

# Enel Cove Fort, LLC

## Change Application a38403 (71-4940)

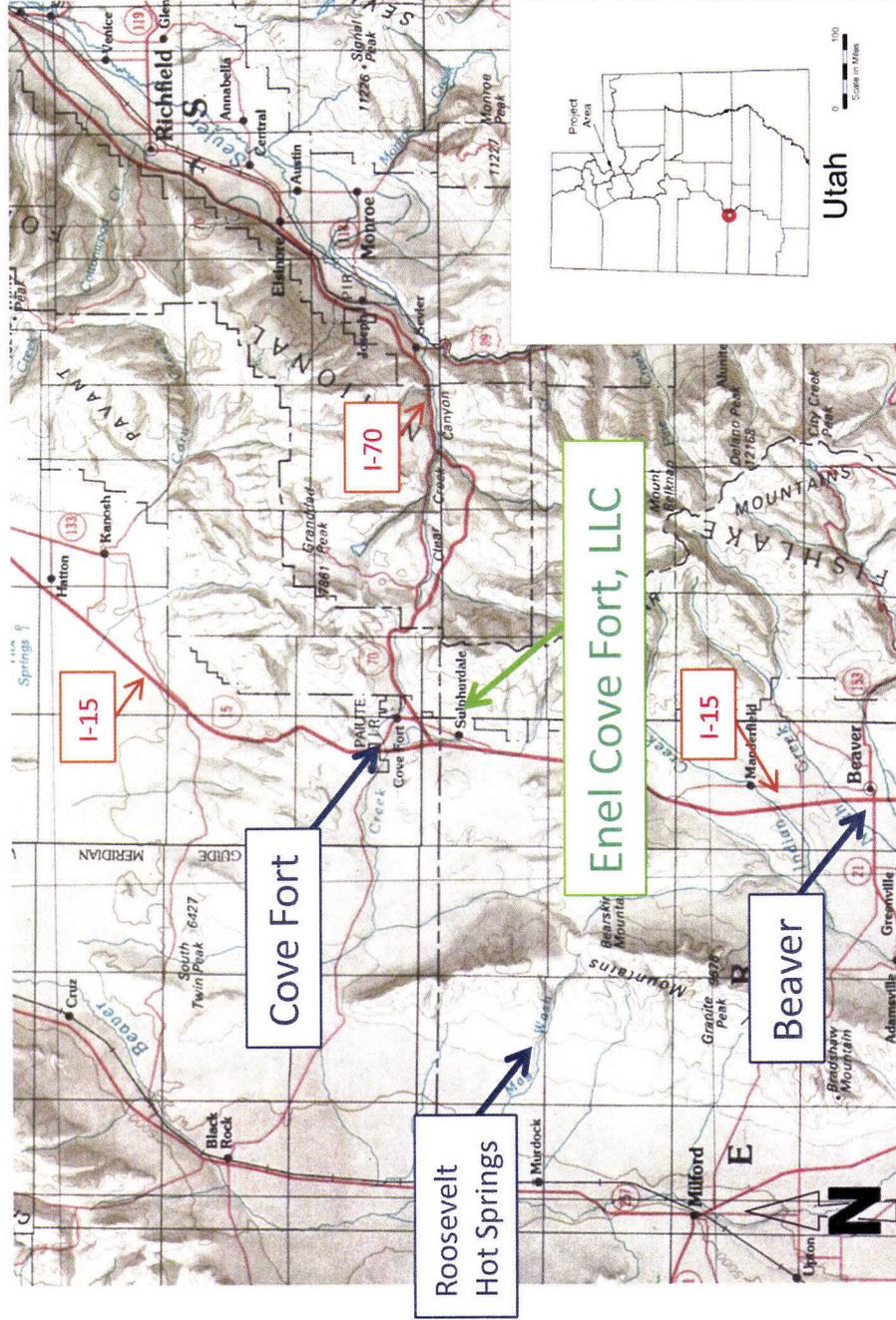
- Introduction
- Review
  - Purpose of application
  - Hydrogeology of application
  - Voluntary groundwater monitoring program
- Address concerns raised in protests
- Summarize opinion of impacts

HEARING SUBMITTAL TO  
DIVISION OF WATER RIGHTS  
Right No.: 71-4940(a38403)  
Date: 1/30/2013  
Submittee: Applicant  
ENEL

# Bill Loughlin, P.G.

- Consulting Hydrogeologist
- Education
  - B.S. in Geology and M.S. in Hydrogeology
- Experience
  - More than 30 years
- Loughlin Water Associates, LLC
  - Four professionals (hydrogeologists and engineers)
  - We help clients find, develop, assess, protect, and manage water resources

# Regional Map



# Change Application a38403 Modifies Approved Water Right 71-4940

- Water right 71-4940
  - Filed on August 26, 2005
    - No protests
  - Approved June 27, 2011
  - Allows diversion and return of 35 cubic feet per second (cfs) of geothermal fluid
    - No geothermal fluid is consumed from this water right
  - 15 Points of Diversion (PODs)
  - 15 Points of Return (PORs)
  - PODs and PORs are same locations

# Intent of Change Application a38403 (71-4940)

- Use binary cycle technology
- Change from steam-dominated to liquid-dominated geothermal fluid
- Propose additional well locations based on
  - Review of previous operations and data
  - Recent
    - Geologic and geophysical studies
    - Drilling and testing program

# a38403 Versus 71-4940

	71-4940 (here- tofore)	a38403 (here- after)	Difference
<b>Geothermal Fluid Diverted</b>	<b>35 cfs</b>	<b>35 cfs</b>	<b>None</b>
<b>Geothermal Fluid Returned</b>	<b>35 cfs</b>	<b>35 cfs</b>	<b>None</b>
<b>Geothermal Fluid Consumed</b>	<b>0 cfs</b>	<b>0 cfs</b>	<b>None</b>

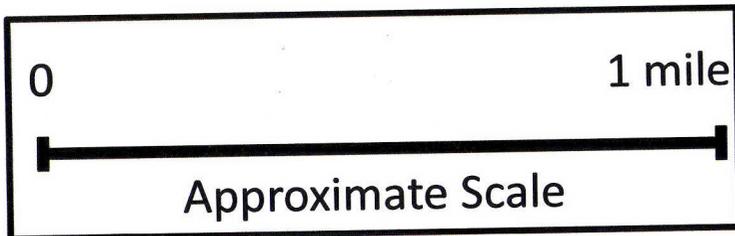
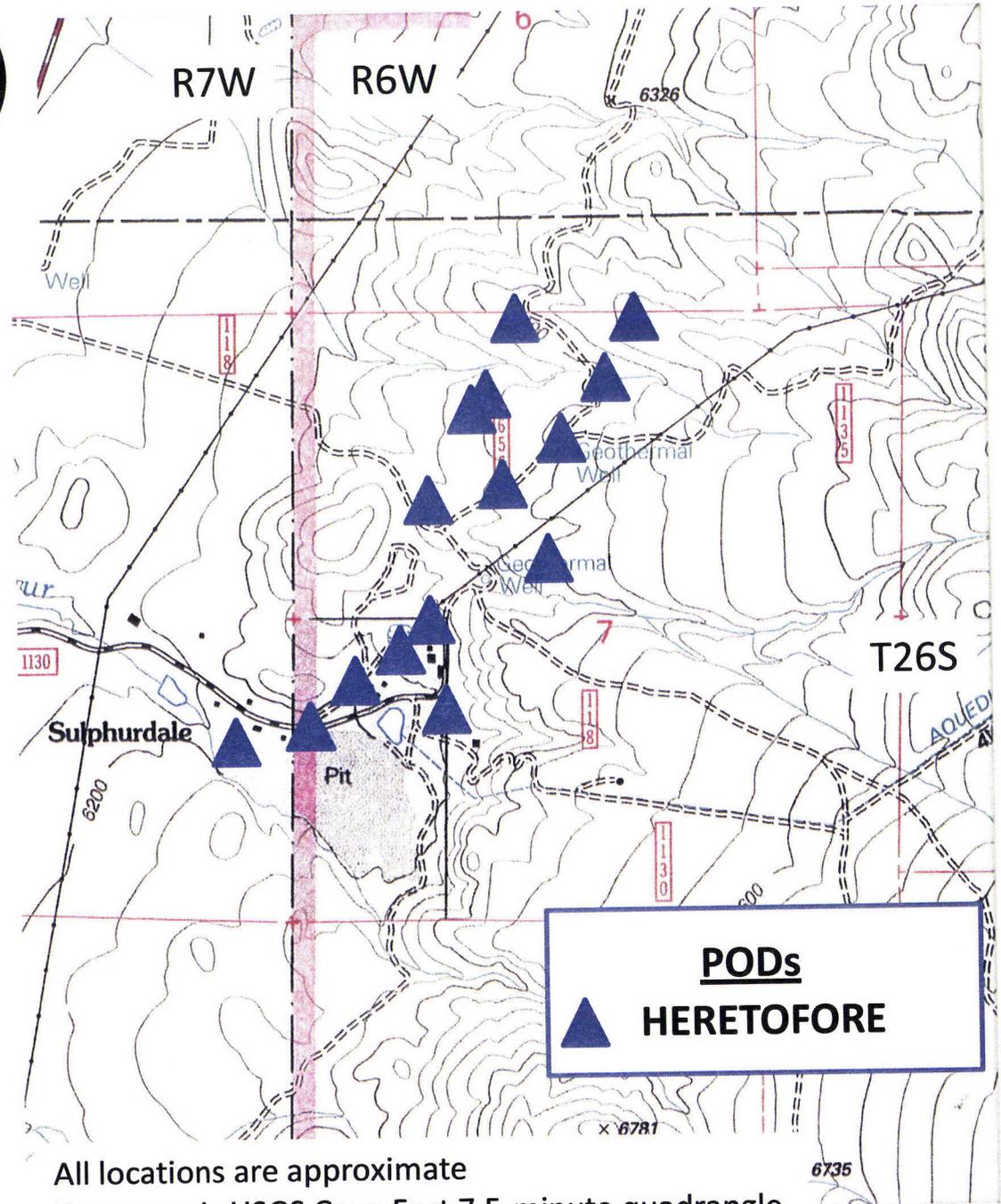
# a38403 (71-4940)

