"Solving Multi-faceted Challenges to Replace 1920s-built Outlet Facilities at the City Lake Reservoir in Port Townsend, WA"

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Original Publication from AWWA 2001: Dawn of the Replacement Era

By 2030, the average utility will have to spend about **three and a half times as much on pipe replacement** due to wear-out as it spends today. Even so, the average utility will also spend **three times as much as on repair** in that year as it spends today, as the **pipe get older and more prone to leakage**.

Presentation Overview

- Project Background
- Existing Condition and Project Needs
- Challenges
- Proposed Improvements
- Schedule Constraints and Project Phasing
- Construction
  - Bypass and Flow Control
  - Lake Draining
  - Shaft Construction
  - Installing Pipeline in Tunnel
- Take –away Messages

5 MG Reservoir
1 MG Standpipe
CT Station

PT Paper Company

Transmission Pipeline
30-miles, 30-inch diam.
Re-built 1950s-70s Welded Steel Pipe w/ some 1920s Pipe remaining in place

Project Site
City Lake Reservoir
1920s Facility

Lords Lake Reservoir

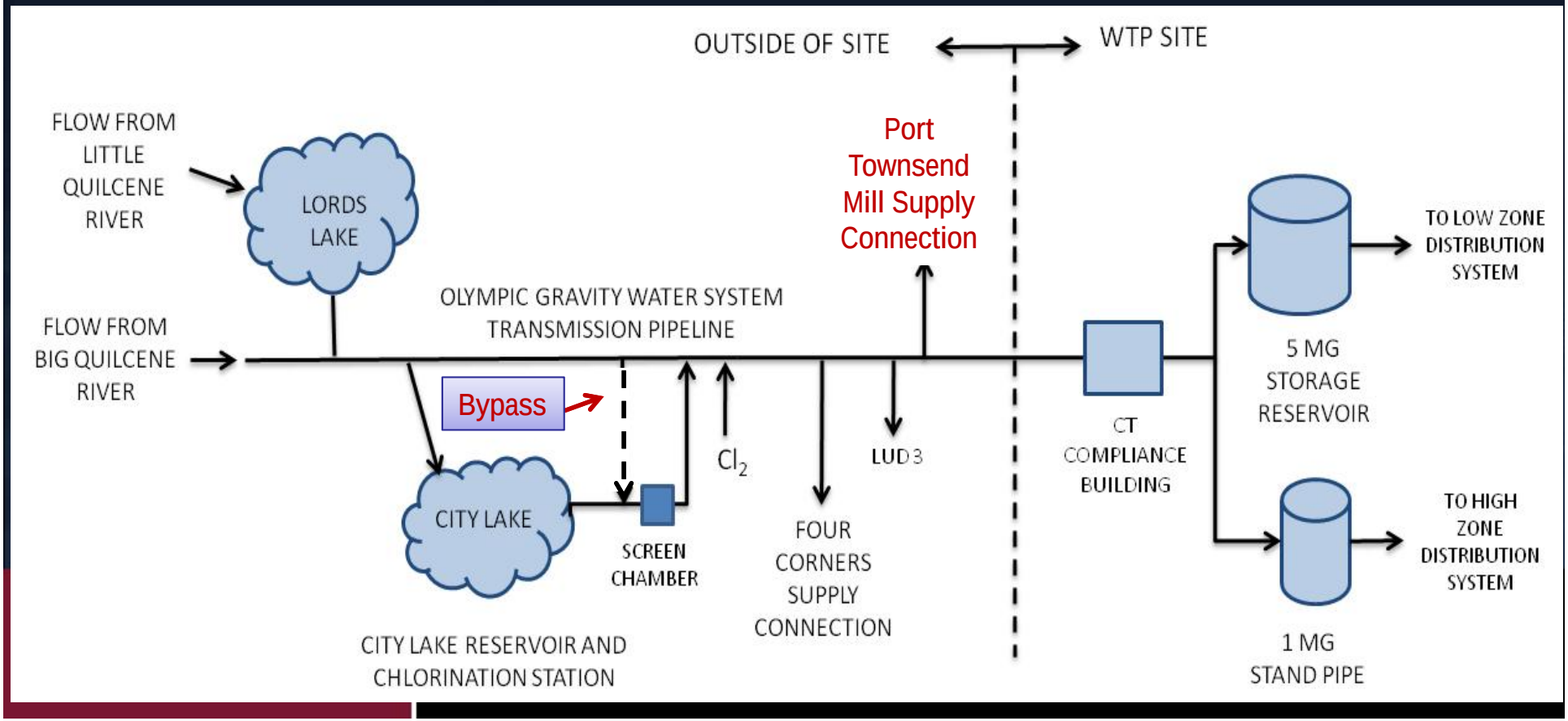
Little Quilcene River Diversion

Big Quilcene River Diversion, 1928

Olympic Gravity Water System (OGWS)

