Ruptured Pipe and Fish Tails!

Lake Washington Dewatering Pump Plant is almost 100 years old and still pumping, but for how long?

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BUILDING STRONG®

Pump Plant Outline

- Lake Washington Ship Canal Overview
- Pump Plant Description and History
- Existing Conditions & Recent Failure
- Current Operation
- Replacement Plans & Funding Issues
- Future Failures & Impacts
- Failure Mitigation Plans

Lake Washington Ship Canal

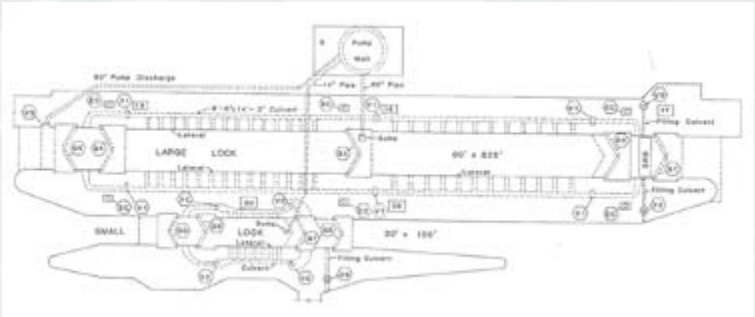
- Construction Started 1911
- LWSC opened in 1917
- Located: Seattle, Washington
- Annually 50,000+ Vessels
- Landmark with 1.3 Million visitors annually
- Fresh Water to Saltwater connecting Lake Washington to Pacific Ocean
- Large Lock – 825 X 80 FT
- Small Lock – 150 X 28 FT

Many Features of Lake Washington Ship Canal

- Fish Ladder with Public Viewing Room
- Smolt Flumes – (Downstream Juvenile Fish Passage)
- Botanical Garden
- Spillway to regulate Lake Washington and Lake Union

LWSC Dewatering Pump Plant

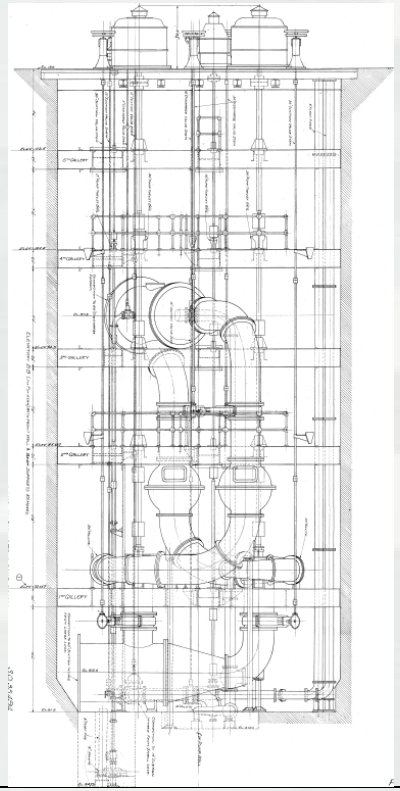
- Important Function: Dewater Large and Small Locks for Inspections, Maintenance Painting, Repairs, and Sacrificial Anode Replacement in Salt Water Environment



LWSC Dewatering Pump Plant

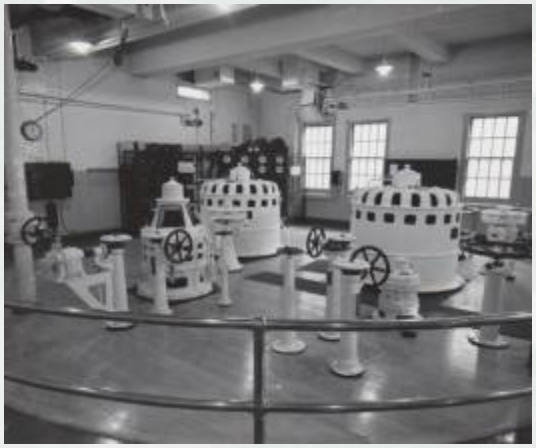
- Construction completed in 1915
- 58 FT deep well
- 26 FT diameter