## Points of Diversion (PODs) - Production Wells

- 25 Hereafter PODs
  - 21 existing wells
    - Drilled under 71-4940 and other water rights and permits
  - 4 new wells
    - Not drilled – contingency locations

# a39403(71-4940)

## Heretofore PODs

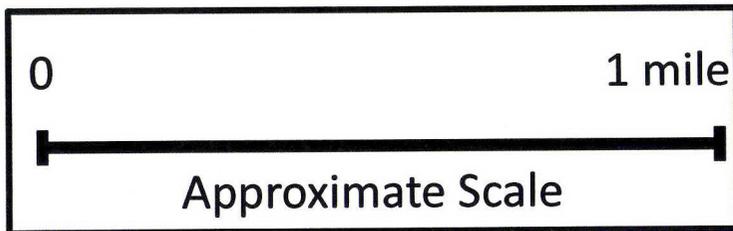
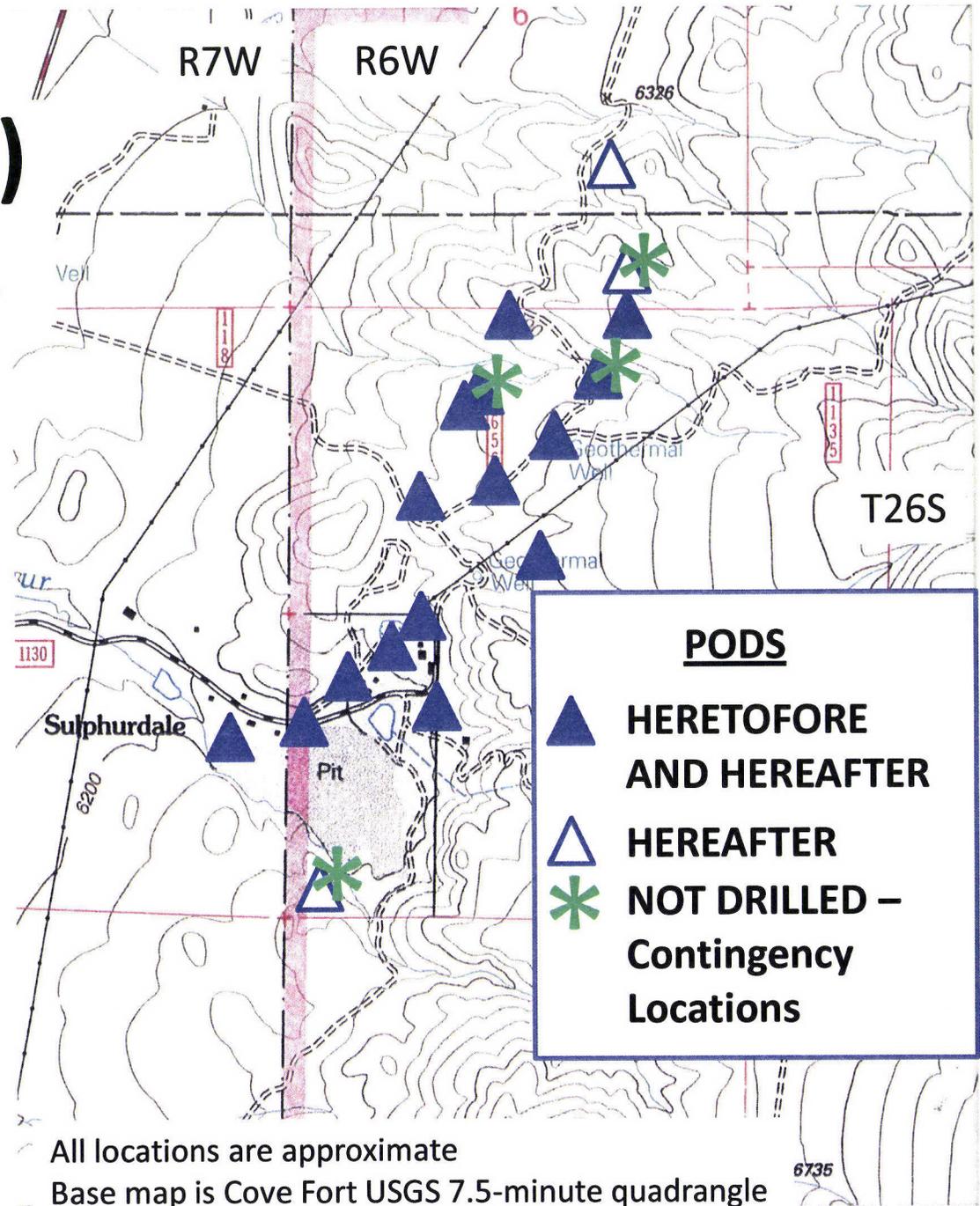


All locations are approximate  
- Base map is USGS Cove Fort 7.5-minute quadrangle  
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# a38403 (71-4940) Hereafter PODs



