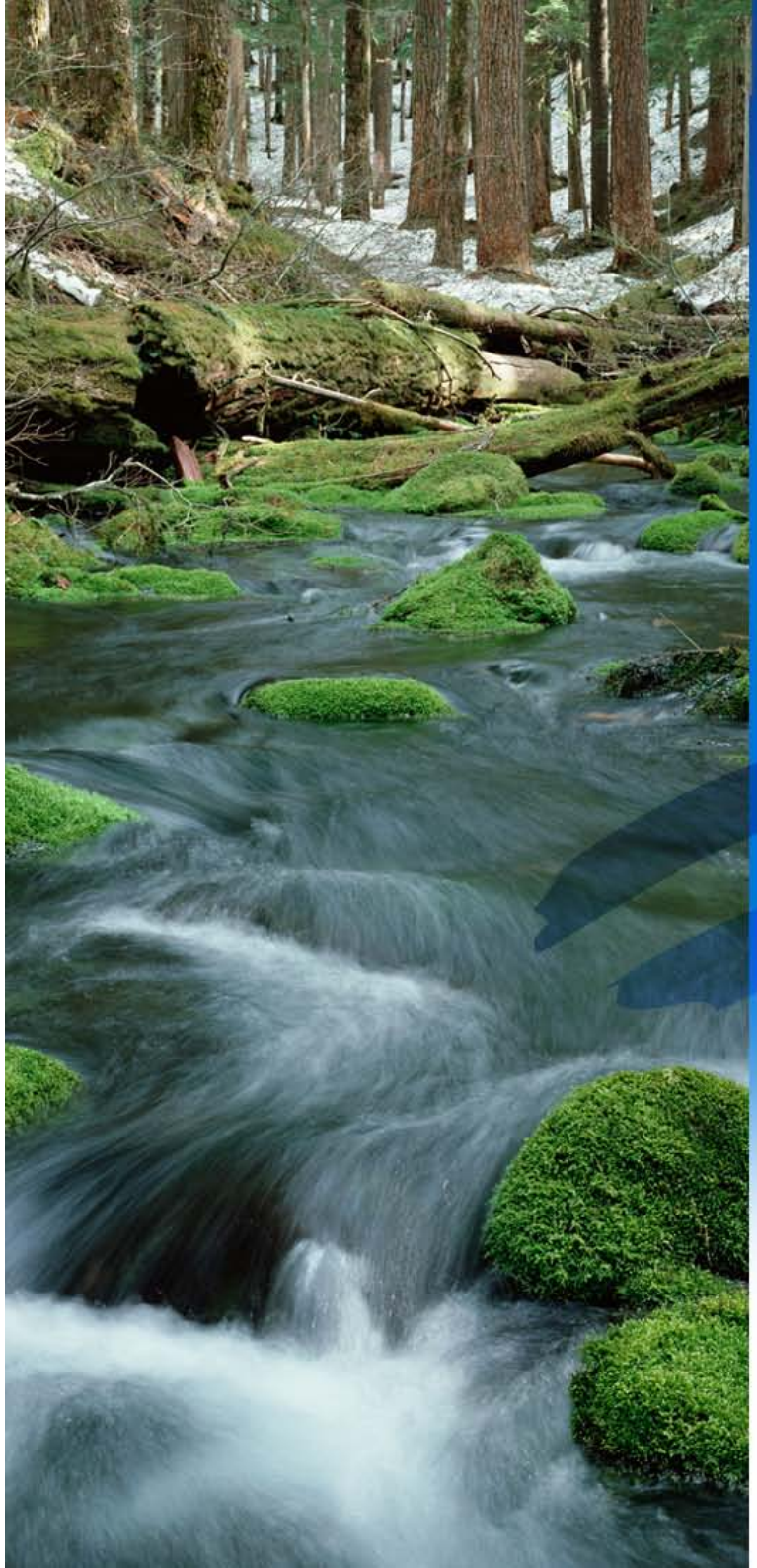


Sixth Taiwan-US-Japan Workshop on Water System Seismic Practices

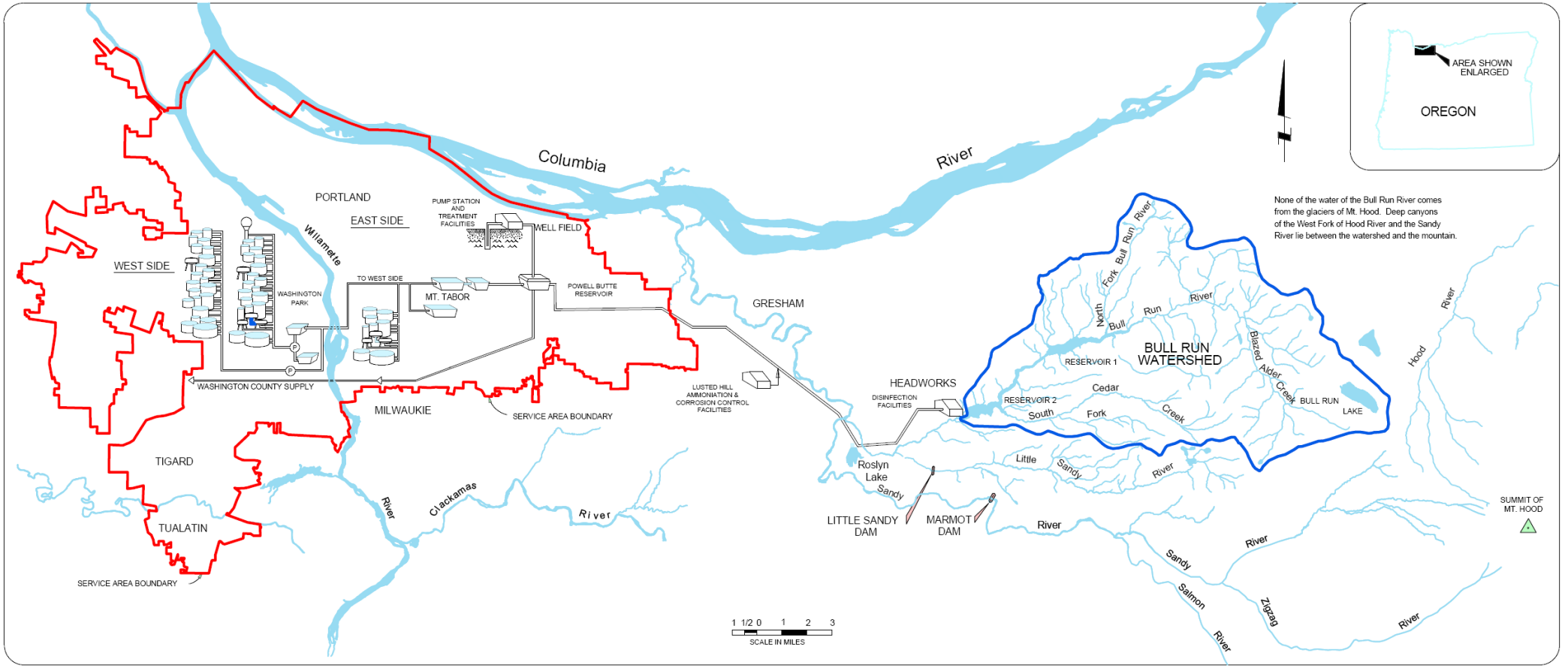
Seismic Upgrades of Portland Water Bureau's Water Supply System

