



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION IX  
75 Hawthorne Street  
San Francisco, CA 94105-3901

Kenneth A. Harris Jr.  
State Oil and Gas Supervisor  
Division of Oil, Gas, and Geothermal Resources  
California Department of Conservation  
801 K Street, MS 18-05  
Sacramento, CA 95814-3530

Re: Approval of Aquifer Exemption for the Cymric Oil Field, Kern County, California

Dear Mr. Harris:

Based on a thorough review of the supporting documents submitted by the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources and the State Water Resources Control Board, the U.S. Environmental Protection Agency (EPA) hereby approves the aquifer exemption request for portions of the Tulare Formation in the Cymric Oil Field in Kern County, California.

The approved aquifer exemption boundaries and depths, along with EPA's analyses and rationale in support of the approval, are detailed in the enclosed Record of Decision. In accordance with applicable regulations at 40 C.F.R. Parts 144, 145, and 146, we find that this aquifer exemption request is a non-substantial program revision, and the requested formation meets the following federal exemption criteria:

- The portions of the formation proposed for exemption in the field do not currently serve as a source of drinking water; and
- The portions of the formation proposed for exemption in the field cannot now and will not in the future serve as a source of drinking water because they are commercially hydrocarbon-producing.

If you have any questions, please contact David Albright, Manager of our Drinking Water Protection Section, at (415) 972-3971.

Sincerely,

A handwritten signature in blue ink, appearing to read "Tomás Torres".

Tomás Torres *September 28, 2018*  
Director, Water Division

Enclosure: Aquifer Exemption Record of Decision for Cymric Oil Field

cc: Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board



## DESCRIPTION OF PROPOSED AQUIFER EXEMPTION

**Aquifer to be Exempted:** Portions of the Tulare Formation within the Cymric Oil Field.

**Areal Extent of Aquifer Exemption:** The areal extent of the existing AE and the proposed expansion in the Cymric Oil Field is approximately 10,755 acres. This acreage includes 2,291 oil-productive acres exempted at primacy in 1983, and approximately 8,464 acres comprising the current oil producing area outside the existing exemption boundaries and areas planned for future commercial hydrocarbon production. The lateral extent of the proposed exempt area is defined by the extent of oil within the hydrocarbon-bearing Tulare Formation; to the south, the Cymric Oil Field is adjacent to the McKittrick Oil Field, where the Tulare Formation is exempt. See Figure 2 for a depiction of the proposed exempt formation.

**Lithology, Total Dissolved Solids (TDS), Depth, Thickness, Porosity, and Permeability of the Aquifer:** The following table presents the lithology, range of TDS levels, depth, thickness, and average porosity and permeability information about the aquifer proposed for exemption.

<i>Aquifer</i>	Tulare Formation.
<i>Lithology</i>	Interbedded sands and gravels, fine-grained silts and clays, and matrix-supported mud-rich conglomerates.
<i>TDS (mg/L)</i>	7,587 mg/L (average); ranges from 1,381 to 14,412 mg/L.
<i>Depth to Top</i>	Ranges from 0 to 1,317 feet BGS; average 484 feet BGS or 350 feet MSL
<i>Thickness (feet)</i>	48 feet to 1,457 feet (averaging 766 feet).
<i>Porosity and Permeability</i>	Porosity ranges from 33% to 37% (averages 35%). Permeability ranges from 200 to 4,000 millidarcies (mD).

**Confining Zone(s):** In the Cymric Oil Field, the Tulare Formation is confined above by clay and shale layers and below by a regionally extensive shale. Lateral confinement in the area proposed for exemption is provided by an inward pressure gradient (i.e., a “pressure sink” caused by the withdrawal of fluids) in all directions, along with folding to the east and west. See Figures 3.1 through 3.5.

## **BACKGROUND**

On July 16, 2018, the EPA received a request from DOGGR to exempt portions of the Tulare Formation of the Cymric Oil Field, in Kern County, California. DOGGR reviewed the operator's request and proposed this AE based on the criteria at 40 CFR §146.4(a): it does not currently serve as a source of drinking water; and at 40 CFR §146.4(b)(1): it cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon, or geothermal energy-producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible. After EPA's approval of the AE, the exempt formation would not be protected as an "underground source of drinking water" (USDW) under the Safe Drinking Water Act (SDWA) and DOGGR would be authorized, subject to state regulatory requirements, to approve Class II injection into the identified formation.

The first oil well producing from the Tulare Formation in the Cymric Oil Field was drilled in 1909. EOR operations in the field using cyclic steam recovery (i.e., steaming) began in 1964 and were expanded to include steam flooding in 1975. These activities expanded through the 1980s. Currently, there are over 937 active production wells completed in the Tulare Formation in the Cymric Oil Field.

## **BASIS FOR DECISION**

### **Regulatory Criteria under which the AE is Requested and Approved**

#### **40 CFR § 146.4(a) It does not currently serve as a source of drinking water.**

In their concurrence on this AE request, the State Water Resources Control Board (State Water Board) determined that the portion of the Tulare Formation proposed for exemption does not currently serve as a source of drinking water and it is not hydraulically connected to any domestic or public water supply wells. This is based on an evaluation of information about water supply wells in the area, groundwater flow patterns, and confinement of groundwater flow. These reviews demonstrate that the aquifer proposed for exemption does not currently serve as a source of drinking water because there are no existing drinking water supply wells, public or private, that currently or in the future would draw water from the portion of the Tulare Formation proposed for exemption. In addition, the formation is vertically and laterally confined (i.e., separated) from other USDWs, and no aquifers that serve as sources of drinking water are hydraulically connected to the formation. Further, within the State's water well search area (described more fully below), the Tulare Formation is not currently a source of drinking water.

