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Managing Water in the West

Concrete, Geotechnical and Structural Laboratory

and

Materials and Corrosion Laboratory

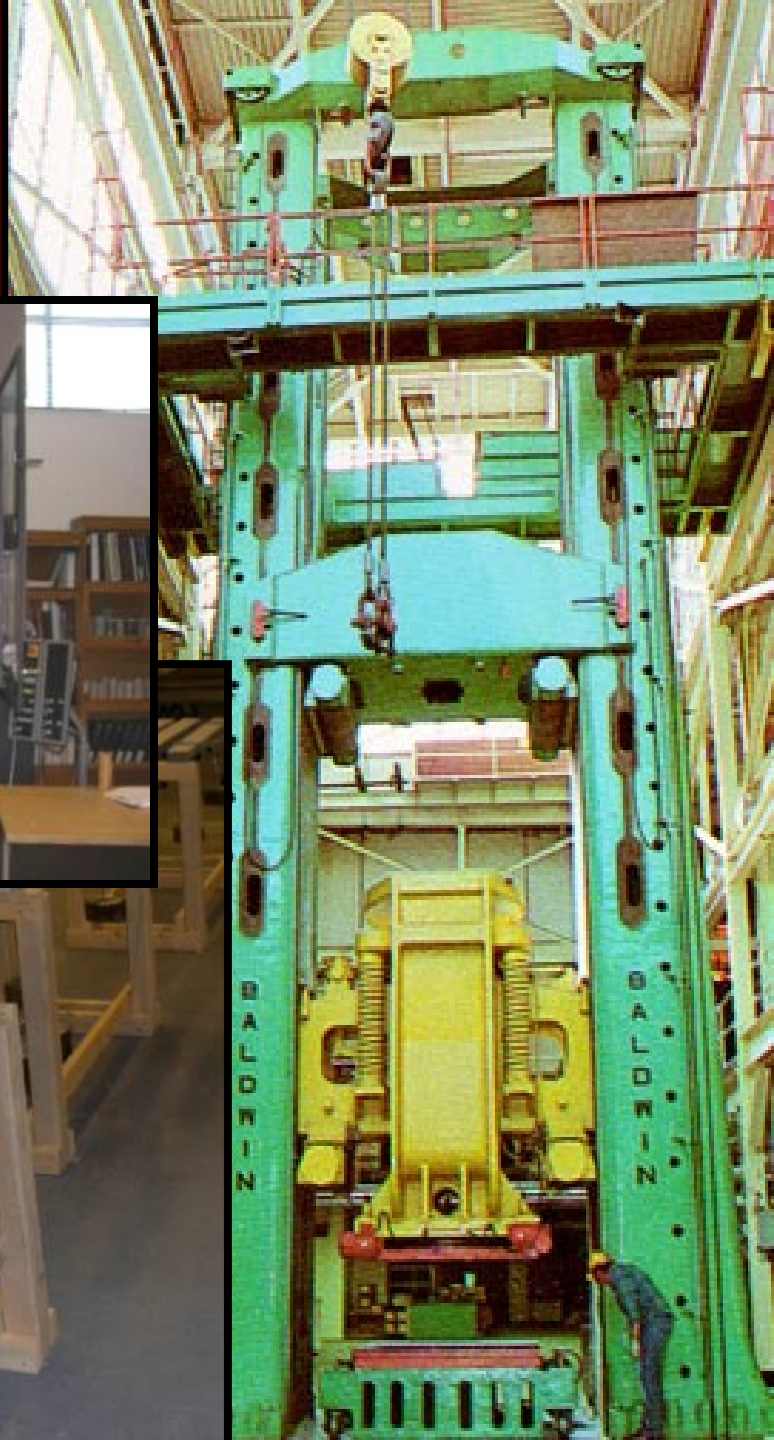
Hydraulics Investigation and Laboratory

Technical Service Center
Denver, Colorado

U.S. Department of the Interior
Bureau of Reclamation

Janet White, P.E.

Laboratories Centralized
1946



Reclamation Laboratories

- Provide expert advice and assistance for construction materials used on Reclamation facilities
  - Concrete
  - Concrete Maintenance & Repair
  - Corrosion Control and Prevention
  - Protective Coatings
  - Soil and rock evaluation
  - Structural Testing
  - Hydraulics
- Perform research related to these areas to solve specific problems

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Concrete Technology

Barbara Aguilera Gonzalez
Katie Bartojay, PE
Shannon Harrell, PE
Westin Joy, PE
Scott Keim, PE
Matthew Klein, PE, PhD
Catherine Lucero, EIT
Veronica Madera, PE
Caleb Nickel, EIT
Trevor Stockton-Salas
Frank Valdez
Janet White, PE

Stony Gorge Dam Modifications

- Testing
- Research
- Design Team Assistance
- Specifications
- Construction Support

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Concrete Technology

Shasta Dam Modifications

Creep Testing

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Concrete Technology

Flexural Strength and
Tensile Strain Capacity

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Large Diameter Concrete Core Testing for

18” ϕ Direct Tension
10” ϕ Static and Dynamic Compression, Direct Tension, Direct Shear
6” ϕ Static Compression, Direct Tension, Direct Shear

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Large Diameter Concrete Core Testing for

