

US Environmental Protection Agency (EPA) Region 9
Underground Injection Control (UIC) Program
AQUIFER EXEMPTION RECORD OF DECISION

This Record of Decision (ROD) provides the EPA’s decision to approve an expansion of the aquifer exemption (AE) for the Transition Zone of the Tejon Oil Field, Western Area, background information concerning the AE request, and the basis for the AE decision.

Primacy Agency: California Division of Oil, Gas, & Geothermal Resources (DOGGR)

Date of Aquifer Exemption Request: December 2, 2016

Exemption Criteria: DOGGR requested this exemption because it has determined that the proposed exempt formation meets the criteria at 40 CFR § 146.4(a) and (b)(1).

Substantial or Non-Substantial Program Revision: Non-Substantial

Although the EPA must approve all revisions to the EPA-approved state UIC programs, the process differs depending on whether the EPA finds the revision to be a substantial or non-substantial program revision. The EPA determined this is a non-substantial program revision because it is associated with site-specific Class II UIC well permits, is an expansion to an existing aquifer exemption in an active oil field, and is not a state-wide programmatic change or a program revision with unique or significant implications for the State’s UIC program. The decision to treat this AE request as a non-substantial program revision is also consistent with the EPA’s “Guidance for Review and Approval of State Underground Injection Control (UIC) Programs and Revisions to Approved State Programs” (“Guidance 34”), which explains that the determination whether a program revision is substantial or non-substantial is made on a case-by-case basis.

Operator: Vintage Production California (VPC) LLC.

Well/Project Name: West Tejon Field (also referred to as Tejon Oil Field, Western Area).

Well/Project Permit Number: Class II injection wells, including 9 active water injection wells, in the area of the Tejon Oil Field, Western Area proposed for exemption.

Well/Project Location: The AE is located in: Sections 31, 32, and 33 of T. 11 N., R. 19 W., and Sections 4, 5, and 6 of T. 10 N., R. 19 W., San Bernardino meridian. [Refer to Figures 1 and 2].

County: Kern

State: California

Well Class/Type: Class II Enhanced Oil Recovery (EOR) and Waste Disposal (WD) wells.

DESCRIPTION OF PROPOSED AQUIFER EXEMPTION

Aquifer to be Exempted: The Transition Zone (the basal portion of the Chanac Formation), which represents the sandstone that lies between the non-basal portions of the Chanac Formation (above) and the Santa Margarita Formation (below).

Areal Extent of Aquifer Exemption: The total areal extent of the existing and proposed AE expansion is approximately 1,300 acres, including the hydrocarbon-producing area which was exempted at the time of DOGGR’s primacy approval (comprised of approximately 735 acres), the current hydrocarbon producing area outside of the productive boundaries approved at primacy, and planned future commercially producible areas and zones. The lateral boundaries of the area proposed to be exempted are defined by the surface expression of the -1,690-foot total vertical subsea depth (TVSS) contour line. DOGGR has provided a GIS shape file that delineates the AE boundary, which is incorporated in the administrative record for this ROD. Refer to Figure 2 for a depiction of the proposed exemption.

Lithology, Total Dissolved Solids (TDS), Depth, Thickness, Porosity, and Permeability of the Aquifer: Geochemical sampling data provided in the AE application reflects samples taken from 10 wells within the Transition Zone (five of the samples were collected in the 1950s, and five were collected between 2013 and 2015). The following table summarizes the lithology, TDS levels, depth, thickness, and average porosity and permeability information about the aquifer proposed for exemption.

<i>Aquifer</i>	Transition Zone (the basal portion of the Chanac Formation)
<i>Lithology</i>	Sandstone with a characteristically-low clay content, variably containing turbidite deposits; terrestrial sands; poorly-consolidated, friable sandstone; and very fine- to very coarse-grained sands and cobbles.
<i>TDS (mg/L)</i>	2,838 mg/L (average of samples ranging from 2,221 to 3,317 mg/L)
<i>Depth to Top (feet bgs)</i>	2,540 to 2,700 feet
<i>Thickness (feet)</i>	210 to 270 feet
<i>Average Porosity and Permeability</i>	Porosity averages 26.4% Permeability ranges from 2 millidarcies (mD) to 4,203 mD (average 1,032 mD)

Confining Zone(s): The upper confining zone is the Chanac Formation, which is 270 to 475 feet thick in the area proposed for exemption. Fluids in the Transition Zone are laterally bounded by sealing faults to the east and west of the field (refer to Figure 3), and by an inwardly-directed pressure gradient due to production activities.

Injectate Characteristics: The injectate is water produced during oil extraction activities. The water is separated from the oil and injected back into the Transition Zone sands, from which it was extracted, for the purposes of secondary oil recovery.