- Located under Administration Building

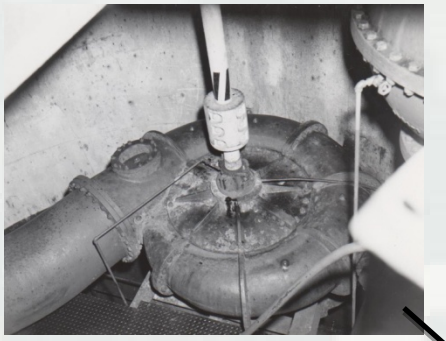


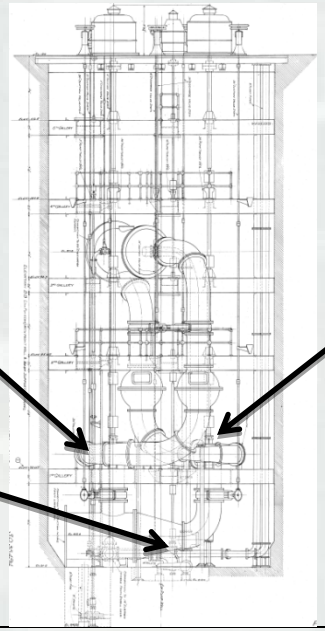
Pump Plant Features

- Two 26,000 GPM Pumps each powered by 300 HP motors



- Electric Motors Purchased 1913 never been rewound





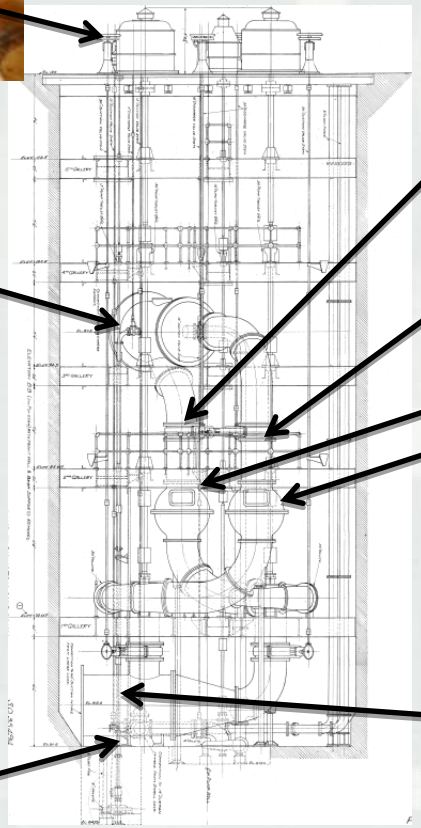
- One 4,500 GPM Pump powered by 75 HP motor

Pump Plant Features

- Valve Controls

- Two Check & Four Gate Valves

- 60” Discharge



- Intake from Small Lock

- Intake from Large Lock

Current State of Pump Plant

- Most Components have been in place since 1915 and operated annually

- Components that have failed have been replaced
- Most components severely corroded and worn

Existing Conditions: Pipe

- 10” Discharge pipe for the small pump ruptured last November during pump out - 6 FT crack with fish tails sticking out.
- Pipe section is currently being replaced
- After this all of the 10” piping will be replaced

Existing Conditions: Pipe

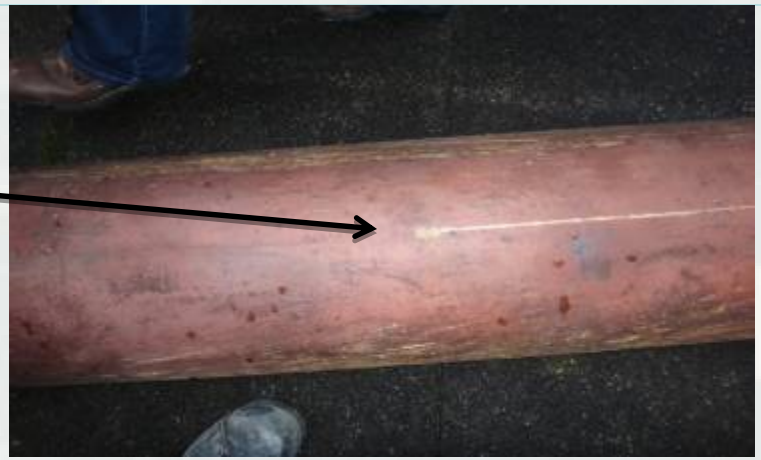
- Cross section of 10” Discharge Pipe that ruptured has severely corroded
- Appears to be graphitization of grey cast iron
- Iron corrodes away leaving matrix of graphite