**Water Supply Wells:** DOGGR's AE request included information about wells in the area proposed for exemption to establish that no drinking water wells draw from the area of the aquifer proposed for exemption. The applicant searched well records in accordance with a request from the Central Valley Regional Water Quality Control Board to identify wells within a water supply well search area ("study area") that extended 1 mile beyond the administrative boundary of the Cymric Oil Field and 1 mile beyond the proposed aquifer exemption boundary, where the boundary is outside the administrative limits of the Cymric Oil Field.

The water supply well search involved reviewing the following sources: the State Water Board's GeoTracker GAMA database, DOGGR's Well Finder database, Kern County Environmental

Health Department data, well completion reports from the Department of Water Resources, the West Kern Water District (WKWD) 2011 Urban Water Management Plan, and well searches associated with AE proposals in oil fields in the area, including the McKittrick, Kern River, Lost Hills, and Midway-Sunset Oil Fields.

The AE request identified two water supply wells in the study area. One is an industrial well that is screened in the Alluvium and is separated from the Tulare by the Basal Alluvial Clay; the other is a well of “unspecified use” that is 250 feet deep and is screened in the Monterey Formation, which is separated from the Tulare by the San Joaquin-Etchegoin and Reef Ridge Formations. (See Table 1.) For completeness, the proposed AE request also identifies 47 non-water supply wells in the search area. These include monitoring wells, corrosion protection wells, and wells that were destroyed or could not be field verified. No public or private drinking water supply wells were identified within the study area. The closest public water supply wells to the Cymric Oil Field, which are operated by the Buttonwillow County Water District, are located 8.3 miles east-northeast of the study area.

The AE package includes a statement from the WKWD that the Tulare Formation does not currently serve as a source of drinking water and is not reasonably expected to be used in the future in the area proposed for exemption.

**Groundwater Flow Patterns:** Fluid flow in the Tulare Formation is toward the producing wells in the center of the field (i.e., from high to low pressure) and away from the boundaries of the area proposed for exemption. This is because more fluid is withdrawn from the aquifer than is injected, based on injection and production data provided in the AE package.

**Confinement of the Formation to Groundwater Flow:** Primary vertical upper confinement of the Tulare Formation is provided by the Basal Alluvial Clay (where it is present). The Basal Alluvial Clay is identified based on well logs. It has a permeability ranging from 0.7 to 1.2 mD; these values are based on the analyses of samples of cores taken from wells in the area. The Basal Alluvial Clay is not present throughout the AE area; however, the oil-bearing sands of the Tulare Formation exist as discontinuous sections that are referred to as “baffles” that are separated by shale intervals, which act as confining layers within and above the sands to prevent migration of injected fluids. The discontinuous nature of the sands is evidenced by temperature measurements from well logs that show that the heat from the injected steam is contained within the injection intervals. Additional upper confinement is provided by a negative pressure sink due to production of fluids from the formation (see below) and geologic structures within the field.

Below the Tulare Formation, a regionally extensive shale layer acts as a lower confining layer. The permeability of this shale ranges from 1.7 to less than 5 mD; this is based on logs from wells in the proposed AE area. The continuity of this shale unit is demonstrated in cross sections provided in the AE package.

Lateral confinement in all directions within the area proposed for exemption is provided by an inward pressure gradient (i.e., a “pressure sink” caused by the withdrawal of fluids) along with folding to the east and west. See Figures 3.1 through 3.5.

- *To the north and south:* confinement is provided by an inward pressure gradient created by the withdrawal of fluids from the Tulare Formation in the Cymric Field. Fluid balance

data provided in the AE package indicates that significantly more fluid has been withdrawn than has been injected. Injection and production data collected between 1977 and 2016 indicate that 2,398,732,322 bbls of oil and water have been produced. Cumulatively, over that same time period, 727,714,422 bbls of steam and 109,267,296 bbls of water have been injected. This equates to a net withdrawal of 1,561,750,604 bbls of fluid from the Tulare Formation during that time period. This withdrawal causes the fluids within the proposed AE area to move toward the producing wells. Additional evidence of this pressure sink is provided by water level data in wells within the oil field; water level measurements over time show that the area that is saturated with oil and the water level is lowering and moving toward the center of the field. The extent of the area that is contained by the pressure sink is defined by the contact between oil and water, which is determined based on well logs and core data.

- *To the east and west:* in addition to the confinement provided by the inward pressure gradient, confinement to the east and west is also provided by geologic features (known as anticlines) that deform the Tulare Formation and trap injected steam. These features are depicted in cross sections provided in the AE package, and presented in Figures 3.3 through 3.5.

After reviewing information regarding the location and depth of the existing drinking water supply wells, groundwater flow within the Tulare Formation, and the lateral and vertical confinement of the formation as described above, the EPA concludes that the Tulare Formation is not currently a source of drinking water and is not hydraulically connected to any domestic or public drinking water supply wells. Therefore, the EPA has determined that the aquifer proposed for exemption meets the criteria at 40 CFR § 146.4(a).

**40 CFR § 146.4(b)(1)** *It cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.*

DOGGR provided information on hydrocarbon production in the area proposed for exemption along with supporting documentation such as historic production data, the locations of current producing wells, well logs, and sidewall core sample data to demonstrate the presence of commercially producible quantities of oil in the Tulare Formation within the Cymric Oil Field.

The Tulare Formation is productive throughout the Cymric Oil Field. Since its discovery in 1909, the Tulare Formation in the Cymric Oil Field has produced over 260 million bbls of oil and 20,926 million cubic feet of gas through 2016. Figure 4 shows the location of all oil wells in the Cymric Field, including the 937 producing wells within the area proposed for exemption.

Throughout the field, the presence of hydrocarbons in the Tulare Formation is demonstrated through historic production data, evaluation of well logs, and the physical properties (including the presence of oil) in cores that were generated when the wells were drilled. Oil saturation of the Tulare Formation within the Cymric Oil Field is 65%.

Based on a review of information such as well logs, production data, the history of oil production, and the implementation of enhanced recovery techniques such as steaming that have

the potential to increase the productivity of the Tulare Formation, the EPA has determined that the aquifer proposed for exemption meets the criteria at 40 CFR § 146.4(b)(1).

