PNWS-AWWA Spring Conference 2022

Optimizing Use of FEMA Funding – Gresham Grant Butte 10MG Seismic Upgrades

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CITY OF GRESHAM OREGON

murraysmith

Today's Agenda

01. City of Gresham's overall Seismic Resilience Plan/Program

02. FEMA Grant PDM Funding

03. Project Details

04. How the site fits in with Gresham's Overall System

05. Key Takeaways

06. Questions & Answers

City of Gresham's overall Seismic Resilience Plan/Program

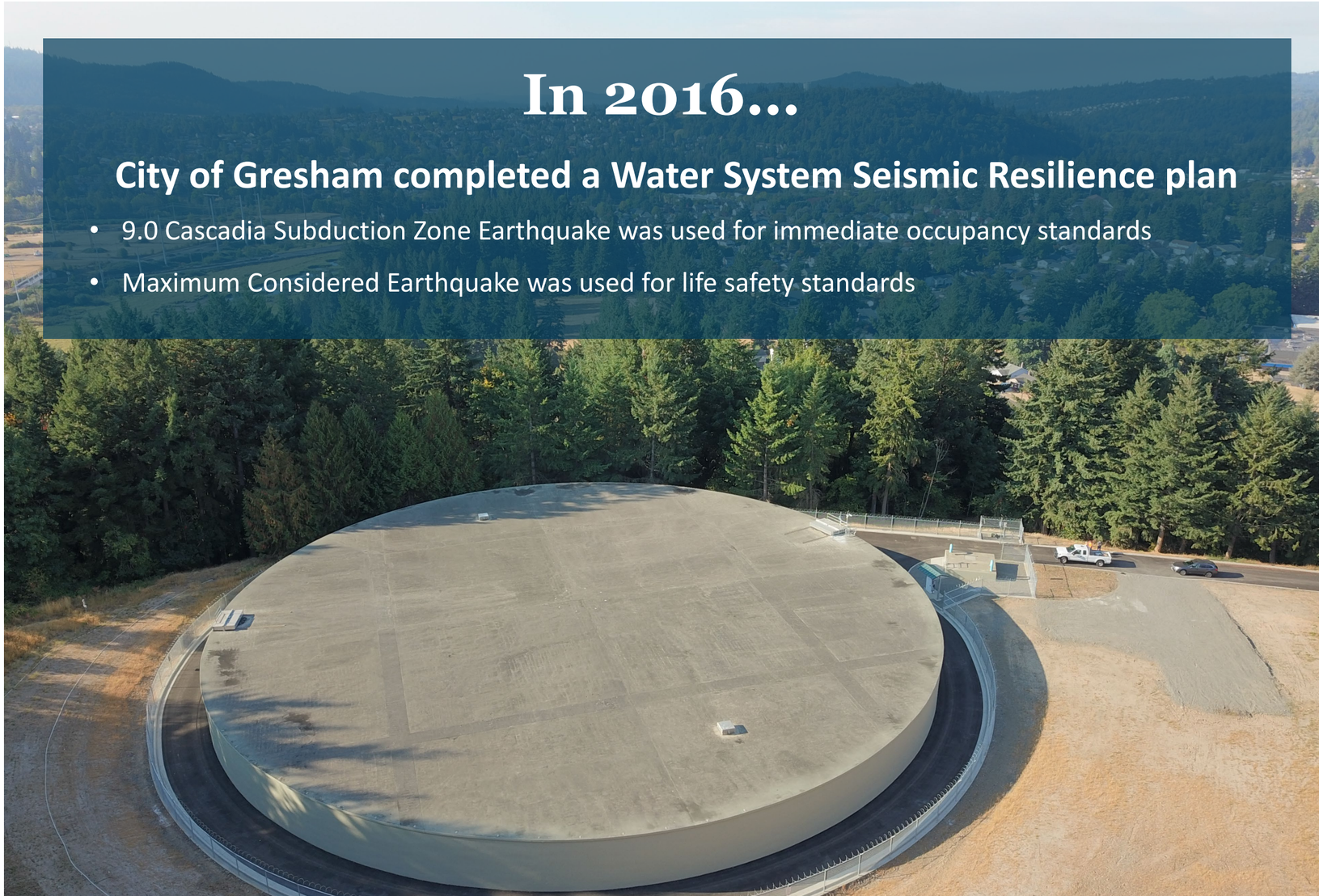
How does Grant Butte fit into overall program and discussion regarding it as first major critical backbone project

Grant Butte Reservoir

- **City's Largest Tank at 10 MG**
- **Ties into two Portland connections**

Recommendations

- **Very low probability of liquefaction**
- **Medium to high probability of seismically induced landslide**
  - Shallow landslide developed upslope of the reservoir
  - Steep downslope below reservoir has high probability of landslide