Powell Butte 2 Reservoir
Sandy River Tunnel Crossing

Keith Walker / Senior Engineer
Portland Water Bureau
09/30/2009

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Portland's Water Supply System



WEST SIDE	EAST SIDE
47 TANKS	11 TANKS
25 PUMPS	18 PUMPS

Geology of Pacific Northwest

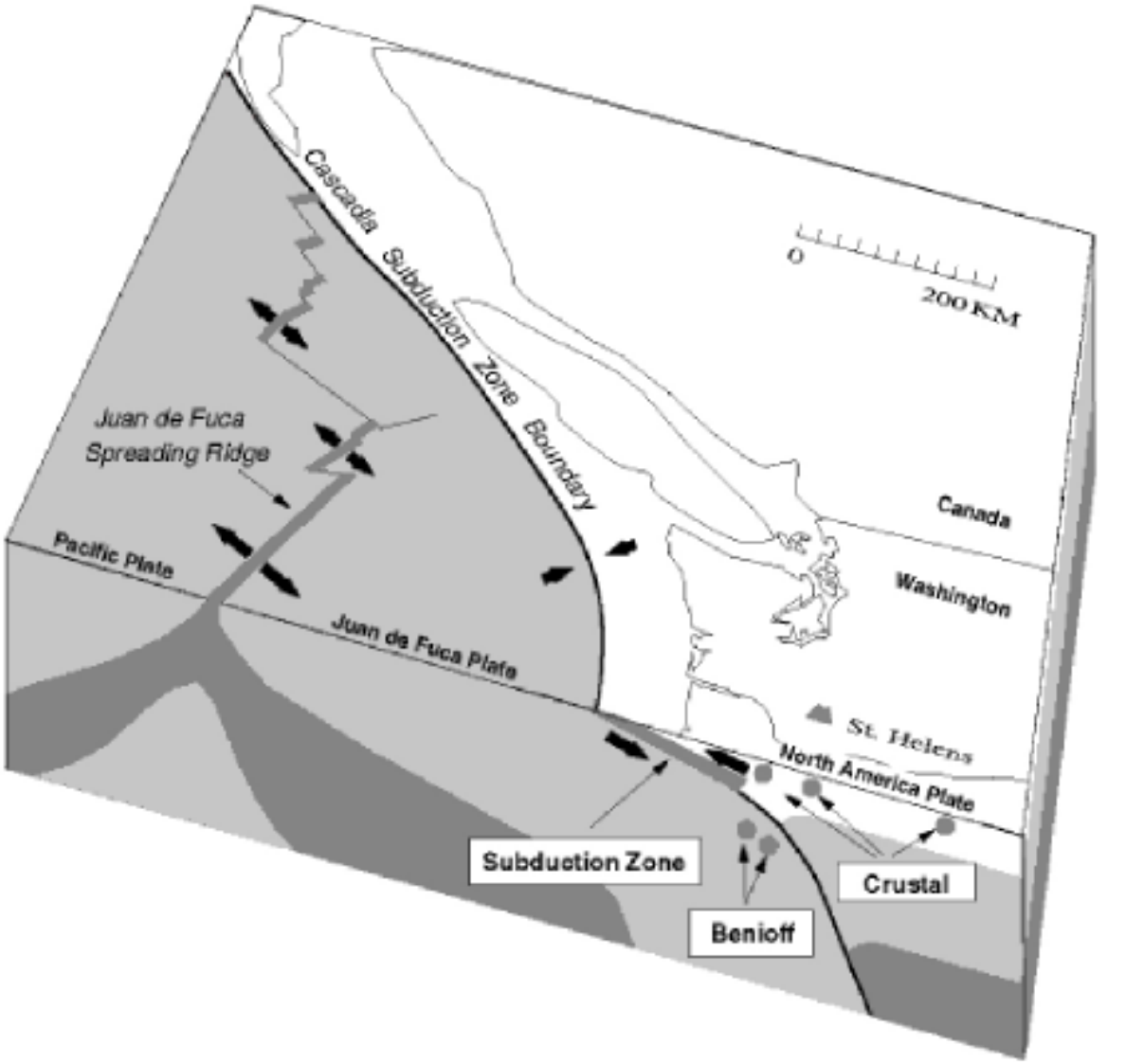