### **PUBLIC NOTICE AND COMMENT**

DOGGR provided public notice of this proposed AE on January 26, 2018 and held a public hearing on February 27, 2018 in Bakersfield, CA. The public comment period closed on March 14, 2018. DOGGR provided the EPA a summary of the public comments, copies of the public comments submitted, a transcript of the public hearing, and their responses to the written and oral comments.

In making this decision, the EPA considered all the information submitted by the State, including all the written and oral comments submitted to the State during its public comment process. Most of the issues raised in the comments are outside of the scope of this AE decision. Specific responses not addressed by DOGGR are provided below.

One commenter (The Center for Biological Diversity) wrote to DOGGR and commented that the EPA should reject the AE request before an environmental review has occurred under the National Environmental Policy Act (NEPA). The EPA believes that the public comment and hearing process afforded by DOGGR and the technical analysis to protect USDWs required in the aquifer exemption proposal process under the EPA's UIC regulations and the enabling legislation in the SDWA provide a functionally equivalent environmental review for this decision.

The same commenter also raised concerns regarding protection of species under the federal Endangered Species Act. This issue is outside the scope of EPA's AE decision, as this action does not authorize future injection activities at the surface. Approval of this aquifer exemption concerns groundwater that is hundreds of feet below the surface, and a review of materials submitted by the commenter indicate that there are no subsurface listed threatened or endangered species that would be affected by the EPA's approval.

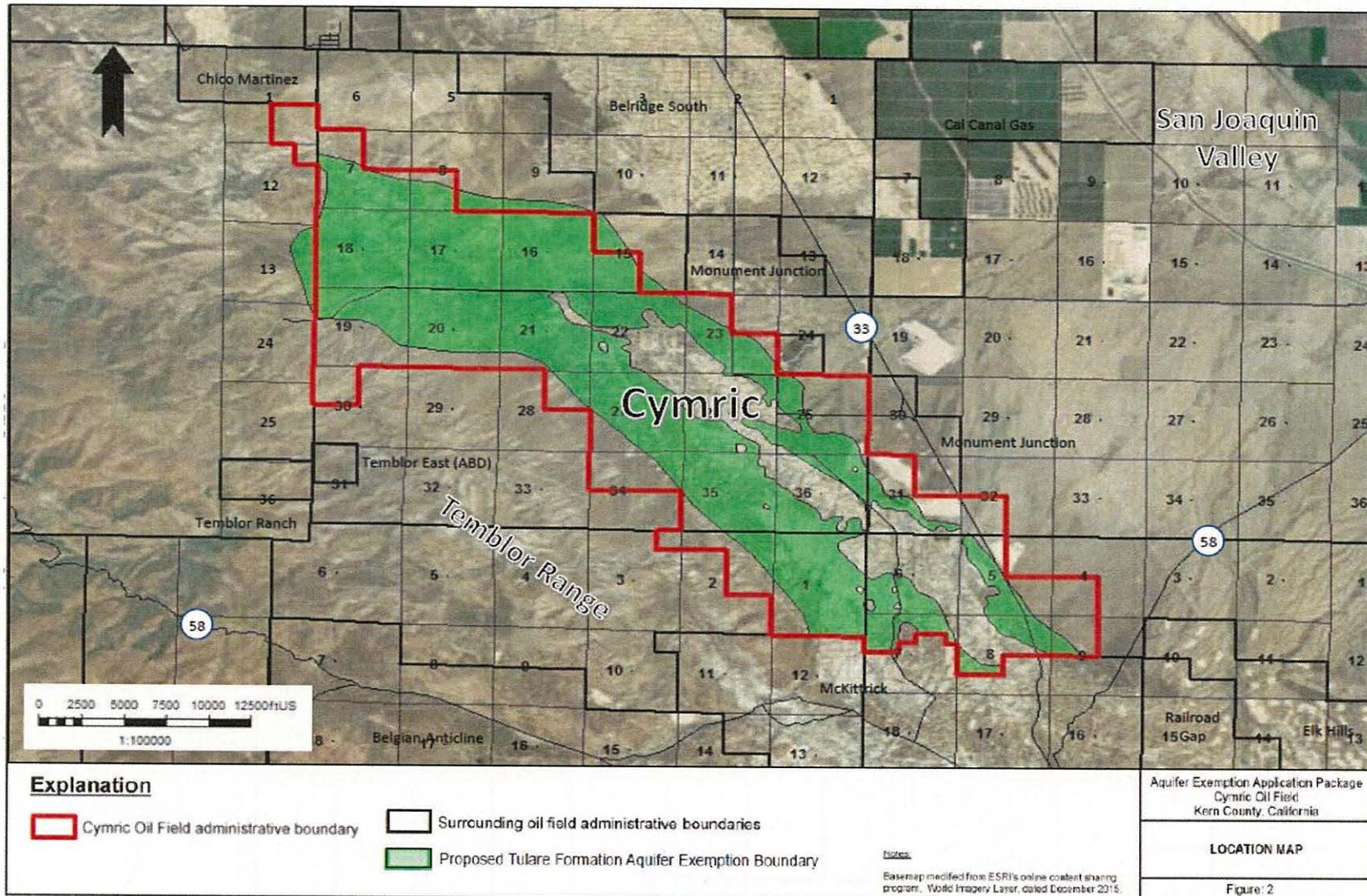
Additionally, the commenter questioned whether the current aquifer exemption criteria reflect changing climate conditions and modern water treatment technologies. In considering whether the aquifer proposed for exemption cannot now and will not in the future serve as a source of drinking water because it is hydrocarbon producing, the EPA reviewed data about hydrocarbon production in the portion of the Tulare Formation that is proposed for exemption. Based on a review of historic production data, well logs, and core data, the EPA believes that it is reasonable to conclude that the formation will continue to be commercially producible into the foreseeable future and meets the requirements at 40 CFR § 146.4(b)(1).

