

Dam Decisions! Understanding Dam Maintenance and Repair

NH Lakes Webinar – July 29, 2026

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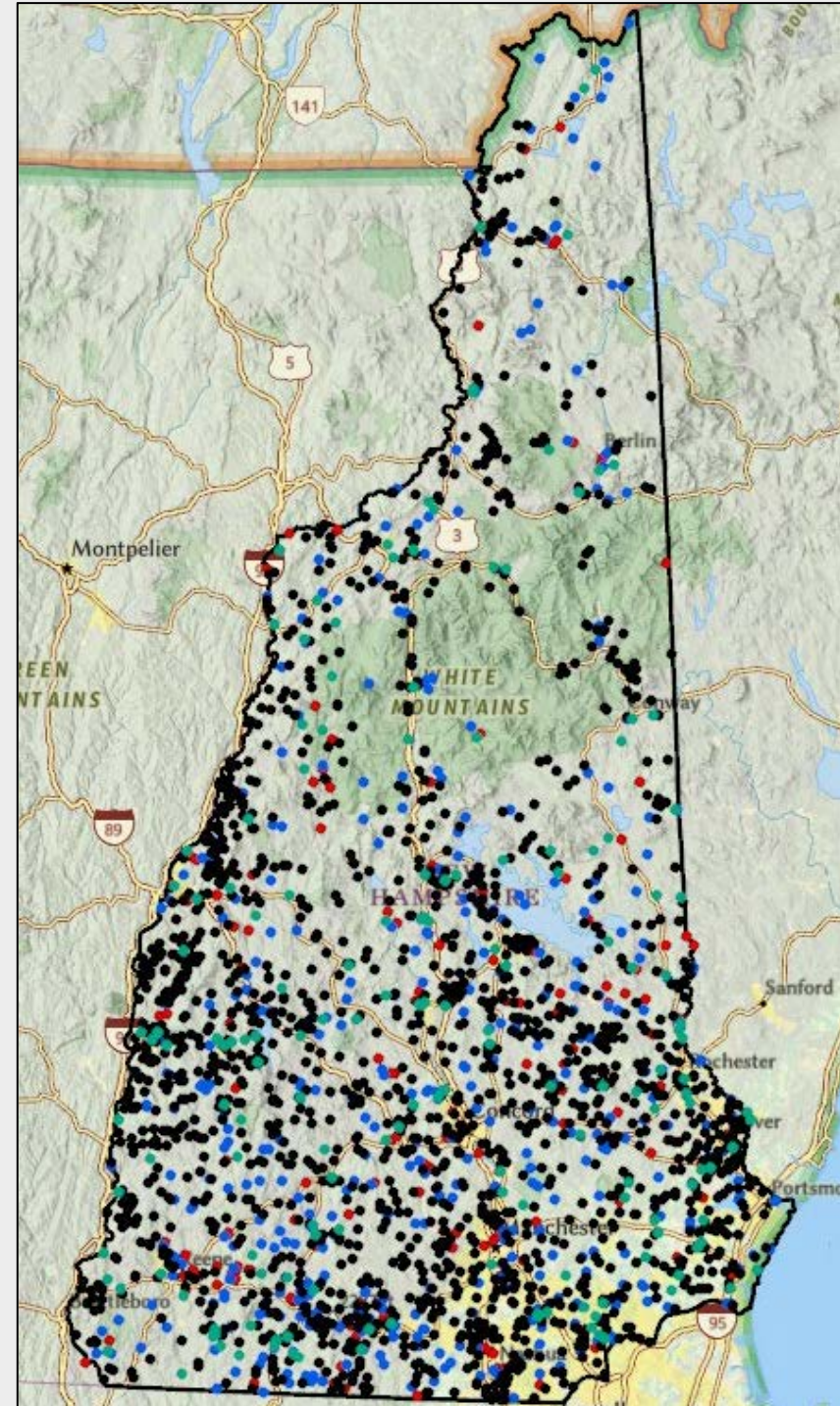


What is a dam in New Hampshire?

- **RSA 482:2(II)(a) " Dam "** means any artificial barrier, including appurtenant works, which impounds or diverts water and which has a height of 6 feet or more, or is located at the outlet of a great pond.
- **High Hazard Dam** – failure of the dam would result in probable loss of human life
- **Significant Hazard Dam** – failure would likely not result in loss of human life but would cause major economic damage (e.g. loss of State road)
- **Low Hazard Dam** – failure would likely not result in loss of human life but would cause minor economic damage (e.g. loss of town road)
- **Non-Menace Dam** – failure would not cause life loss or damages

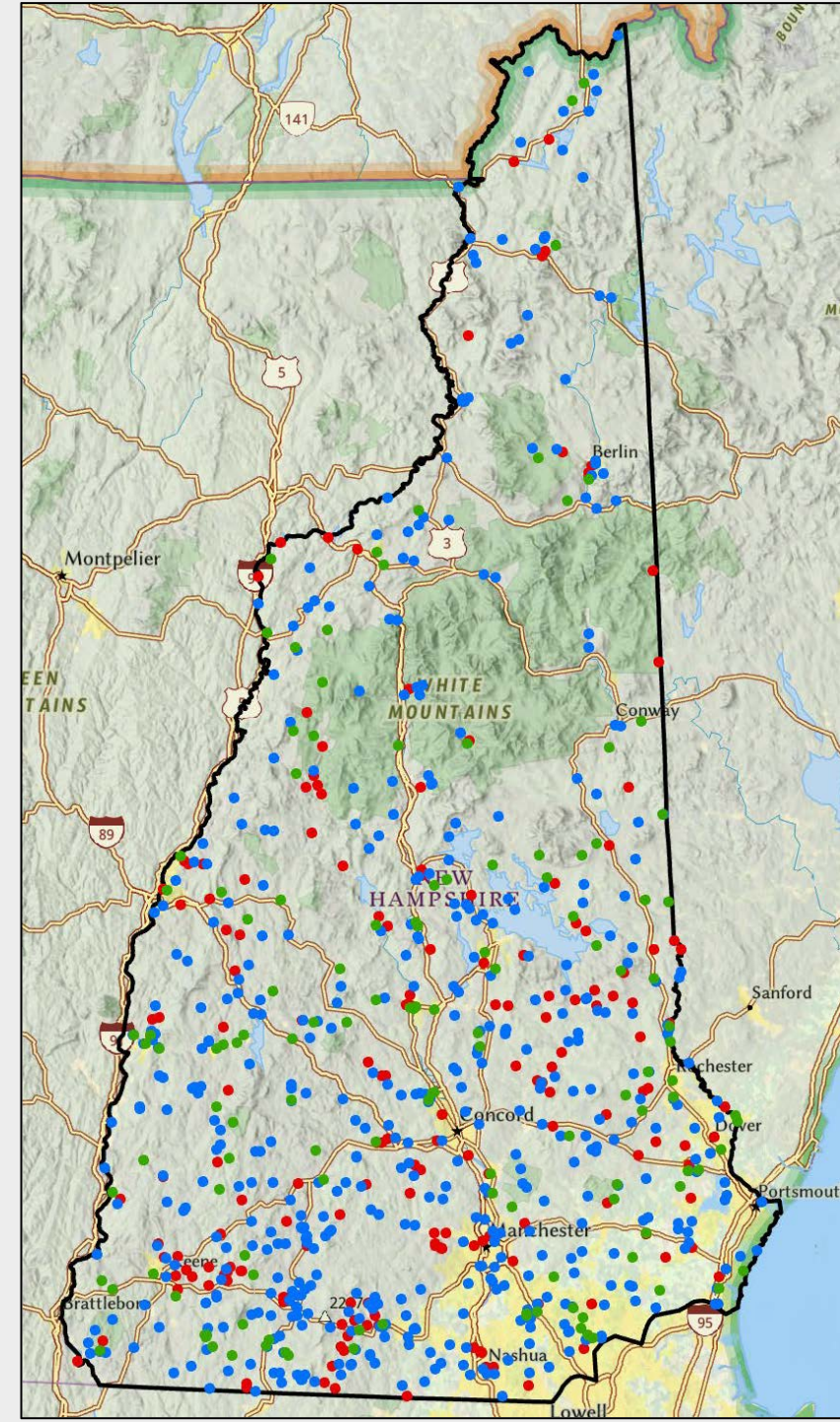
How many dams are in New Hampshire?

- **5,251 dam records**, these are all the dams that are currently active and those that were active at one time
- **2,596 active dams**, these are all the dams that currently meet the definition of a dam (active dams)
- **814 hazardous dams**, these are all the dams that pose a threat to downstream property, infrastructure or lives



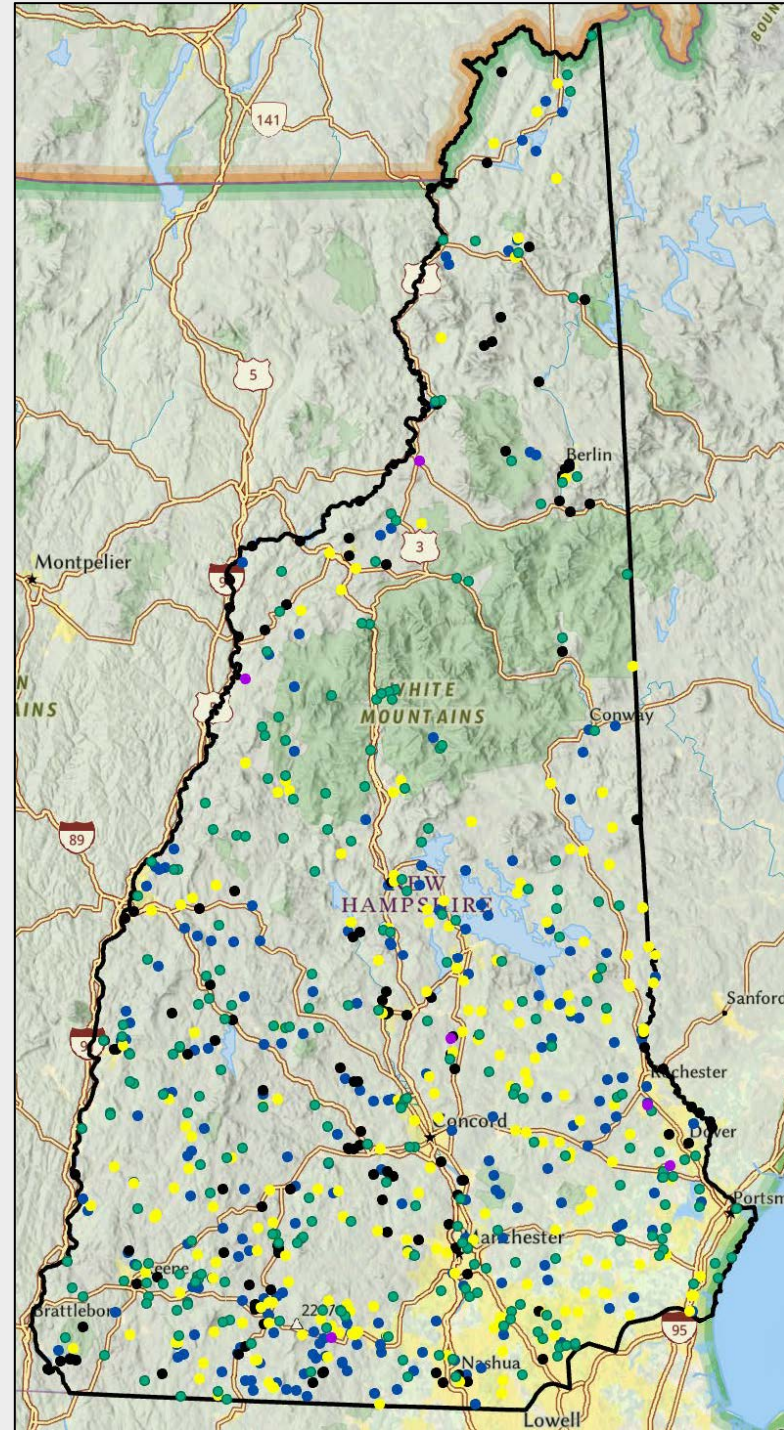
How many hazardous dams are in New Hampshire?

- 814 hazardous dams
- 179 high hazard dams (red)
- 131 significant hazard dams (green)
- 503 low hazard dams (blue)
- 1783 non-menace dams (not shown)

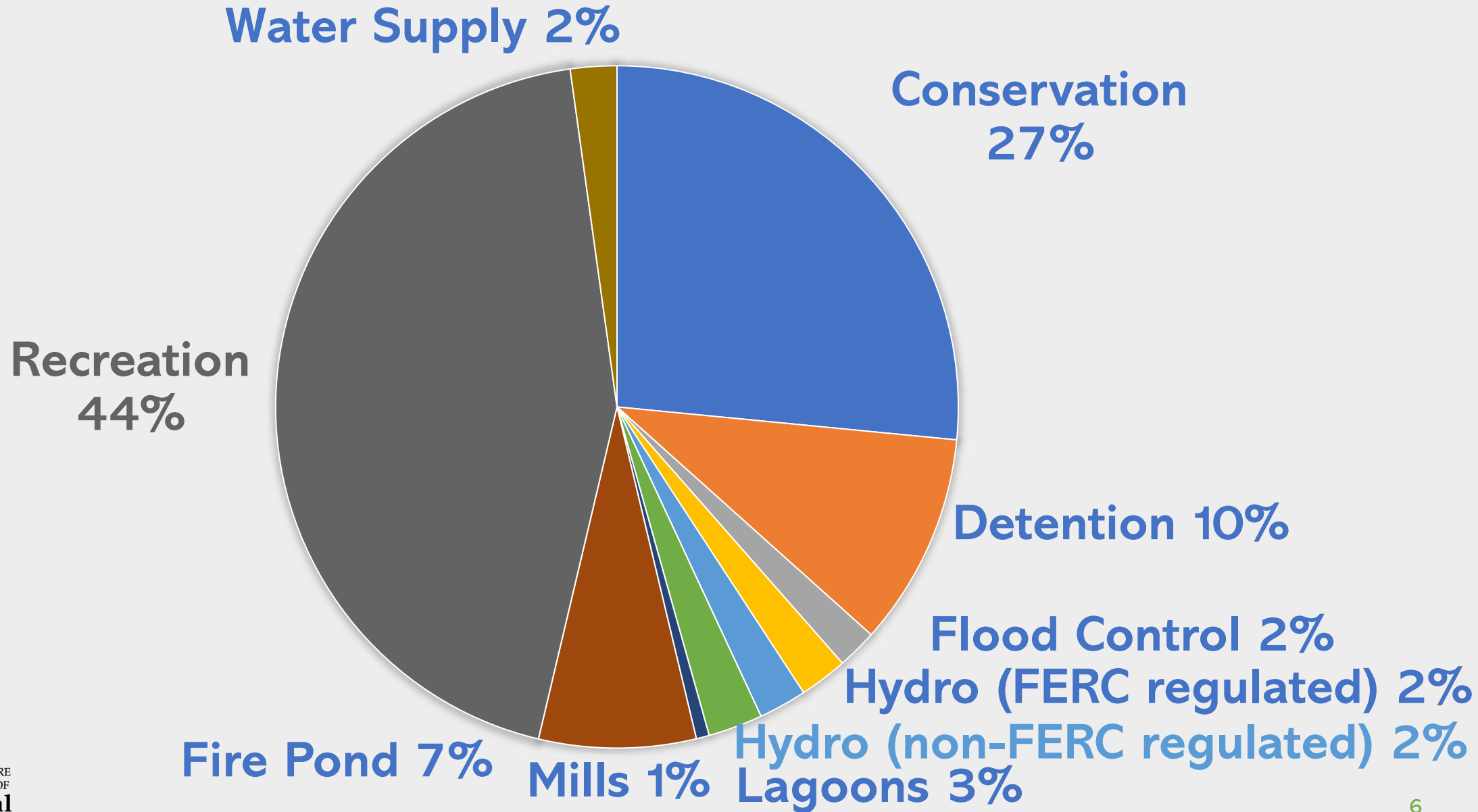


What is the condition of dams in New Hampshire?

