



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

To: William Munson
Associate Oil & Gas Engineer
California Department of Conservation

FROM: Jim Lederhos, PE
Chief Executive Officer
Premier Resource Management, LLC

DATE: September 16, 2024

**SUBJECT: PRM RESPONSE TO WATERBOARDS: REVIEW OF THE NORTH
ANTELOPE HILLS AQUIFER EXEMPTION FOR THE TULARE
FORMATION, KERN COUNTY**

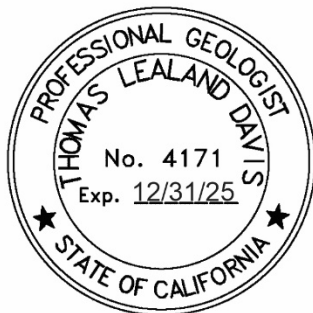
Statement of Certification

I certify that this document and all attachments were prepared under my direction and supervision. The findings, recommendations, specifications, or professional opinions presented in this document were prepared in accordance with generally accepted professional geologist practice and, to the best of my knowledge and belief, are true, accurate, and complete.

Thomas L Davis

DATE: October 15, 2024

Registered Geologist No. 4171





33728 Dresser Avenue, Bakersfield, California USA

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Premier Resource Management, LLC (applicant) respectfully submits the follow responses, and attached documents, to the State Water Resources Control Board and the Central Valley Regional Water Quality Control Board (Central Valley Water Board). These documents are provided in response to Central Valley Water Board staff (Staff) preliminary review letter issued on December 7, 2023.

The following contains PRM's responses to Staff's questions and concerns, which have been numbered to correspond with the letter issued December 7, 2023. All requests for updated figures and tables have been addressed with new files placed in a shared folder with CalGEM, labeled "PRM Tulare AE_June 2024 Addendum."

1. Title 40 of the Code of Federal Regulations Section 146.4 criteria for exempted aquifers (a) – it does not currently serve as a source of drinking water.

A. The location of the GAMA Wells within the study area are noted on Figure 1. Five wells are found within the study area, all located in Section 34, T20S-R20E. All five wells are located outside the proposed Tulare Oil Sand Aquifer Exemption Area. All data available through the GAMA Groundwater Information System online database (<https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/>) is presented in Tables 1 through 5 in the Water Board Response Appendix included with this document.

As stated in previous documents, the Tulare Oil Sand Aquifer Exemption Area represents the contiguous extent of the Tulare Oil Sand Aquifer, as bounded by faults or sand pinchout. This sand was deposited at the very beginning of deposition of Tulare Formation strata. This permeable sand was derived from detritus eroded from exposed Eocene-age strata (dominantly Point of Rocks Sand) and deposited within a broad, shallow valley or gully trending roughly east-west. This deposition was restricted to the depression in which it was deposited and thus has defined limits to the north and south (ie. Sand pinches out to the north and south). Structural evolution subsequent to deposition has introduced limited faulting, which form the lateral boundaries on the east and west of the proposed exemption area. A subsurface structure contour map of the Tulare Oil Sand interval is presented in Figure 2.

Figure 2 shows that the Tulare Oil Sand does not extend to the area of the GAMA wells noted in Figure 1. The Tulare Oil Sand requested for aquifer exemption cannot be present in the area of the GAMA wells due it's restricted lateral extent.

Examination of the available well data obtained from the GAMA Groundwater Information System shows that depths are unknown for four of the 5 wells. Depth is only known for the southernmost of the five GAMA wells and is stated to be 460 feet in depth. Assuming the other four GAMA wells are of similar depth, that would put the GAMA well depths at 500 to 800 feet above the equivalent depth of the Tulare Oil Sand, likely within the alluvium and uppermost portion of the Tulare Formation, above the Tulare Clay interval. The status of the five GAMA wells is unknown from available public data, but sampling records for all five



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

wells date from 1954 to 1966. There is no evidence of any activity or use for sampling for 58 years. Furthermore, examination of the water chemistry results for the five GAMA wells show that of the tested components, most tested at above the required reporting limits for components such as Boron and others. Please see appendices A & B attached for additional water quality data.

B. Applicant contacted Kern Groundwater Authority Groundwater Sustainability Agency (Kern GSA) to inquire about local management goals within one mile of the proposed AE.