### **CONCLUSION AND DECISION**

Based on a review of the entire record, including all written and oral comments submitted to DOGGR during its public comment process, the EPA finds that the exemption criteria at 40 CFR § 146.4(a) and § 146.4(b)(1) have been met, and the EPA approves the aquifer exemption request as a non-substantial program revision.

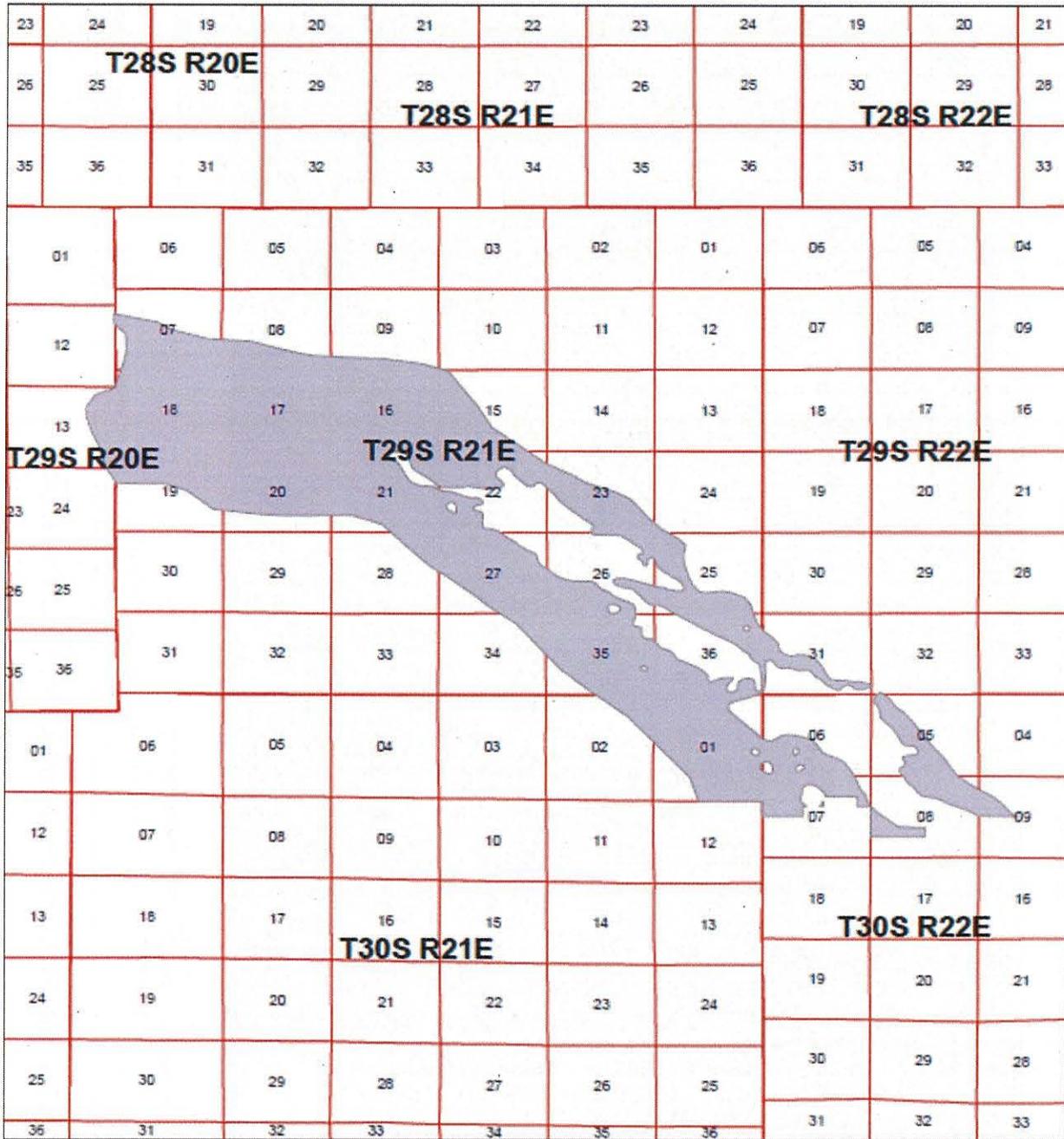