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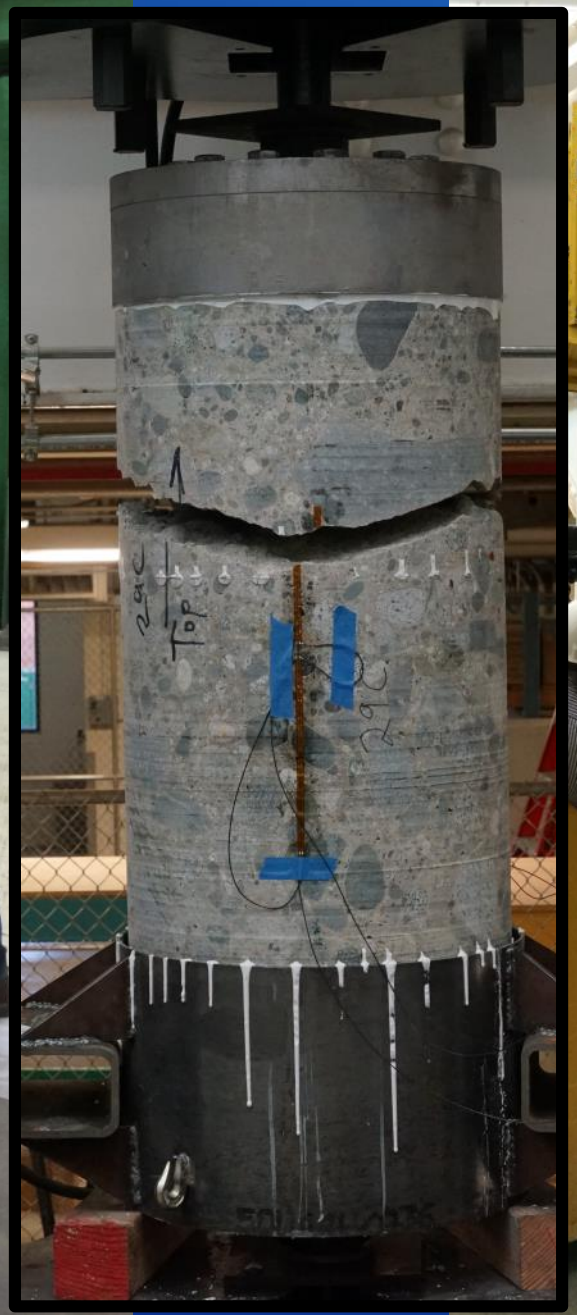
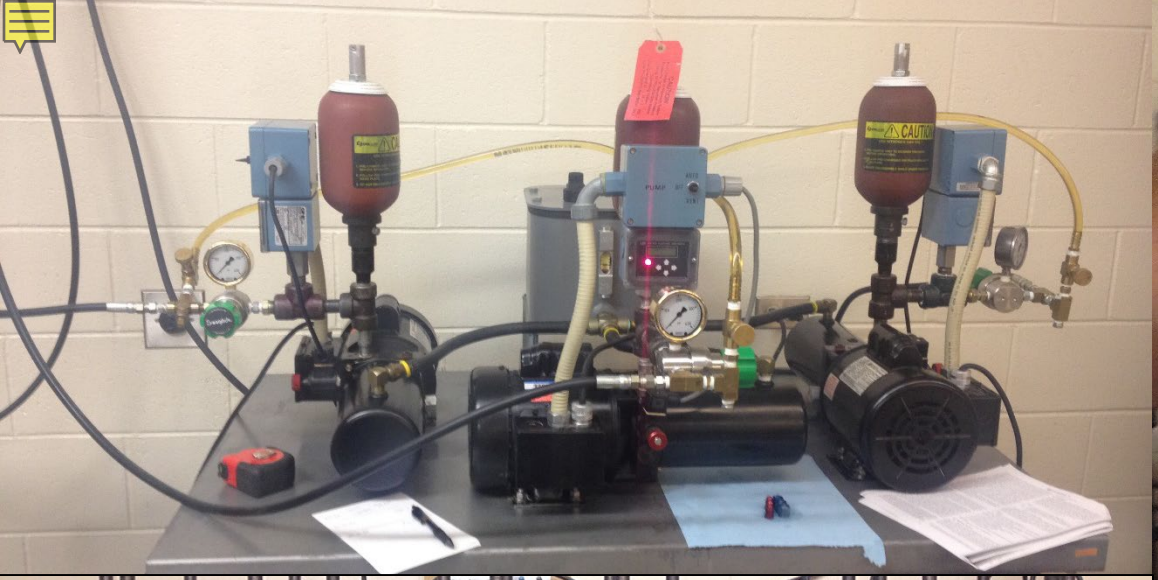
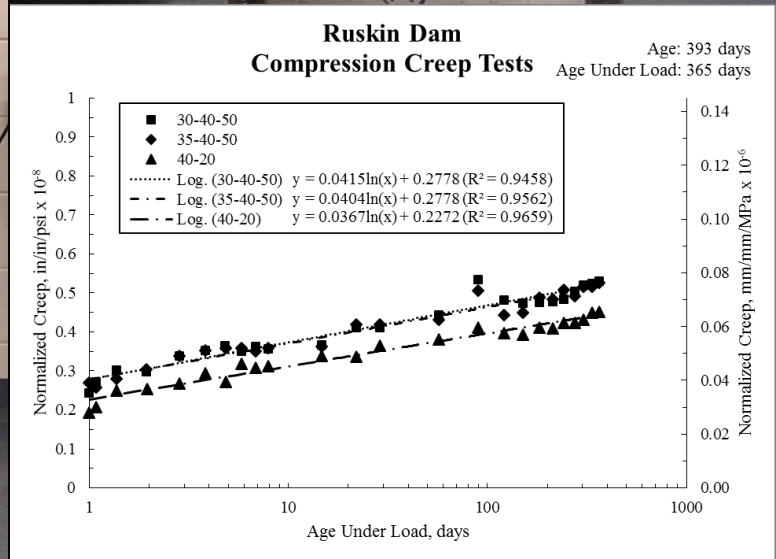
BALDWIN


