



# AQUIFER EXEMPTION

## Lower Tulare Formation: Elk Hills Oil Field, Phase 1 & 2

A presentation by the Division of Oil, Gas and Geothermal Resources with preliminary concurrence by the State Water Resources Control Board and Central Valley Regional Water Quality Control Board

The Elk Hills Oil Field, Aquifer Exemption can be accessed at:  
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### Agenda:

Open Meeting – 4 pm

Introductory remarks – Bill Bartling

Discussion of Phase 1 and 2 Exemption Proposals – Emaad Abdullaay

Public Comments – facilitated by Bill Bartling

Final Remarks

Close Meeting



# AQUIFER EXEMPTION

## Lower Tulare Formation: Elk Hills Oil Field, Phase 1 & 2

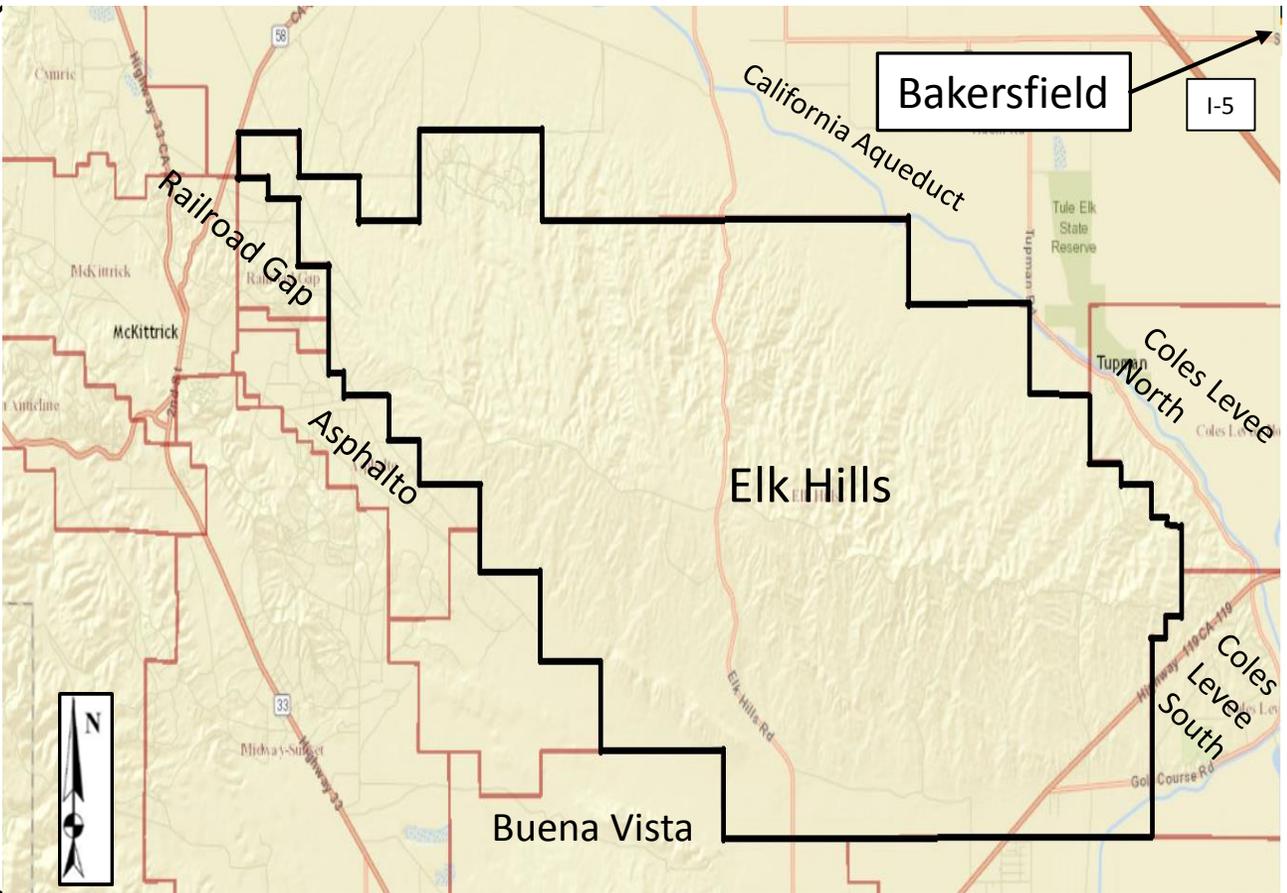
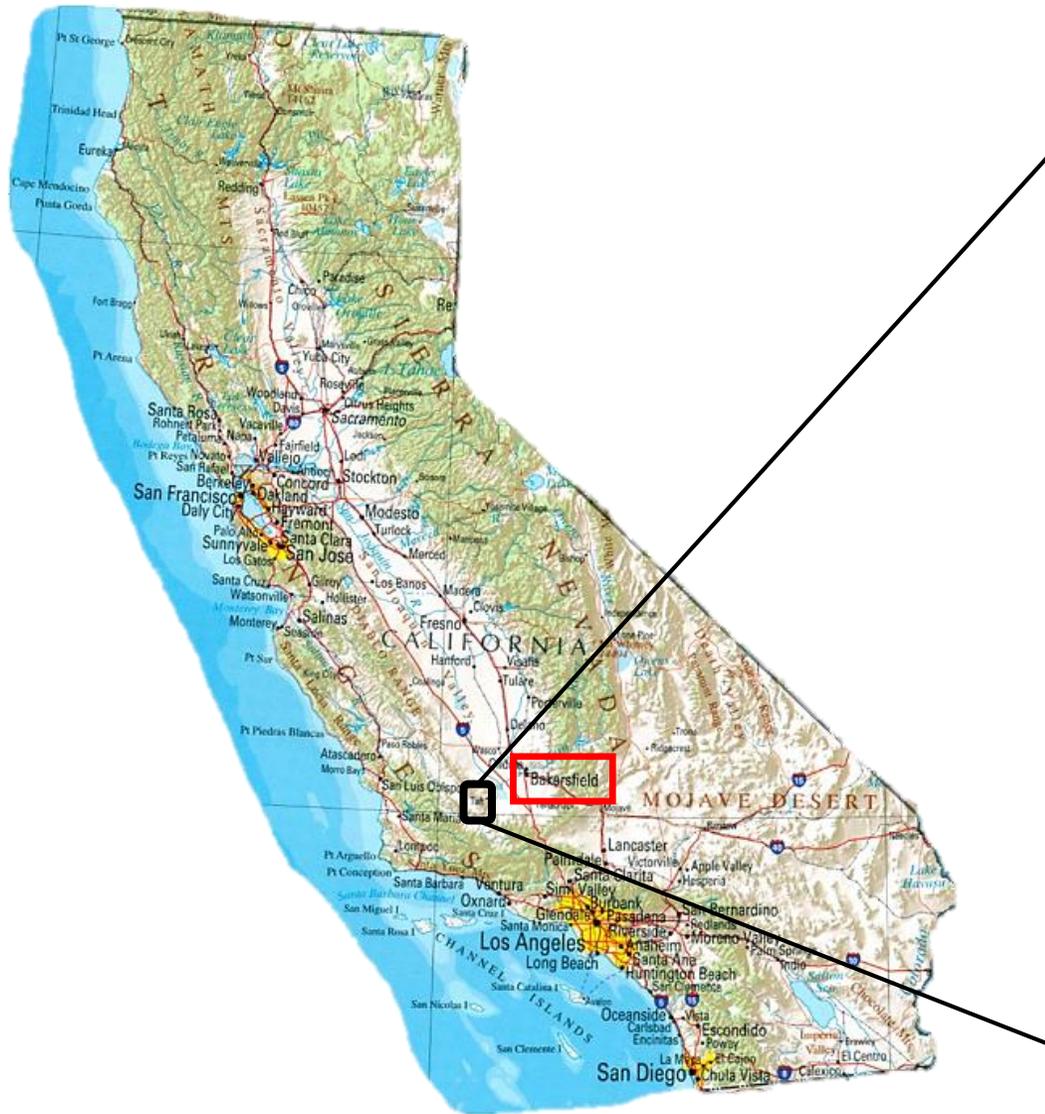
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# Contents

- 1. Location**
- 2. Stratigraphy**
- 3. History**
  - a. Development
  - b. Injection
- 4. Exemption Proposal**
- 5. Meets Federal Exemption Criteria**
  - a. Not a current source of drinking water.
  - b. Total Dissolved Solids more than 3,000 and less than 10,000 mg/l and not reasonably expected to supply a public water system.
- 6. Meets CA State Exemption Criteria**
  - a. The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.
  - b. The Injected fluid will remain in the aquifer or portion of the aquifer that would be exempted.



