Montana Association of Dam and Canal Systems

2024 Rock Lake Operator Repair and Monitoring System Improvements

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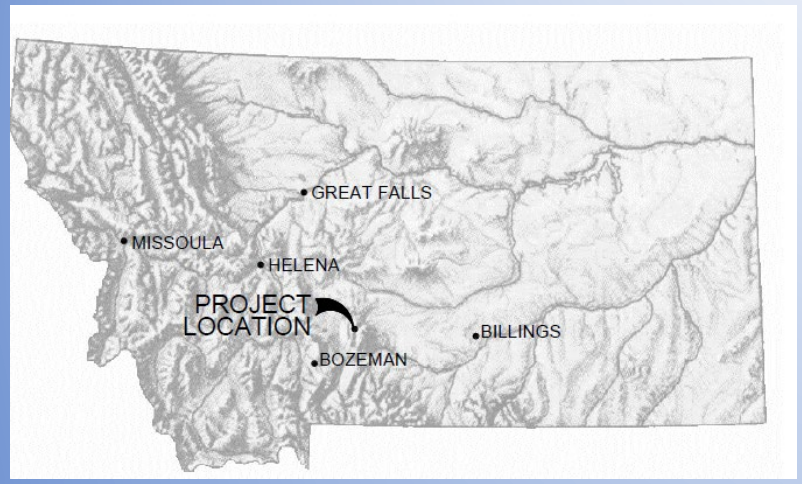
Water Resources Engineer

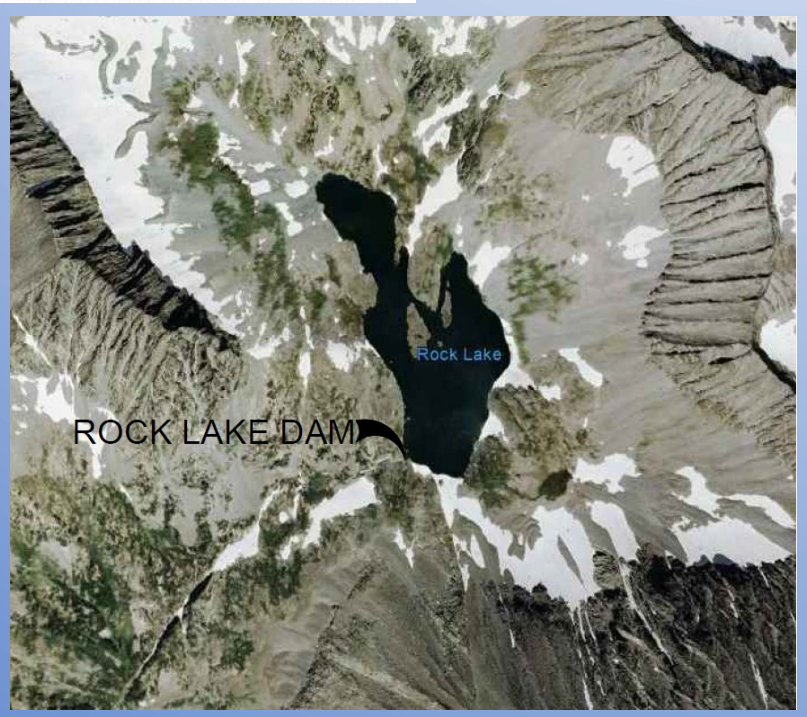
Hydrometrics, Inc.
Consulting Scientists and Engineers

OCTOBER 15, 2025

Rock Lake

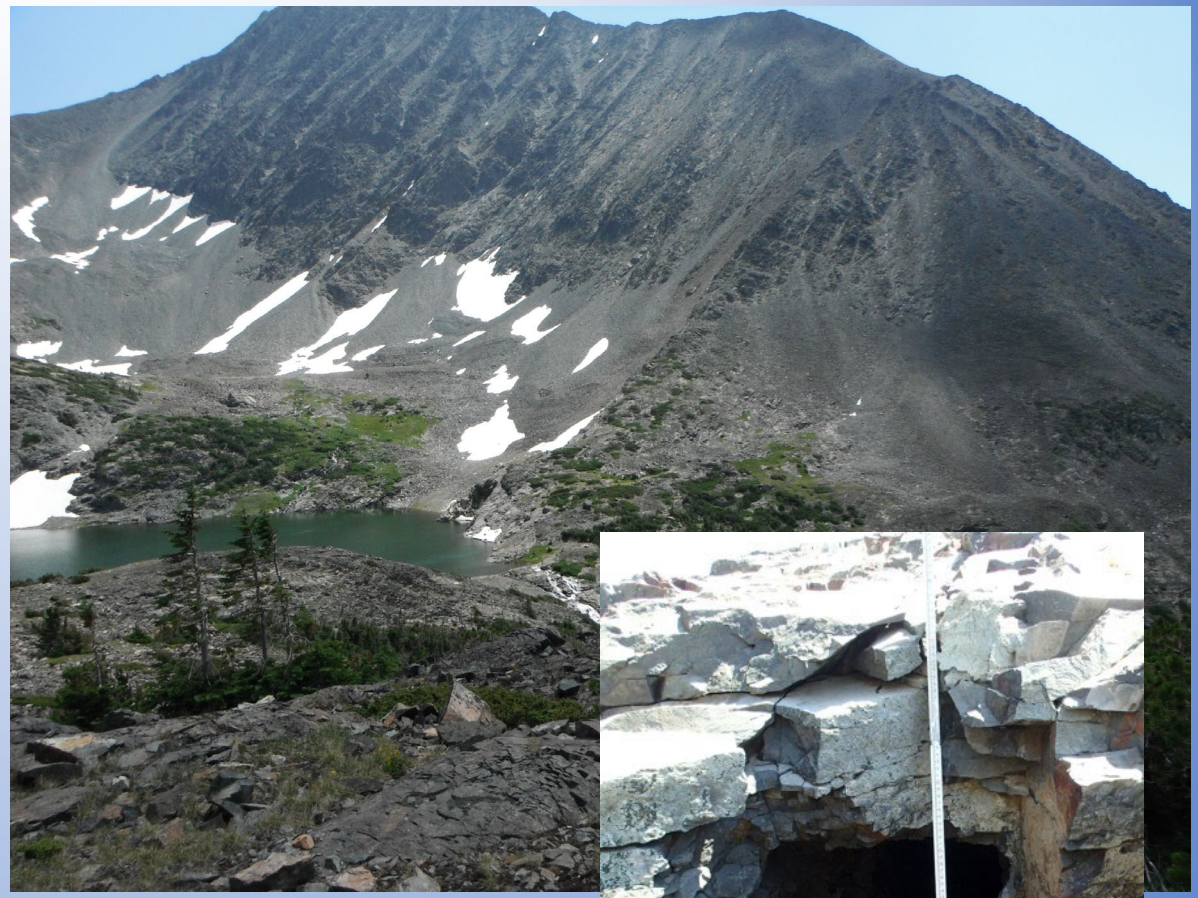


- Not High Hazard Dam located in Crazy Mountains.



Unique Construction

- Dam Height = 10 feet, 487 AF
- Operating Pool Depth = 40 feet, 1454 AF



Additional Reservoir storage created in 1966 by tunneling/blasting through mountain

2022 Survey

STAHLY ENGINEERING & ASSOCIATES
PROFESSIONAL ENGINEERS & SURVEYORS
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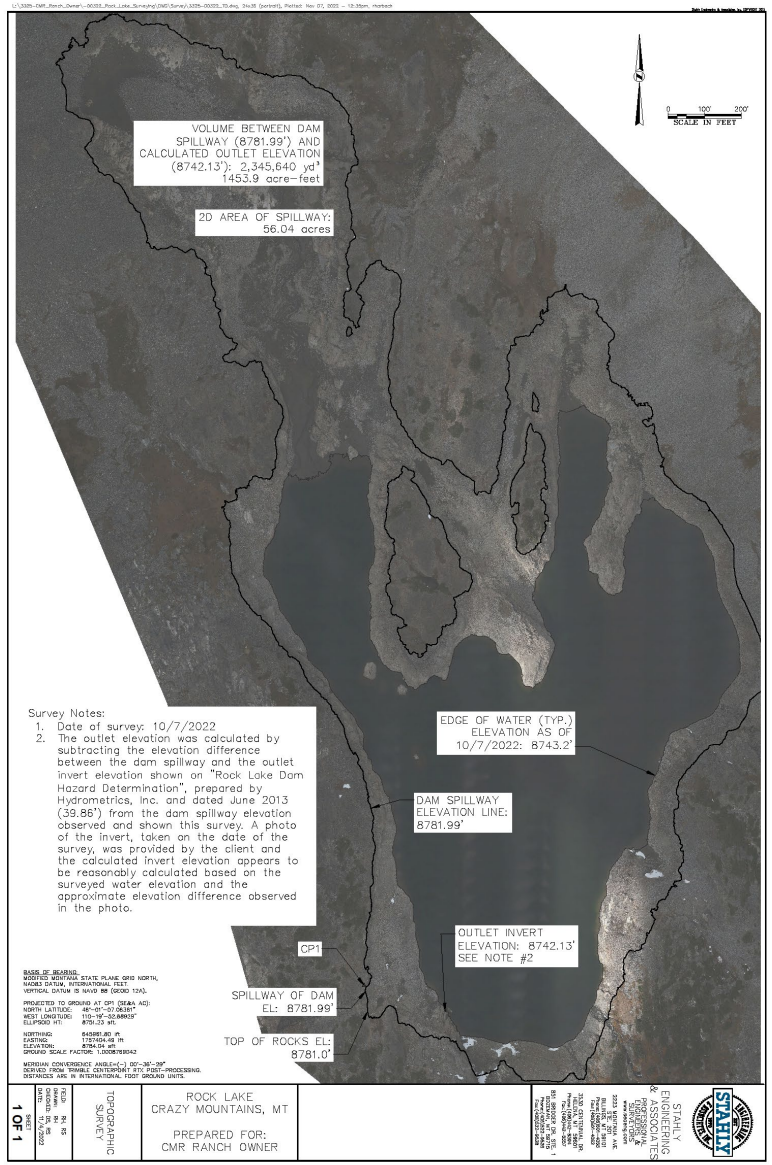
- Survey Performed using Drone and Ortho-imagery.
- Survey Performed at Low Water Level.
- Survey Gave Accurate and Detailed Bathymetric Map
- Level of Accuracy = approx. +/- 0.5 feet.
- Control Point Set During Survey.
- Hydrometrics Used Survey to Develop Accurate Stage-Storage Curve.