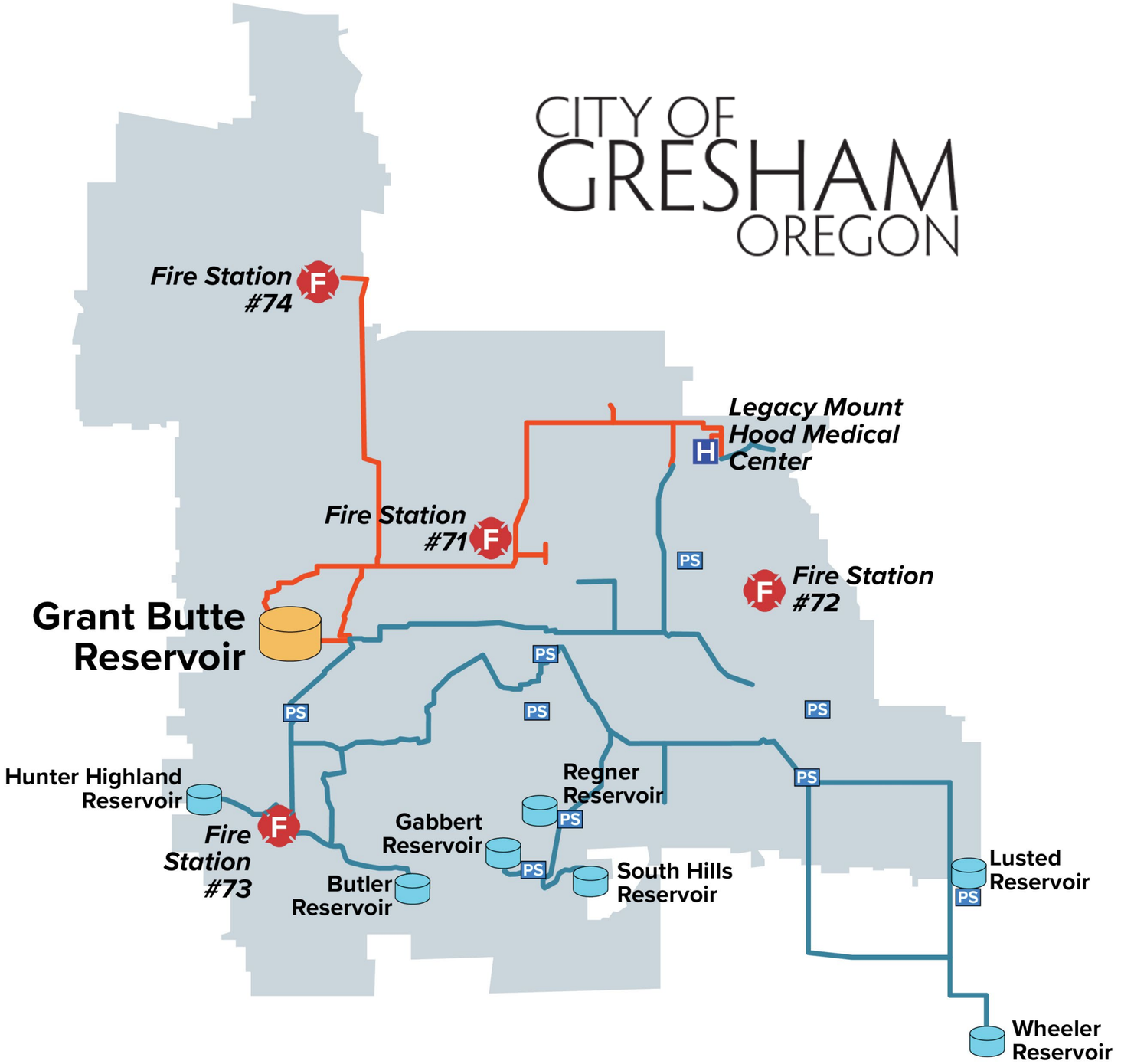


In 2016…

City of Gresham completed a Water System Seismic Resilience plan

- 9.0 Cascadia Subduction Zone Earthquake was used for immediate occupancy standards
- Maximum Considered Earthquake was used for life safety standards

Backbone Infrastructure Map



Project Details

Seismic Resilience Study - Findings

Reservoir

- **Built in 1991, Prestressed Concrete, AWWA D110 Type I (37’, 220’ dia, 10.0 MG)**
- **Original identified deficiencies**
    - Landslide susceptibility
    - Insufficient freeboard (1” vs 3” CSZ, 5’-6” MCE)
    - Insufficient anchorage (wall-to-floor connection)
    - Insufficient hoop strength

Pipeline

- **2800+ feet of 20” Unrestrained DIP**
- **Original identified deficiencies**
    - Landslide susceptibility
        - Peak ground displacement (PGD) of 8 feet
    - Lack of isolation valves
    - 3 breaks anticipated due in Grant Butte service level

Project Details

Seismic Resilience Study - Findings

Reservoir

- **Built in 1991, Prestressed Concrete, AWWA D110 Type I (37’, 220’ dia, 10.0 MG)**
- **Recommendations**
  - Lower Overflow – 5’-6” of freeboard
  - Additional seismic cables
  - Additional circumferential prestressing

Pipeline

- **2800+ feet of 20” Unrestrained DIP**
- **Recommendations**
  - Replace with seismically resistant pipe systems
    - (DIP with seismic joints / steel with double-welded joints / HDPE with fused joints)
  - Isolation Valves

$2,732,000 Estimate ($863,000 Tank, $1,869,000 for Pipeline)

FEMA Grant PDM funding – how the City went out and got funding

75%

Project funded by FEMA Pre-Disaster Mitigation Grant

Now known as FEMA's Building Resilient Infrastructure and Communities (BRIC) grant

