Seattle's Turbine Pumps

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PNWS-AWWA Conference

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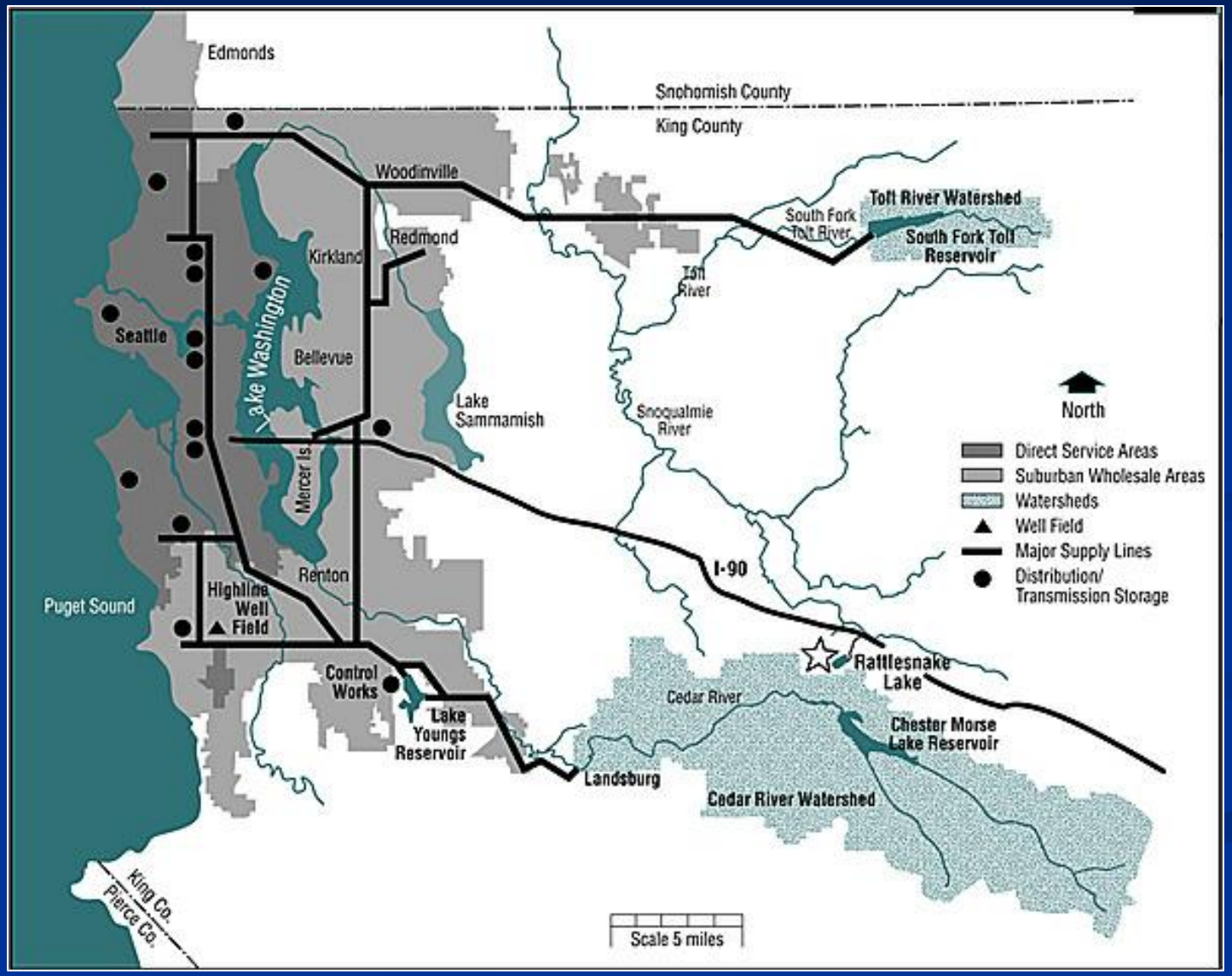
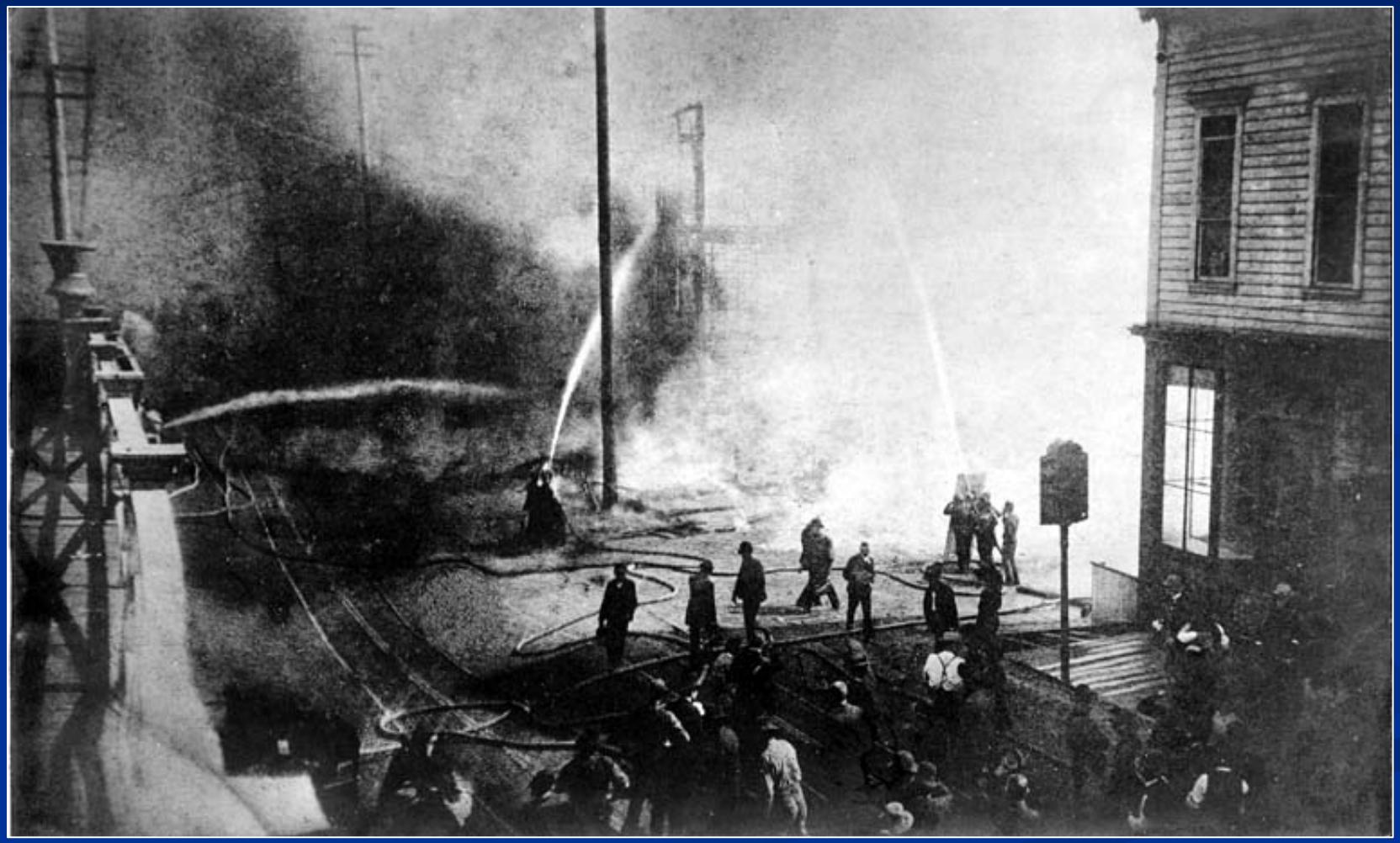
Overview

- Seattle System
- Topography
- Concept
- Operational Needs
- The Turbines

Seattle System



The Great Seattle Fire



Courtesy of University of Washington Libraries Digital Collection

Seattle Water Department is Born

- June 1889 – The Great Seattle Fire destroys 50 blocks of downtown Seattle's commercial & business district.
- July 1889 – Voters authorize a bond issue to create a city-owned waterworks system.
  - 1875 for, 51 against
- 1901 – Water is delivered from the Cedar River to Volunteer and Lincoln Reservoirs.

Topography

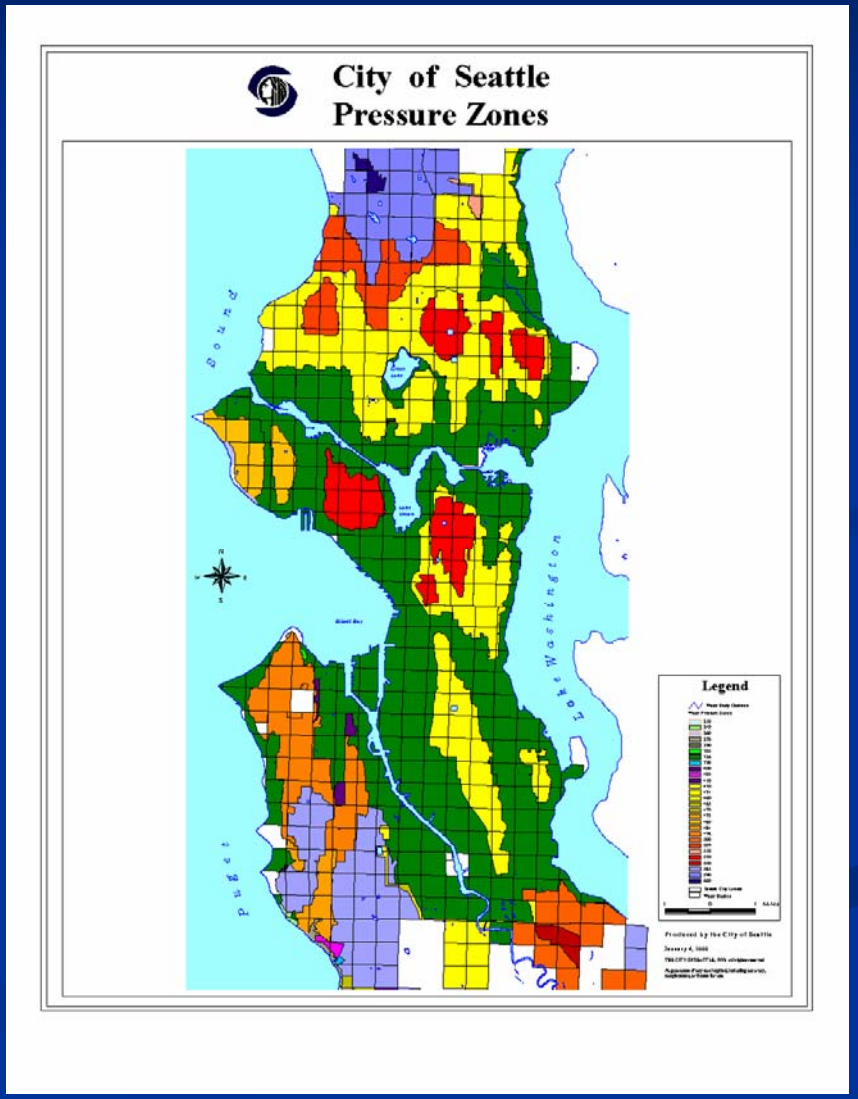
"Seattle has hills, and to spare. With surface elevation of Lake Youngs at 498 feet above sea level, water incoming from Cedar River is vented by gravity into reservoirs at surface elevation 430 feet, as is the reservoir on Capitol Hill. Leo Tank on Beacon Hill is supplied by gravity, off the pipelines, at elevation 480 feet. So are reservoirs on the West Seattle hills, at elevation 440 feet.

Topography (cont.)

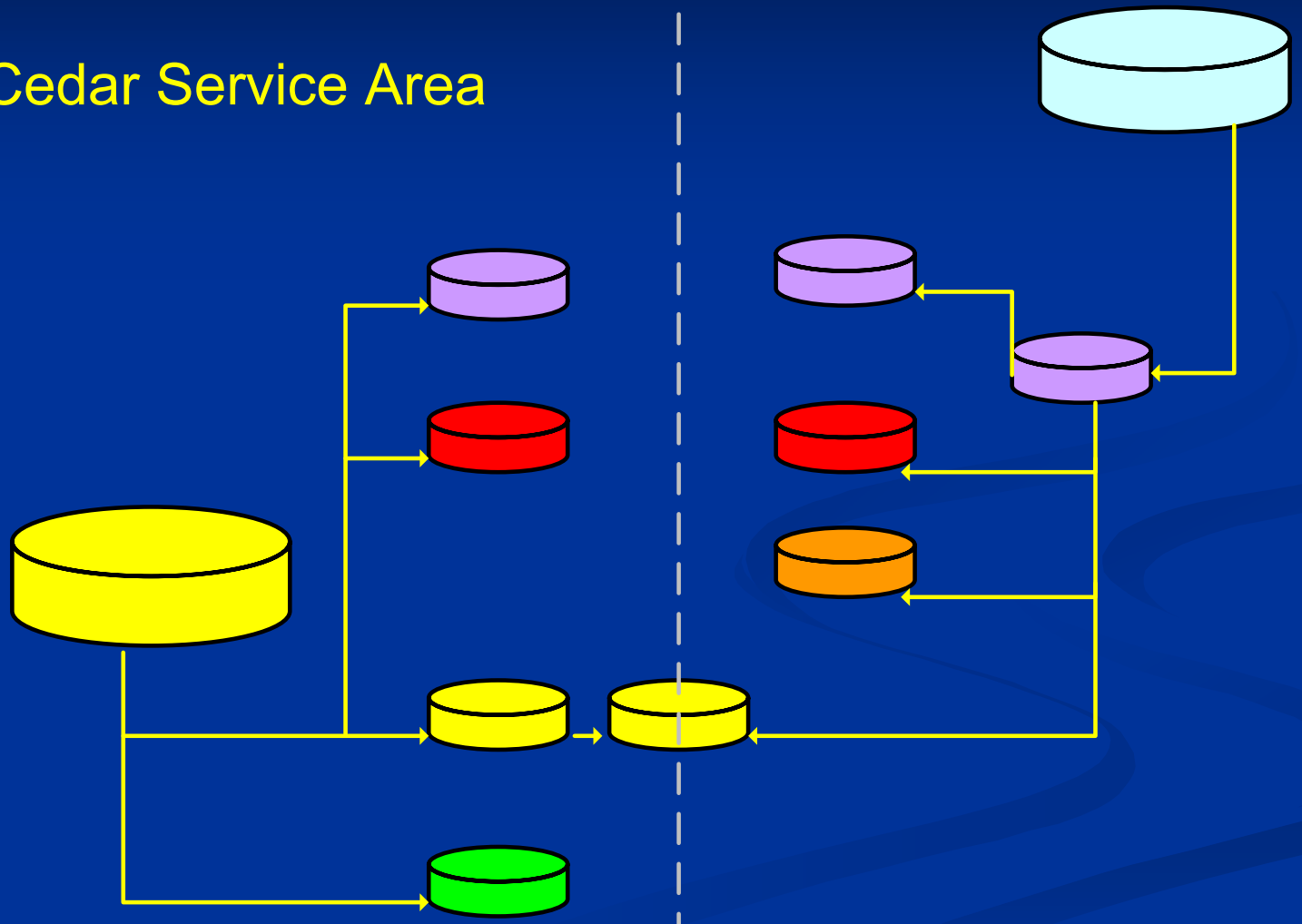
"Hydraulic turbines placed on the lines, take advantage of the kinetic energy of water between elevations. Pumps connected to these units force water to high zone towers and tanks with overflows of 530 feet above sea level, such as Queen Anne Hill."

