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

Presented by: Lael Alderman, PE | Murray, Smith & Associates, Inc.

Are you taking care of your assets?

Are the coatings sound?

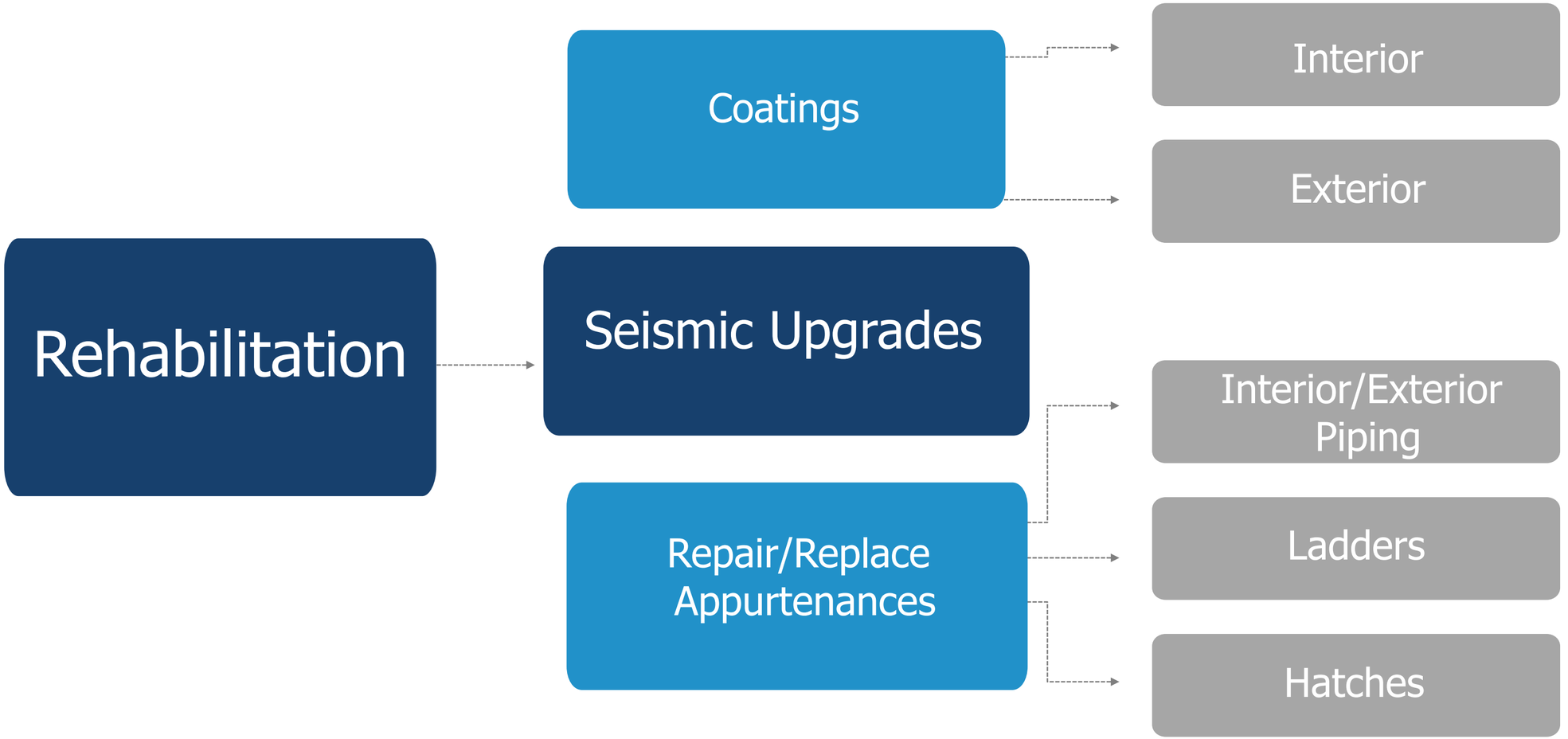
What if there is an earthquake?

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



Pleasant Home Water District

PO Box 870
Gresham, OR 97030

Pleasant Home Water District

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

600,000

gallon reservoir

500 gpm

Firm capacity pump station

17 miles

of distribution main

575

Metered service connections

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.

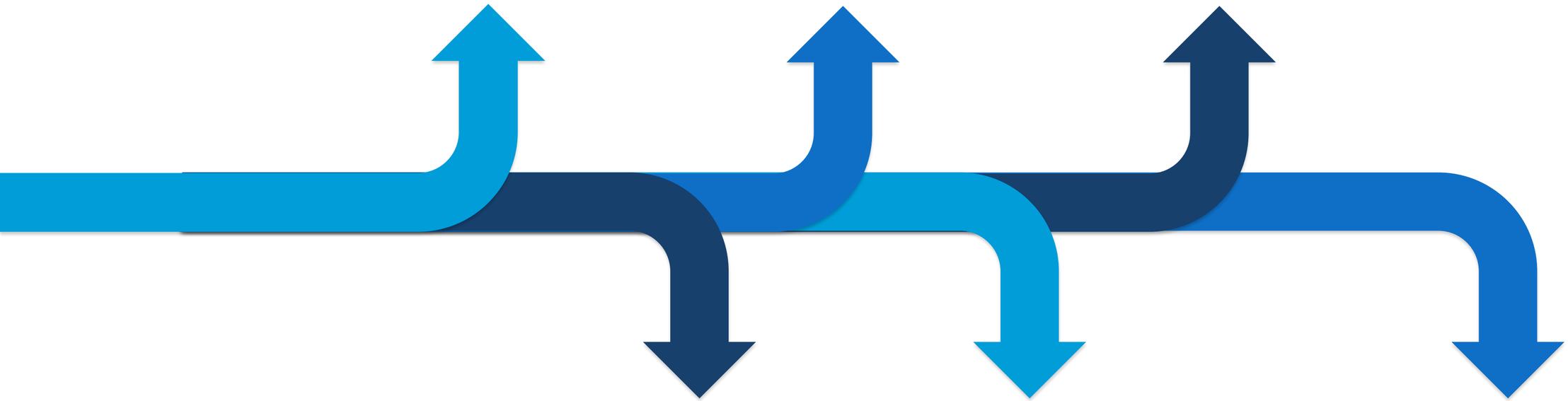
Structural Engineer
Peterson Structural Engineers, Inc.

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

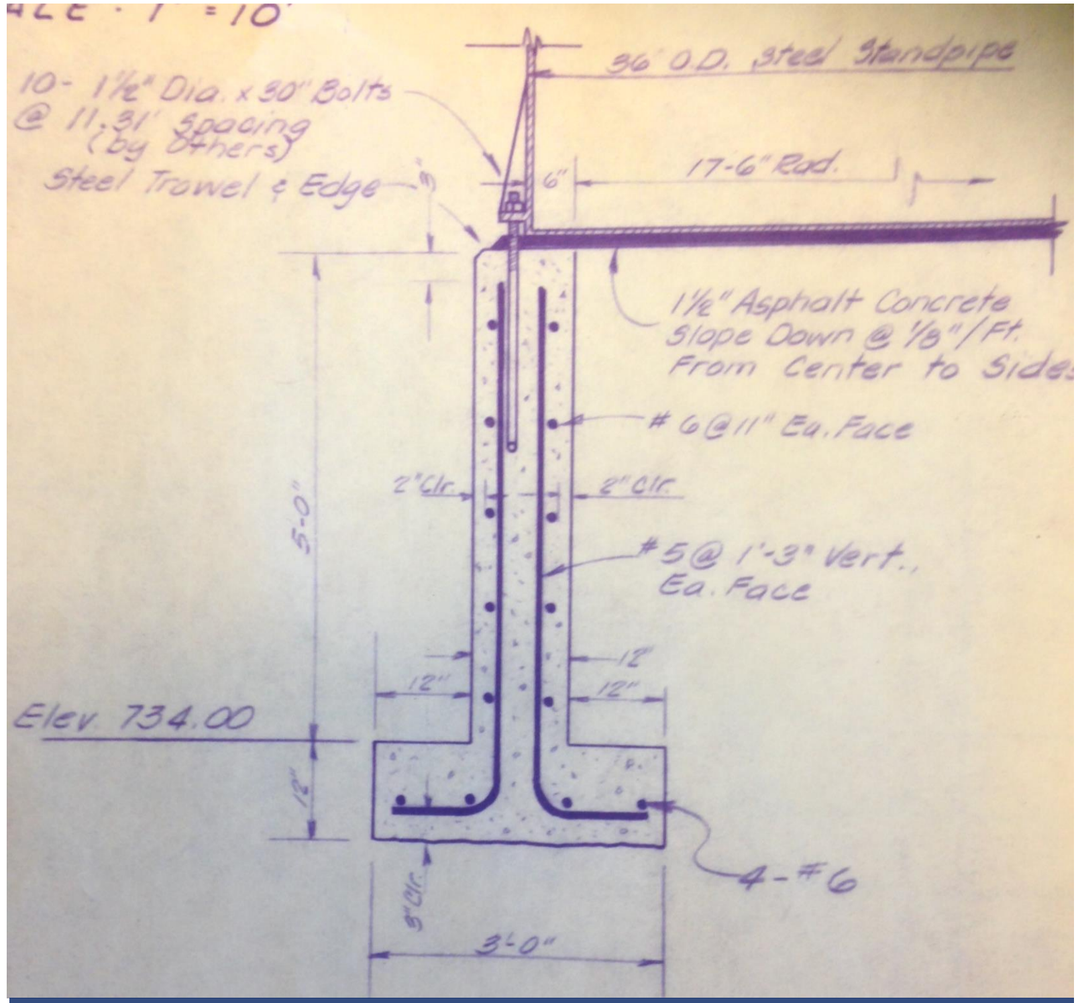
Failed coatings | Ceiling

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?