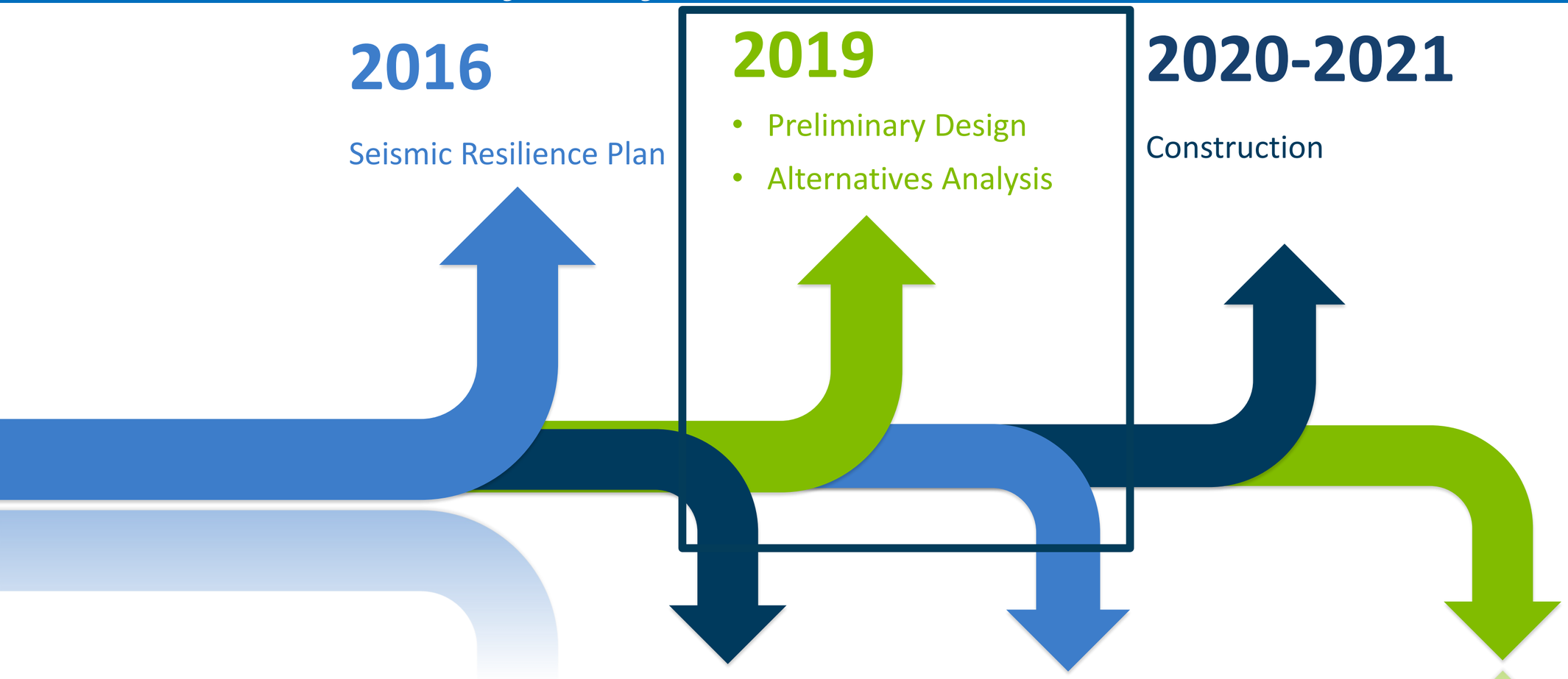
- **Application process is run through State Hazard Mitigation Officer (SHMO)**
  - If not initially selected, project can still progress go to the National competition process
- **This was the only project submitted by the State of Oregon to FEMA for this grant in 2017 and we competed against 254 projects nationwide**

Sub-applications must contain:

- **Scope of Work**
- **Schedule**
- **Cost Estimate/Budget**
- **Feasibility & Effectiveness Documentation**
- **Benefit-Cost Analysis & Documentation**
- **Environmental Planning & Historic Preservation (EHP) Compliance Documentation**
- **Letters of Support**
- **Nature-based Solutions**
- **Climate Resilience Benefits**

Timeline/Scope of Work

Seismic Resilience Study - Findings



Project Details

Putting the Pieces together

The Seismic Resilience Plan + FEMA Grant PDM Funding

1) Deficiencies and Recommendations
2) Funding

How do we put the pieces all together?

Project Details

Alternatives Analysis

Goal of preliminary design/Alternatives analysis:

- Recommend associated pipeline and reservoir upgrades in support of final design

Geotechnical Evaluations + Structural Evaluations in order to:

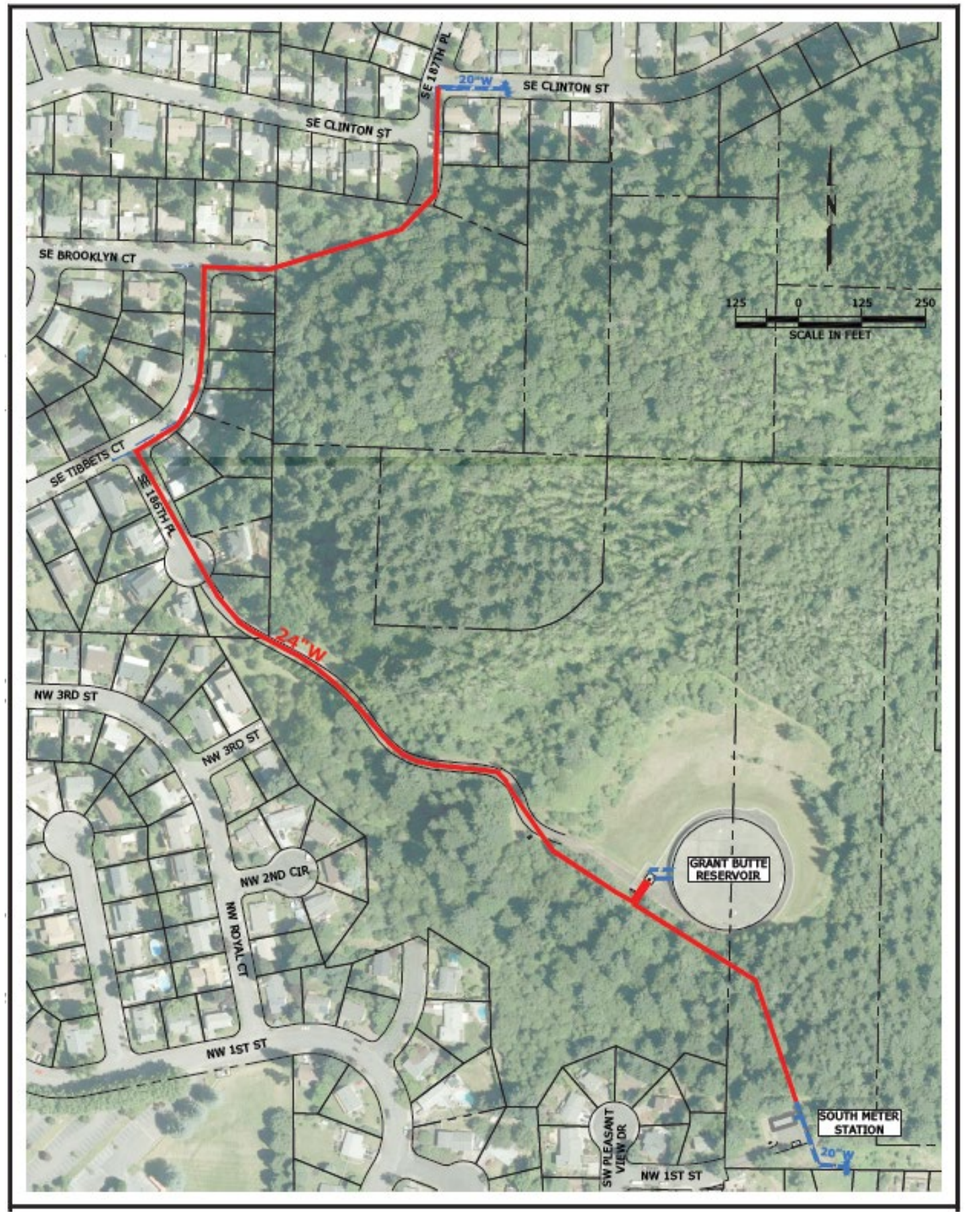
- Review recommendations from 2016 Seismic Resilience Plan
- Alignment Study

McMILLEN JACOBS ASSOCIATES

PSE PETERSON STRUCTURAL ENGINEERS

Project Details

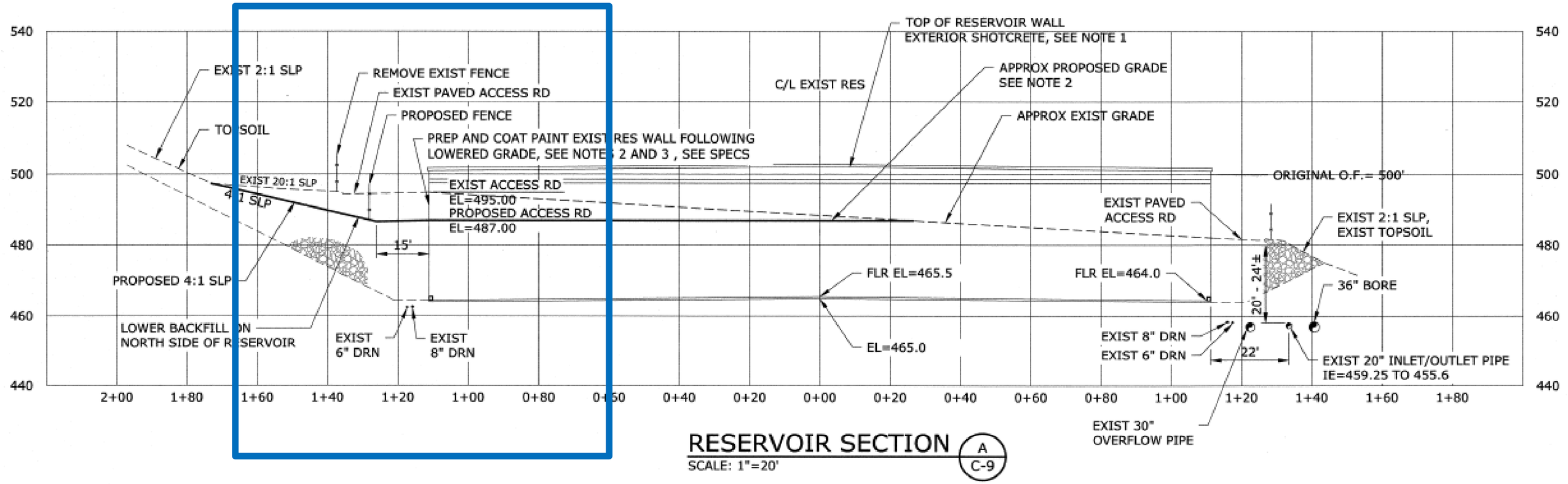
Alternatives Analysis – A. Landslide Susceptibility