Existing Conditions: Pipe

- Sandblasted and untouched coupons from cracked pipe
- Original wall thickness of 0.57”
- Many portions below 1/8”

Existing Conditions: Pipe

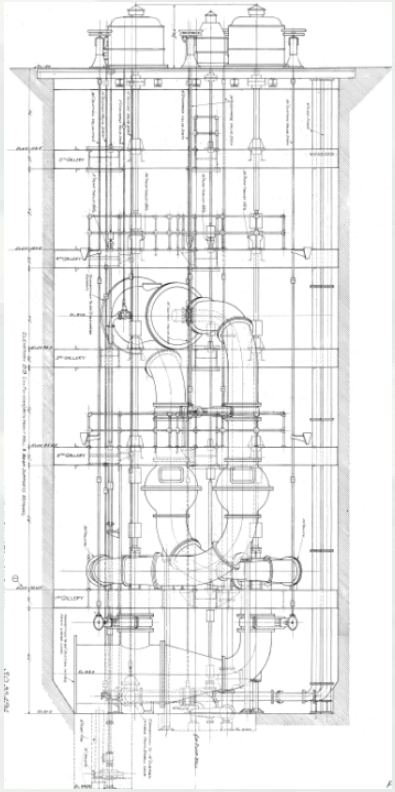
- Crew noticed pinholes in sections of pipe



- Pinhole turned out to be something much larger
- Original wall thickness 0.57”

Existing Conditions: Pipe

- Condition of most of the 60” and 30” pipe is unknown



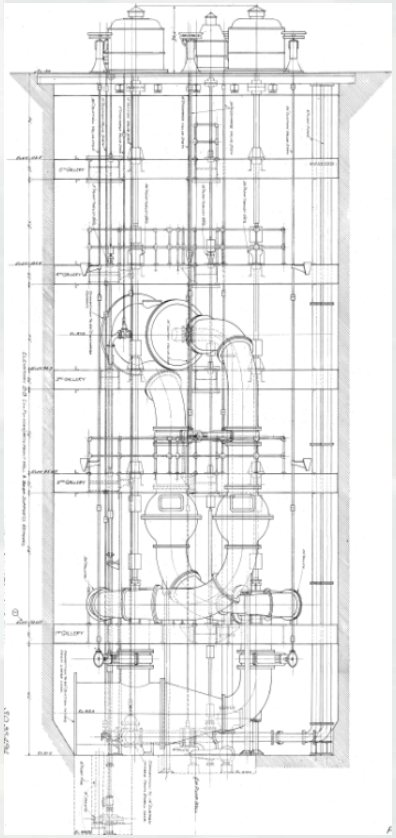
- Unsuccessful NDT testing
- Destructive Testing on 60” Discharge last year

Existing Conditions: Pipe

- Exterior of 60” Intake

Existing Conditions: Pipe

Existing Conditions: Beams and Bracing



Multiple Locations
•Original Thickness: Web = 0.6”, Flange 0.917”
•Current: Web = 0.23”, Flange = 0.22”