# Location

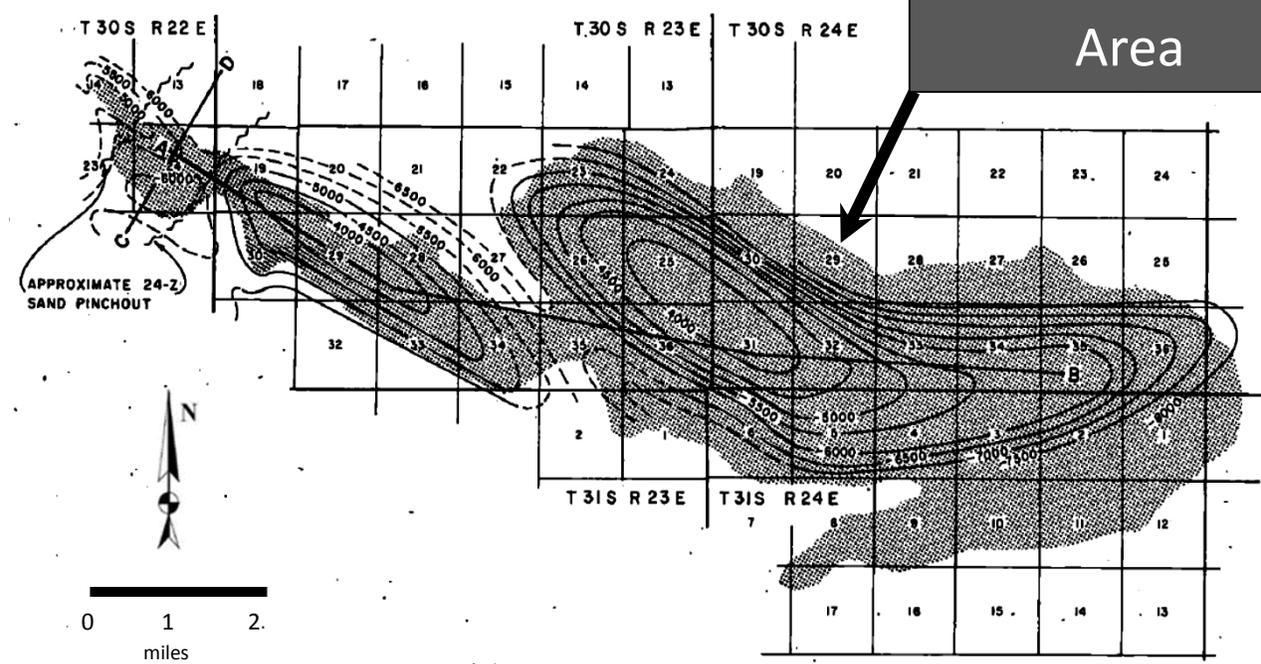
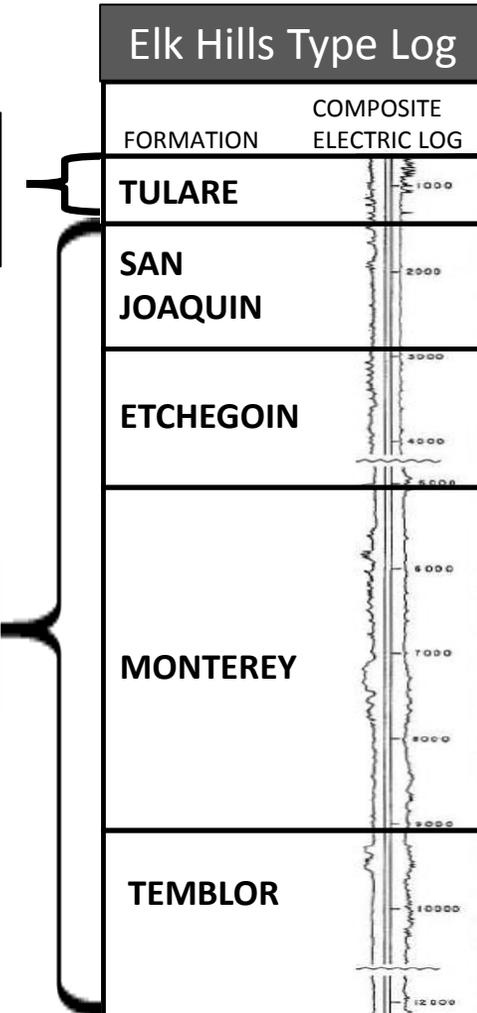


Approx. 27 Miles southwest of Central Bakersfield



1973 Non-Hydrocarbon  
Producing Zone (Tulare)  
(Not Exempted)

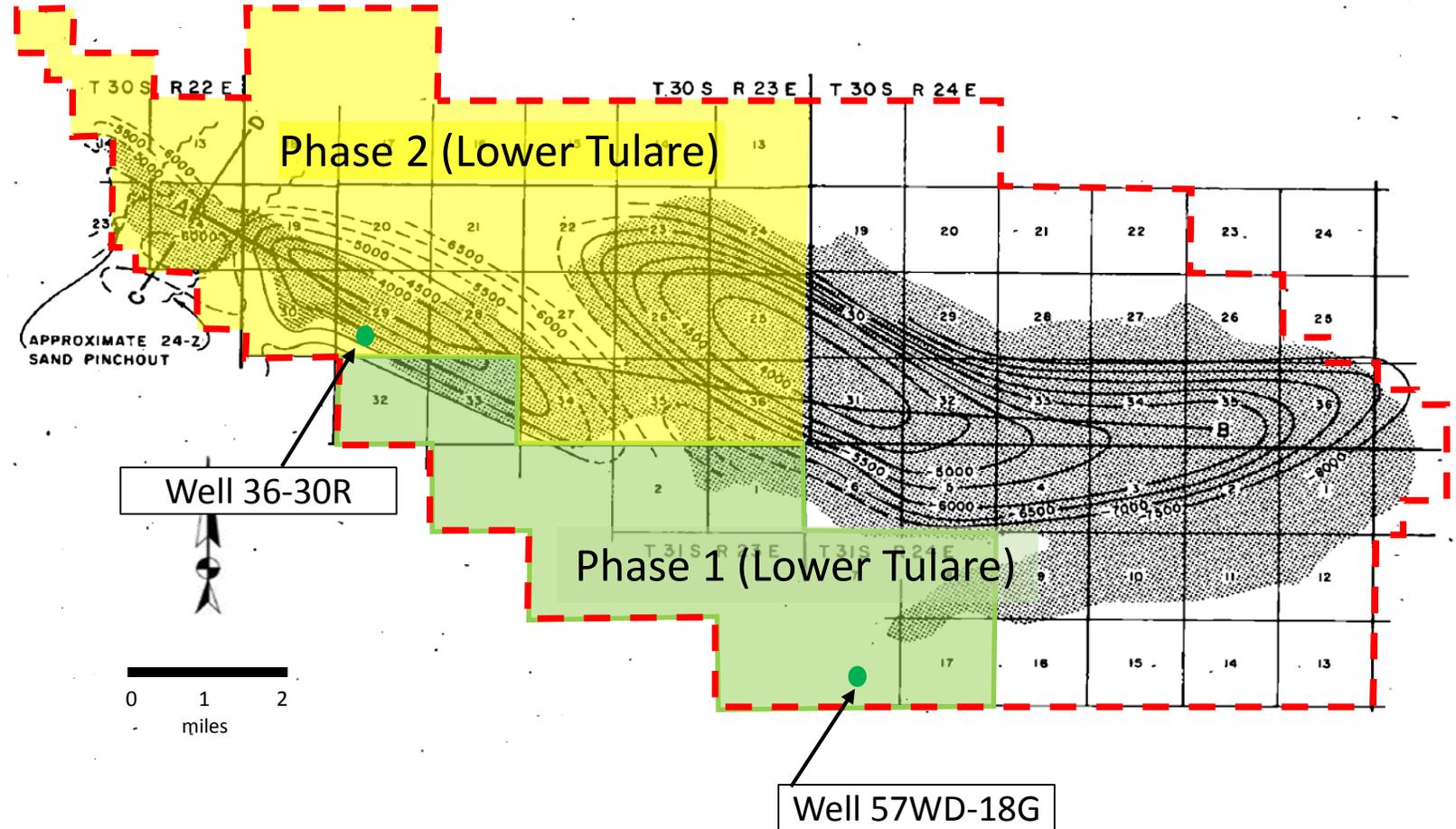
1973 Hydrocarbon  
Producing Zones  
(Exempted)



California Oil and Gas Fields, 1973



- Map of the Elk Hills Administrative Boundary showing the Phase 1 and Phase 2 aquifer exemption proposal areas.