Original Construction

Project Details

Alternatives Analysis – A. Landslide Susceptibility

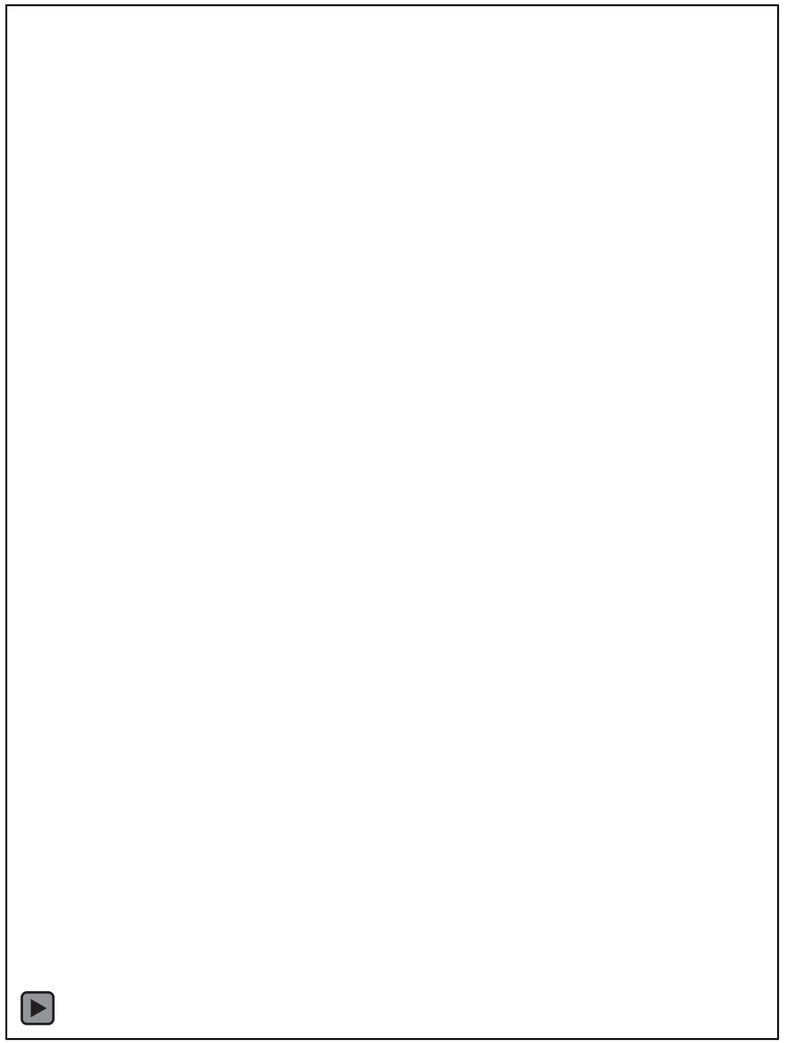


- **Recommendation: Lower backfill on north side of reservoir 8’**
  - **Will decrease 13’ maximum backfill differential to recommended 5’**
  - **minimal impact on the structural integrity of the reservoir.**

Project Details

Alternatives Analysis – B/C. Insufficient Freeboard/Anchorage

- **Slosh and freeboard discussion**
- **Original recommendation to lower overflow elevation 5’-6” (Full slosh wave height)**
- **Although overflow is at 36’, the City was already operating at 32-feet, providing for 5-feet of existing freeboard**



- **Source: Particleworks (Youtube)**

Project Details

Alternatives Analysis – B/C. Insufficient Freeboard/Anchorage

Three factors to consider when evaluating different operation levels

1. **The amount of freeboard provided and the associated loss of storage capacity**
2. **Potential upgrades at the base connection**
   - *An interior shear curb was recommended as a cost-effective solution to harden the connection*
3. **Potential roof reinforcement upgrades for slosh constraints**

Project Details

Alternatives Analysis – B/C. Insufficient Freeboard/Anchorage

Comparison of modified reservoir operation levels

Reservoir Operation Level (above the base slab)	Reduction of Storage capacity (approx.)	Recommended upgrade to Base Connection	Recommended upgrade to Roof Slab
36' – 0" (Current) (1'-0" Freeboard)	0 gallons	Interior Shear Curb Estimate ~ $60,000	FRP Reinforcing and Ties. Likely Cost Prohibitive (minimum 2x or 3x more than 2' Freeboard option)[1]
35' - 0" (2'-0" Freeboard)	280,000 gallons	Interior Shear Curb Estimate ~ $60,000	FRP Reinforcing and Ties[2] Estimate ~ $615,000
34' – 6" (2'-6" Freeboard)	420,000 gallons	No upgrade required	FRP Reinforcing and Ties[2] Estimate ~ $550,000
34' – 0" (3'-0" Freeboard)	560,000 gallons	No upgrade required	FRP Reinforcing and Ties[3] Estimate ~ $435,000
33' – 6" (3'-6" Freeboard)	700,000 gallons	No upgrade required	Roof reinforcing and tension ties not required