2010 Storage

2010 Storage Required

2010 Storage Deficiency

20-year projected demand

Additional storage needed

Conclusions & Recommendations from 600,000 Gallon Standpipe Assessment

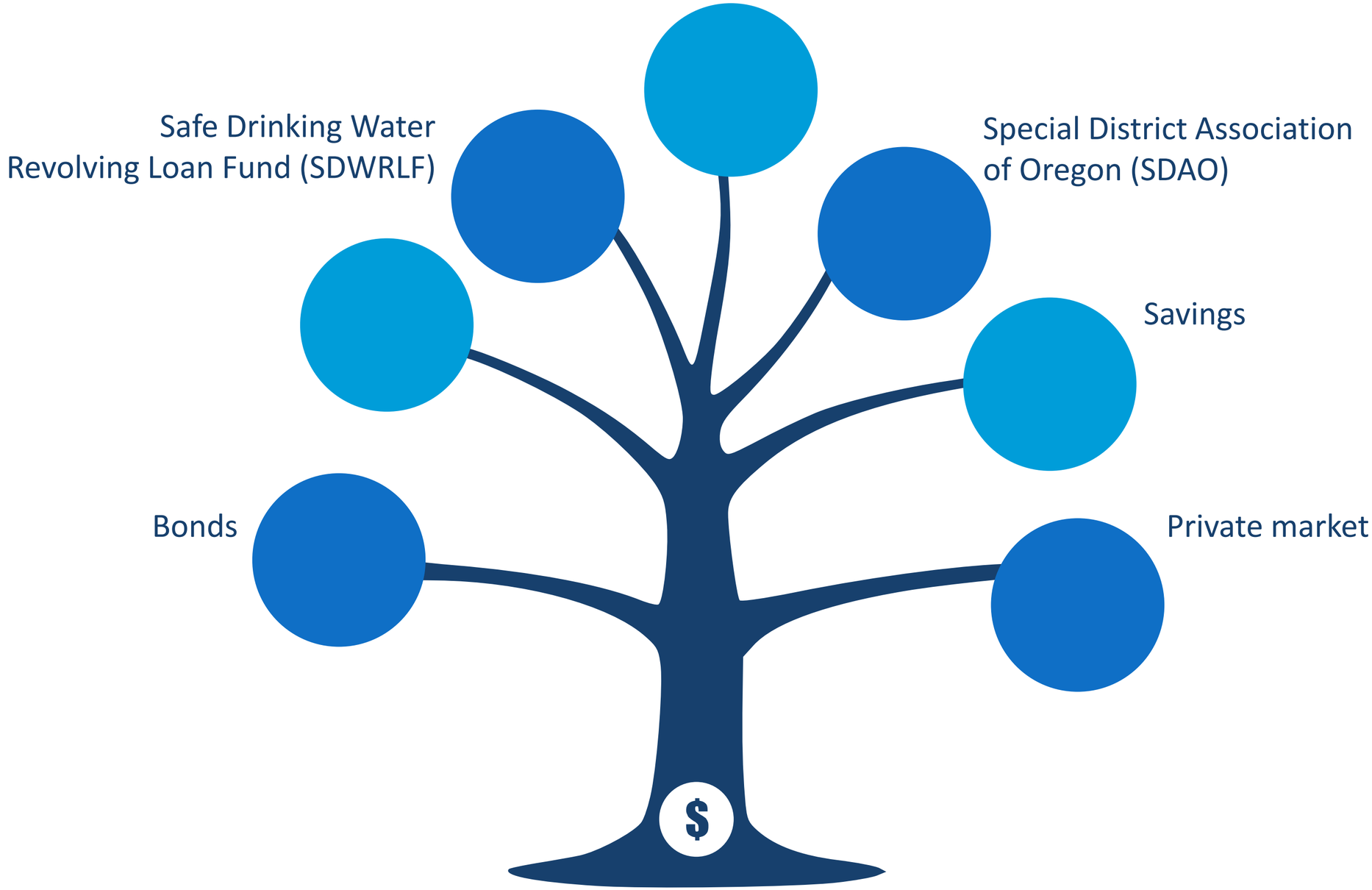
$ Rehab < $ Construct replacement

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

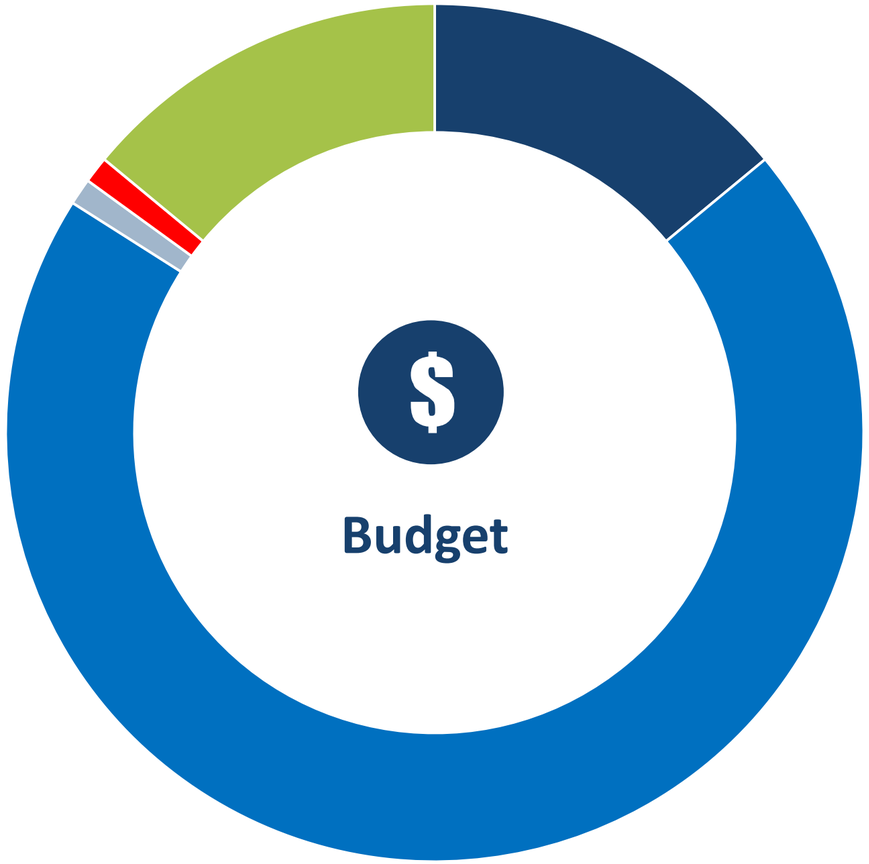
2011

In search of
project funding

Know Your Available Funding Sources



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