1
TOP


Yale




A
Starrett
THE L.S. STARRETT CO.
ATHOL, MASS. U.S.A.
LPW
5
A


Ruskin Dam
Compression Creep Tests
Age: 393 days
Age Under Load: 365 days
30-40-50
35-40-50
40-20
Log. (30-40-50) y = 0.0415ln(x) + 0.2778 (R² = 0.9458)
Log. (35-40-50) y = 0.0404ln(x) + 0.2778 (R² = 0.9562)
Log. (40-20) y = 0.0367ln(x) + 0.2272 (R² = 0.9659)
Normalized Creep, in/in/psi x 10⁻⁸
Normalized Creep, mm/mm/MPa x 10⁻⁶
Age Under Load, days
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
1
10
100
1000

Thick Repairs

Glen Elder Dam

Hydro-demolition 20,000 psi 6" depth

80-90% crack reduction
with new concrete additive

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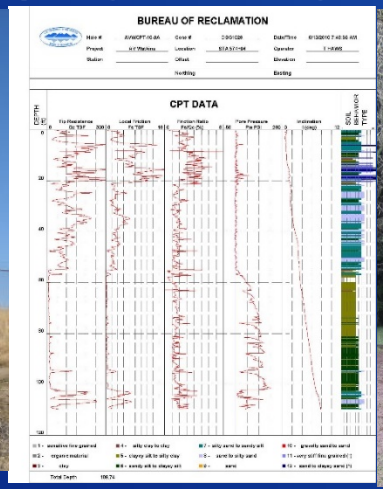
Crack Repairs

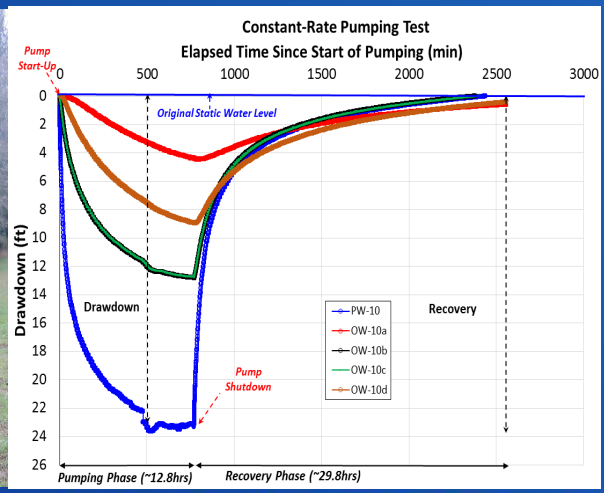
- Mechanical methods (additional reinforcement)
- Resin injection
  - Epoxy resin
  - Polyurethane resin
  - Polyurea resins
- Joint Sealants

CGSL Concrete Repair Crew

Geotechnical Lab

- Gergo Arany, MSc
- Amber Brusak, EIT
- Justin Downs, EIT
- Blake Armstrong
- Rick Bearce, PhD
- Jong Beom Kang, PhD, PE (Hydrogeology Support)
- Tyler Chatfield, PE (Field Testing Coordination)
- Evan Lindenbach, PE, PG (Rock Lab Coordination)
- Robert Rinehart, PhD, PE (Soils Lab Coordination)
- Bart Pfeifer, (Engineering Technician)