- R.H. Calligan, Superintendent of Water, 1893

Topography & Pressure Zones

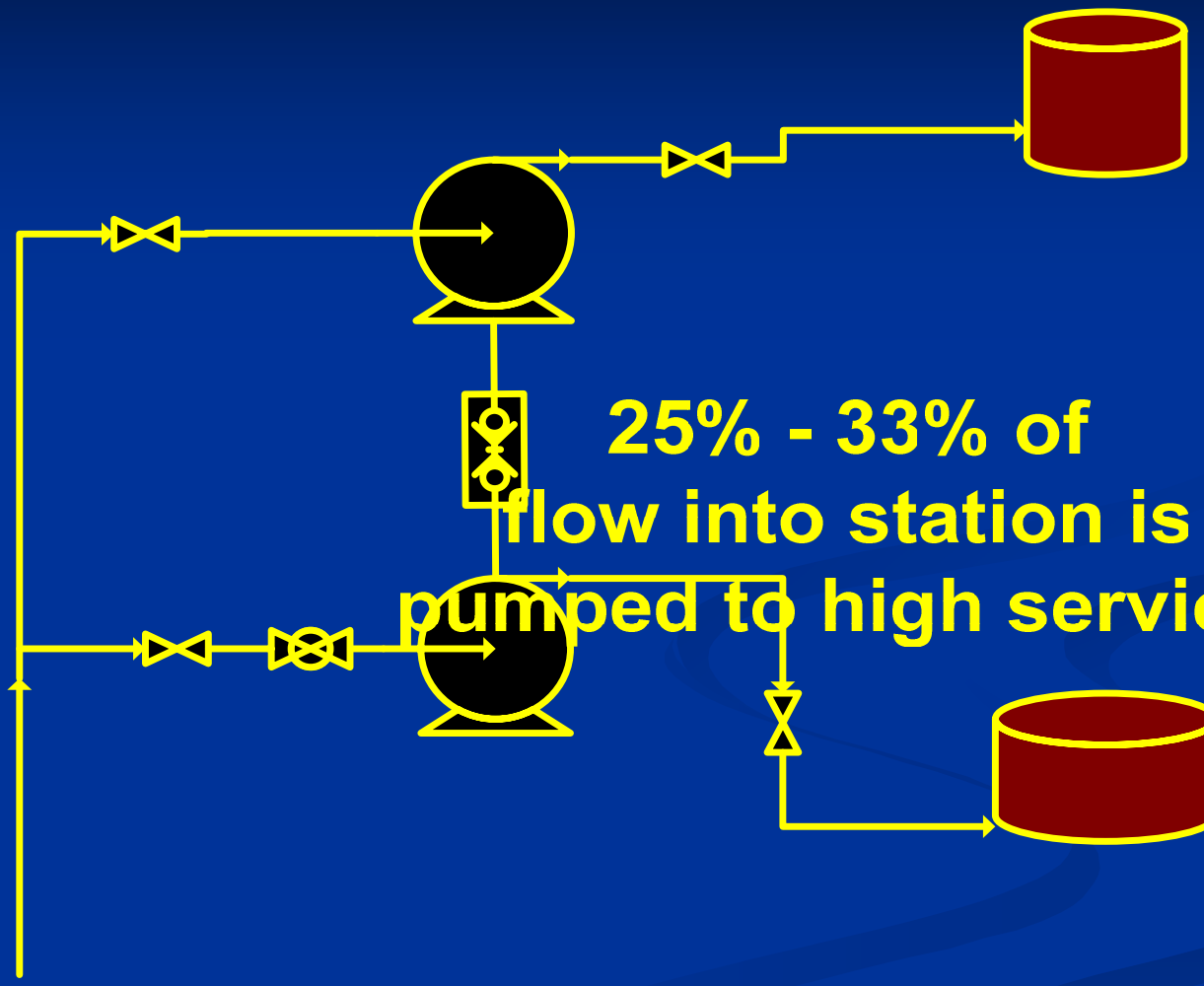


Pressure Zone Hydraulic Profile



The Concept
and
The Operational Needs

Turbine Schematic



25% - 33% of flow into station is pumped to high service.

Pump

Operational Needs

- Hills & multiple pressure zones
- Stable & adequate suction head
  - Output varies along with gradient on pipeline supply
  - Turbine must be shut down if gradient drops too far
- Vent on supply pipeline

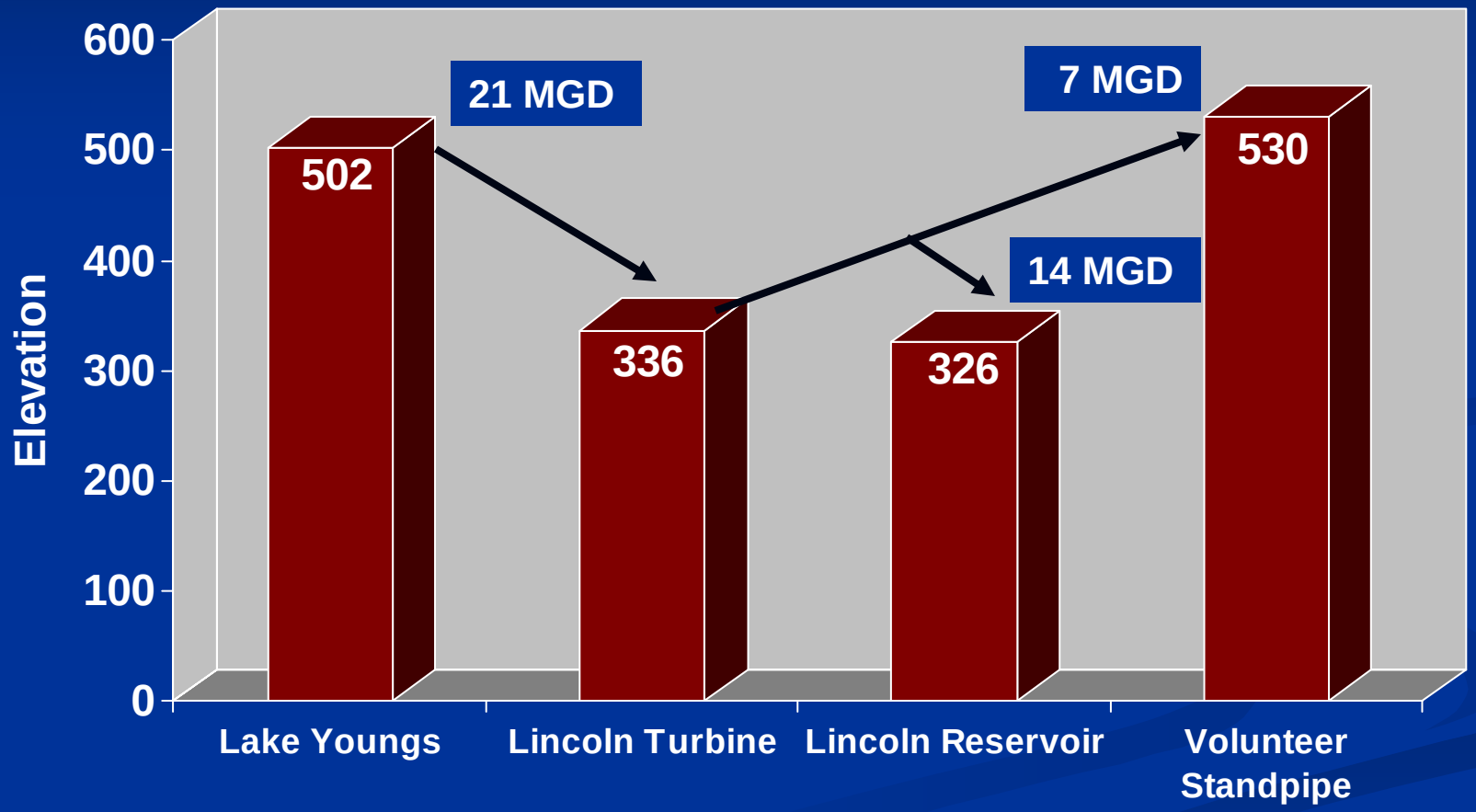
Operational Needs

- Storage or demand for the drive-water, and
- Storage or demand in the pumped zone

- Managing demands can be challenging
  - Ability to move water out of zones can extend running time

The Turbines

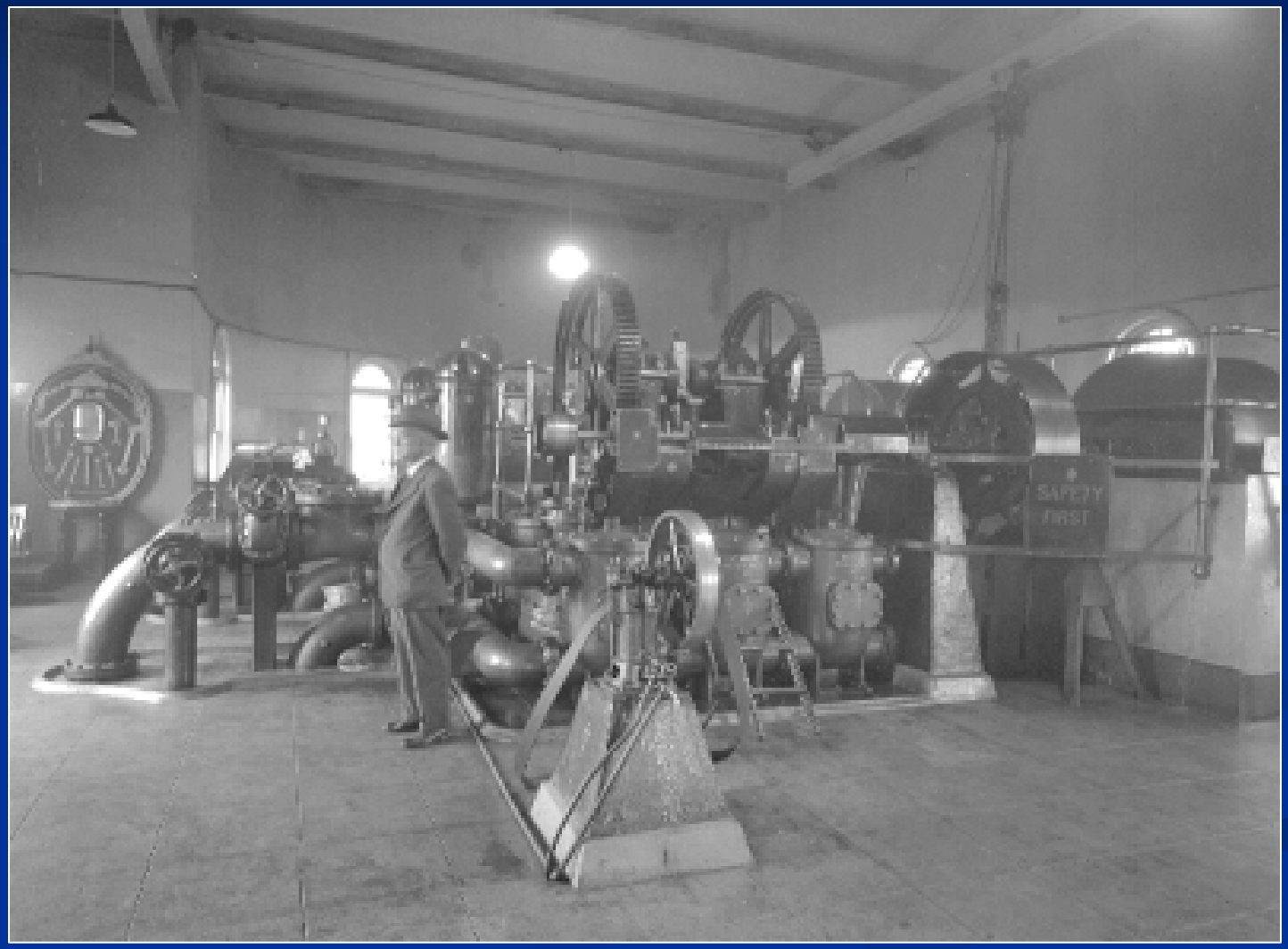
Lincoln Turbine Hydraulic Profile



Lincoln Turbine

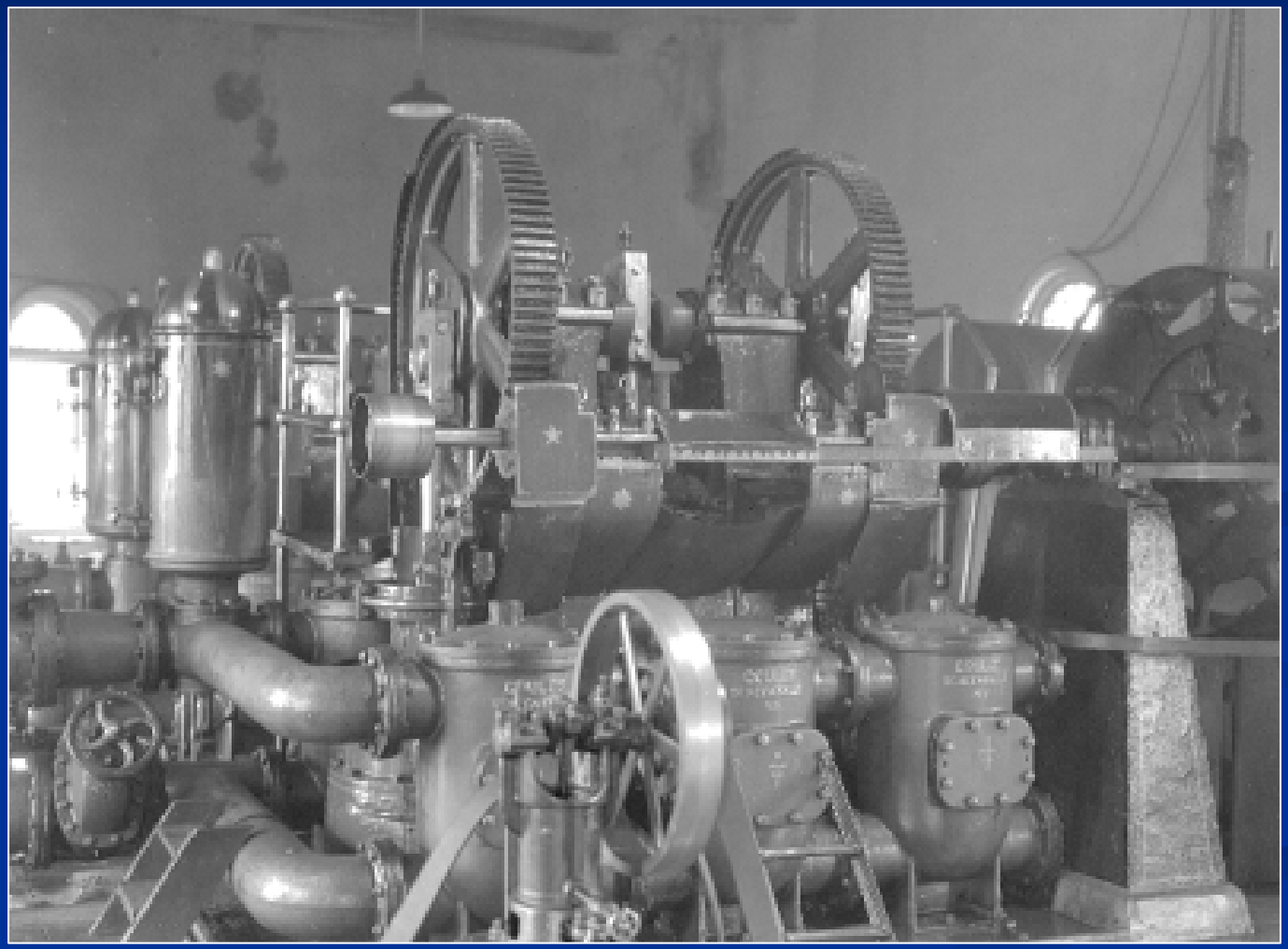
- 1900 – two 10x12” Gould Triplex pumps connected through reducing gears to 90hp Pelton water wheels