$

X

Adjustment for time

=

Updated Construction Cost Estimate

$ $

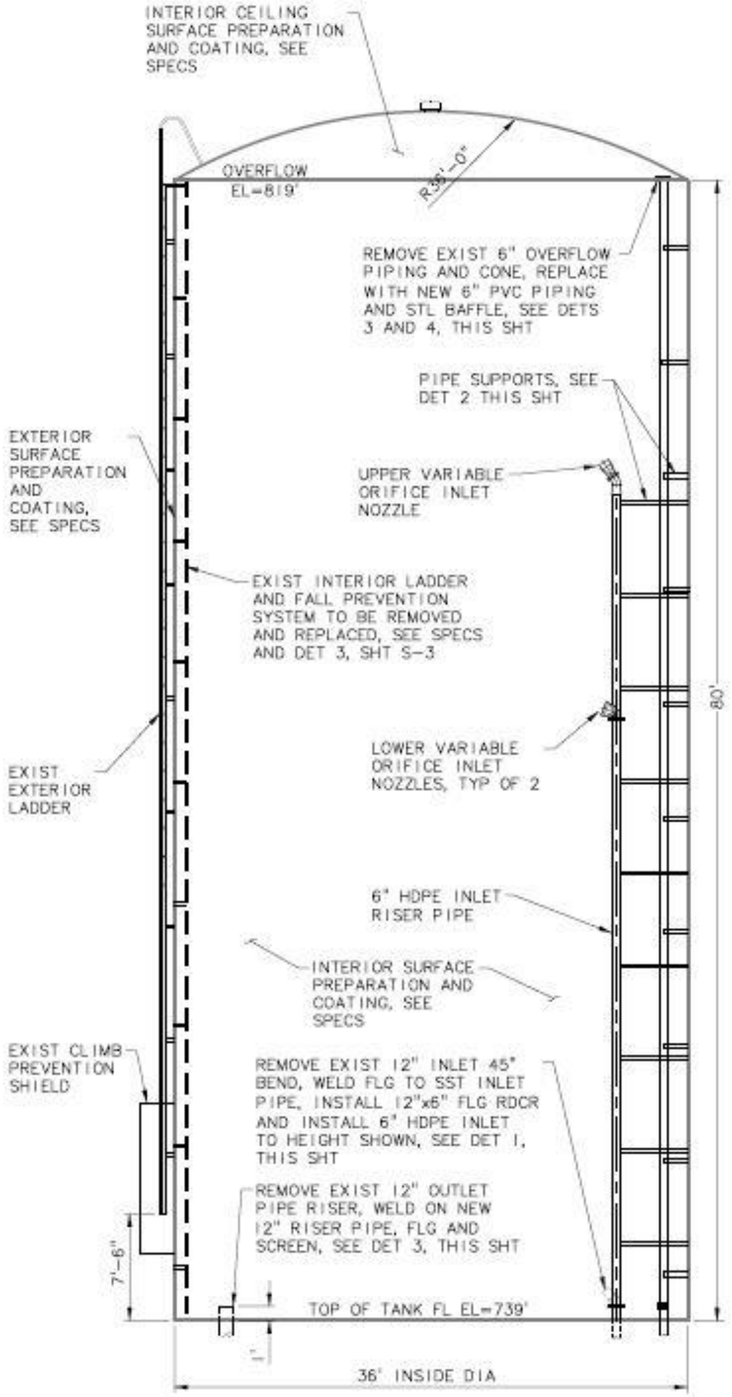
2013

Final designs

Design Goals

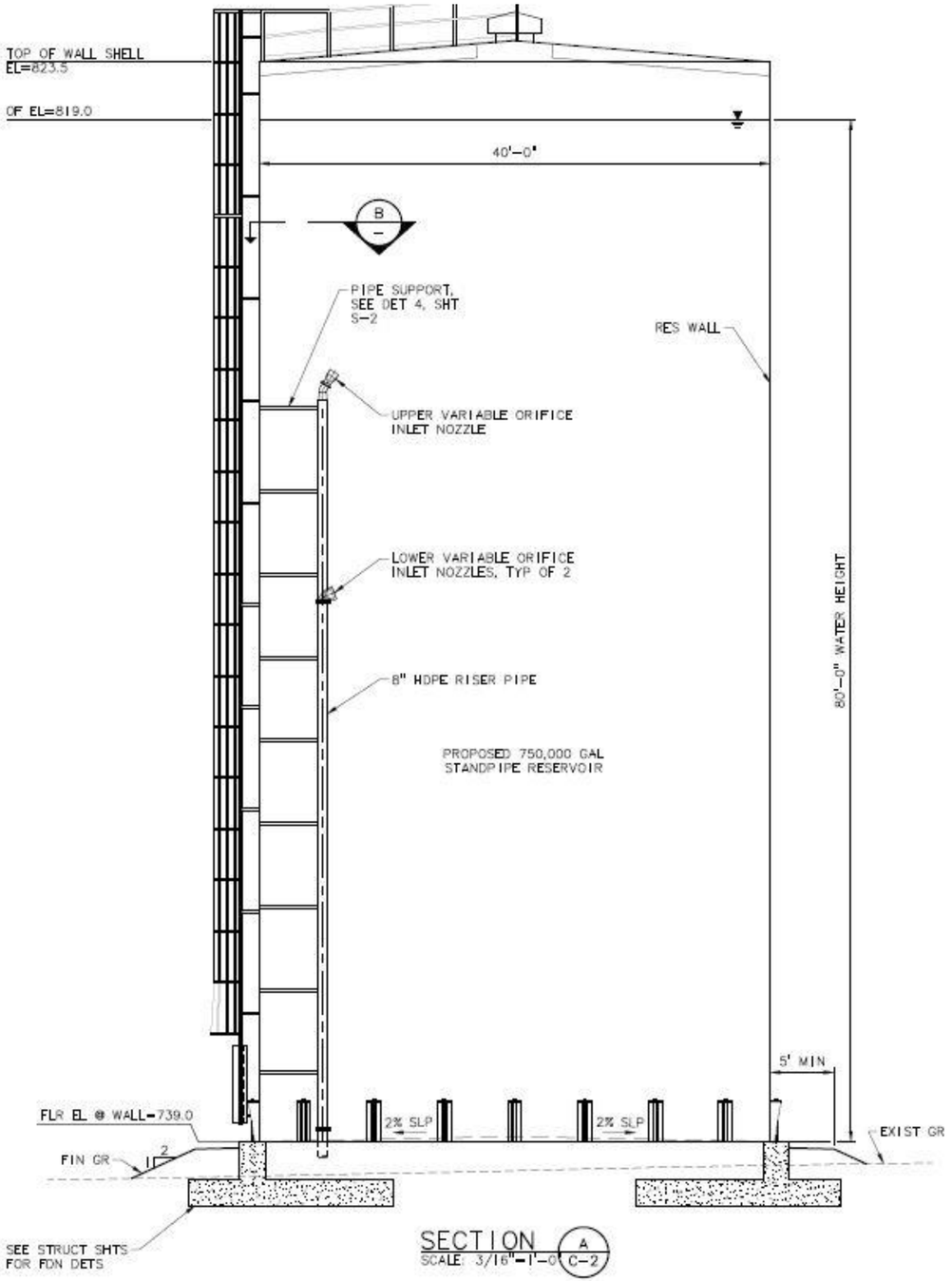
600,000 Gallon Standpipe

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



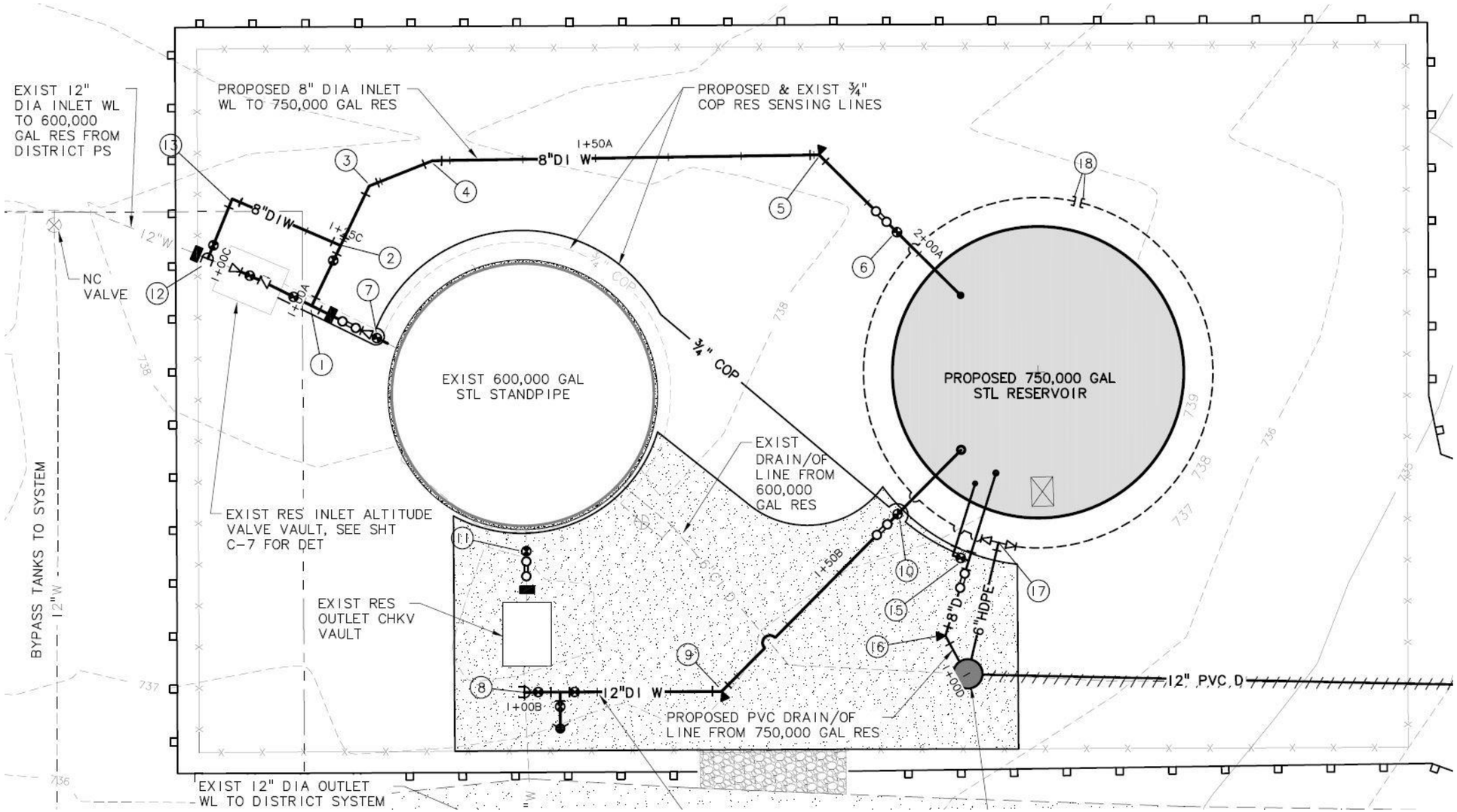
750,000 Gallon Standpipe

- Design to current OSSC & AWWA standards
- Modern personnel safety features
- Passive hydraulic mixing system