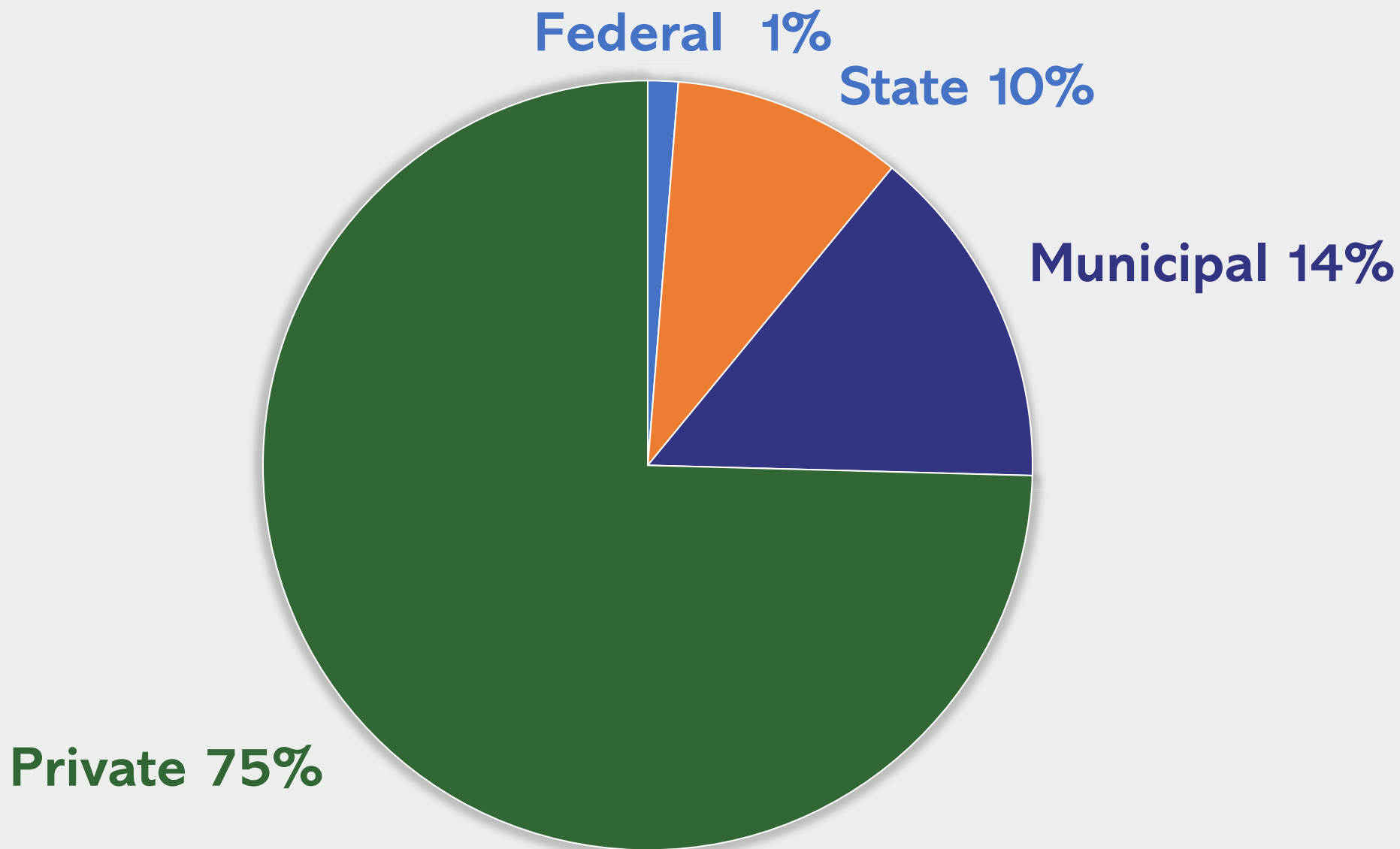
- **251 Satisfactory (green)** Meets all loading conditions with little to no deficiencies.
- **223 Fair (blue)** Meets all loading conditions with minor deficiencies that may require remedial action.
- **205 Poor (Yellow)** A deficiency is recognized for any loading condition and remedial Action is necessary.
- **6 Unsatisfactory (purple)** Considered unsafe. A deficiency is recognized that requires immediate action. Reservoir lowering may be necessary.
- **129 Not Rated (black)**(pending, FERC, USACOE)



What is the purpose of New Hampshire Dams?



Who are the owners of dams in New Hampshire?



Dam Bureau Overview



**Dam Safety
and Inspection
Section**



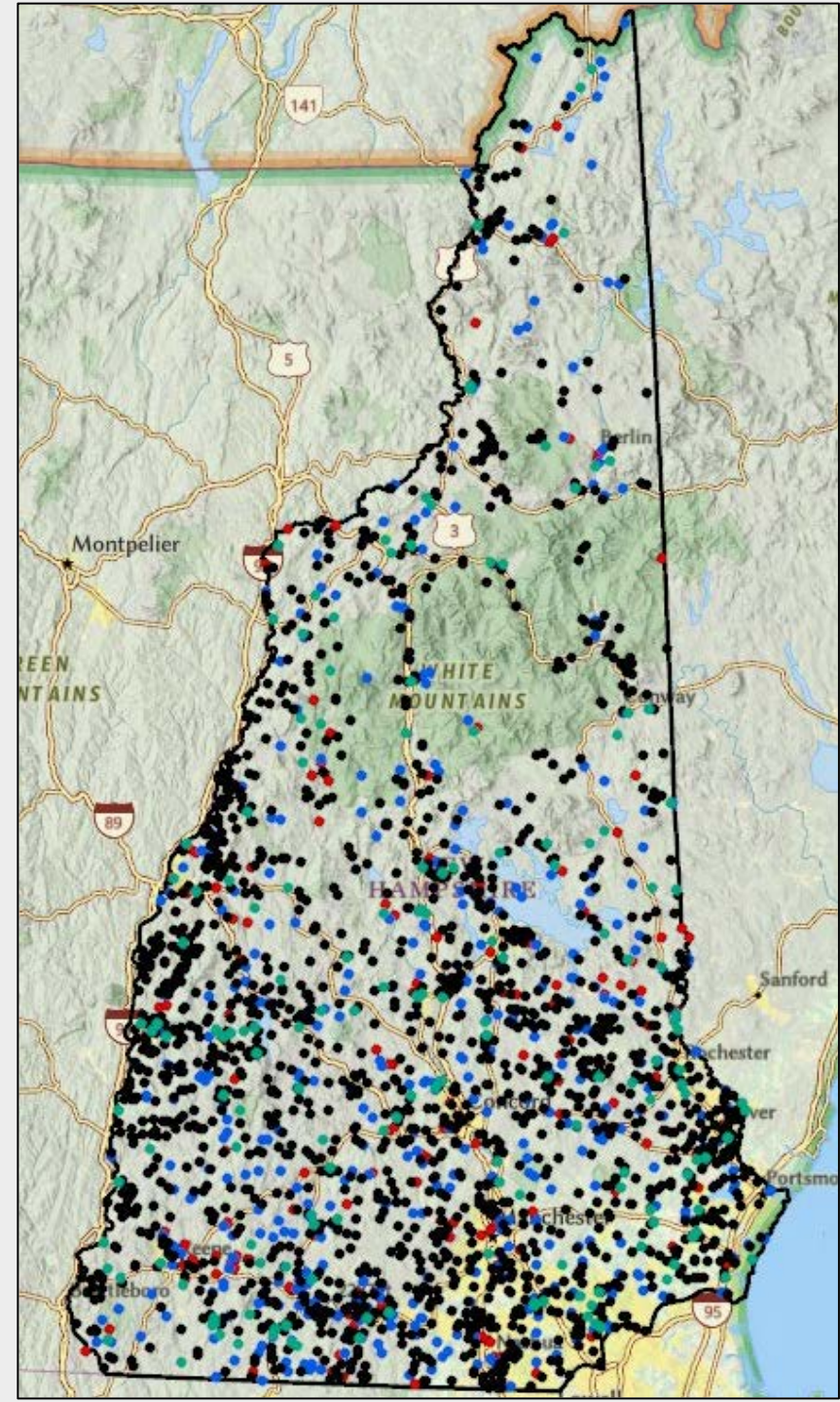
**Operations and
Maintenance
Section**



**Engineering and
Construction
Section**

Dam Safety and Inspection Section

- Responsible for inspection of **2,596** privately and publicly owned dams. This includes routine inspections and construction inspections.
- Responsible for permitting of repairs on existing dams and permitting for new dam construction.



Dam Safety and Inspection Section

- Works with dam owners to ensure dams are operated and maintained in proper working order and works with AG's office on enforcement actions
- Coordinates with Federal Energy Regulatory Commission (FERC) on inspections and permitting actions for hydropower projects



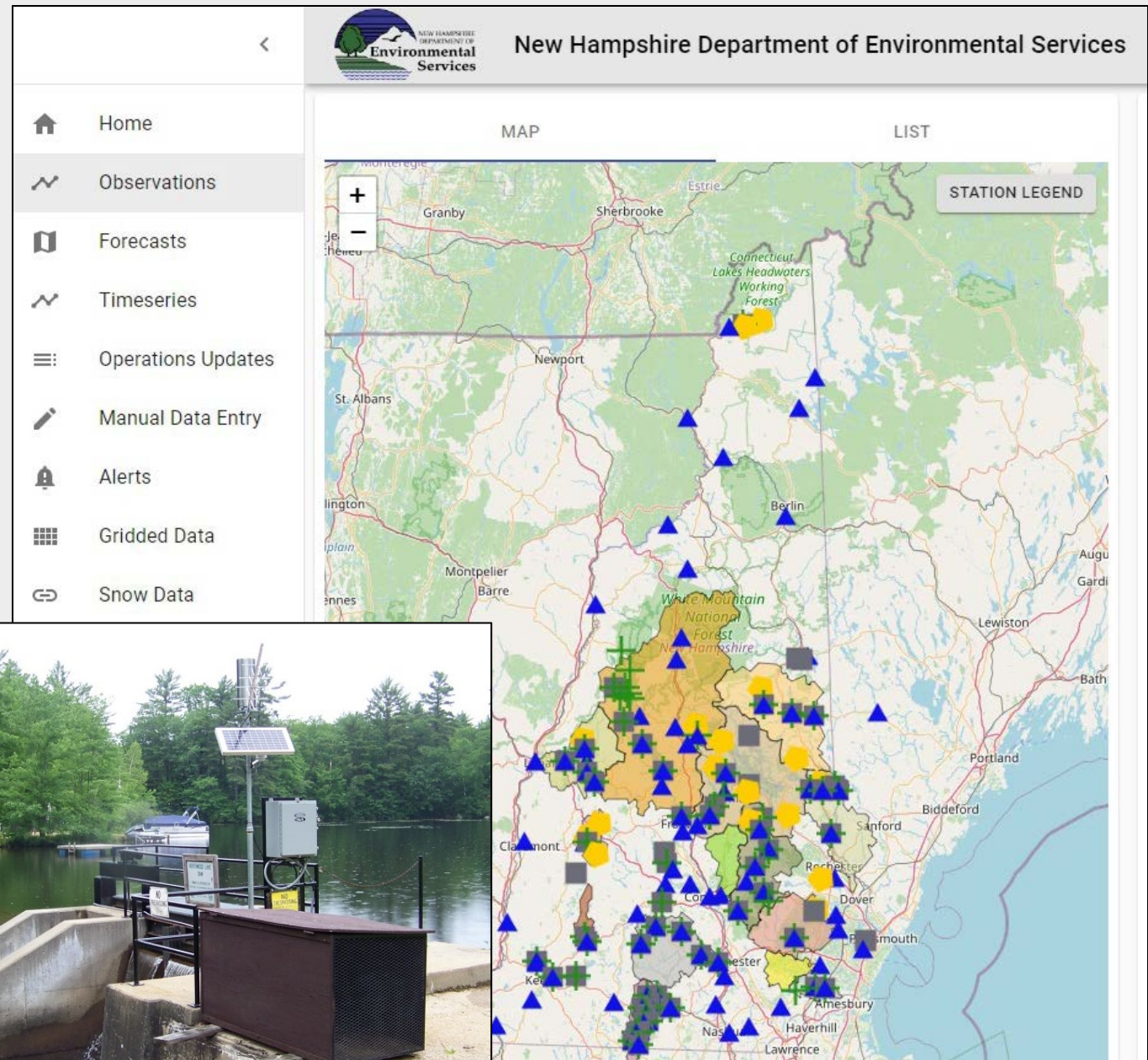
Operations and Maintenance Section

- Responsible for the operations and maintenance of **202 dams**.
- Responsible for maintaining dams and lake levels at the State's largest lakes (e.g., Lake Winnepesaukee, Lake Winnisquam, Squam Lake, Newfound Lake, Lake Sunapee, Lake Ossipee)



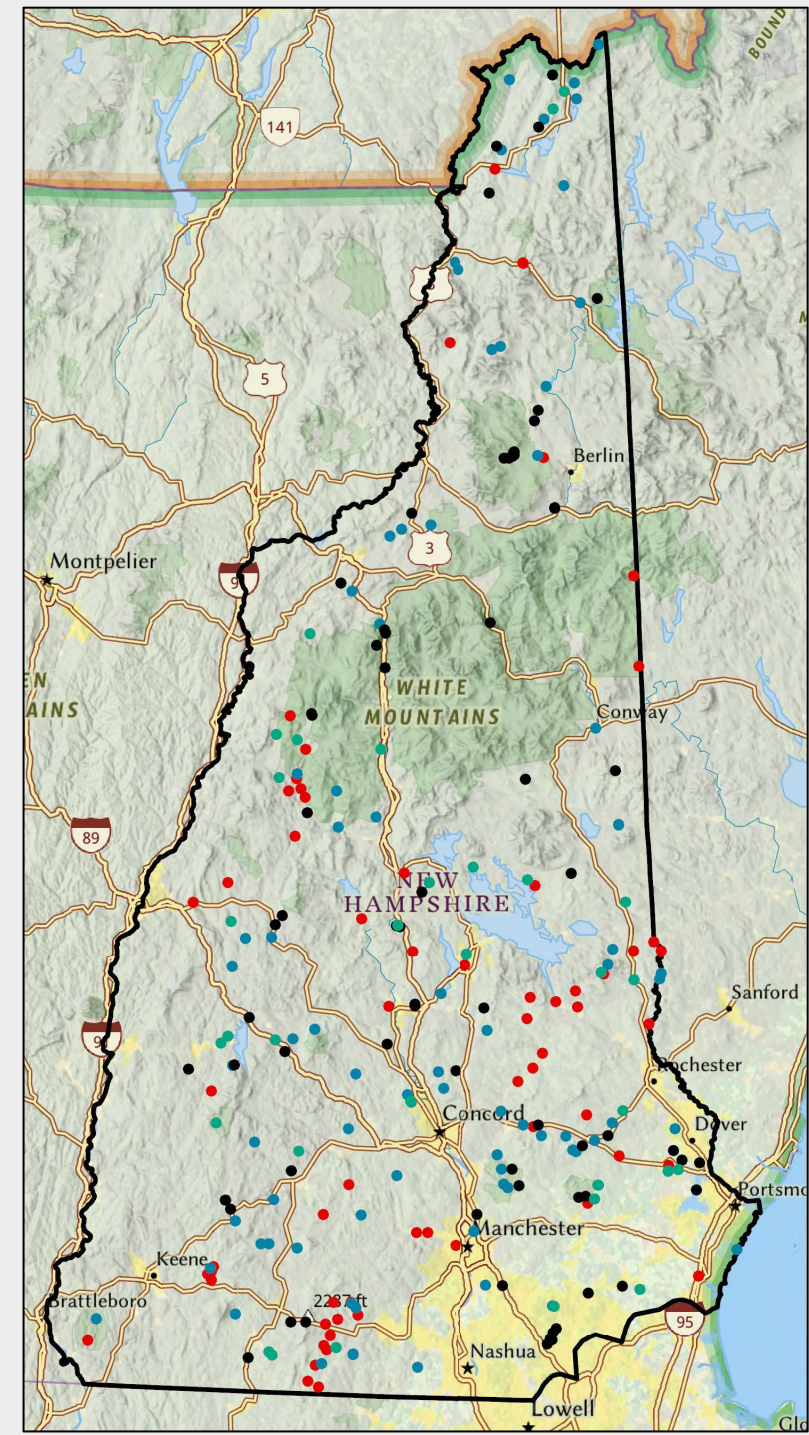
Operations and Maintenance Section

- Provides real time lake level, temperature, precipitation and discharge data at 31 lakes in NH through the <https://nhdes.rtiamanzi.org/> web platform.
- Manages 8 leases and 26 water user agreements with hydropower operators