Lincoln Turbine 1901 - 1931



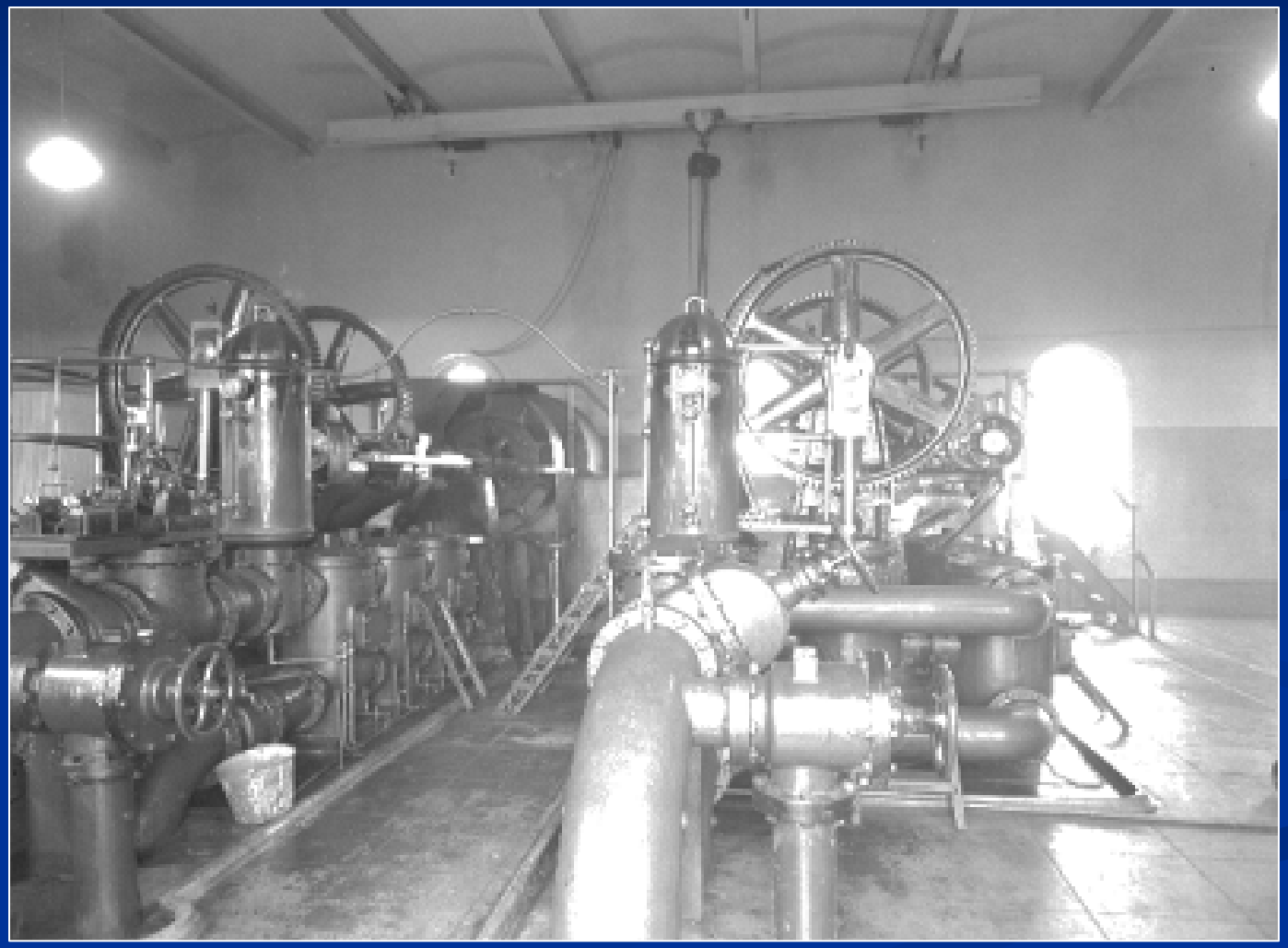
Courtesy of Seattle Municipal Archives, 6910 (1929)

Lincoln Turbine 1901 - 1931



Courtesy of Seattle Municipal Archives, 6909 (1929)

Lincoln Turbine 1901 - 1931



Courtesy of Seattle Municipal Archives, 6908 (1929)

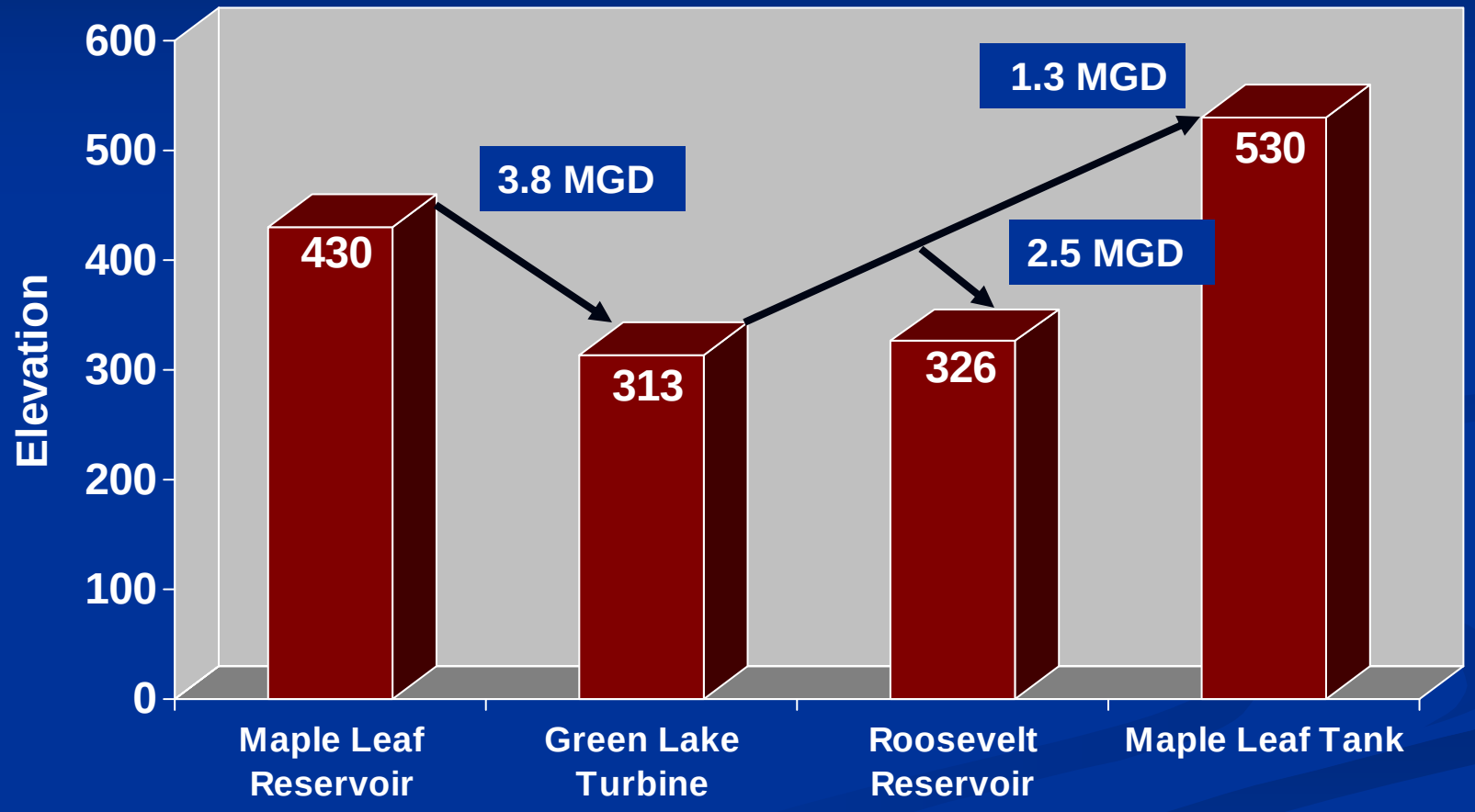
Lincoln Turbine

- 1931 – original units replaced by a 120 hp Worthington 16” turbine of the reaction type direct-connected to a 12x10” single stage double suction centrifugal pump

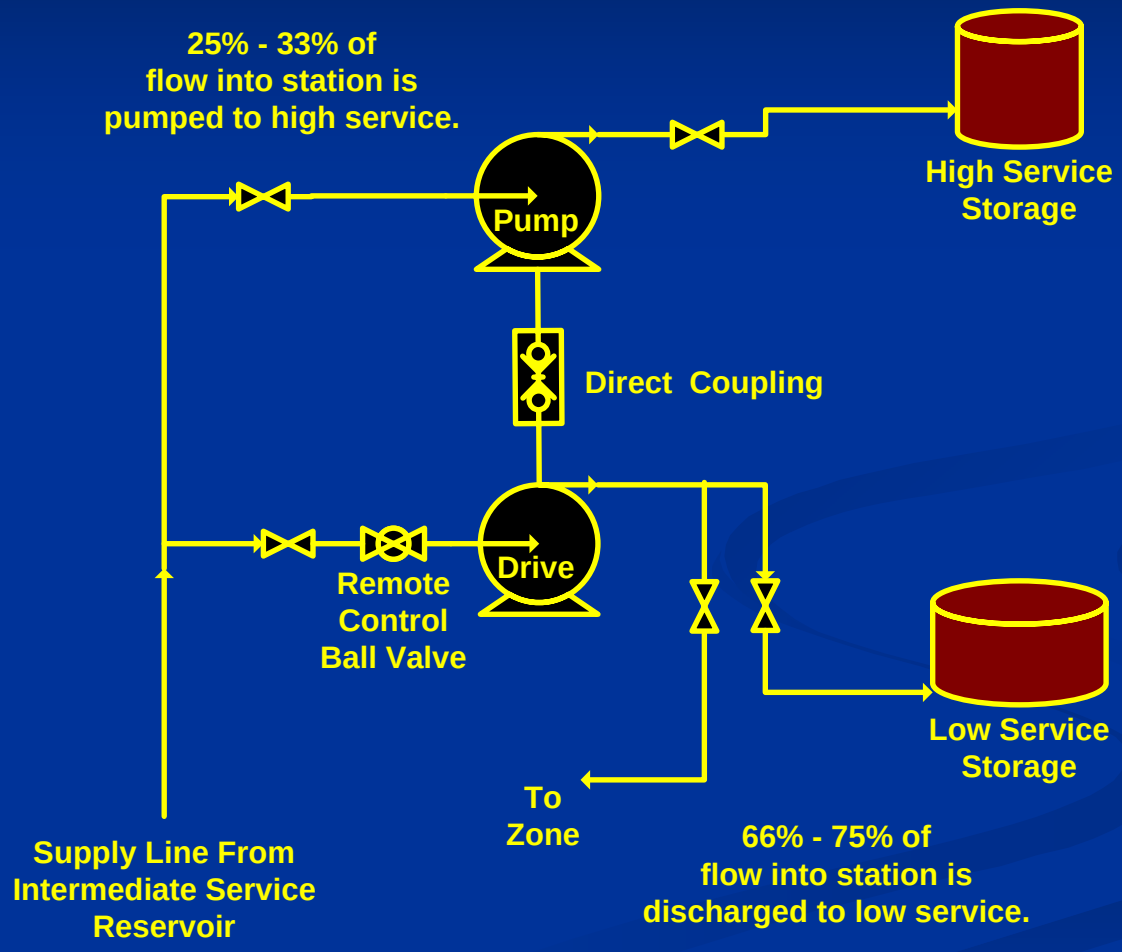
Lincoln Turbine 1931 - Present

Courtesy of Seattle Municipal Archives, 131318 (2002)