2024 Failure

July 17, 2024

Existing Gearbox Failed During Initial Operation of the Year, with Full Reservoir Pool on Original Gate.

2024 Emergency Repair

Planning for Repair, Sourcing of Materials, Equipment, Mobilization to Site and Installation of Emergency Fix All **Performed in 6 Days**

Emergency Repair Completed on July 23, 2024

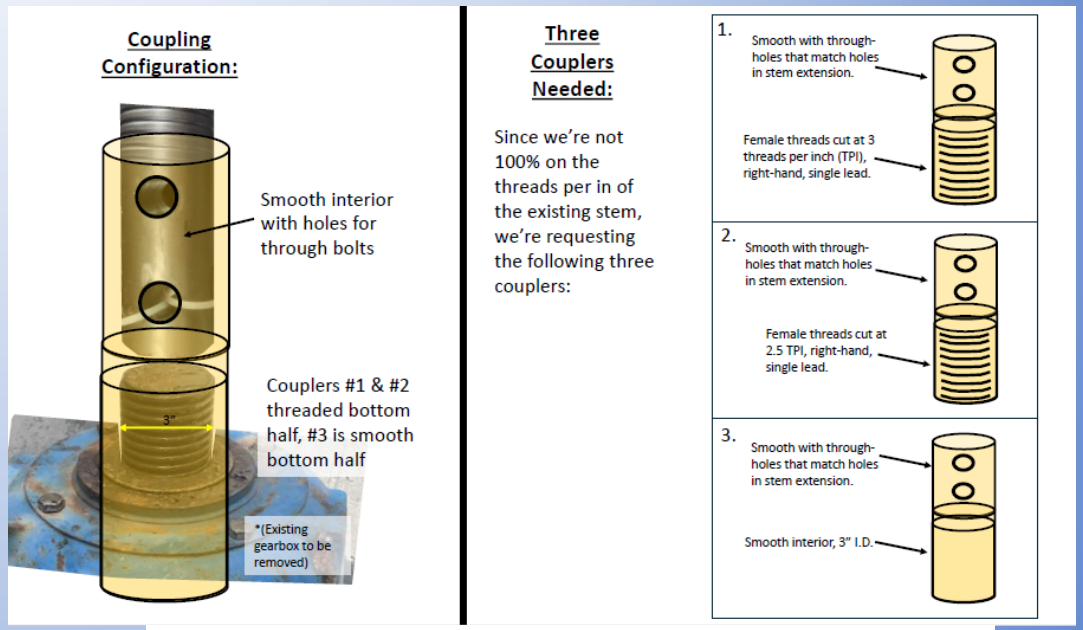
Previous site visits, & sourcing of “off-the shelf” equipment and materials was

CRITICAL!!!!

2024 Emergency Repair

Biggest Unknowns Going into Emergency Repair

- Thread pitch, lead and spacing of original stem
  - Believed was 3 TPI, single lead
  - Brought 3TPI, 2.5 TPI, and smooth machined couplers
- Force needed to break free gate
  - Performed Force Calculations (Estimated at ~ 40,000-50,000 pounds of lifting force needed to break gate free), ~3,000-4,000 ft-lbs .
  - Brought TWO gearboxs that were big enough, and that were "on the shelf"
  - Designed and Fabricated a "yoke" to sit on top of the structure.
- Limited most unknowns by bringing in a "system" that was self contained and didn't rely on existing components.
  - Finding a 3" stem was difficult.



Required Lifting Force

To determine the lifting force required to open a gate, the following formula is used:

$$F = 62.4APf+W+w+dp$$

Where:

F = lifting force required in pounds
A = area of gate opening in square feet
P = effective head of water in feet
f = coefficient of friction
W = weight of gate slide in pounds
w = weight of stem in pounds
dp = downpull in pounds

2024 Emergency Repair

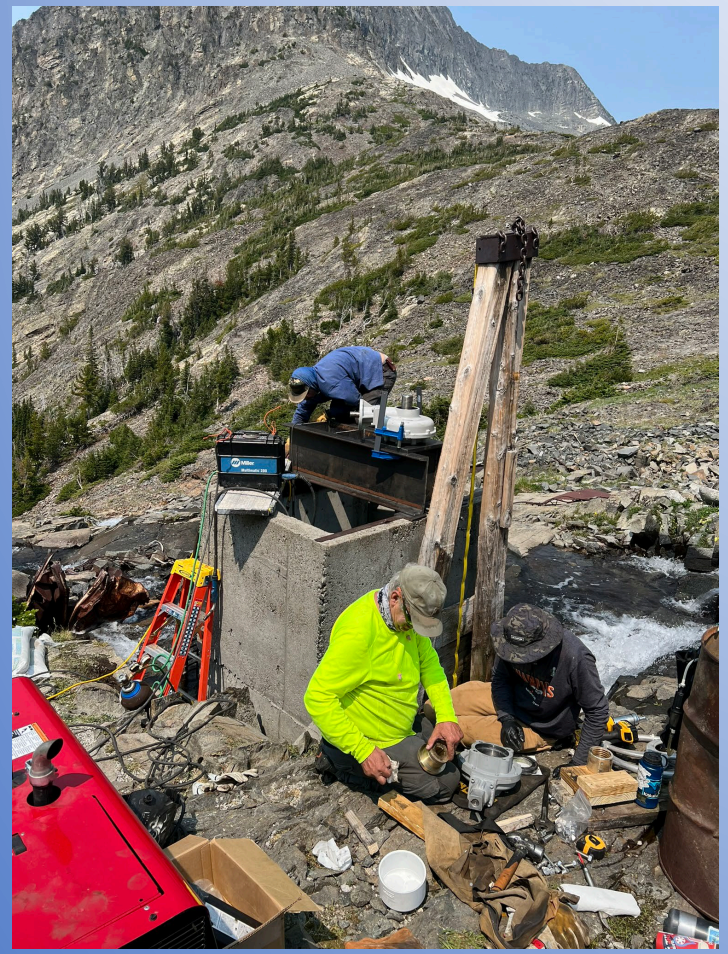
HERE IT COMES

AND

IT FITS!