BACKGROUND

On December 2, 2016, DOGGR submitted a request for the EPA Region 9 approval to expand the current AE designation for the Transition Zone in the Tejon Oil Field, Western Area, in an unincorporated area of the southern San Joaquin Valley in Kern County, California. DOGGR reviewed the operator's request and proposed this AE based on the criteria at 40 CFR §146.4(a): that it does not currently serve as a source of drinking water; and at 40 CFR §146.4(b)(1): that 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. Subsequent to the 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 and, therefore, would allow DOGGR, subject to state regulatory requirements, to approve Class II injection into the identified formation, either for EOR and/or for disposal of fluid associated with oil and gas production.

The West Tejon Oil Field has been producing hydrocarbons since 1937. The West Tejon Area was developed with vertical wells in the 1940s through 1960s, reaching peak oil production in the mid-1950s; there was minimal drilling activity in the 1970s through early 1990s. In 1998, horizontal redevelopment began in the Transition Zone and rejuvenated the field, initially effectively reducing water-cut (the percent of water in the produced fluids). However, water-cuts have steadily increased since the late 1990s and currently exceed 90 percent throughout the field. Installation of horizontal production wells continues to the present day, with five wells completed in 2014. Most of the vertical wells have been abandoned, and several of the horizontal wells are idle or have been converted from production to injection.

Operations in the Transition Zone sands include 76 active producing wells and 9 active water injection wells. Production wells currently extract approximately 993 barrels of oil per day and 49,275 barrels of water per day (based on 2014 totals). The West Tejon field has produced a little over 16 million barrels of oil and 2 trillion cubic feet of gas to date from the Transition Zone.

The prior aquifer exemption area was based on commercial petroleum production boundaries depicted in the document, "California Oil and Gas Fields, Vol. I, North and East Central California, 1973." The Transition Zone in the West Tejon field was included as an exempted aquifer since it was a productive interval. The exemption was granted at the time of Class II primacy in 1983; approximately 735 acres were exempted. [See Figure 4.]

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 package, the State Water Resources Control Board (State Board) determined that the Transition Zone is not currently a source of drinking water, and it is not hydraulically connected to domestic or public water supply wells. This is based on an evaluation of the formation's properties (based on information about oil accumulation and oil/water

contacts, core data, permeability and porosity data, and reservoir pressure), groundwater flow patterns, confinement of the formation to groundwater flow, and information about water supply wells in the area. These reviews demonstrate that the Transition Zone does not currently serve as a source of drinking water because there are no identified current public or private drinking water supply wells that draw water from the aquifer proposed for exemption. Further, the Transition Zone is vertically and laterally confined (separated) from underground sources of drinking water (USDWs) such that no existing drinking water sources are hydraulically connected to the aquifer proposed for exemption.

Water Supply Wells: The State's AE proposal included information about water wells in the area proposed for exemption to confirm that no drinking water wells or other water supply wells draw from the aquifer proposed for exemption. To support the State's effort, the applicant performed water well database searches, well records review, and site reconnaissance to identify all potential water supply wells.

DOGGR contacted the Wheeler Ridge-Maricopa Water Storage District (Wheeler Ridge District) to gather information on current use. The Wheeler Ridge District maintains a database containing both current monitoring data and available historical records. Most of the wells in the Wheeler Ridge District were originally drilled as agricultural wells. Reported depths for water supply wells in the area range from 202 feet to 1,580 feet. There is approximately 1,000 feet or more of vertical separation between these wells and the depth of the zone proposed for exemption. These wells are all screened in either alluvium or the Kern River Formation, which are above the formation proposed for exemption. The water wells are utilized for a variety of purposes, such as agriculture and domestic services, and are used in some instances as drinking water. None of the drinking water wells are completed in the Transition Zone.

In addition to the wells identified through the Wheeler Ridge District, the State and Regional Board identified several additional water wells, and confirmed that none of these wells are completed in the Transition Zone. The closest public water supply well—Well ID #12—lies at the western boundary of the area proposed for exemption. This well is vertically separated from the Transition Zone by 1,186 feet. In their concurrence on the AE package, the State Board determined that the formation proposed for exemption is not currently a source of drinking water and is not hydraulically connected to domestic or public water supply wells.

No drinking water supply wells within at least 2.5 miles around the surface boundary of the proposed exemption area currently draw from the aquifer proposed for exemption. The dimensions of this additional search area were determined as follows: the northern extent of the search area was set at 2.5 miles north of the proposed exemption area based on the location of Well A4, which is the northernmost well in the map supplied by the Wheeler Ridge District; the southern and western extent of the search area was set according to the extent of potential aquifer recharge; and the eastern extent was set at 3 miles east of the proposed exemption area for both general consistency with the northern extent of the search area, and the prevalence of water wells used for agriculture in this area.

Additionally, the shape and size of the search area were deemed sufficient by the State because both the Transition Zone and Chanac Formations deepen in all directions away from the

proposed exemption area. Therefore, the vertical separation between the total depth of the water wells and the top of the Transition Zone also increases outward from the proposed exemption area.