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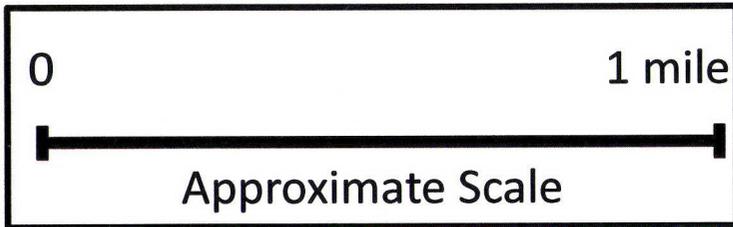
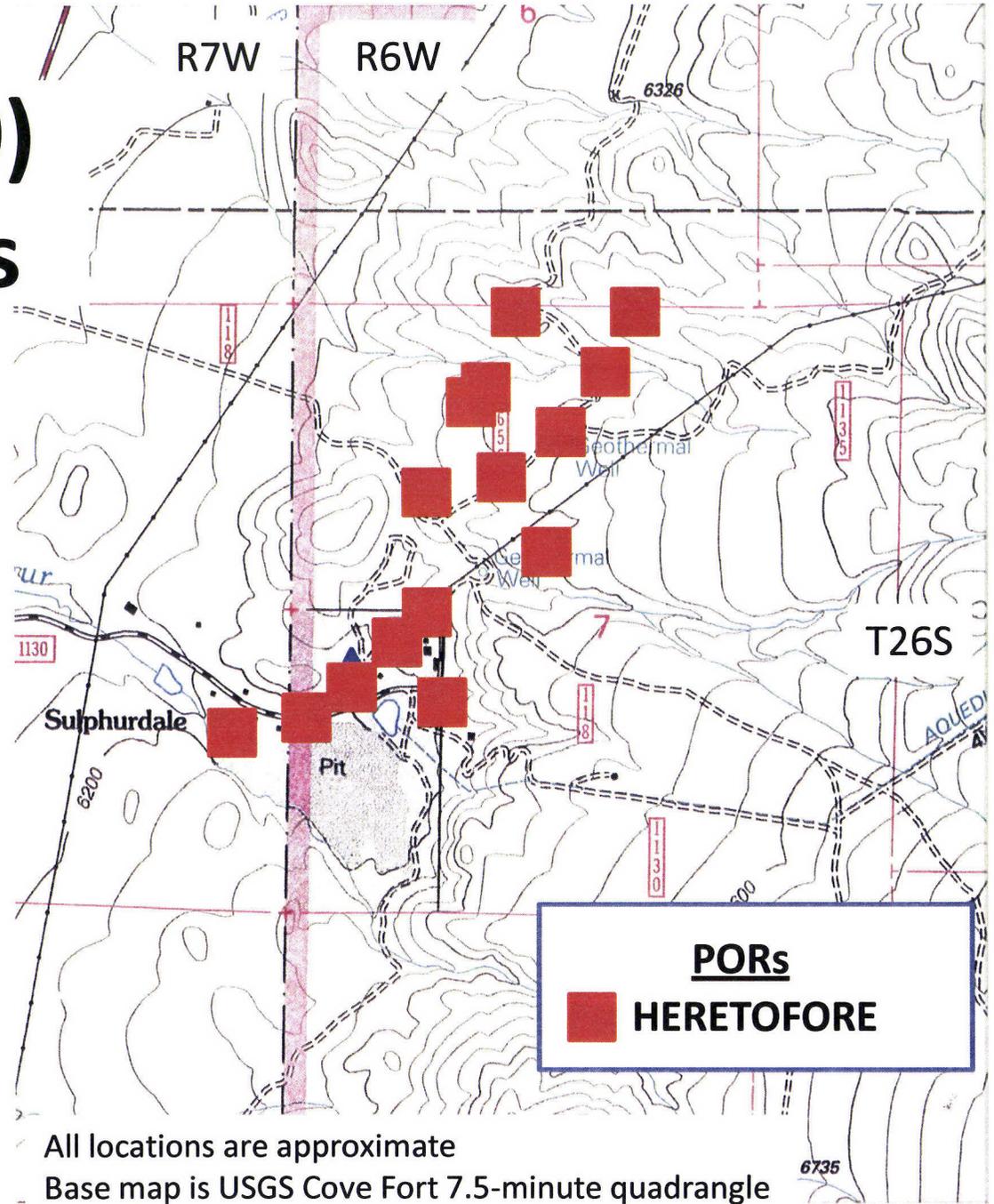
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## Points of Return (PORs) – Injection Wells

- 20 hereafter PORs
  - 15 are the same as the 15 heretofore PORs
  - 5 new PORs
    - 3 existing wells
      - Already drilled under 71-4940 and other water rights and permits
    - 2 new wells
      - Not drilled – contingency locations

# a38403 (71-4940) Heretofore PORs



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All locations are approximate  
Base map is USGS Cove Fort 7.5-minute quadrangle

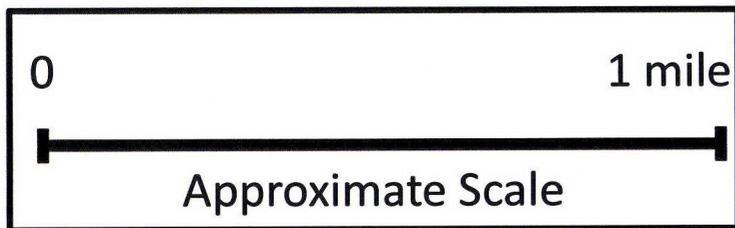
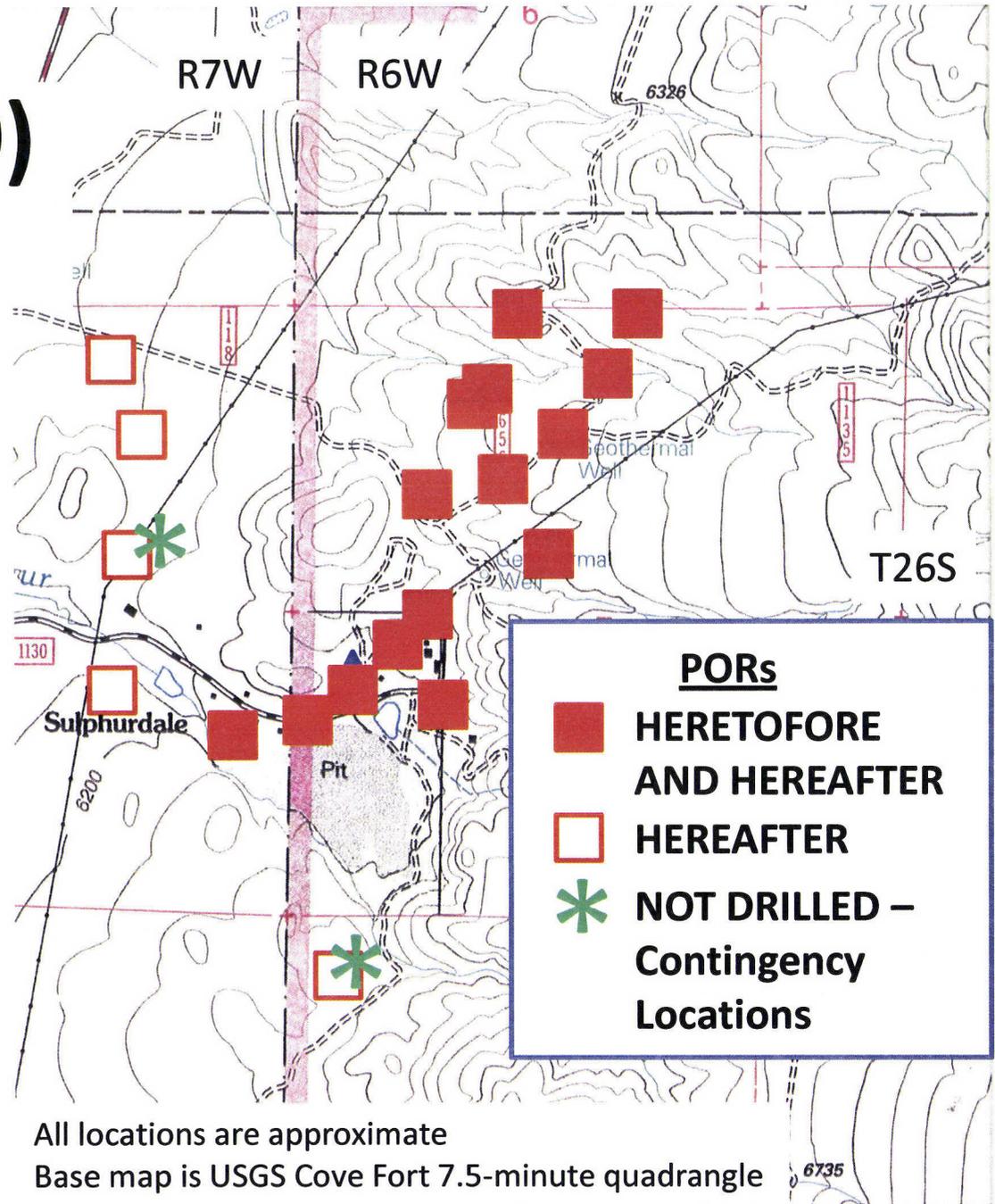
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# a38403 (71-4940) Hereafter PORs



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# Why New PODs and PORs?