Green Lake Turbine Hydraulic Profile



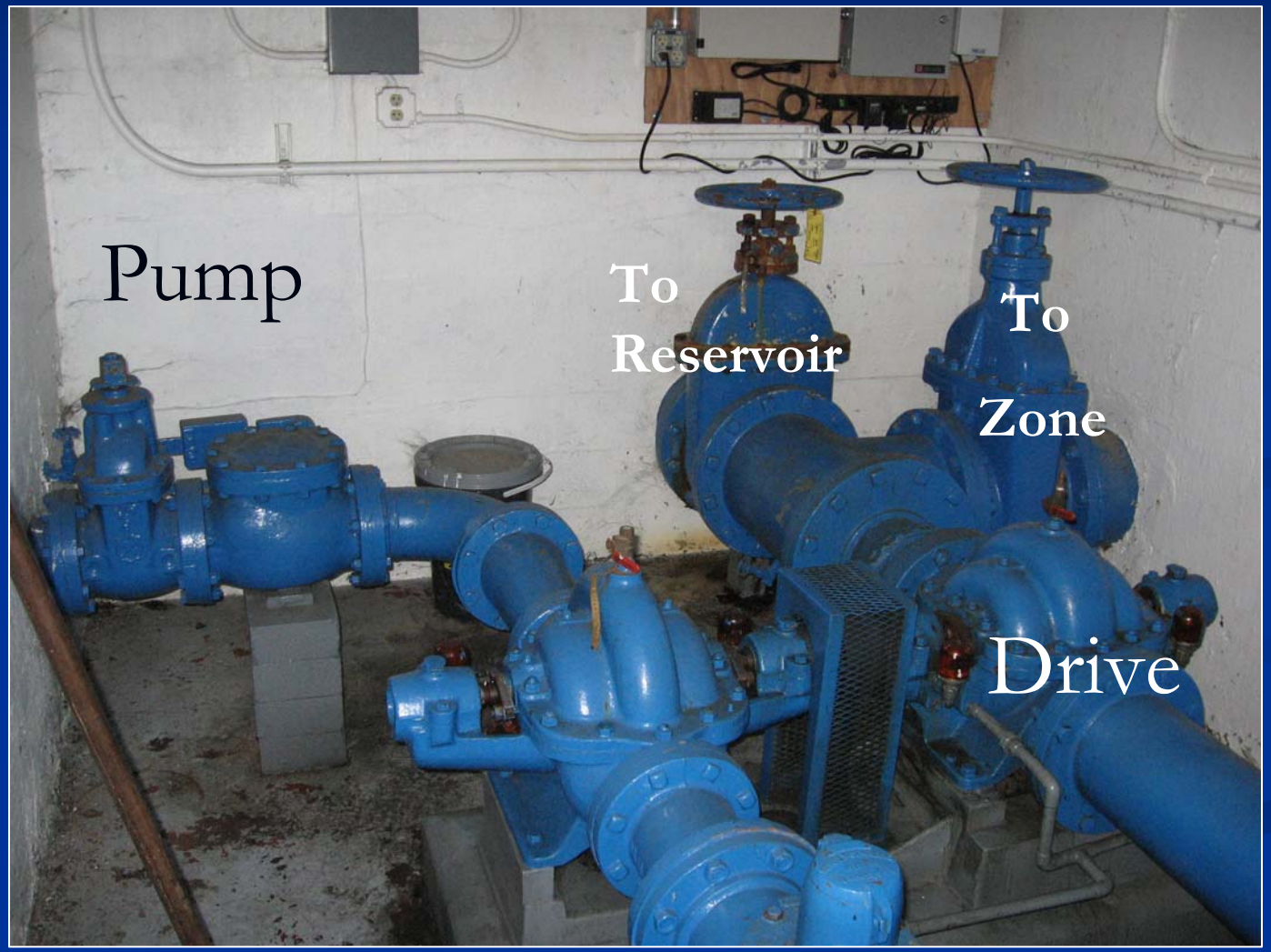
Green Lake Turbine



Green Lake Turbine

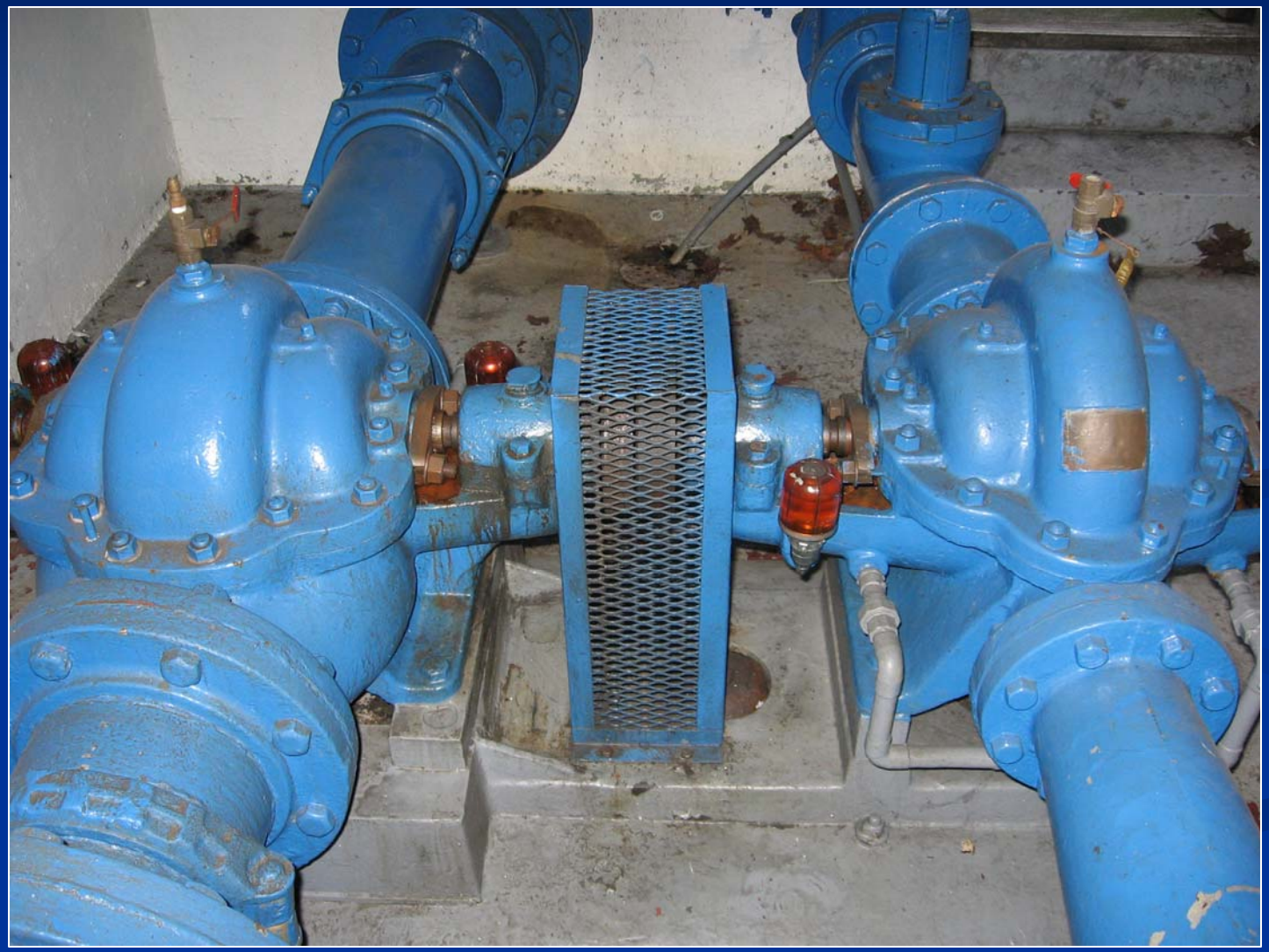
- Drive-water line was originally constructed as a conventional reservoir inlet in 1910
- Primary reservoir inlet was moved in 1930
- 50 hp DeLaval unit was installed in 1933, replacing an electric pump at a savings of $1000 a year

Green Lake Turbine Discharge Piping



Green Lake Turbine Suction Piping

Green Lake Turbine Pump



Green Lake Turbine Discharge

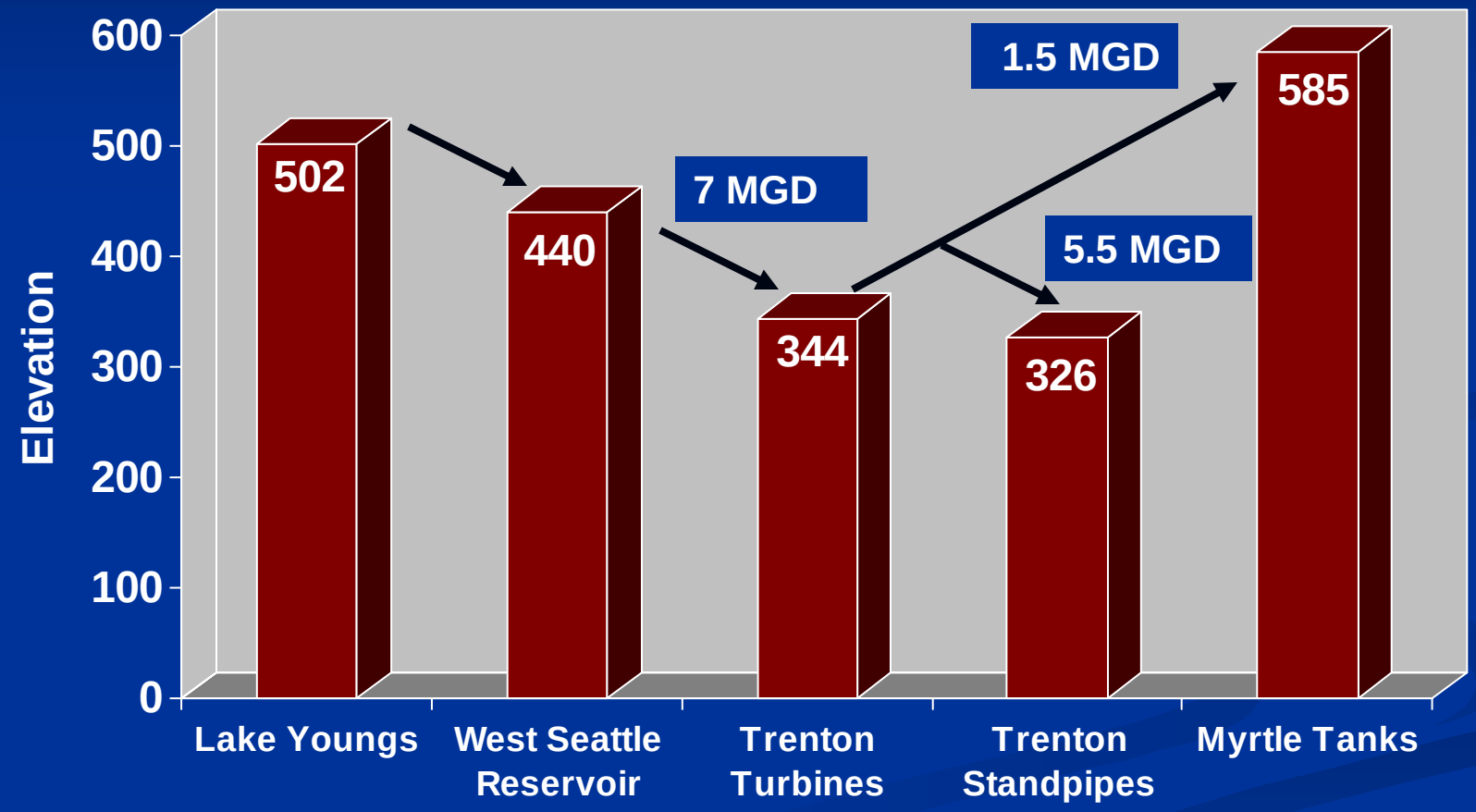
Courtesy of Seattle Municipal Archives, 149680

Trenton Turbines

- 1935 –Trenton Pumping Plant and Trenton Standpipes enter service

- 1994-95 – Turbine #2 is overhauled after a screwdriver left in the reservoir outlet line during the liner installation was sucked into an impeller.

Trenton Turbine #1 Hydraulic Profile



Trenton Turbines

- Turbine #1
  - 7 MGD total demand
  - 1.5 MGD to upper zone
  - 5.5 MGD to lower zone
- Turbine #2
  - 21 MGD total demand
  - 4.3 MGD to upper zone
  - 16.7 MGD to lower zone

Trenton 1932

Courtesy of Seattle Municipal Archives, 5493 (1932)

Trenton 1934

Courtesy of Seattle Municipal Archives, 7196 (1934)

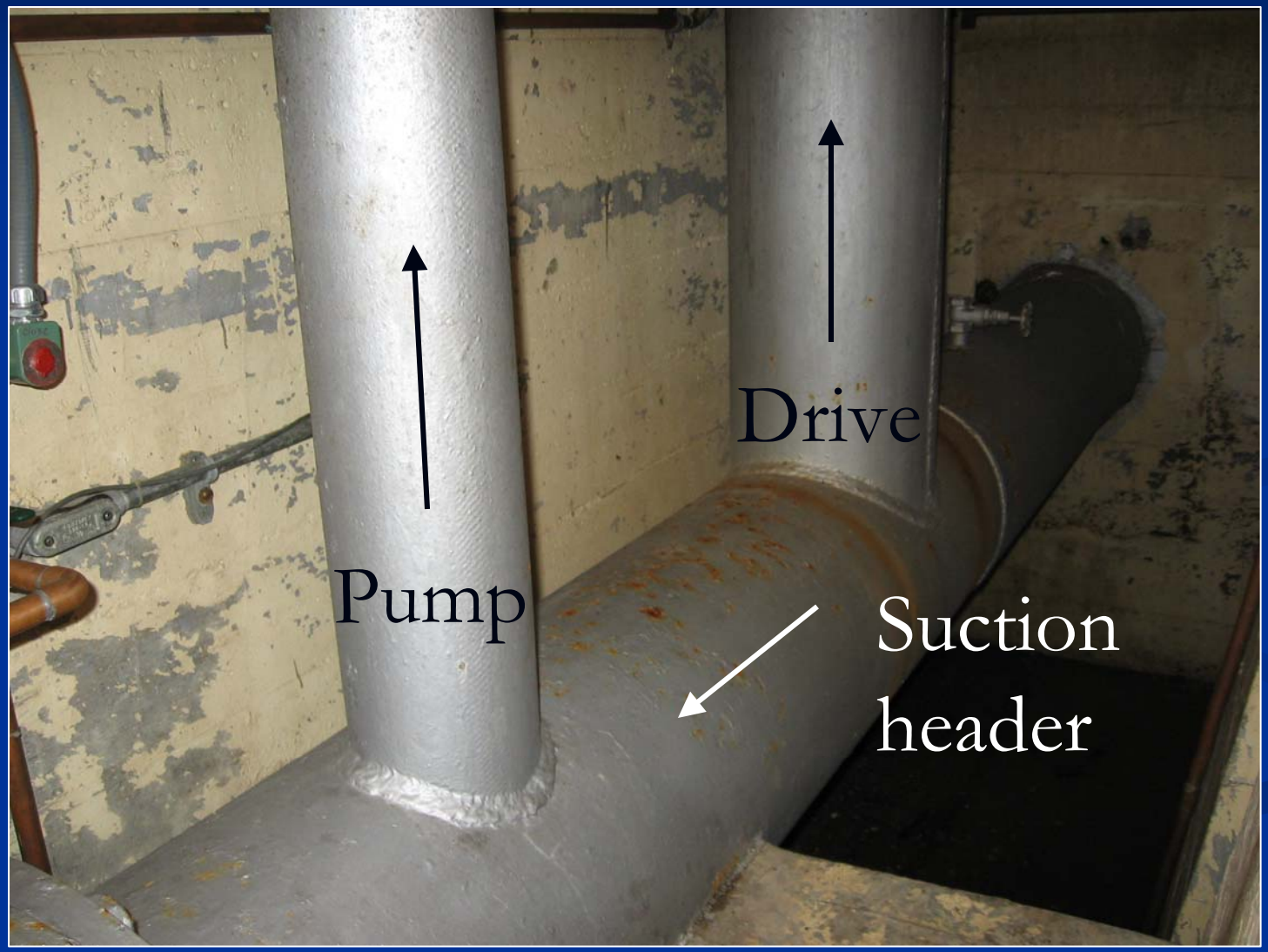
Trenton #2, 1934

Courtesy of Seattle Municipal Archives, 7192 (1934)