Groundwater Flow Patterns: DOGGR evaluated available hydrogeologic information on the Transition Zone, including groundwater flow maps and information on historic pumping patterns. Overall groundwater flow in the area is generally from recharge areas in the surrounding uplands (in the south) to discharge areas at dry lake beds (in the north).

In the Transition Zone, flow is driven by production and injection activities. There is a net-negative fluid balance in the Transition Zone, which means that more fluid is withdrawn from the aquifer than is reinjected. This creates an inward pressure gradient (i.e., a “pressure sink”) that is localized around the producing wells. Due to current and historic production, formation fluids within the Transition Zone flow inward from the proposed exemption boundary toward the center of the field.

Confinement of the Formation to Groundwater Flow: Fluids in the Transition Zone are contained by bounding faults to the east and west of the field, and by the fine-grained rocks of the Chanac Formation overlying the Transition Zone. An inwardly-directed pressure gradient due to production activities also causes fluids to remain within the Transition Zone. Geologically, the West Tejon Oil Field is comprised of a series of rock layers dipping away from the center of the field (known as an anticlinal dome), which traps the oil that is produced from the field.

The fine-grained rocks of the Lower Chanac Formation overlying the Transition Zone serve as the upper confining zone. To the north and south, the geologic features of the Lower Chanac Formation isolate oil and injected fluids in a structural trap. The Lower Chanac is a very fine-grained (occasionally very coarse), very silty, clayey, sometimes pebbly sandstone with variable clay content to a very silty, slightly calcareous mudstone.

While there is no direct information on the Lower Chanac’s permeability, there is evidence of an absence of fluid movement between the Lower Chanac and the Transition zone, including the oil column that is present below the Lower Chanac. In addition, reservoir pressure data indicate that the Lower Chanac has sealed oil over geologic time and well core data indicate that total clay percentages in the Lower Chanac are high relative, to the Transition Zone.

The Transition Zone is underlain by the Santa Margarita Formation, which is not an exempt Formation. Flow across the lower boundary of the Transition Zone into the Santa Margarita Formation is prevented by fluid incompressibility and an inward hydrostatic pressure increase with depth, in addition to production activities which result in an inward pressure gradient.

The Transition Zone is also confined laterally by faults. Faults on the western and eastern sides of the area proposed to be exempted are shown by the State to be sealing due to differences in oil-water contacts on either side of the fault, and offset stratigraphic contours. In addition, regional faults to the north and south of the field provide additional evidence of containment.

The EPA reviewed the analyses in the AE application, as described above, and concludes that the portion of the aquifer proposed for exemption does not currently serve as a source of drinking water, pursuant to 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.*

The West Tejon Oil Field has been producing hydrocarbons since 1937. DOGGR provided available information on previous hydrocarbon production, along with supporting information such as core data, well logs, and other well tests (e.g., drill stem tests) that support a demonstration of the presence of producible hydrocarbons in the Transition Zone.

The AE request provides conventional core, sidewall core, and mud log drill cutting descriptions, along with cross-sections and a type log for the Transition Zone. These cores confirm the presence of oil and provide evidence for the oil-water contact locations. Oil saturation information verifies the presence of commercially producible quantities of hydrocarbons. Drill stem testing results demonstrate the presence of oil sands in the Transition Zone.

DOGGR also provided information on past and present hydrocarbon production from the Transition Zone within the Tejon Oil Field, Western Area including annual and cumulative production information, and a summary of year-by-year and cumulative production and injection volumes in the area to evaluate which of the down-dip or down-gradient fault block areas have the potential to be commercially hydrocarbon productive in the future. Based on this information, the EPA agrees with DOGGR's determination that the Transition Zone will be used for continued and expanded production within the West Tejon Field. This concurrence is made on the basis of demonstrated historical and current production [see Table 1] and the presence and degree of oil saturation in the Transition Zone as evidenced by oil shows, mud logs, drill cuttings, and core saturation data.

Based on a review of information such as core data, well logs, and other well tests (e.g., drill stem tests) and given the long history of hydrocarbon production, the implementation of enhanced recovery techniques, and recent trends in field production, the EPA has determined that the aquifer proposed for exemption meets the criteria at 40 CFR § 146(b)(1).

PUBLIC NOTICE AND COMMENT

DOGGR provided public notice of this proposed AE on August 12, 2016. A public hearing was held on September 12, 2016 in Bakersfield, CA. The written comment period closed on September 26, 2016. 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 verbal comments.