Existing Conditions: 10” Pump

- New 10” Pump as of March 2012

Existing Conditions: 30” Pumps

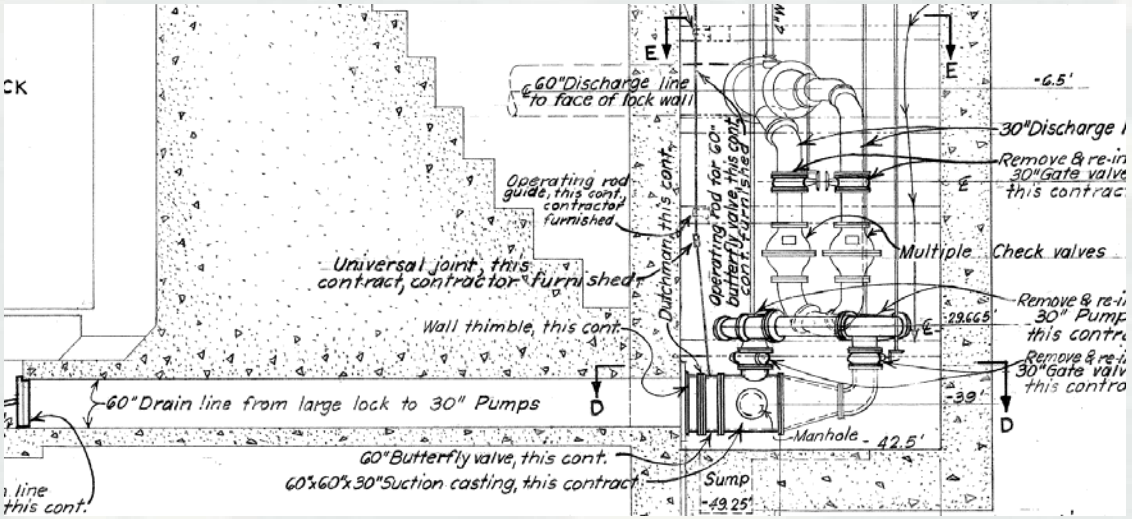
- 30” pumps recieved new impellers in 1943 and new castings in 1951
- Castings received temporary patches shortly after with in 1 year (still patched)

Existing Conditions: 30” Pumps

Repair Patches and Pack seals Periodically

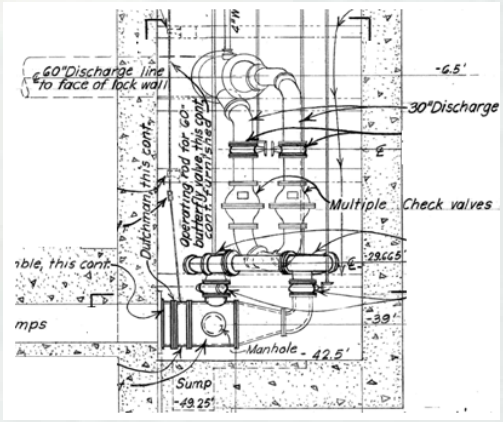
Existing Conditions: Valves

- Intake butterfly valve was added in 1954
- Intake valve slows down flow but will not shut it off