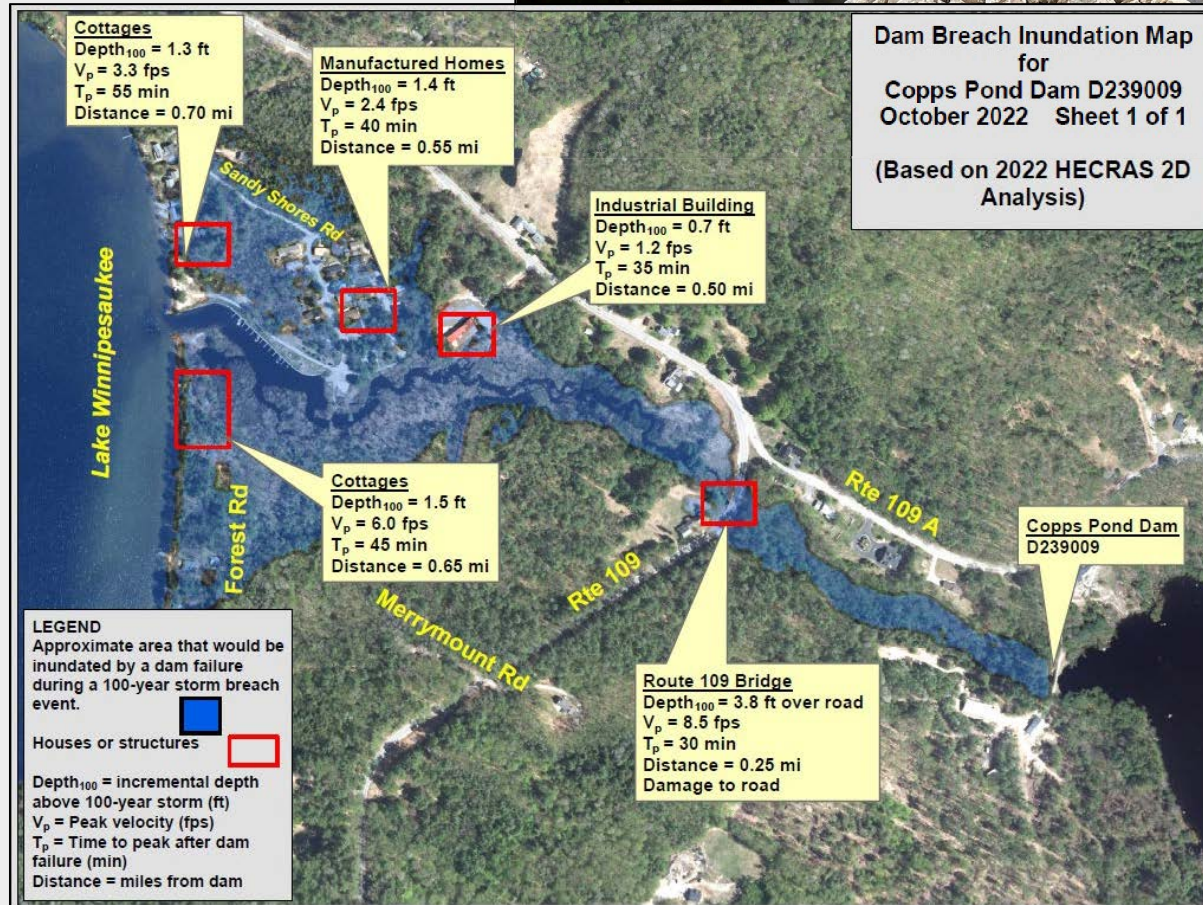
Engineering and Construction Section

- Responsible for major repairs and reconstruction of **270 dams** on either a force account or contract basis. This includes preparing and managing contracts, budget estimates and long-term schedules.
- Maintains ownership records and easements necessary for dam operations and repairs through the Land Management group.



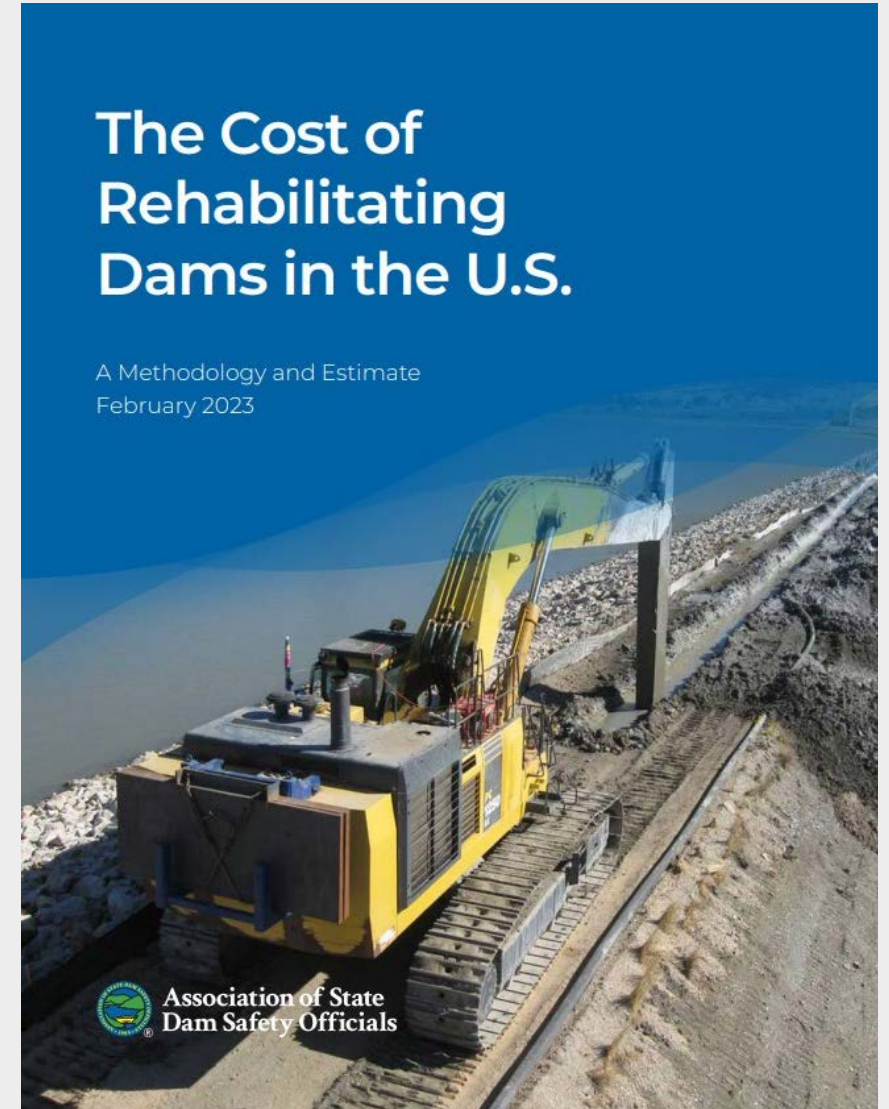
Engineering and Construction Section

- Oversees an in-house construction crew and outside engineering and construction contracts
- Prepares Emergency Action Plans (EAP)s at 64 High and 34 Significant hazard dams.



Rehabilitation Cost of State-owned Dams

- **64 High Hazard Dams**
- \$300 million
- **34 Significant Hazard Dams**
- \$54 million
- **80 Low Hazard Dams**
- \$54 million
- **97 Non-Menace Hazard and Exempt Dams**
- \$6 million
- **Total Approximate Cost = \$414 million**



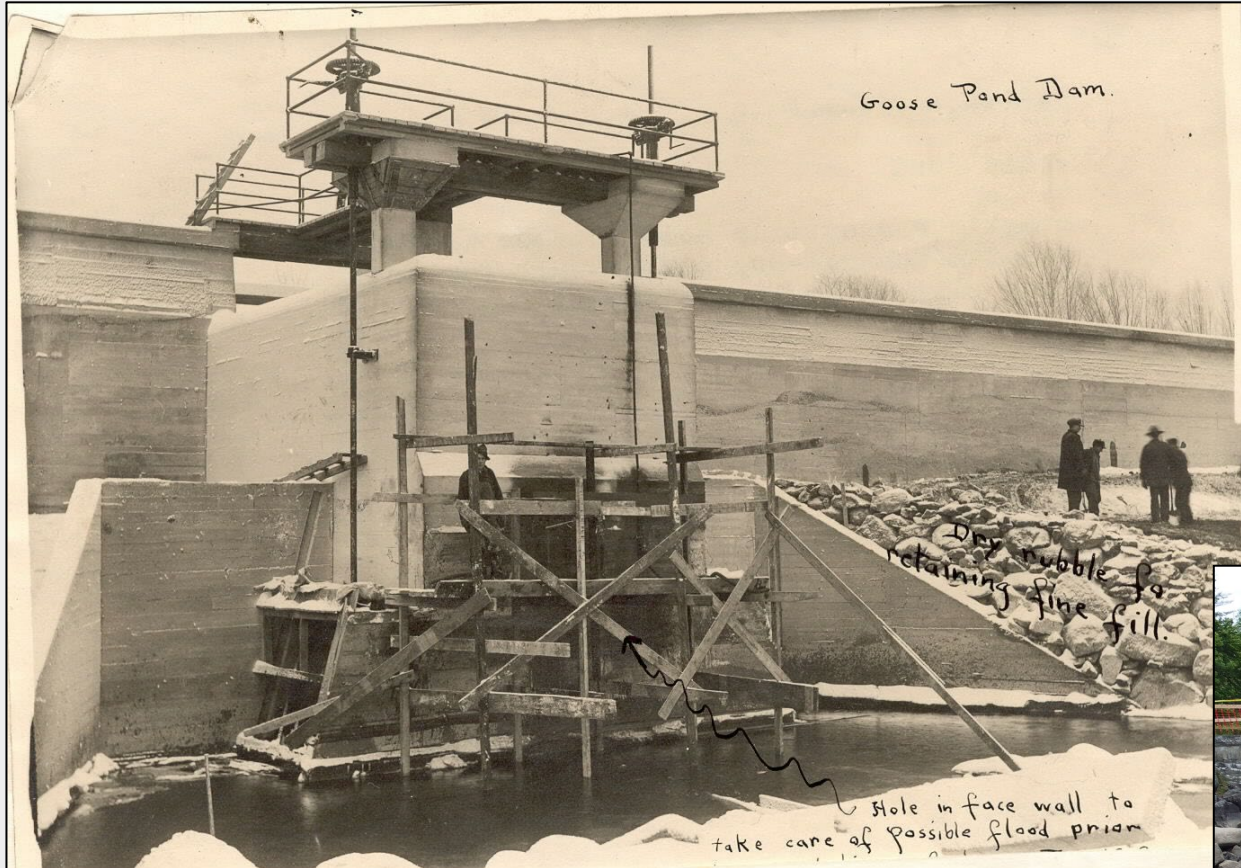
Dam Bureau costs to manage State-Owned Dams

- \$7,500,000 currently needed annually (70% state funded, 30% grant and fee funded)
- To bring all state-owned dams into compliance over the next 50 years ($\$414,000,000 / 50 = \$8,280,000$) the dam bureau would need approximately ***\$16,000,000 annually***



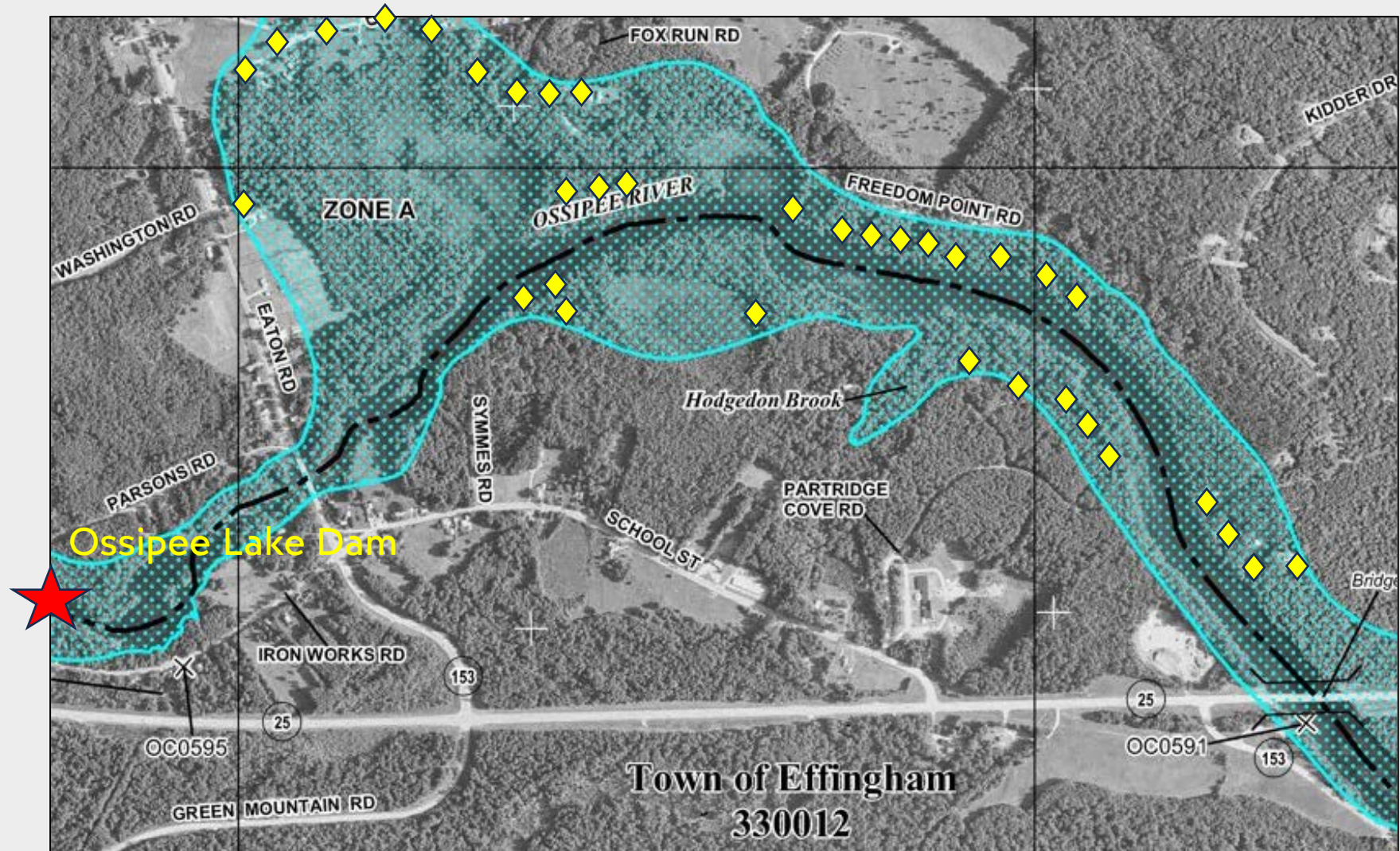
Age of State-owned Dams

- The average age of the State-owned dams is over 100 years.
- Numerous State-owned dams have not seen major retrofits or rehabilitation in 40 to 50 years or longer.