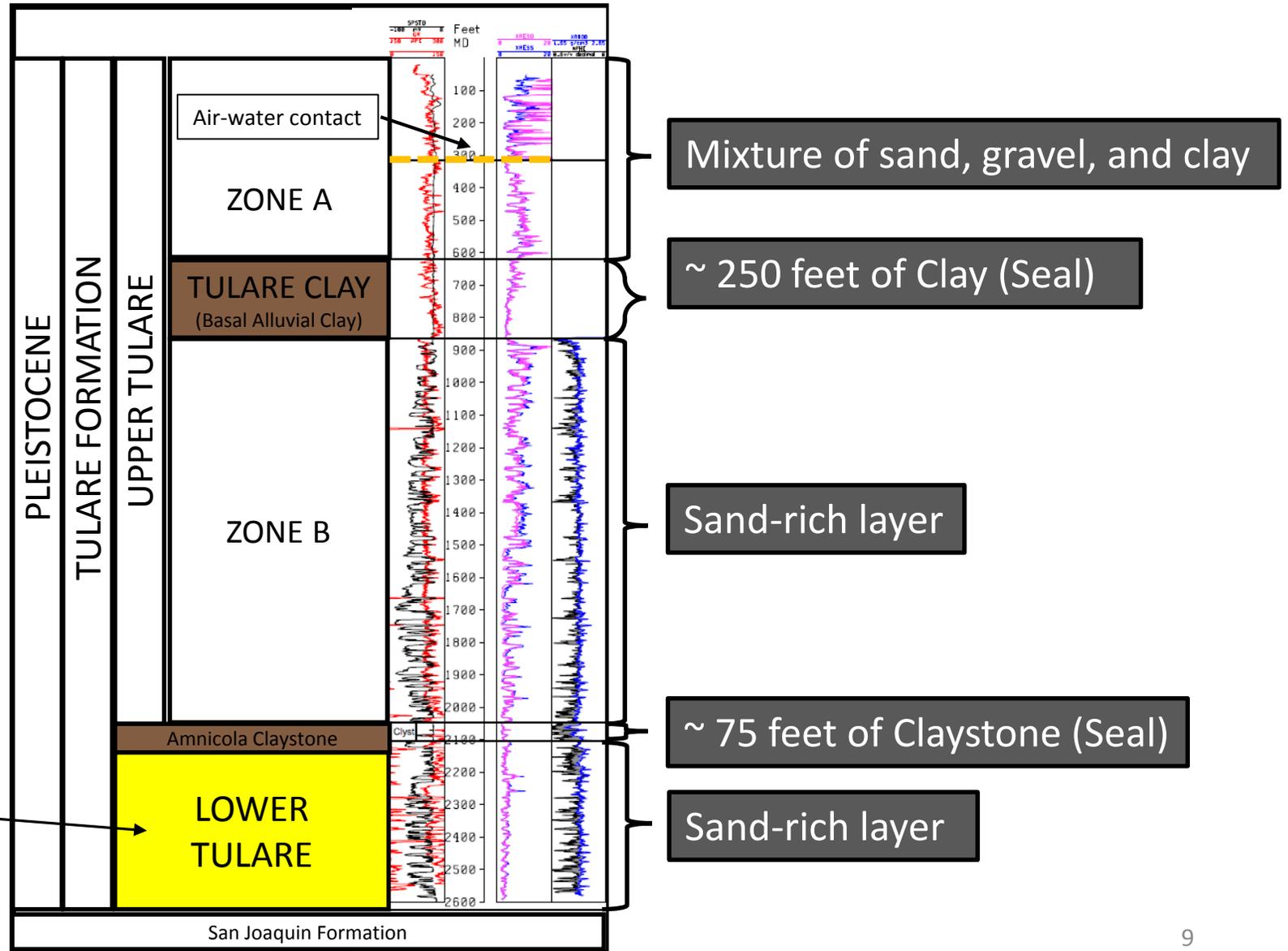


# Tulare Stratigraphy-Phase 1

## Phase 1 Tulare Formation Type Log Well 57WD-18G

- At the Elk Hills Oil Field, the Tulare Formation consists of fluvial channels, floodplain and lacustrine deposits of gravel, sand, silt, clay, and limestone.

Phase 1 Lower Tulare  
Proposal

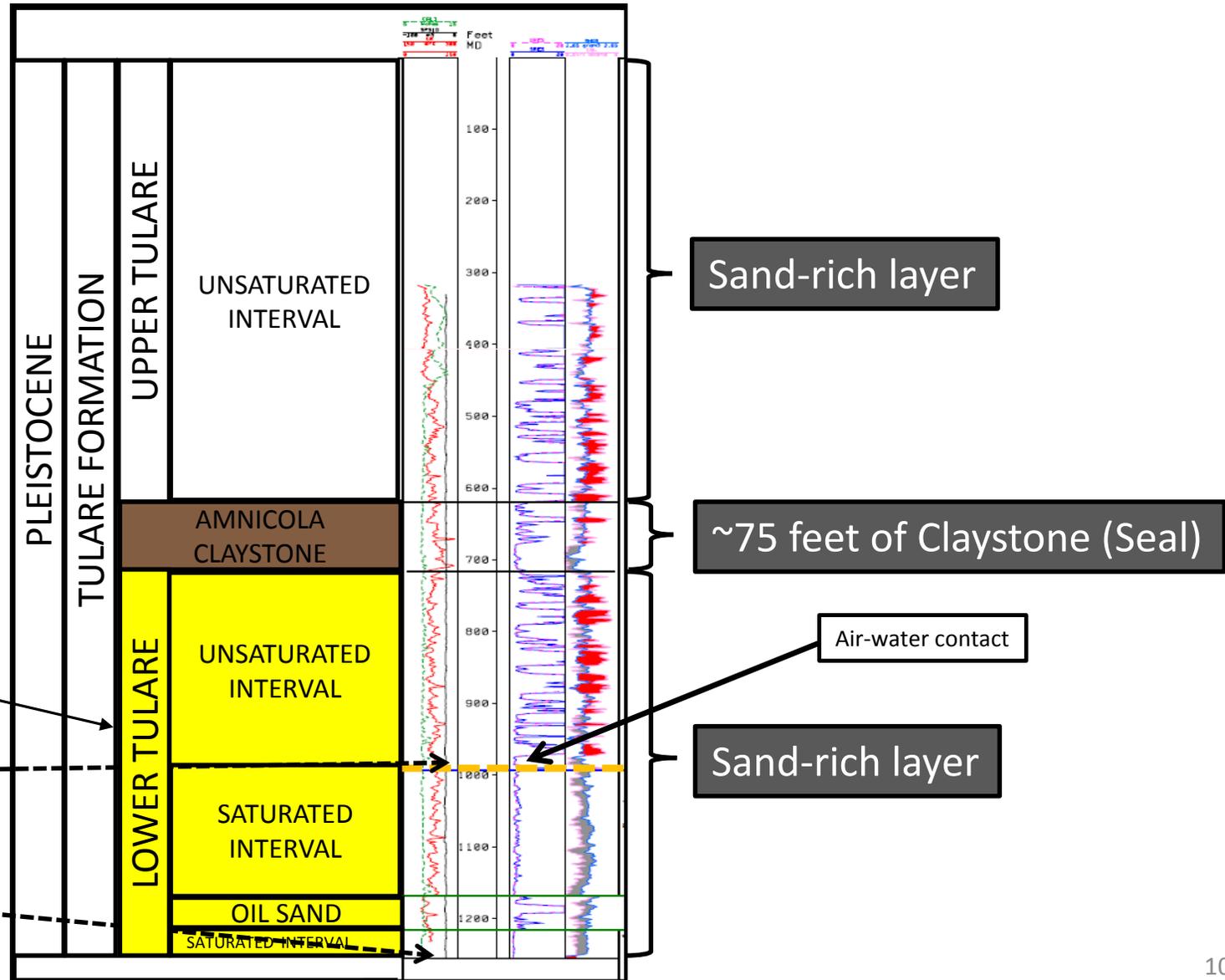


# Tulare Stratigraphy-Phase 2

Phase 2 Tulare Formation  
Type Log  
Well 36-30R

Phase 2 Lower Tulare  
Proposal

Water and Oil  
bearing interval



## **1911**

Production from the Etchegoin Formation occurred at Elk Hills Oil Field as early as 1911.

## **1957 - Present**

Waterflooding was initiated in 1957 and has continued to the present for the Etchegoin and Monterey Formations.

## **1981**

The Tulare Formation has been used since 1981 for injection and disposal of produced water.

## **1998**

The Elk Hills Oil Field was formerly Naval Petroleum Reserve 1 and managed by the US Navy and the US Department of Energy before being sold in 1998 to Occidental Petroleum Corporation (OXY).