Figure 3-1. Seismic Hazard Sources

Powell Butte Reservoirs

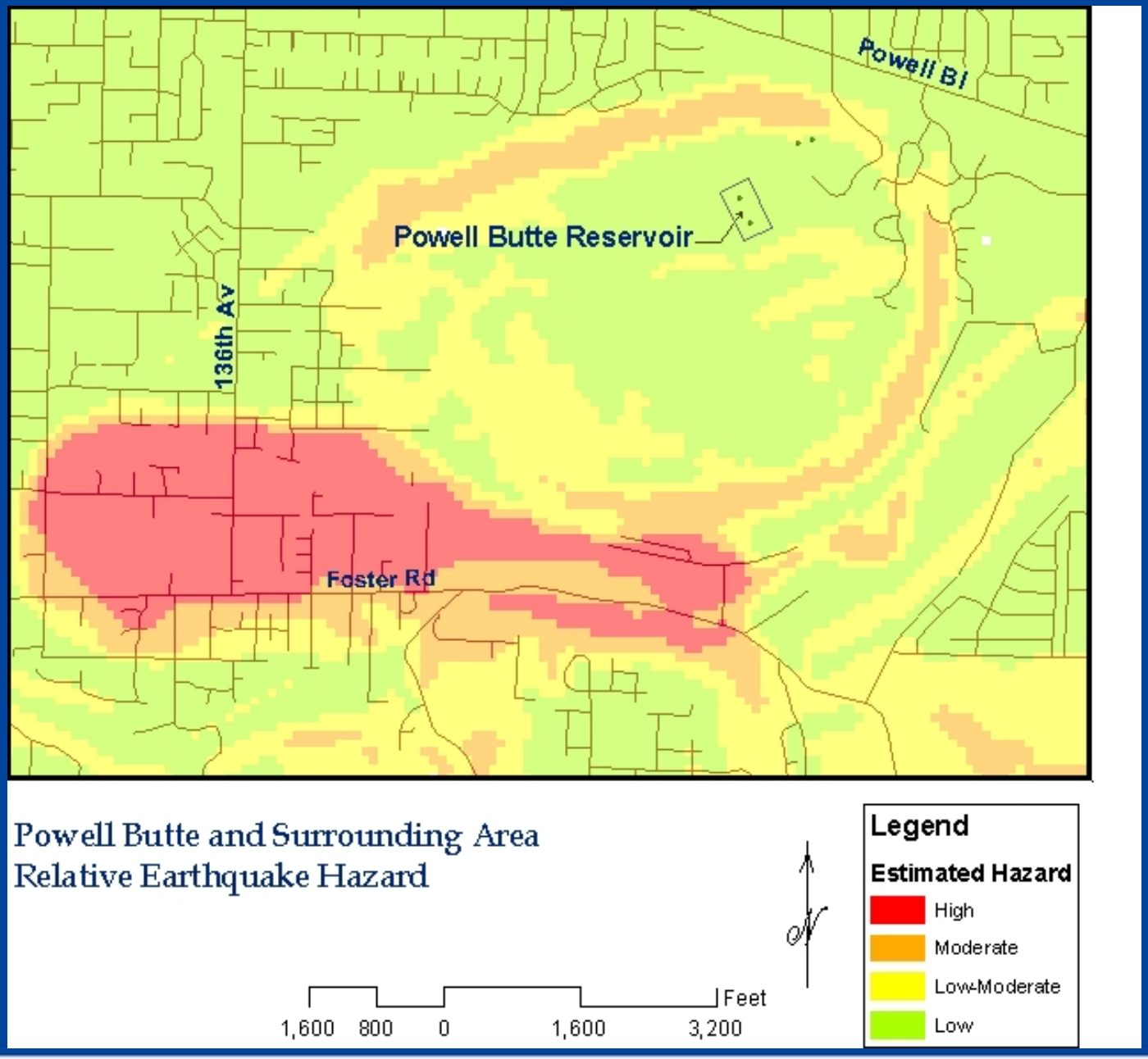
- Site purchased in 1925
- 50MG Powell Butte I constructed in 1979-1980 (photo, right)
- Also a Nature Park accessible to the public
- Master Plan for a total of 220MG ultimate capacity
- 50MG Powell Butte II construction begins in 2009, estimated completion in 2013