- Actual surveyed locations versus proposed locations
- Change from steam-dominated to liquid-dominated geothermal fluid
- Plug and abandon steam wells
- Improved knowledge of resource results in better well locations and depths

# Approval of Change Application a38403(71-4940)

- Geothermal fluids are available
- No change in allowed diversion and return of 35 cfs
- No consumed geothermal fluid
  - Any consumption in overall project allowed under other existing approved water rights
- Application is
  - The addition of 3 new PODs and 5 new PORs
    - In same general area of heretofore PODs and PORs
  - More accurate legal description of existing PODs and PORs
- Change application will not impair existing water rights

# Geothermal Reservoir

- Characteristics known from
  - Drilling and logging of many wells
  - Multi-day high capacity production and injection tests of many wells
  - Extensive geologic and geophysical studies
  - Operation of power plant from mid 1980s to early 2000s

# Geothermal Reservoir(continued)

- Highly fractured and highly permeable Paleozoic-age sedimentary quartzite and carbonate rocks
- Capped by low-permeability clay-rich overlying Tertiary-age volcanic rocks
- Bounded and compartmentalized by faults

# Geothermal Reservoir (continued)

- Production wells about 2,500 to 4,000 feet deep
- Injection wells about 4,400 to 6,000 feet deep
- Very little groundwater in clay-rich low-permeability volcanic rocks that overlie geothermal reservoir
- Static geothermal fluid level is about 1000 to 1400 feet deep (elevation of about 5100 feet)
  - At least 900 feet below static groundwater level in shallow aquifer (elevation of about 6000 feet)

# Geothermal Reservoir (continued)

- Temperature about 300 to 350 degrees Fahrenheit (F)
- Total dissolved solids (TDS) about 4000 to 5000 milligrams per liter (mg/L)

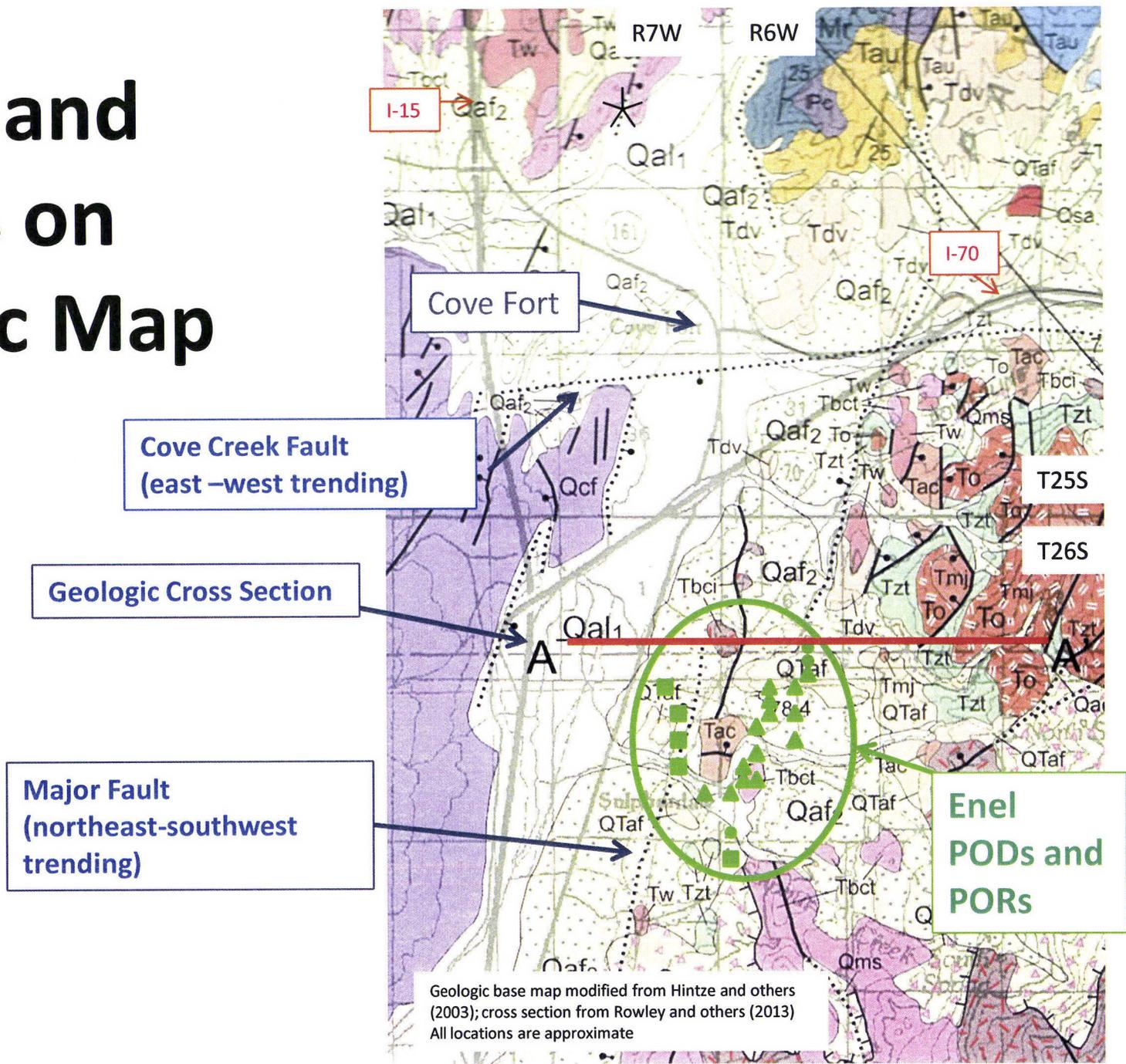
# Non-Geothermal (Shallow) Aquifer

- Used for water supply
- Used by protestants
- Subject of recent detailed study by Stephan Kirby (2012) of the Utah Geological Survey (UGS)