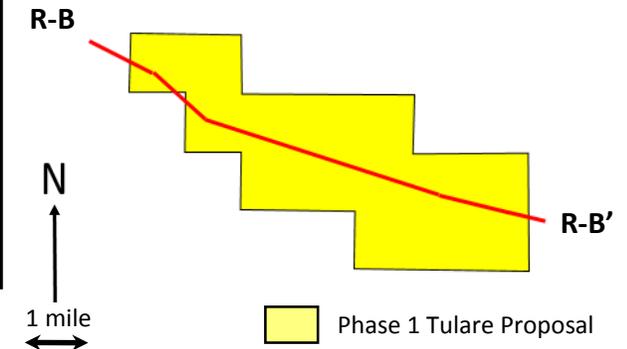
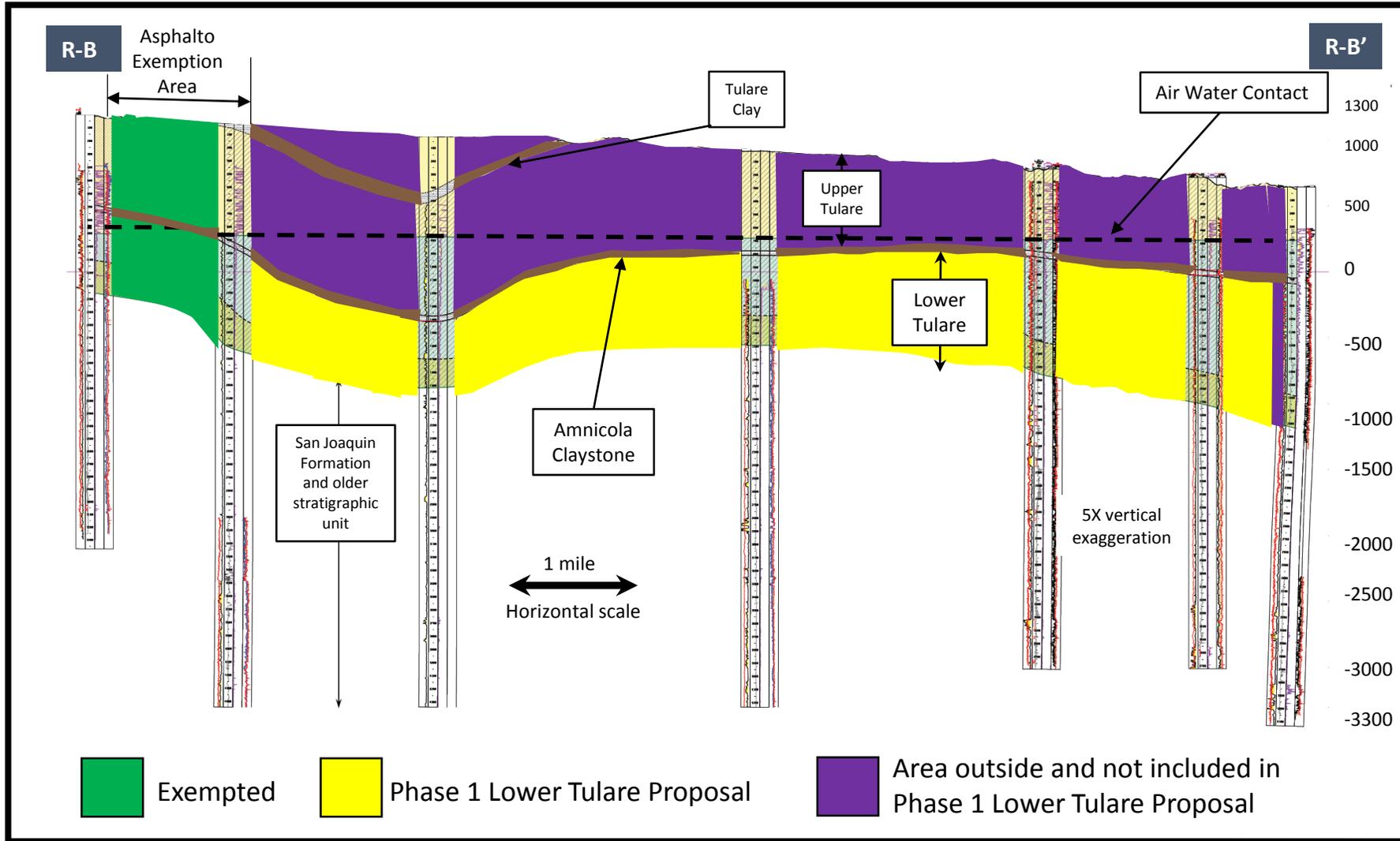
## **2014**

In 2014 California Resources Elk Hills, LLC became the operator of Elk Hills Oil Field.



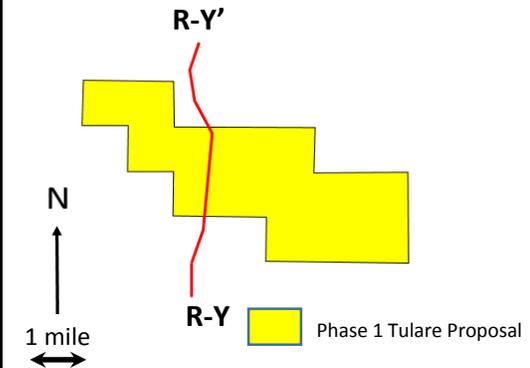
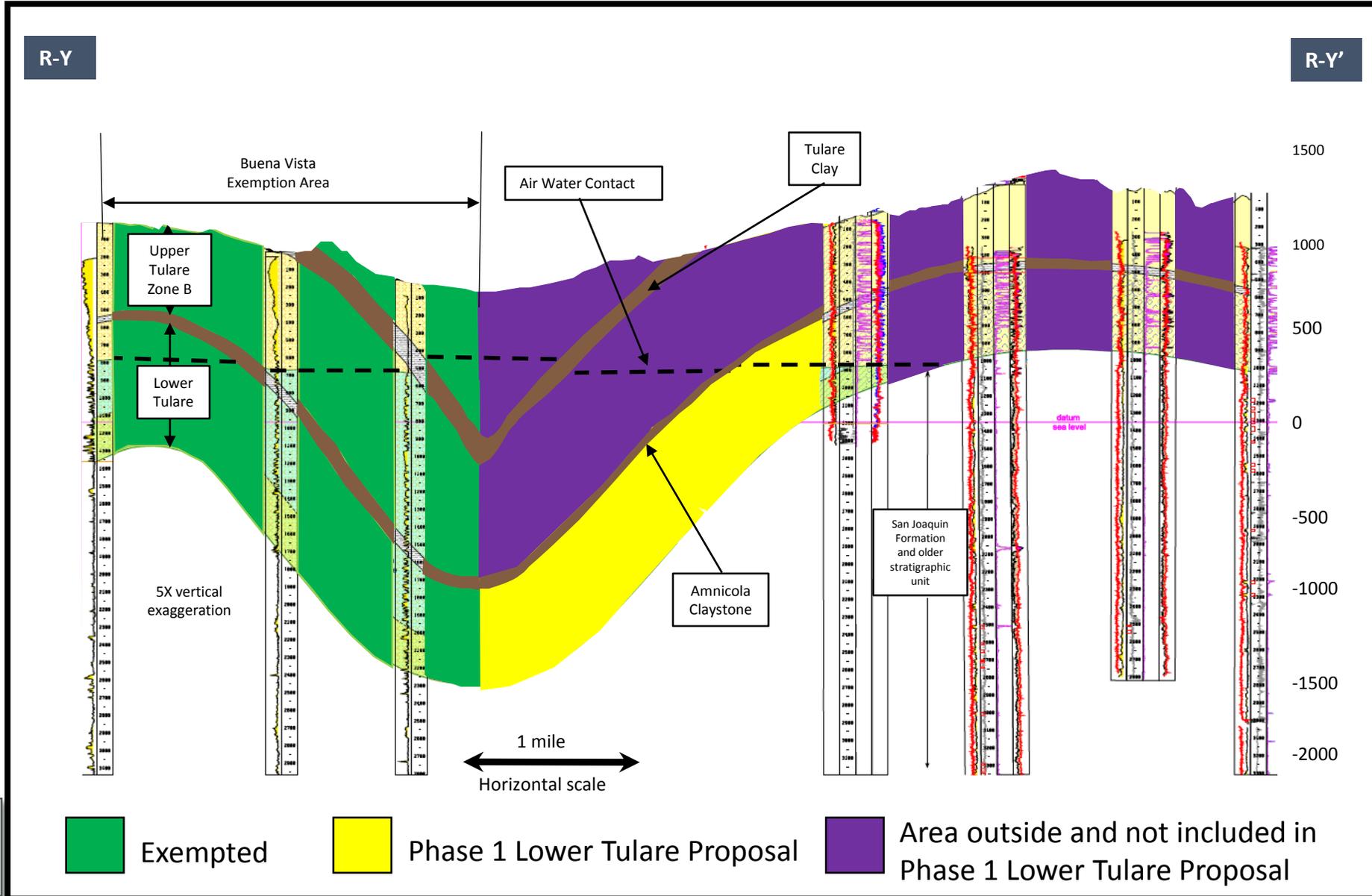
# Exemption Proposal-Phase 1