Powell Butte Today

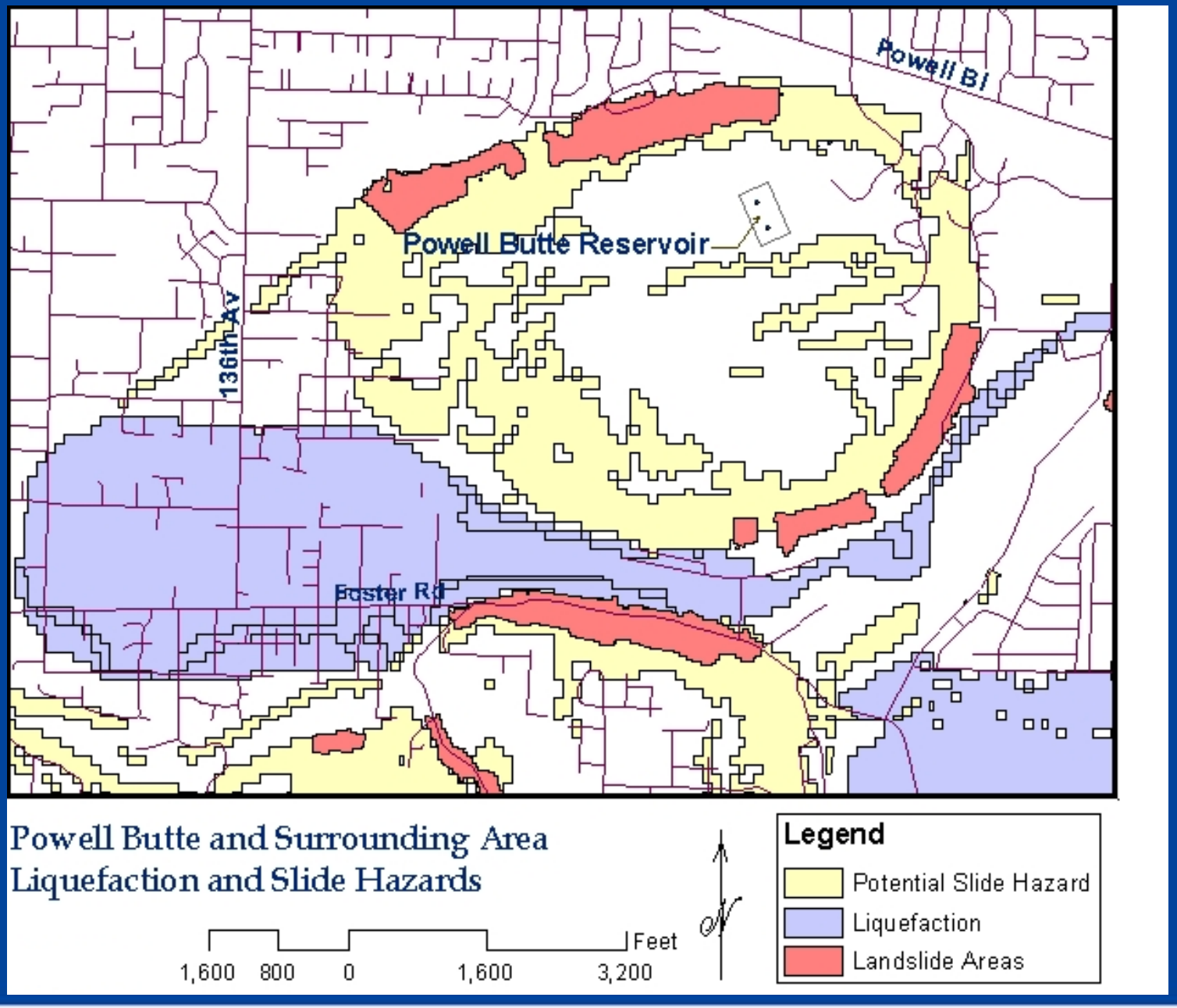
Overview of Reservoir I (existing) & II (future) Placement

LIDAR map of Powell Butte

DOGAMI Relative Earthquake Hazard



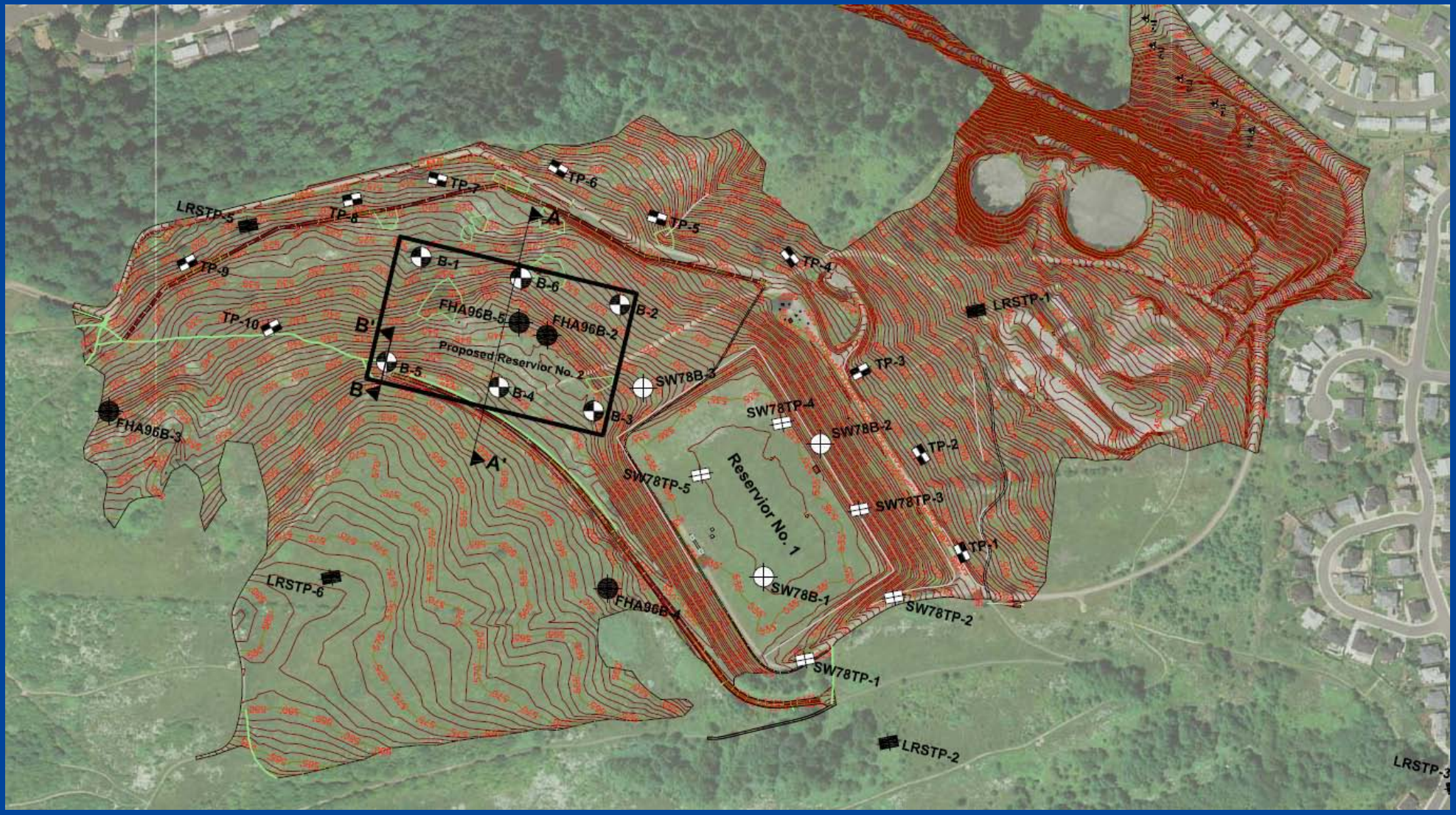
DOGAMI Liquefaction and Landslide Hazards