2024 Emergency Repair

GEARBOX SETUP



GEARBOX CONFIGURATION

YOKE INSTALLATION

2024 Emergency Repair

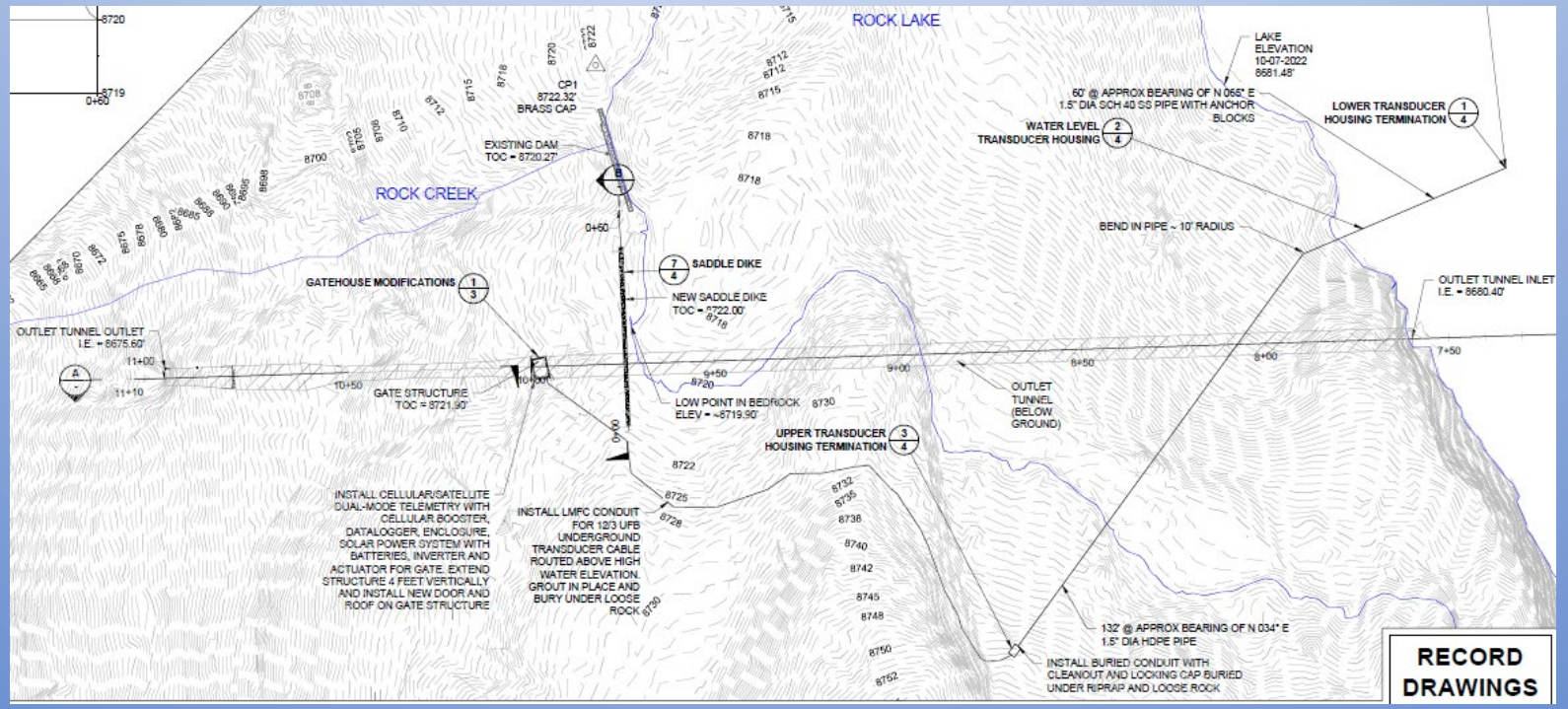
EMERGENCY REPAIR COMPLETE WITH 2 DAYS OF ONSITE WORK

2024…2 months later

The Emergency Repair worked, but it did not address the primary causes of the gearbox failure…exposure of the gearbox to weather

Sept/Oct 2024 Improvement Objectives

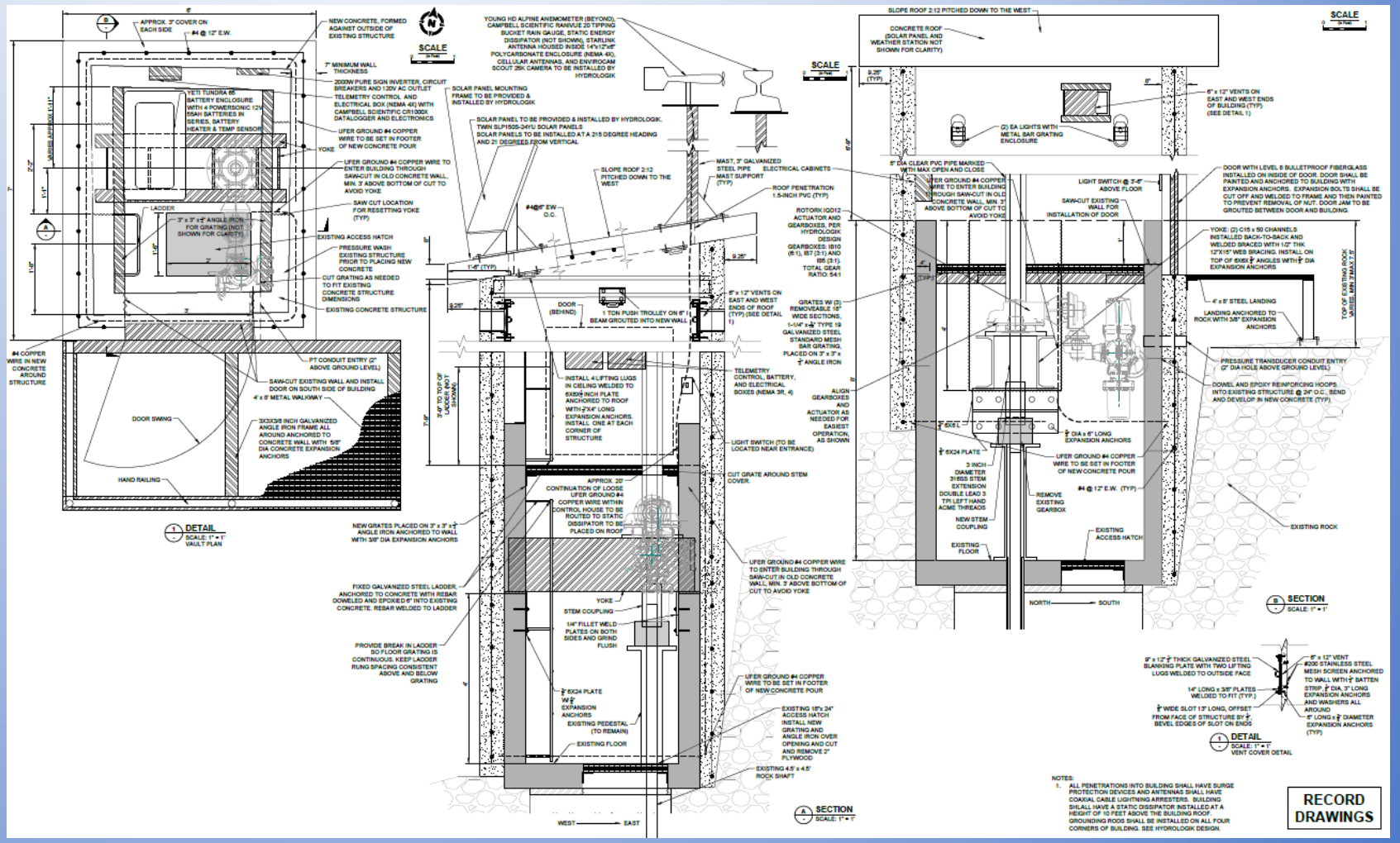
- Install Permanent Structure Over Gearbox
- Install Operation System to Operate Gate Remotely
- Install Telemetry and Monitoring System to Observe and Monitor Reservoir, System, & Weather Conditions
- Install Reservoir Level Monitoring System
- Install Outlet Flow Monitoring System
- Install Saddle Dike to Protect Structure
- Repair Existing Dam



Mobilization / Demobiliztion

Gatehouse

- Protects system from elements and vandalism.
- Houses controls, batteries, gearboxes, and other critical system components.



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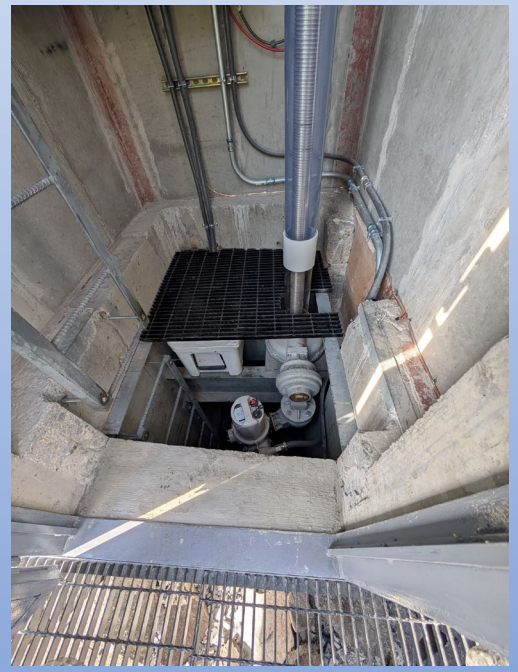
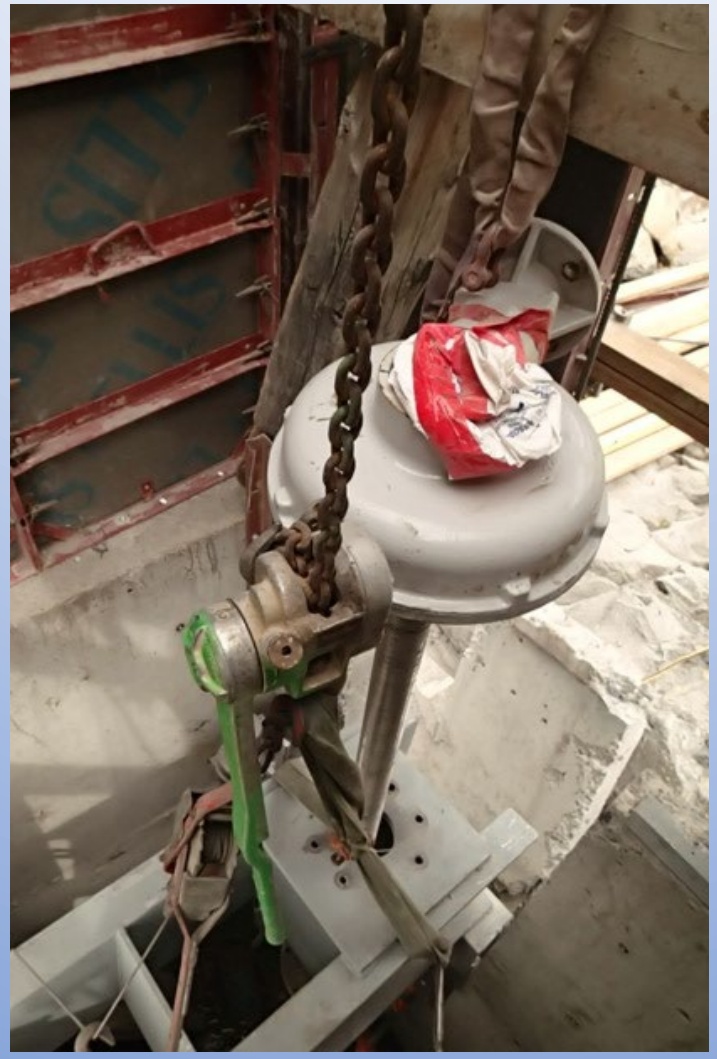