R-B to R-B' cross-section



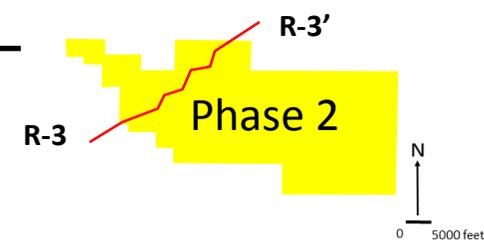
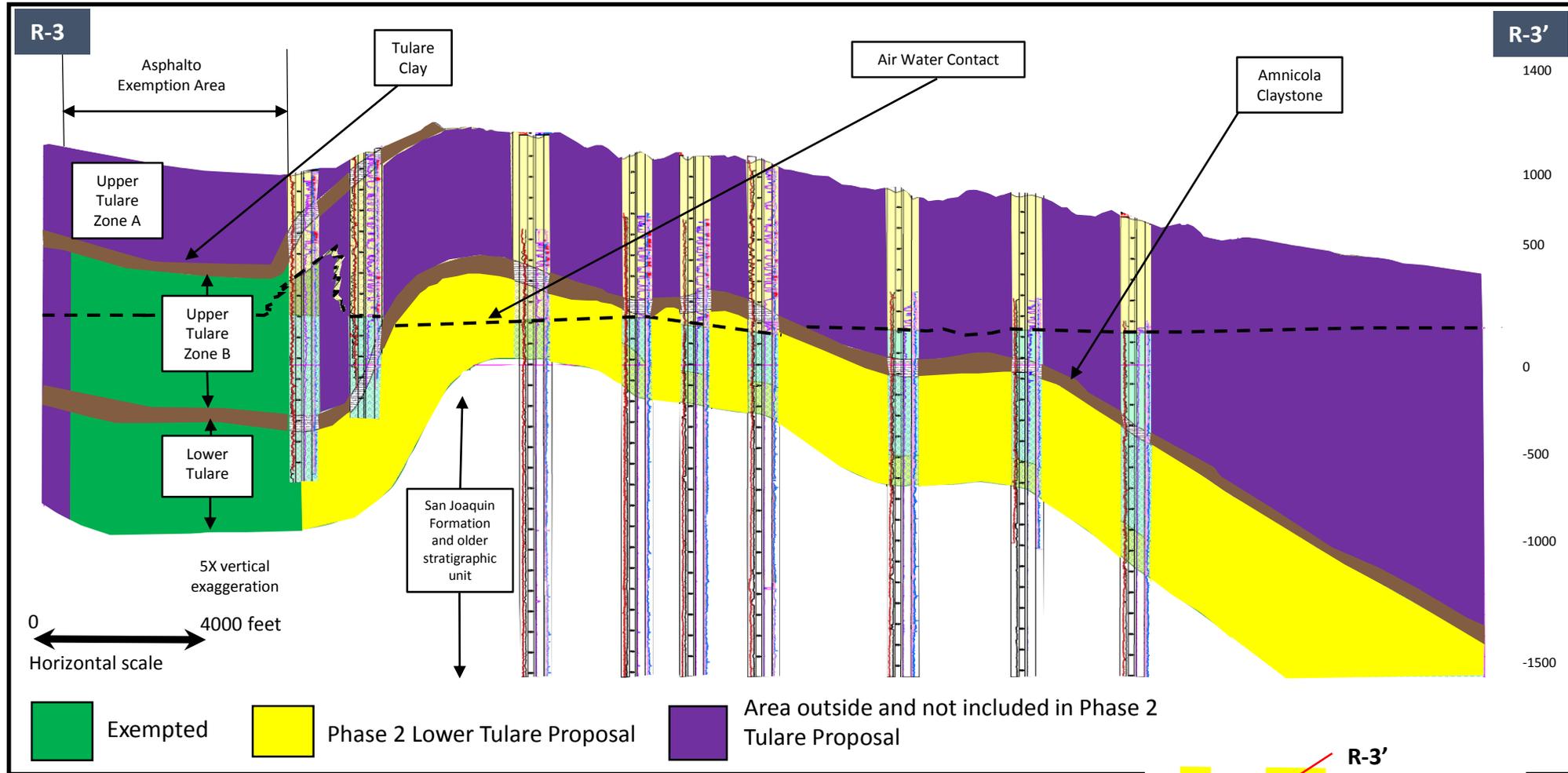
# Exemption Proposal-Phase 1

R-Y to R-Y' cross-section



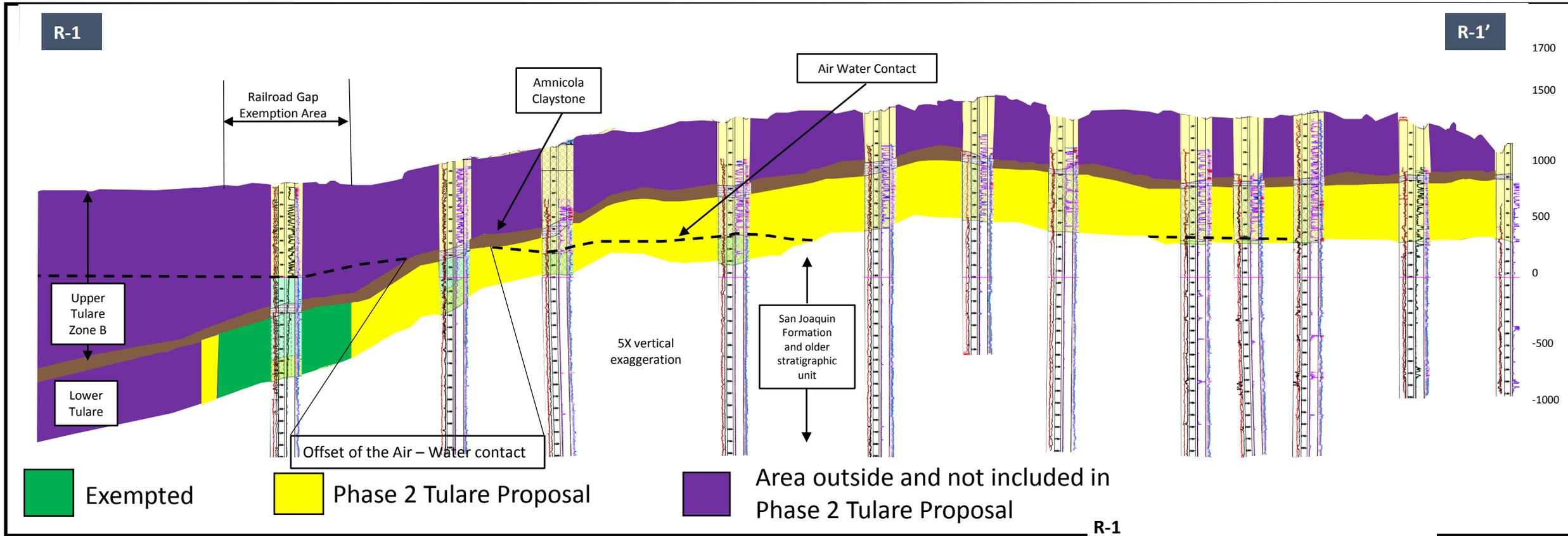
# Exemption Proposal-Phase 2

R-3 to R-3' cross-section

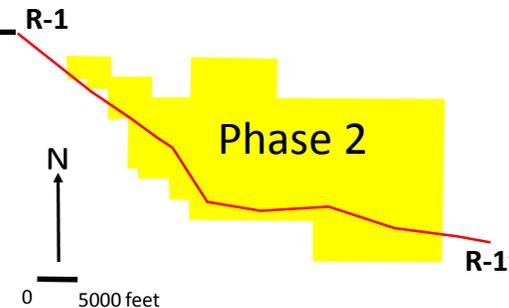


# Exemption Proposal-Phase 2

R-1 to R-1' cross-section



0 4000 feet  
Horizontal scale



# Federal Exemption Criteria

## Exemption criteria as specified in 40 CFR 146.4

a) The aquifer does not currently serve as a source of drinking water.

AND

c) The total dissolved solids (TDS) content of the ground water is more than 3,000 and less than 10,000 milligrams per liter (mg/L), and it is not reasonably expected to supply a public water system.



## Exemption criteria as specified in 40 CFR 146.4

a) The aquifer does not currently serve as a source of drinking water.

AND

c) The total dissolved solids (TDS) content of the ground water is more than 3,000 and less than 10,000 mg/L, and it is not reasonably expected to supply a public water system.