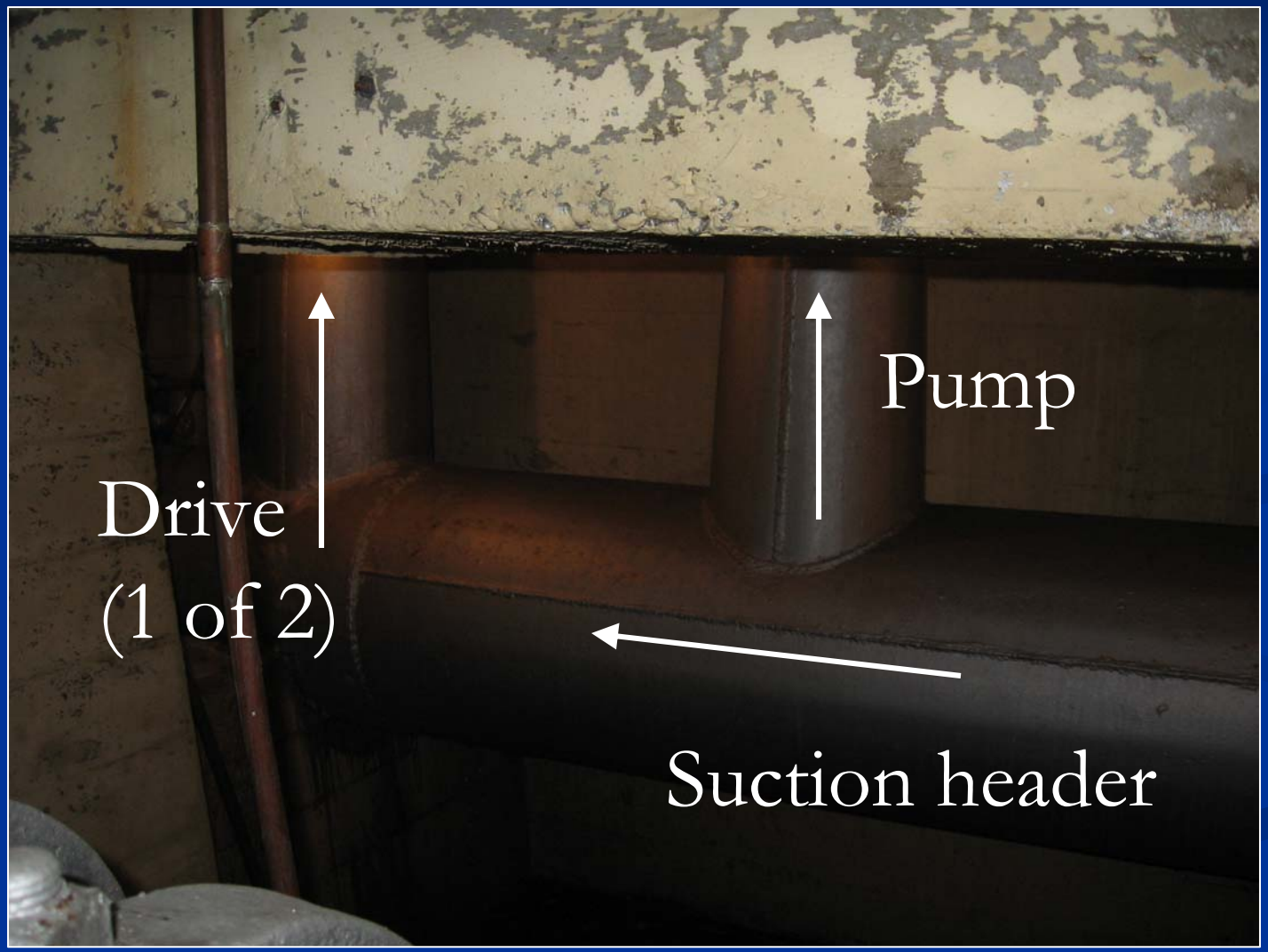
Trenton #2, 2008

Trenton #1, 2008

Suction Piping, Trenton #1

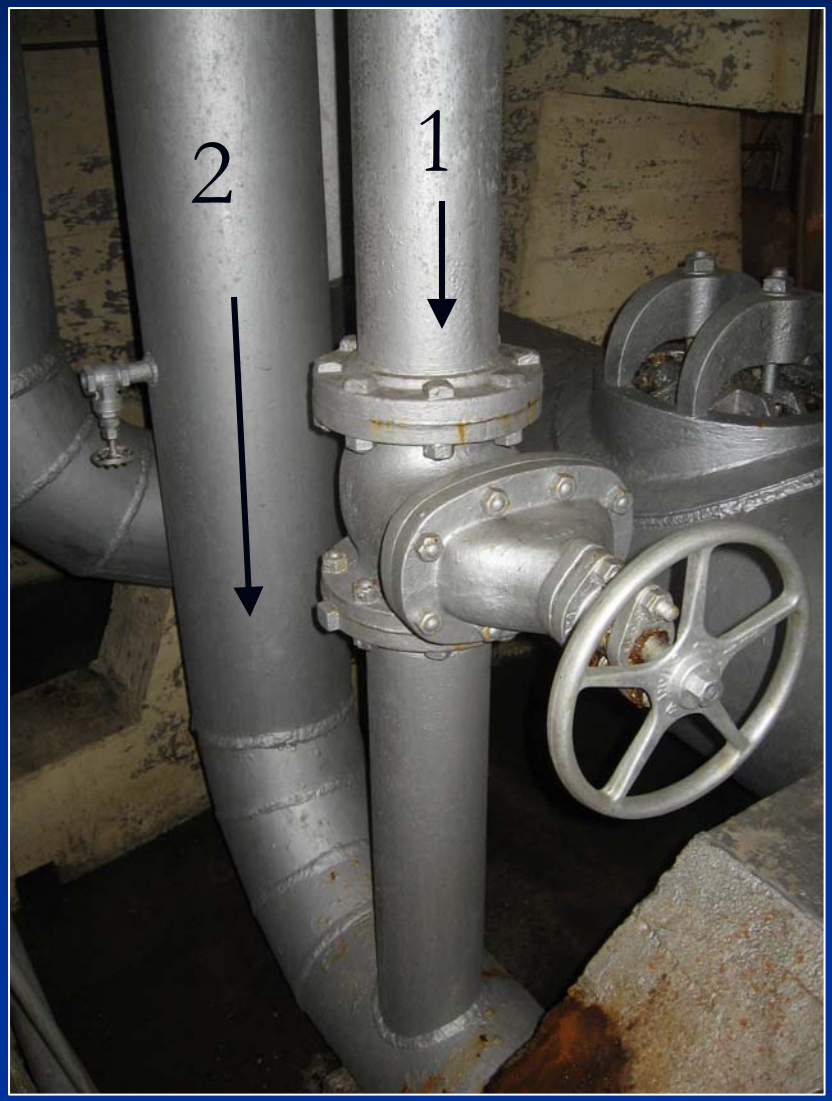


Suction Piping Trenton #2



Trenton Drive-water Discharge

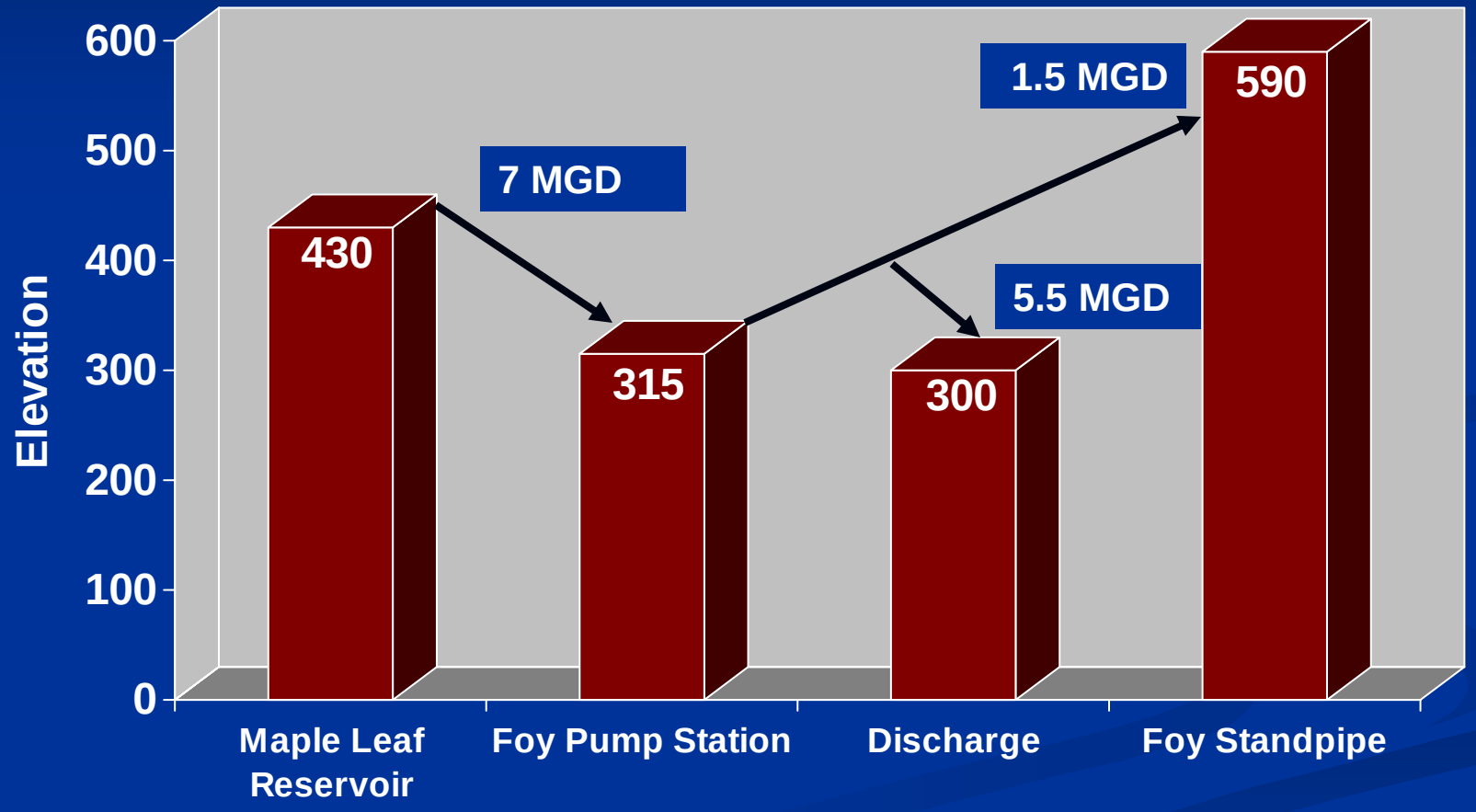
Trenton Pump Discharge



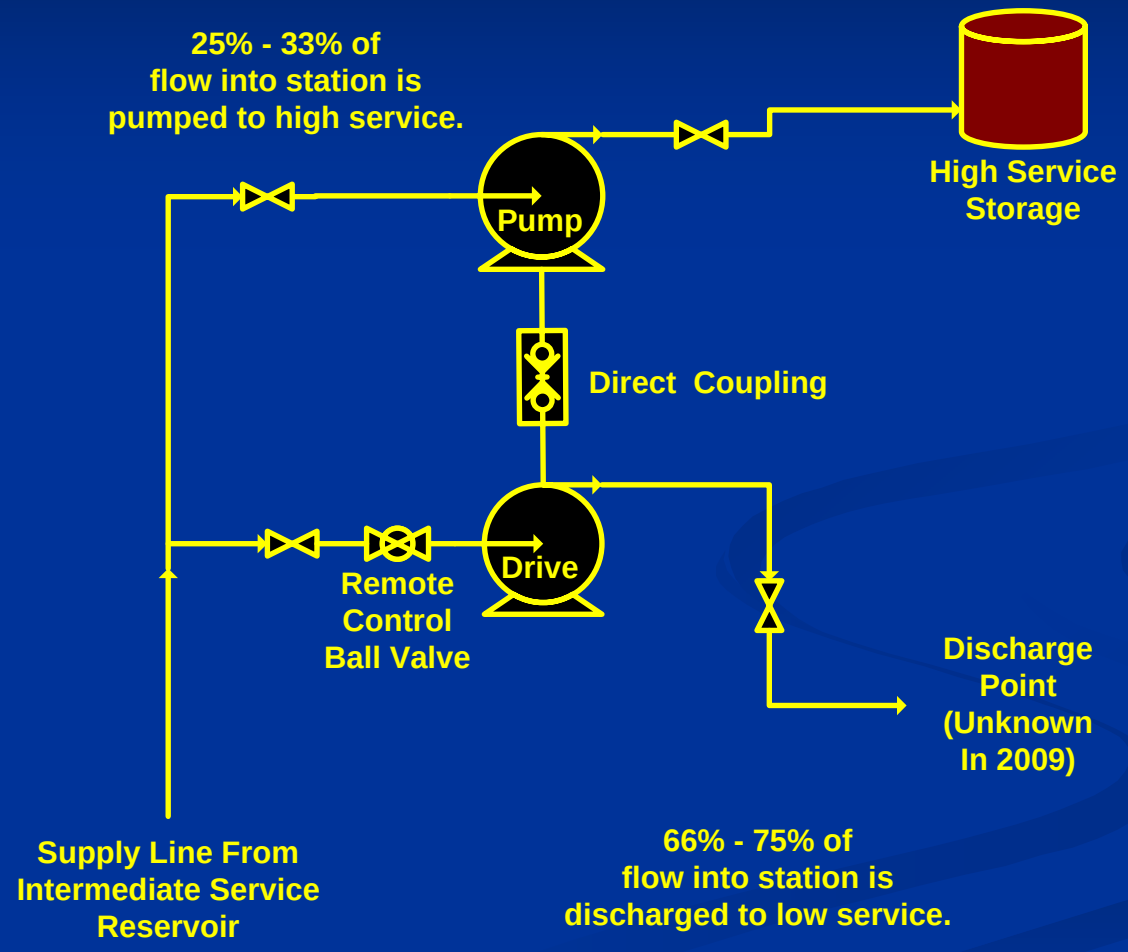
Pump discharge piping in foreground.

Drive-water discharge piping in background.

Foy Turbine Hydraulic Profile



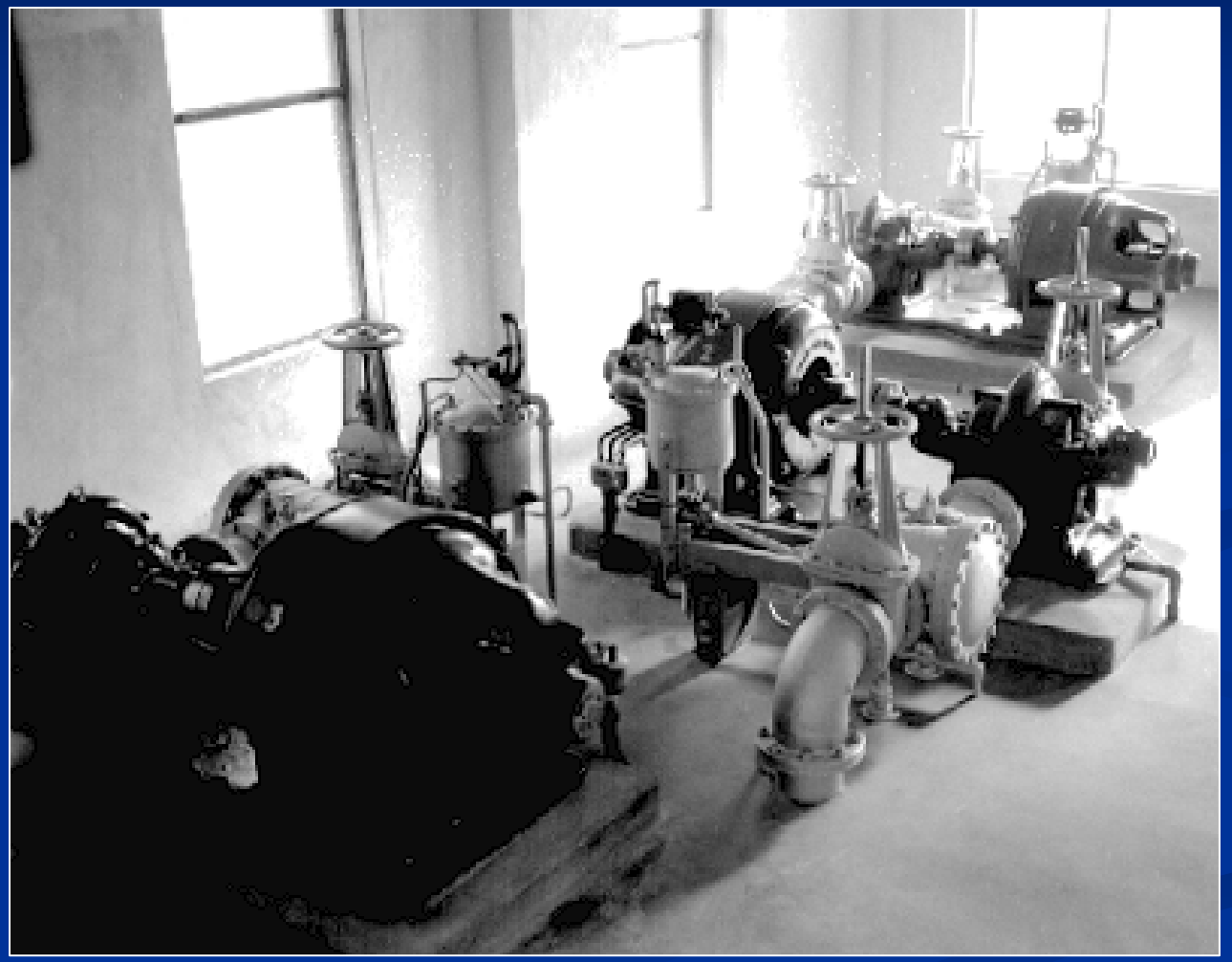
Foy Turbine


25% - 33% of
flow into station is
pumped to high service.
High Service
Storage
Pump
Direct Coupling
Drive
Remote
Control
Ball Valve
Discharge
Point
(Unknown
In 2009)
Supply Line From
Intermediate Service
Reservoir
66% - 75% of
flow into station is
discharged to low service.