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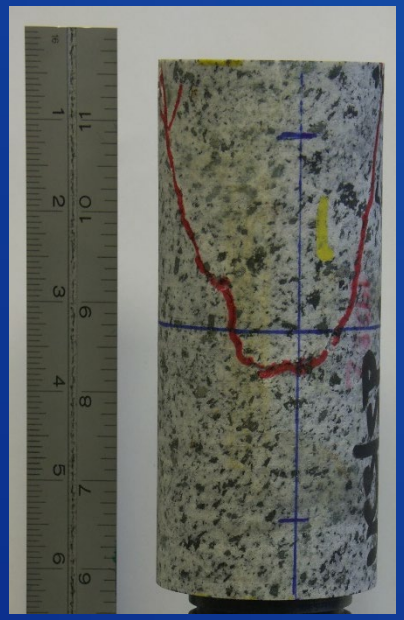
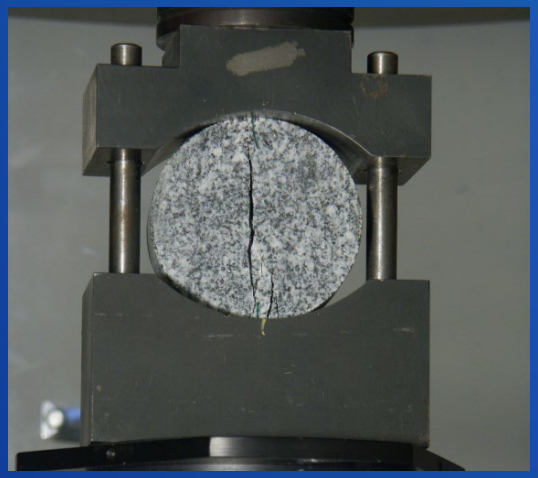
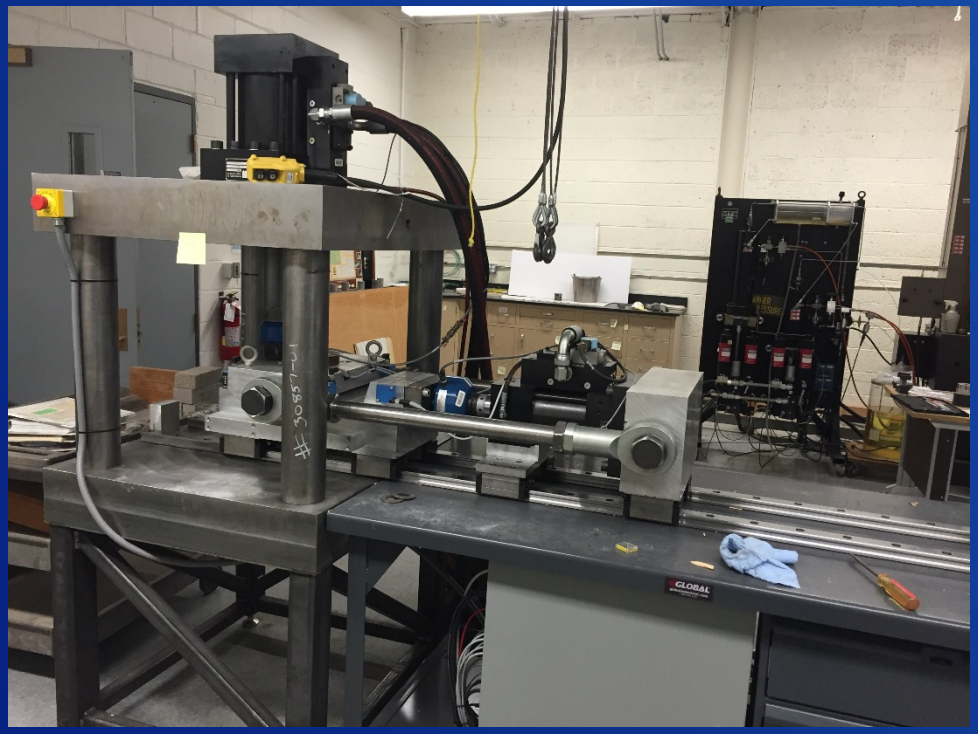
Rock Testing





Rock Compression Testing (Triaxial and Unconfined with elevated temperatures and pore pressure measurements)



Direct Shear Machine (7” and 12” diameter specimens)

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Soil Testing

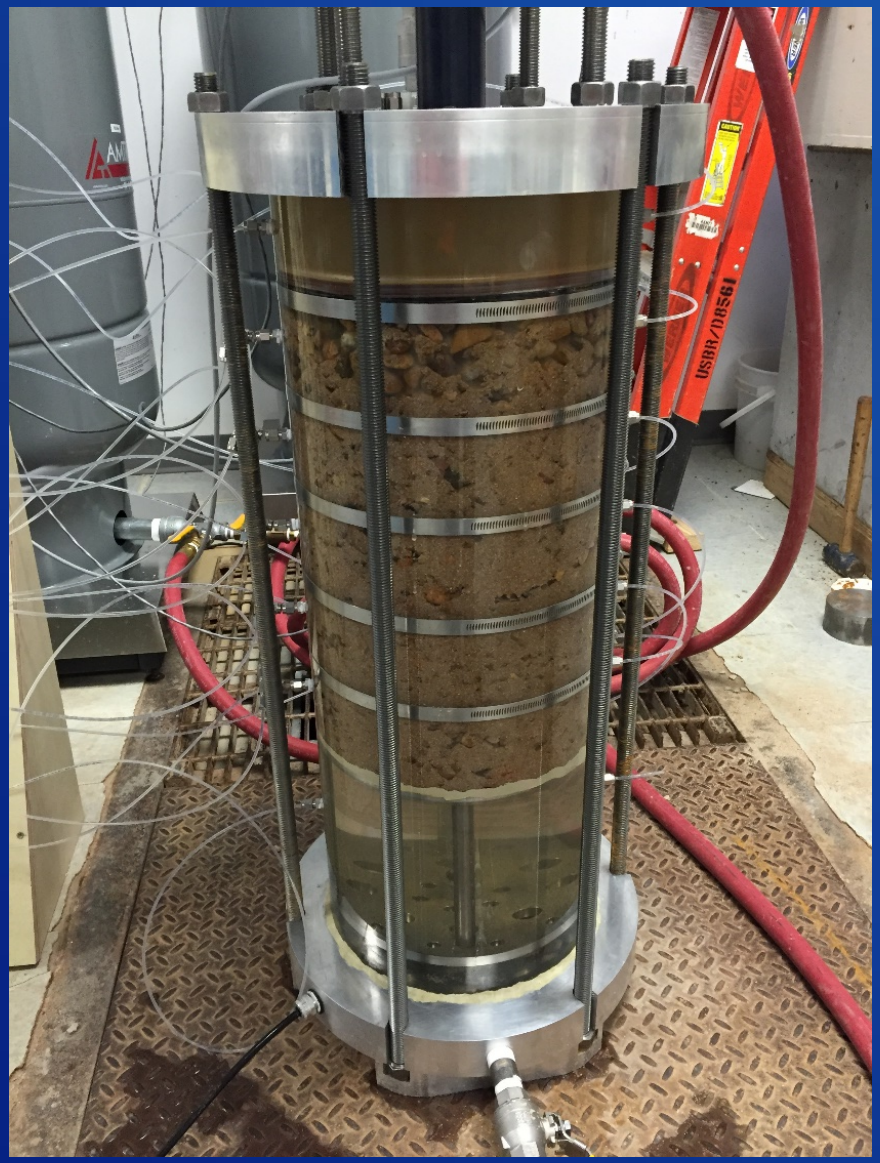
Direct Simple Shear
(Static and Cyclic)

