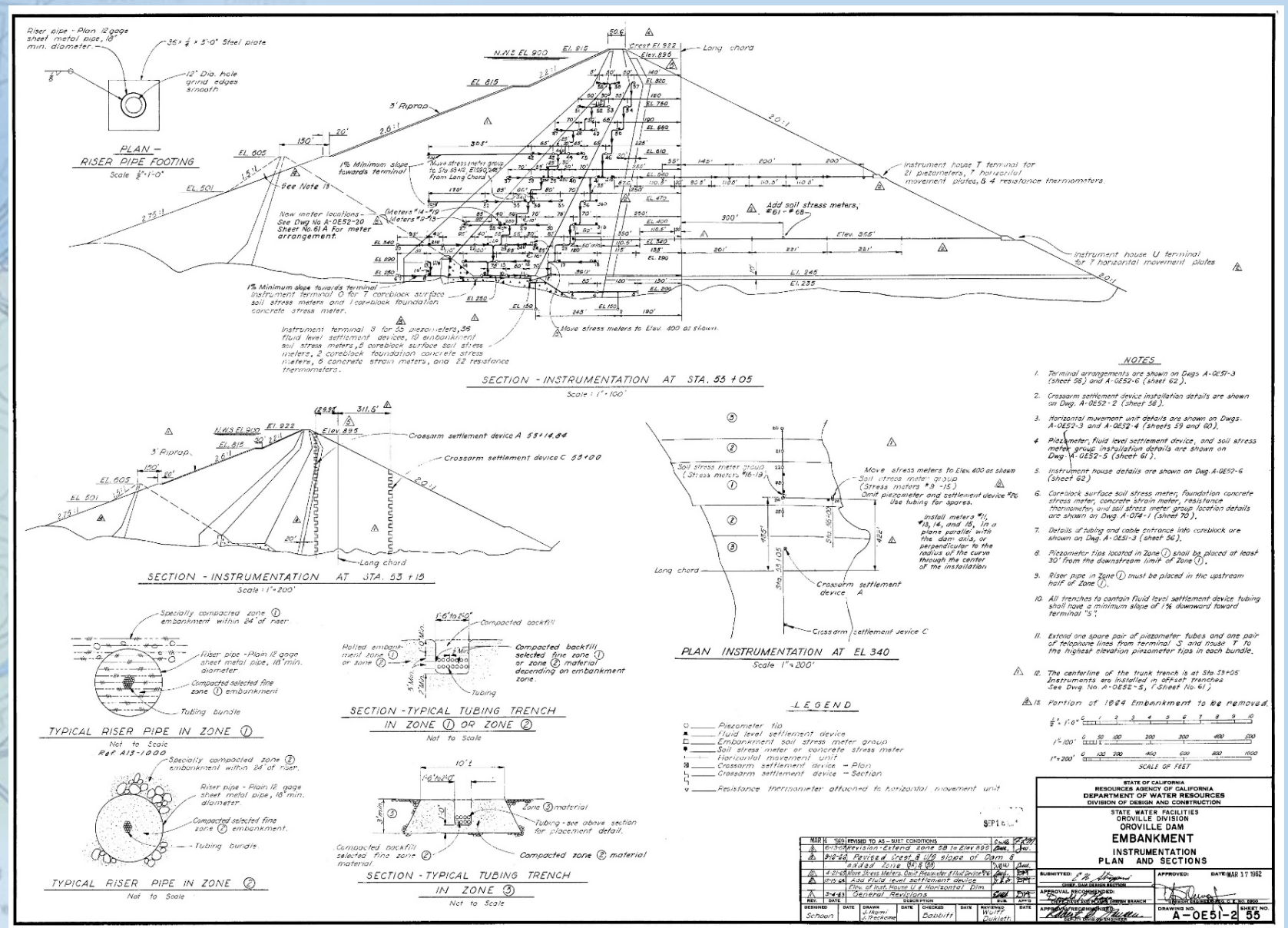
- Existing instrumentation.
- Avoid damage to existing structures.
- Physical inaccessibility.
- Instrument reliability and life.
- Technology.
- Data review protocols and processes.
- Reporting and response.