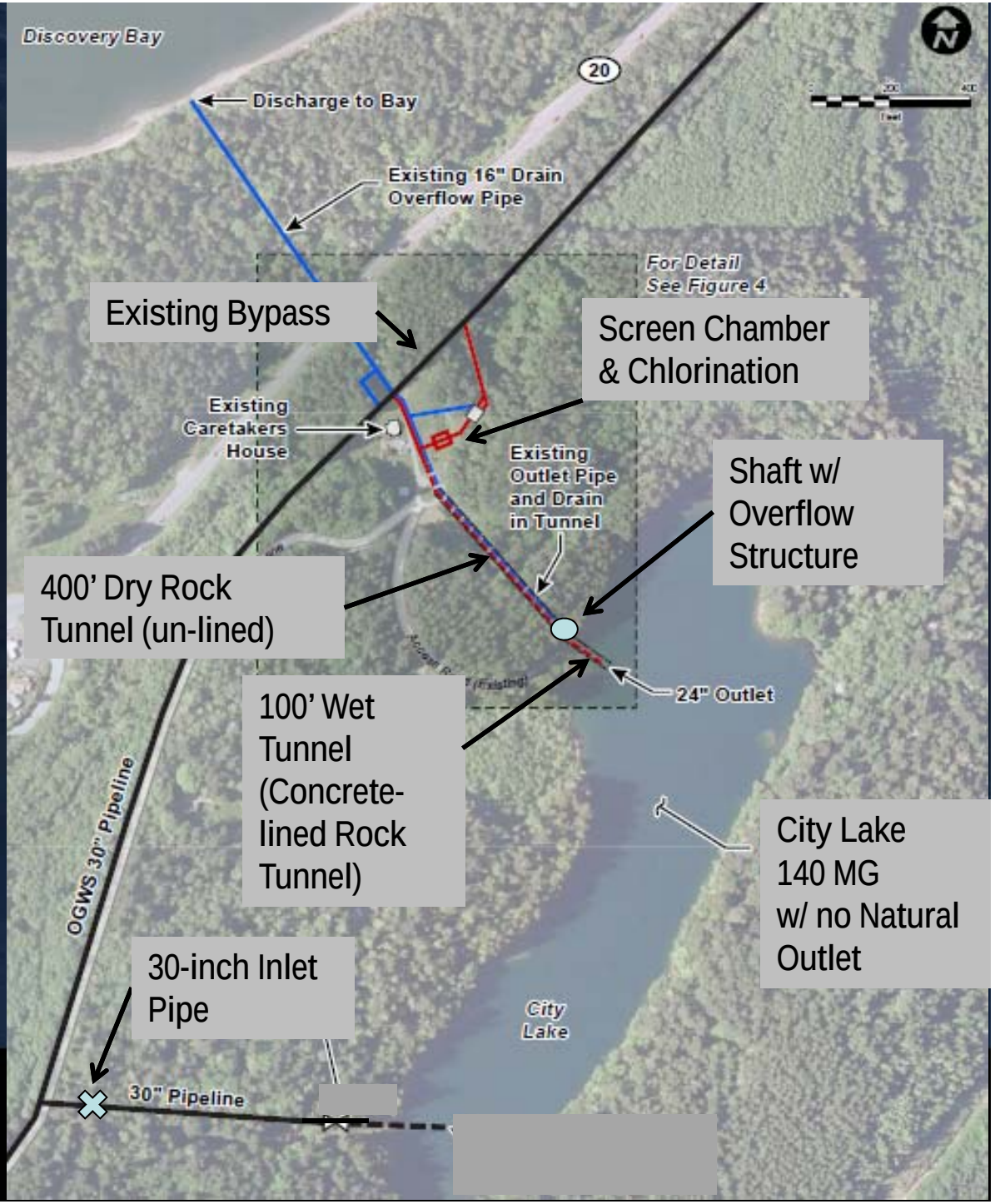
Water System Schematic

- Single Supply Source for City & Mill
- 24/7 Un-interrupted Operation
- Average Daily Demand – 15.5 MGD (14.5 MGD Mill)