**Effective Date:** September 28, 2018

Figure 1: Location of the Cymric Oil Field, Kern County, California



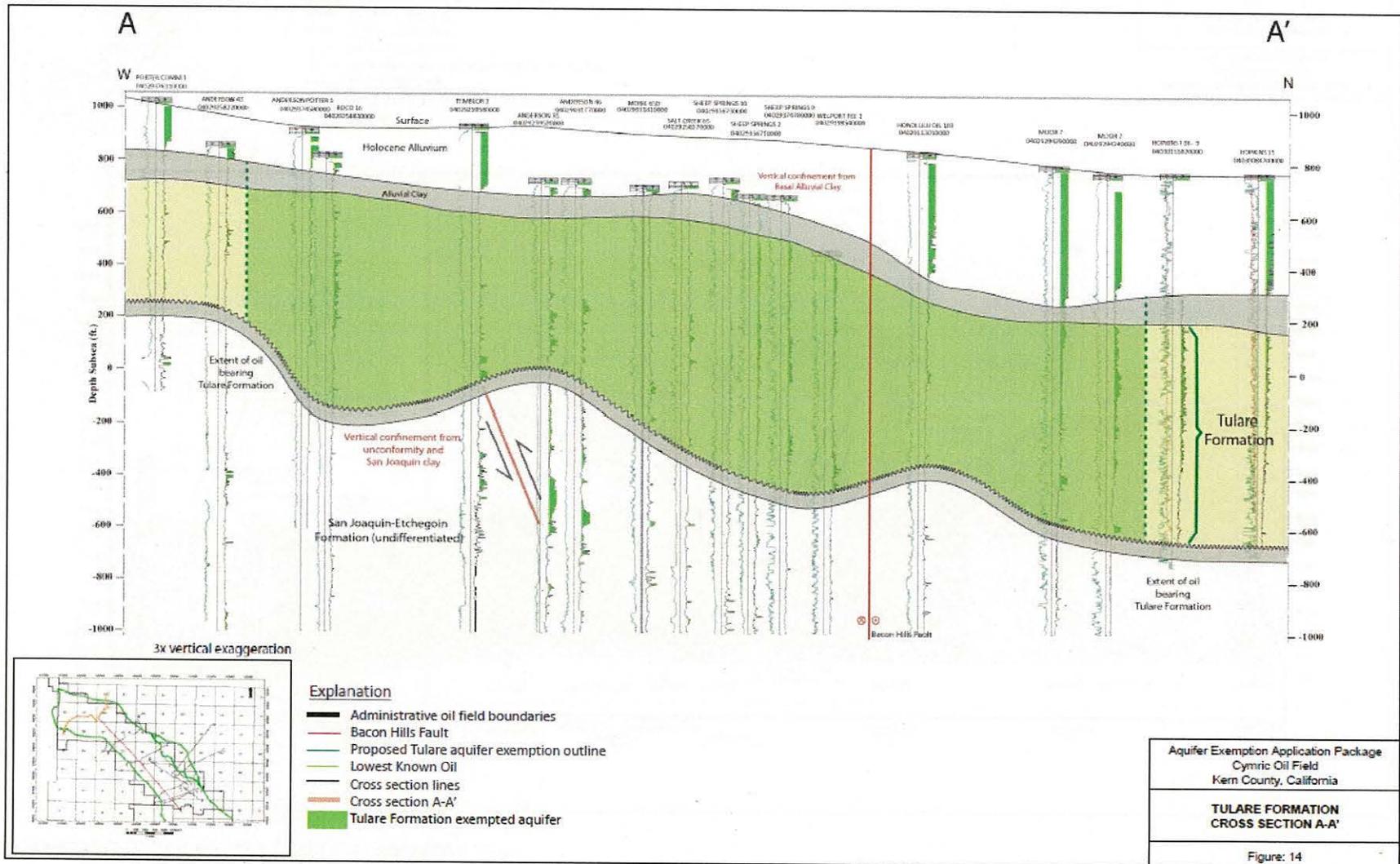
Source: Figure 2, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

**Figure 2: Tulare Formation Aquifer Exemption Location Map, Cymric Oil Field, Kern County, California**



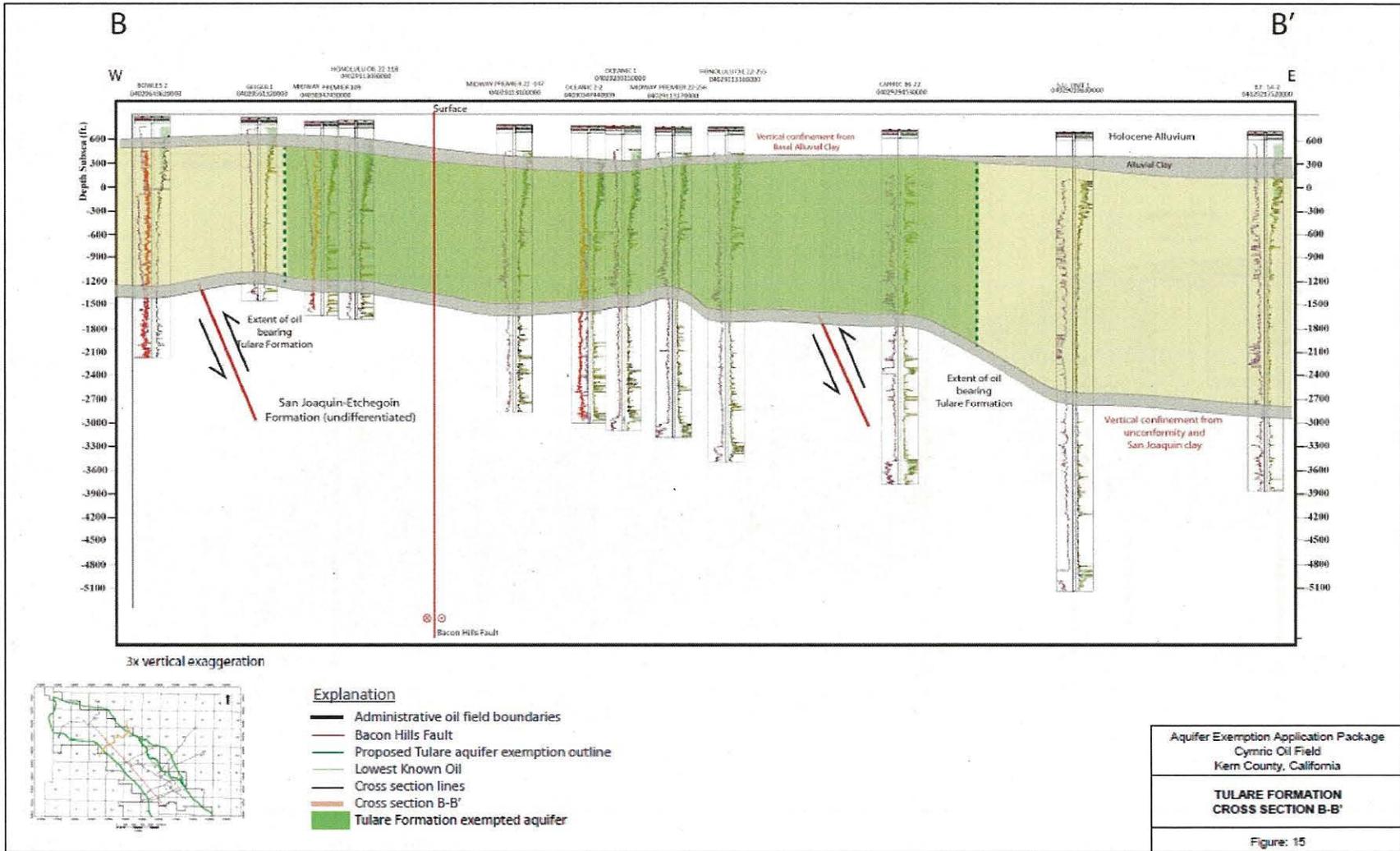
**Source: DOGGR's Aquifer Exemption Application for the Cymric Oil Field**