Initial Field Survey Work

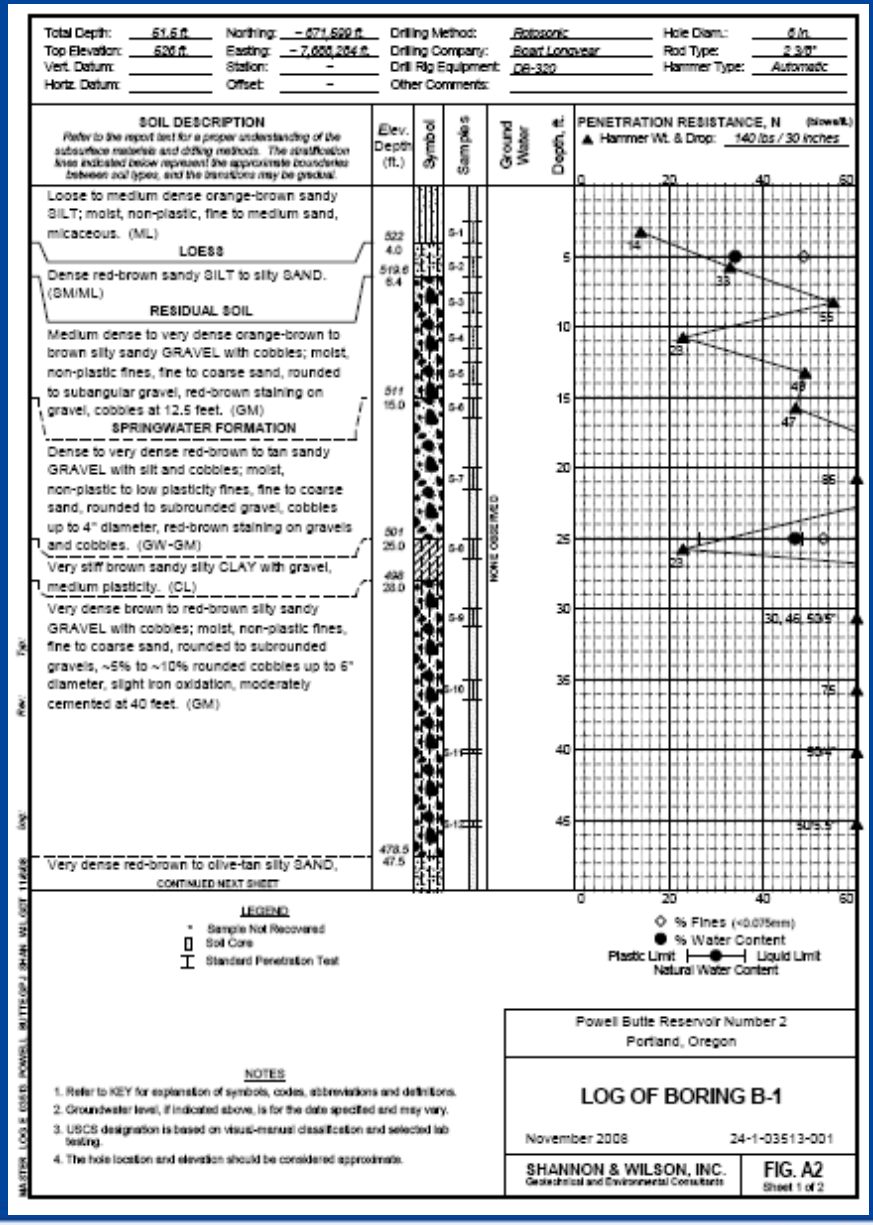
- Geological Reports
  - Regional Geology
  - Local faulting
  - Borings
  - Test Pits
  - Groundwater
  - Subsurface Conditions
- Horizontal Shear and Compressional Wave Velocity Profiling
- Aerial Photographic Documentation