The details supporting PRM's communication with Kern GSA include:

Initial Letter

TO: Patricia Poire
Executive Director
Kern Groundwater Authority GSA

FROM: Jim Lederhos
Chief Executive Officer
Premier Resource Management, LLC

DATE: May 2, 2024

SUBJECT: Request for local management goals for the current or future use of groundwater within one mile of Premier Resource Management's proposed aquifer exemption area

LOCATION:

Township 27 South, Range 19 East, MDB& M

Section 25: North Half of Southeast Quarter (N/2 SE/4) and South Half of South Half of Northeast Quarter (S/2 S/2 NE/4) (Tract 1), Township 27 South, Range 20 East, MDB&M
Section 30: Southwest Quarter (SW/4) and West Half of Southeast Quarter (W/2 SE/4)

Township 27 South, Range 20 East, MBD&M

Section 31: Northwest Quarter (NW/4) and the West Half of the West Half of the Northeast Quarter (W/2 W/2NE/4),

REQUEST:

Premier Resource Management, LLC (PRM) has proposed an aquifer exemption for the Tulare Formation to Central Valley Regional Water Quality Control Board. As part of this process, PRM needs to contact Kern Groundwater Authority GSA to inquire if they have local management goals for the current or future use of groundwater within one mile of the proposed



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

AE area (map below). We respectfully ask for written supporting communication of your response for Kern Groundwater Authority GSA.

Thank you,

Jim Lederhos

Initial Response

Hello,

Thank you for reaching out to me, however I have retired. If you need any information concerning the Kern Groundwater Authority, please contact Valerie Kincaid at vkincaid@pariskincaid.com.

It has been a pleasure working with you.

Patty Poire

Second Attempt (Same Letter Used) May 2, 2024

Good afternoon Director Kincaid,

Premier Resource Management respectfully requests your written response for Kern Groundwater Authority GSA local management goals in relationship to our proposed aquifer exemption under consideration at the Central Valley Regional Water Quality Control Board.

This formal request is attached. We appreciate your timely response with written supporting communication.

Best regards,

Mike Umbro

Partner, Premier Resource Management

Third Attempt June 11, 2024

Dear Miss Kincaid- I am following up on our request last month. Does Kern Groundwater Authority GSA have local management goals in relationship to our proposed aquifer exemption?

Thank you,

Mike Umbro

Partner, Premier Resource Management



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

Response June 11, 2024

Mike,

The KGA has a groundwater sustainability plan that guides groundwater management in its jurisdiction. See the link below to the most recent GSP and annual reports:

[Reports – Kern Groundwater Authority \(kerngwa.com\)](https://kerngwa.com)

Valerie C. Kincaid

Partner

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PRM Teaming with Westside Water Authority (WWA)

- **PRM met with Justin Rowe, WWA in early July 2024**
- **PRM & National Renewable Energy Laboratory (NREL) presented a funding opportunity through Department of Energy Geothermal Technologies Office GRID – July 24, 2024.**
 - **NREL submit a letter of intent listing WWA and PRM as teaming partners for this FOA (copy of support letters provided in addendum).**
 - **PRM invited to Belridge Water District on August 14, 2024, with WKWA members to discuss teaming opportunities in the region.**



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

Kern Groundwater Authority: Groundwater Sustainability Plan

Immediately following Valerie Kincaid's response, PRM accessed the Amended Kern Groundwater Authority's Groundwater Sustainability Plan dated July 27, 2022.

PRM's Tulare AE is located within the boundaries of the Westside Districts Water Authority (WDWA)

The following section "KGA Management Area Responses to Deficiency 2, Comment CC to all GSPs" was copied from WDWA's response Table 2b on page 25:

"Chronic Lowering of Groundwater Levels. Due to naturally occurring poor groundwater quality, groundwater demand (i.e., 3,000-5,000 AFY) is largely limited to use for blending with surface water from the aqueduct. Further, much of the WDWA is undeveloped rangeland, or is used for oil and gas production with no significant current or planned groundwater uses. The WDWA has no control over oil and gas activities. The WDWA has revised categorization of areas within its management area to coordinate with adjacent management areas and match subbasin definitions. The revised WDWA will contain a single management area and two watch areas as follows. Lost Hills Watch Area (approximately 33,191 acres) and Southwest Watch Area (approximately 48,739 acres). The watch areas include non-cultivated lands, areas adjacent to former or active oilfields and open rangeland.

Reduction in Groundwater Storage. Due to naturally occurring poor groundwater quality, groundwater demand (i.e., 3,000-5,000 AFY) is largely limited to use for blending with surface water from the aqueduct. SGMA-related groundwater extraction de minimis when compared to natural underflow. Based on CV2Sim modeling, the principal factor (approximately 111,000 AFY) affecting change in groundwater storage is natural underflow toward the axis of the valley. To further monitor for changes in groundwater storage, the WDWA will utilize data from representative monitoring wells and the planned update to the CV2Sim model. Representative monitoring well Minimum Thresholds are set above historic low groundwater levels.