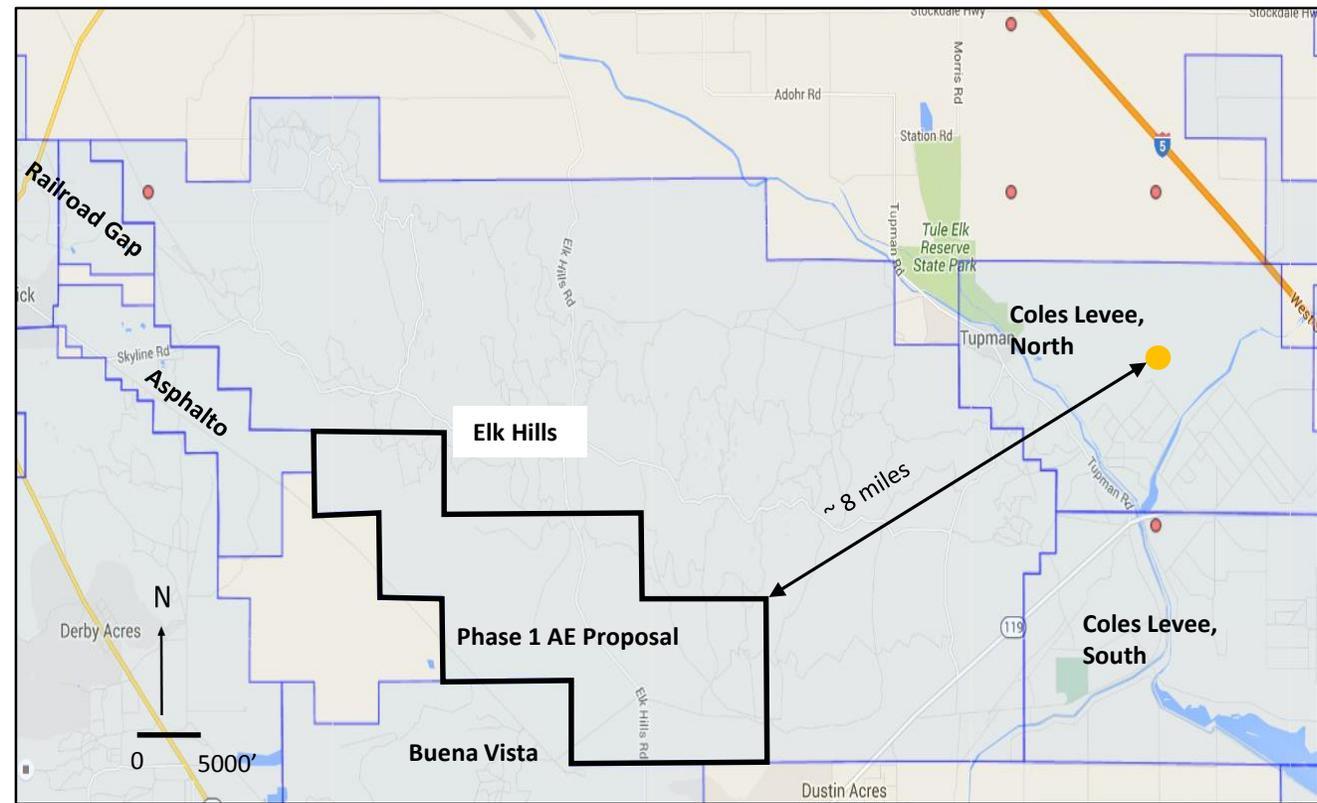


## Exemption criteria as specified in 40 CFR 146.4

- ✓ a) The aquifer does not currently serve as a source of drinking water

### Public Water System Wells

- No water wells are currently used as source of drinking water within Phase 1 Proposal Area, and the Elk Hills Oil Field administrative boundary.
- The closest Public Water Well is located about 8 miles from the proposed exemption area.
- The well draws water from zones above the proposed exemption area (Lower Tularne Formation).



● Location of the Closest Public Water Well (GEOTRACKER GAMA)



## Exemption criteria as specified in 40 CFR 146.4

✓ a) The aquifer does not currently serve as a source of drinking water.

### Water Wells Locations in the Review Area

- 29 abandoned water wells were located within the water wells review area.
- All of the water wells were completed above the Amnicola Claystone.

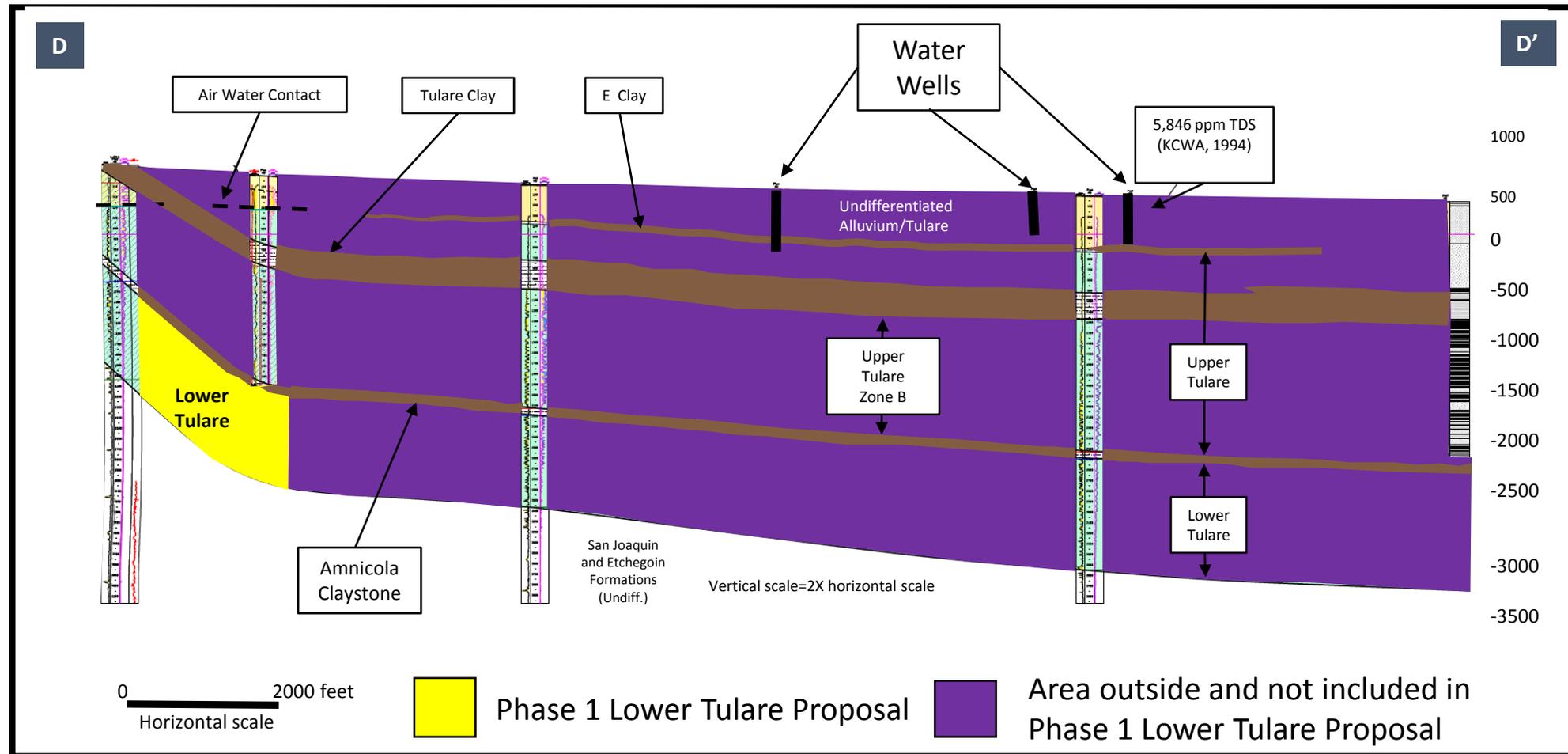


● Approximate Water Well Location (GEOTRACKER GAMA)



## Exemption criteria as specified in 40 CFR 146.4,

- ✓ a) The aquifer does not currently serve as a source of drinking water.  
Water Wells Completion Zone in the Review Area

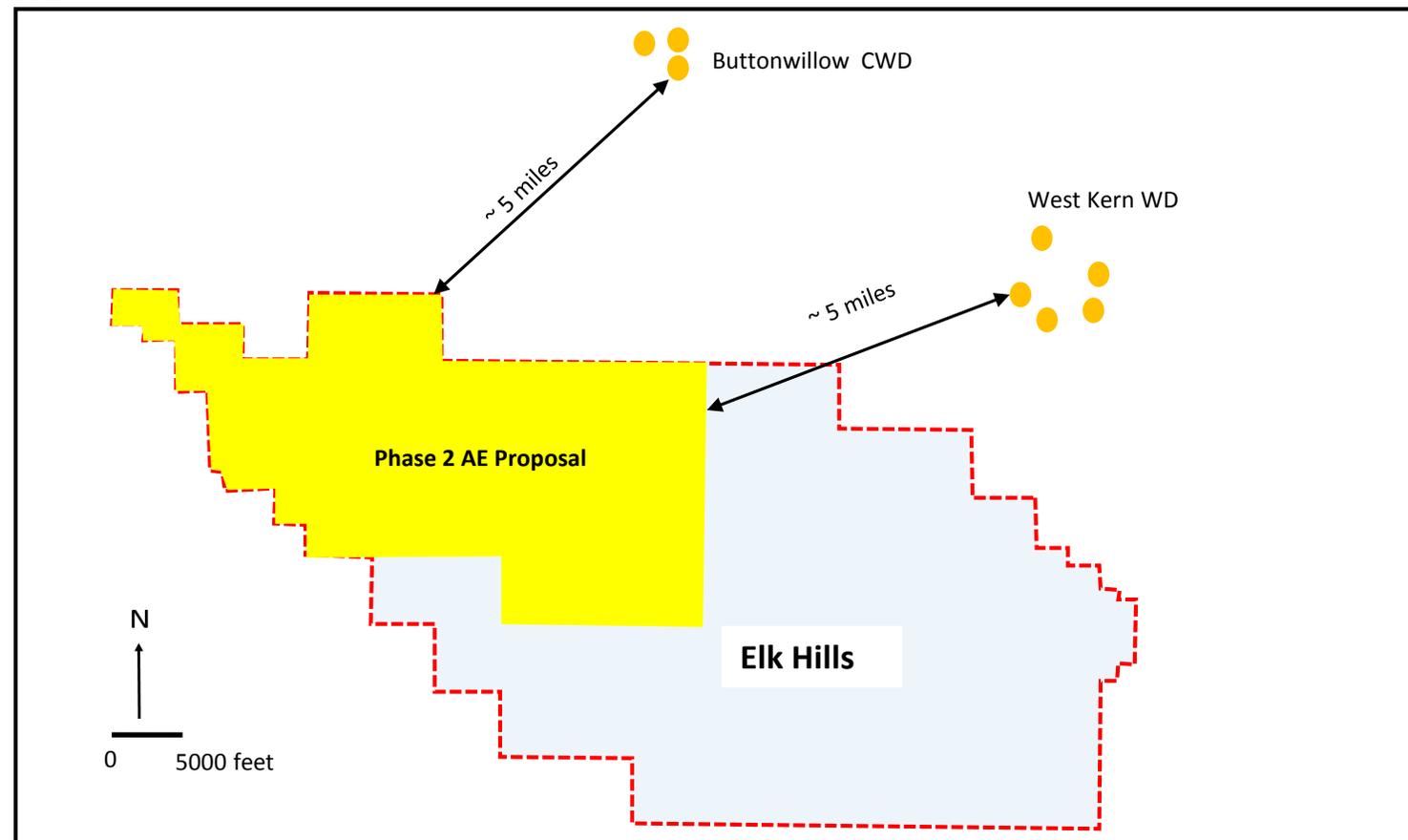


## Exemption criteria as specified in 40 CFR 146.4,

- ✓ a) The aquifer does not currently serve as a source of drinking water

### Public Water System Wells

- No water wells currently used as source of drinking water within Phase 2 Proposal Area, and the Elk Hills Oil Field administrative boundary.
- The closest Public Water Well is located 5 miles from the proposed exemption area.