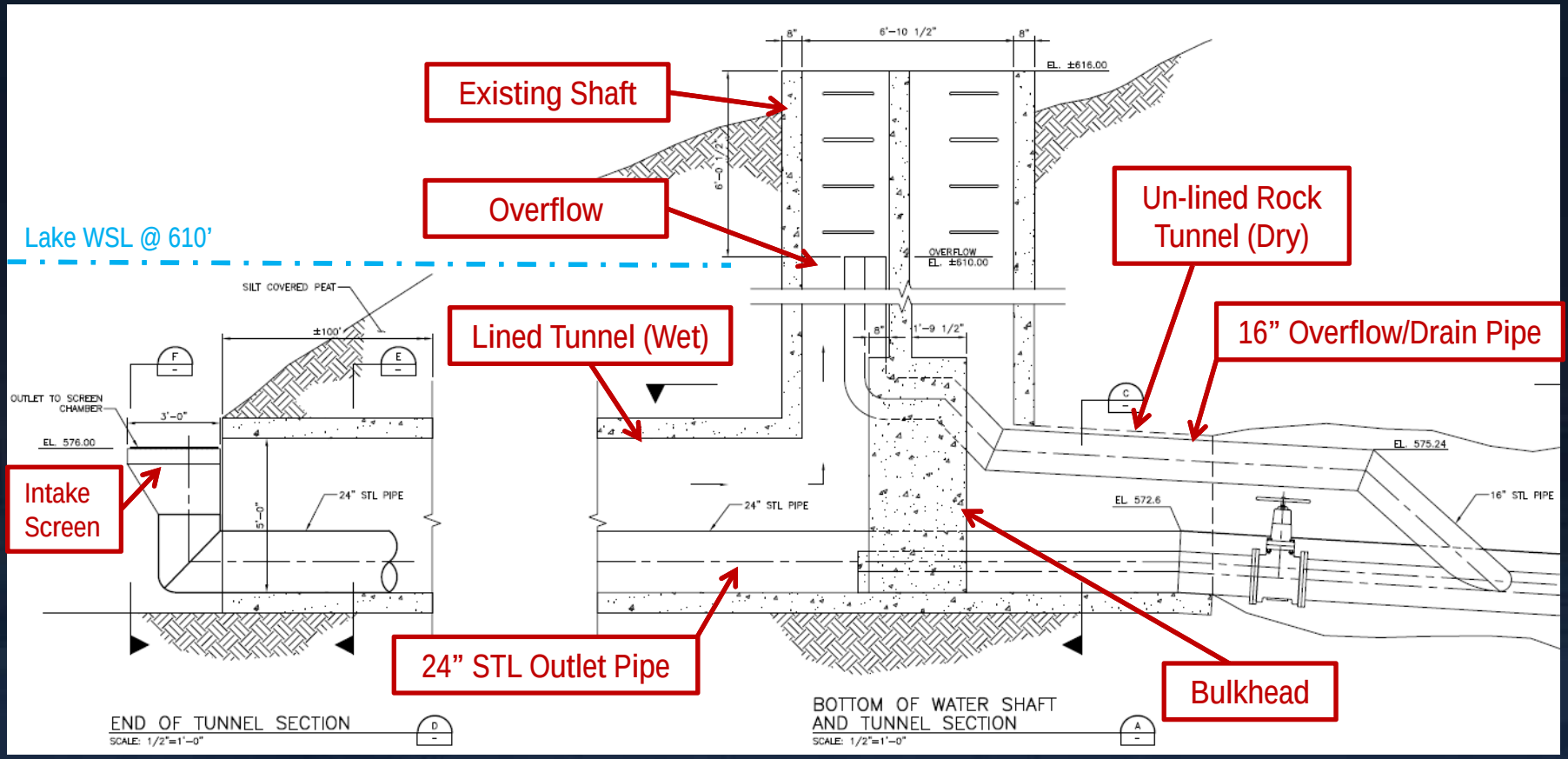


Existing City Lake Facilities

- 140 MG City Lake
- 30” Inlet Pipe
- Shaft w/ Overflow Structure
- 24” Outlet Pipe
- 16” Overflow/drain
- Intake Tunnel in Rock
- Screen Chamber & Chlorination



Existing Intake Tunnel Profile



Tunnel Entrance with 24” Outlet Pipe and 16” Drain/Overflow Pipe

Un-lined Tunnel with Outlet Pipe and Overflow/Drain pipe

Difficult access
Susceptible to damage from rock fall

Overflow/Drain pipe Valve and Outlet Pipe inside tunnel

Temporary Repair with Carbon Fiber Wrap

Outlet pipe and Overflow/drain pipe at bulk head inside tunnel

Corroded Outlet Pipe, poorly supported on a deteriorating piece of wood

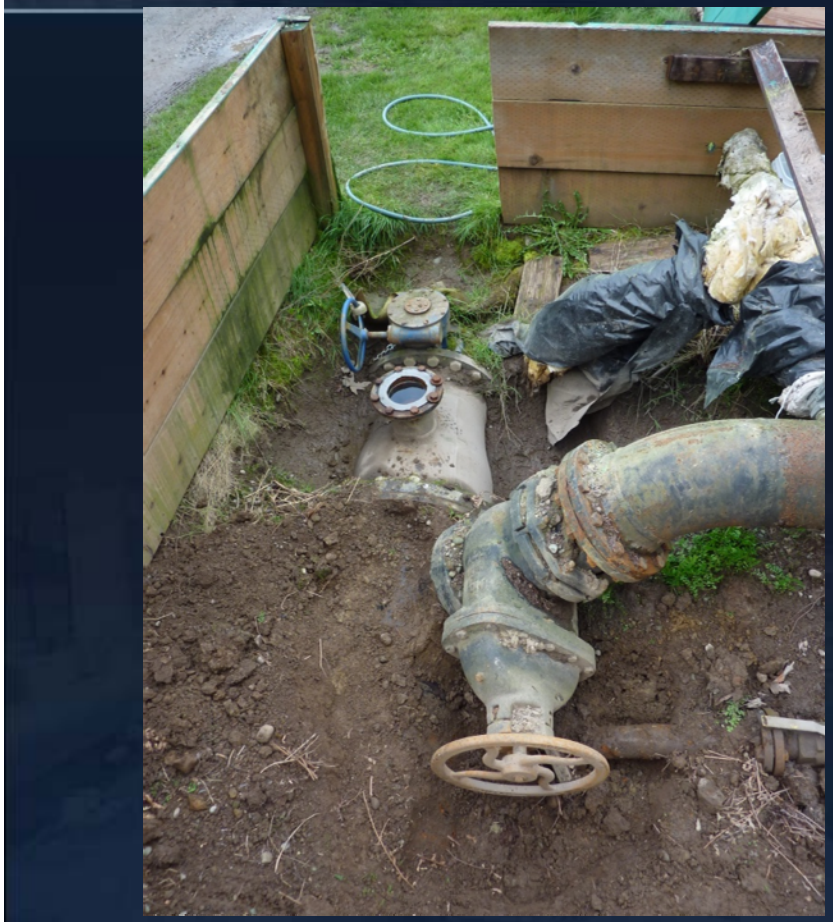
Corrosion of Drain Pipe

Extremely Tight Space inside Shaft
Hard to Assess

Overflow, Wet Shaft

Existing Shaft

No SCADA / Telemerty at Headworks



20” Isolation Valve for Current Flow Control
(Manual , Cavitating)

Wooden Vault

10-inch Isolation Valve (motorized)

Project Chronology

Pipe Failure in 2009 – *Broken Welds*

Other Deficiencies:

- *No Isolation at Source*
- *Cavitation of Valves*
- *Limited Access to Shaft and Tunnel*
- *Primitive SCADA & Telemetry*
- *Significant Corrosion*
- *No Means of Bypass*

↓

Need to Improve and Update Facilities

→

Condition Assessment (2010)

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Project As-built/ Hydraulics (2010)

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Alternatives Analysis (2010)

↓

FEMA Funding Opportunity
$ 1.5M Pre-disaster Grants
(Seismic Fragility Analysis)

↓

Final Design & Permits (2011-12)

↓

Construction (2012 & 2013)
(Phase 1 & Phase 2)

Project Overall Challenges

- Single Source Supply
- No Shut down of System Allowed, 24/7 Operation
- No Record Drawings, Aging Facilities, No HGL
- No Isolation or Bypass for Lake
- Access difficult for design (underwater, cont. operation)
- Leaking pipes in constricted rock-lined tunnel
- Risk mitigation due to severe consequences
- Difficult to scope and budget