**Figure 3.1: Cross Section A-A' across the Tulare Formation Aquifer Exemption Area  
Cymric Oil Field, Kern County, California**



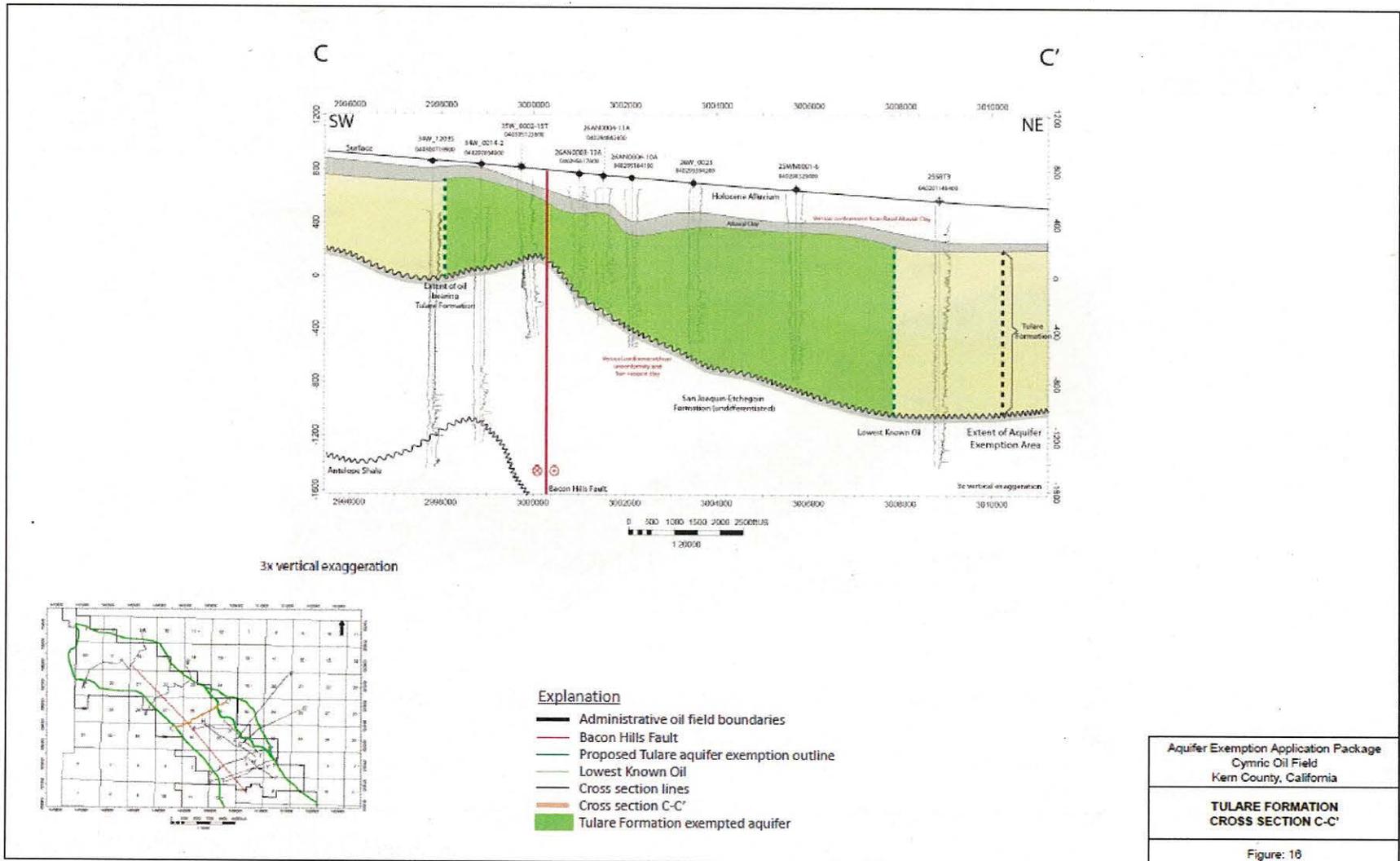
Source: Figure 14, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

**Figure 3.2: Cross Section B-B' across the Tulare Formation Aquifer Exemption Area  
Cymric Oil Field, Kern County, California**