Degraded Water Quality. An analysis of historical groundwater quality has determined that groundwater quality within the WDWA is naturally degraded due to the presence of marine sediments and saline connate water. The WDWA therefore relies on surface water as its primary water source. As a result, the WDWA typically utilizes groundwater (i.e., 3,000-5,000 AFY) for the purpose of blending when surface water deliveries are low.

Subsidence. Two recent studies conducted by the WDWA and KGA indicate that current rates of subsidence within the WDWA and adjacent to Regional Critical Infrastructure are attributable to oilfield activities. The WDWA has no control over oil and gas activities."

According to the Subsidence Rate map on page xxxix, PRM Tulare AE is located in an area with 0 ft/yr to 0.1 ft/yr subsidence.

Kern GSA recognizes the lack of quality groundwater within one mile of PRM's Tulare AE. Furthermore, PRM's Tulare AE will not interfere with the GSA's sustainability goals on page



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

9 of the GSP. PRM will actively monitor for subsidence in accordance with Kern WDWA GSP.

2. Title 40 of the Code of Federal Regulations Section 146.4 criteria for exempted aquifers (b) – It cannot now and will not in the future serve as a source of drinking water because: (1) 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.

A. All Tulare Zone core data that is available to PRM has been uploaded in a file labeled “Tulare Zone Core Data.”

B. The designations of “OIL” and “SHOW” are qualitative. Table A-2 has been updated to reflect laboratory results for oil saturation (as % of pore volume) where analysis had been done. For core data where oil saturations are not measured, the designation of “OIL” and “SHOW” reflect the strength of the oil saturation as noted by the operator, driller, or mud logger at the time the samples were collected and examined and are thus qualitative statements. The updated table of Tulare Formation core data (Table A-12) has been included in the Appendix to this document as a superseding version to that previously submitted.

C. See updated Figure A-12 Tulare Core Wells.

D. The Tulare Oil Sand was completed in four wells within the PRM leasehold (Hankins 4-30 and 6-30, Opaque 1-30 and 2-30) as seen in Figure 3. Production from the Tulare Oil Sand was comingled with production from underlying intervals in the Phacoides and Point of Rocks in all of the wells with the exception of the Hankins 6-30, which has produced oil solely from the Tulare Oil Sand.

A Tulare Oil Sand equivalent (a basal sand unit of the Tulare Formation) has produced to the south in the Antelope Hills Oil Field. More than 100,000 barrels of oil have been recovered from a pool in this thin sand from four wells in the Pickrell-Williams lease in the southeast portion of the Antelope Hills Oil Field.

E & F. Measured oil saturation values are presented in Figure 4. Oil Saturation (as percentage of pore volume occupied by oil) ranges from 0 to 43% for wells within the PRM leasehold. This saturation range is roughly similar to the oil saturation range of 0 to 58% (from Pickrell-Williams #10 well which is the only well in the pool with oil saturation measurements) seen in the productive Pickrell-Williams basal Tulare Sand pool of the Antelope Hills Oil Field, roughly 2 miles south of the PRM leasehold. Oil production from the 4 wells completed, in whole or in part, in the Tulare Oil Sand within the PRM leasehold demonstrate that commercial quantities of oil are present.

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

Development of the oil resource is expected to be restricted to the PRM leasehold, with no plans for any oil exploration or production in the eastern half of the proposed exemption area. As noted in Figure 2, there is no evidence of commercial quantities of hydrocarbons in the Tulare Oil Sand interval outside of the PRM leasehold and its immediate surroundings. The proposed exemption area extends east of the planned development area of the PRM leasehold due to the contiguous nature of the sand body proposed for exemption. Because the Tulare Oil Sand is expected to be in possible hydraulic communication throughout the proposed exemption area, the entire contiguous sand is proposed for exemption.

G. Please reference documented entitled “Value of Tulare” which has been saved to the shared folder.

3. California Public Resources Code section 3131, subdivision (a) – (2) The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.

A. The source of injectant will be produced brackish water produced from the same Tulare formation. Current lab reports should be sufficient as treatment processes will be minimal.

B. Updated summary tables and the wellbore diagram provided in the addendum.

1. Please see the updated Tulare Oil Sand Sample Table in the addendum.

2. Please see the updated wellbore diagram for well 6-30 in the addendum.

3. Please see Water Salinity Summary Table in the addendum, which includes all water quality data collected in the project AOR.

4. California Public Resources Code section 3131, subdivision (a) – (3) The injected fluid will remain in the aquifer or portion of the aquifer that would be exempted.