Static Triaxial Shear and Flow Pump Permeability with K_o Consolidation

Cyclic Triaxial Shear

Automated Consolidometers

Internal Erosion Permeameter



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Corrosion

Chrissy Henderson
Daryl Little, PhD
Jessica Torrey, PhD
Mike Walsh, PhD
Grace Weber, MS
Dave Tordonato, PhD, PE

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Capabilities of TSC Corrosion Team

Corrosion Mitigation Engineering:

- Cathodic Protection Systems
  - · Development of Specifications
  - · Design of Galvanic and Impressed Current CP Systems
- Materials Selection

Field Inspections, Installation, Testing, Monitoring:

- Field Testing and Monitoring CP Systems
- Installation and repair of CP systems
- Inspection During and After Construction/ Installation
- Inspection of Aging and Corroding Infrastructure including Failure Analysis

Other Corrosion Mitigation and Damage Repair Techniques:

- electro-osmotic pulse technique
- fiber-reinforced polymer repair of concrete

Corrosion Chemistry:

- Quantitative analysis of soil and water chemistry including sulfate and chloride concentrations

Education and Manuals:

- Corrosion and Coatings School
- Corrosion Webinar Series and Online Instructive Videos
- Corrosion-related guides and manuals

Corrosion Research

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Coatings

Bobbi Jo Merten, PhD
Rick Pepin, PCS
Stephanie Prochaska, MS
Allen Skaja, PhD
David Tordonato, PhD, PE

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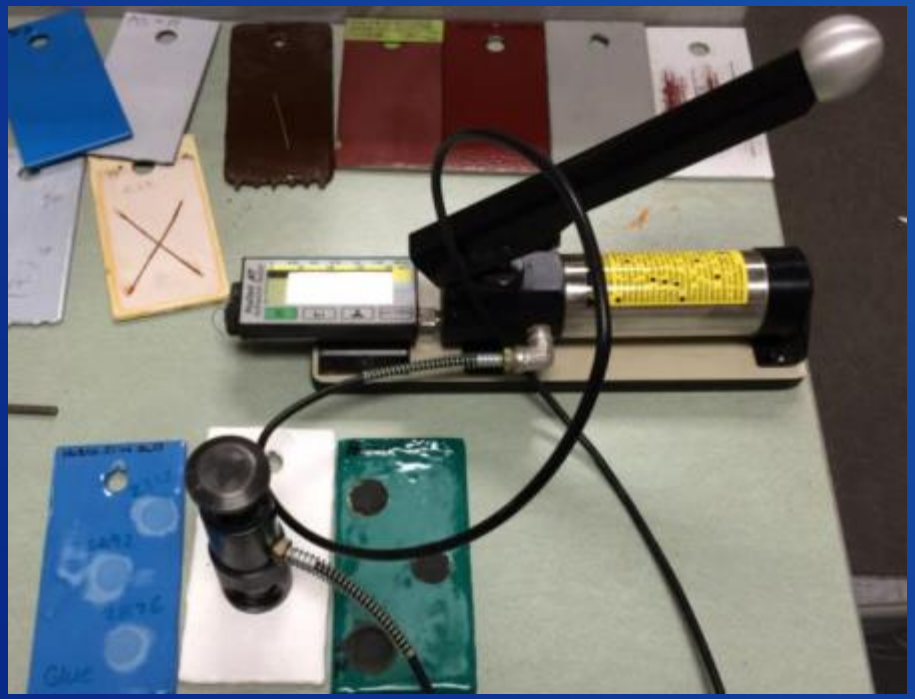
Inspection of Aged Coatings

Coatings Evaluations for Projects



Pulloff Adhesion Test

Undercutting Test

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Zebra/Quagga Mussel Research

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Rope Access for Inaccessible Features

Rope access techniques are frequently used to facilitate cost effective inspection and minor maintenance of otherwise inaccessible features. Examples include:

- **Penstock surveys** (coatings and corrosion assessments) – Wolf Creek Dam, KY & Dworshak Dam, ID - **USBR/COE collaboration**, Grand Coulee Dam, Mt Elbert
- **Dam Face & Abutment Inspection (Visual, Geophysical or Core Sample Collection)** – East Canyon Dam (UT); Hubbart Dam - **BIA/USBR Collaboration**, Yellowtail Dam, Hungry Horse, (MT); Seminoe Dam, Glendo Dam, Guernsy Dam, (WY)
- Bridge inspection: Cimmaron Bridge (CO) - **NPS/USBR Collaboration**
- Gate Inspections: Olympus Dam, Angostura Dam, Imperial Dam
- Vertical Piping Surveys: Trinity
- Spillway inspection: Granby Dam (CO)
- Concrete Coring: American Falls Dam, Guernsey Dam

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BOR TSC – Denver

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Underwater Examinations of Normally Inaccessible Features

- TSC Divers are members of the PN Regional Underwater Inspection Team (13 Divers).
- Scuba, Surface Supplied Air (SSA), and/or Remotely Operated Vehicle (ROV).
- Intake Structures, Spillways, Outlet Works, Stilling Basins, Bridges, Power and Pumping Plants, and Temperature Control Structures.
- Comprehensive Facility Reviews, Periodic Facility Reviews, and O&M Reviews.
- Special Investigations (i.e., Shasta TCD, Temperature Control Curtains)
- Construction Oversight (i.e., Canyon Ferry, Buffalo Bill PP, Red Willow)
- Biological Surveys (i.e, Zebra and Quagga Mussels).

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Concrete Coring & Testing

Core drilling – Guernsey Dam Spillway

Core drilling – Glen Elder Dam Approach

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Unmanned Aerial System (UAS) Inspections and Data Collection

UAS can be used to safely and efficiently perform cursory inspections in difficult to access features and collect high quality analysis data for decision-making. Examples include:

- **3D modeling** – Elephant Butte Dam
- **Penstock inspection** – Glen Canyon Dam
- **LiDAR RGB texture** – Glen Canyon Dam
- **Visual inspection**
- **Deterioration mapping**
- **Change detection**
- **Point cloud measurements and analysis**
- **Subsurface defect detection**

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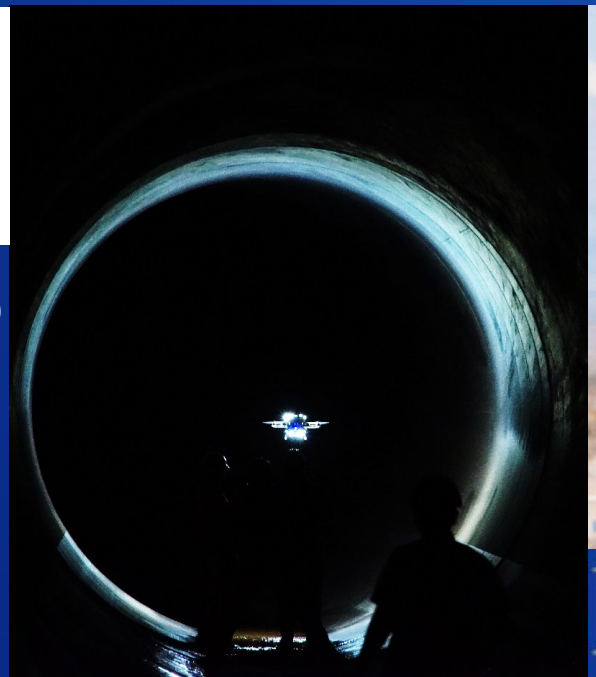

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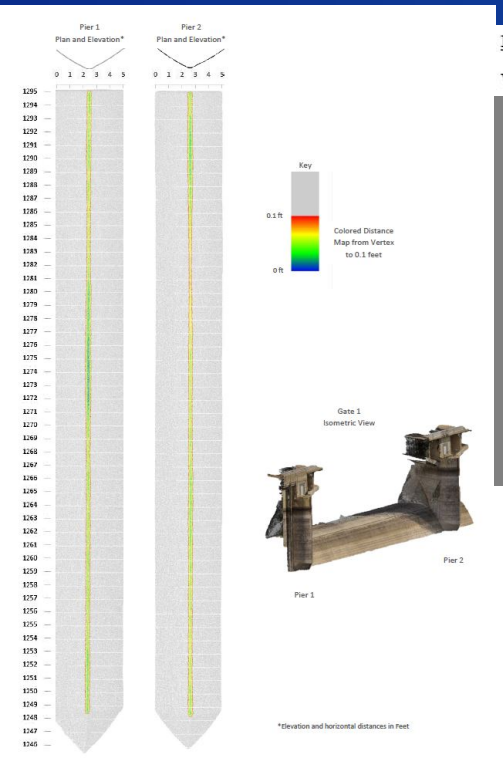
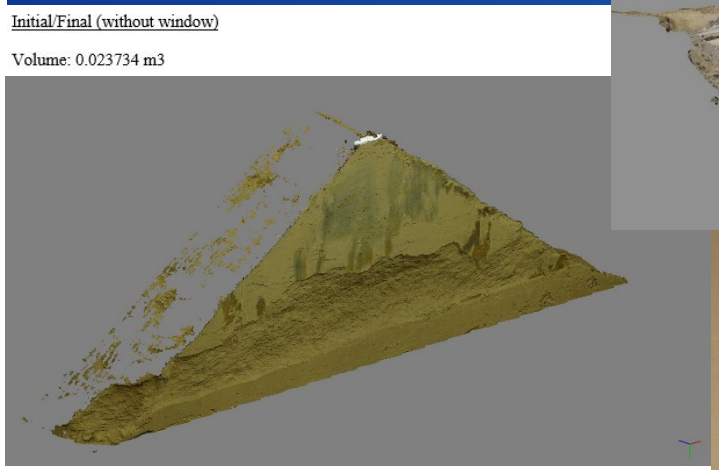
Photogrammetry