● Location of The Closest Public Water Well (GEOTRACKER GAMA)

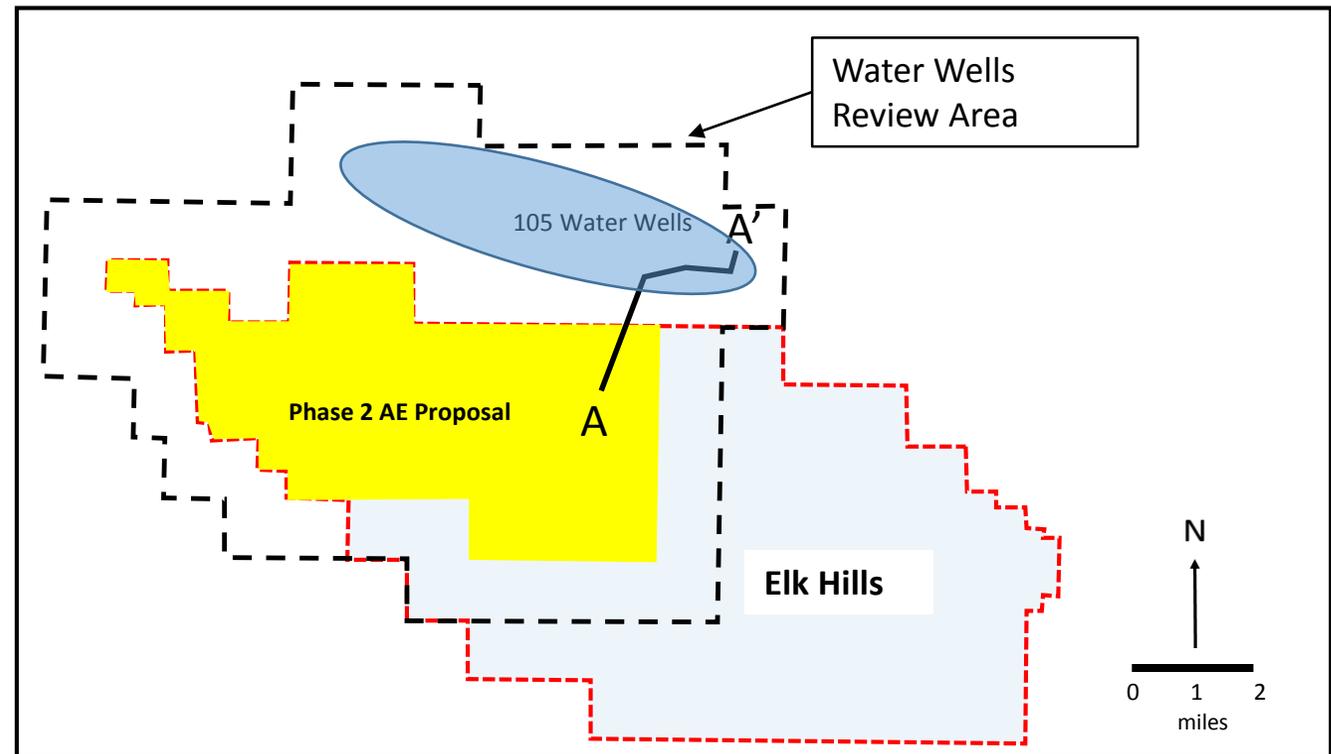


## Exemption criteria as specified in 40 CFR 146.4

✓ a) The aquifer does not currently serve as a source of drinking water.

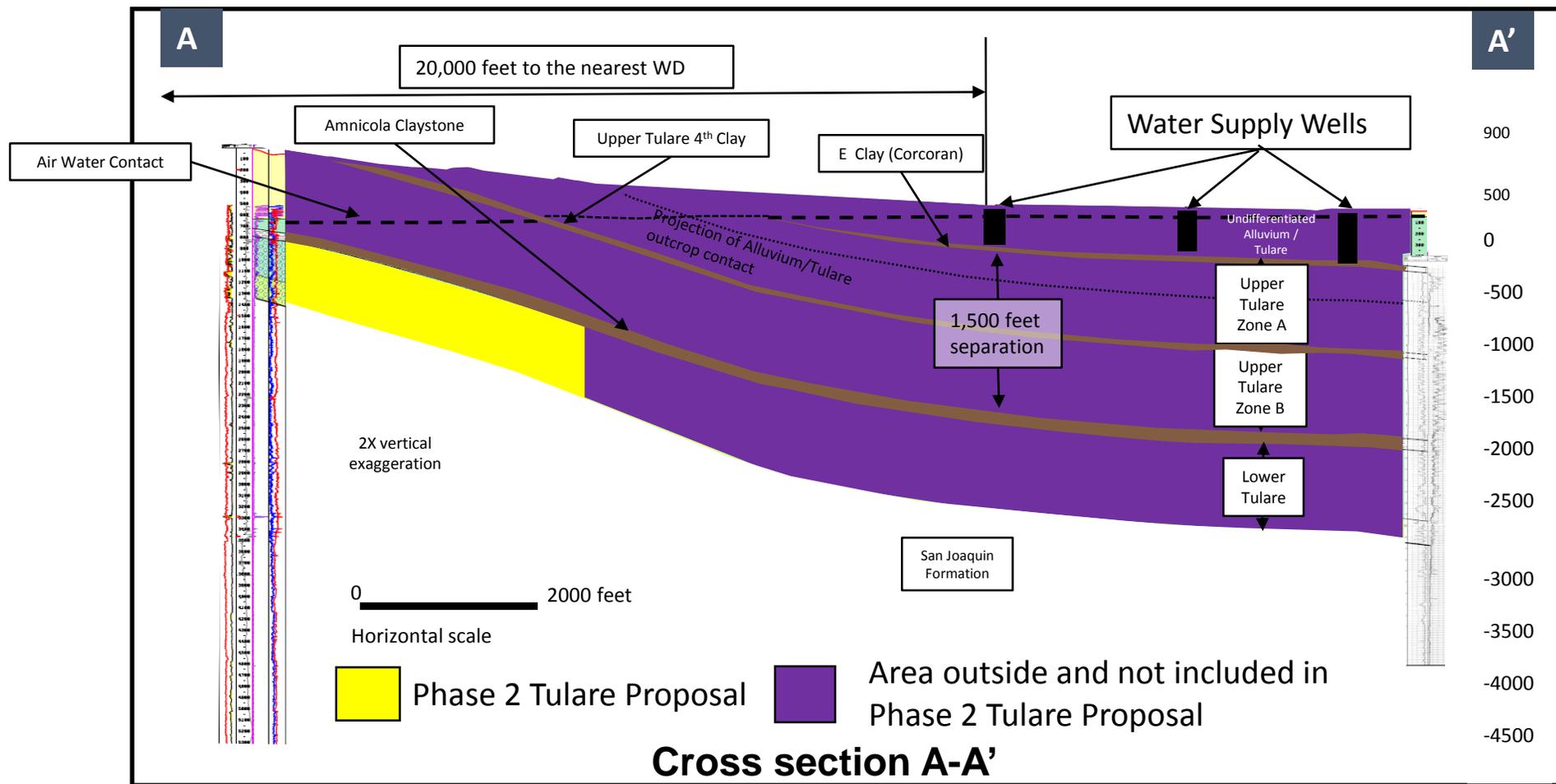
### Water Wells Location in the Review Area

- 105 records of water supply wells found within the water wells review area.
- All water supply wells completed above the Amnicola Claystone.
- Water wells are vertically separated from the lower Tulare by approximately 1070 to 2410 feet.
- No water wells currently used as source of drinking water within Phase 2 Proposal Area, the water wells review area and Elk Hills Oil Field administrative boundary.



## Exemption criteria as specified in 40 CFR 146.4

- ✓ a) The aquifer does not currently serve as a source of drinking water.  
Water Wells Completion Zone in the Review Area



## Exemption criteria as specified in 40 CFR 146.4

a) The aquifer does not currently serve as a source of drinking water.

**AND**

c) The total dissolved solids (TDS) content of the ground water is more than 3,000 and less than 10,000 mg/L, and it is not reasonably expected to supply a public water system.

- Lower Tulare Formation groundwater within the administrative boundary of Elk Hills Oil Field has TDS concentrations between 7,168 and 20,000 mg/L (Appendix 5).
- The West Kern Water District (WKWD), the local water district within the area of review, has declared that the Tulare Formation in the Elk Hills aquifer exemption area does not currently serve as a source of drinking water and will not reasonably be expected to supply a public water system (Appendix 7).