The EPA considered all of the information submitted by the State, including all of the written and oral comments submitted to the State during its public comment process. Additionally, the EPA considered one unsolicited comment letter submitted directly to the EPA, although it was submitted outside the public comment process provided by DOGGR. In this letter, the Center for Biological Diversity requested that the EPA conduct formal notice, provide an opportunity for public comment, and a public hearing for the proposed aquifer exemption. However, federal UIC regulations do not require the EPA to provide an additional opportunity for public comment for a non-substantial program revision, and it was determined that an additional public comment period would not likely yield additional comments that were not already raised during the State's process, which was conducted consistent with 40 CFR § 144.7. While the EPA is not required to conduct public notice on non-substantial program revisions submitted by a primacy state, the EPA is exercising its discretion to respond to the comments that pertain to the EPA's action and authority. Most of the issues raised in the unsolicited comment letter from the Center for Biological Diversity are addressed by this decision document on the proposed exemption; additional responses are provided below.

The commenter questioned whether the current technical criteria to consider future drinking water uses is adequate to consider changing climate conditions and new technology available for water treatment. 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 Transition Zone – including historic oil and gas production and potential future commercial producibility. Based on a review of core data, well logs, and other well tests (e.g., drill stem tests), the EPA believes that it is reasonable to conclude that the Transition Zone in the West Tejon Oil Field will continue to be commercially producible into the foreseeable future and it meets the requirements at 40 CFR § 146.4(b)(1).

The commenter questions DOGGR's evaluation of faults in the area and its rationale for and reliance on the evidence presented as demonstrating containment. The State's analysis showed that lateral confinement is based on the presence of faults and an anticlinal dome, which traps the oil produced from the field and confines the Transition Zone. The EPA reviewed the State's analysis and examined a variety of information about the faults, including differences in oil-water contacts on either side of the fault and offset stratigraphic contours. Based on the information provided, EPA concurs with the State's findings. Moreover, the concept of aquifer containment is mandated by the State's regulations, but it is not specifically required by EPA's aquifer exemption regulations, so long as the aquifer is demonstrated to meet the federal criteria at 40 CFR § 146.4(a) and 146.4(b) or (c).

The commenter also asserts that the Kern River Formation is highly permeable and undifferentiated from the Chanac Formation. The EPA evaluated the hydraulic isolation of the Transition Zone, with respect to the Kern River Formation, as well as other USDWs, and, as stated above, EPA has concluded that no existing drinking water sources are hydraulically connected to the aquifer proposed for exemption.

The commenter also requested the EPA reject the exemption request before environmental review has occurred under the National Environmental Policy Act (NEPA). The EPA believes

that the public comment and hearing procedures afforded by DOGGR and the in-depth 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 action.

The commenter expressed concern about an evaluation of the cumulative effects of this exemption with potential future exemption requests for the same formations. This concern is out of the scope of the EPA's review in approving an aquifer exemption.