Site Piping

Design for Operational Flexibility



2014

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

3 600,000 Gallon Standpipe

Substantial Completion Milestone 1

October 31, 2014

Substantial Completion Milestone 2

July 15, 2015

750,000 Gallon Standpipe

Foundation

Foundation excavation

750,000 Gallon Standpipe

Foundation

Foundation pour

750,000 Gallon Standpipe

Foundation

Final foundation

Foundation

CLSM fill of foundation

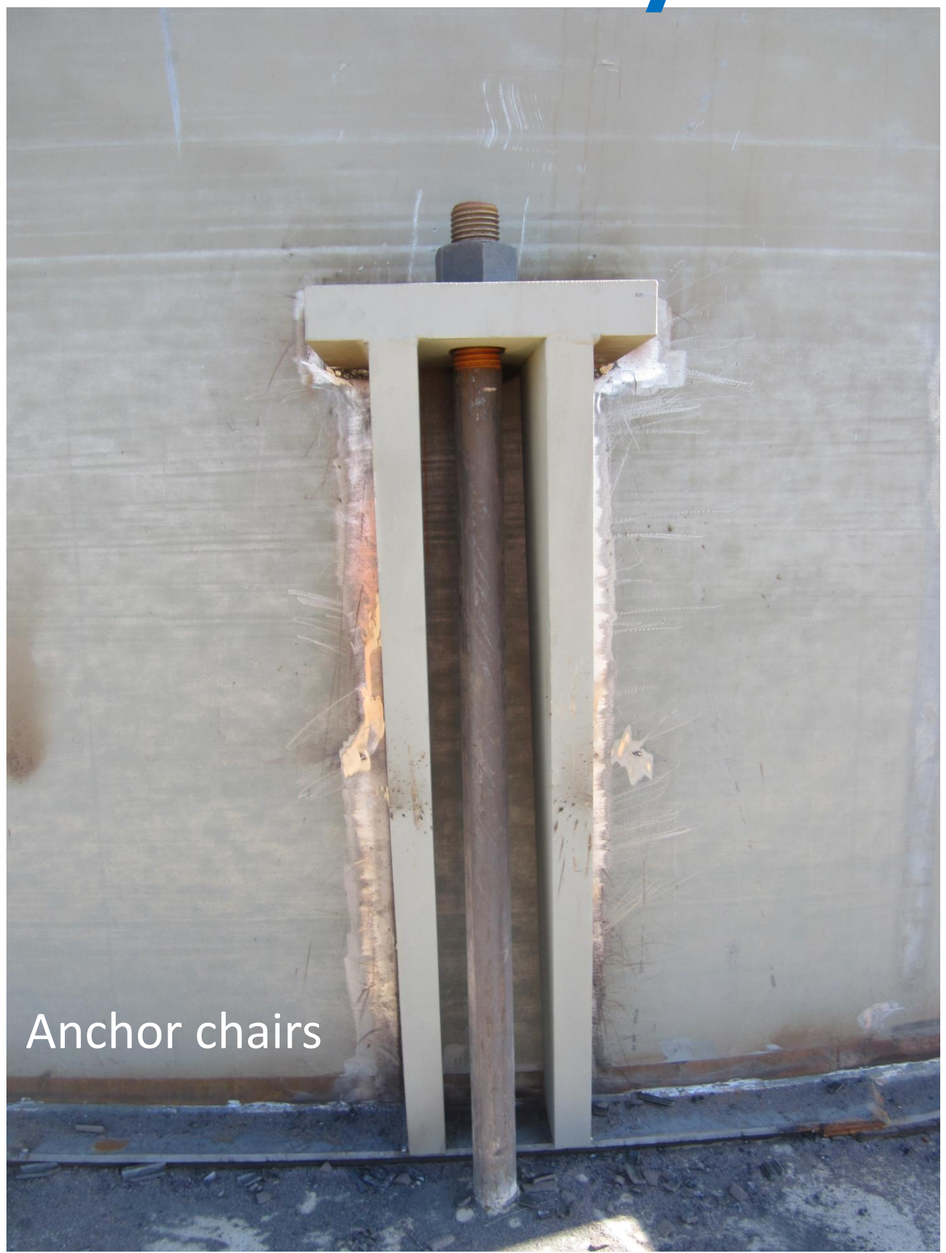