Foy Pump Station

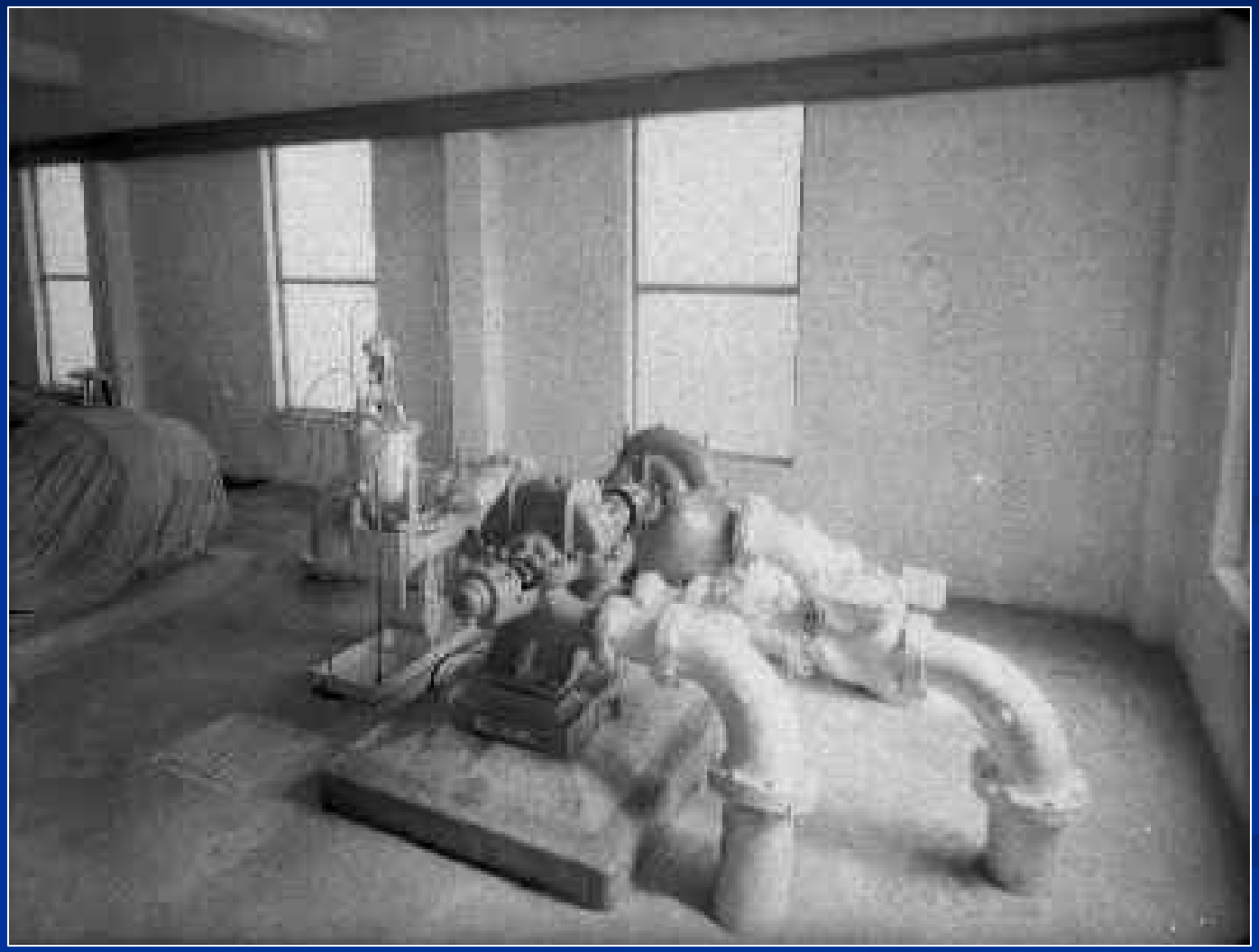
- Built 1933, initially all electric
- By 1935, one pump replaced with turbine
- By 1942 – electric pumps upsized
- Report by W.A. Herrigel in 1952 indicates Foy Turbine is still operational
- Turbine was likely removed when the Tolt source was brought on line, around 1960