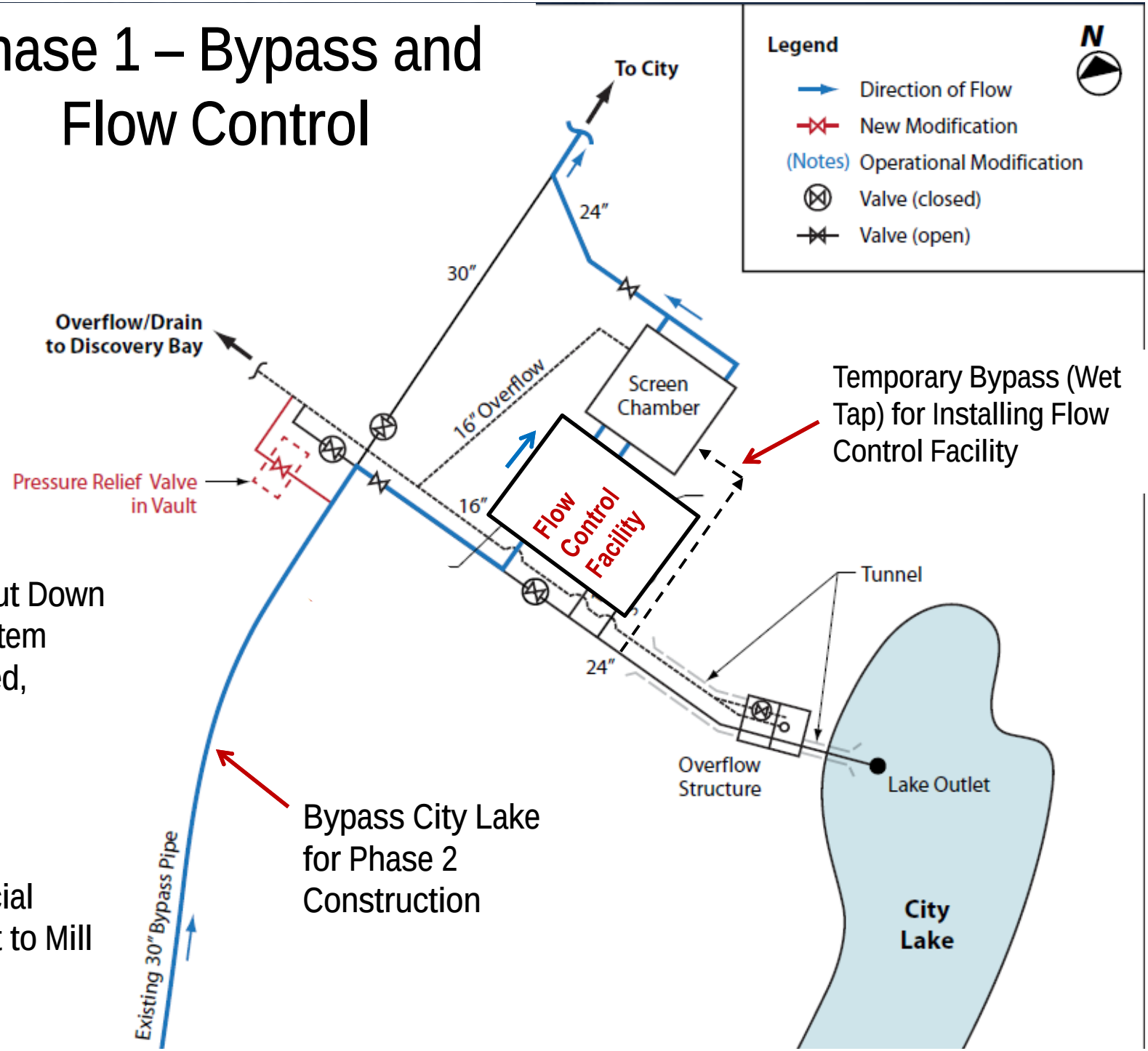
Construction Challenges

- Tight schedule
- Phasing of construction
- Lake draining & associated impacts
- Disposal of turbid water
- Unique sub-surface – shallow soil over bedrock
- Tight work space in Tunnel & Shaft
- Unknown condition
- Safety

Project Components

- Phase 1 – Lake Bypass and Flow Control (May-Dec 2012)
  - Temporary Bypass
  - Flow Control Facility
  - Pressure Relief Valve
  - Isolation Valve at 30” Inlet Pipe
  - Telemetry and I&C
- Phase 2 – Outlet Pipeline and Control Structure (Jan – June 2013)
  - Lake Draining and Care of Water
  - Stabilize Tunnel & Demolition
  - Outlet Control in New Shaft
  - Outlet & Drain/Overflow Pipe Replacement