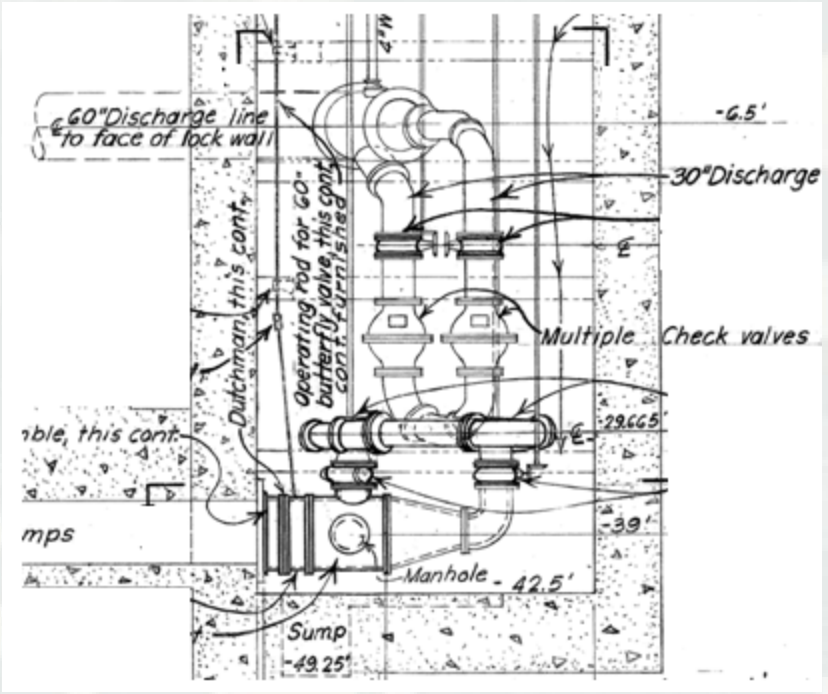
Existing Conditions: Gate Valves

- Four gate valves rehabbed in 1954
- Gate valves close but do not seal



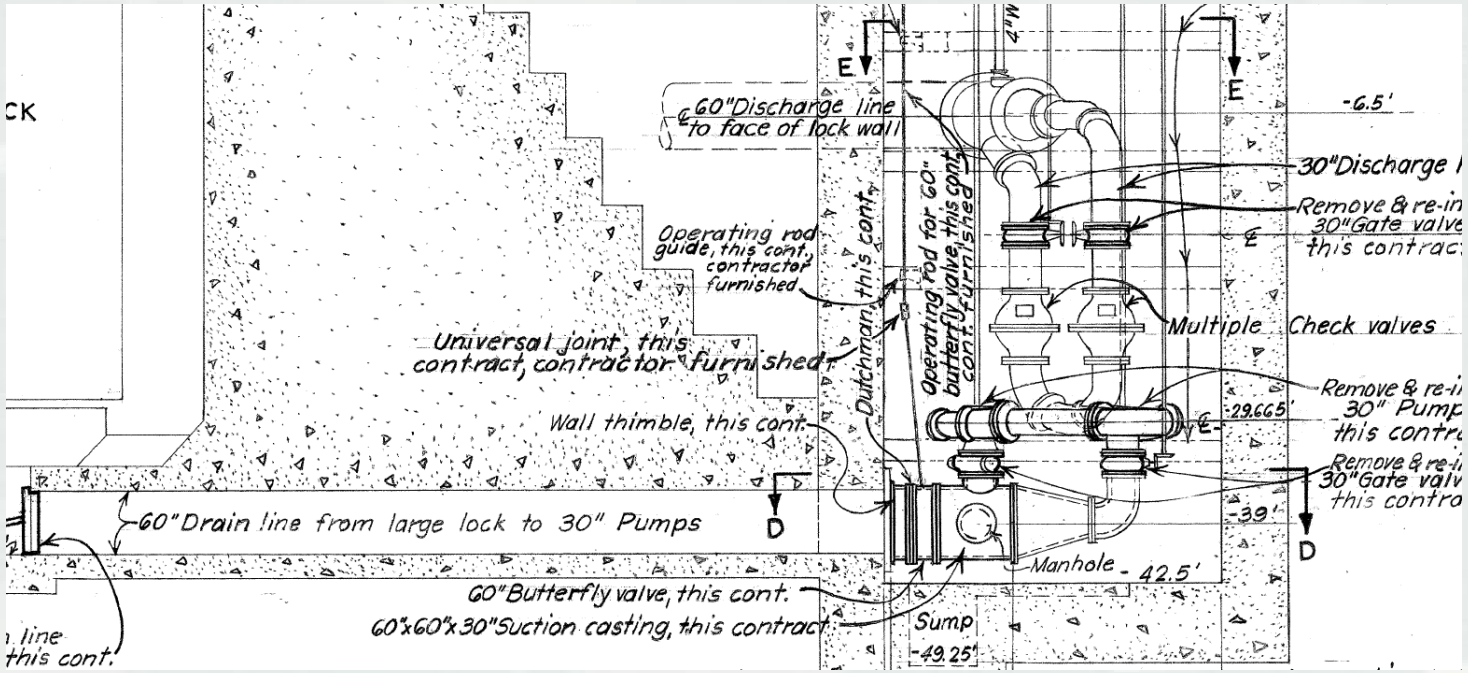
Existing Conditions: Valves

- Both check valves internal parts are completely corroded away



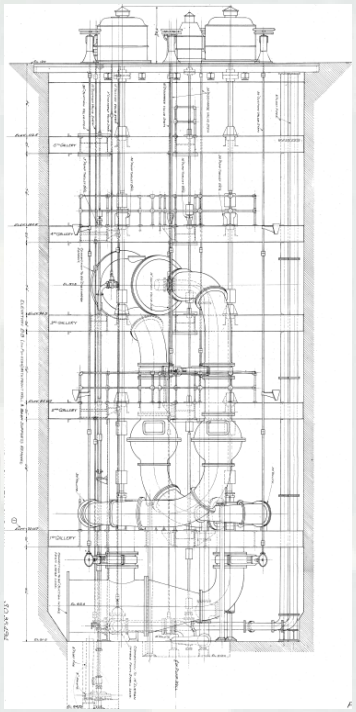
Current Operation of Plant

- Check valves are gone. Pump Start up and Shutdown has to be done carefully and valves manually actuated to prevent damage to pumps, shaft, and motors.



Current Operation of Plant

- Grease cups need to be manually turned for babbit bearings on shafts
- Life risk if major failure during operation

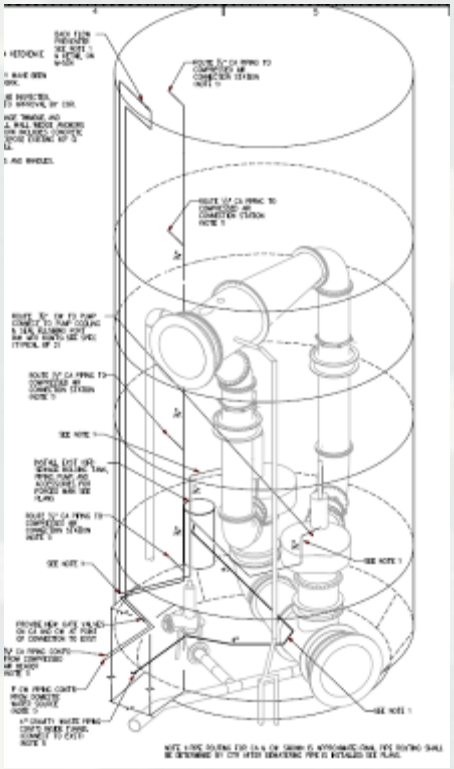


With age and all the issues, Why not replace?

- Recent burst……
- Past failures……
- Patches ……
- Missing Check valves ……
- Severe Corrosion……..

Replacement Plans

- Replacement plans initiated design in 2008
- Currently there is a 100% Design in Waiting
- New Design: Submersible Motors, everything new underneath but maintain Historic look on top



NEW PUMP SCHEDULE