Foy Electrics - 1933



Courtesy of Seattle Municipal Archives, 8245

Foy Turbine

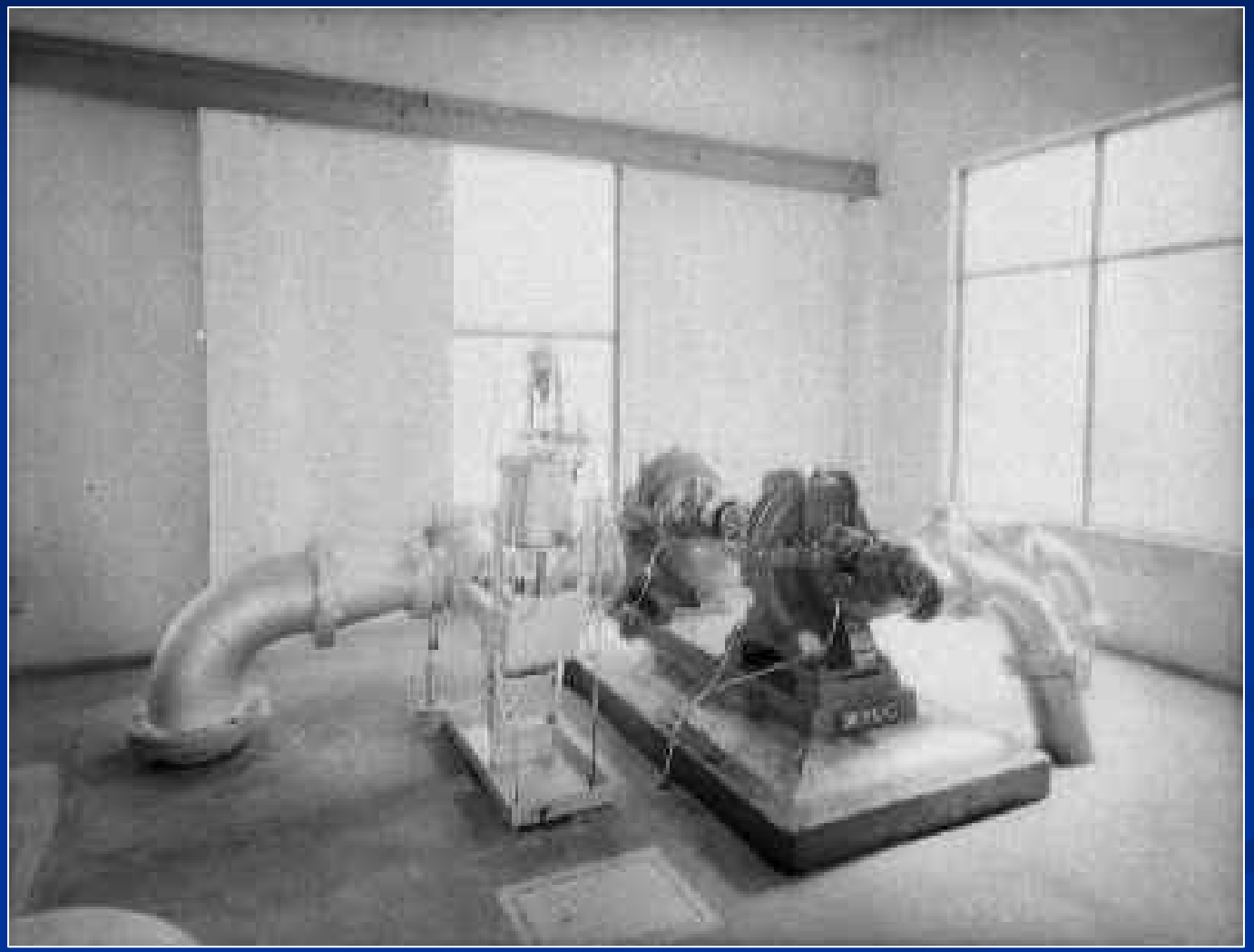


Courtesy of Seattle Municipal Archives, 7204

Foy Turbine

Courtesy of Seattle Municipal Archives, 7205

Foy Turbine

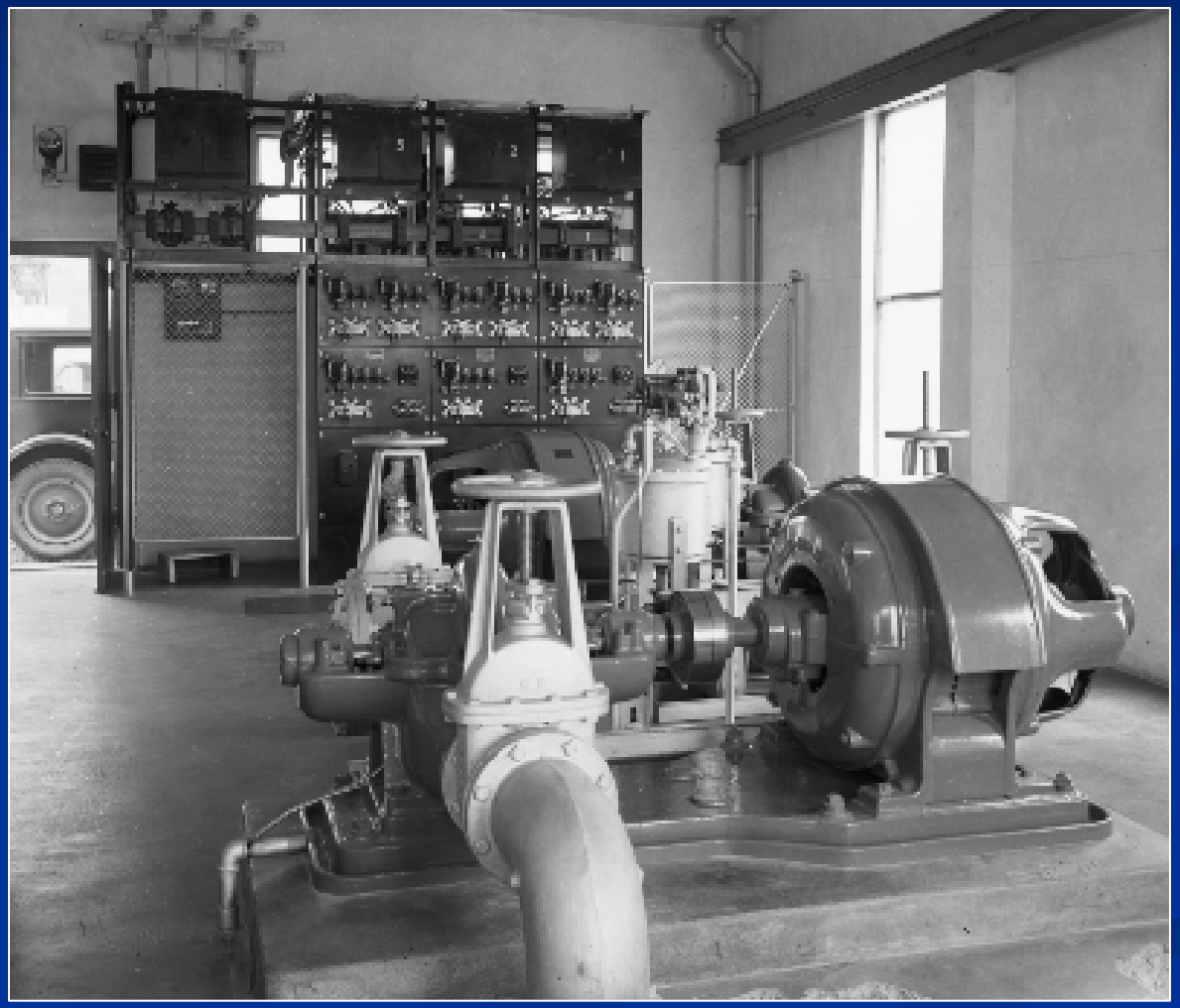


Courtesy of Seattle Municipal Archives, 7206

Foy Electrics

Courtesy of Seattle Municipal Archives, 50565

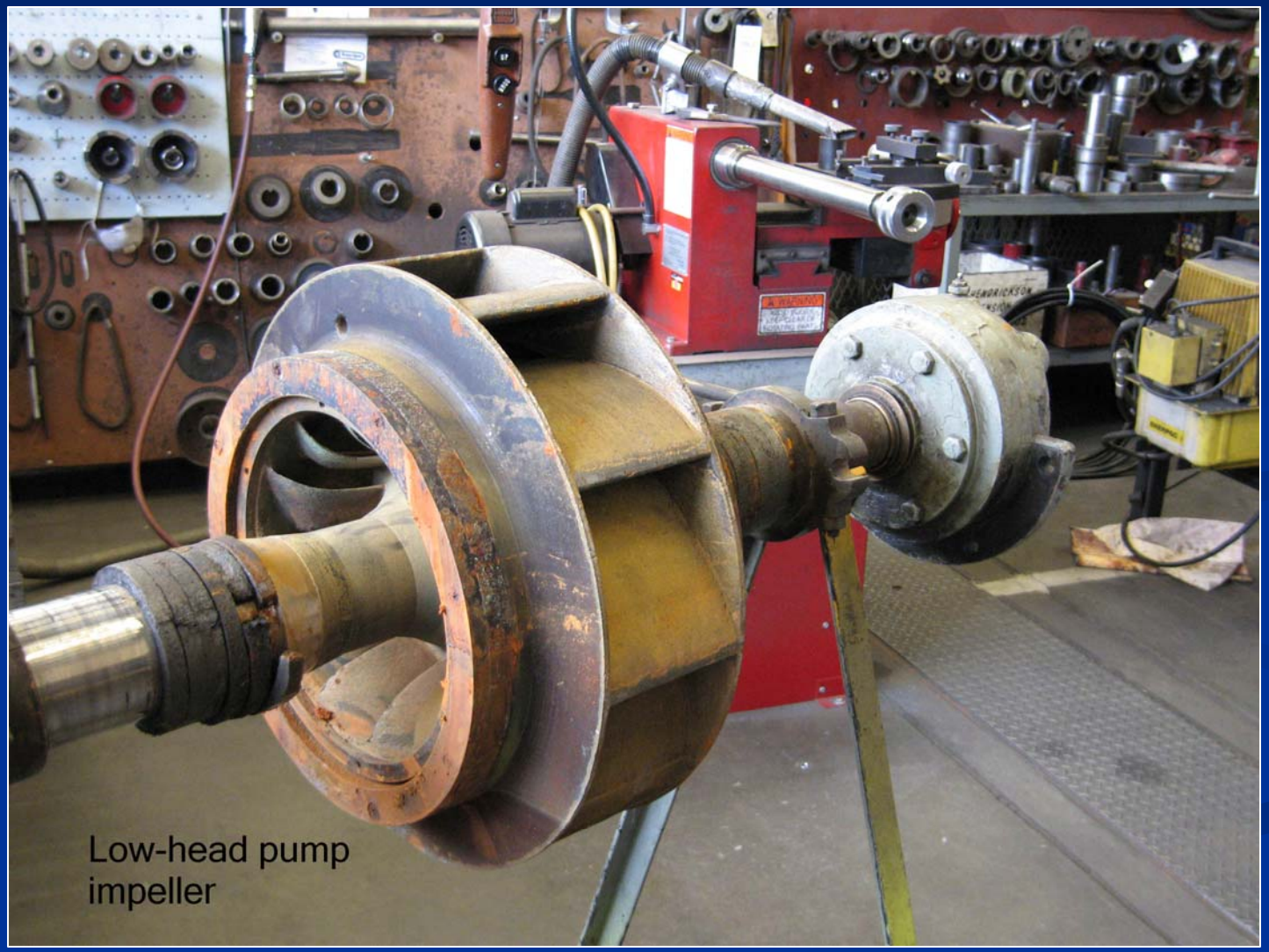
Foy Electrics



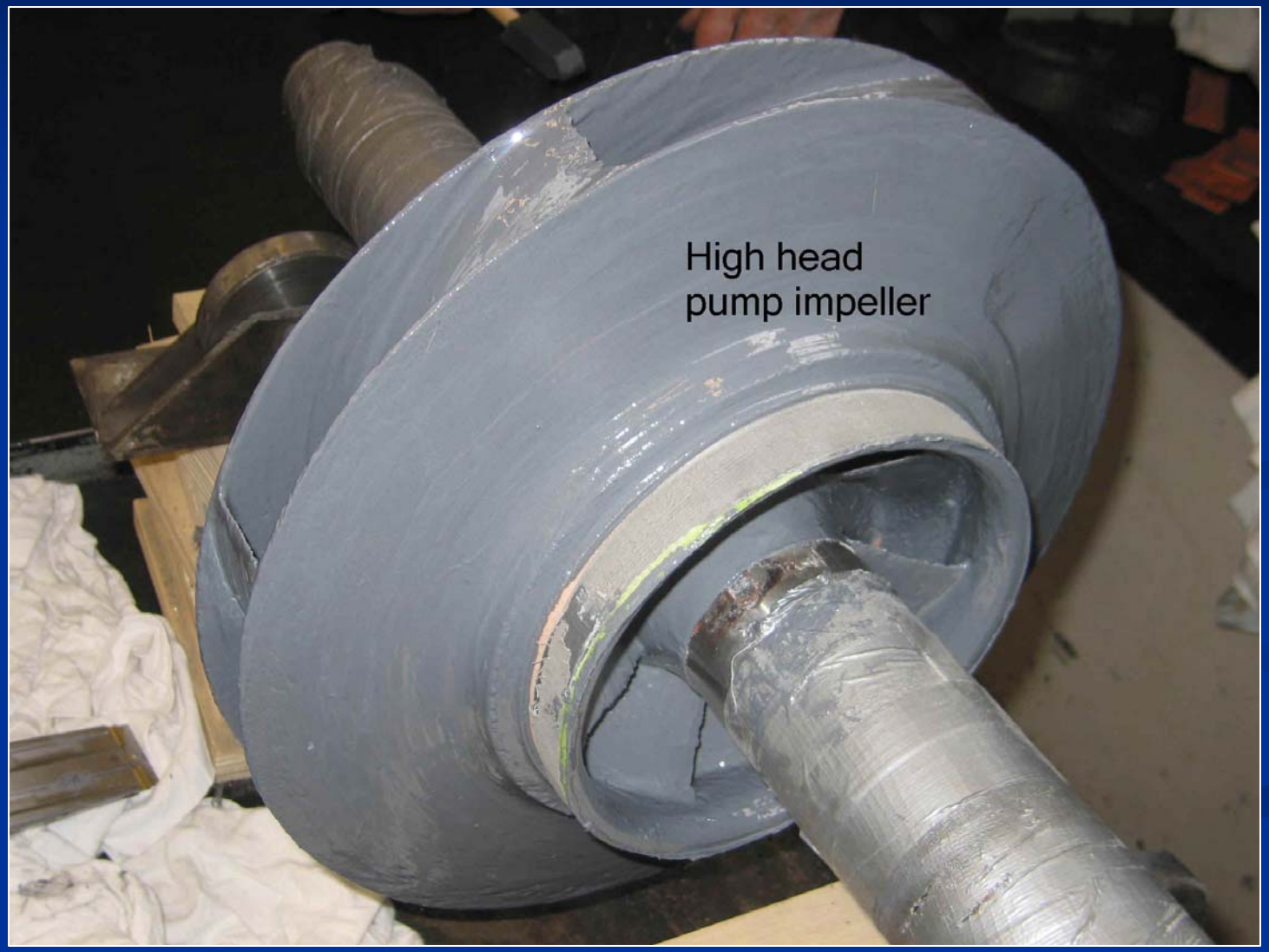
Courtesy of Seattle Municipal Archives, 50567

What's Inside?