Phase 1 – Bypass and Flow Control



Temporary Bypass (Wet Tap) for Installing Flow Control Facility

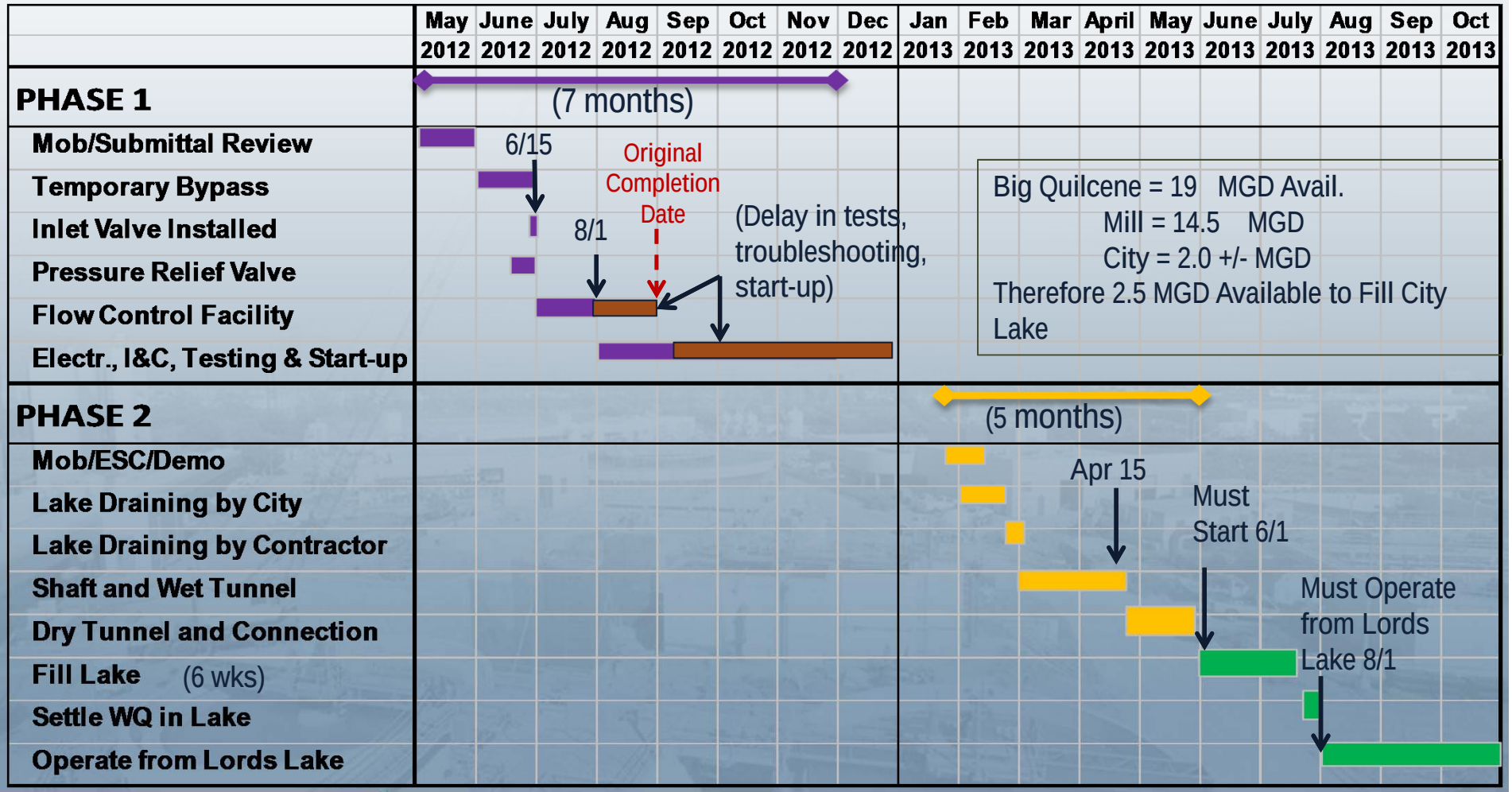
No Shut Down of System Allowed,

or

Huge Financial Impact to Mill

Bypass City Lake for Phase 2 Construction

Schedule Constraints

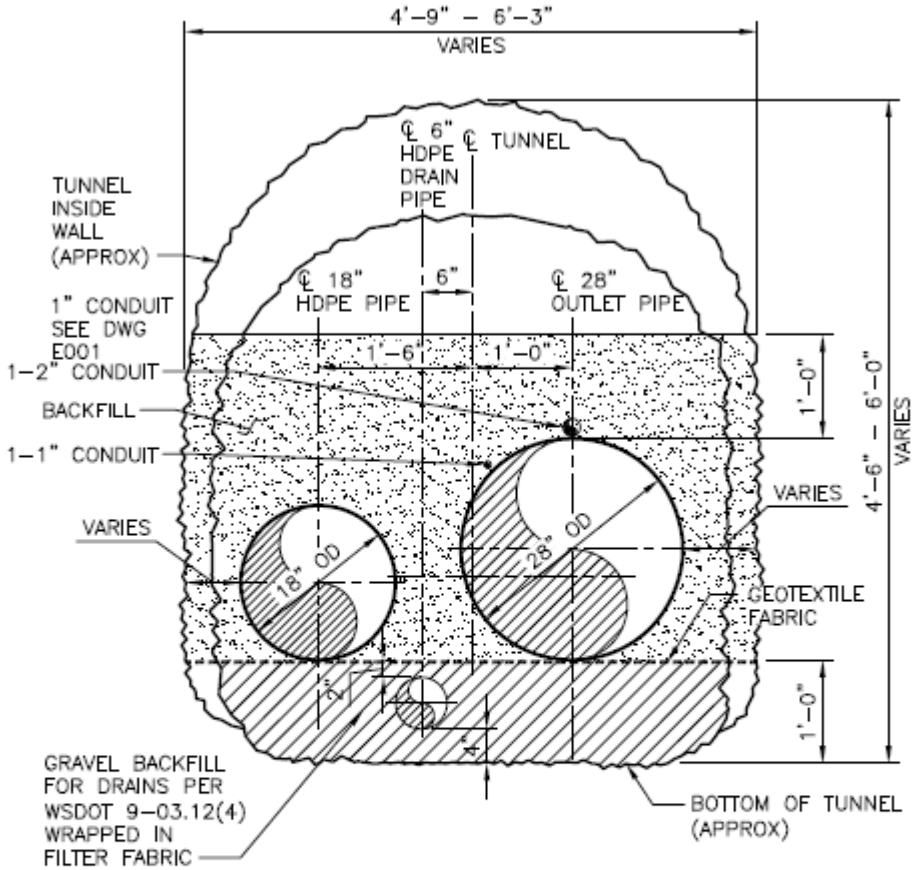


Phase 2 – Lake Drain & Care of Water

- No Feasible Way to Cofferdam due to schedule constraints and Rock
- Study Environmental & Water Quality Impacts
  - Fish & Amphibian monitoring
- Lake Draining Plan
  - < 2 NTU: Supply to City and Mill
  - > 2 NTU and < 25 NTU: Drain to Discovery Bay w/o Treatment
  - > 25 NTU: Dispose to Discovery Bay w/ Treatment or Infiltration