Instrumentation Overview

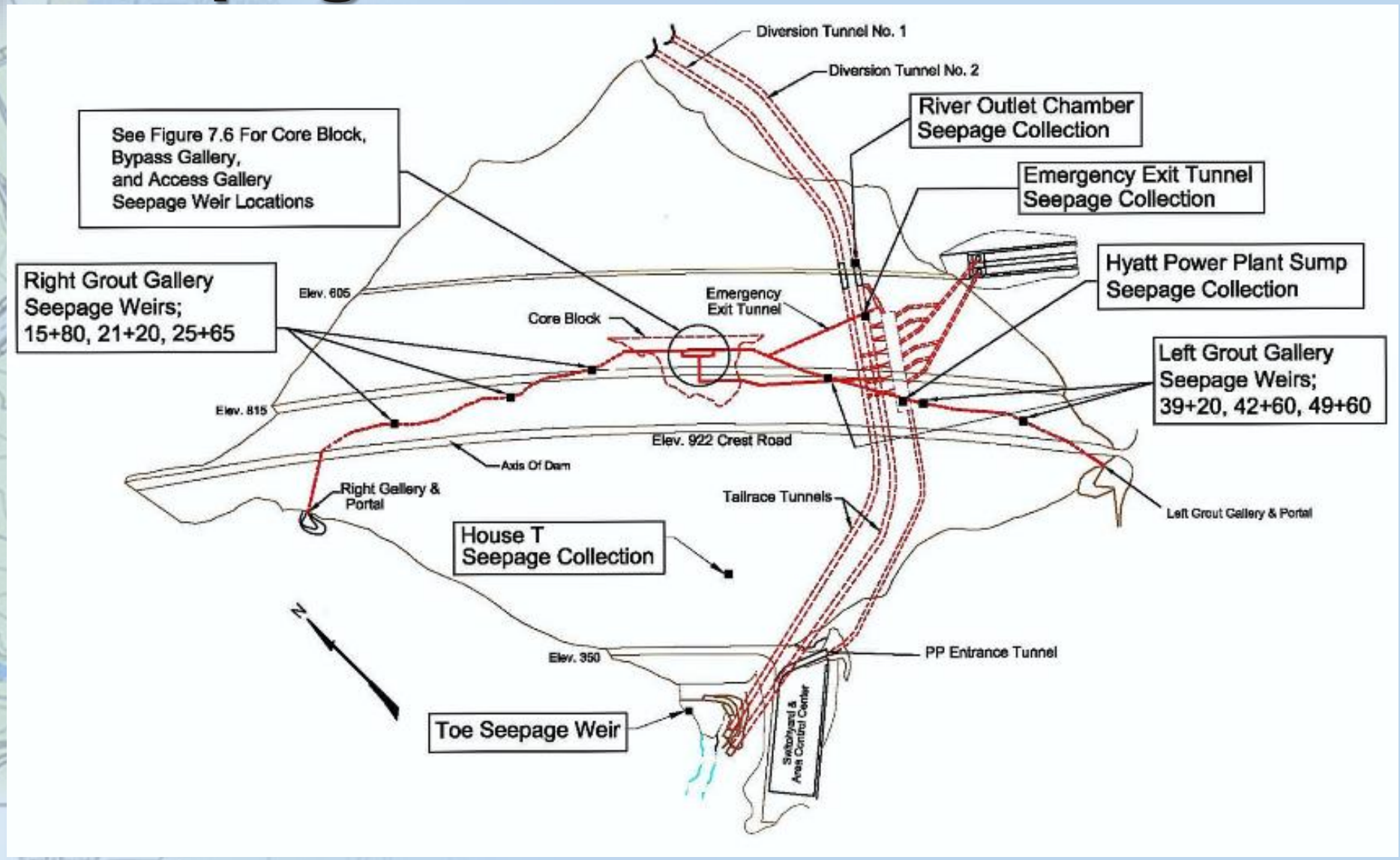


- Piezometers
- Seepage Instruments
- Survey Monuments
- Seismic Instruments

Oroville Dam - Originally Installed Instruments

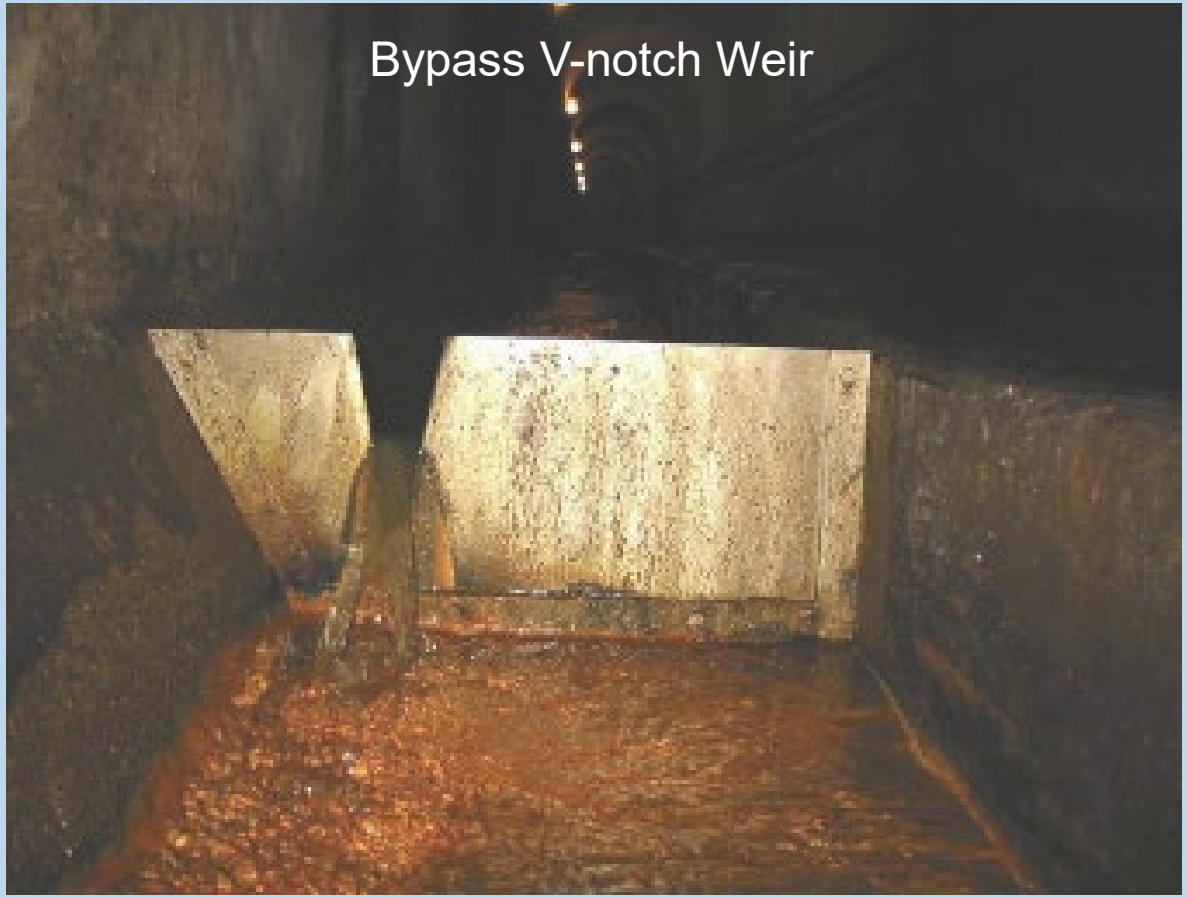


Seepage Collection Locations



Seepage Collection Locations

Toe Seepage Weir and Orifice

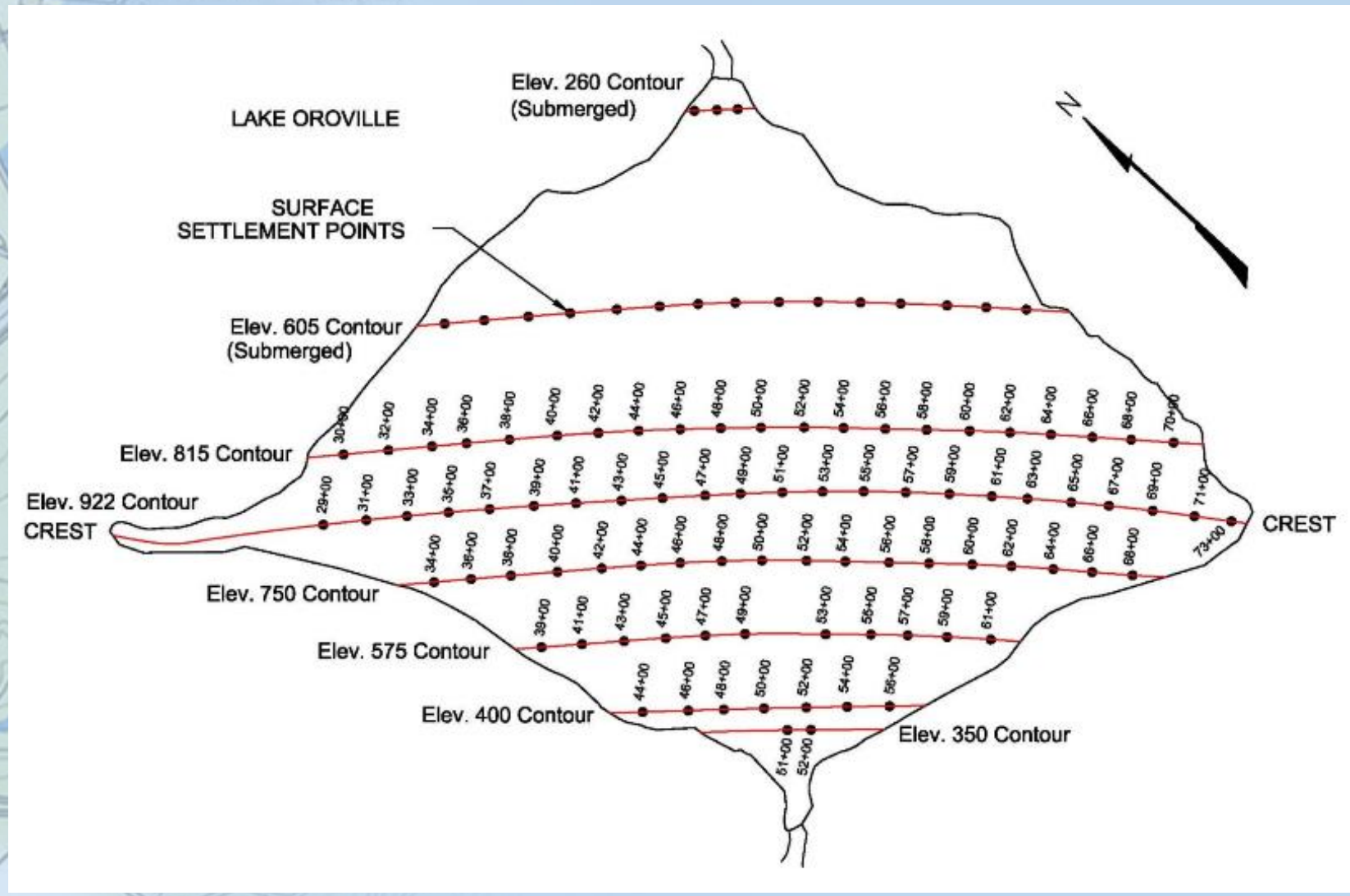


Bypass V-notch Weir

Grout Gallery - Seepage

Intermediate Weirs Are Installed in Right and Left Grout Galleries

Survey Monuments



Seismic Instruments

Potential Failure Modes - Summary

Part 12D - 2014

PFM	Structure	Loading Type	Brief Description	Category
F1	FCO	Hydrologic	Uplift Pressure below the FCO during the PMF Leads to a Stability Issue of the FCO Structure	III
F2	Spillway/ Ogee	Hydrologic	Uplift Pressure below the Emergency Spillway Weir during PMF Leads to a Stability Issue of the Emergency Spillway Structure	III
F3	Dam/ FCO	Static/ Hydrologic	Breach near Dam Crest under High Reservoir Conditions due to Erosion of Fill at the Right Abutment Contact with FCO Structure	II