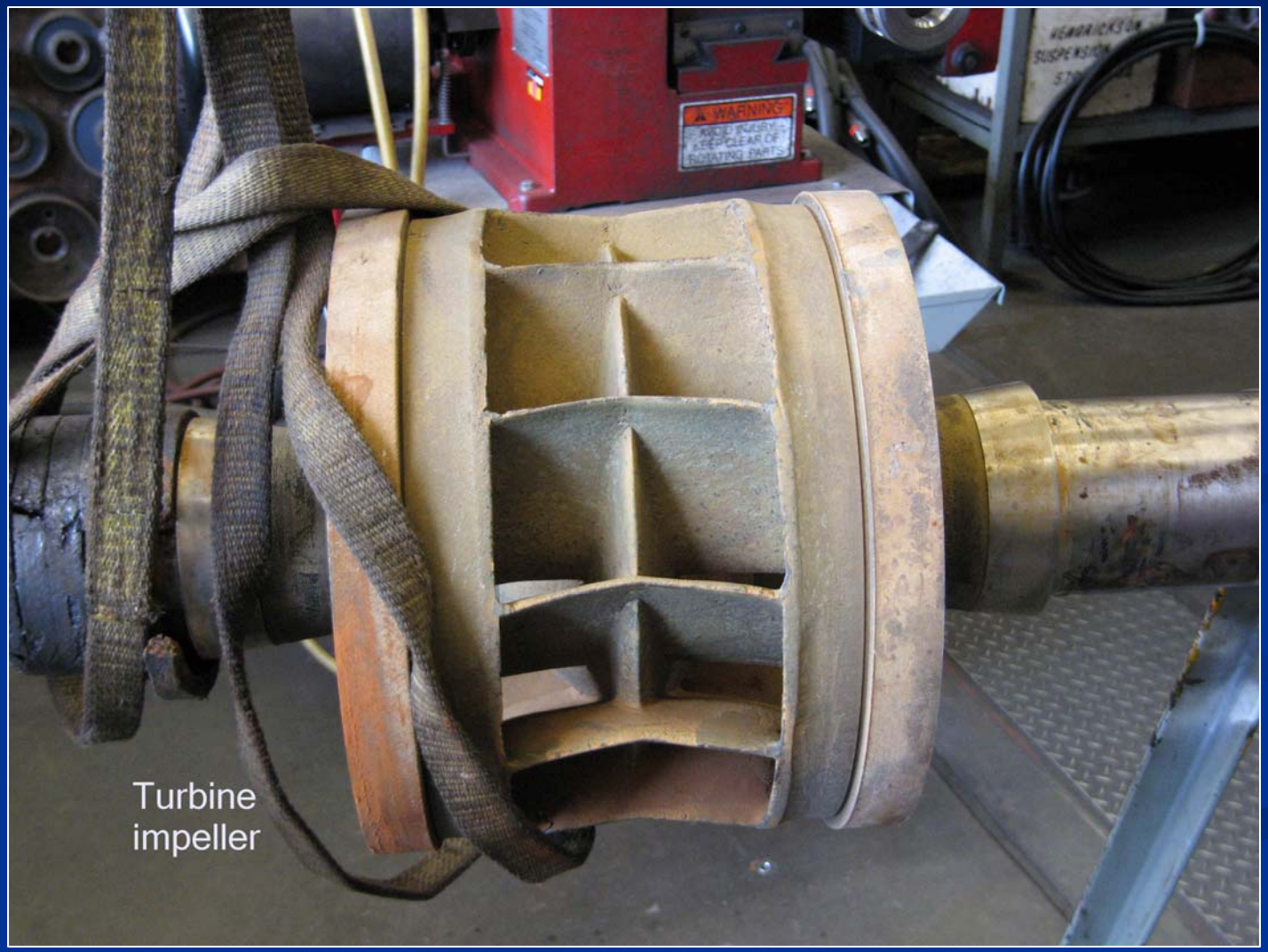
Typical Low-Head Pump Impeller



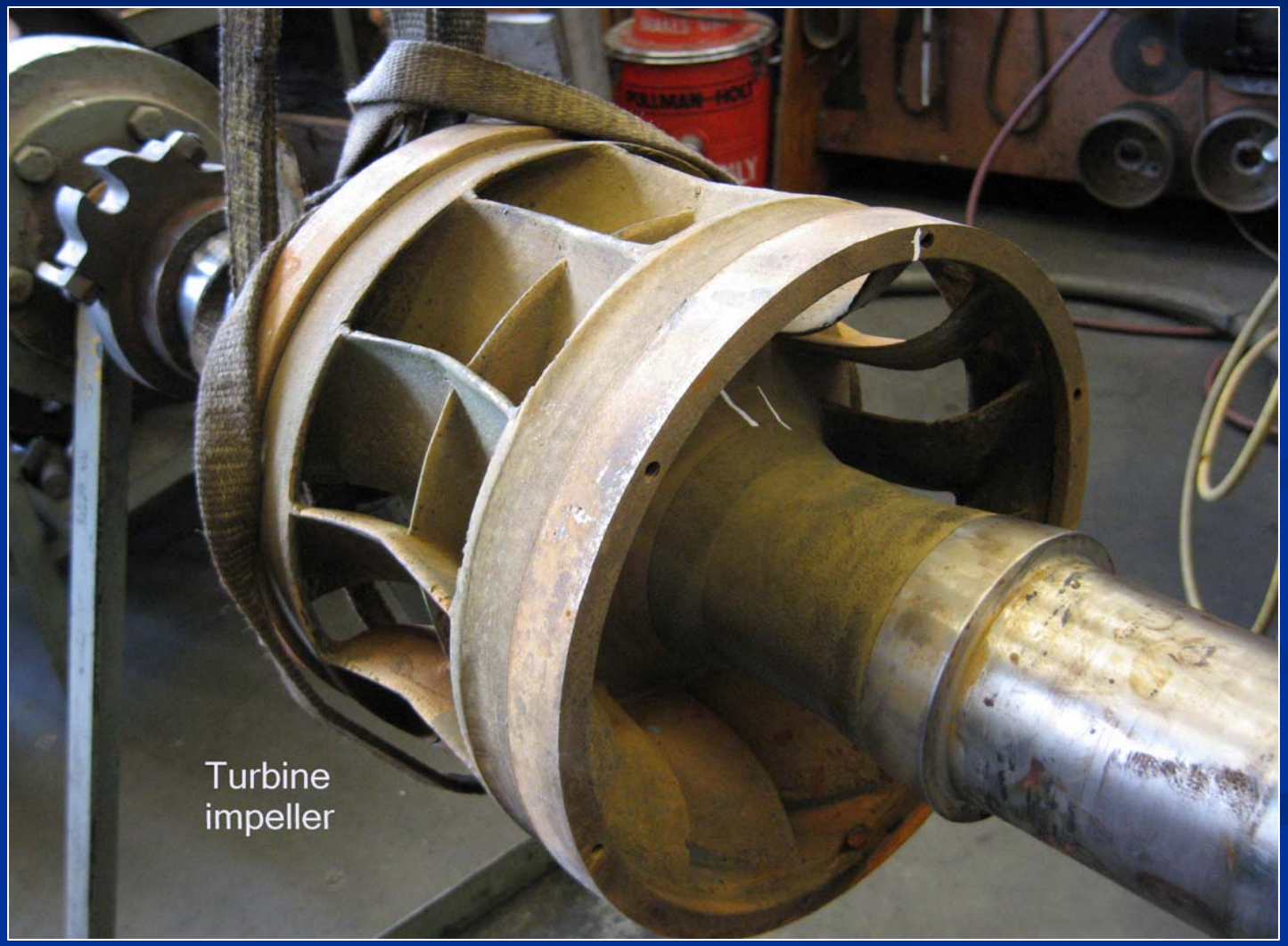
Typical High Head Pump Impeller



Turbine Pump Impeller

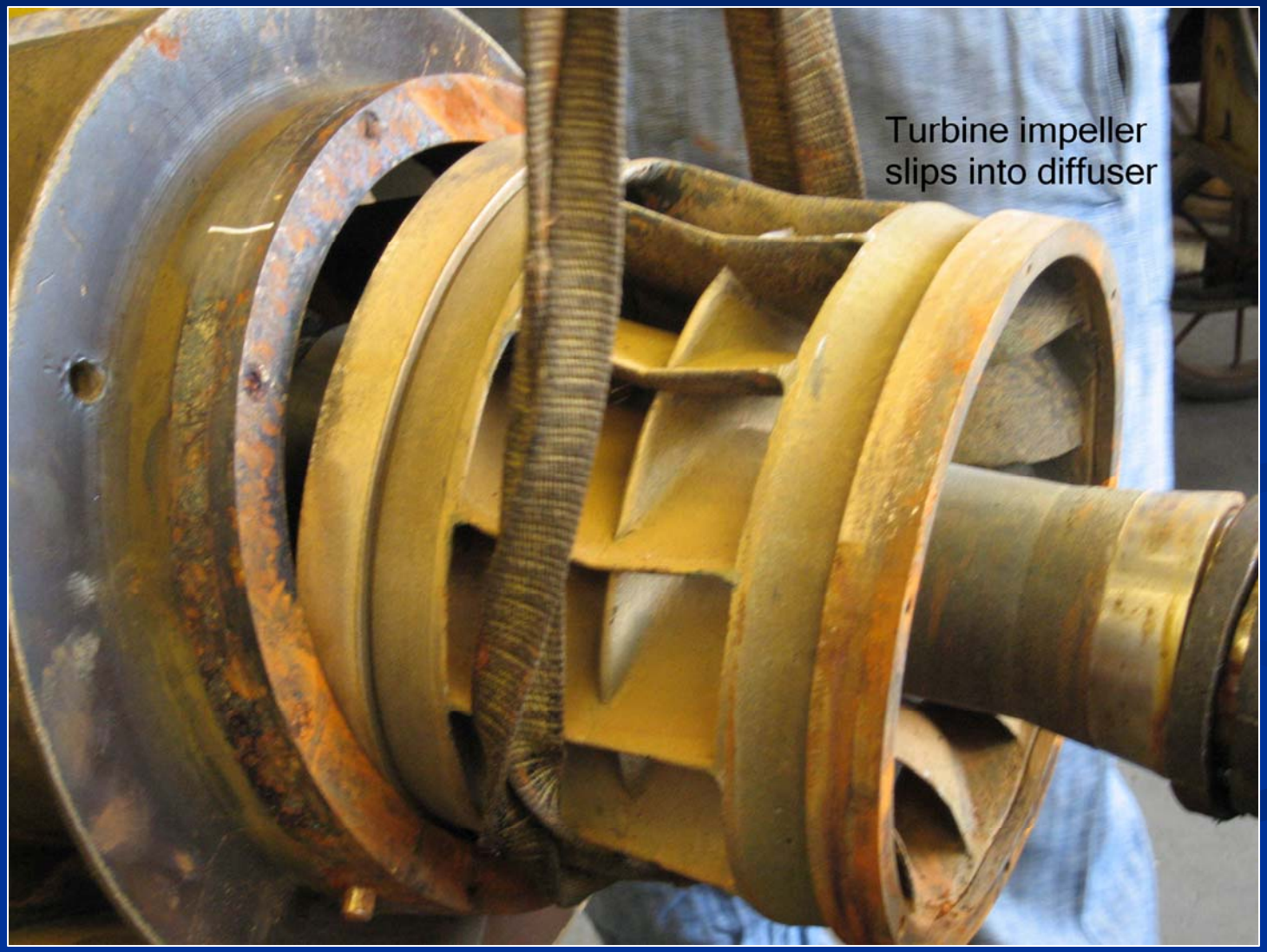


Turbine Pump Impeller

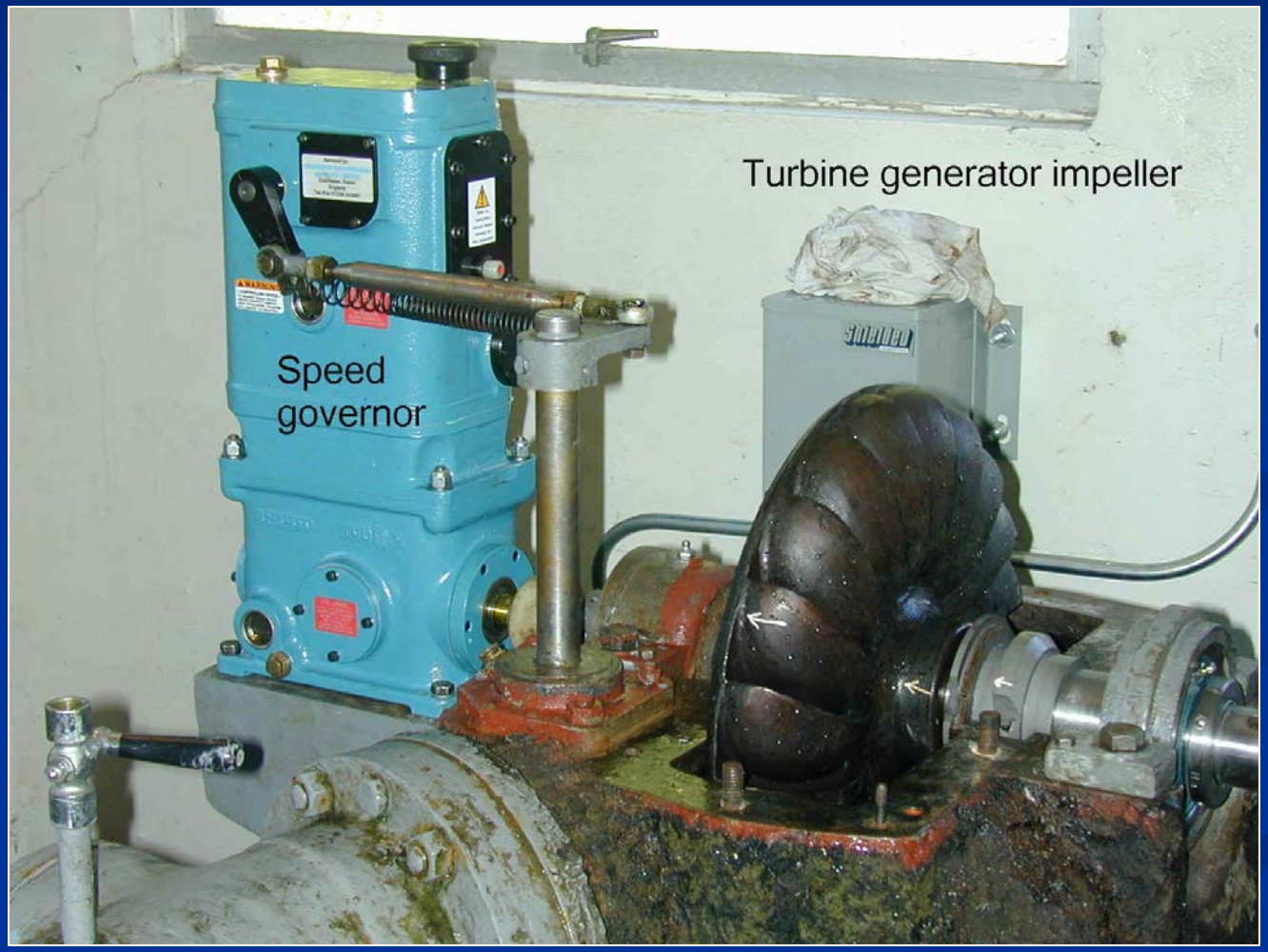


Turbine Pump Diffuser

Diffuser & Impeller Assembly



Turbine Impeller – Electrical Generator

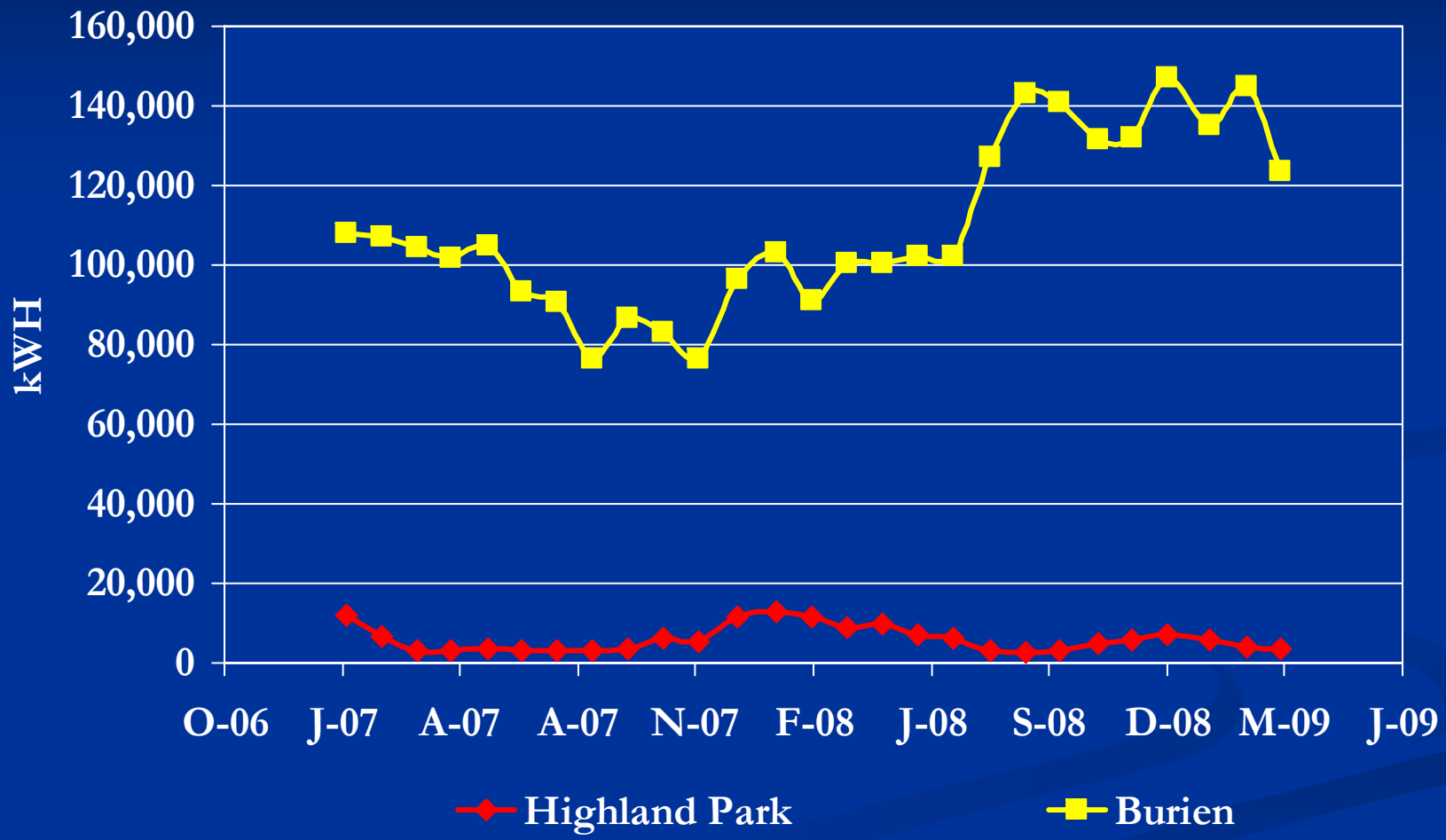


What's the Payoff?

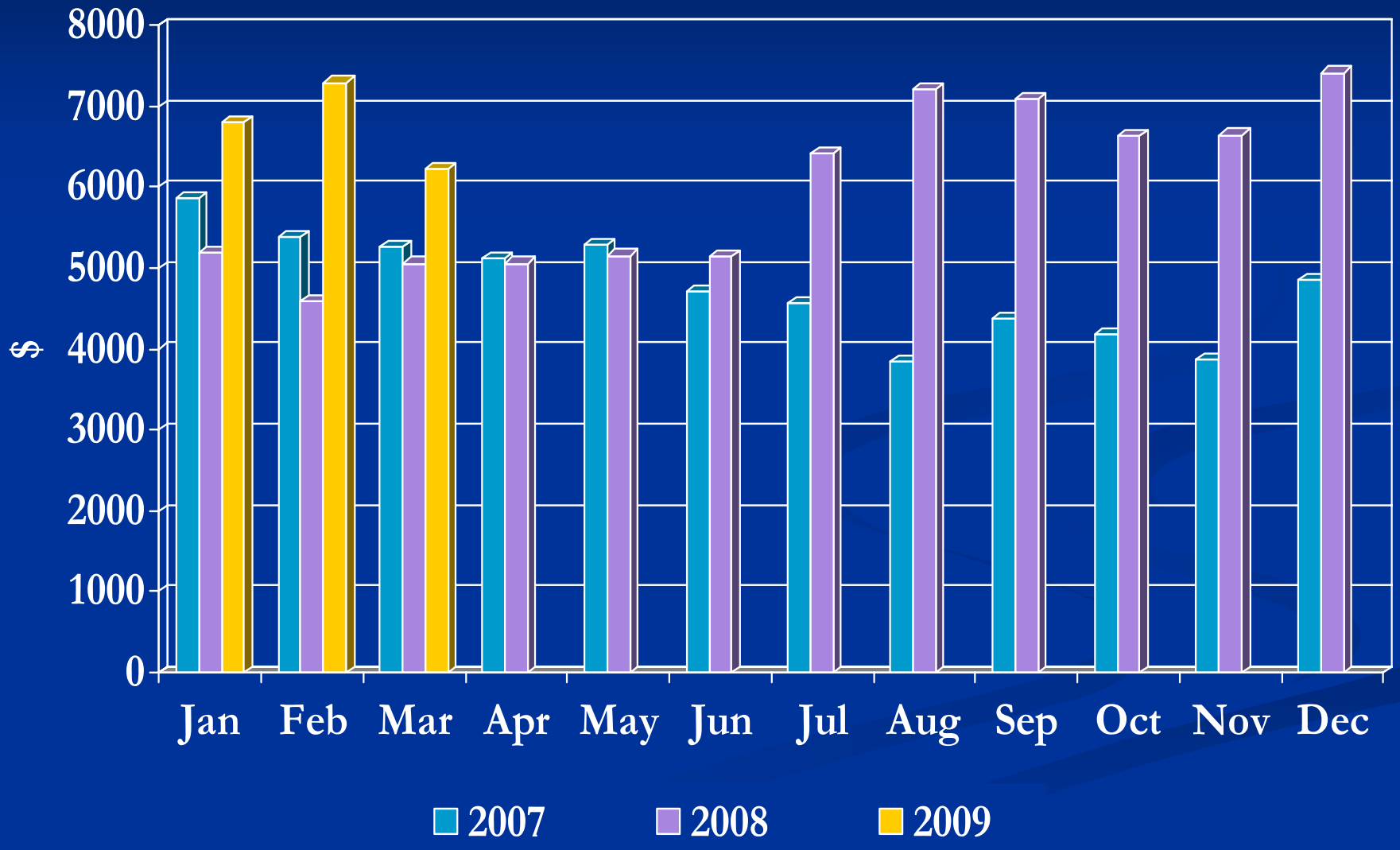
Example of Savings

- Trenton Turbines shut down July 2008
  - West Seattle Reservoir construction
- Burien PS usage up an average of 35,000 kWH per month
- Burien kWH charges up $1000 - $1500 per month.

585 Zone Electrical Use



Burien PS kWH Dollars

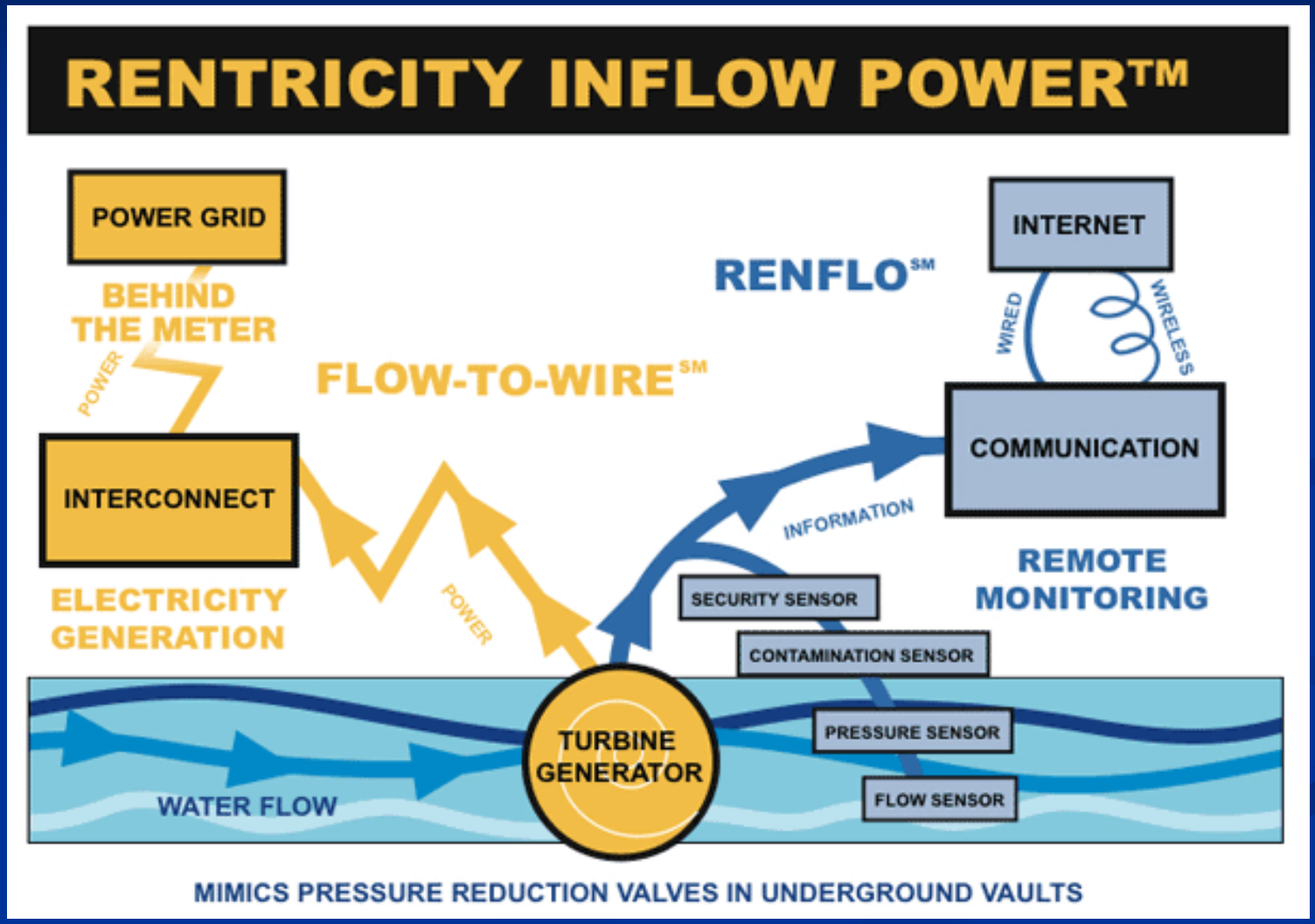


Where Do I Get One?

Sweden, Maybe

- SPU looked into replacing Lincoln Turbine with 2 smaller units when the reservoir was down-sized. The only potential manufacturer we found was in Sweden.
- Spare parts
  - We make our own. Patterns are made from existing equipment, then parts are cast and machined.

Looking to the Future



Credits

- University of Washington Libraries Digital Collection
- City of Seattle Municipal Photo Archives
- Seattle Water Department History 1854:1954 Operational Data and Memoranda
  - Mary McWilliams, published 1955

Questions?

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206.386.1265