MARK NO.	QUANTITY	LOCATION	TYPE	FLOW GPM	HEAD FT	2ND OPERATING POINT GPM	2ND OPERATING POINT FEET	POWER SPECIFICATIONS BHP	VOLTS	RPM (MAX)	PH	HZ	IMPELLER (INCH)	ENCLOSURE	REMARKS (SEE NOTE 1)
800	1	EL72.5 LOWER (1ST) GALLERY	CENTRIFUGAL VERTICAL CI	24,000	45	21,800	48	310	460	510	3	60	26.5	SEALED (SEE SPEC)	VARIABLE FREQUENCY DRIVE W/INTEGRAL COOLING SYSTEM VIA WATER JACKET SUBMERSIBLE FLOAT VIBR OR EQUAL (SEE NOTES 2&3)
801	1	EL72.5 LOWER (1ST) GALLERY	CENTRIFUGAL VERTICAL CI	24,000	45	21,800	48	310	460	510	3	60	26.5	SEALED (SEE SPEC)	VARIABLE FREQUENCY DRIVE W/INTEGRAL COOLING SYSTEM VIA WATER JACKET SUBMERSIBLE (SEE NOTES 2, 3, 4)
810	1	EL81.5 BASEMENT FLOOR	CENTRIFUGAL VERTICAL CI	5230	40	4500	45	85	460	880	3	60	16.25	SEALED (SEE SPEC)	VARIABLE FREQUENCY DRIVE SUBMERSIBLE (SEE NOTES 2, 3, 4)
820	1	EL81.5 BASEMENT FLOOR	SUMP	50	40			0.8	460	3450	3	60	X		SUBMERSIBLE (SEE NOTE 4)
821	1	EL81.5 BASEMENT FLOOR	SUMP	50	40			0.8	460	3450	3	60	X		SUBMERSIBLE (SEE NOTE 4)
CP-1	1	MOTOR FLOOR (AT GRID)	END SUCTION CENTRIFUGAL	100	40			1.75	460	3450	3	60	X		IN-LINE CNTRFGL