Fully Drained City Lake
Inlet to Tunnel
Cofferdam
Pumps
Outlet Control Shaft

Phase 2 - Tunnel Cross Section



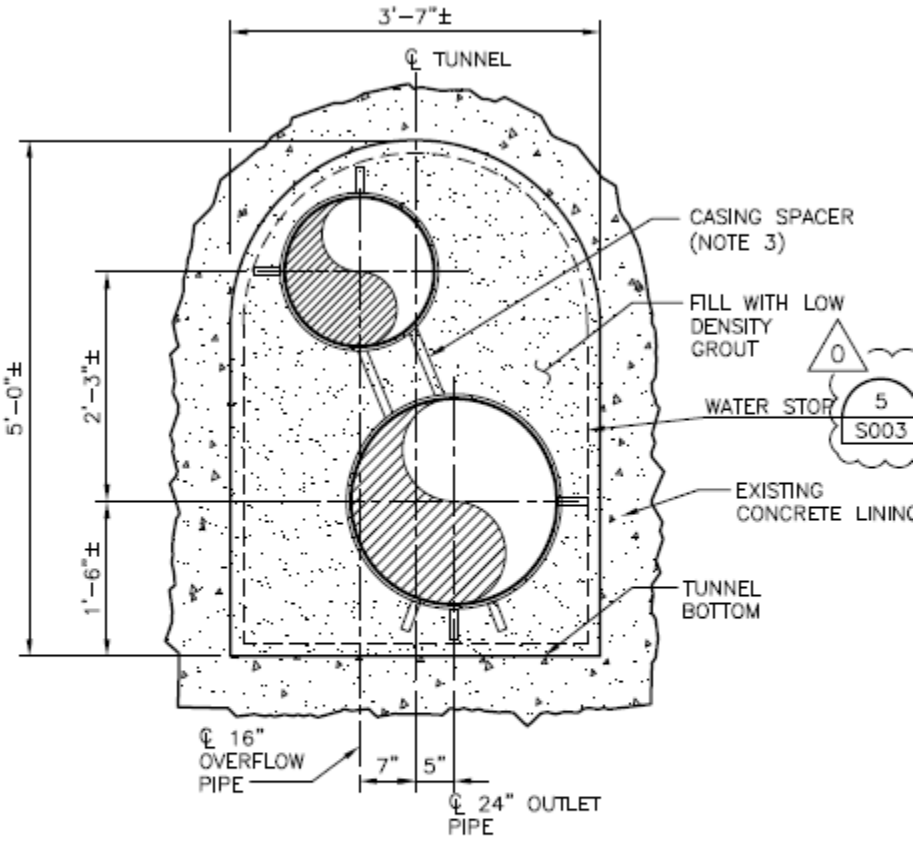
STA 3+50 TO STA 6+08

DRY TUNNEL

TYPICAL TUNNEL SECTION

SCALE: 3/4"=1'–0"

A C302



STA 7+64 TO STA 8+66

WET TUNNEL

TYPICAL TUNNEL SECTION

SCALE: 3/4"=1'–0"