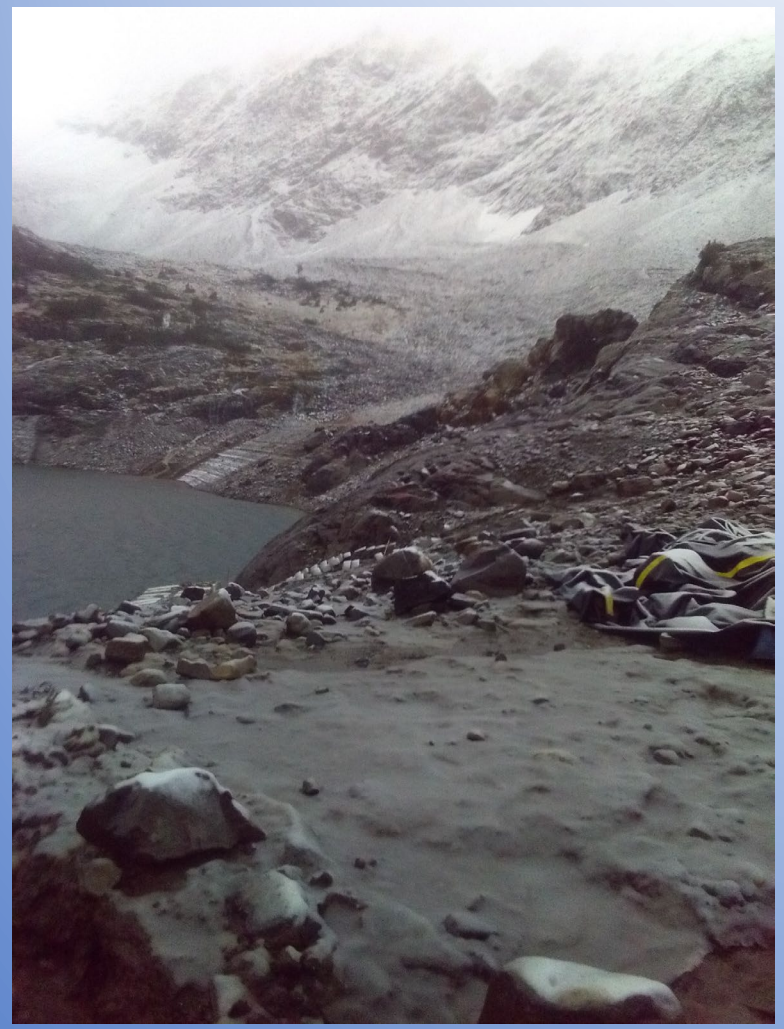
Gatehouse Construction



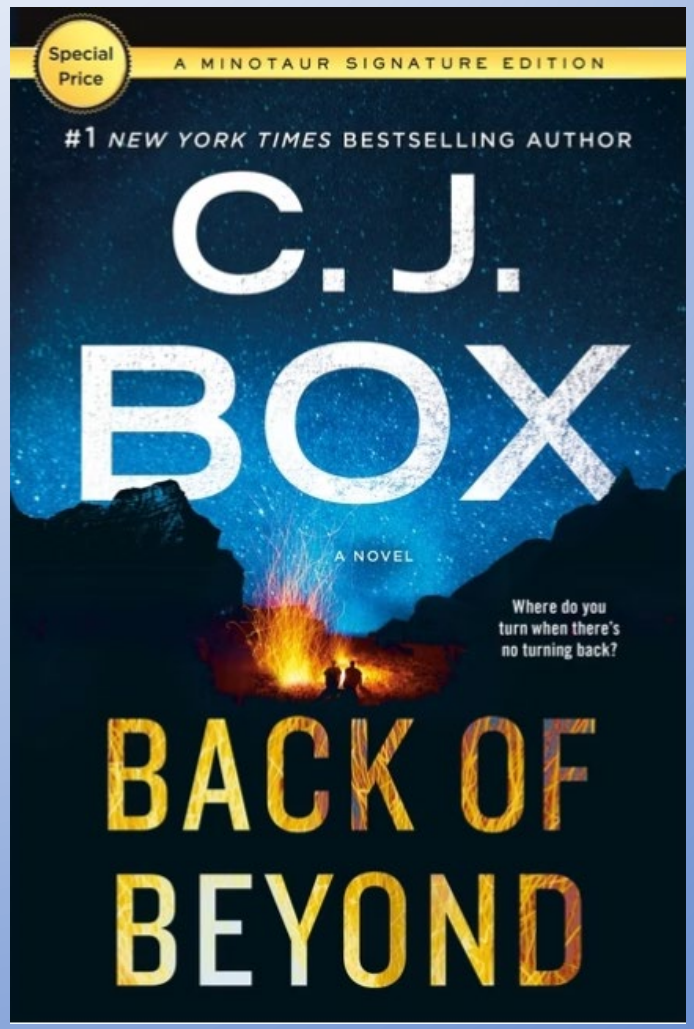
Gatehouse Construction

Gatehouse Construction

CONSTRUCTION PROBLEMS



CONSTRUCTION SOLUTIONS



Gatehouse Construction

Gatehouse Construction

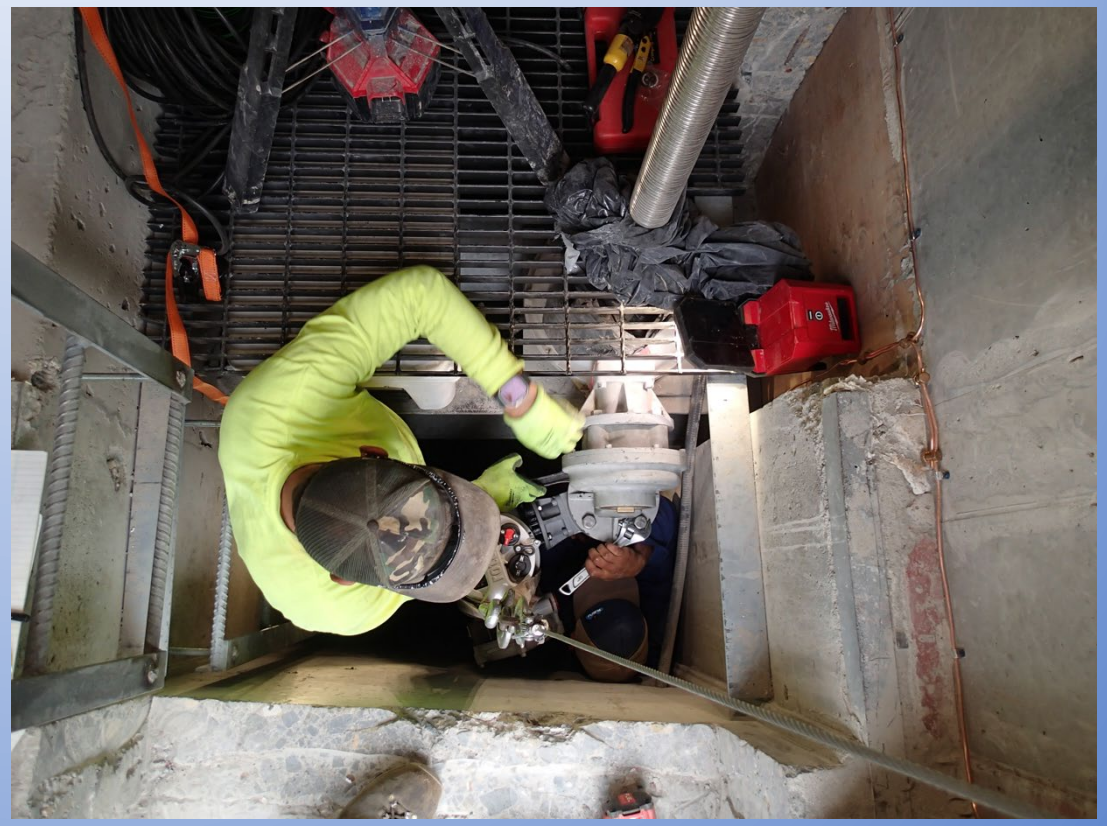
Gatehouse Construction

Gatehouse Construction

- Once we didn’t have that “thing”, and the “thing” couldn’t wait.
  - The 3/4-inch anchor bolts and nuts we had brought for the ladder went missing somewhere (presumably flown out by accident).
  - So, anchor bolt epoxy and a welder did the trick.
  - The ladder was properly “tested” prior to being put into service.