S1	Dam	Static	Internal Erosion of Fines from Dam Core Zone 1 Exiting into Transition Zone 2 due to Imperfect Filter Compatibility	II

PFM - Summary

PFM	Structure	Loading Type	Brief Description	Category
S2	Dam	Static	Scour Erosion of Fines Initiating along a Crack in Zone 1 Core and Exiting into Transition Zone 2 due to Imperfect Filter Compatibility	II
S3	Dam	Static	Internal Erosion of Fines Initiating and Progressing along Outside of Broken Instrumentation Tubing within Trench that Extends Upstream to Downstream across Zone 1 Core at Dam Sta 53+05, El 540	IV
E1	Dam	Earthquake	Earthquake Loading during High Reservoir Pool Conditions Causes Transverse Crack to Form at Crest of Dam, Leading to Erosion and Breach at the Location of the Crack and Uncontrolled Release of Reservoir Water	IV
E2	Dam	Earthquake	Earthquake Opens Repaired Cracks or New Cracks in the Core Block, Leading to Erosion of Zone 1 Material from the Dam Core into the Gallery and Sump System and Development of a Void within the Core	IV
E3	Dam	Earthquake	Earthquake Occurs during a Wet Period in Which "Green Spot" Area of Left Dam Abutment is Saturated with a Perched Phreatic Condition, Resulting in Downstream Slope Instability	III
E4	Dam	Earthquake	Large Earthquake (on the order of the 84th Percentile) on the Cleveland Hills Fault Leads to Deformation and Loss of Freeboard and Overtopping of the Crest of the Dam	III
E5	Hyatt Intake	Earthquake	Earthquake Causes Failure of the Slide Gate Hoist and Rapid Closure of Hyatt Intake Structure, Which Collapses Penstock due to Negative Pressure and Inability to Make Reservoir Releases through the Plant	III
E6	FCO	Earthquake	Earthquake Shaking under Normal Reservoir Pool Conditions Causes Failure of Corroded Radial Gate Tendons at the FCO Structure, Loss of Two (or More) Gates and Uncontrolled Release of Reservoir down to El 813	I
E7	FCO	Earthquake	Seismic Forces due to a Large Earthquake Damage the FCO Gates and Prevent Opening to Lower Reservoir as Reservoir is Rising, Resulting in Uncontrolled Release over the Emergency Spillway Section	III

PFM	Structure	Loading Type	Brief Description	Category
E8	Emergency Spillway	Earthquake	Earthquake Loading under Normal Reservoir Pool Causes "Debonding" between the Concrete at the Base of the Ogee Weir and the Rock Foundation, Dislodging an Ogee Section Monolith, Resulting in Partial Release of Reservoir to Approximately El 850	III
O1	FCO	Operational	Human Error on Entering Gate Opening Setpoint Results in Uncontrolled Release	II
O2	FCO	Operational	SCADA Malfunction Results in Uncontrolled Release	II
O3	Powerplant	Operational	Generating Unit Comes out of Block due to Mechanical Failure of Head Cover	III
O4	FCO	Operational	Gate in the FCO Fails to Open during Flood Event due to Binding	II
O5	Palermo Tunnel	Operational	Failure of the Palermo Tunnel 30-inch Valve or Upstream Pipe Stub due to Corrosion	II
O6	River Outlet	Operational	Pressure Relief Wall in the River Outlet Blows Out, Resulting in High-Velocity Wind Which Damages Hydraulic Control Lines and Electrical Control Lines	IV

Questions?