# Groundwater Constituents in Elk Hills Lower Tulare

## Drinking Water Standards – Maximum Contaminant Levels (MCLs)

3 Water samples collected from 3 wells (Appendix 5).

Constituent	Mean Concentration or Range mg/l	MCLs and Regulatory Thresholds mg/l	Threshold Exceeded?	% of Threshold
Selenium (Lower Tulare)	0.720	0.05	Yes	1440%
TDS (Lower Tulare)	7,168 to 20,000	500	Yes	1434% to 4,000%
Chloride (Lower Tulare)	3,115 to 10,000	250 (recommended)	Yes	1,246% to 4,000%
Sulfate (Lower Tulare)	700 to 3,200	250 (recommended)	Yes	280% to 1,280%

MCLs: Maximum Contaminant Levels

**Exceeds Drinking Water Standards (Primary & Secondary MCL)**

(California State Water Resources Control Board)



# Groundwater Constituents in Elk Hills Lower Tulare

## Environmental Protection Agency Drinking Water Health Advisory

3 Water samples collected from 3 wells (Appendix 5).

Constituent	Mean Concentration or Range mg/l	Regulatory Thresholds mg/l	Threshold Exceeded?	% of Threshold
Boron (Lower Tulare)	5.7 to 24	6.00	Yes	Up to 400%
Strontium (Lower Tulare)	4.8 to 17	4.00	Yes	120% to 425%
Sodium (Lower Tulare)	2,041 to 4,700	20.00	Yes	10,205% to 23,500%

**Exceeds USEPA Drinking Water Health Advisory**  
\* EPA Action Level  
(US Environmental Protection Agency)



# Meets State Exemption Criteria

## Exemption criteria as specified in PRC 3131(a),

- ✓ 1. Criteria set forth in Section 146.4 of Title 40 of the Code of Federal Regulations.
- 2. The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.
- 3. The injected fluid will remain in the aquifer or portion of the aquifer that would be exempted.



# Meets State Exemption Criteria

## Exemption criteria as specified in PRC 3131(a),

✓ 1. Criteria set forth in Section 146.4 of Title 40 of the Code of Federal Regulations.

2. The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.

- The Elk Hills Lower Tulare formation groundwater is not expected to be put to beneficial use as defined by the PRC 13050 (f), because of poor water quality in aquifer intervals located below the Amnicola Claystone.



# Groundwater Constituents in Elk Hills Lower Tulare

## Guidelines for Interpretation of Water Quality for Irrigation

Untreated Lower Tulare groundwater within the Elk Hills Oil Field is unfit for Agricultural use.

Constituent	Mean Concentration or Range mg/l	Degree of Restriction on Use		
		None mg/l	Slight to Moderate mg/l	Severe mg/l
TDS (Lower Tulare)	7,168 to 20,000	< 450	450 to 2000	> 2000
Chloride (Lower Tulare)	3,115 to 10,000	< 142	142 to 354	> 354
Boron (Lower Tulare)	5.7 to 24	< 0.7	0.7 to 3.0	> 3.0
Sodium (Lower Tulare)	2,041 to 4,700	< 69	69 to 207	> 207

Adapted from University of California Committee of Consultants, 1974



# Meets State Exemption Criteria

## Exemption criteria as specified in PRC 3131(a),

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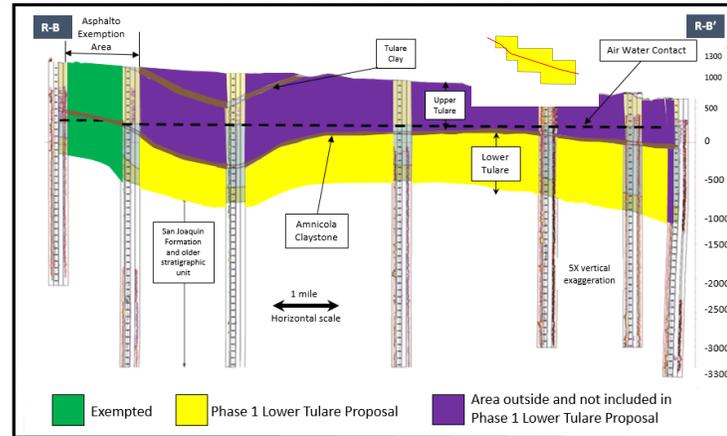
- Amnicola Claystone is the vertical confining layer for the Lower Tulare.
- The injected water will remain within Elk Hills Phase 1 and 2 Tulare Formation Proposal Area.



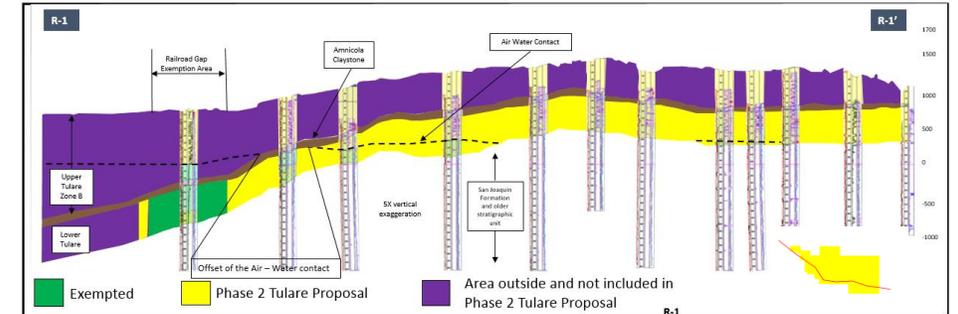
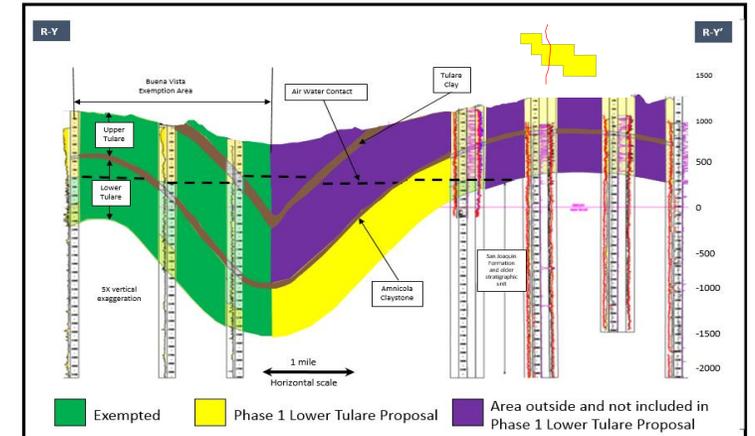
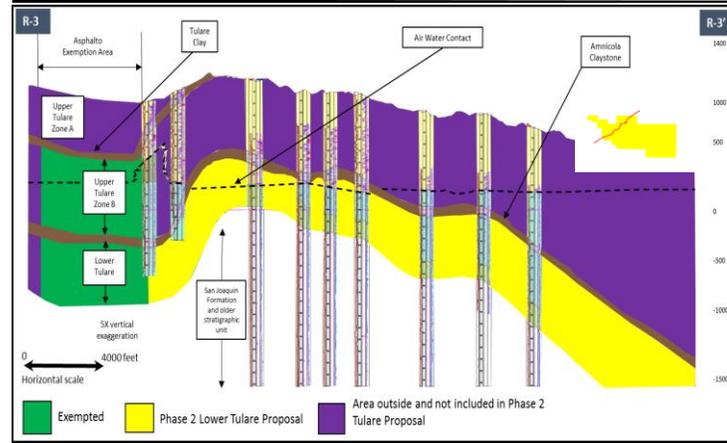
# Meets State Exemption Criteria

- Amnicola Claystone is a regionally extensive confining layer that provides vertical containment of injected water.
- Consists of silty claystone and has vertical permeability measuring less than 0.1 md from conventional core sample (Appendix 2).
- Evidence of confinement consists of the thickness, continuity, and low permeability of the Amnicola Claystone, and the offset of the Air – Water contact below and above the Amnicola Claystone, and is further supported by the numerous gas and oil shows seen in the lower Tulare.

Phase 1 →



Phase 2 →



# Meets State Exemption Criteria

## Exemption criteria as specified in PRC 3131(a),

- ✓ 1. Criteria set forth in Section 146.4 of Title 40 of the Code of Federal Regulations.
- ✓ 2. The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.
- 3. The injected fluid will remain in the aquifer or portion of the aquifer that would be exempted.
  - Amnicola Claystone is the vertical confining layer for the Lower Tulare.
  - Lateral containment is achieved through operational controls limiting the migration of injected fluids to the Phase 1 and 2 Lower Tulare Formation Proposal Area.



# Conclusion

## Exemption criteria as specified in 40 CFR 146.4,

- ✓ a) The aquifer does not currently serve as a source of drinking water.
- ✓ b) The total dissolved solids content of the ground water is more than 3,000 and less than 10,000 mg/l and it is not reasonably expected to supply a public water system.

## Exemption criteria as specified in PRC 3131(a),

- ✓ 1. Criteria set forth in Section 146.4 of Title 40 of the Code of Federal Regulations.
- ✓ 2. The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.
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Please state your name and spell it for the record.  
Please speak clearly so that we may accurately  
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