Hazard Creep

- 35 of the 64 State-owned high-hazard dams have been reclassified as such since 2004
- Development has increased the number of homes located in floodplains
- Creating hazard creep where dams built as low hazard are now high hazard



Improved Modeling of Dams

- Advancements in engineering tools are revealing previously unknown deficiencies at dam facilities, such as inadequate discharge capacity and structural instability

Dam Name	H&H	Slope Stability	Sliding Stability
Merrymeeting Lake Dam	X	✓	N/A
Jones Dam	X	X	X*
Alton Power Dam	X	✓	X
* Jones Dam fails gravity stability requirements when the flashboards are added to the analysis			

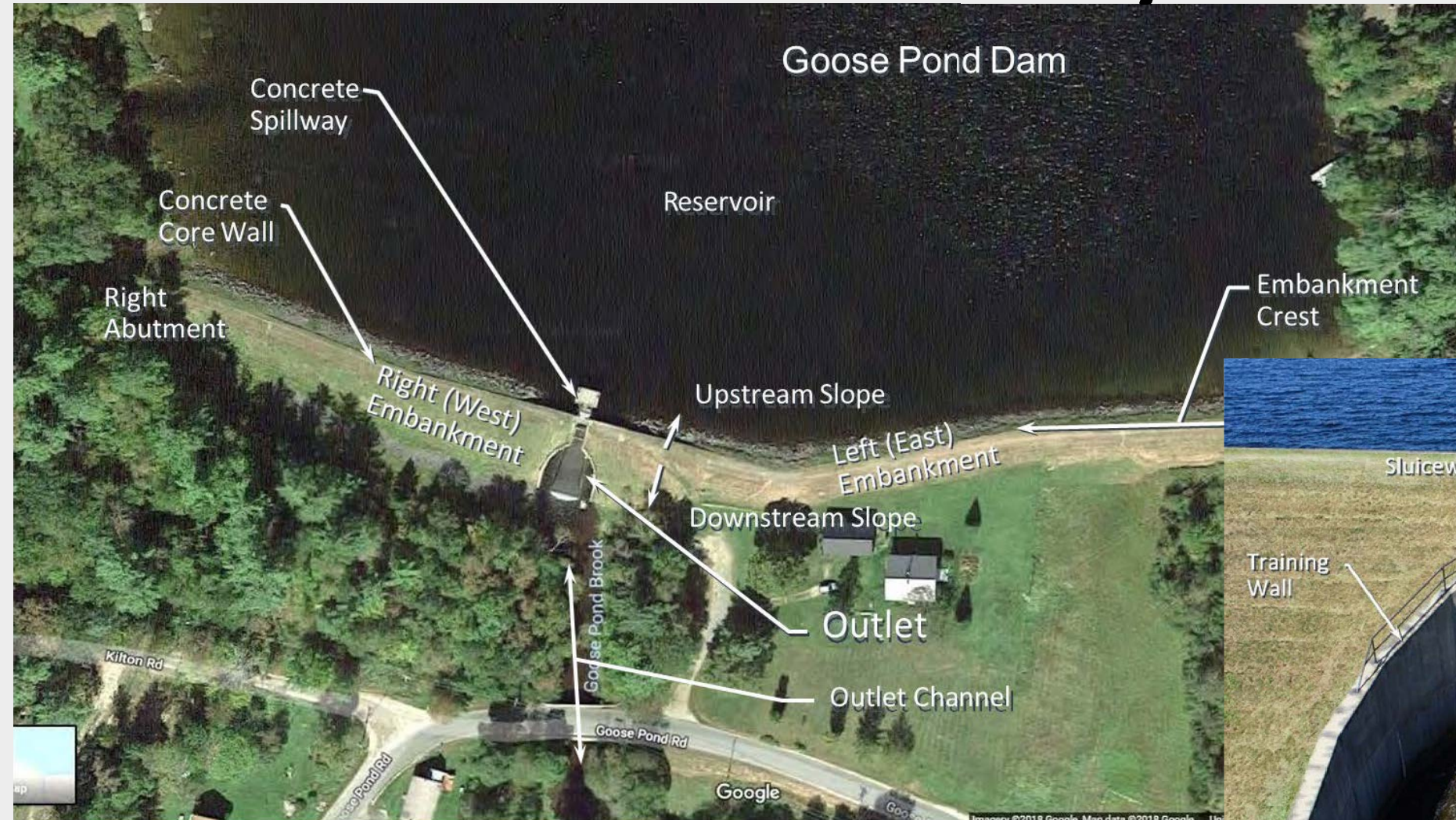
“✓” = Meets Current Criteria “X” = Does Not Meet Minimum Criteria

Dam Removal

- Many dams are no longer serving their original purpose, including those constructed for power production.
- Increasing number of dams in which the risk posed outweighs the benefits provided by the dam.
- Challenging political circumstances when the State decides to pursue dam removal



Goose Pond Dam – Case Study



- 31 feet tall, 1,240 feet long
- 15.7 square mile drainage area
- 618 acre waterbody

Goose Pond Dam – Case Study



- 1918 construction for water storage for downstream mill purposes
- Designed as an earth embankment with concrete core wall

Goose Pond Dam – Case Study



- 1928 toe drain was installed along downstream left side of the dam to mitigate seepage issues

Goose Pond Dam – Case Study



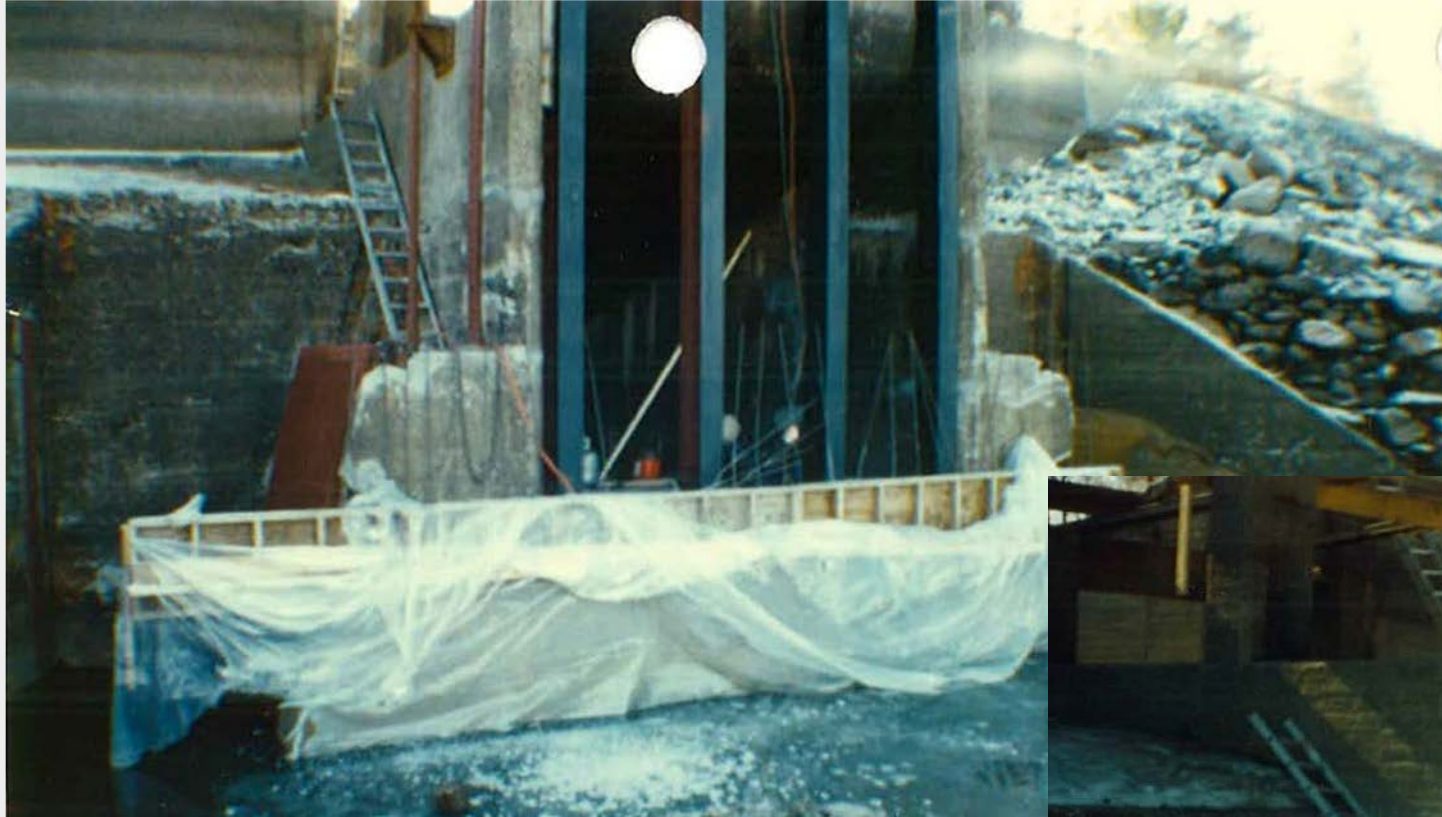
- In 1952 outlet was reconfigured to what is seen today

Goose Pond Dam – Case Study



- 1969 – State of NH acquired Goose Pond Dam from Granite State Electric Company
- 1980's – Additional drain lines installed along downstream right side of the dam

Goose Pond Dam – Case Study



- 1990 – NHDES performs repair work on outlet structure

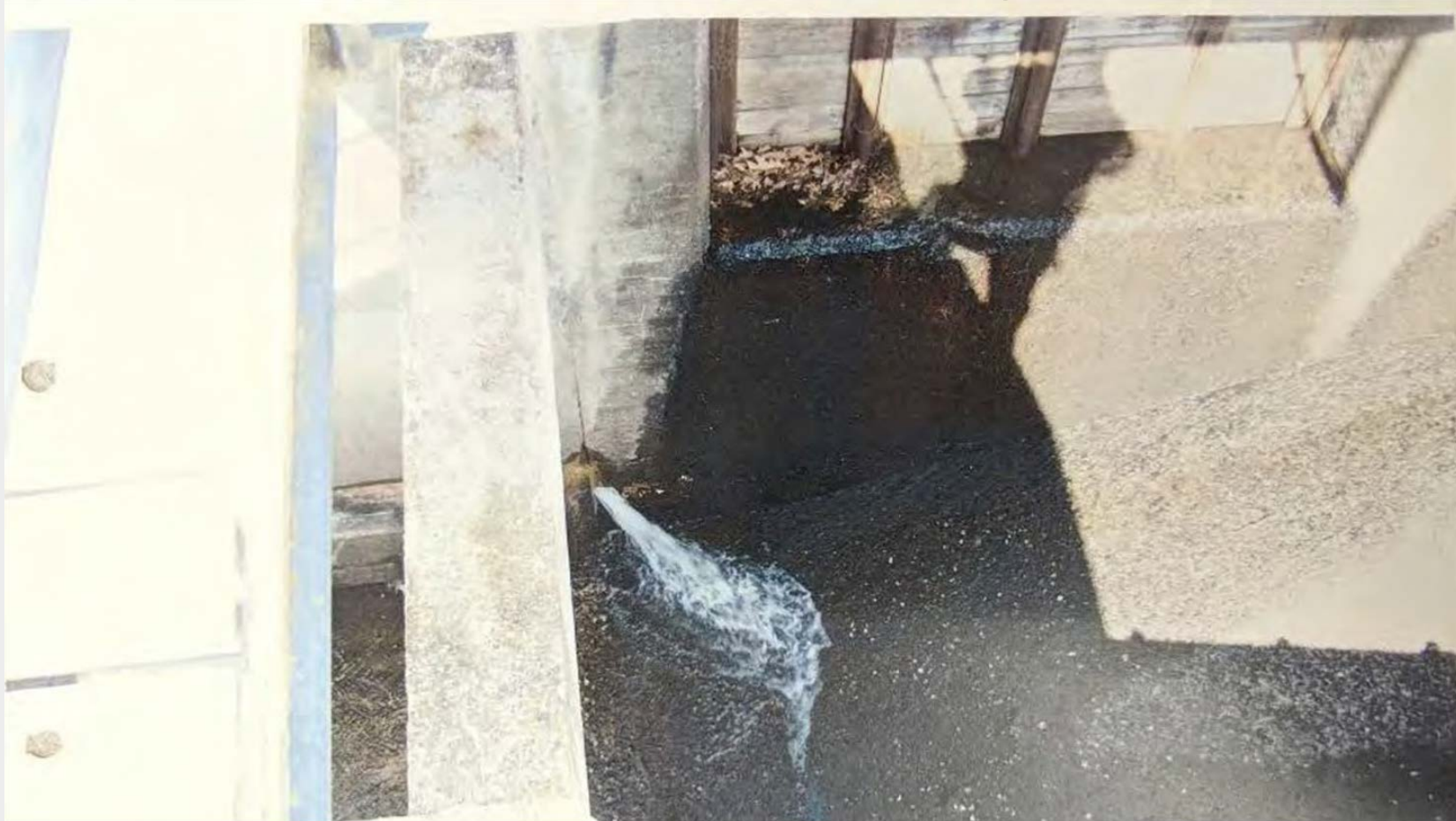


Goose Pond Dam – Case Study



- 2012 Repairs made to outlet tunnel

Goose Pond Dam – Case Study



- 2013 drilling completed due to leakage concerns
- Wells installed indicated high water levels along the downstream side of the dam
- Soft soils were observed in borings completed for well installation

Goose Pond Dam – Case Study

- 2018 Potential Failure Modes Analysis was completed with assistance of outside consultant
- Seepage along abutments of outlet works leads to failure of the dam
- Seepage beneath concrete core wall leads to failure of the dam

Table 4 - Summary of Potential Failure Modes

PFM	Description	Loading	Category
1	Seepage along abutments of outlet works/spillway leads to piping failure.	Normal	I
2	During a flood the downstream slope of the embankment becomes saturated and results in a deep slope failure near steep section of embankment that also results in failure of core wall and breaching the dam.	Flood	II
3	Seepage through crack(s) in core wall leads to piping failure of the embankment. (Critical location appears to be juncture of wall closing or two penetrations constructed subsequently) (Similar to PFM 7 and PFM 13)	Normal/ Flood	I
4	Piping of material through section of embankment without core wall (abutments) leads to breaching the embankment.	Flood	II
5	Seismic event leads to structural collapse of the spillway structure. Goose Pond Dam is located in a zone of relatively low seismicity. The PFM is so remote a possibility as to be non-credible or not reasonable to postulate.	Seismic	IV
6	Seismic event leads to deep slope failure near steep section of embankment. Goose Pond Dam is located in a zone of relatively low seismicity. The PFM is so remote a possibility as to be non-credible or not reasonable to postulate.	Seismic	IV
7	Seep beneath core wall of embankment section leads to piping failure of the embankment. (Similar to PFM 3 and PFM 13)	Normal/ Flood	I
8	Seismic induced failure of support struts of the sluiceway structure leads to inward collapse of walls and reduced spillway capacity, leading to overtopping. Goose Pond Dam is located in a zone of relatively low seismicity. The PFM is so remote a possibility as to be non-credible or not reasonable to postulate.	Seismic	IV
9	Flood event that exceeds the capacity of the spillway leads to overtopping of the embankment at the left dam abutment (lowest point along the dam) and erodes and fails the dam. The spillway capacity at Goose Pond Dam exceeds the minimum 2.5x100-year flood event design requirement. The spillway can realize significant additional capacity through the designed automatic failure of the flash boards or by opening the outlet gates. A flood event required to overtop and erode Goose Pond Dam is believed to be so remote a possibility as to be not reasonable to postulate.	Flood	IV
10	Sudden reservoir drawdown leads to upstream slope failure, collapse of core wall, and subsequent uncontrolled seepage and breaching of the embankment. The embankment material on the	Sudden Drawdown	III/IV