Funding is Tight

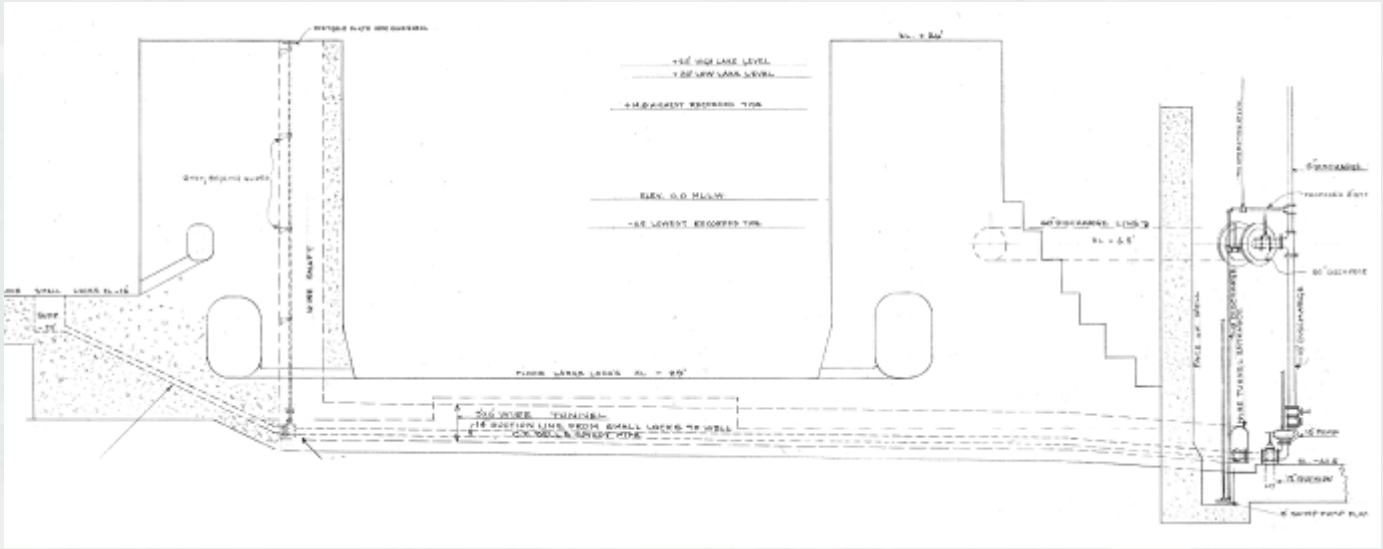
- O&M Funding cannot support replacement, cost is $5-$10 million, routine navigation budget is not large enough. In addition many features of LWSC are over 100 years old and need replacement.
- Not enough tonnage to compete effectively for funding in non-routine business line. Even with 50,000+ vessels annually the MDD is only about 1 million tons per year
- Initiated Major Rehabilitation Study to obtain Funding but cost for completion was more than available, so district decided to pause and explore other options.
- Considered phasing the work, partial replacement, etc. But it is difficult and not cost effective to do with a pump plant.