750,000 Gallon Standpipe

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

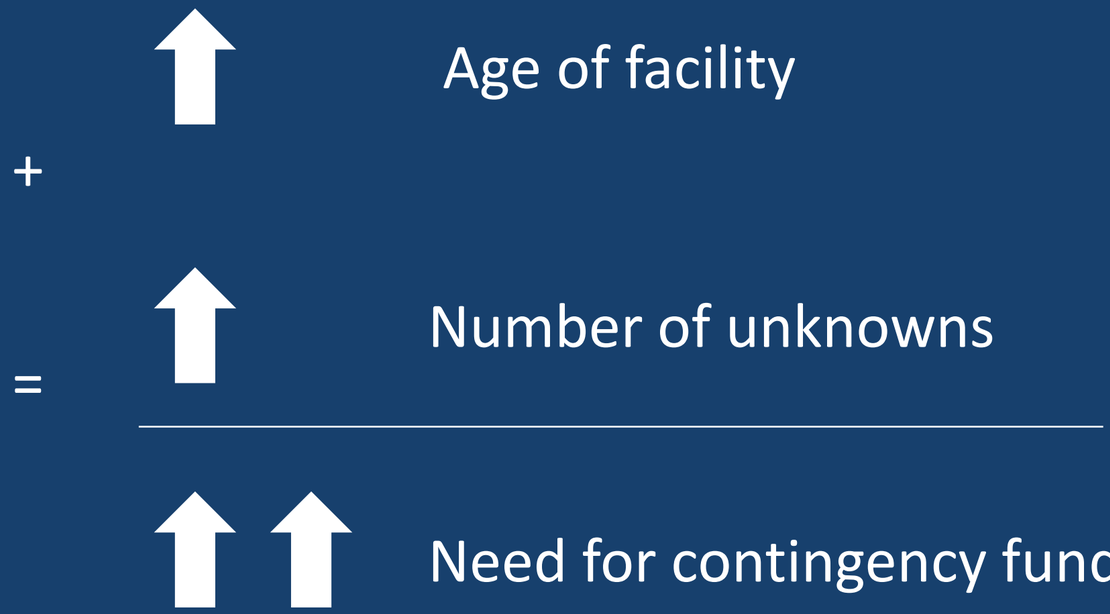
Roof Assembly

750,000 Gallon Standpipe

2015

Rehab of 600,000 Gallon Standpipe

Budgeting Tip



600,000 Gallon Standpipe

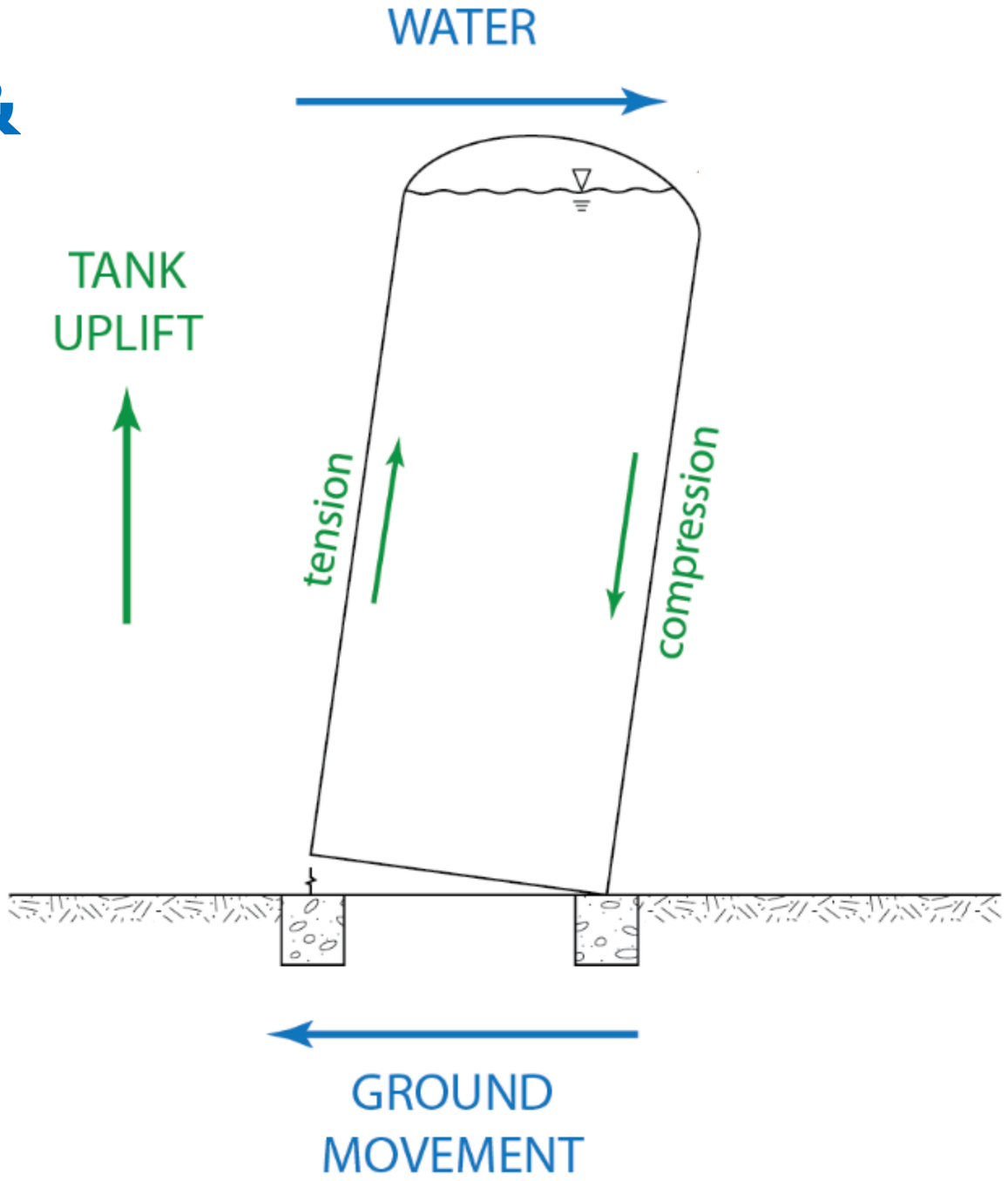
Foundation Improvements

- 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

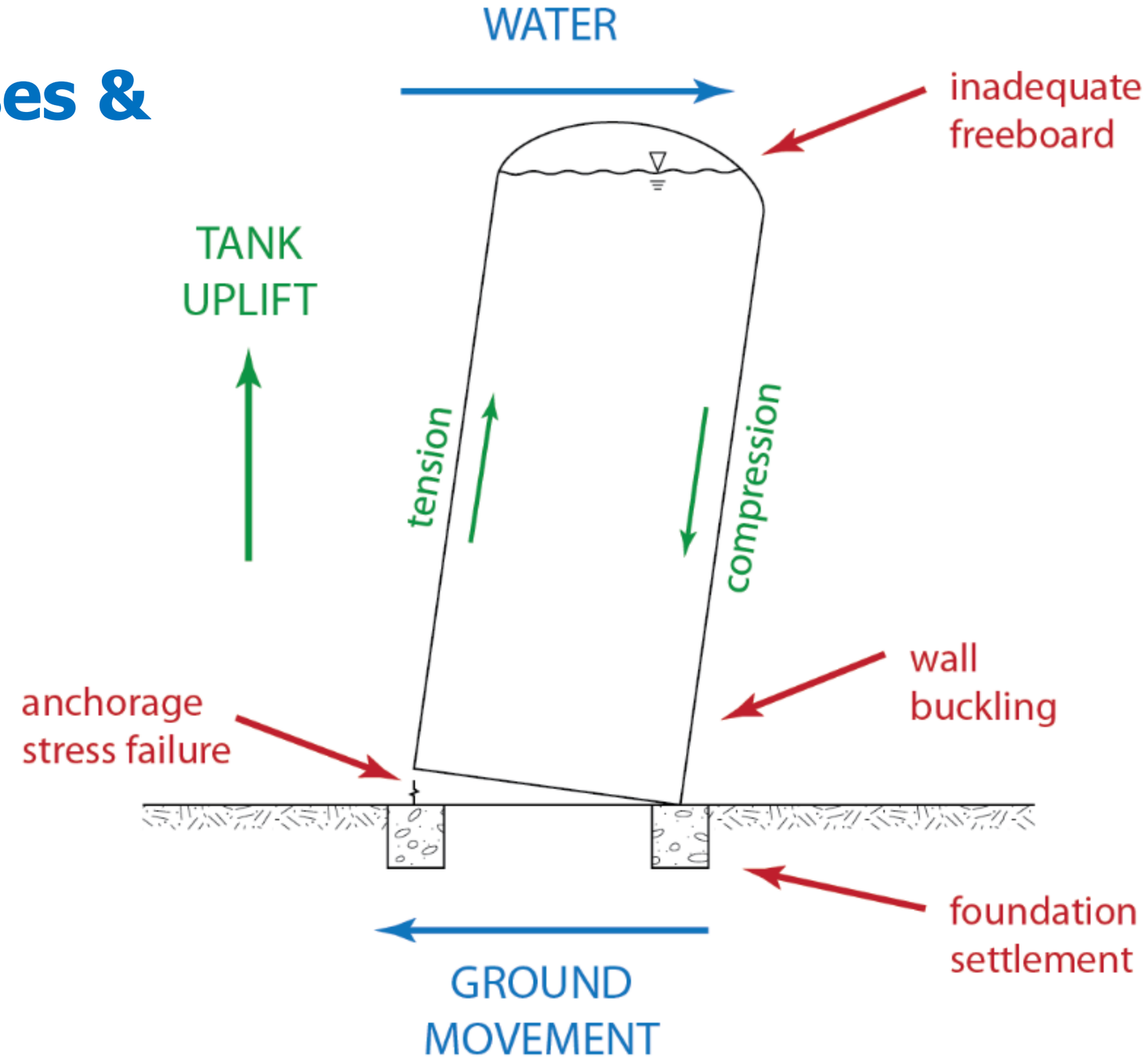
600,000 Gallon Standpipe

Seismic Stresses & Key Issues