Field Exploration Locations



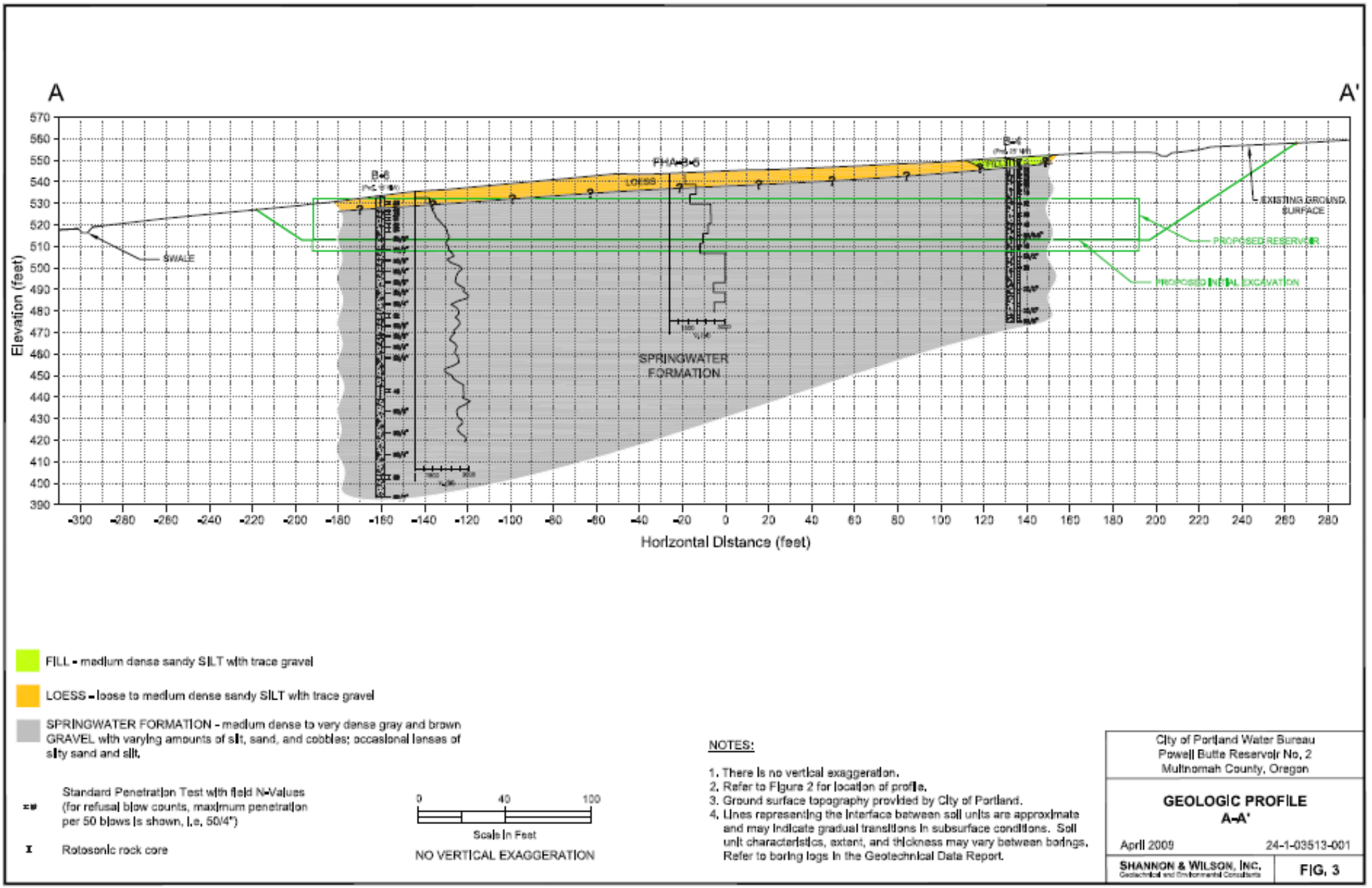
Geologic Sampling

- Test Pits and Borings
  - Five Rotosonic Borings, 50-90 foot depths
  - One Mud Rotary Boring, 140 foot depth (B-6)
  - Penetration Resistance measured
- Test Pits, 10 foot depth



Suspension Soil Velocity Measuring (Suspension Logging)

Geologic Profile



Powell Butte II Reservoir, Current Status

- Two Phase Project
- Phase I: Excavation, August 2009 to present
  - 350,000 cubic yards of material removed
  - 6-8 month duration
  - 100 truck trips/day, 30,000 vehicle trips total to haul spoils
- Phase II: Reservoir Design and Construction, 2010-2013
  - Buried reservoir, rectangular conventionally reinforced construction
  - Stormwater Overflow Improvements
  - Piping and vaulting improvements
- Estimated Cost $138M

Sandy River Crossing Project (SRX)

- Original Pin Truss Bridge constructed in 1893
- Carries Conduits 2 & 4 (52" & 66" diameters)
- Identification as highest priority to reduce risk of service interruption in delivery system

Vulnerabilities

- Seismic
- Existing Loading
- Flood Scour
- Lahars
- Malevolent Acts

Project Location

System Schematic Showing Conduit System

- Larsons Intertie completed 2001
- Hudsons Intertie completed 2004
- 22 conduit trestles in other locations