Future Failures

- Without replacement failure is eminent.
  - Expert Opinion Elicitation said "…. 70% chance the plant would fail by 2015 and there was 82.5% failure would be due to something serious such as pipe rupture."
  - PFMA (2009) - credible failure mode due to the pump plant.
- Pipe rupture could lead to worker fatality and/or pump well flooding when plant is idle or pumping.
- Two Flood Level Scenarios:
  - Tide Level
  - Lake Level

Future Failures

- Tide Level flooding would shut LWSC down for 1-2+ months because of the 2400V electrical feeder that runs under the lock chamber. Electrical equipment and wiring would likely need to be replaced.
- Spillway would be operated manually or by generators



Future Failures

Lake Level flooding would shut LWSC down for 6 months to 1 year or more

- Complete flooding of the pump well, including the pump motors, the electrical substation in the basement of the Admin Building, electrical rooms below the 4 control houses, Stoney gate valve motors, hydraulic pump motors for miter gates, driver cards, transformers, feeders etc.

Future Failures

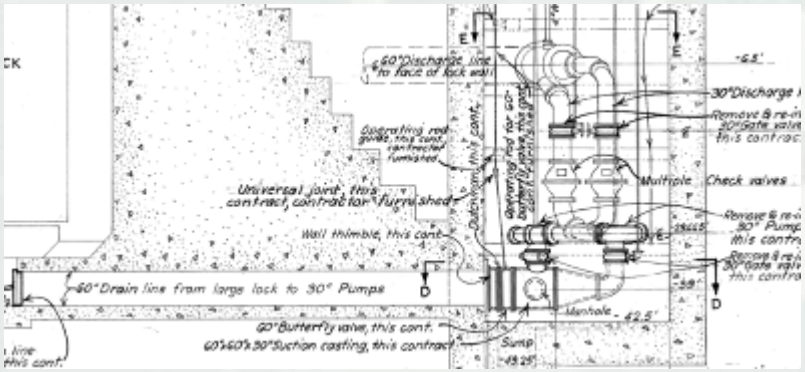
- If flooding is at lake level a nearly complete rebuild of the electrical system would be needed estimated at $5-$10 Million. Complications are antiquated wiring and components. Abandoned wires, unlabeled wires, items not up to code. Many items are no longer available and would need replacement.

Impacts from Failure

- **The 520 Floating Bridge**: The State of Washington is in the process of building the new 520 bridge and has brought the first sections of the bridge through the locks. This project is scheduled to be completed by 2015. All equipment, support vessels, and bridge sections need to transit the locks to reach the worksite. Any closure would severely impact the completion of this project.
- **Commercial Navigation**: About 13,000 per year transit the project per year.
- **Environmental Stewardship:** Depending on the time of year, there could be significant impacts to the project's ability to pass salmon.
- **Recreational Boats:** LWSC is the busiest lock in the nation. It provides a freshwater port for thousands of recreational vessels that head for Puget Sound, mostly May through September, with a lesser number in the winter. About 40,000 recreation vessels transit the Locks in a year.

Planning for Failure

- Mitigation Plans
  - Dewater the system when not in use. Place plug at end of pump out and divers remove each time for pump out.
  - Not sure if it will be operated again unless a complete inspection of the system can be performed
  - Replace manually-turned greasing cups with auto-greasing devices. Minimize the requirement for LWSC staff to enter the pump plant during operation
  - Possibly replace all bolts on the flange connections.
  - Add surveillance cameras to the pump well.

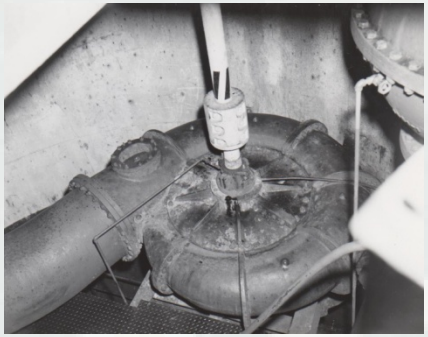


Pump Plant Needed

- Painting, inspections, repairs, and sacrificial anode replacement has to happen annually.
- Dewatering pumps will have to be rented for maintenance and possible emergency inspections or repairs
- Minimum cost of $95,000 per dewatering of large locks (not including contracting costs)
- Does any District have a spare 52,000 GPM pump plant sitting in a warehouse we could borrow?
- Does any District have $5-10 Million in a warehouse?

Questions or Advice

If you have some knowledge or advice you would like to impart please come up and talk to us or email: nathan.d.mcgowan@usace.army.mil



Thank you!