Goose Pond Dam – Case Study



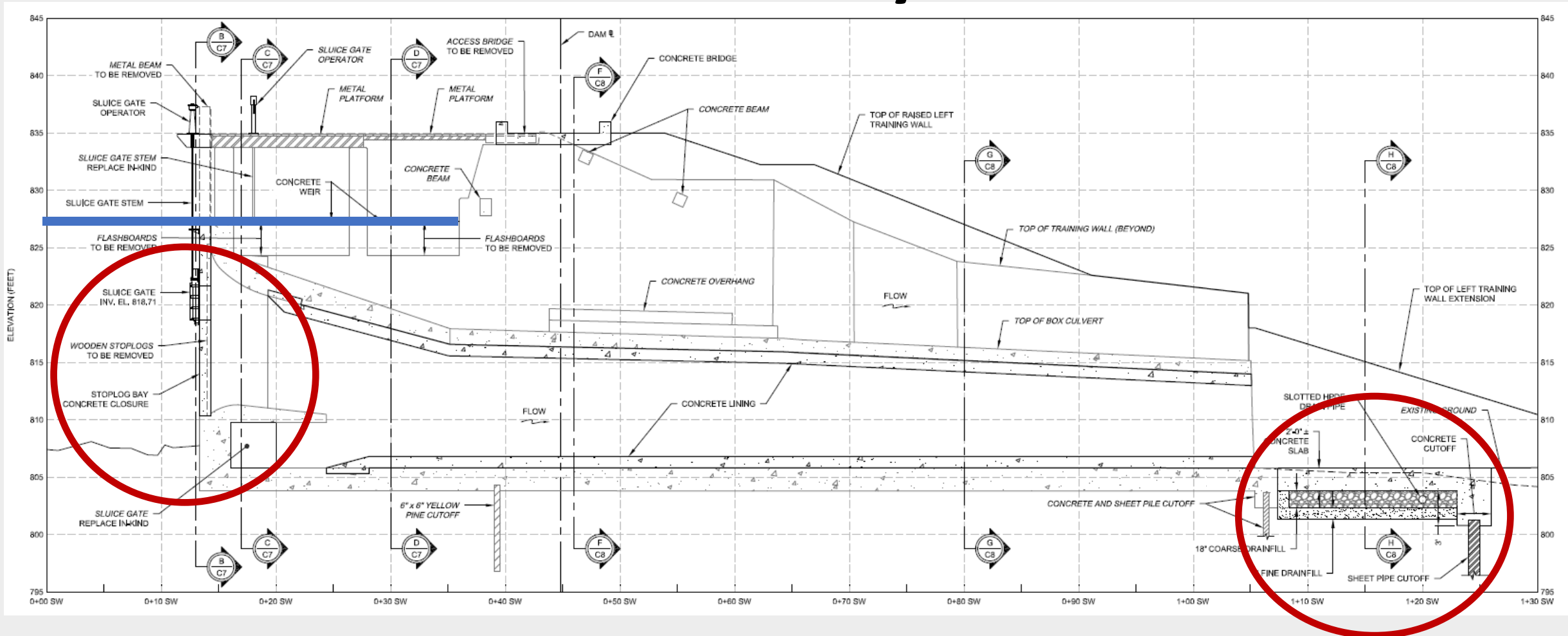
- In 2018 11 additional borings installed
- Wells installed in each boring
- Video inspection of toe drains



Goose Pond Dam – Case Study

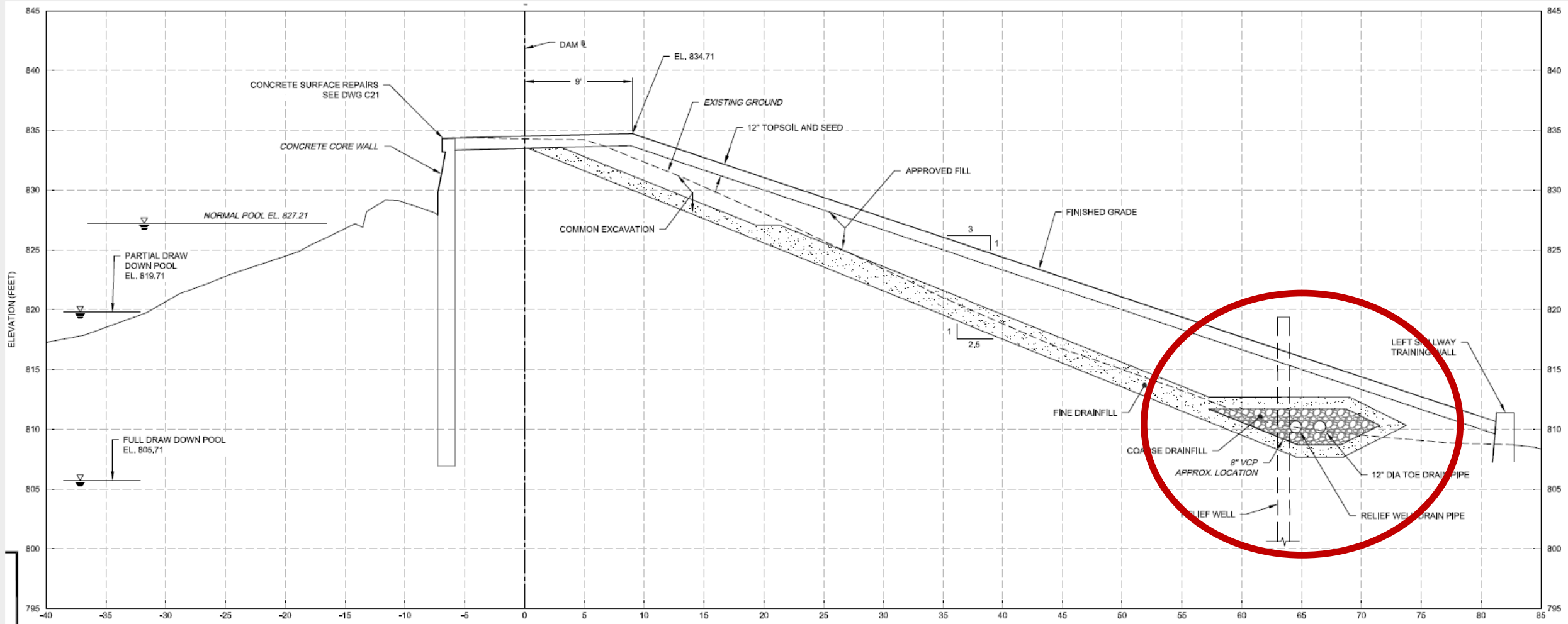
- Artesian water pressure in several wells along downstream side of dam
- Rock encountered between 8 and 54 feet below the ground surface
- Deepest rock observed in vicinity of the outlet structure

Goose Pond Dam – Case Study



- Full reconstruction design started in 2020
- Focused on rehabilitating the inlet structure and mitigating seepage and underground water pressures

Goose Pond Dam – Case Study



- To mitigate seepage and pressures 20 (4-inch diameter) relief wells and toe drain system were installed on the downstream side of the dam

Goose Pond Dam – Case Study



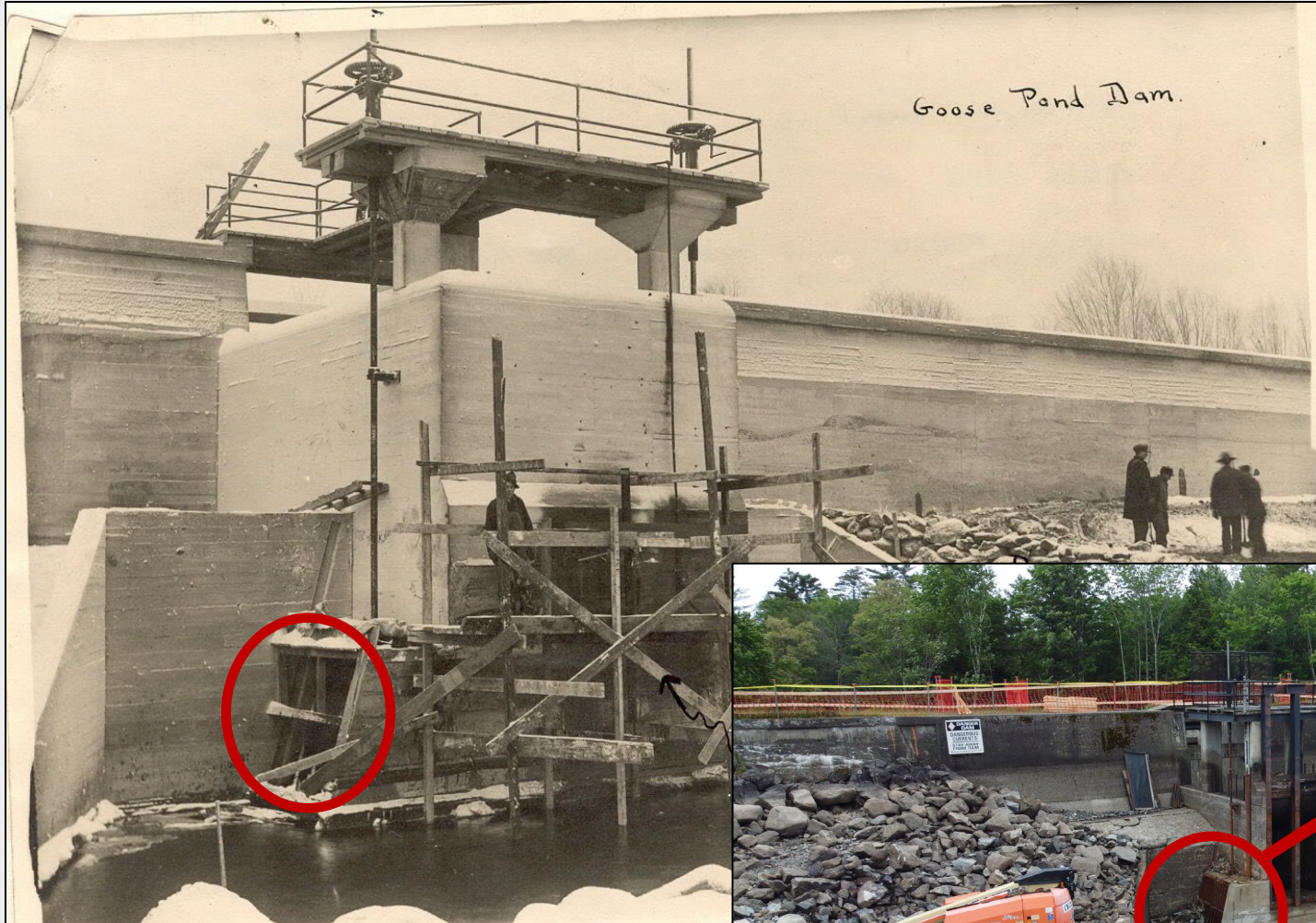
- Goose pond was lowered approximately 20 feet in the fall of 2023 with construction starting in the spring of 2024

Goose Pond Dam – Case Study

- Contractor installed 10-12 foot tall cofferdam and installed two 12-inch bypass pipes in the spring of 2024



Goose Pond Dam – Case Study



- Determined that existing gates needed replacement

Goose Pond Dam – Case Study

- Contractor performed shotcrete concrete placement throughout the summer of 2024



Goose Pond Dam – Case Study

- Upstream walls were rehabilitated and historic wooden discharge gates were removed and replaced with smaller stainless-steel gate



Goose Pond Dam – Case Study

- Relief wells and toe drains were installed throughout the summer and winter of 2024-2025



Goose Pond Dam – Case Study



Goose Pond Dam – Case Study



- As project was being completed and new gates were installed the existing cofferdam was overtopped during the spring of 2025

Goose Pond Dam – Case Study

- Toe drains and relief wells have been operating as intended since the lake refilling process started in 2025



Goose Pond Dam – Case Study

- Goose Pond was lowered in the fall of 2025 for gate adjustments after unsatisfactory gate testing
- Goose Pond was refilled in May 2026
- Final gate testing in June of 2026 indicated that gates are not properly sealing
- Contractor and gate manufacturer are seeking solutions

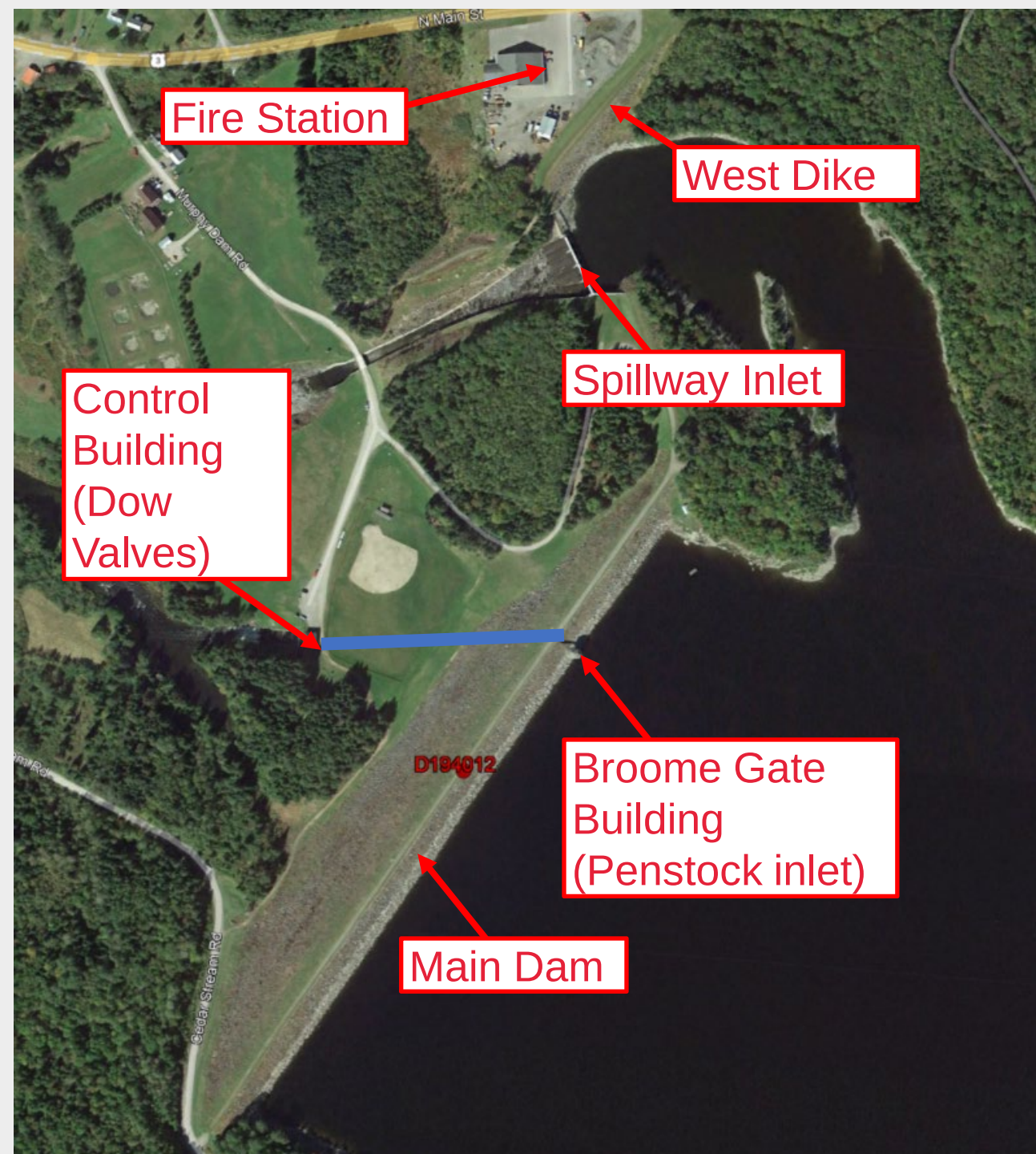


Goose Pond Dam – Case Study

- Exploratory drilling and design work was completed for \$900,000 using a combination of FEMA high-hazard dam funds and state capital funds.
- In 2024 construction was initiated for \$6.49 million (93% American Rescue Plan Act (ARPA), 7% state capital funds). *In 2020 construction cost estimate was \$3,400,000 – 47% less*
- The construction oversight of this project \$1.1 million (100% ARPA funded).
- **The estimated total of all costs to reconstruct this dam is \$8.49 million dollars with less than \$1 million of state funding.**