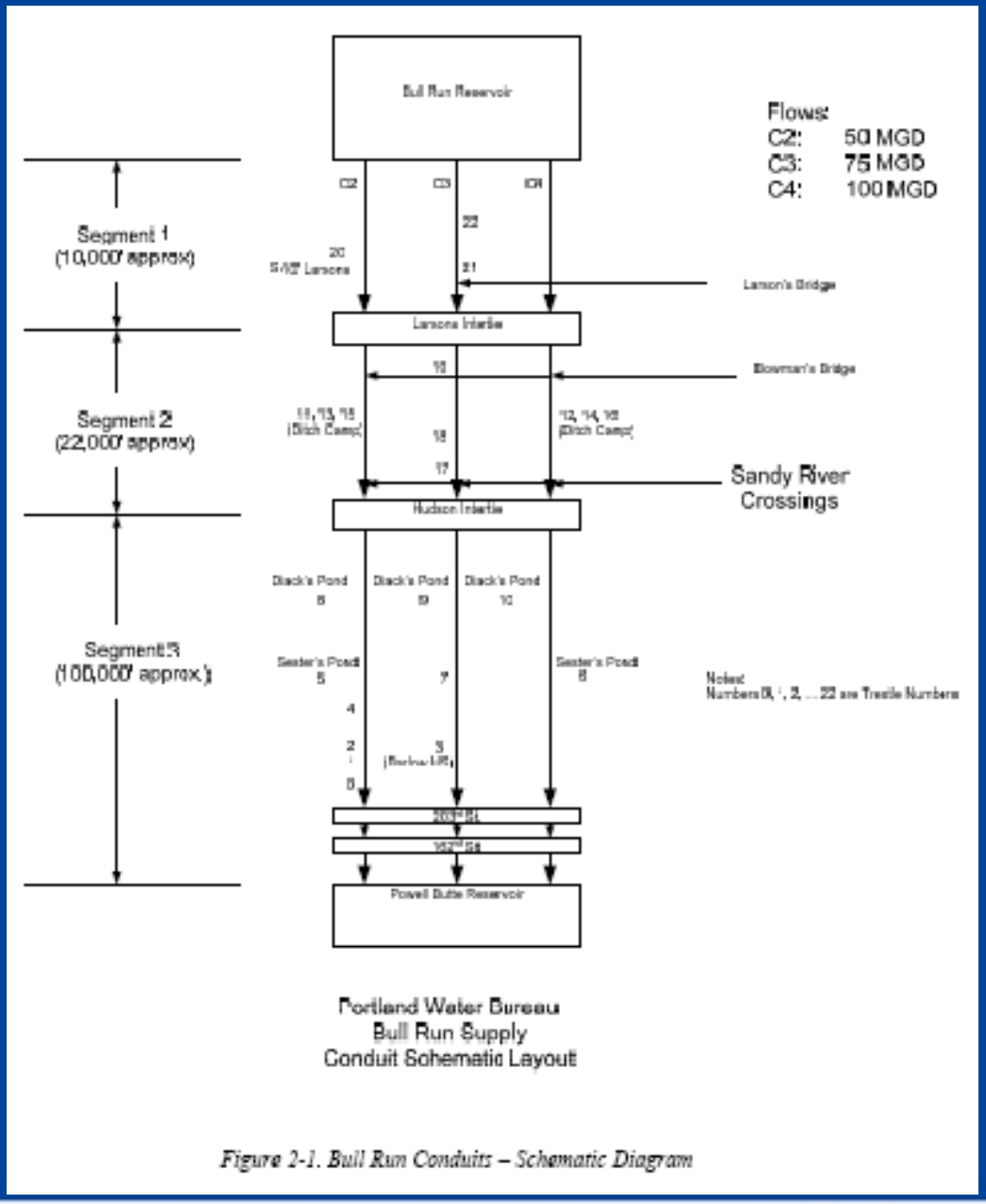
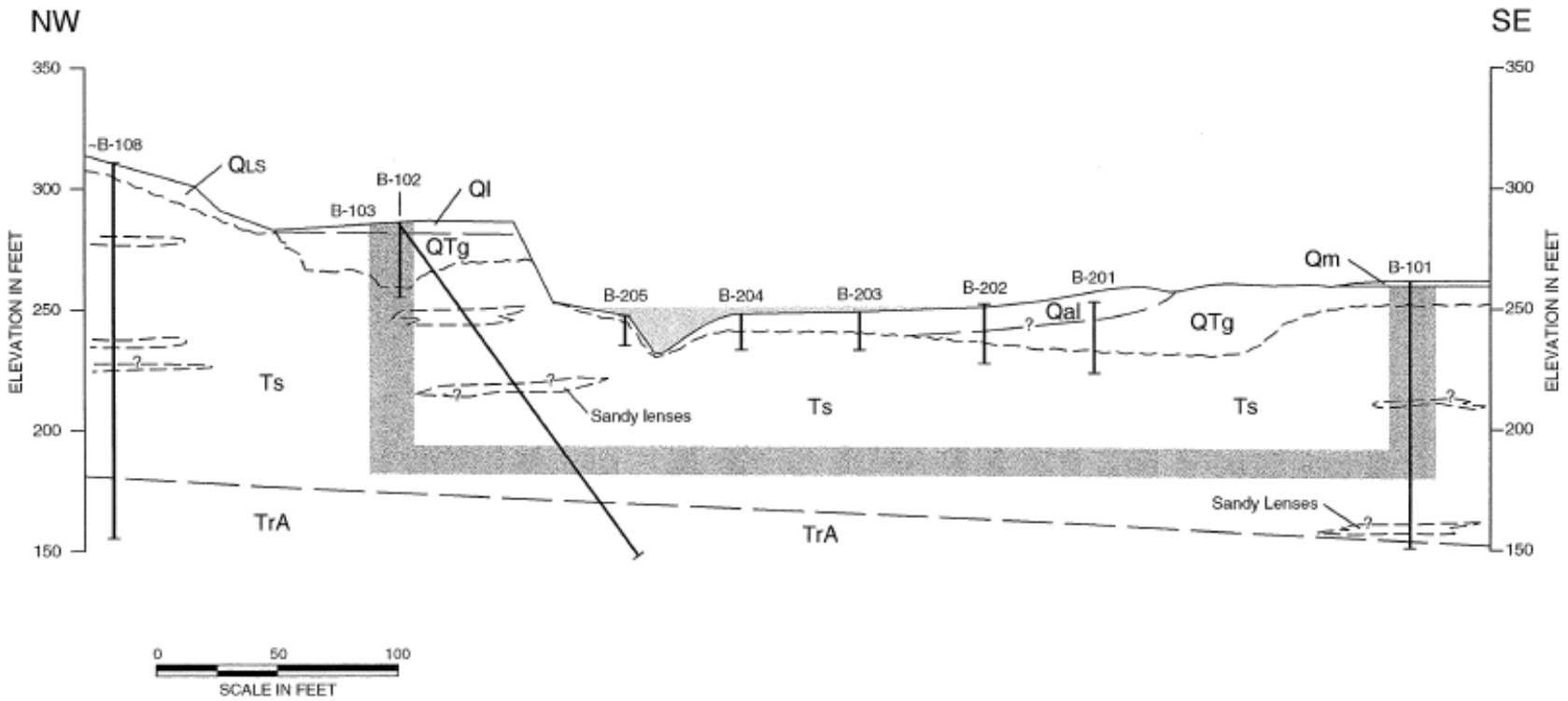


Figure 2-1. Bull Run Conduits – Schematic Diagram

Geologic Profile

BDR FIGURE 7:
Tunnel 2, Conduits 2 & 4 Profile



KEY

Qm	Manmade Fill	QTg	Terrace Sand and Gravel
Qal	Alluvium	Ts	Sandy River Mudstone
QLS	Landslide	TrA	Rhododendron Formation, Unit A
QI	Lahar Deposit		