C C304

Phase 2 - Pipe Installation in Wet Tunnel

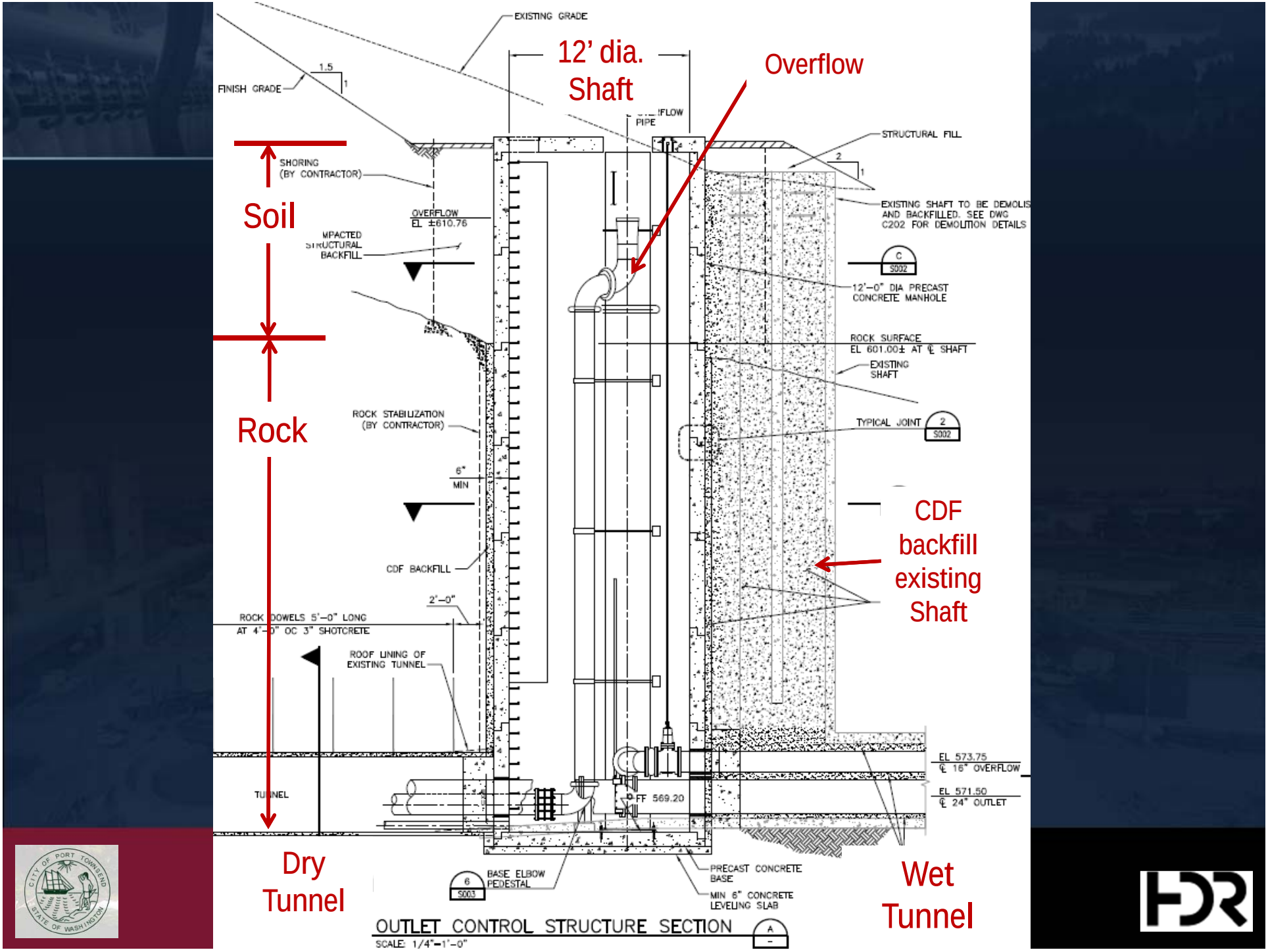
Wet Tunnel looking towards City Lake

Phase 2 - Pipe Installation in Dry Tunnel

Drain Pipe at the bottom of Dry Tunnel

28” Outlet Pipe and 16” Overflow/drain pipe (HDPE)

Blowing backfill inside dry tunnel


EXISTING GRADE
12' dia. Shaft
Overflow
FINISH GRADE
1.5
1
OVERFLOW PIPE
STRUCTURAL FILL
2
1
SHORING (BY CONTRACTOR)
Soil
OVERFLOW EL ±610.76
IMPACTED STRUCTURAL BACKFILL
EXISTING SHAFT TO BE DEMOLISHED AND BACKFILLED. SEE DWG C202 FOR DEMOLITION DETAILS
C S002
12'-0" DIA PRECAST CONCRETE MANHOLE
ROCK SURFACE EL 601.00± AT ℄ SHAFT
EXISTING SHAFT
Rock
ROCK STABILIZATION (BY CONTRACTOR)
TYPICAL JOINT 2 S002
6" MIN
CDF backfill existing Shaft
CDF BACKFILL
2'-0"
ROCK DOWELS 5'-0" LONG AT 4'-0" OC
3" SHOTCRETE
ROOF LINING OF EXISTING TUNNEL
EL 573.75
℄ 16" OVERFLOW
EL 571.50
℄ 24" OUTLET
TUNNEL
FF 569.20
Dry Tunnel
Wet Tunnel
6 S003
BASE ELBOW PEDESTAL
PRECAST CONCRETE BASE
MIN 6" CONCRETE LEVELING SLAB
OUTLET CONTROL STRUCTURE SECTION
A
SCALE: 1/4"=1'-0"

Phase 2 - Shaft Construction

Excavating around Existing Control Shaft

Excavation in soil w/ slide rail shoring system at new Control Shaft site

Phase 2 - Shaft Construction cont.

Excavation of rock from the surface

Rock dowels and netting to stabilize exposed rock inside shaft

Phase 2 - Shaft Construction cont.

Lowering equipment inside the shaft

Operating at the bottom of the excavated shaft

Phase 2 - Shaft Construction cont.

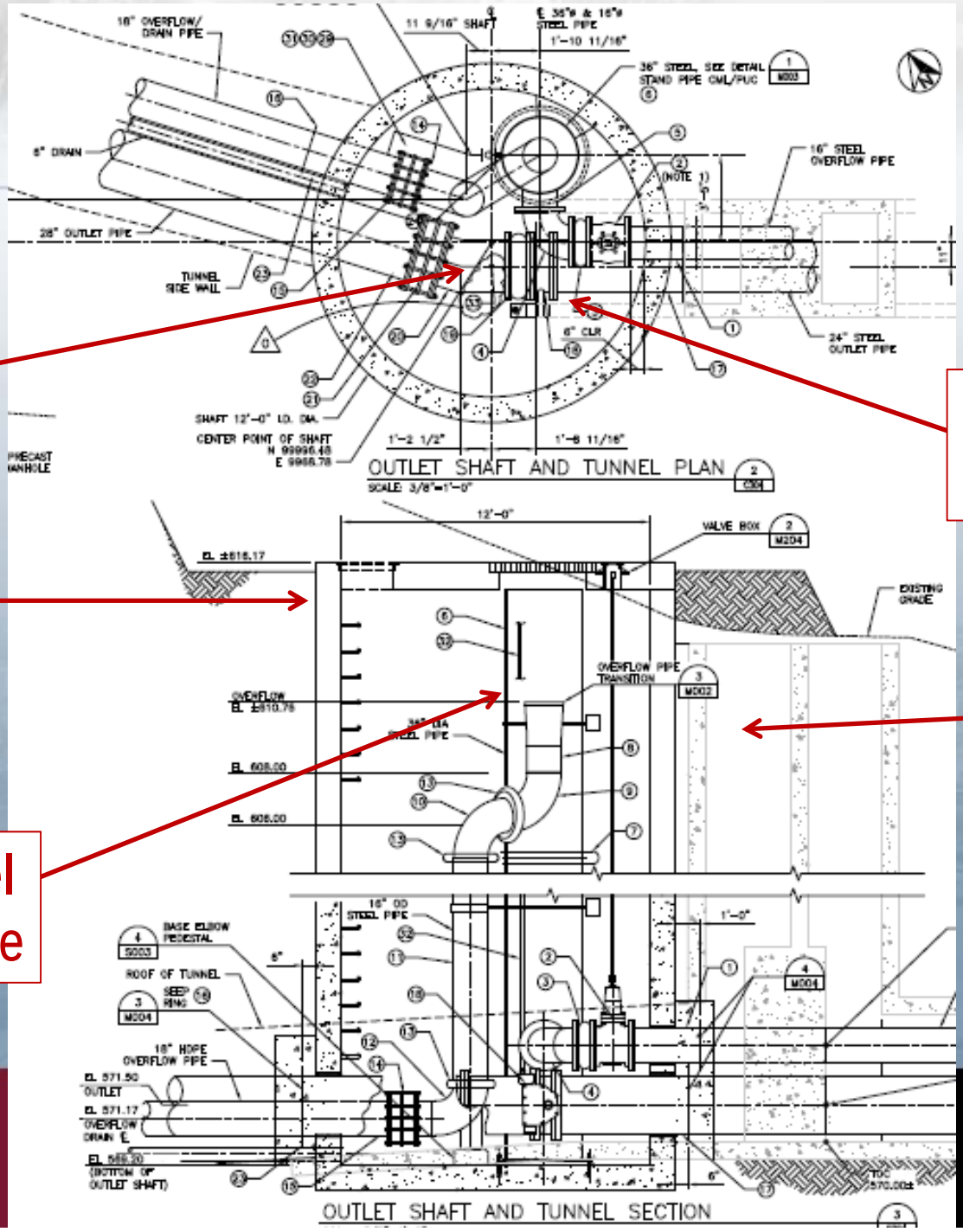
Installing 12-foot diameter precast segments