Murphy Dam Case Study

- Built between 1937–1940 by the New Hampshire Water Resources Board to regulate river flows, support industry, and reduce flooding
- Since construction, water user agreements with downstream hydro entities have been in place for use of the water in Lake Francis
- Cost was \$2,300,000 in 1939 = \$55,105,000 in 2026



Murphy Dam Case Study

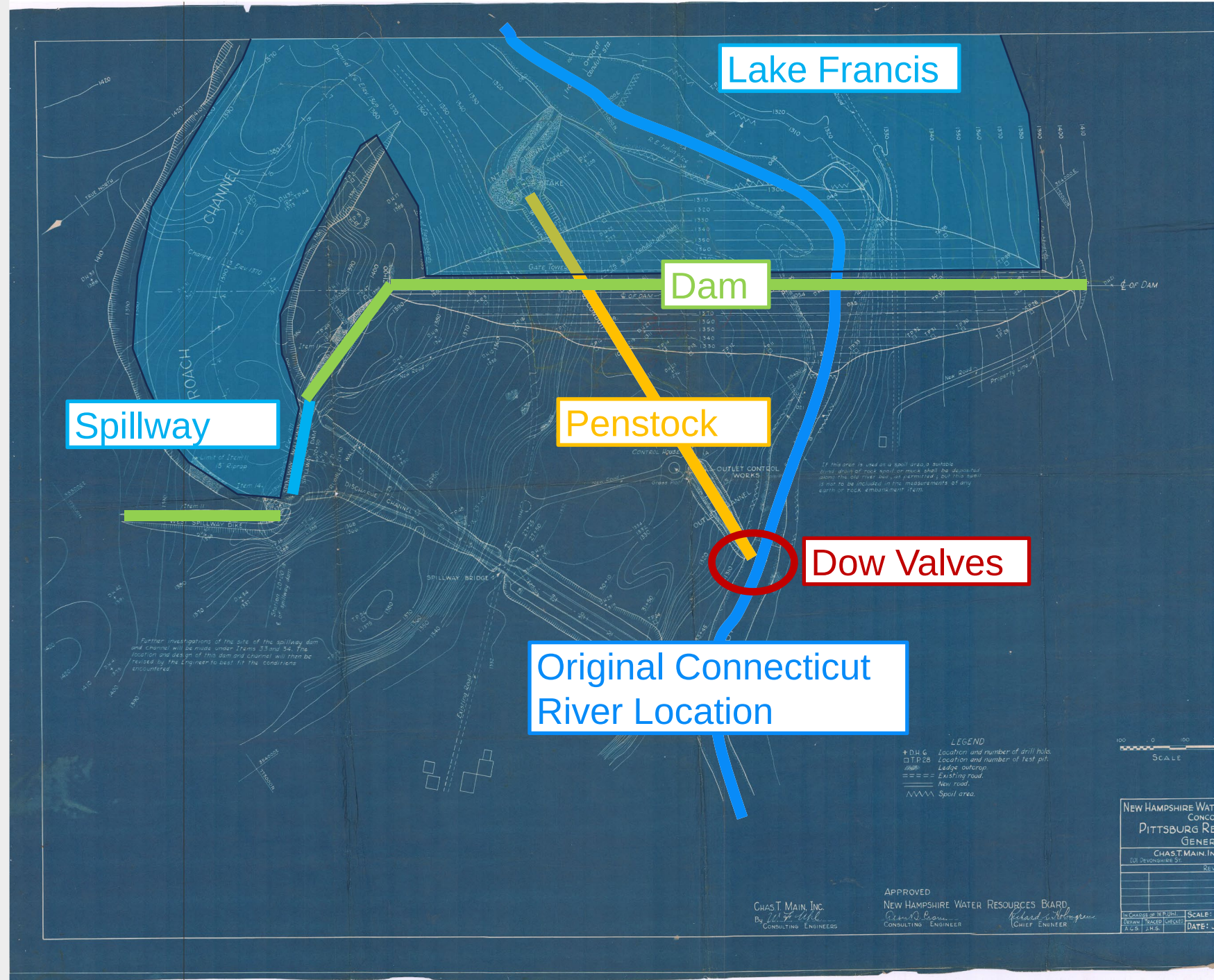
106-foot-tall earth dam

2,200 feet long

224-foot-wide spillway

13-foot diameter
penstock

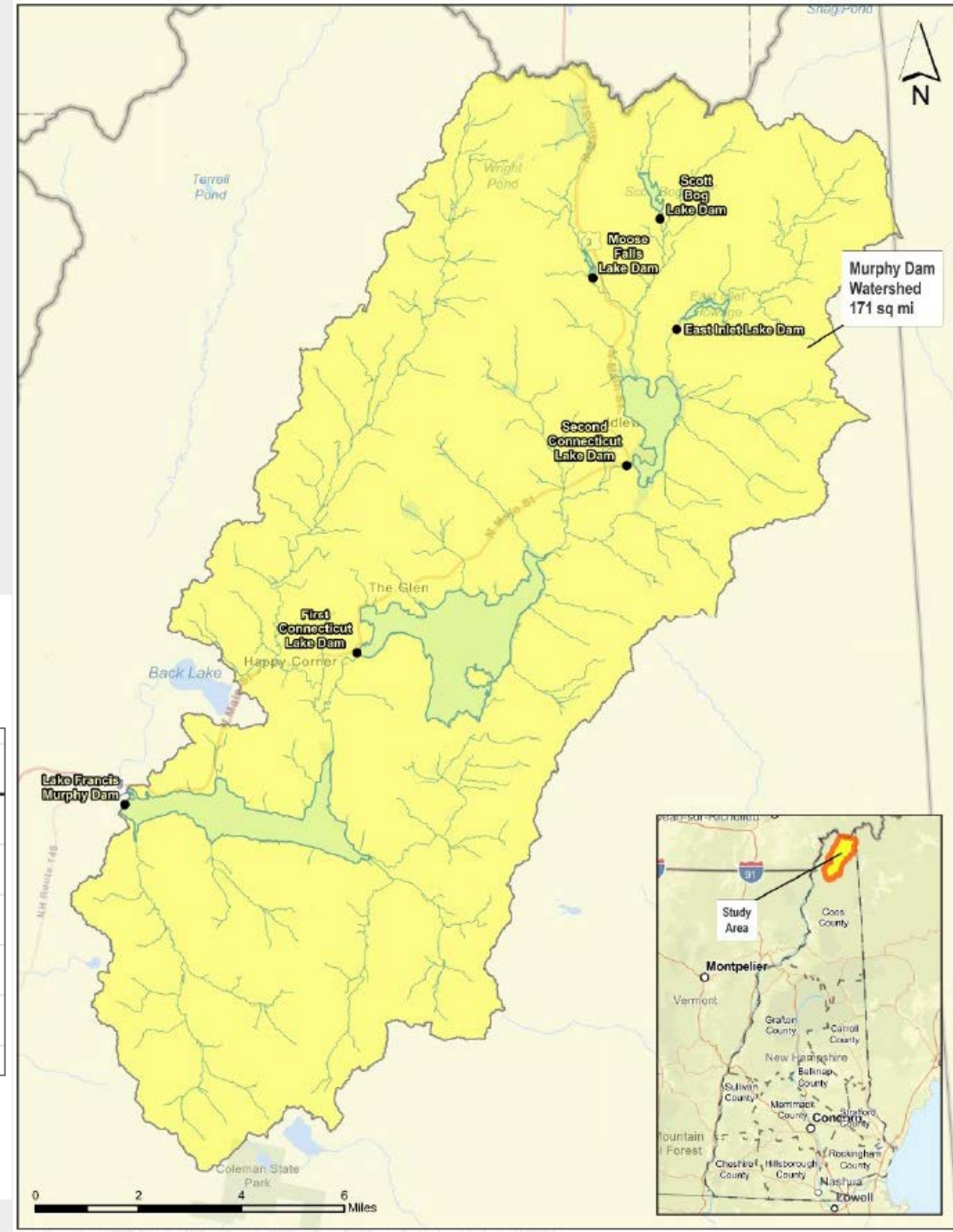
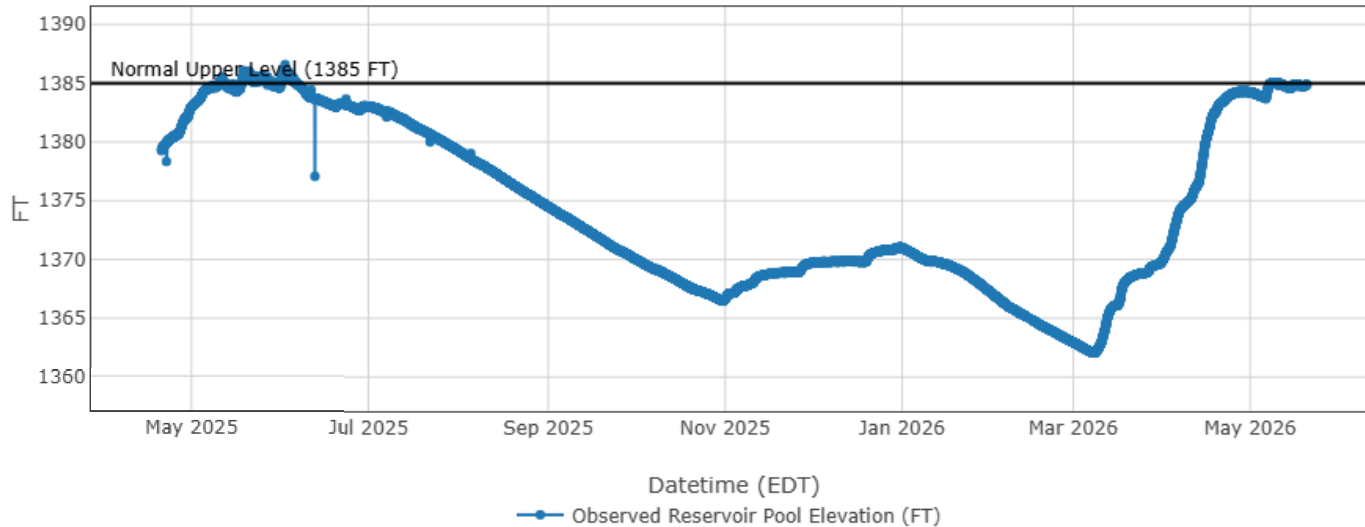
Two 7-foot diameter
Dow Valves



Murphy Dam Case Study

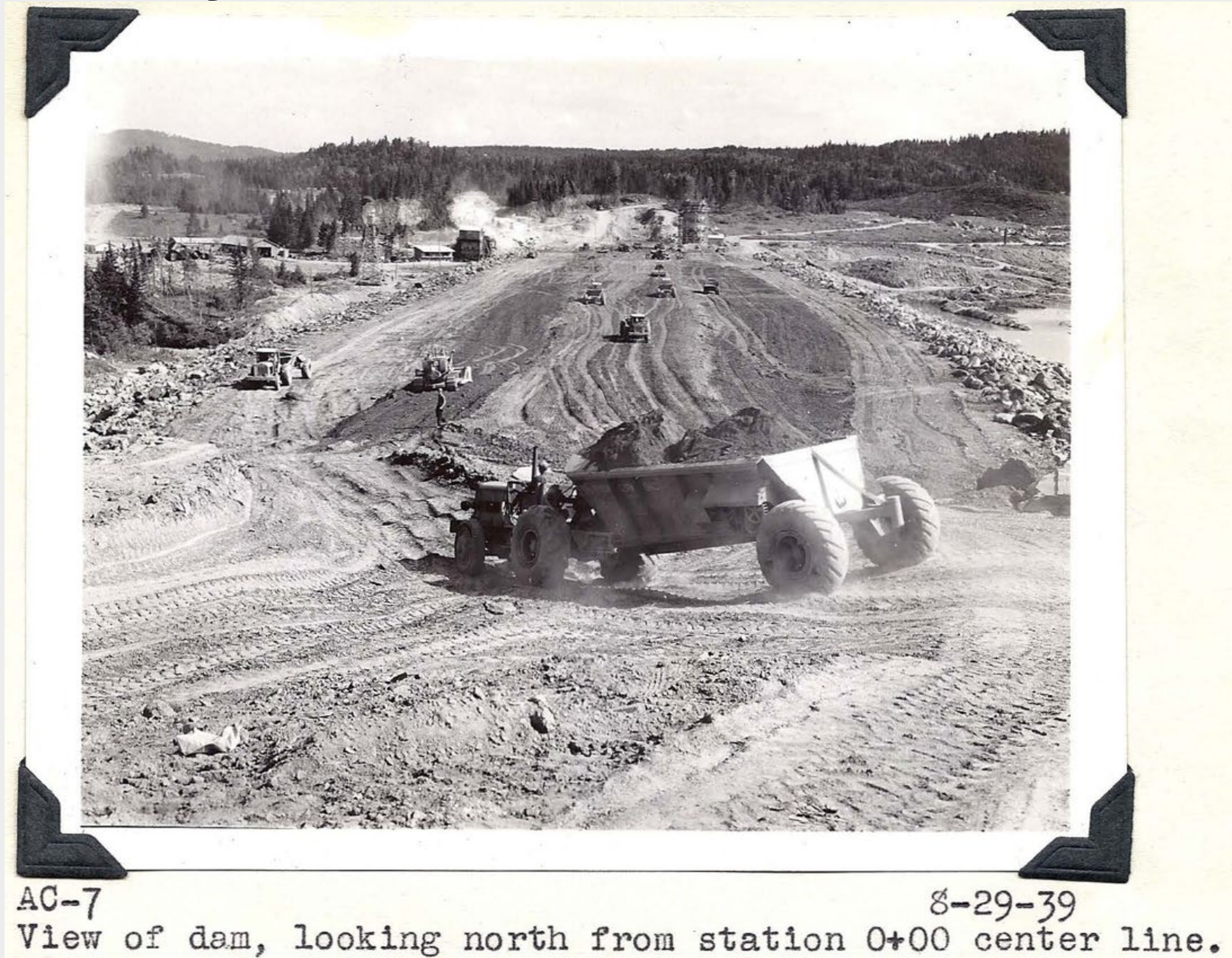
- 171.1 square mile watershed
- 2,010-acre lake
- 15 to 25 foot winter drawdown provides significant flood storage capacity
- Normal pond at 1385 feet

Murphy Dam (Lake Francis) (LFRNH)



Murphy Dam Case Study

- 106-foot-tall earth fill embankment dam with impervious core and pervious shells
- Top of dam at 1400 feet
- Normal pond at 1385 feet
- Nearly 1 million cubic yards of fill



Murphy Dam Case Study

- 224-foot-wide spillway
- Discharges into 1,400-foot-long channel excavated into rock
- 3 gates installed in 2022 to allow for regulated discharge when penstock is inoperable