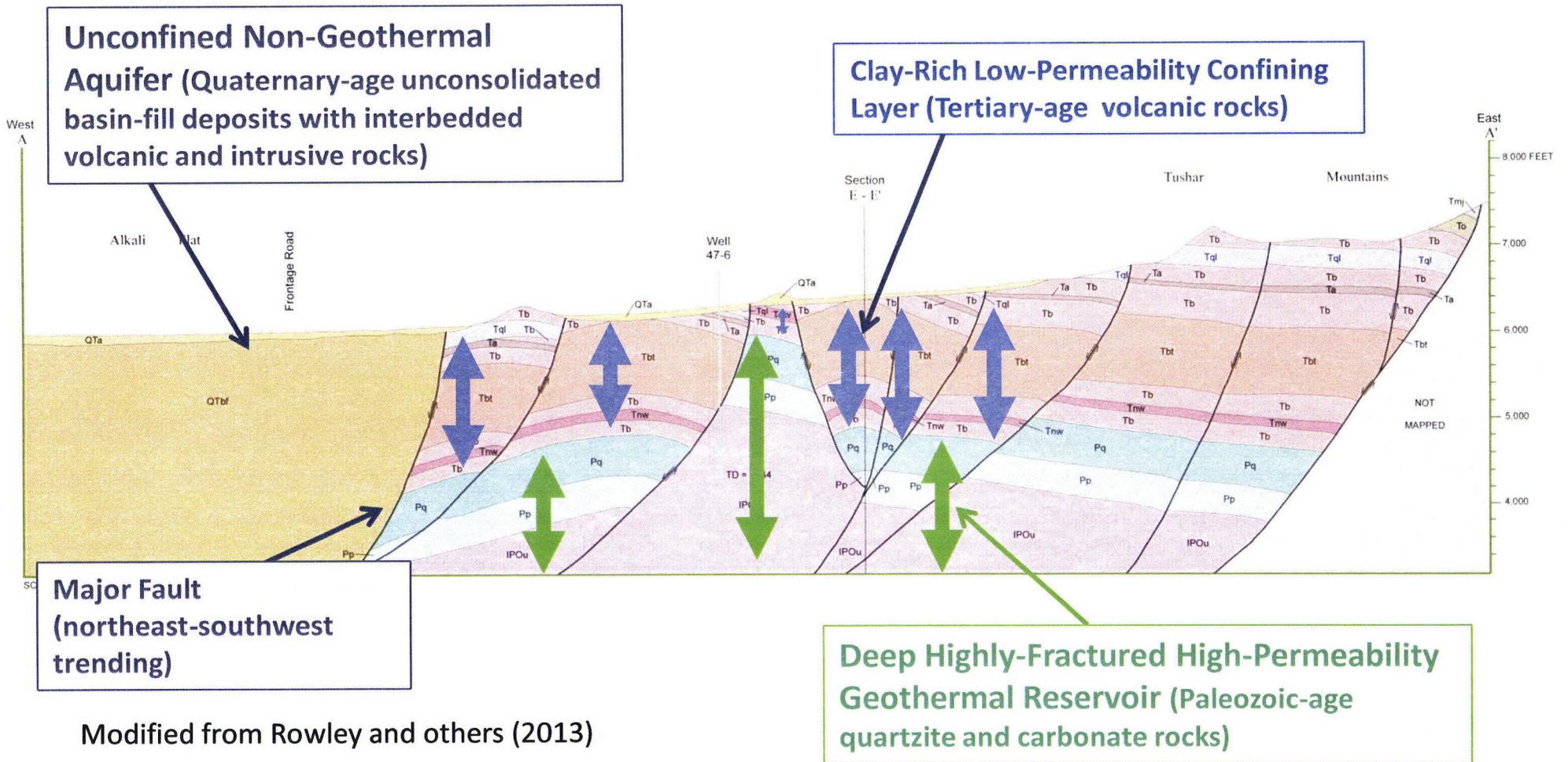
# Non-Geothermal (Shallow) Aquifer (Continued)

- Unconsolidated basin-fill deposits and interbedded volcanic and intrusive rocks
- Good quality groundwater with TDS generally less than 1000 mg/L
- Temperatures generally less than about 70 degrees F in Cove Fort area

# PODs and PORs on Geologic Map



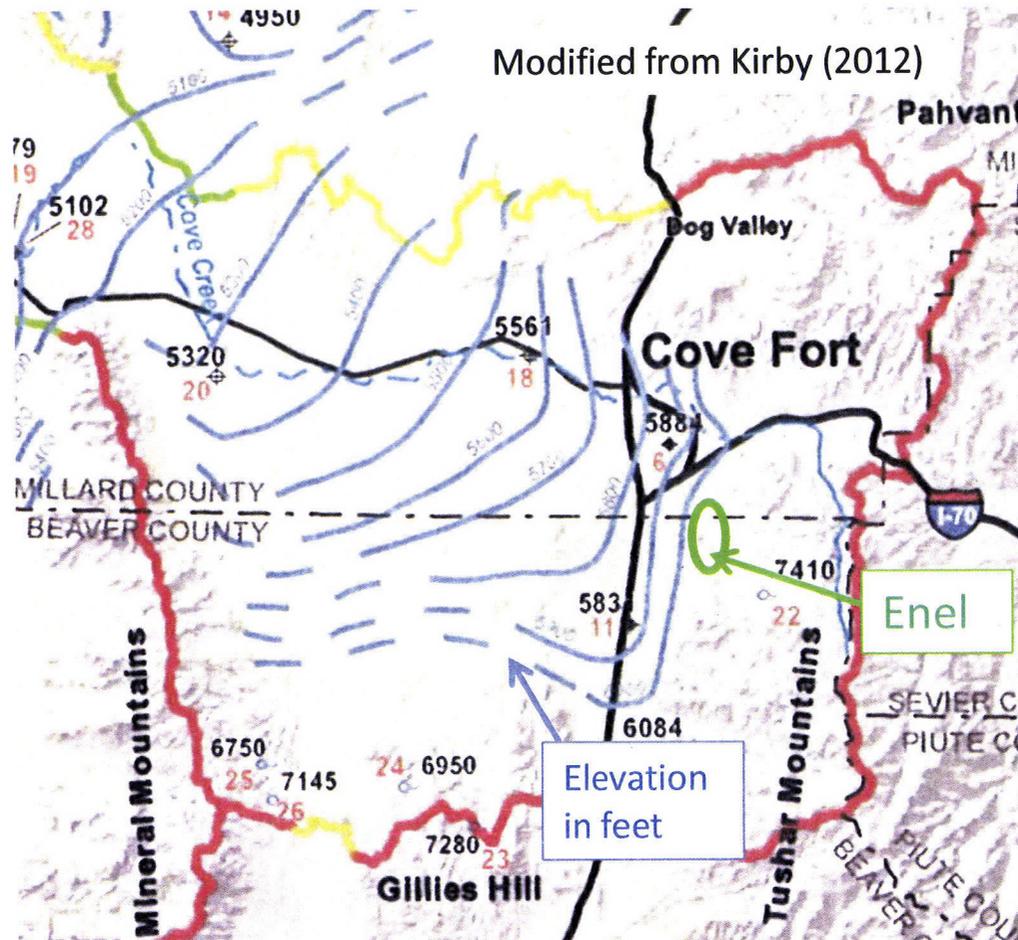
# Geothermal Reservoir versus Non-Geothermal Aquifer



Modified from Rowley and others (2013)

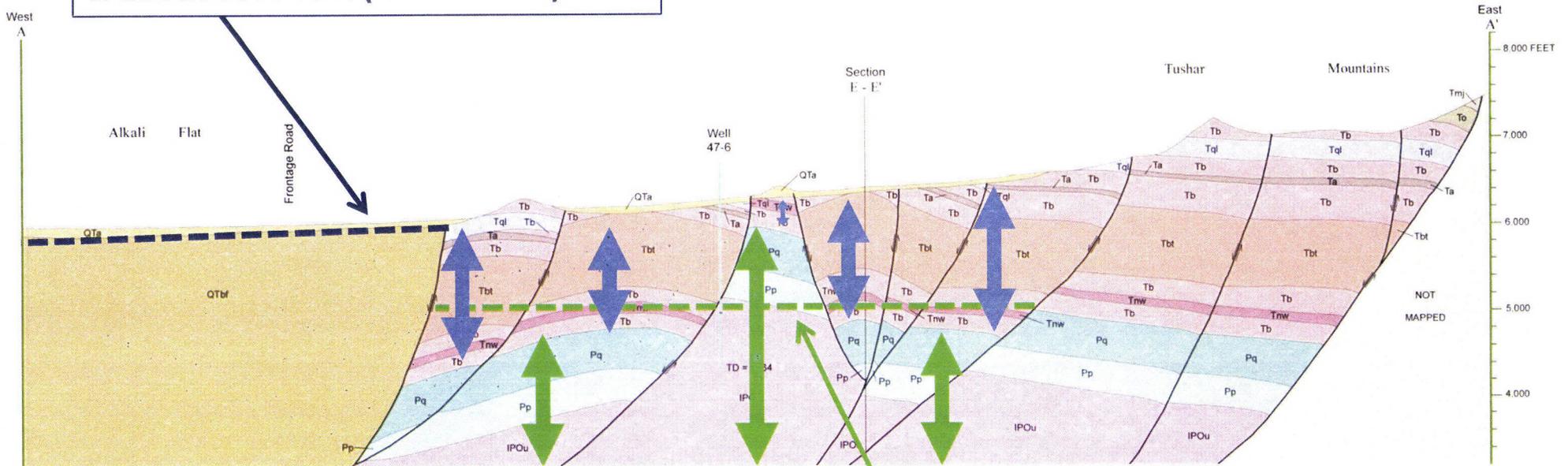
No vertical exaggeration

# Potentiometric Surface in Shallow (non-geothermal) Aquifer



# Hydrostatic Head Elevations

Groundwater Elevation in Unconfined Non-Geothermal Aquifer is about 6000 feet (falls to west)