1212-10FIGURE02.AW

CITY OF PORTLAND, BUREAU OF WATERWORKS

Cornforth Consultants, Inc.
10250 S.W. Greenburg Rd.
Portland, OR 97223

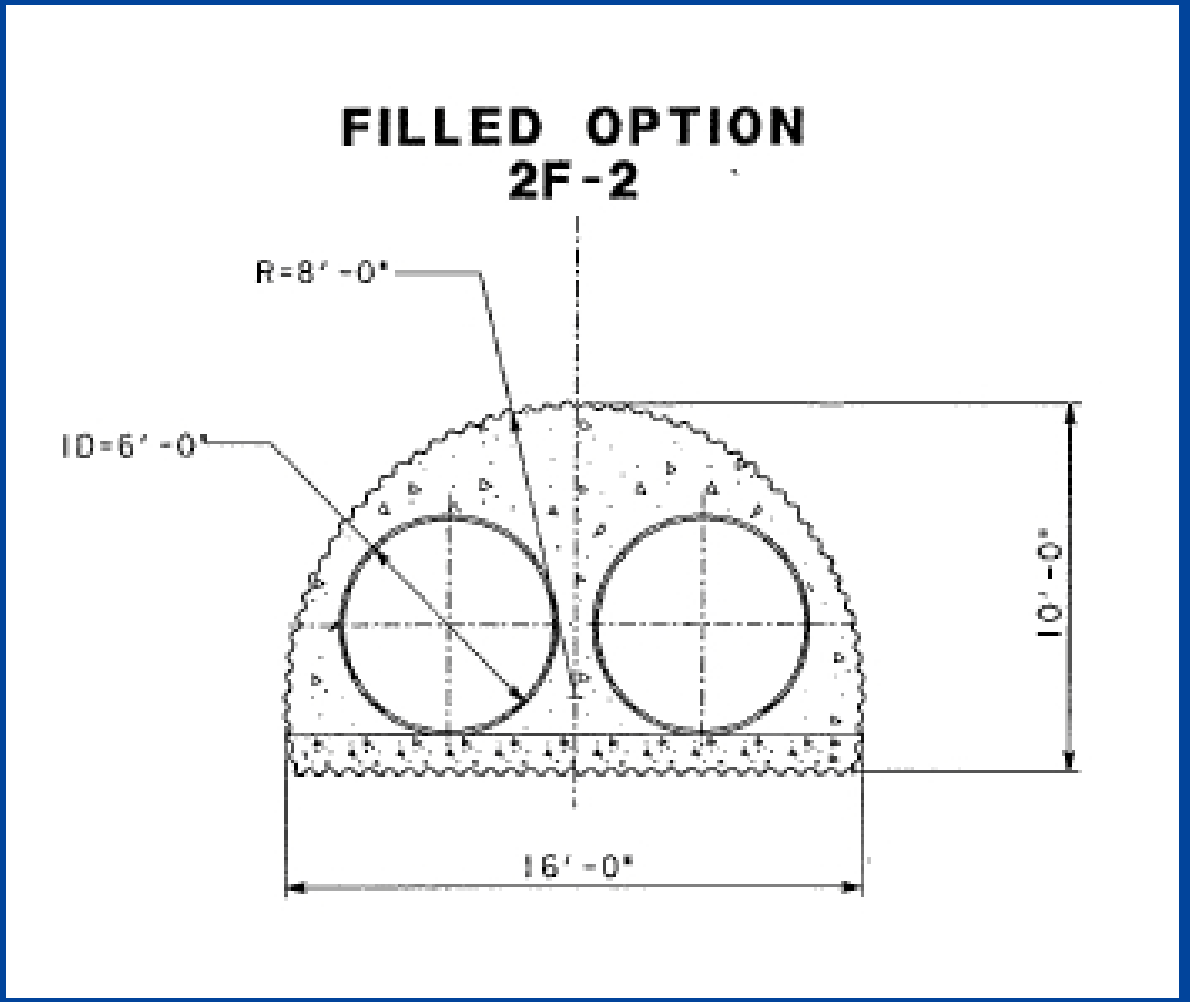
GEOLOGIC PROFILE
TUNNEL NO. 2

PRELIMINARY ENGINEERING REPORT
SANDY RIVER CONDUIT CROSSINGS

DATE MAR 2000
JOB NO. 1212
FIG. 4-6

Tunnel Design & Construction Features

- Portland Water Bureau's 1st Design Build Contract
- Estimated Cost $21M
- Hydraulic Capacity 165 MGD
- Tunnel Length: 450 feet
- Tunnel Depth: 90 feet
- 2 x 72" diameter conduits, backfilled with grout
- Three basic components:
  - Tunnel
  - East Shaft
  - West Shaft



East Shaft

- Initial Construction
- 30 foot diameter shaft for insertion of excavation & tunneling equipment
- Surface excavated first 15 feet, and shored
- Excavation to 80 feet depth shotcreted

East Shaft (continued)

West Shaft

- Two individual west side shafts, one for each conduit.
- Outer casing 3m diameter
- Inner Casing 2.5m
- Annular Space injected with Grout for rigidity

Tunnel

- Conventional Tunneling Method
  - Excavation through Sandy River Mudstone and Sandy lenses
  - Lattice Truss support system
  - Layered Shotcrete applications
  - Laser Alignment
  - Ventilation
  - Safety

Tunnel (continued)

Tunnel (continued)

Sandy River Crossing Status

- East and West Shafts Complete
- Tunnel Complete
- Conduits to be installed
- Performance Testing
- Backfill with Grouting

Questions?

Acknowledgements:

•Powell Butte II Reservoir:

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–Jerry Moore

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–Tim Collins

–Terry Black

–Brenda Nelson

–Bill Reed

–Julian Ribera

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