A. Available core data for the Tulare Formation is found in the updated Table A-2 included in the appendix of this document. The Tulare Clay forms the upper (top) seal to the hydrocarbon accumulation in the Tulare Oil Sand. Permeability values for the Tulare Clay interval are generally notably low in comparison with those of the Tulare Oil Sand. It should be noted that high permeability values for samples within the Tulare Clay reflect the preferential sampling of sandy lenses within the Tulare Clay interval by the operator at the time of well drilling and completion. These high permeability samples are not reflective of the permeability of the Tulare Clay interval as a whole. Only Tulare Clay samples with a lithology designated as “Clay” or “Silty Clay” should be considered representative.

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

B. No supporting numerical data are available regarding lateral seal across either Fault A or Fault B (Figure 2), due to the fact there is no production west of fault A with which to compare.

Fault seal can be qualitatively assumed due to the fact that oil has accumulated on one side of a fault, implying that oil migration up-structure to the west has been inhibited by the indicated faults. These faults must be sealing over geologic time for oil to accumulate in commercial quantities.

As was stated previously in Addendum A, faults have been shown to be sealing in the neighboring oil fields of North Antelope Hills and Antelope Hills. Within the Antelope Hills Oil Field, faults of modest offset (50 feet or less) have been proven to be sealing as evidenced by differing oil/water contacts between fault blocks. Faulting provides the western boundary of the Point of Rocks pool of the North Antelope Hills Oil Field. Again, this fault must have served as an effective lateral seal in order for oil to accumulate over geologic time, otherwise it would have migrated elsewhere. (See previously submitted Addendum A – Fault Seal Analysis section and accompanying figures).

5. Additional Questions and Concerns

B & C & D. Figure 5 provides a type log representative of the complete stratigraphic interval of the study area as a whole. Figure 6 is a Type Log representative of the PRM leasehold proposed development area and is represented by well Hankins 6-30. The stratigraphy of the PRM leasehold is greatly truncated by substantial structural relief in the subsurface combined with a major erosional unconformity at the base of the Tulare Formation.

Figure 6 also demonstrates the expected depth of unsaturated strata or “air sands”. These sands are characterized by very high resistivity readings, combined with very low neutron porosity (NPHI) readings. Neutron logs are particularly helpful in the determination of unsaturated or “air sand” intervals as explained by the following (taken from AAPG WIKI entry for density-neutron porosity https://wiki.aapg.org/Density-neutron_log_porosity):

“The [neutron log](#) mainly measures hydrogen concentration in a formation. The logging device is a noncontact tool that emits neutrons from a source. Emitted neutrons collide with nuclei of the formation and lose some of their energy. Maximum energy loss occurs when emitted neutrons collide with hydrogen atoms because a neutron and a hydrogen atom have almost the same mass. Therefore, most neutron energy loss occurs in the part of the formation that has the highest hydrogen concentration.”



33728 Dresser Avenue, Bakersfield, California USA

North Antelope Hills Oil Field Aquifer Exemption for the Tulare Formation, Kern County

Neutron energy loss can be related to porosity because in porous formations, hydrogen is concentrated in the fluid filling the pores. Reservoirs whose pores are gas filled may have a lower porosity than the same pores filled with oil or water because gas has a lower concentration of hydrogen atoms than either oil or water.

Because of the low density of hydrogen in an unsaturated sand, neutron porosity will be notably low, well below that the density porosity (this “crossover” effect is used in exploration for natural gas to identify gas bearing sands for precisely this reason).

In the area of the PRM leasehold, the depth of this unsaturated zone, or “air sands” extends to roughly 250 feet below ground surface. This roughly represents the thickness of recent alluvium in the PRM leasehold area. Below the unsaturated alluvium are sand, silt, and clay layers belonging to the upper Tulare Formation. Sand lenses within the uppermost Tulare Formation may be saturated with brackish water as noted in the Water Board Review document Section 5B. The uppermost Tulare Formation sand lenses are of limited lateral extent with very limited groundwater capacity and have no demonstrated capacity to serve as a water source for any purpose in the proposed PRM leasehold development area. These brackish sand lenses are isolated from the underlying Tulare Oil Sand by the Tulare Clay. The Tulare Clay is approximately 500 feet thick and composed dominantly of low permeability clay with occasional thin sand lenses of limited lateral extent. The low permeability and substantial thickness of the Tulare Clay will serve isolate any overlying strata from oil recovery operations in the underlying Tulare Oil Sand.

Because of the unsaturated nature of the alluvium/uppermost Tulare Formation, combined with a lack of any permeable sand body of any substantial lateral extent (individual sands within this interval cannot be correlated across any distance with any certainty) for any saturated sand body, there are no USDW aquifers, non-USDW aquifers to designate beyond what has already been noted on previously submitted cross sections.

E. Superseding Figures A-12 through A-14 from Addendum A, as well as Superseding Figures 6 through 12 from the original document are included within this document to reflect requested changes.