40 Years and Counting:
How To Keep A Good Tank Going

How is that old tank doing?

- Are the coatings sound?
- What if there is an earthquake?
- Is my site secure?
- Is that ladder still safe?
- What does the inside of the tank look like?
How to Keep a Good Tank Going

- **Rehabilitation**
  - Coatings
    - Interior
    - Exterior
  - Seismic Upgrades
    - Interior/Exterior Piping
  - Repair/Replace Appurtenances
    - Ladders
    - Hatches
Pleasant Home Water District

- Serving unincorporated Multnomah County and Clackamas County, Oregon
- Portland Water Bureau wholesale customer

- Gallon reservoir: 600,000
- Firm capacity pump station: 700 gpm
- Miles of distribution main: 17 miles
- Metered service connections: 575
600,000 Gallon Standpipe

Style
Welded Steel

Year Constructed
1976

Diameter
36 feet

Height
80 feet
**Project Team**

*Owner: Pleasant Home Water District*

**Prime Consultant**
Murray, Smith & Associates, Inc.

**Structural Engineer**
Peterson Structural Engineers, Inc.

**Geotechnical Engineer**
Geotechnical Resources, Inc.

**Tank Interior Inspection**
LiquiVision Technology, Inc.

**Prime Contractor**
Clackamas Construction, Inc.

**Tank Contractor**
Western Tank & Pipe
2010
Initial tank assessment

2011-12
Search for funding

2013
- Loan secured
- Final designs
- Land use permit

2014
- Project bidding
- Construct new 750,000 Gallon Standpipe

2015
Rehab of 600,000 Gallon Standpipe

2016
Final completion
2010

600,000 Gallon Standpipe Assessment
600,000 Gallon Standpipe Assessment

Exterior inspection

Coatings

Wall-to-foundation sealant

Roof hatch
600,000 Gallon Standpipe Assessment

Dive inspection with cleaning

Failed coatings | Ceiling

Interior ladder

Corroded outlet screen
600,000 Gallon Standpipe Assessment

Structural evaluation

Foundation

Anchor chairs
A first look at a second tank

- Provide system redundancy (maintenance, flexibility).
- Size to meet District’s 20+ years demand.
- Construct to current code requirements.
A second tank?

$0.6 \text{ MG} - 0.75 \text{ MG} = 0.15 \text{ MG} + 0.60 \text{ MG} = 0.75 \text{ MG}$

- 2010 Storage
- 2010 Storage Required
- 2010 Storage Deficiency
- 20-year projected demand
- Additional storage needed
Conclusions & Recommendations from 600,000 Gallon Standpipe Assessment

$ \text{Rehab} < \$ \text{Construct replacement}$

- Coating failures → Rehabilitation of interior & exterior coating systems
- Corroded/failing appurtenances → Replacement of appurtenances
- Seismically deficient structure → Foundation improvements
- Storage deficiencies → Construct second standpipe at 750,000 gallons
In search of project funding
Know Your Available Funding Sources

- Safe Drinking Water Revolving Loan Fund (SDWRLF)
- Special District Association of Oregon (SDAO)
- Savings
- Bonds
- Private market
How much to plan for?

1. Engineering
   Design, bid, construction

2. Permitting

3. Special Inspections

4. Construction

5. Contingency
   10 to 15% of Construction estimate
Budgeting Tip

Original Construction Cost Estimate × Adjustment for time = Updated Construction Cost Estimate

$ × 24 = $$
Final designs

2013
Design Goals

- Durability
- Meet jurisdictional permitting requirements
- Redundancy
- Flexibility in operations
- Security of assets
600,000 Gallon Standpipe

- Seismic upgrades to foundation
- Interior and exterior coatings rehab
- Repair/replace aged appurtenances
- Update personnel safety features
- Passive hydraulic mixing system
750,000 Gallon Standpipe

- Design to current OSSC & AWWA standards
- Modern personnel safety features
- Passive hydraulic mixing system
Site Piping
Design for Operational Flexibility
Project Bidding
Construction of 750,000 Gallon Standpipe
Project Bidding

- Engineer’s estimate = All available District funds
  - Bid project with all wish list items, discuss cuts later

- Lowest bid = $5k over Engineer’s estimate
  - < 5% contingency
Construction Sequence

1. Site Piping Improvements
2. 750,000 Gallon Standpipe
   - Substantial Completion Milestone 1
     - October 31, 2014
3. 600,000 Gallon Standpipe
   - Substantial Completion Milestone 2
     - July 15, 2015
Foundation excavation
Foundation pour

750,000 Gallon Standpipe Foundation
750,000 Gallon Standpipe Foundation
CLSM fill of foundation
750,000 Gallon Standpipe

Tank Assembly

Shell base course assembly
750,000 Gallon Standpipe

Tank Assembly

Anchor chairs

Shell assembly
750,000 Gallon Standpipe
Roof Assembly
750,000 Gallon Standpipe

Roof Assembly
750,000 Gallon Standpipe
2015

Rehab of 600,000 Gallon Standpipe
Budgeting Tip

\[
\text{Age of facility} + \text{Number of unknowns} = \text{Need for contingency funds}
\]
Anchor embedment:
Not designed to resist full yield capacity of the anchor bolt, resulting in a potential brittle failure mode

Ringwall foundation:
Undersized, potential to produce large settlements in compression and foundation uplift in tension
600,000 Gallon Standpipe

Seismic Stresses & Key Issues
600,000 Gallon Standpipe

Seismic Stresses & Key Issues

- inadequate freeboard
- wall buckling
- foundation settlement
- anchorage stress failure
- tension
- compression
- tank uplift

GROUND MOVEMENT
600,000 Gallon Standpipe

Foundation Improvements

Micropile plan
600,000 Gallon Standpipe

Foundation Improvements

Footing section with micropiles
600,000 Gallon Standpipe

**Foundation Improvements**

- Test piles failed to install at ~20 foot depth
- Soil too cohesive
- Limits of geotechnical investigations
600,000 Gallon Standpipe Foundation Improvements

Modified foundation design
600,000 Gallon Standpipe
Foundation Improvements

Foundation & anchorage plan
600,000 Gallon Standpipe

Foundation Improvements

Excavate around foundation

Saw cut concrete
Foundation rebar

600,000 Gallon Standpipe
Foundation Improvements
Concrete placement

600,000 Gallon Standpipe

Foundation Improvements

Concrete placement
600,000 Gallon Standpipe

Foundation Improvements

New anchor chairs
600,000 Gallon Standpipe
Foundation Improvements
600,000 Gallon Standpipe

Appurtenances

- Replaced ladder in vapor zone
- Passive hydraulic mixing system
600,000 Gallon Standpipe

Appurtenances

Old overflow coupling

Rehab of old coupling

Rehab of existing overflow pipe
600,000 Gallon Standpipe

**Interior coatings**

Poor welds at plate seams, splatter

Reconditioned welds (grind)
600,000 Gallon Standpipe

**Interior coatings**

- **Recoated ceiling**
- **Tank interior**
600,000 Gallon Standpipe

Exterior coatings

Surface preparation

Spot priming

Tie coat
600,000 Gallon Standpipe

**Exterior coatings**

Final appearance
600,000 Gallon Standpipe

**Construction complete**

- Redundancy
- Storage to meet 20 +/- year demand
- Facilities meet current OSSC & AWWA standards
Lessons

01. No substitutions for redundancy

02. More unknowns ➔ more contingency

03. Open communication
Questions?