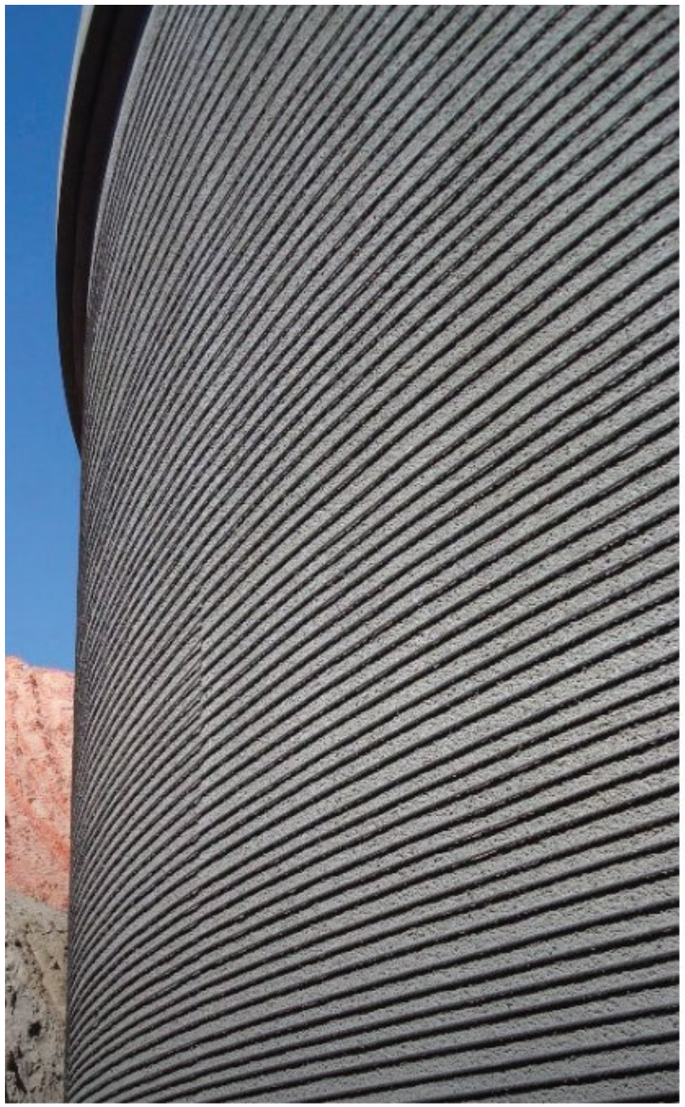
- **Every 6" of freeboard = 140,000 gallon reduction of storage**
- **Potential upgrades at the base connection not required at 34'-6" or less operating levels**
- **Roof reinforcing not required at 33'-6" Operational level**

- **The City elected to proceed with an operating level of 33'-6".**

Project Details

Alternatives Analysis – D. Insufficient Hoop Strength

- **Original prestressing contractor provided submittals and as-built documents**
  - Original strand-wrapping provided exceeded requirements for static and seismic loads
  - As-built strand wrapping provides adequate pre-stressing to meet current code requirements.



Courtesy: DN Tanks

Project Details

Reservoir Design Takeaways

- **Collaboration with the City to really think through design**
- **Most of the original upgrades not necessary due to City Operations**
- **Prioritization of funding then “reallocated” to Pipeline discussions with the City regarding current operations**