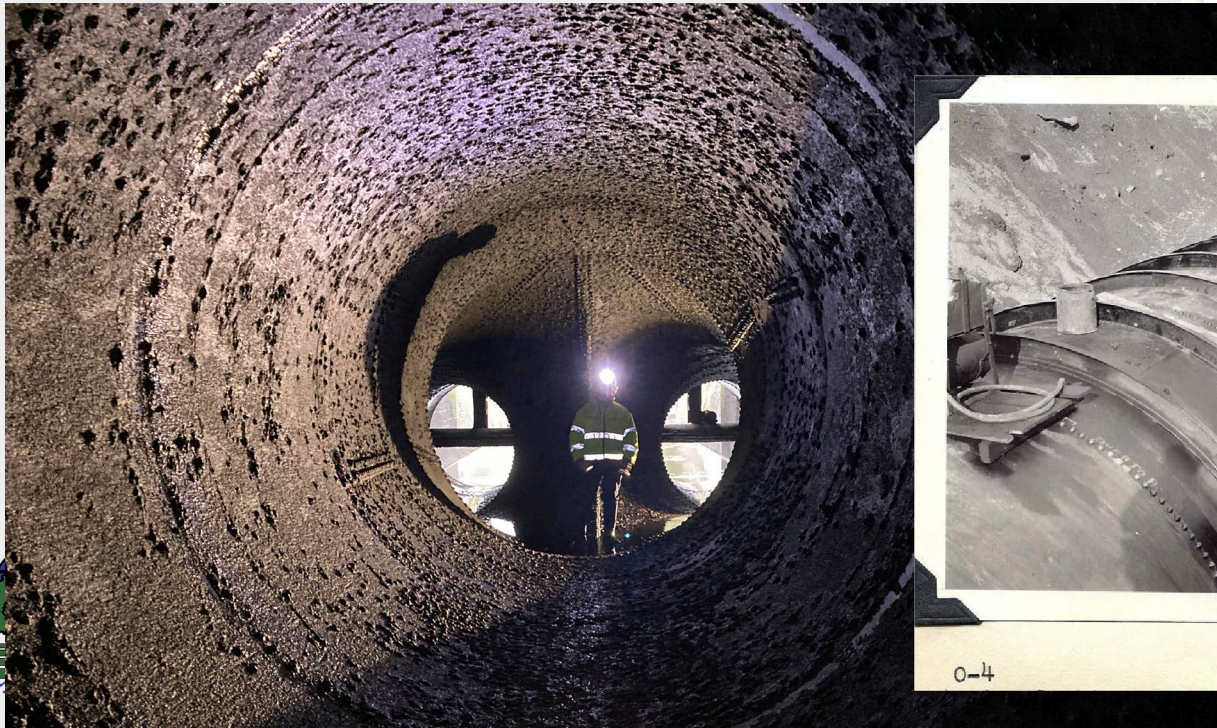


June 23, 1940



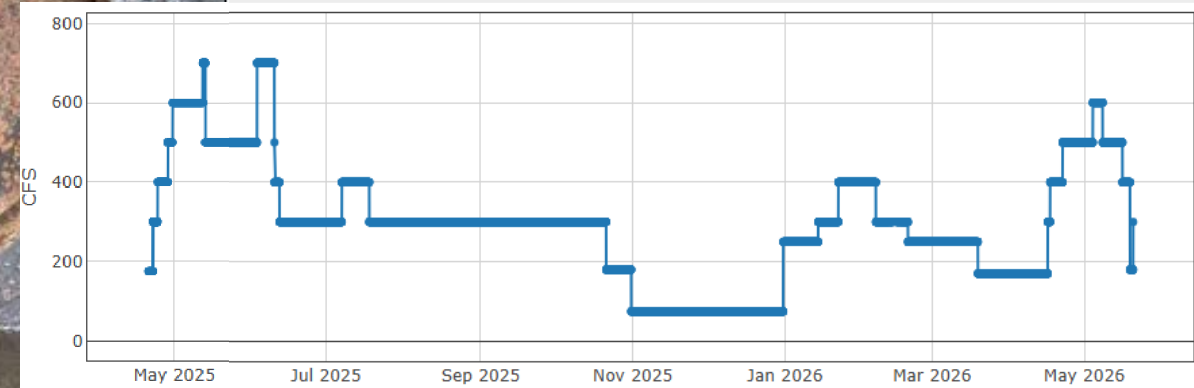
Murphy Dam Case Study

- 226-foot concrete conduit leading to the Broom gatehouse from the lake bottom
- Gatehouse is followed by a 560-foot-long, 13-foot-diameter riveted steel penstock



Murphy Dam Case Study

- 7-foot diameter butterfly valves
- Used to regulate Connecticut River flow
- Max discharge for both is 3,900 cfs (avg 300 cfs)

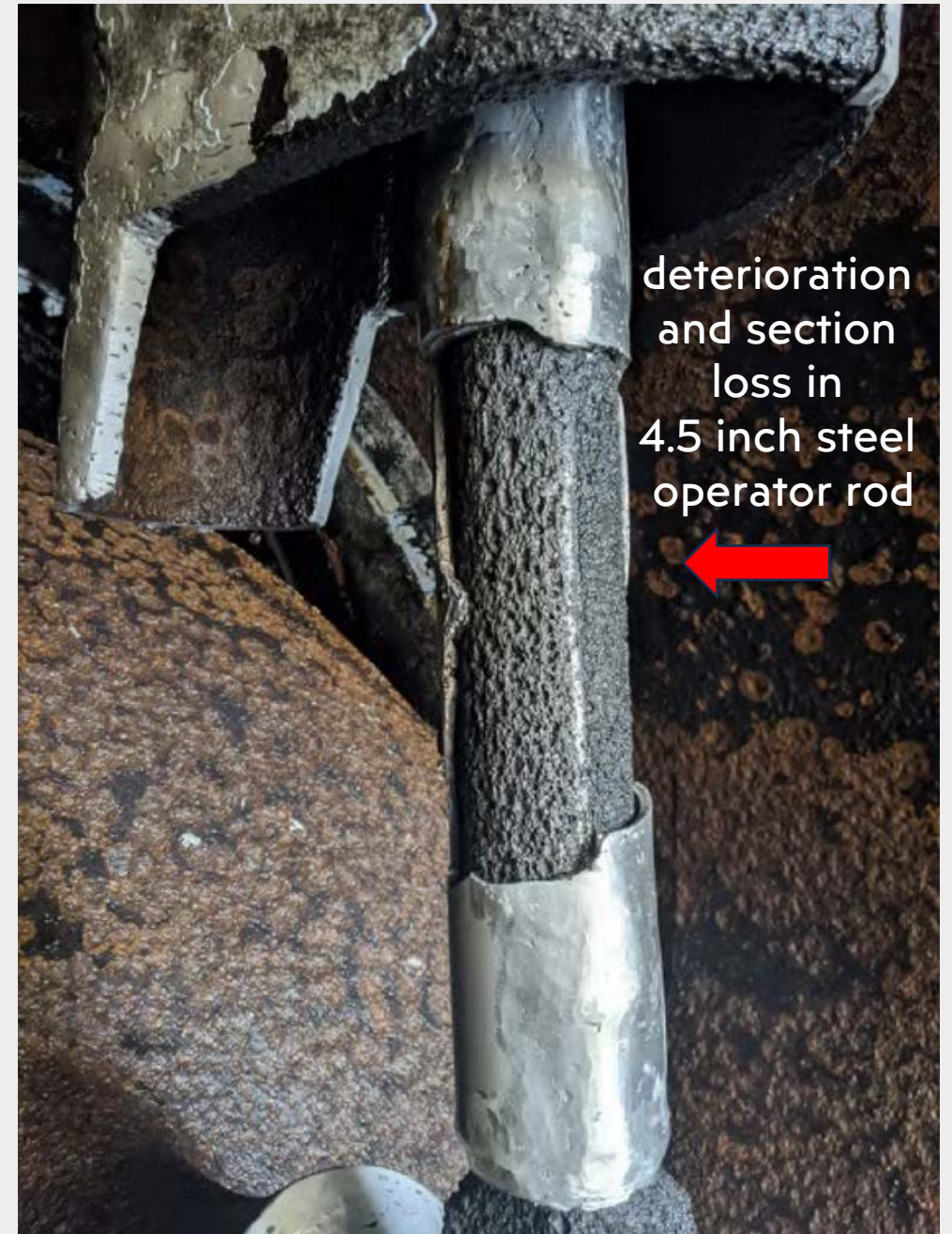


Murphy Dam Case Study

- 2018 Potential Failure Mode Analysis Completed
 - Structural Failure of Spillway Structure due to Concrete Deterioration
 - Failure of Stanchions due to Structural Failure of Spillway Walkway Bridge
 - *However, the PMFA highlighted the importance of maintaining the Dow Valves to maintain and control the reservoir.*
- 2022 Consultant Evaluated Dow Valves
- “we recommend that both Dow Valves be replaced along with the required electrical upgrades at the site within 2 to 4 years”

Murphy Dam Case Study

- Valves must run at very small openings they weren't designed for
- Small openings cause cavitation and steel loss
- Valves knock at flows over 400 cfs



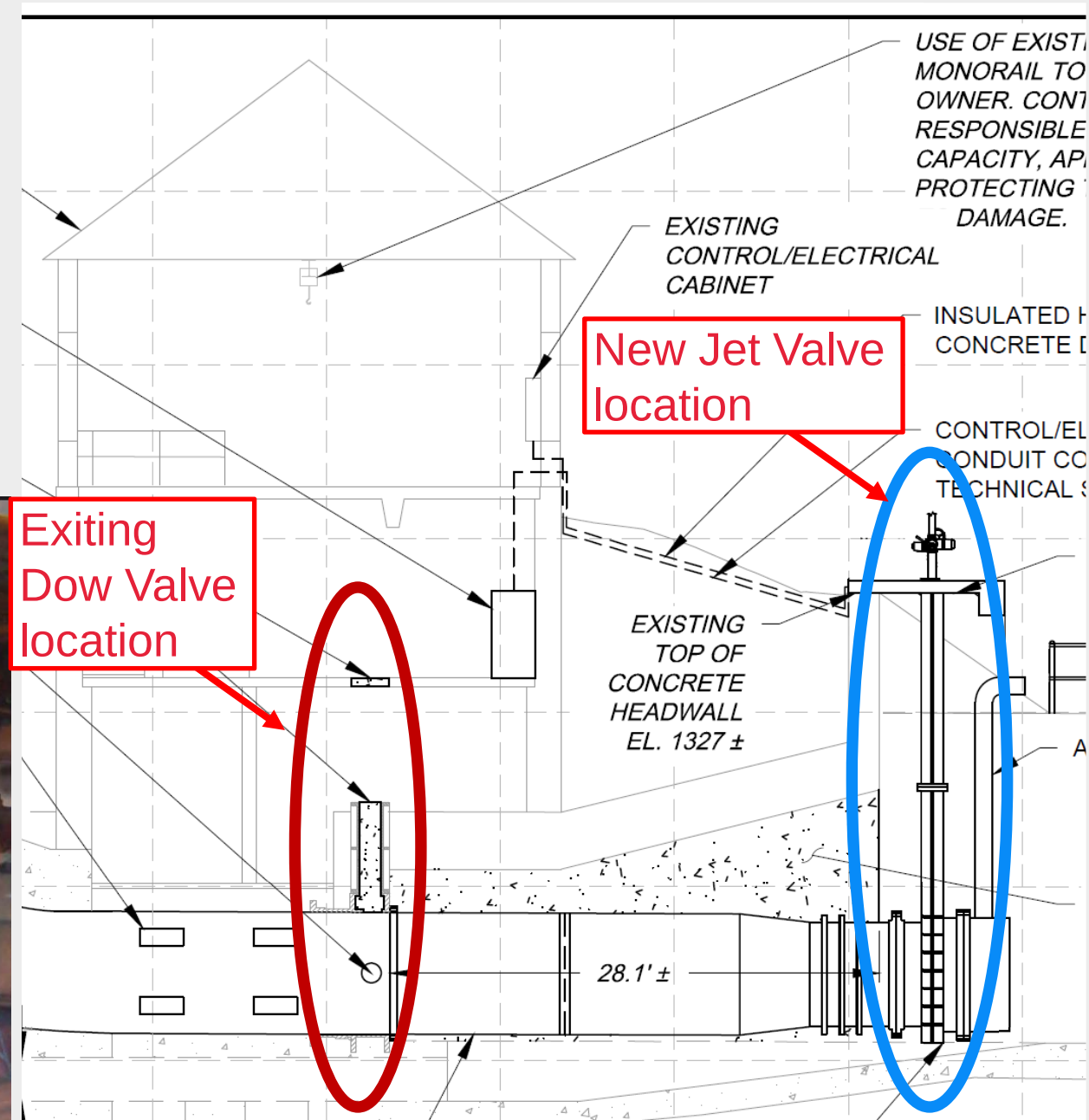
Murphy Dam Case Study

- 2023 Consultant Performed Alternatives Analysis
 - NHDES chose to pursue design for Alternative 4
- 2024 Consultant Prepared Design Plans
- 2025 NHDES collected temperature data within the lake and spillway to determine when penstock can be shut down

Recommended Alternative	Summary	Pros	Cons
0	Do Nothing	• Most Cost Effective	• Imminent maintenance • Potential initiation of project in emergency scenario.
1	Rehabilitate Valves in Place	• No change in operation • Cost effective • No lead time on fabrications.	• Need for maintenance program to upkeep coating (10 – 15 year cycles)
2	Replace One Valve with Fixed Cone Valve, Rehabilitate One Valve In-Place	• Fine control of valve discharges from small minimum flows to fully open • Allows remaining butterfly valve to operate in fully-open or fully-closed, leading to less long-term maintenance.	• Would need detailed hydraulic modeling to understand submerged discharges of the fixed cone valve. • Need recessed operations chamber to access valve and components as to not operate the valve in a manner that exposed mechanical equipment to ice • Lead time for fabrication. .
3	Replace One Valve with Jet-flow Gate, Rehabilitate One Valve In-Place	• Fine control of valve discharges from small minimum flows to fully open • Allows remaining butterfly valve to operate in fully open or fully closed, leading to less long-term maintenance.	• More expensive valve than fixed cone valve. • Lead time for fabrication.
4	Replace both valves with jet flow gates.	• Fine control of valve discharges from small minimum flows to fully open • Replaces historical mechanical equipment with modern upgrades which reduces long-term maintenance.	• Highest estimated cost. • Lead time for fabrication of jet flow gates.

Murphy Dam Case Study

- Replace both valves with new Jet-Flow gates
- Construct new working platform for gate operation
- Integrate gate controls into existing Control Building
- Demo Dow Valves when new valves are operating



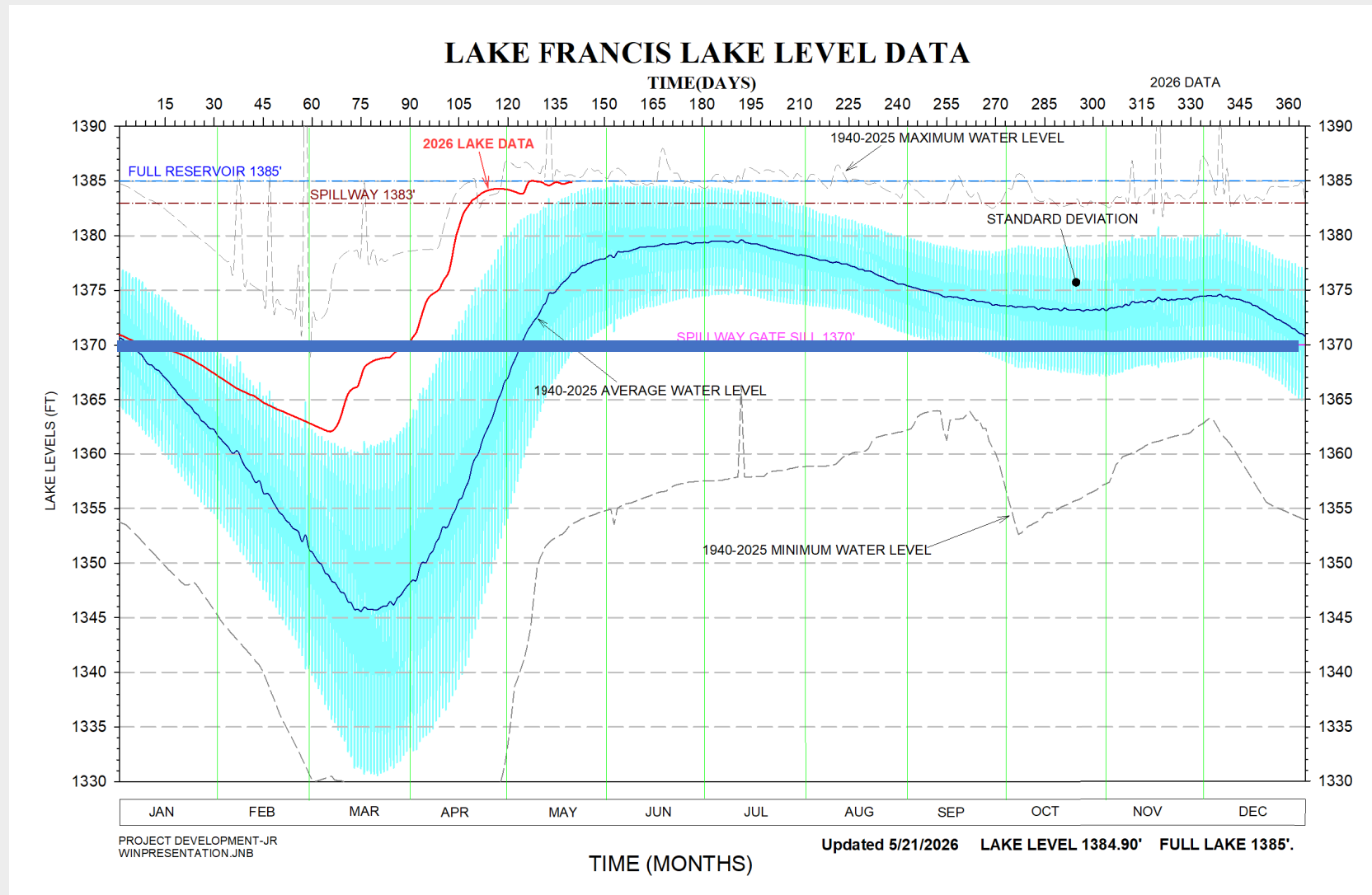
Murphy Dam Case Study

Dow Valve - Replacement Project - Schedule

- Received bids in June 2026
- Construction starts summer/fall 2026
- **Penstock shut down between October 1st and January 1st**
- Penstock operated and lake lowered during winter months
- **Penstock shut down between April 1st and June 1st**
- Shut down schedule repeats in 2027 and 2028
- Contract end date of December 31, 2028