Gatehouse Construction

- Sometimes it was a tight fit.



Saddle Dike

- Protects system from flood waters

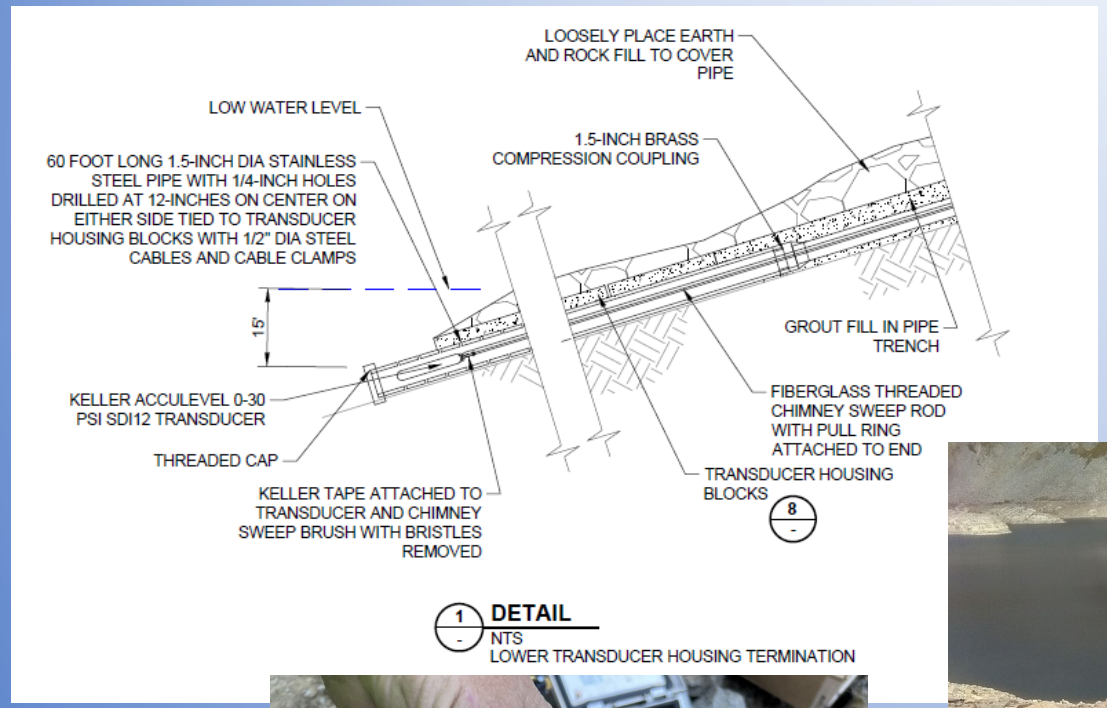
Dam Repair

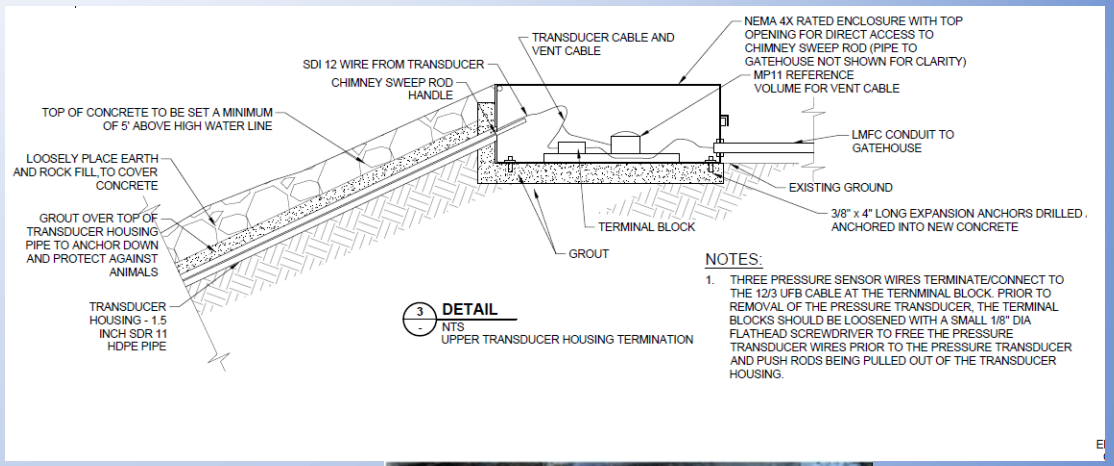
- Concrete was deteriorating due to corrosive water
- Repaired cracks and installed epoxy cured cement coating to surface

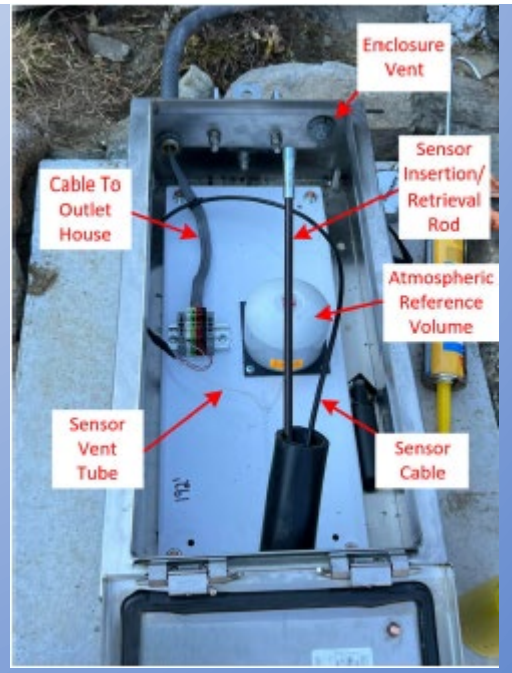
Before

After

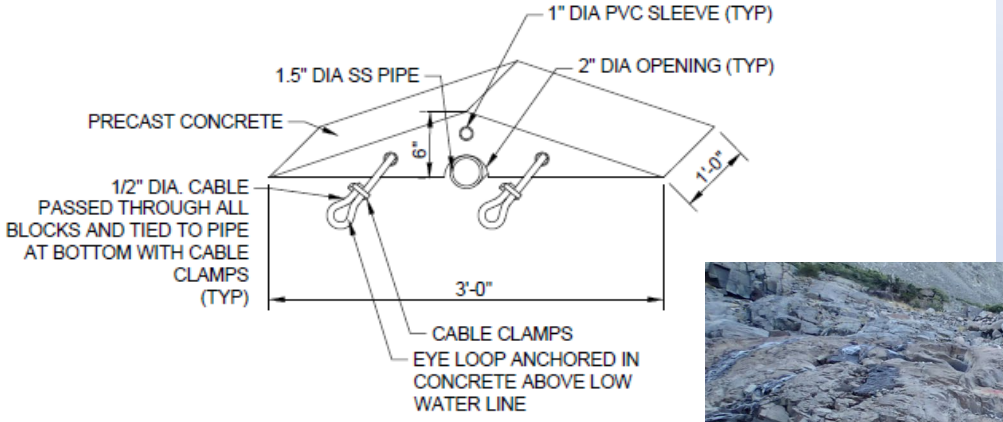
Transducer


LOOSELY PLACE EARTH AND ROCK FILL TO COVER PIPE
LOW WATER LEVEL
1.5-INCH BRASS COMPRESSION COUPLING
60 FOOT LONG 1.5-INCH DIA STAINLESS STEEL PIPE WITH 1/4-INCH HOLES DRILLED AT 12-INCHES ON CENTER ON EITHER SIDE TIED TO TRANSDUCER HOUSING BLOCKS WITH 1/2" DIA STEEL CABLES AND CABLE CLAMPS
15'
GROUT FILL IN PIPE TRENCH
FIBERGLASS THREADED CHIMNEY SWEEP ROD WITH PULL RING ATTACHED TO END
KELLER ACCULEVEL 0-30 PSI SDI12 TRANSDUCER
THREADED CAP
TRANSDUCER HOUSING BLOCKS
KELLER TAPE ATTACHED TO TRANSDUCER AND CHIMNEY SWEEP BRUSH WITH BRISTLES REMOVED
8
1
DETAIL
NTS
LOWER TRANSDUCER HOUSING TERMINATION