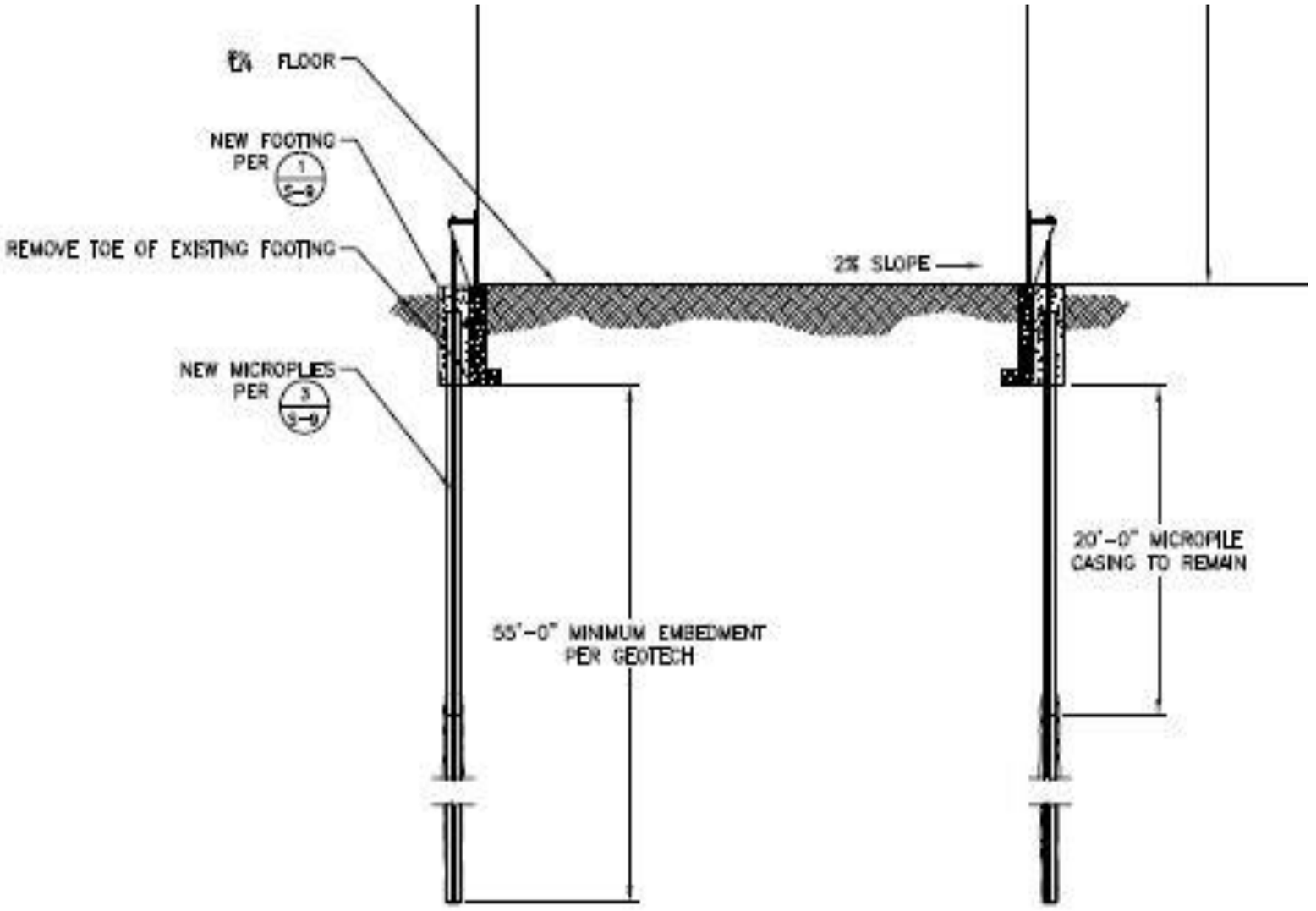
600,000 Gallon Standpipe

Seismic Stresses & Key Issues



600,000 Gallon Standpipe

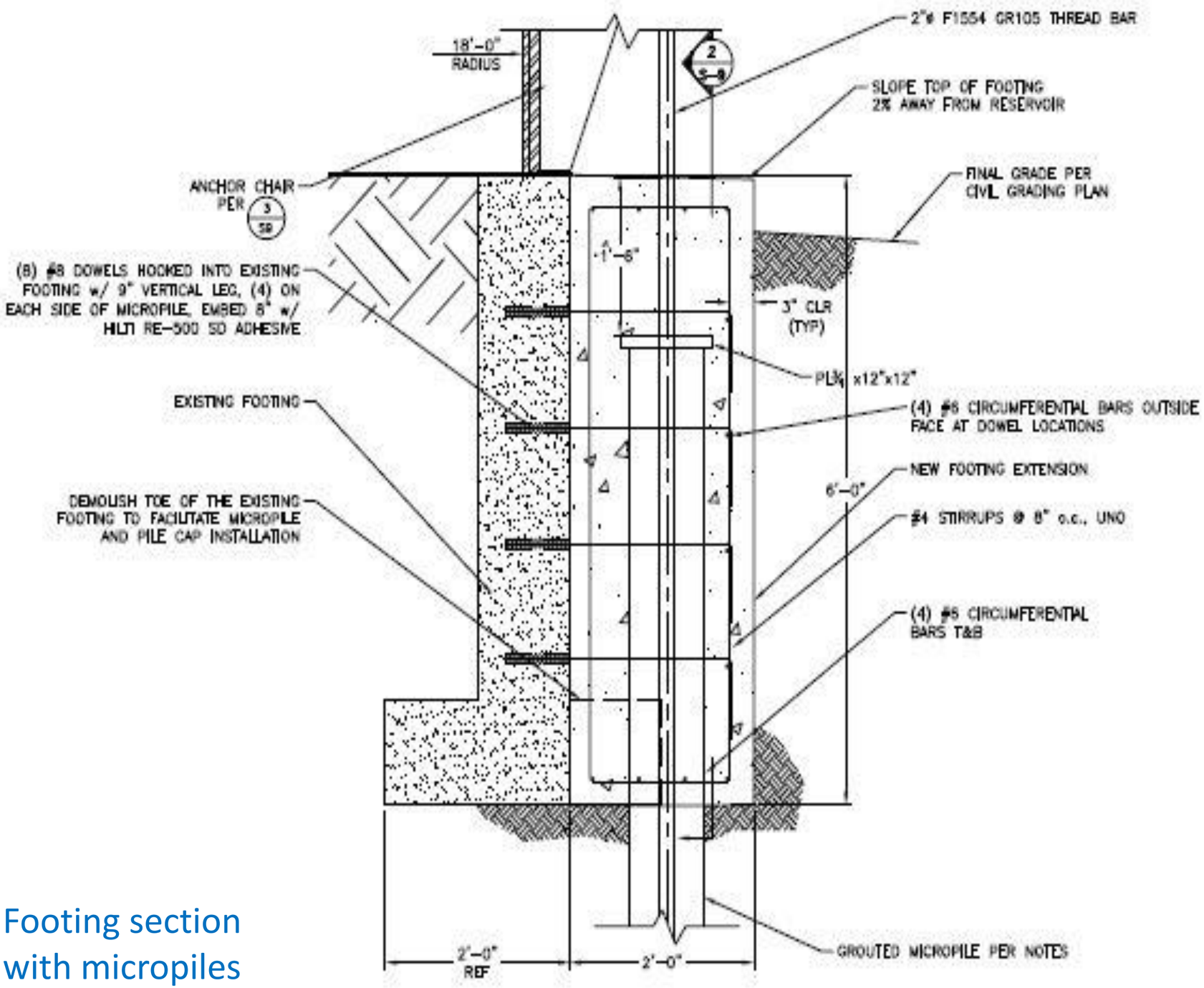
Foundation Improvements



Micropile plan

600,000 Gallon Standpipe

Foundation Improvements



Footing section with micropiles

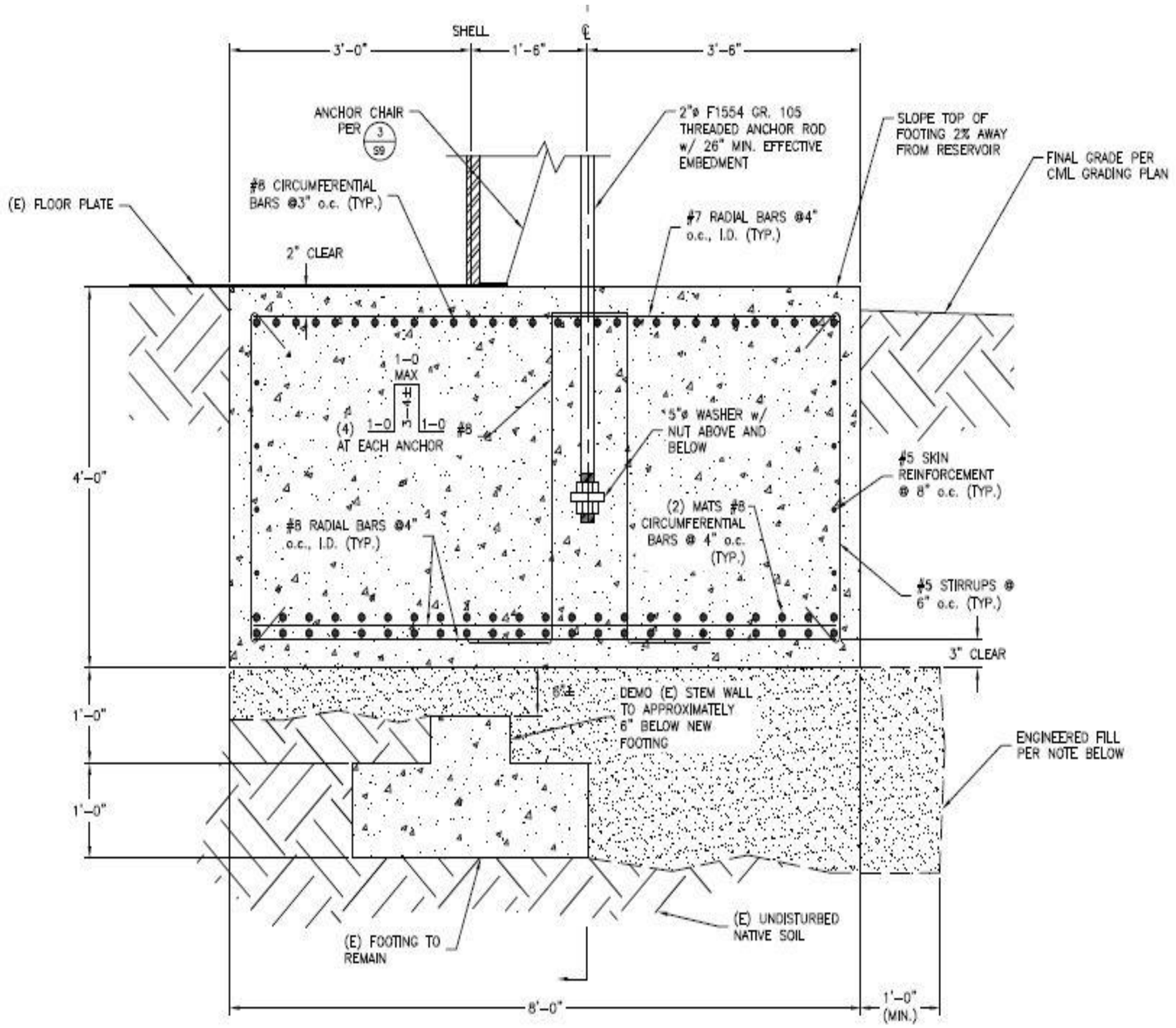
600,000 Gallon Standpipe

Foundation Improvements

- Test piles failed to install at ~20 foot depth
- Soil too cohesive
- Limits of geotechnical investigations