Project Details

Alternatives Analysis – Landslide Susceptibility

2018

2021

Project Details
Pipeline

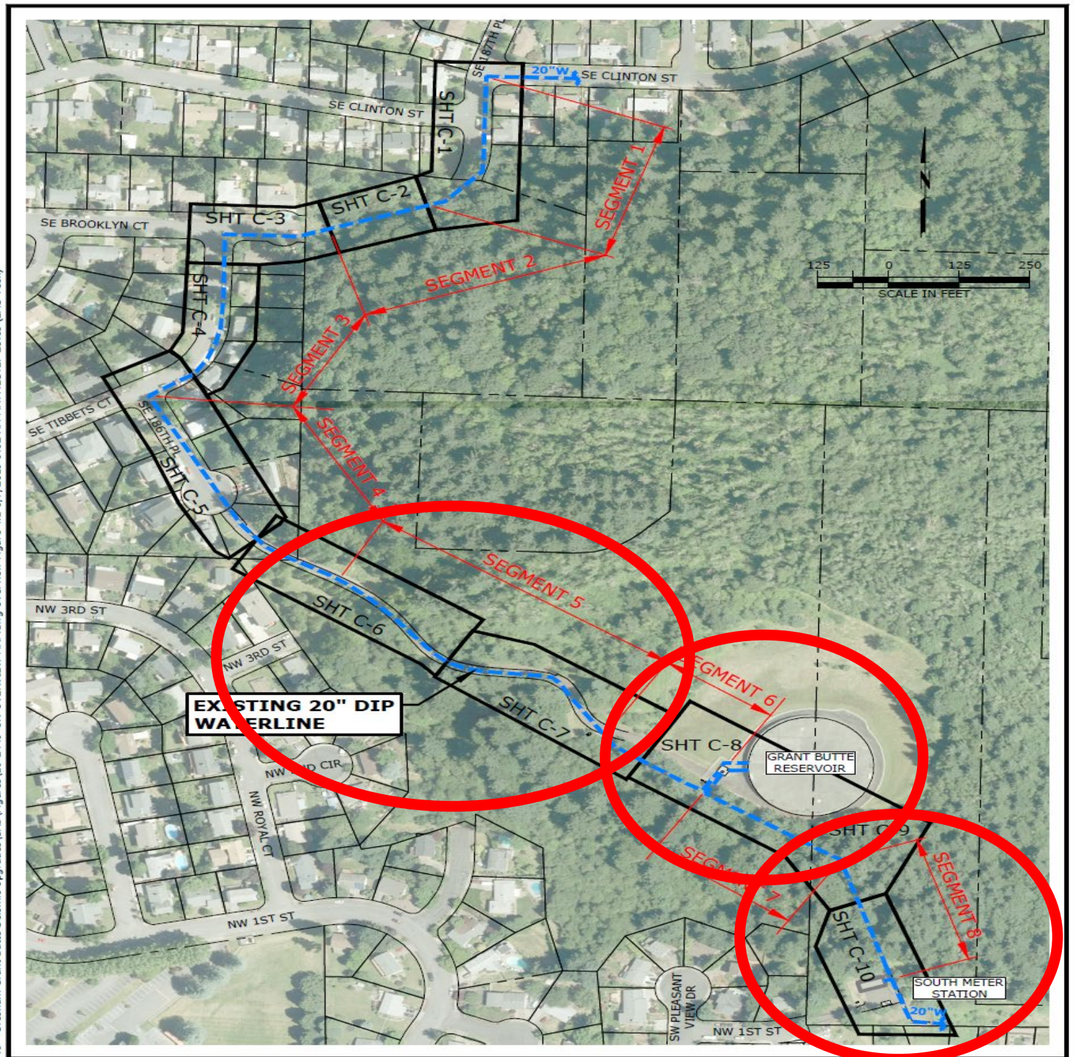


Figure 3-1
Overview Map

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G:\PDX_Projects\19\2449 - Gresham Grant Butte Seismic Upgrades\CAD\Figures\19-2449-OR-OVERVIEW MAP.dwg Overview Figure 4.1 8/7/2019 9:02 AM MATT.ESTEP 23.0s (LMS Tech)

2800

Total length of Pipe

Upsize
20” to 24”

Pipeline was broken up into multiple segments

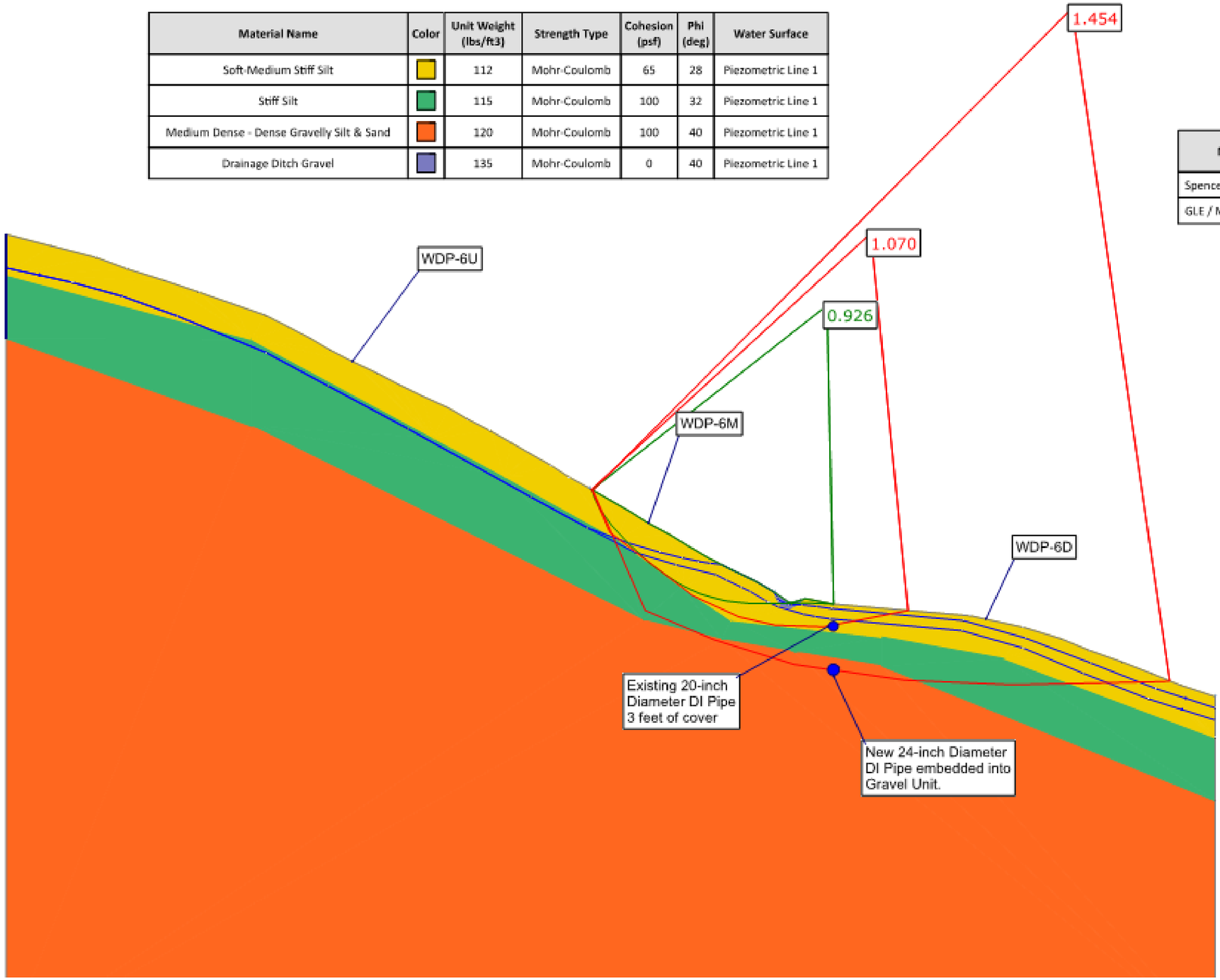
1. North Line Reservoir Access Road
2. South Line
3. On site piping & Seismic Actuator Valves

Project Details

North line Reservoir Access Road

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Soft-Medium Stiff Silt		112	Mohr-Coulomb	65	28	Piezometric Line 1
Stiff Silt		115	Mohr-Coulomb	100	32	Piezometric Line 1
Medium Dense - Dense Gravelly Silt & Sand		120	Mohr-Coulomb	100	40	Piezometric Line 1
Drainage Ditch Gravel		135	Mohr-Coulomb	0	40	Piezometric Line 1