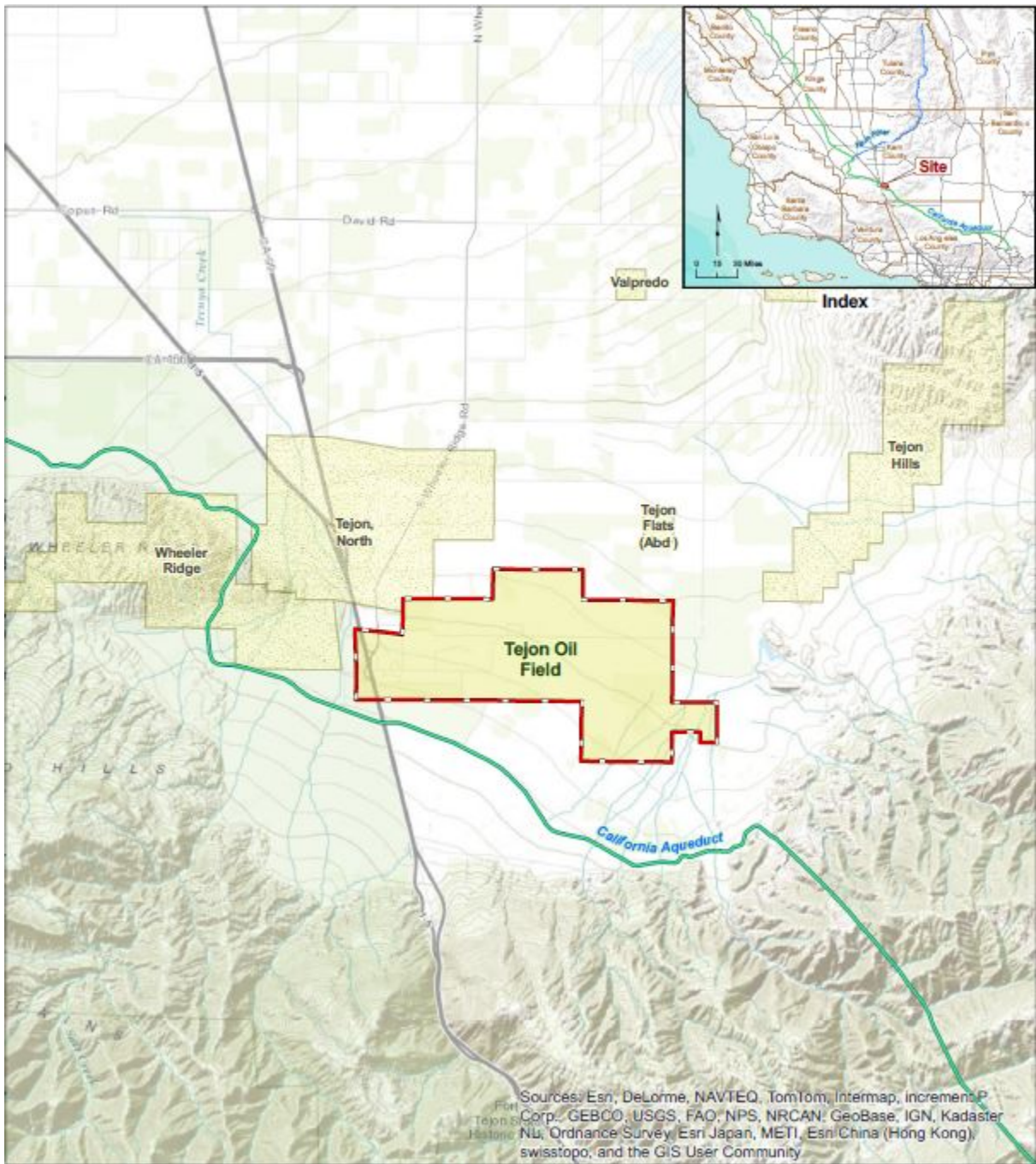
The commenter raised several additional issues, including concern over the lack of state environmental review under CEQA due to potential land use changes in Kern County, potential seismicity risk from injection activities, and potential impacts on endangered species. These issues are outside the scope of EPA's AE decision. DOGGR has primary permitting and enforcement authority over the Class II program in California, and operators may seek permits from DOGGR in the future, which authorize activities such as Class II injection well permits. The State's consideration of these permits, in accordance with applicable state and federal requirements, is expected to address these issues at the time of permitting. Moreover, with specific regard to endangered species, there are no specific ground disturbing activities authorized by this aquifer exemption approval. The proposed aquifer exemption area is 2,540 to 2,700 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.

CONCLUSION AND DECISION

Based on review of the entire record, including all the 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.