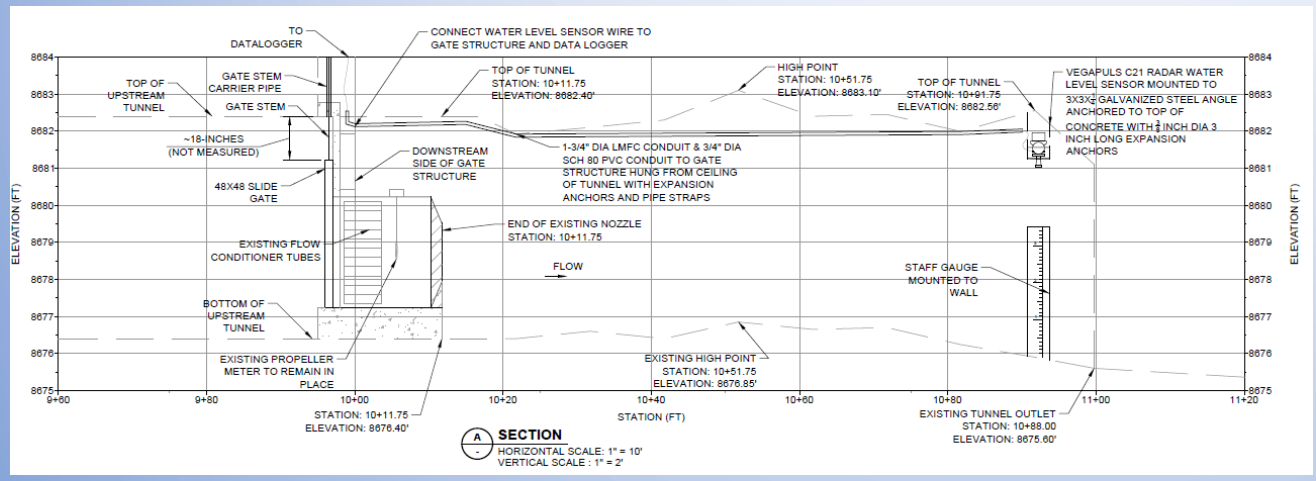

TRANSDUCER CABLE AND VENT CABLE
NEMA 4X RATED ENCLOSURE WITH TOP OPENING FOR DIRECT ACCESS TO CHIMNEY SWEEP ROD (PIPE TO GATEHOUSE NOT SHOWN FOR CLARITY)
SDI 12 WIRE FROM TRANSDUCER
CHIMNEY SWEEP ROD HANDLE
MP11 REFERENCE VOLUME FOR VENT CABLE
TOP OF CONCRETE TO BE SET A MINIMUM OF 5' ABOVE HIGH WATER LINE
LMFC CONDUIT TO GATEHOUSE
LOOSELY PLACE EARTH AND ROCK FILL,TO COVER CONCRETE
EXISTING GROUND
GROUT OVER TOP OF TRANSDUCER HOUSING PIPE TO ANCHOR DOWN AND PROTECT AGAINST ANIMALS
3/8" x 4" LONG EXPANSION ANCHORS DRILLED ANCHORED INTO NEW CONCRETE
TERMINAL BLOCK
GROUT
TRANSDUCER HOUSING - 1.5 INCH SDR 11 HDPE PIPE
3
DETAIL
NTS
UPPER TRANSDUCER HOUSING TERMINATION
NOTES:
1. THREE PRESSURE SENSOR WIRES TERMINATE/CONNECT TO THE 12/3 UFB CABLE AT THE TERNMINAL BLOCK. PRIOR TO REMOVAL OF THE PRESSURE TRANSDUCER, THE TERMINAL BLOCKS SHOULD BE LOOSENED WITH A SMALL 1/8" DIA FLATHEAD SCREWDRIVER TO FREE THE PRESSURE TRANSDUCER WIRES PRIOR TO THE PRESSURE TRANSDUCER AND PUSH RODS BEING PULLED OUT OF THE TRANSDUCER HOUSING.


Enclosure Vent
Cable To Outlet House
Sensor Insertion/ Retrieval Rod
Atmospheric Reference Volume
Sensor Vent Tube
Sensor Cable

Transducer Protection



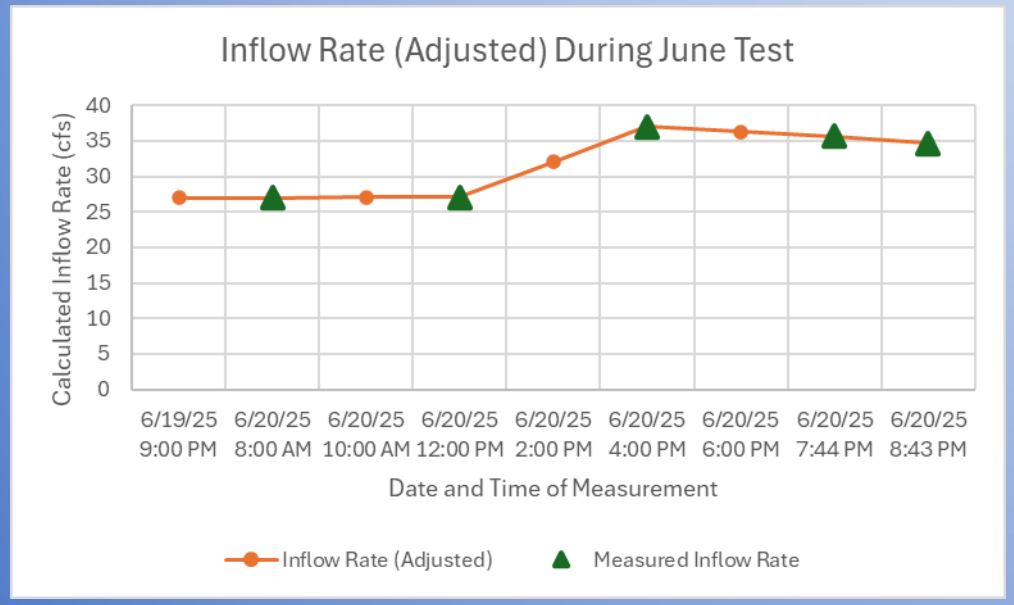
Outlet Tunnel Monitoring

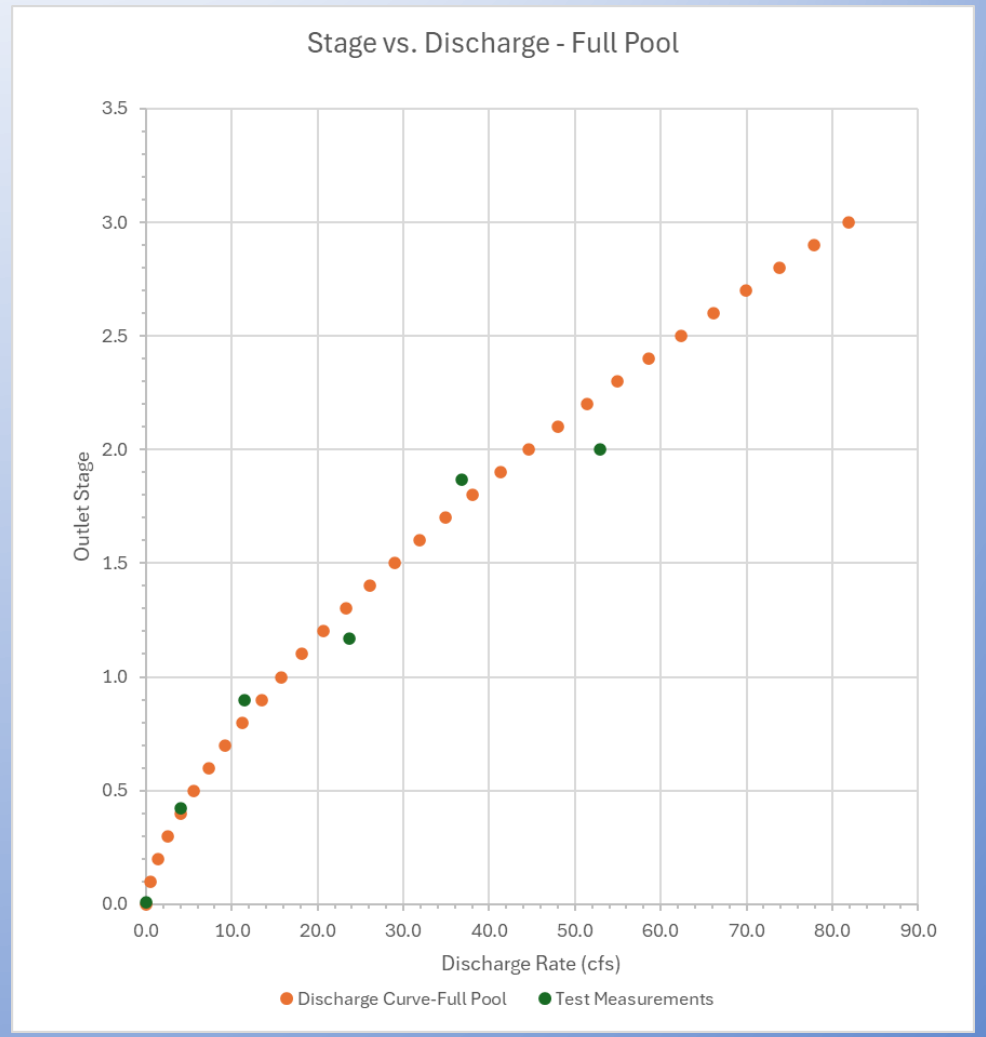


- Installation of a cutthroat flume was too expensive, so prepared custom outlet rating curve
- Avoided Changing Outlet Flow profile
- Supercritical flow conditions
- Measurements taken using a radar water level sensor
- Custom curve developed based on Stage-Volume-Inflow-Drawdown Calculation