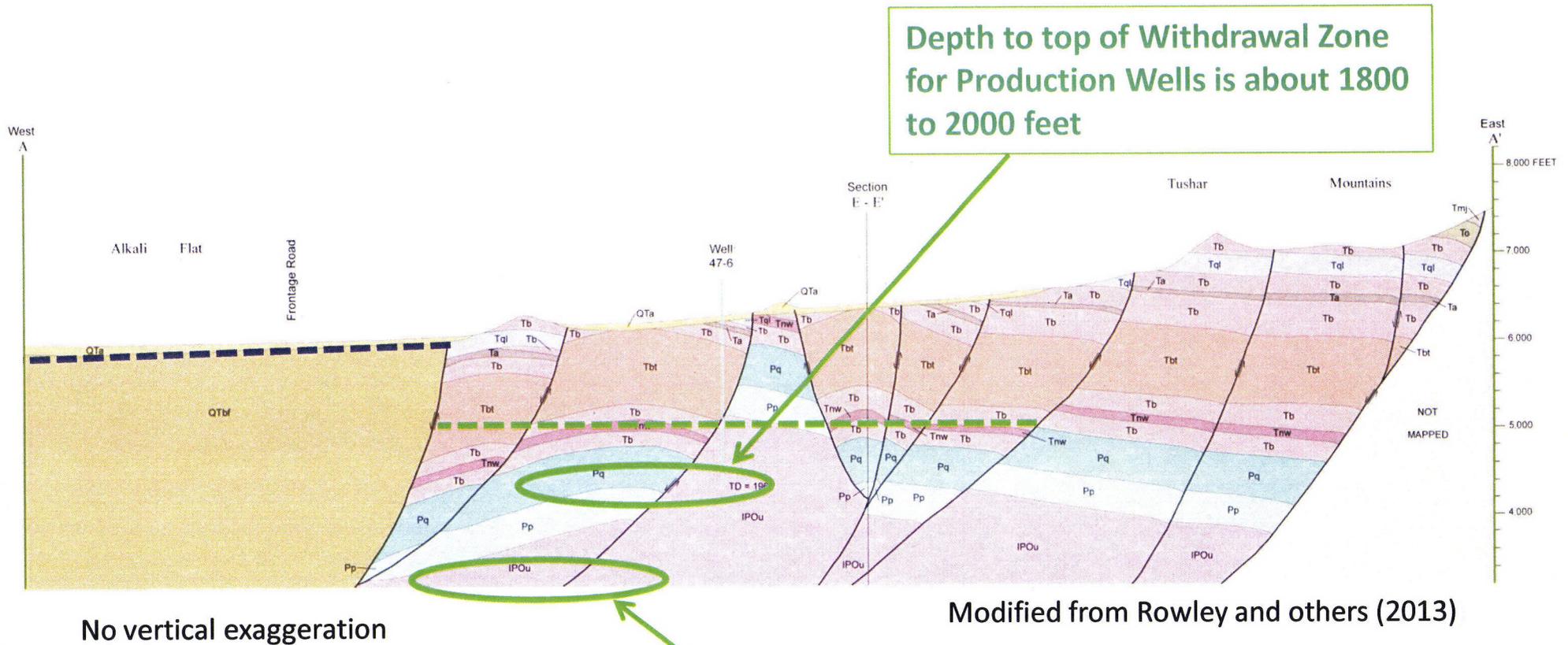


No vertical exaggeration

Modified from Rowley and others (2013)

Geothermal Fluid Elevation in Geothermal Reservoir is about 1000 to 1400 feet below ground surface (elevation about 5100 feet)

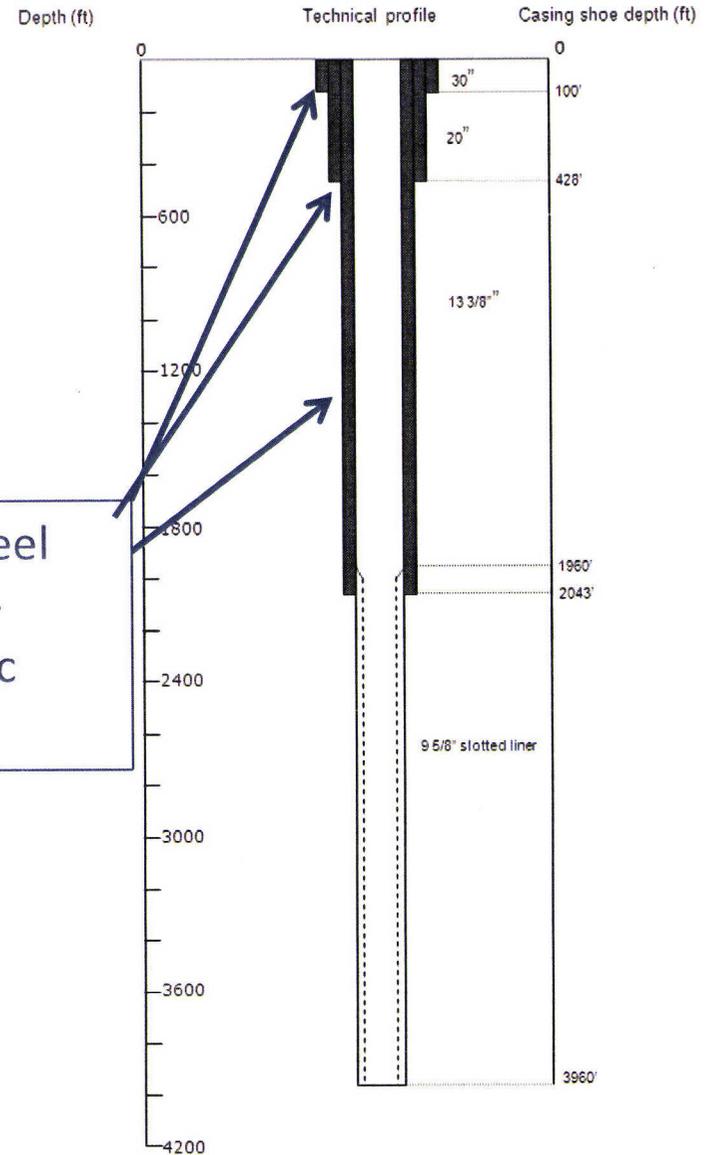
# Production and Injection Zones



# Typical Production Well Construction

Cement seals and steel casings through low-permeability volcanic confining layer

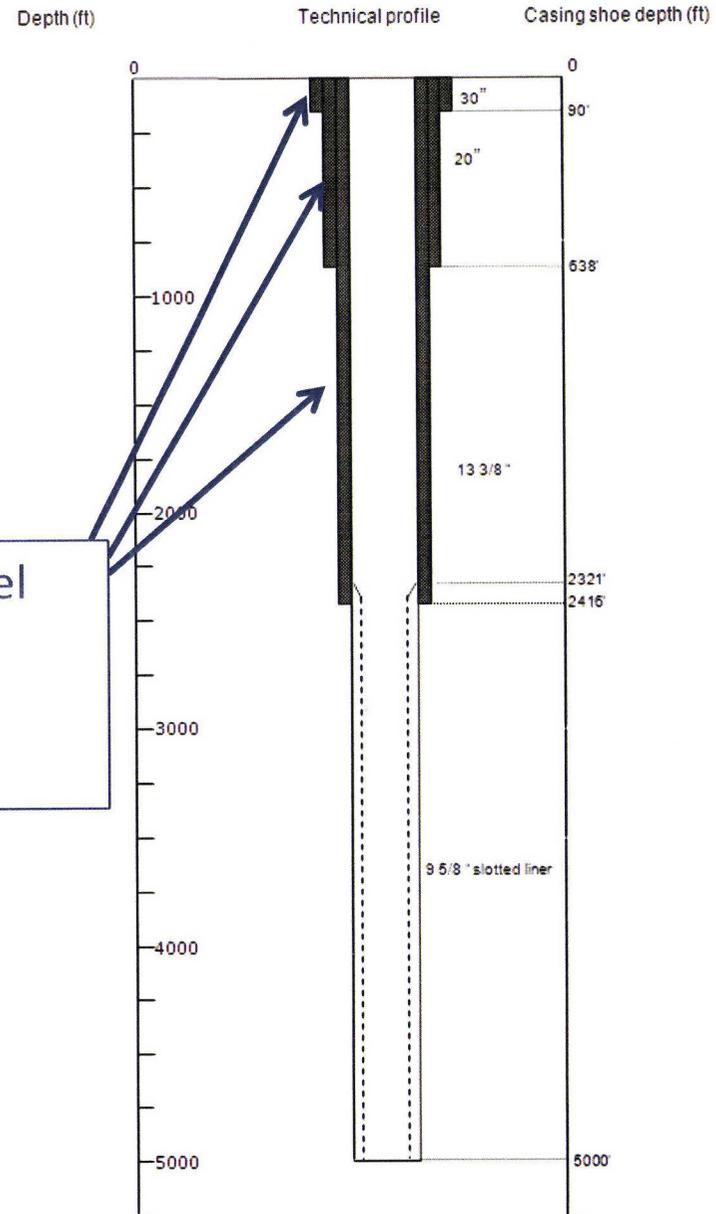
Note: DWRi (1) reviews well design including plan to install cement seals and steel casings and (2) has option to inspect installation of cement seals and steel casings