600,000 Gallon Standpipe

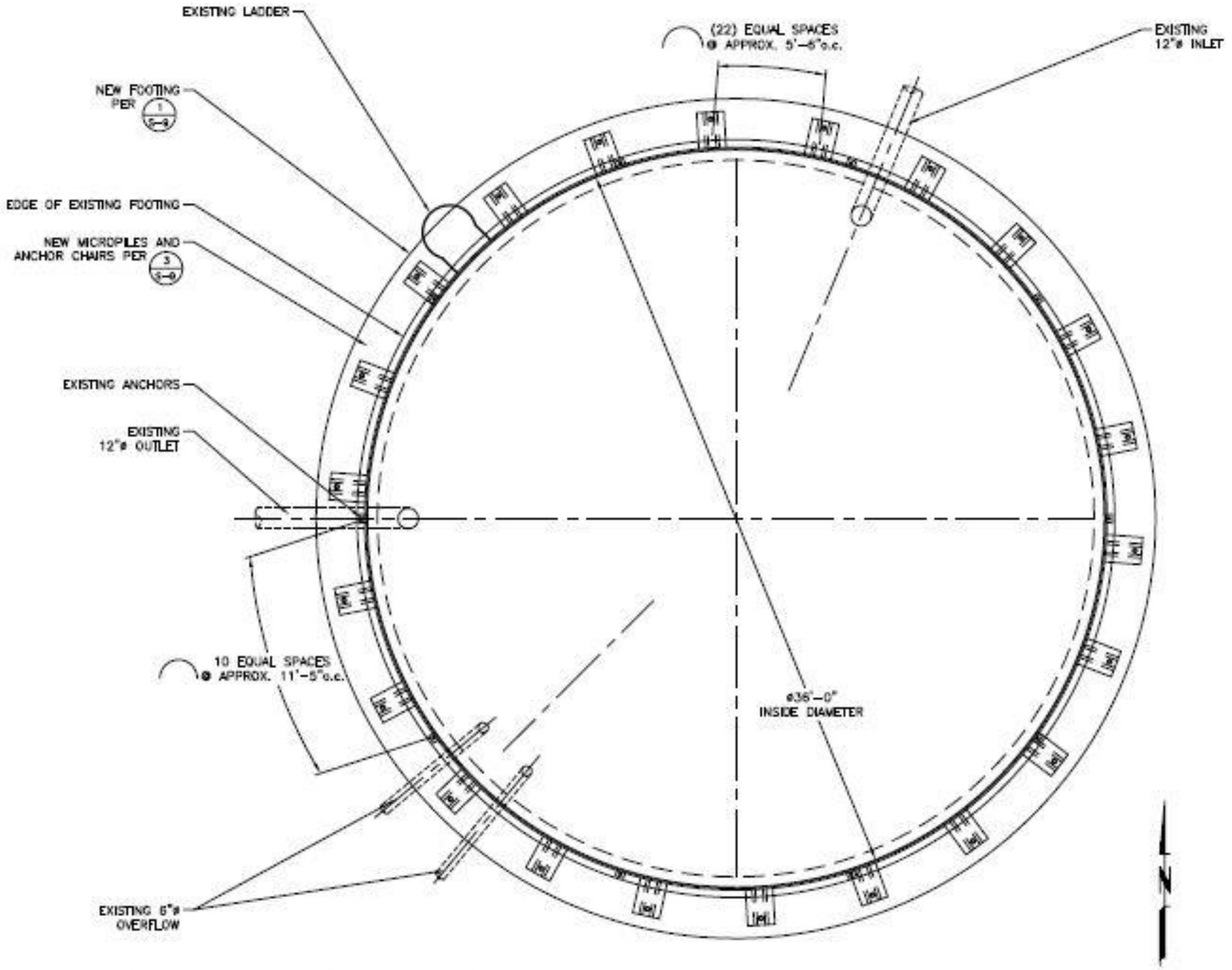
Foundation Improvements



Modified foundation design

600,000 Gallon Standpipe

Foundation Improvements



Foundation & anchorage plan

600,000 Gallon Standpipe

Foundation Improvements

Excavate around foundation

Saw cut concrete

600,000 Gallon Standpipe

Foundation Improvements

Foundation rebar

600,000 Gallon Standpipe

Foundation Improvements

Concrete placement

600,000 Gallon Standpipe

Foundation Improvements

New anchor chairs

600,000 Gallon Standpipe