Outlet Rating Curve Development

- Custom curve developed based on Stage-Volume-Inflow-Drawdown Calculation
- Due to water rights consideration, development needed to occur during a significant rainstorm



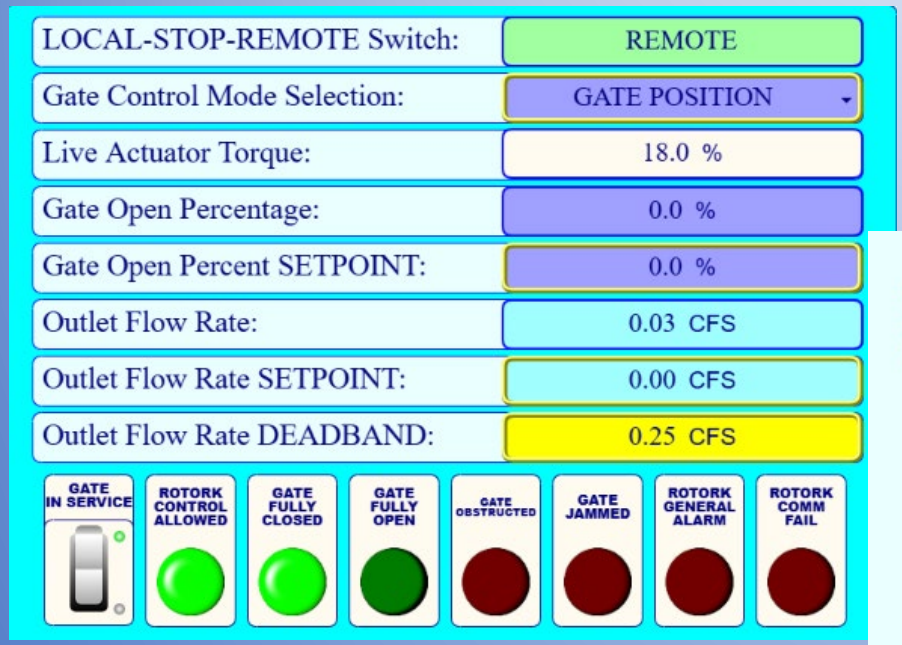


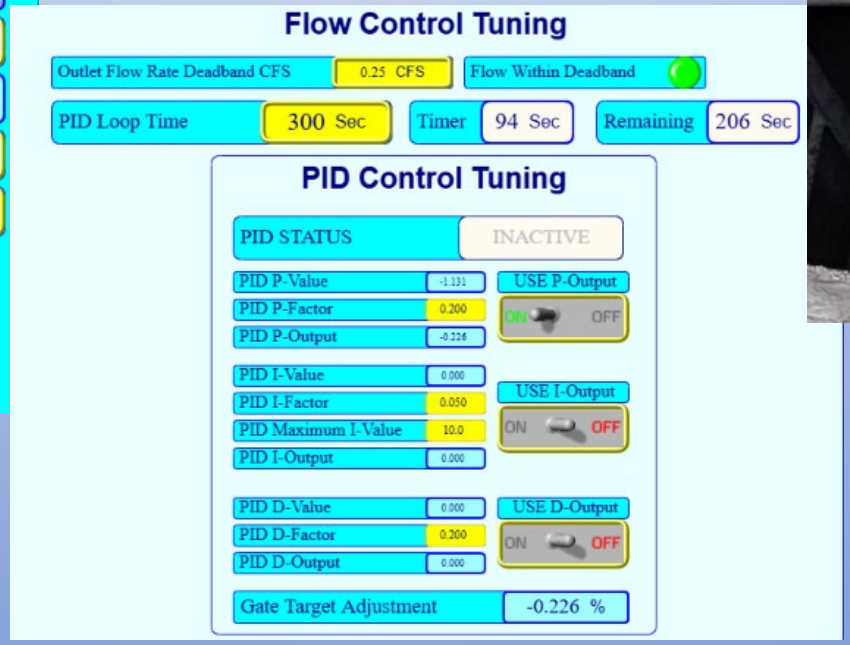
Controls Construction

- Bringing Pre-assembled Materials Significantly reduced onsite time and risk of missing parts…unlike those 5/8 inch SS anchor bolt nuts

Controls

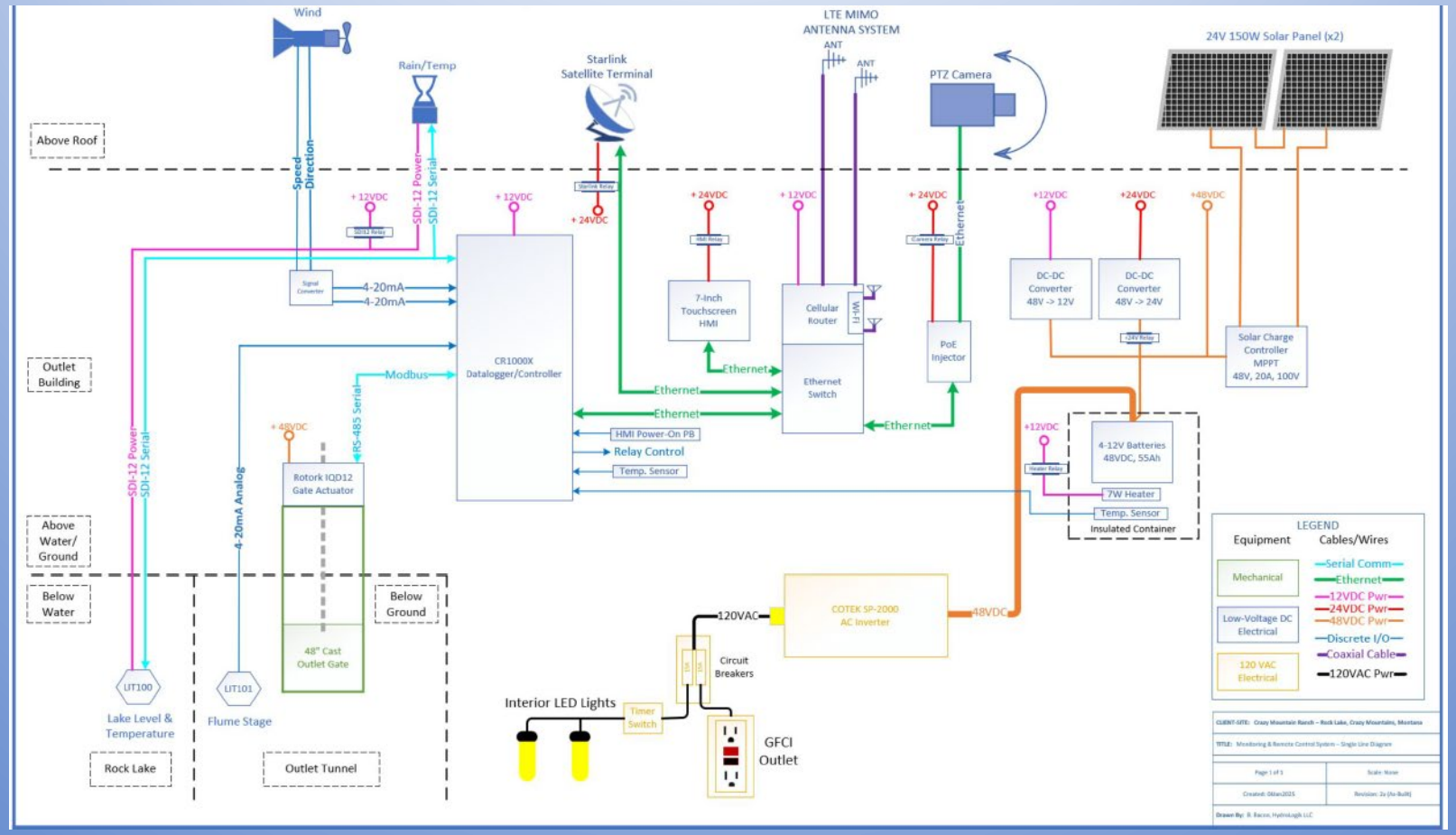
- Gate Operations can be performed both manually and remotely
- Gate Can be set to a position point, or set to a flow point