# Typical Injection Well Construction

Cement seals and steel casings through low-permeability volcanic confining layer

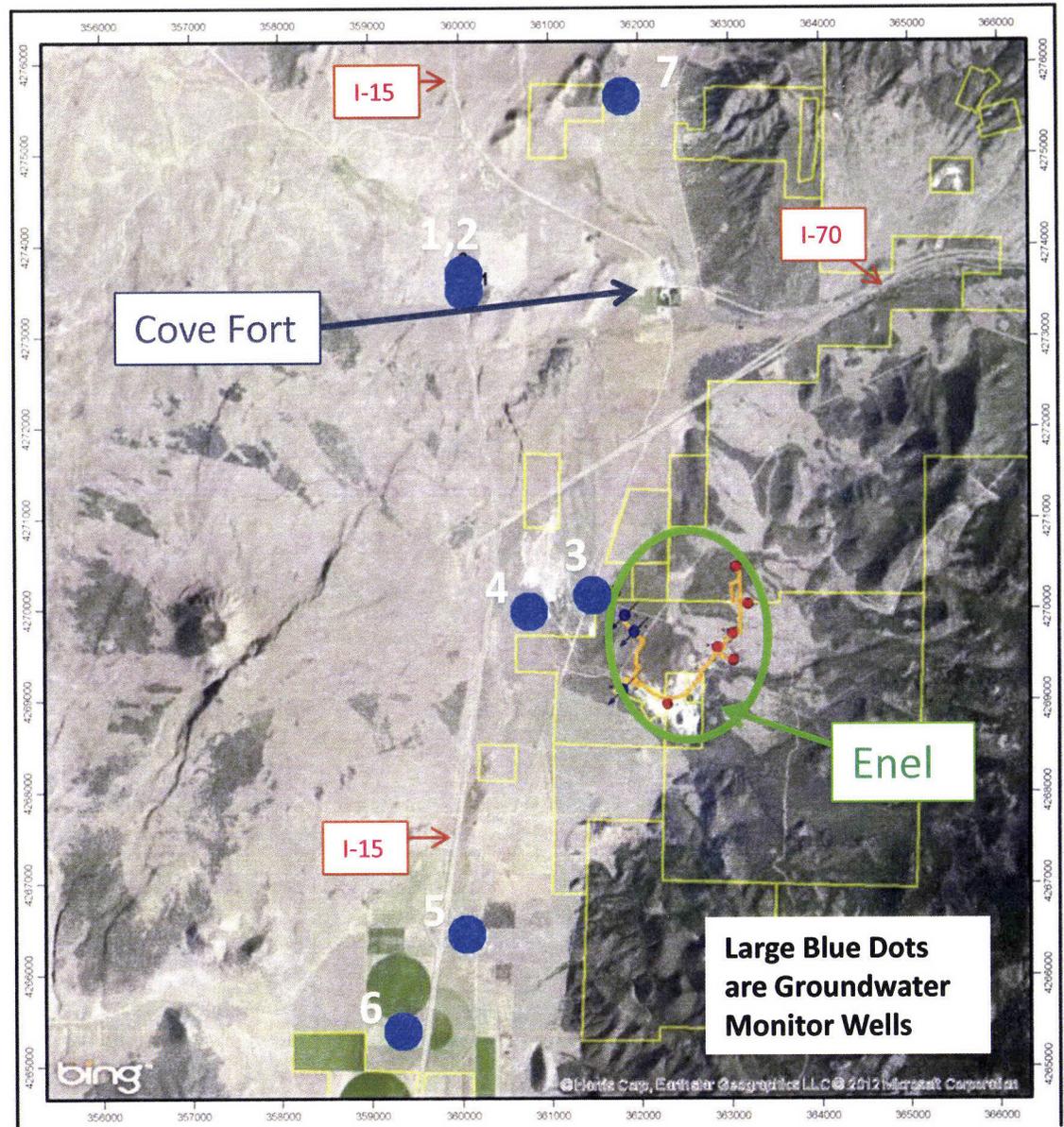
Note: DWRi (1) reviews well design including plan to install cement seals and steel casings and (2) has option to inspect installation of cement seals and steel casings



# Enel Implemented Voluntary Groundwater Monitoring Program

- Selected 7 area wells for monitoring groundwater level and quality
- Conducted baseline monitoring
  - Provided analytical results to well owners
- Will monitor wells during operations
  - Subject to consent of participating well owners
  - Will provide results of analyses to consenting well owners

# Wells in Groundwater Monitoring Program



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# Response to Concerns in Protests

- Degradation groundwater quality
  - Wells cased and sealed into geothermal reservoir
  - Geothermal reservoir is separate and distinct from water supply aquifer
  - Geothermal fluid returned to geothermal reservoir
- Lower groundwater levels and reduce yields of wells and deplete shallow aquifer
  - All pumped geothermal fluid permitted by change application a38403 (71-4940) will be reinjected back into geothermal reservoir
  - No groundwater will be withdrawn from shallow non-geothermal aquifer
  - Yields and groundwater levels in shallow non-geothermal aquifer will not be impaired