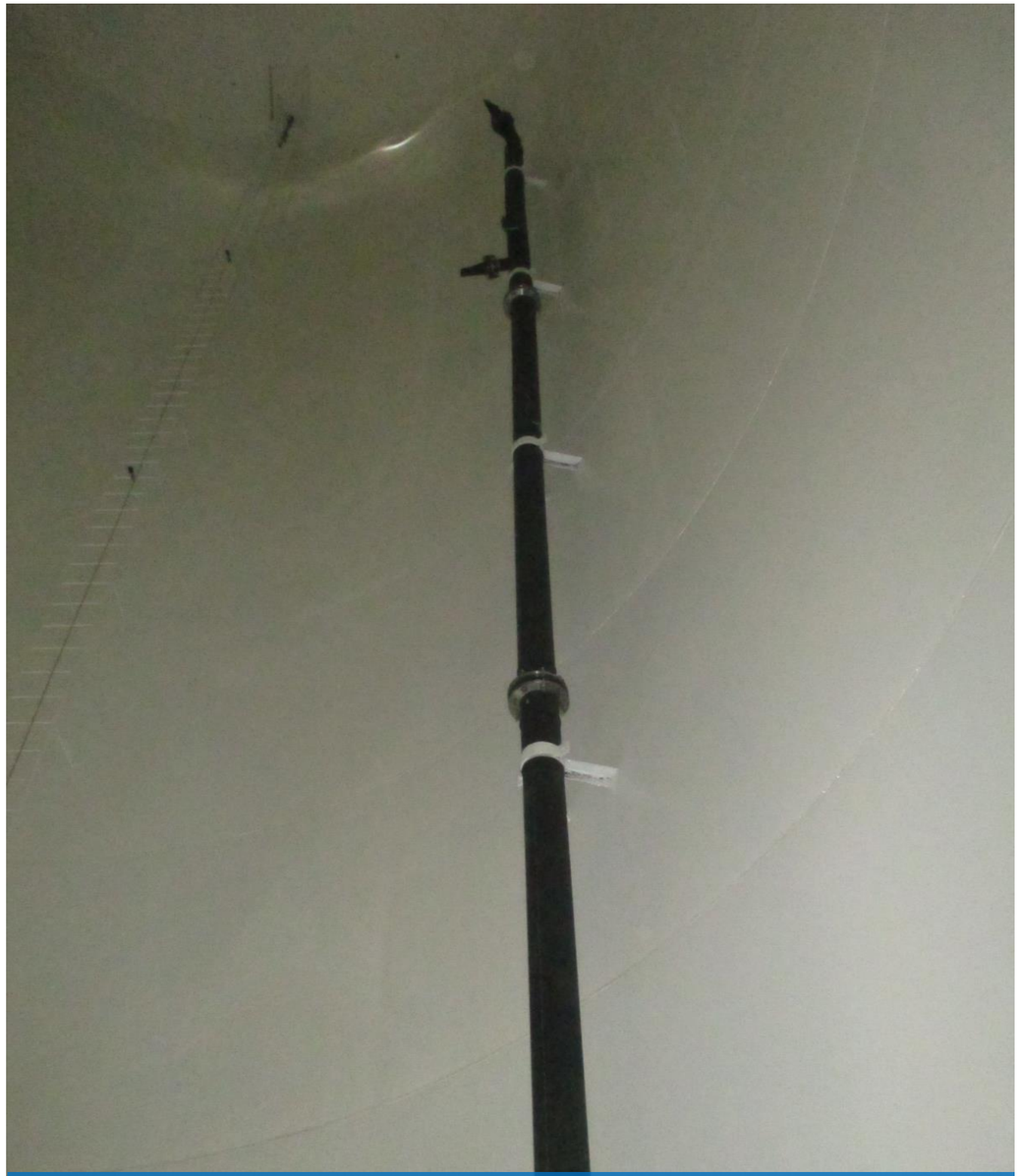
Foundation Improvements

Final foundation work

600,000 Gallon Standpipe

Appurtenances

Replaced ladder in vapor zone



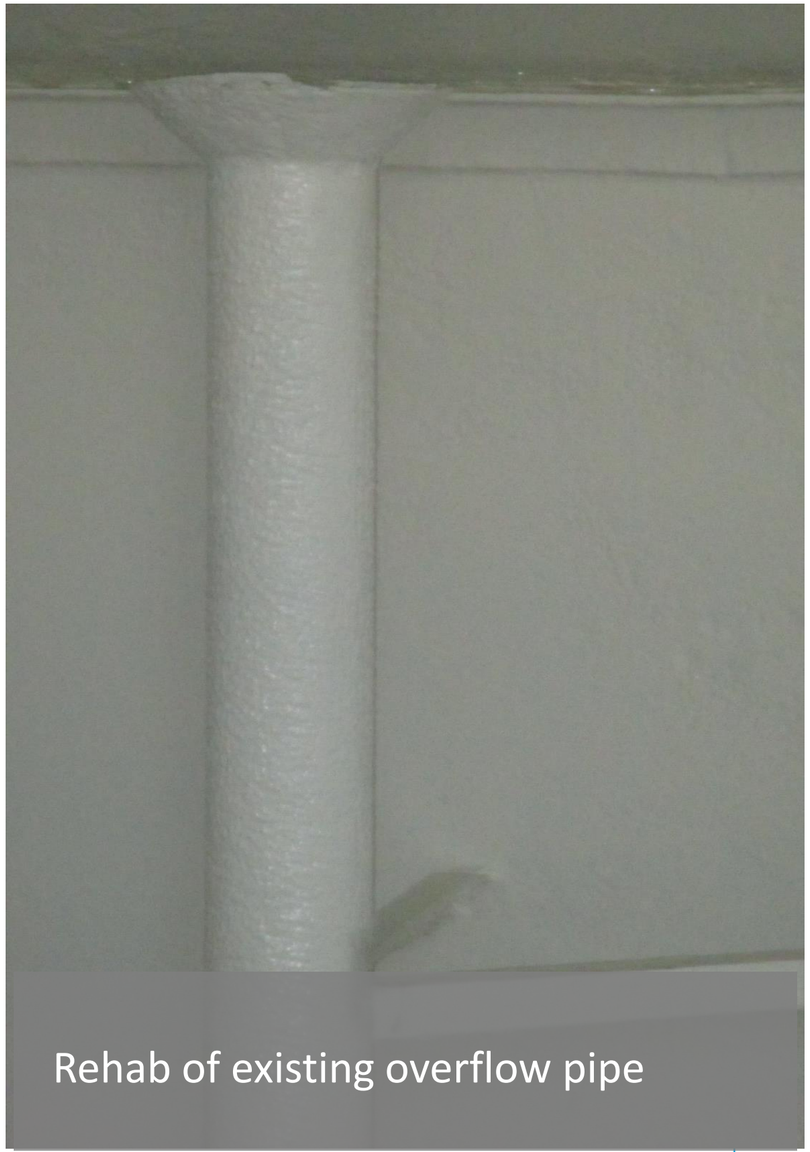
Passive hydraulic mixing system

600,000 Gallon Standpipe

Appurtenances

Old overflow coupling

Rehab of old coupling



Rehab of existing overflow pipe

600,000 Gallon Standpipe

Interior coatings

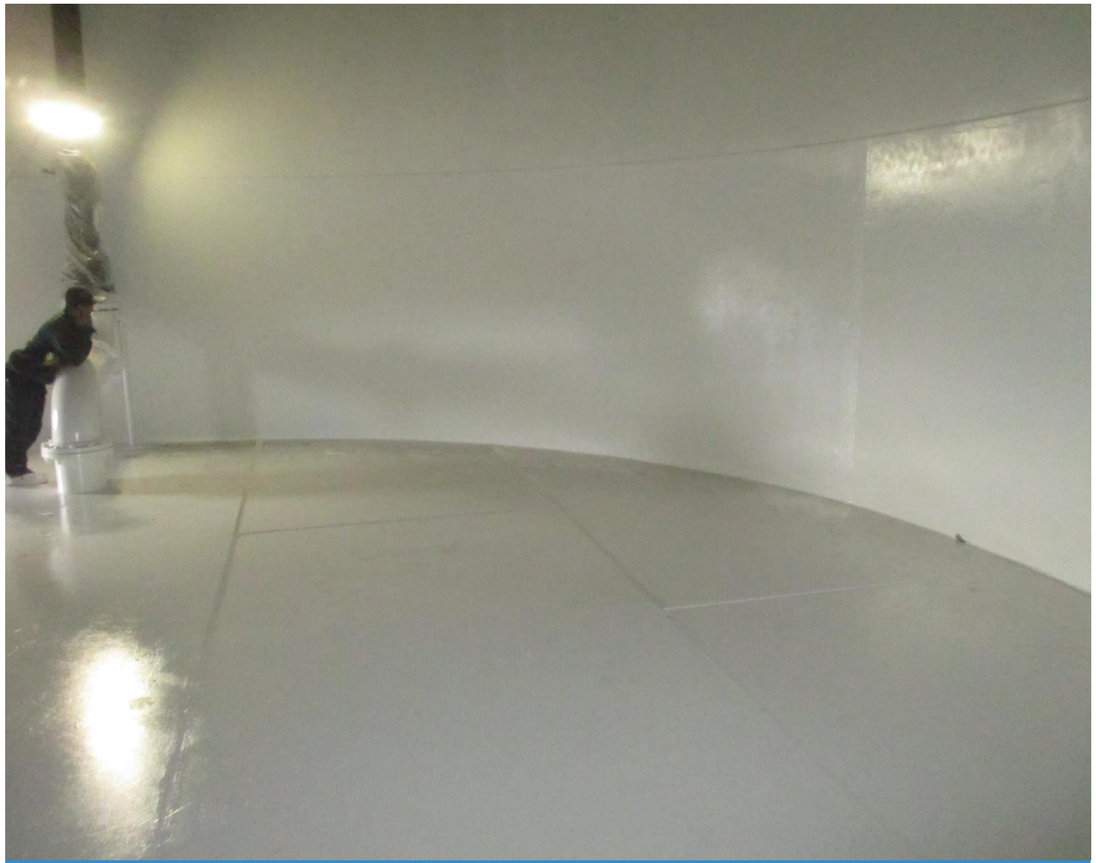
Poor welds at plate seams, splatter

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?