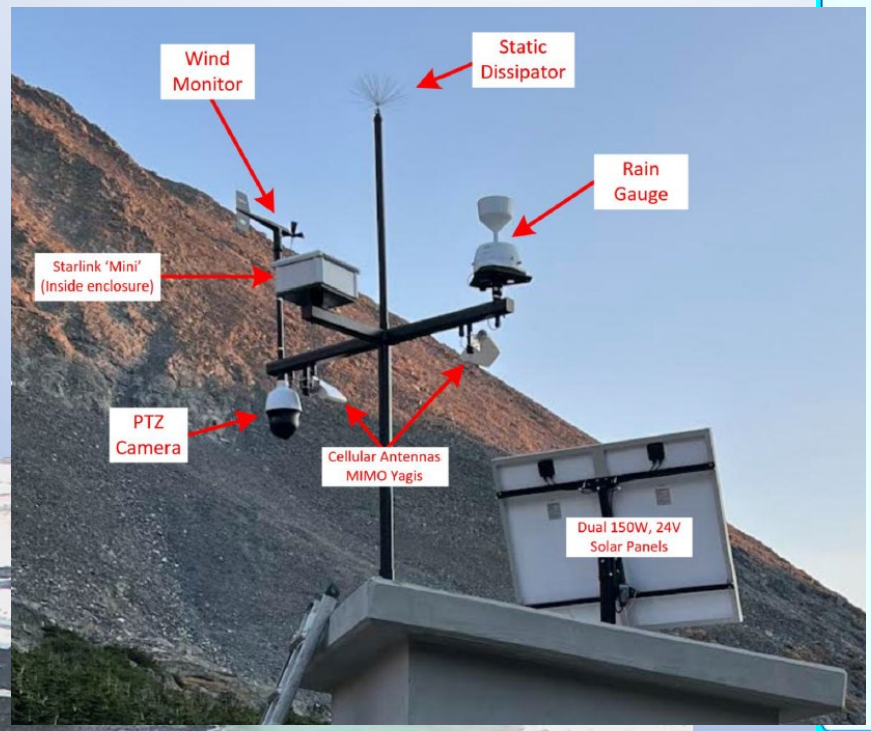
Controls

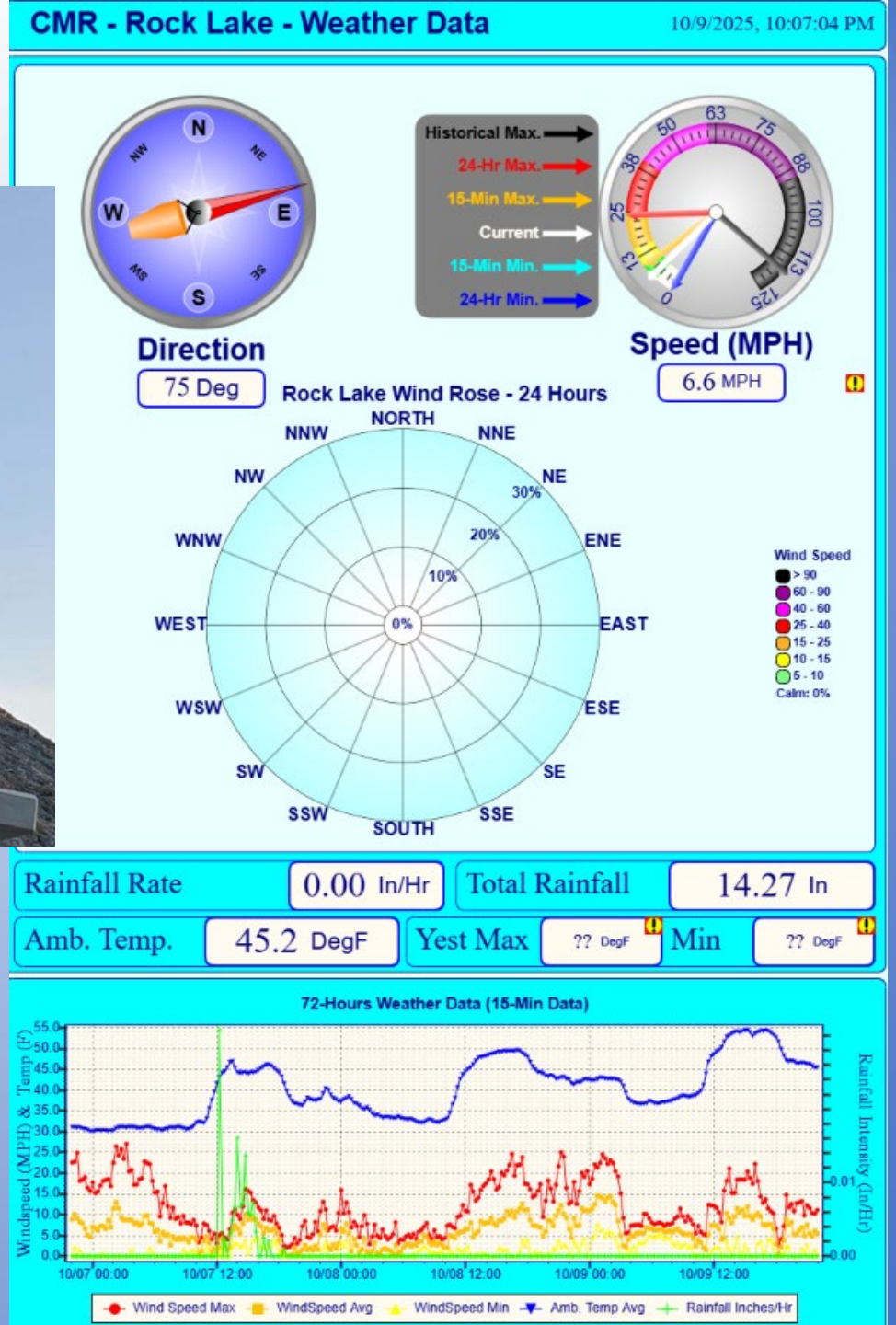
- Complex Wiring is simplified by separating out components into different circuits that can be turned off and on as needed.
- All circuits are monitored and controlled by the central datalogger/controller.



Weather Monitoring

- Anemometer
  - 117 mph max wind recorded
- Rain Gauge
- Camera





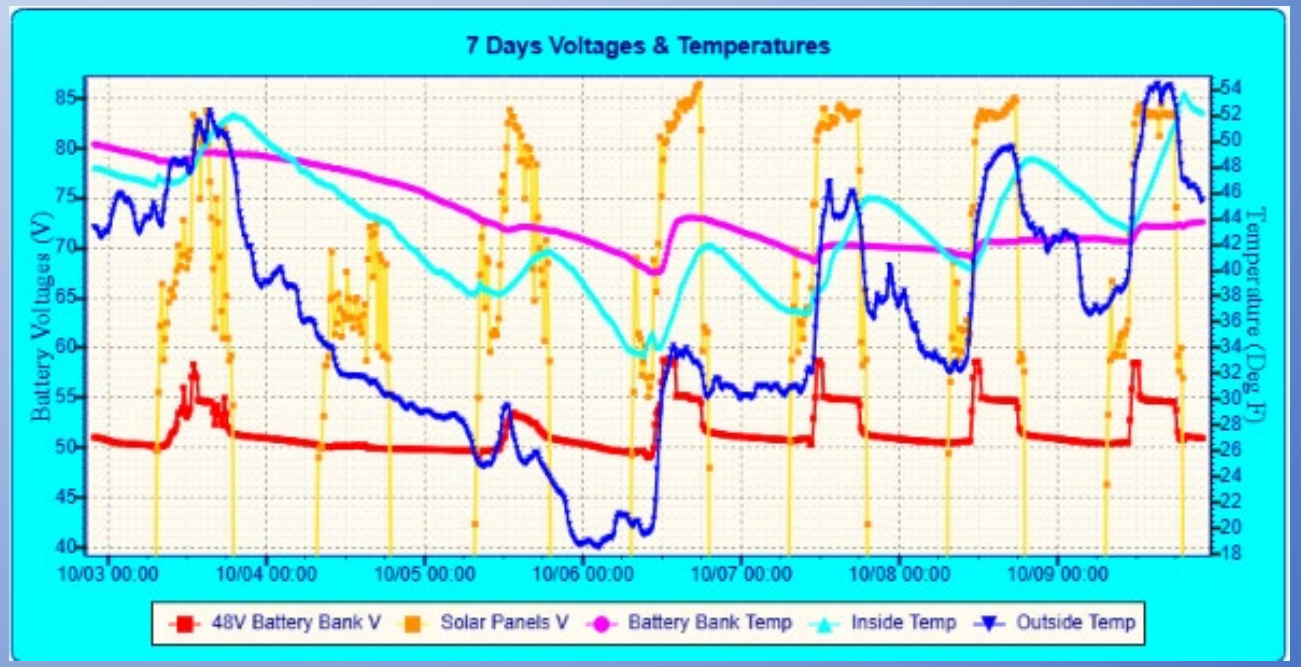
System Monitoring

- Active and Current Battery and Temperature Monitoring
- Power intervention Built into datalogger programming
- Cellular & Satellite Telemetry

System Information 10/9/2025, 10:15:34 PM

	Voltages		Temperatures
Solar Panel Voltage	0.01 V	Outdoor	45.0 DegF
48V Battery Bank	50.92 V	Battery Box	43.8 DegF
24V DC-DC Power	-0.00 V	Indoor	52.0 DegF
12V DC-DC Power	13.67 V	Controller	53.9 DegF

Battery Heater ON Threshold	15.0 DegF	ENABLE
Battery Heater OFF Threshold	25.0 DegF	
Load Shedding Trig. Voltage	46.0 V	ENABLE
Load Shedding Hold-Off Time	120 Sec	
Winter Auto Power-Down Time	3,600 Sec	ENABLE
Power-Down Countdown	3,600 Sec	Reset



QUESTIONS?

Contact Information

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