Murphy Dam Case Study

- Contractor required to monitor discharge temperatures during penstock shut down periods
- Flows will be managed in conjunction with Great River Hydro
- The level of Lake Francis will likely be run slightly higher to ensure spillway discharge on October 1st and April 1st



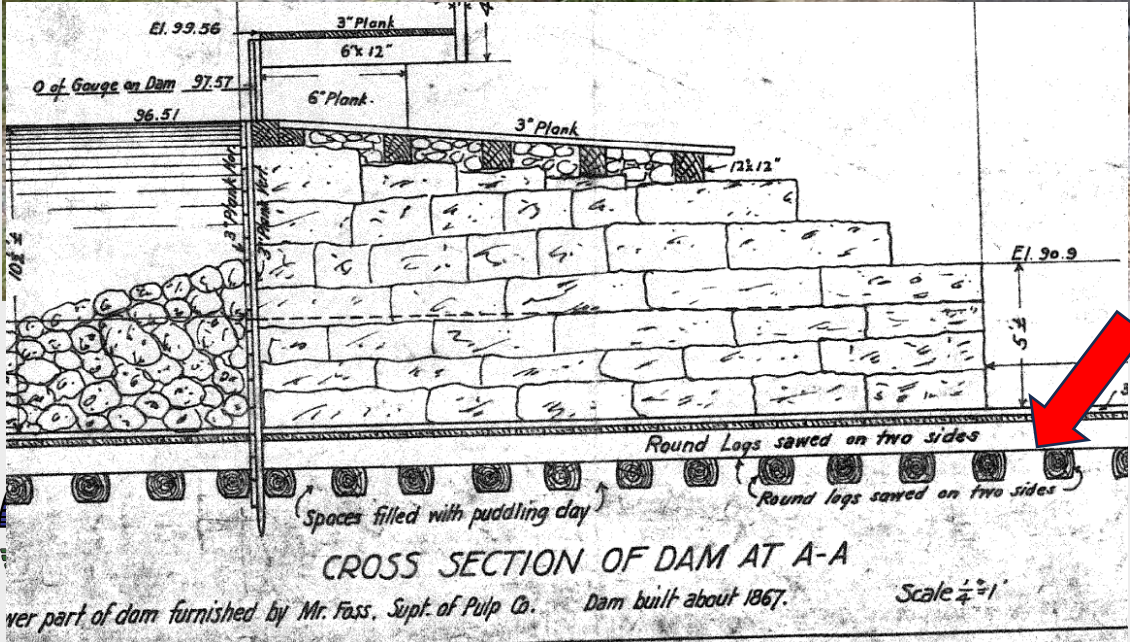
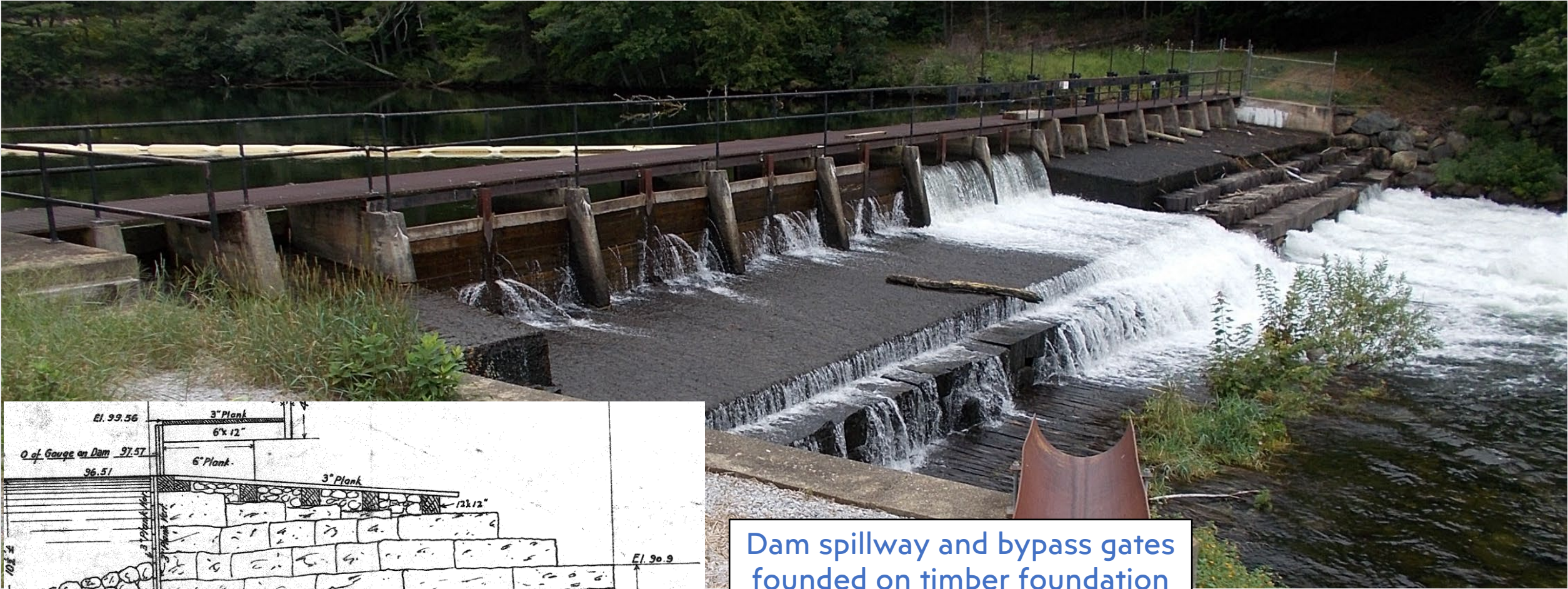
Murphy Dam Case Study

- PFMA was completed in 2018 for \$49,000 (100% project funds).
- Dow Valve assessment was completed in 2022 for \$428,000 and included cable replacement for proper operation of Broom Gate (88% project funds, 10% state capital funds)
- By-pass gate installation on spillway in 2022 for \$162,000 to allow for penstock shutdown (100% project funds).
- Electrical work in 2023 to allow Dow Valve operation \$413,000 (100% ARPA funds)
- Alternative Analysis and Design of new Jet Valves \$385,000 (100% ARPA funds)
- Construction Oversight of Jet Valves \$596,000 (100% capital funds)
- Construction and installation of Jet Valves approximately \$7,000,000 (cost per valve of \$1,400,000) (60% project funds, 40% capital funds)
- **The estimated total to assess and replace Dow Valves is \$9 million dollars with approximately \$3.6 million of state funding.**

Lakeport Dam – Lake Winnepesaukee – Gate Deterioration



Lochmere Dam – Lake Winnisquam – Poor Foundation



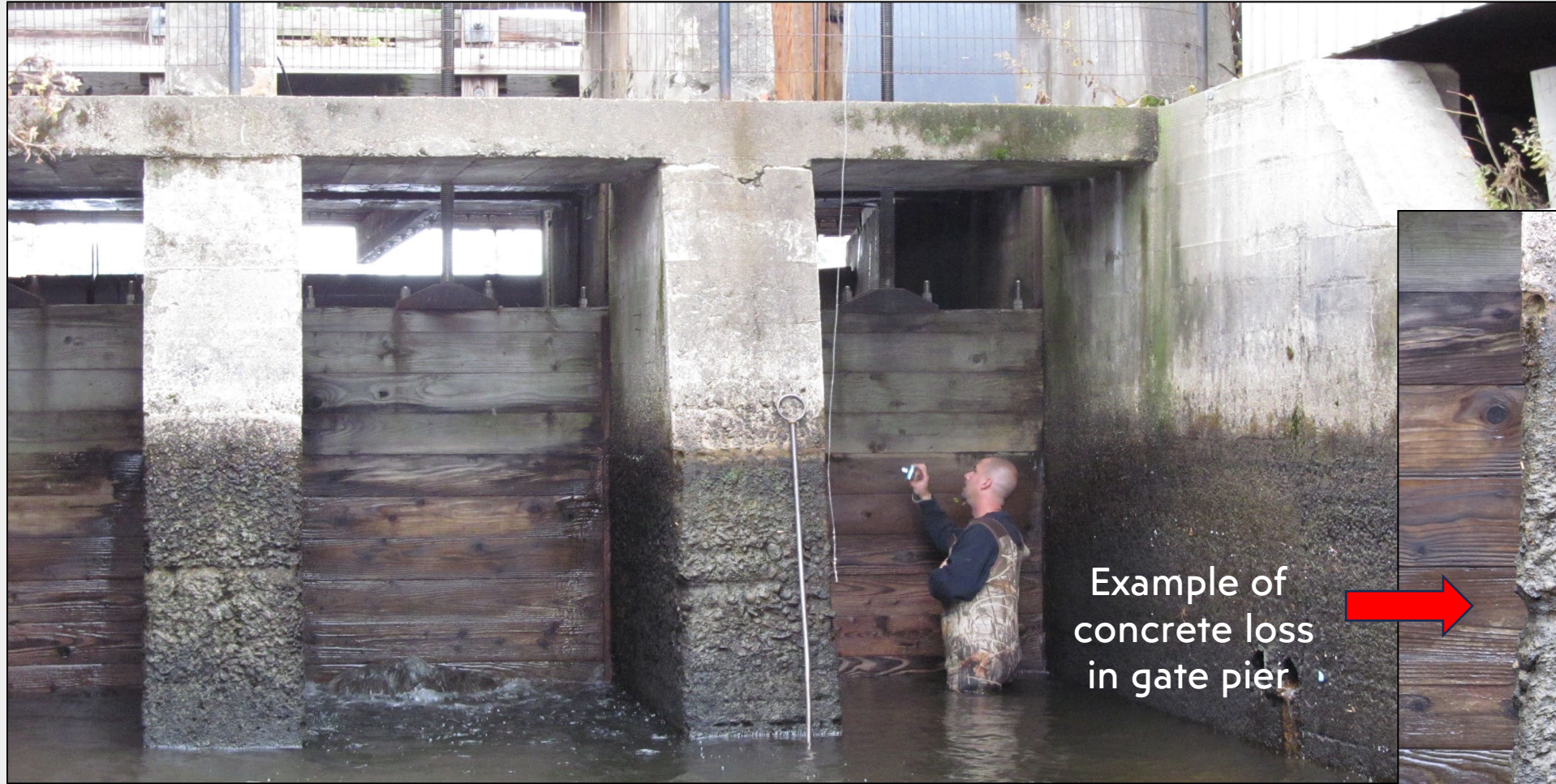
Dam spillway and bypass gates founded on timber foundation from 1867

Squam Lake Dam – Potential Overtopping During Flood



Elevation of floodwater
that the dam needs to be
able to withstand
(approximately 2.9 feet
above current top of dam)

Lake Sunapee Dam – Concrete Deterioration

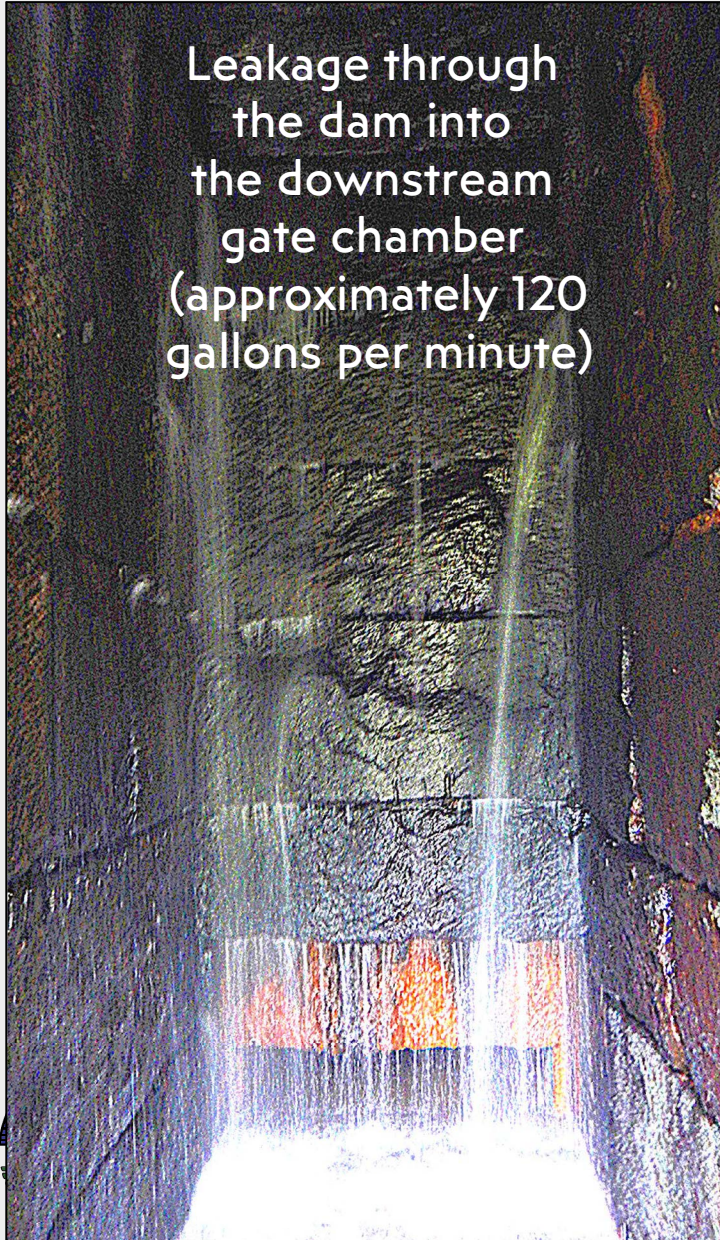


Example of
concrete loss
in gate pier



Dollof Dam, Pawtuckaway Lake - Leakage and Sinkhole

Leakage through
the dam into
the downstream
gate chamber
(approximately 120
gallons per minute)



1-foot-deep sinkhole
present next
to gate chamber
(increased in size during
the winter of 2024/2025)



Maintenance and Repair Life Cycle

- Identify known historical issues through inspection and documentation
- Determine gaps in understanding through PFMA and additional studies
- Review alternatives for rehabilitation, including removal
- Design selected alternative, conduct historical reviews, and obtain necessary permits from resource agencies
- Conduct construction and post construction monitoring
- **Secure funding for each step of the process**

Thank you

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