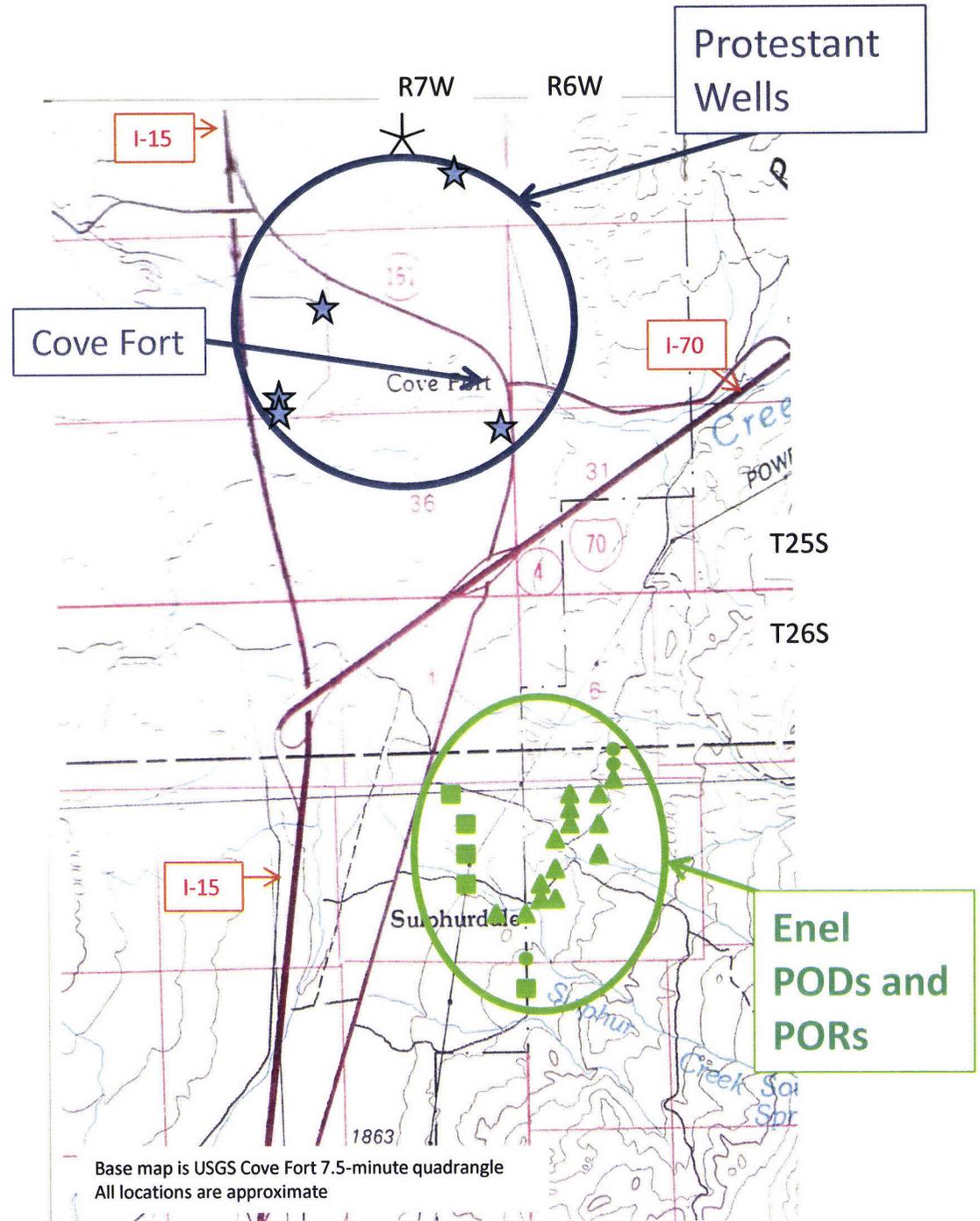
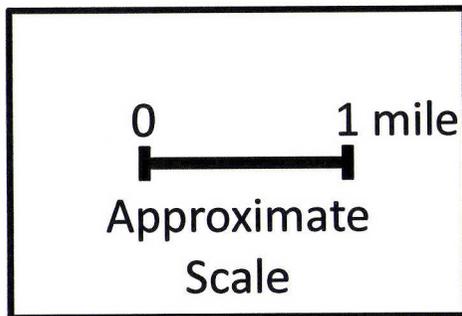
# Response to Concerns in Protests (continued)

- Inadequate characterization of subsurface
  - Many wells drilled, logged, and tested
  - Extensive geophysical studies
- Damage aquifer/possibly create subsidence
  - Will reinject all produced fluid into geothermal reservoir
  - Thick cap of volcanic rock acts to prevent subsidence at surface

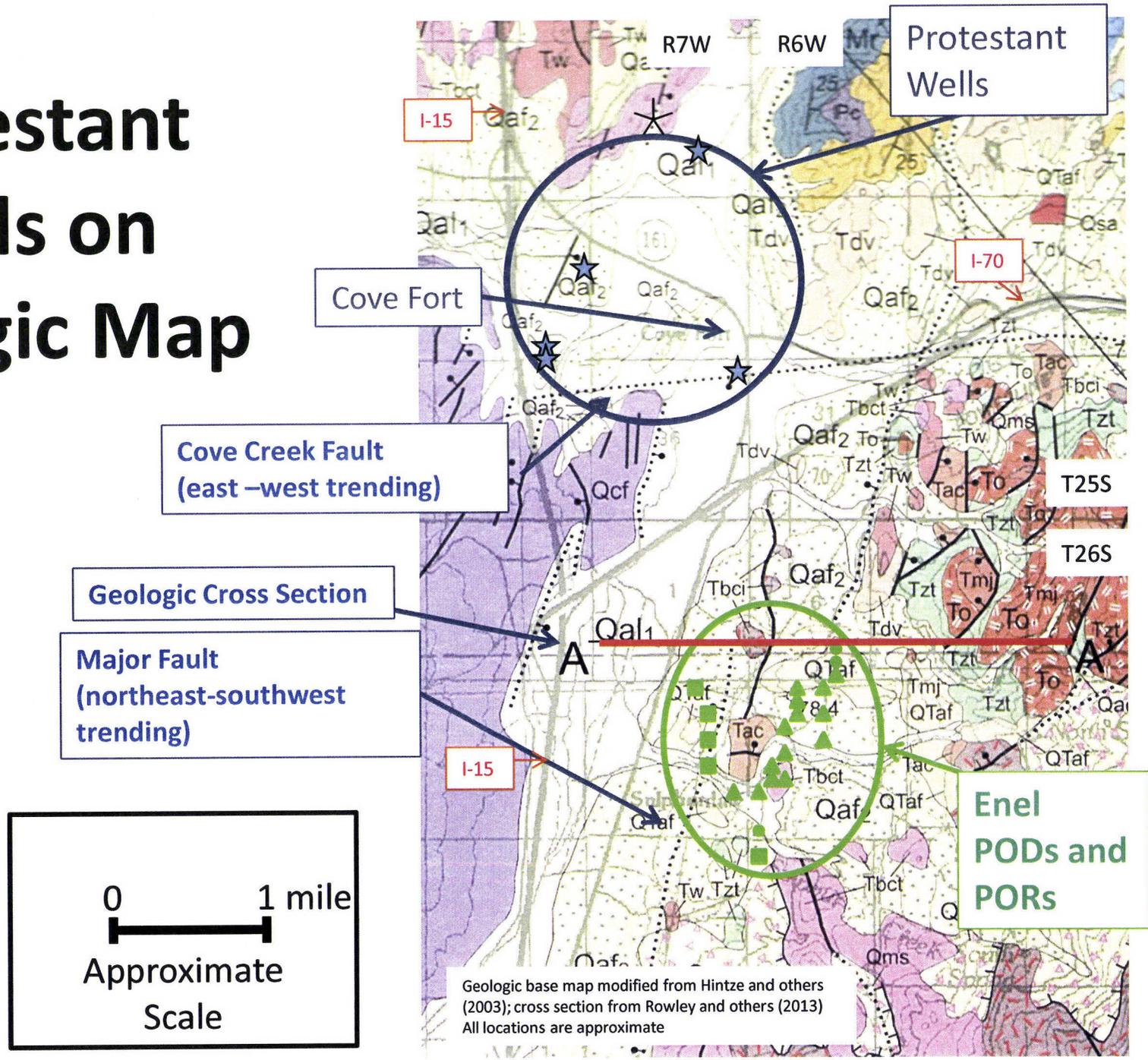
# Response to Concerns in Protests (continued)

- Water rights in area fully appropriated
  - a38403 (71-4940) modifies an existing approved water right and is not a new appropriation
- Request for groundwater monitoring program
  - Voluntary ongoing groundwater monitoring program implemented in 2012 prior to filing a38403 (72-4940) and prior to filing of protests

# Protestant Wells on Topographic Map



# Protestant Wells on Geologic Map



# Opinion Why a38403(71-4940) Should Be Approved

- Geothermal fluids are available
- There is no change in currently-allowed diversion and return of 35 cfs
- No consumed geothermal fluid
  - Any consumption in overall project will be under other existing approved water rights
- Application is
  - The addition of 3 new PODs and 5 new PORs
    - In same general area of heretofore PODs and PORs
  - More accurate legal description of existing PODs and PORs

# Opinion Why a38403(71-4940) Should Be Approved (continued)

- There will be no impairment of water rights
  - Geothermal reservoir is separate and distinct from shallow aquifer
  - Groundwater levels in and yields of wells in shallow non-geothermal aquifer will not be impaired
  - Groundwater quality in shallow aquifer will not be impaired
- Implemented voluntary and ongoing groundwater monitoring program