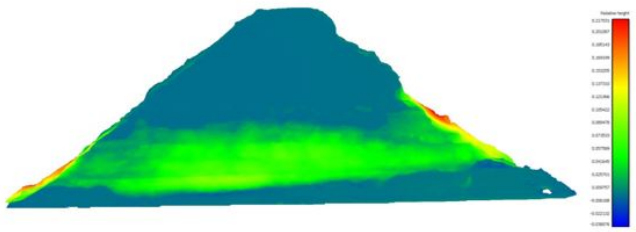
Photogrammetry is used to capture spatial references for 3d modeling and high-level measurement analysis including accurate distances, areas and volumes.

Examples include:

- **Grand Coulee Gate Pier Profile Analysis**
- **Embankment Dam Breach Volumetric Loss**
- **Elephant Butte 3D Modeling and Printing**







Hydraulic Investigations & Laboratory Services

- Water Conservation
- Environmental Hydraulics
- Dam Safety
- Hydraulic Structures & Equipment
- The Reclamation Detection Laboratory for Exotic Species (RDLES)

Hogback

- 1:60 Froude scale model
  - Investigation of large debris pieces in the San Juan River

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Cle Elum

- 1:50 Froude scale model
  - Investigation of erosion potential in tailwater area

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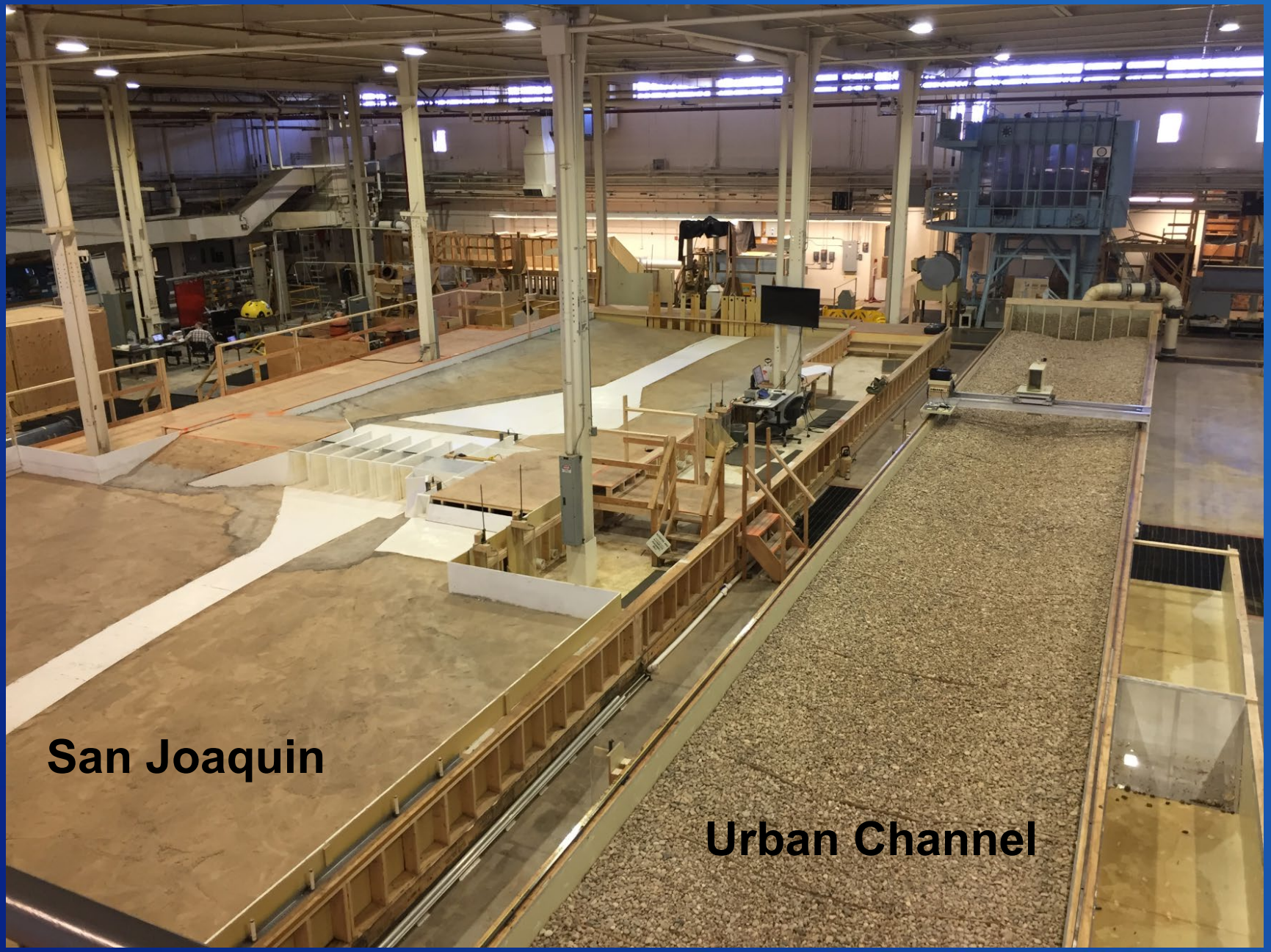
San Joaquin
Urban Channel