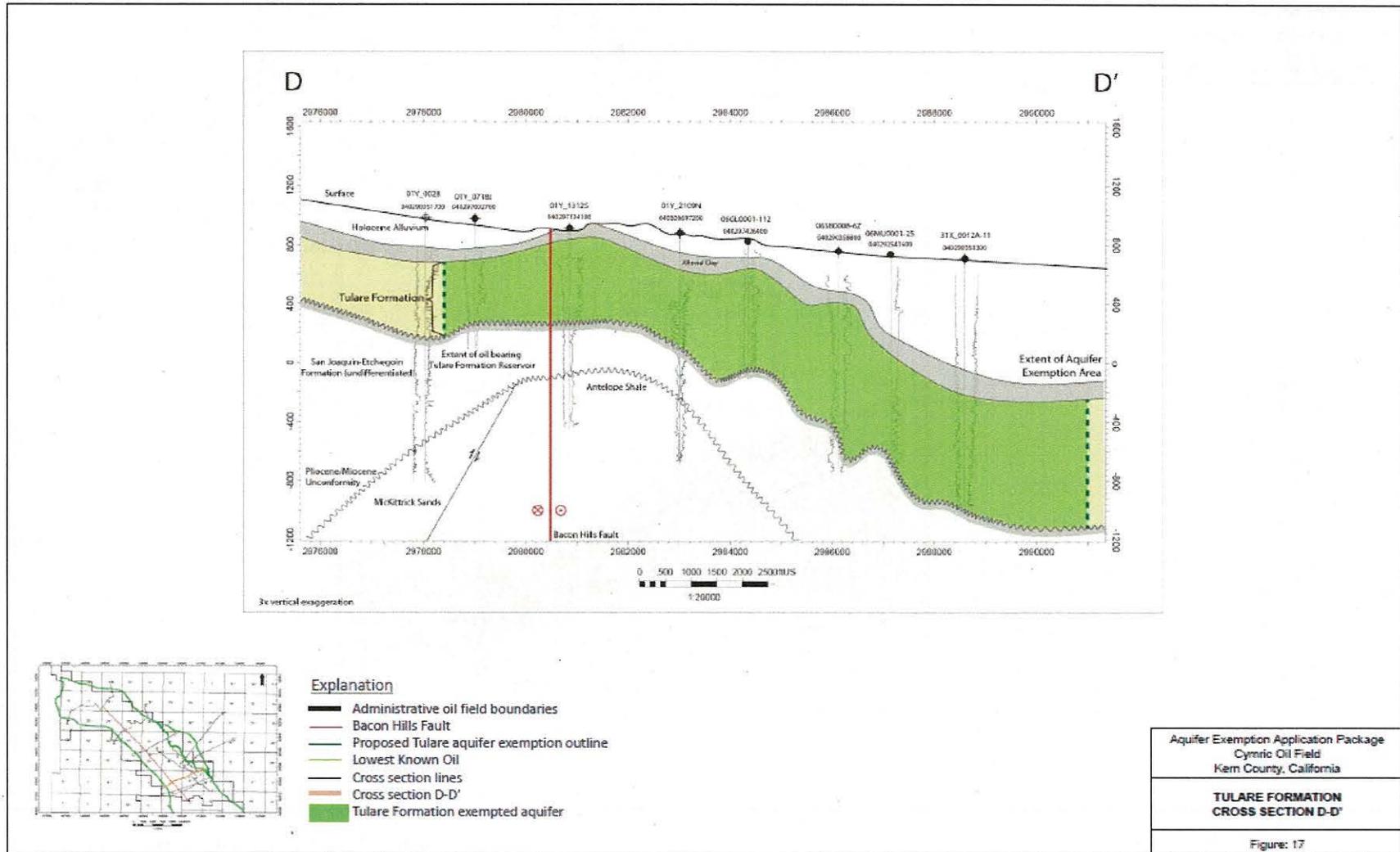
Source: Figure 15, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

**Figure 3.3: Cross Section C-C' across the Tulare Formation Aquifer Exemption Area  
Cymric Oil Field, Kern County, California**



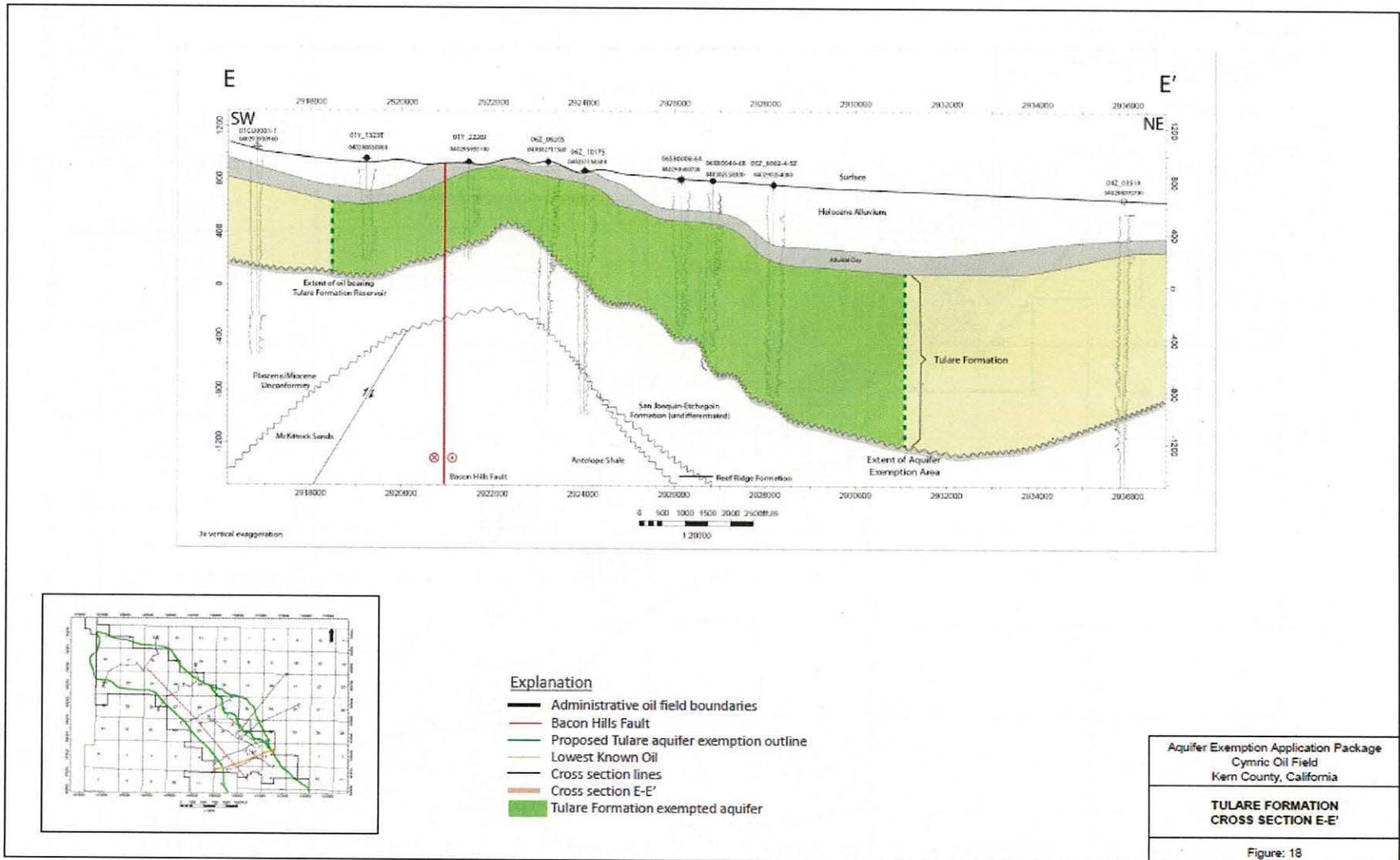
Source: Figure 16, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