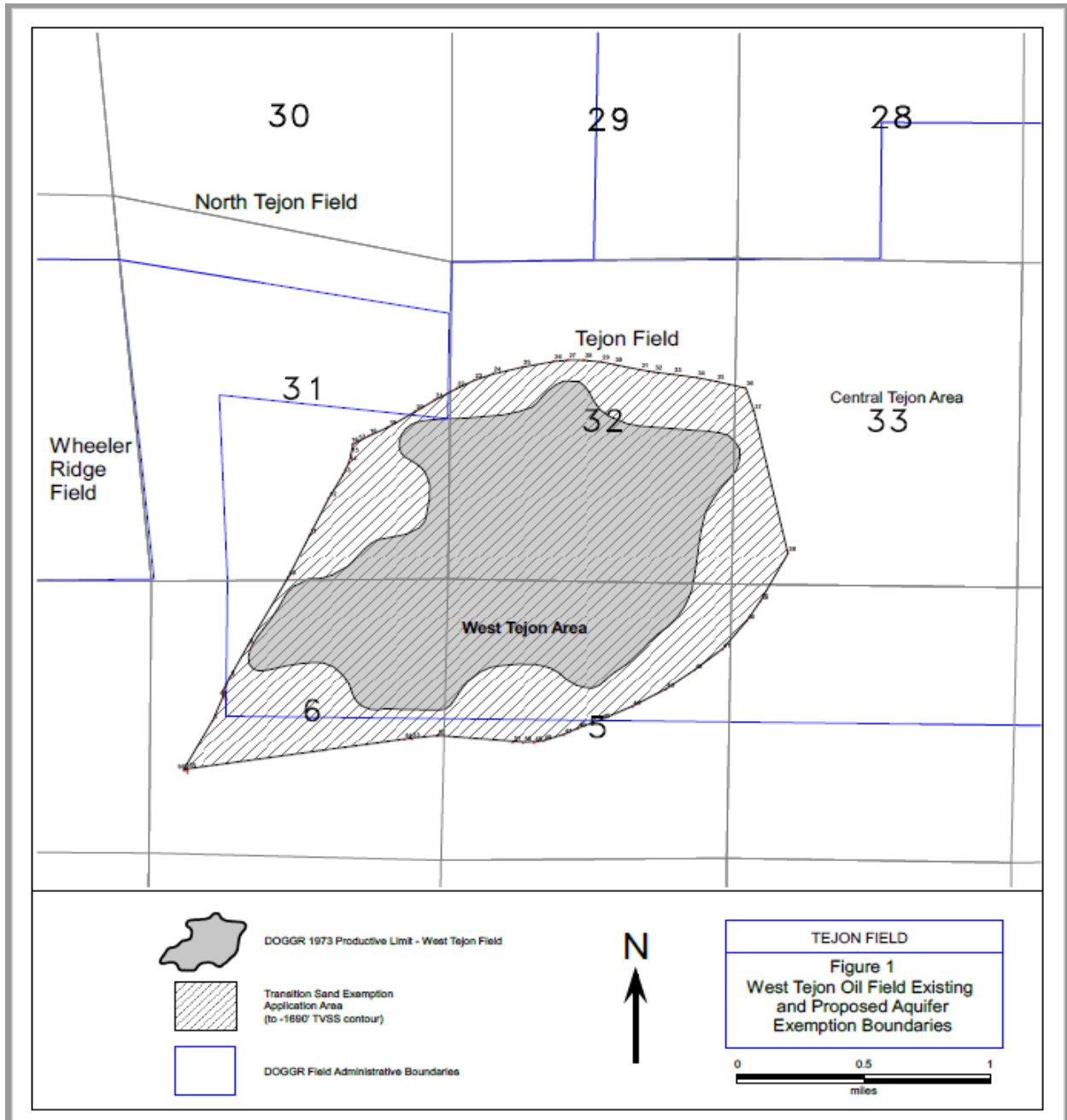
Effective Date: February 9, 2017

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



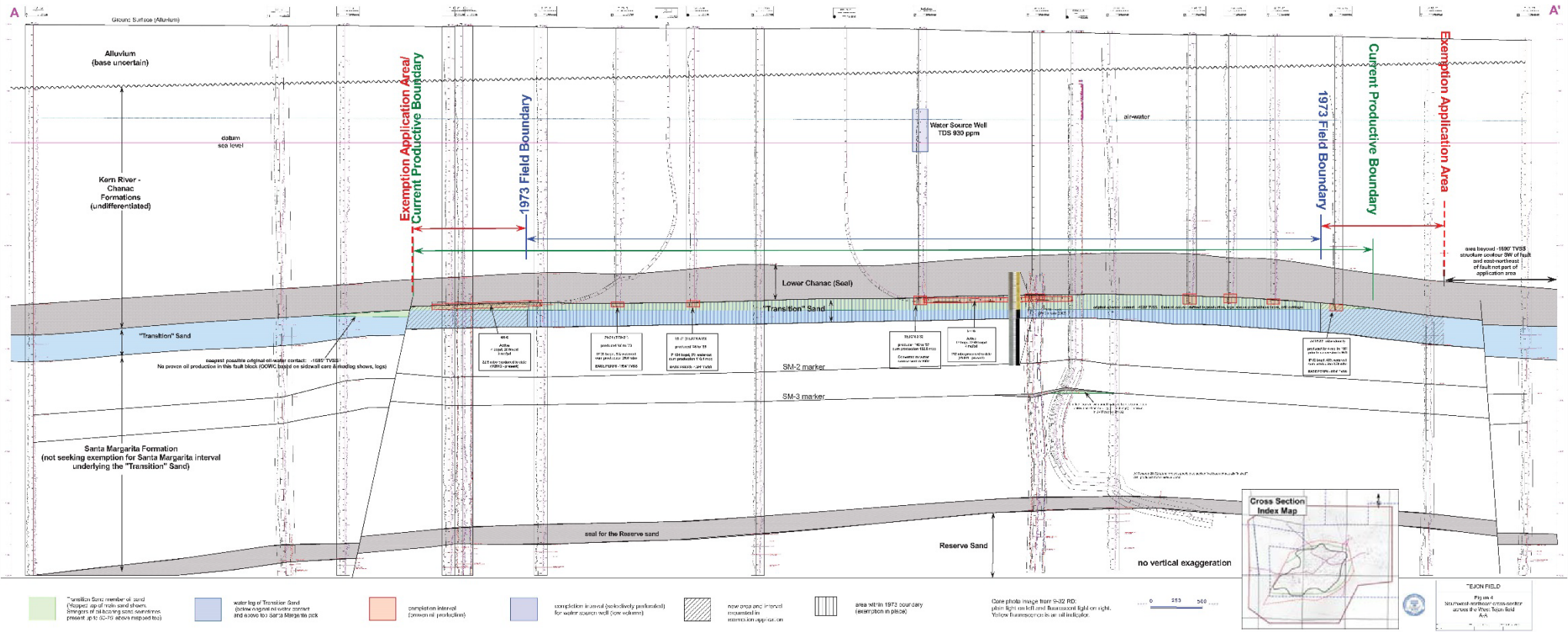
Source: Figure 1, DOGGR's Aquifer Exemption Application for the Tejon Oil Field, Western Area