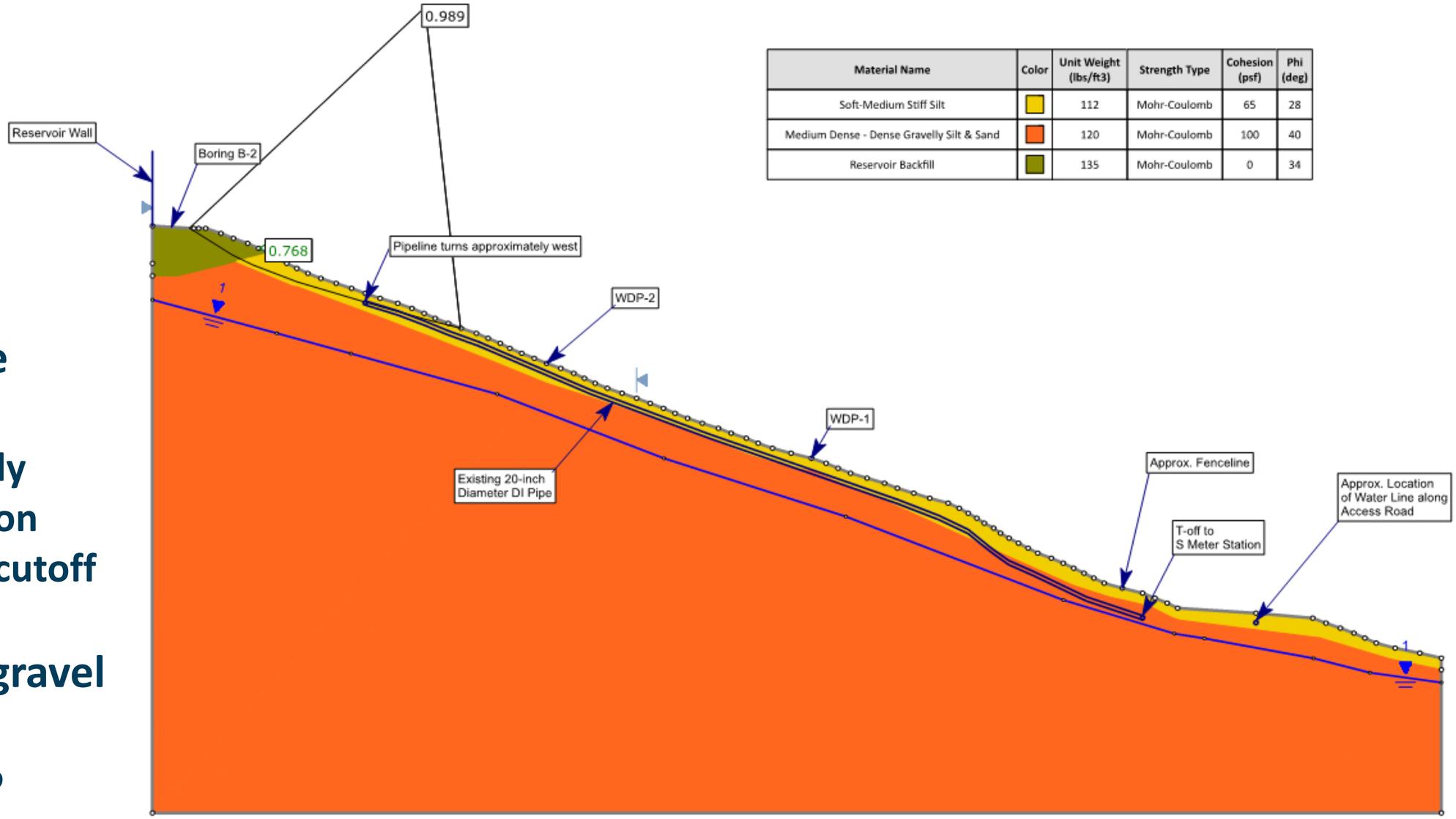
Method Name	Min FS
Spencer	0.926
GLE / Morgenstern-Price	0.939



Project Details

2) South Line - Steep Slope

- Trenchless technologies are infeasible
  - Bends, Cobbly soils, elevation differential, cutoff walls
- Installed in the gravel unit (4’ Cover)
- Looked at ERDIP



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soft-Medium Stiff Silt		112	Mohr-Coulomb	65	28
Medium Dense - Dense Gravelly Silt & Sand		120	Mohr-Coulomb	100	40
Reservoir Backfill		135	Mohr-Coulomb	0	34

Project Details

On site piping + Seismic Actuator Valves

- **Flex-Tends**
- **Seismic Actuator Valves**
  - **ShakeAlert**
  - **Local seismic sensor as backup**

ShakeAlert™

Now, MORE Ready for the Big One

How the site now fits in with Gresham's Overall System

Before

- Reservoir impacted by landslides
- Landslides break both watermains and the access road
- Breaks elsewhere in the system cause the reservoir to empty

Now

- Less differential backfill mitigates potential impact to reservoir
- Landslides pass over and around the water mains
- ShakeAlert and valve actuator protect from major water loss

Key Takeaways/Lessons Learned

Step 1: Identify problem areas with a seismic study

Step 2: Utilize FEMA funding to make project possible sooner

Step 3: Optimize how funds are spent with thoughtful design

Step 4: Construction

Step 5: Be happy with your new, more resilient system

Questions & Answers

Thank You

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