CDF backfill around the Shaft

Bend in Alignment

New 12’ diameter Shaft

36” dia. Steel Overflow Pipe



24” BFV on Outlet Pipe

Existing Shaft

Phase 2 - Overflow Pipe and Valves inside Shaft

Project Cost & Funding

	Total Project Cost	Construction Cost	Change Orders
Phase 1	$1.3 M	$ 0.7 M	13%
Phase 2	$3.2 M	$ 2.0 M	5%
Total	$4.5 M	$ 2.7 M	7%

Source	Funding Amount
Public Works Trust Fund	$1.0 M
FEMA Grant	$1.3 M
OGWS Replacement Fund	$2.2 M
Total	$4.5 M

Take-Away Message

- Repair and Rehabilitation of Aging Infrastructure requires careful planning and evaluation of risk.
- Lake draining can be permitted w/ mitigation measures.
- Can never have too many borings
  - *limited geotechnical exploration led to encountering different subsurface condition, required different construction approach.*
- Tight schedule requires planning w/ contingency
  - *WQ treatment equipment was un-used but it was like an insurance against unknown condition and un-acceptable delay in schedule.*
- Risk can be mitigated and minimized with careful planning
  - *Very few surprises but extra effort upfront in planning and engineering.*

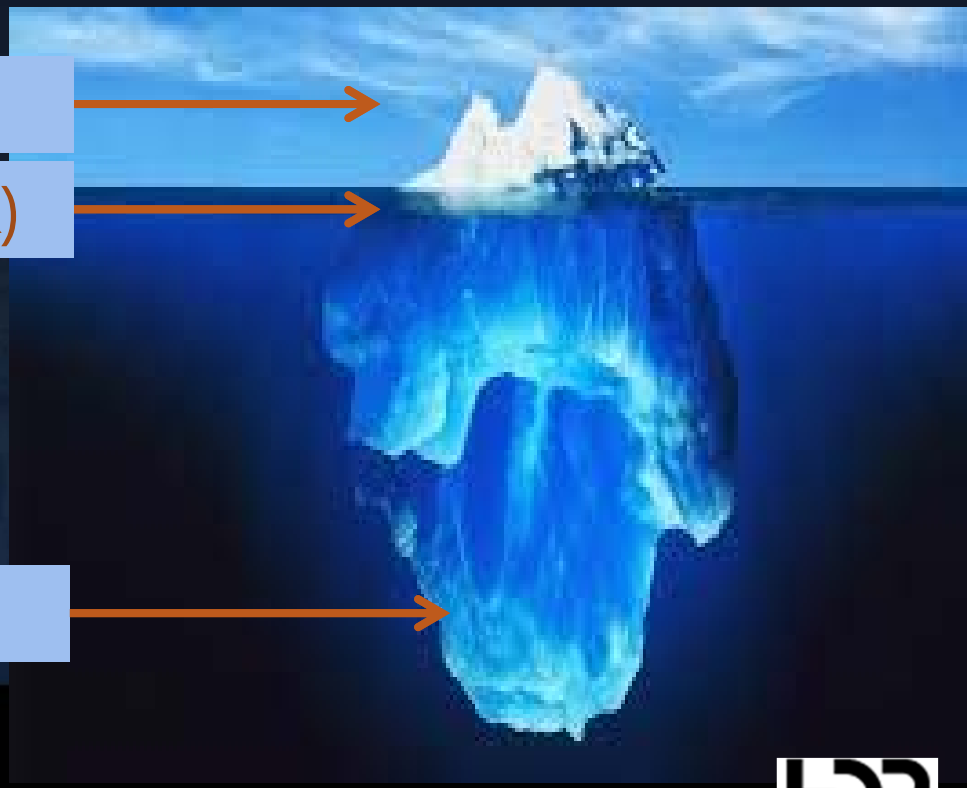
Conclusion

As with many repairs of aging infrastructure, the extent of the problem and solutions were not fully known until further exploration.

Repair pipe with patch ($10 K)

Rehabilitate w/ Slip lining ($40 K)

Full Replacement ($4.5 M)



Questions ?

Rewards at Fat Smitty's @ Discovery Bay, Port Townsend

Acknowledgements:

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Ian Jablonski (Project Manager and Project Photographer)