Figure 2: Transition Zone Aquifer Exemption Location Map with Identifying Features, West Tejon Oil Field, Kern County, California



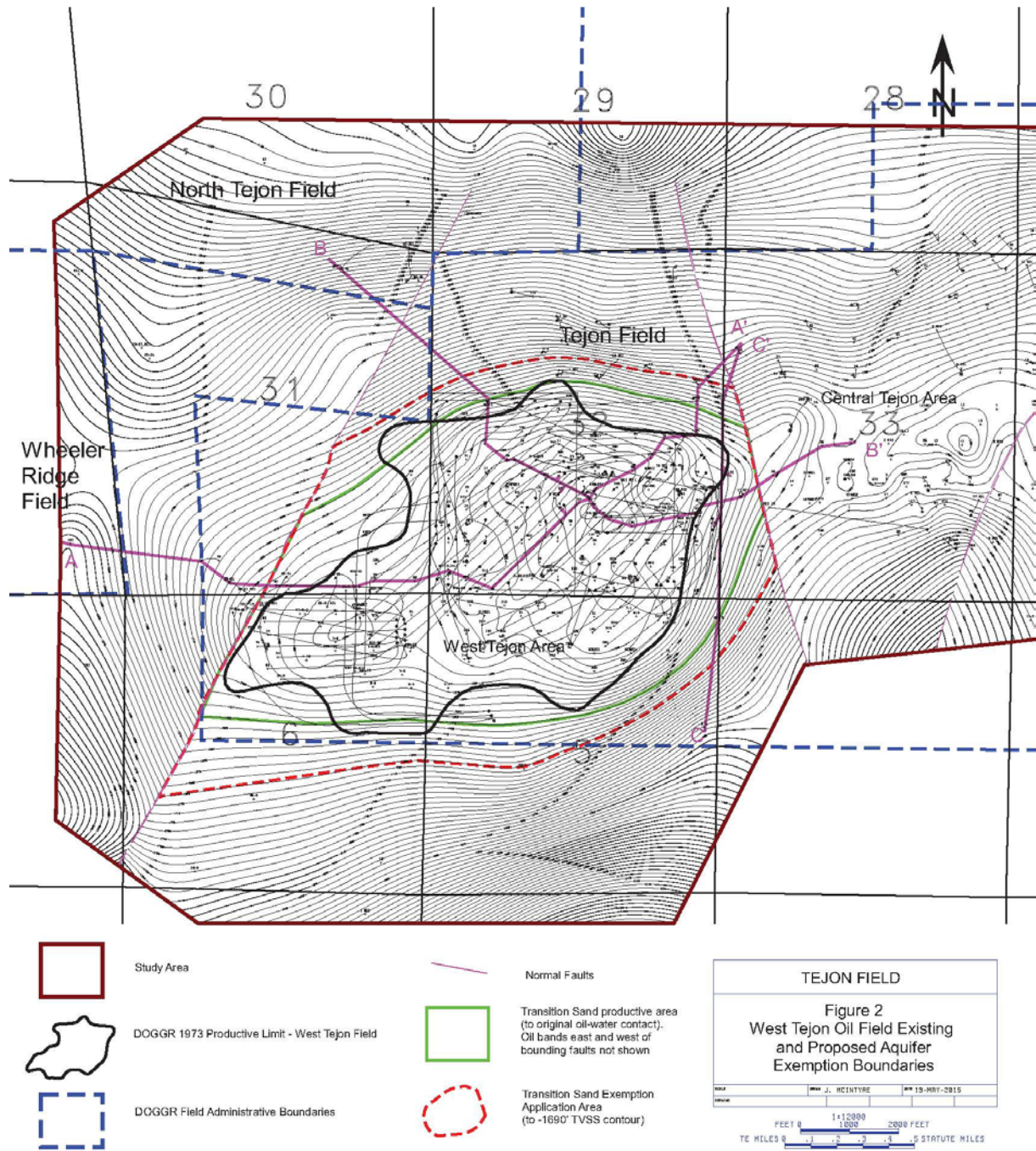
Source: DOGGR's Aquifer Exemption Application for the Tejon Oil Field, Western Area

Figure 3: Southwest-northeast Cross-section across the West Tejon Field A-A'



Source: Figure 4, DOGGR's Aquifer Exemption Application for the Tejon Oil Field, Western Area

Figure 4: West Tejon Oil Field Existing and Proposed Aquifer Exemption Boundaries



Source: Figure 2, DOGGR's Aquifer Exemption Application for the Tejon Oil Field, Western Area