Dam Safety Reservoir Debris Model

- 1:18 Froude scale model of a radial gated ogee crest spillway and a morning glory spillway
  - Research to determine potential impacts to reservoir WSE and discharge capacity

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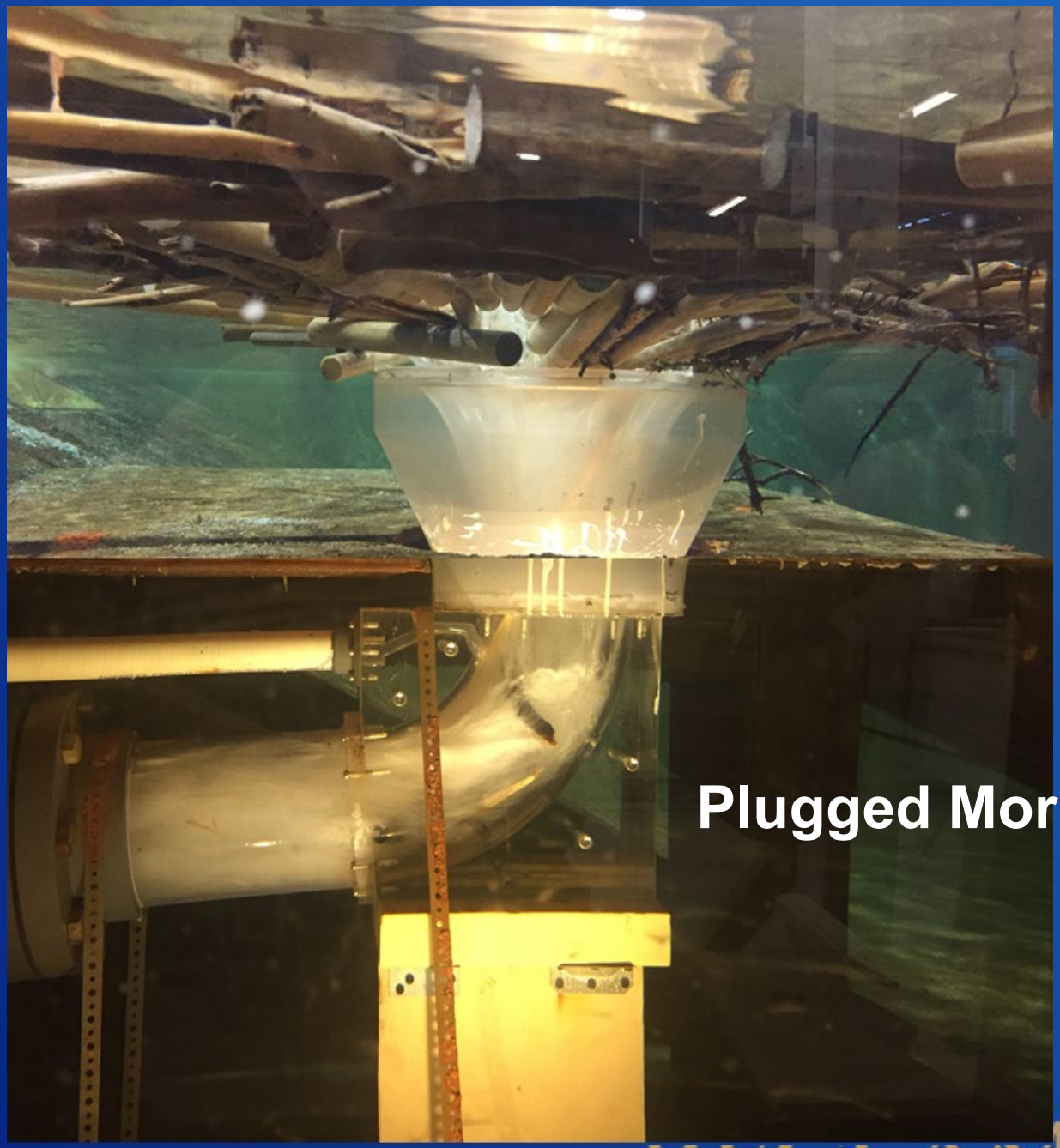

Plugged Morning Glory

Final natural jam (ΔWSE = 2.5 feet, ΔQ = -12.1%)

Manual compacted jam (ΔWSE = 5.3 feet, ΔQ = -23.0%)

Shasta Dam

- 1:50 Froude Scale model to investigate design of potential Shasta Dam 18.5 foot raise

Contact Information

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Thank You!

Any Questions?

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