**Figure 3.4: Cross Section D-D' across the Tulare Formation Aquifer Exemption Area  
Cymric Oil Field, Kern County, California**



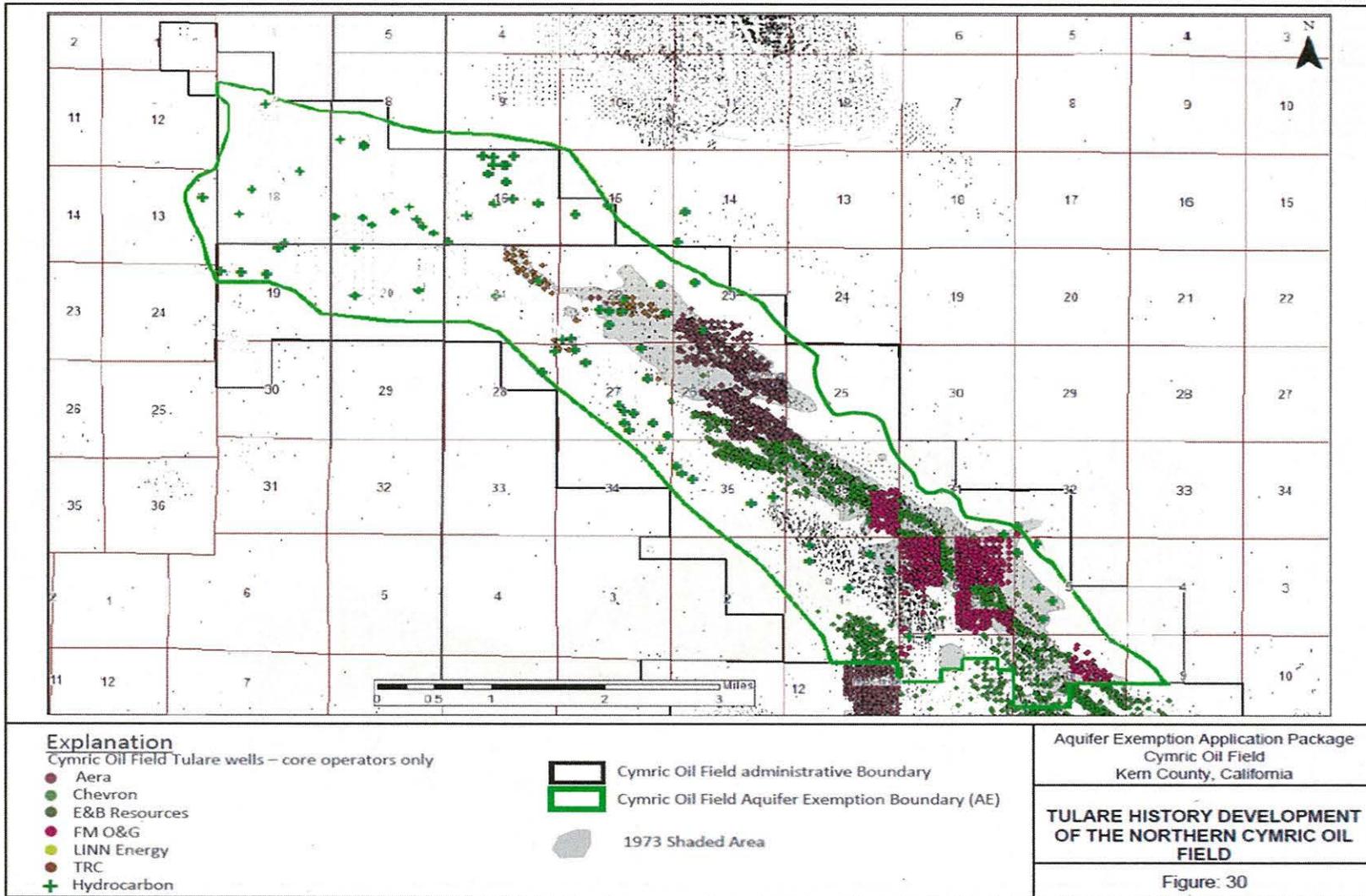
Source: Figure 17, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

**Figure 3.5: Cross Section E-E' across the Tulare Formation Aquifer Exemption Area  
Cymric Oil Field, Kern County, California**



Source: Figure 18, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

Figure 4: Location of Oil Wells in the Cymric Oil Field, Kern County, California



Source: Figure 30, DOGGR's Aquifer Exemption Application for the Cymric Oil Field

**Table 1: List of Water Supply Wells**

Well ID/ Name	Water Well Type	Distance from proposed area (feet)	Total Depth of Well (feet bgs)	Top of Well Screen (feet bgs)	Geologic Formation in Screen/Perf Interval	Township	Range	Section	Address (or Description) of Well
T30S/R21E-3	Industrial	922 from field; 3,632 from AE boundary	210	165	Alluvium	30S	21E	3	250 ft north to Sec. line from well, 2500 ft. east to sec. line from well.
T30S/R21E-11J1	Unspecified	3,472 from field; 4,583 from AE boundary	250		Monterey	30S	21E	11J1	Owner; Tidewater Oil Company, 5 mi northwest of McKittrick. (Not field verified).

**Source: Table 1, Appendix A of DOGGR’s Aquifer Exemption Application for the Cymric Oil Field**