Table 1: Yearly Production and Injection Volumes for Transition Zone Wells

Year	Oil Produced (bbl)	Gas Produced (Mcf)	Water Produced (bbl)	Injected Water (bbl)
1946	449.00	-	-	-
1947	251,546.00	50,626.00	59,413.00	-
1948	944,819.00	33,848.00	246,725.00	-
1949	951,656.00	73,281.00	445,477.00	-
1950	661,261.00	24,641.00	611,916.00	-
1951	475,095.00	1,809.00	677,426.00	-
1952	389,415.00	5,516.00	695,055.00	-
1953	322,414.00	590.00	711,405.00	-
1954	335,707.00	554.00	793,547.00	-
1955	543,682.00	115,889.00	1,032,424.00	-
1956	447,328.00	281.00	1,080,523.00	-
1957	562,072.00	63,173.00	1,223,376.00	-
1958	647,709.38	137,082.00	1,424,129.00	-
1959	438,442.00	157,301.00	1,826,055.00	-
1960	354,695.00	120,220.00	1,999,812.00	130,987.00
1961	364,959.00	63,041.00	1,904,228.00	823,532.00
1962	530,684.00	18,024.00	2,819,617.00	1,552,237.00
1963	452,098.00	7,712.00	3,726,082.00	2,516,221.00
1964	382,219.00	9,581.00	3,974,090.00	3,333,776.00
1965	179,047.00	47,984.00	2,209,848.00	3,657,007.00
1966	313,724.00	4,691.00	3,889,905.00	3,693,563.00
1967	293,833.00	19,029.00	3,982,699.00	3,193,677.00
1968	257,448.00	2,490.00	3,647,247.00	2,267,090.00
1969	215,541.00	3,707.00	3,446,700.00	2,175,354.00
1970	179,595.00	3,836.00	2,812,629.00	2,366,671.00
1971	159,326.00	1,207.00	2,594,768.00	2,399,192.00
1972	136,234.00	1,299.00	2,451,861.00	2,880,866.00
1973	118,459.00	1,187.00	2,146,841.00	2,062,426.00
1974	108,651.00	1,118.00	1,995,040.00	1,942,845.00
1975	95,740.00	484.00	1,941,364.00	2,110,698.00
1976	94,420.00	-	1,876,926.00	2,076,978.00
1977	83,242.00	19,969.00	1,744,731.00	2,002,200.00
1978	72,112.00	58,633.00	1,422,565.00	719,579.00
1979	70,700.00	32,200.00	1,421,329.00	725,514.00
1980	72,692.00	6,978.00	1,689,686.00	1,007,429.00
1981	71,123.00	5,977.00	1,629,944.00	990,693.00
1982	69,856.00	5,418.00	1,578,862.00	722,306.00
1983	66,383.00	2,525.00	1,206,474.00	699,886.00

1984	49,526.00	17,372.00	1,006,883.00	682,980.00
1985	48,345.00	-	1,068,602.00	866,623.00
1986	48,134.00	-	1,022,715.00	1,070,870.00
1987	26,176.00	-	474,814.00	900,811.00
1988	20,564.00	-	351,290.00	340,420.00
1989	18,511.00	22,850.00	456,589.00	410,511.00
1990	19,315.00	36,193.00	269,724.00	302,055.00
1991	17,862.00	-	529,943.00	656,872.00
1992	16,053.00	-	519,202.00	657,927.00
1993	15,615.00	-	473,246.00	580,917.00
1994	13,638.00	-	352,850.00	405,198.00
1995	3,373.00	-	65,798.00	85,257.00
1996	4,555.00	-	215,422.00	250,252.00
1997	5,127.00	-	207,168.00	245,863.00
1998	4,893.00	-	179,783.00	208,531.00
1999	2,154.00	48,129.00	211,217.00	309,924.00
2000	5,628.00	-	469,285.00	507,405.00
2001	21,066.00	-	807,408.00	1,201,270.00
2002	88,744.00	65,548.00	572,980.00	697,898.00
2003	191,467.00	22,549.00	1,461,679.00	1,485,560.00
2004	188,103.00	48,362.00	2,687,576.00	2,701,147.00
2005	244,130.00	40,505.00	4,654,916.00	4,760,429.00
2006	240,096.00	36,852.76	5,219,411.00	4,926,738.00
2007	217,511.00	43,227.00	6,516,315.00	6,481,257.00
2008	228,065.68	73,945.62	5,339,304.99	5,920,639.00
2009	484,643.86	72,028.94	7,554,106.78	7,594,027.00
2010	444,595.92	93,115.33	10,609,360.83	10,675,750.00
2011	394,631.57	91,531.75	11,562,937.17	11,676,259.00
2012	635,492.10	133,391.03	14,232,244.37	12,786,612.00
2013	665,012.42	137,588.46	19,030,508.91	19,082,115.00
2014	380,871.02	118,845.07	18,260,760.08	18,427,013.00

Source: Table 7, DOGGR's Aquifer Exemption Application for the Tejon Oil Field, Western Area