ANNUAL PERFORMANCE REPORT:
MODEL CRITERIA FOR GROUNDWATER MONITORING
IN AREAS OF OIL AND GAS WELL STIMULATION
REPORTING PERIOD:
JULY 7, 2015 THROUGH DECEMBER 31, 2016

STATE WATER RESOURCES CONTROL BOARD

MAY 5, 2017

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DEFINITIONS, ABBREVIATIONS AND ACRONYMS

ADSA	Axial Dimension Stimulation Area
CIPA	California Independent Petroleum Association
DOGGR	Division of Oil, Gas, and Geothermal Resources
GeoTracker	GeoTracker Information System
GWMPs	Area-specific Groundwater Monitoring Plans
Interim GWMPs	GWMPs approved during interim period
Interim period	January 1, 2014 - July 6, 2015
mg/L	Milligrams per Liter
Model Criteria	Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation
Notifications	Well Stimulation Treatment Neighbor Notification Form
Performance Measures	Model Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation
Project Sites	Locations of Area-specific GWMPs or Requests for exclusions
Protected Water	Water with less than 10,000 milligrams per liter of total dissolved solids, and outside an exempt aquifer (meeting the criteria of Code of Federal Regulations, title 40, part 146.4).
Regional Water Board	Regional Water Quality Control Board
Reporting period	July 7, 2015 - December 31, 2016
Request for exclusion	Request for Exclusion from Groundwater Monitoring
State Water Board	State Water Resources Control Board
TDS	Total Dissolved Solids
USGS	United States Geological Survey
Water Boards	State Water Board or Regional Water Quality Control Board

DEFINITIONS, ABBREVIATIONS AND ACRONYMS (cont.)

WSPA	Western States Petroleum Association

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1.0 INTRODUCTION

The State Water Resources Control Board (State Water Board) *Model Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation* (Performance Measures) specifies that the State Water Board prepare and make publicly available an "Annual Model Criteria Performance Report." This report summarizes work conducted from July 7, 2015 through December 31, 2016 (reporting period) associated with the State Water Board *Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation* (Model Criteria). Well stimulation permits are issued to oil and gas operators by the Division of Oil, Gas, and Geothermal Resources (DOGGR). The number and status of well stimulation permits can be found on DOGGR's website at: http://www.conservation.ca.gov/dog/Pages/WST.aspx.

1.1 Background

California Water Code section 10783 (Senate Bill 4, Pavley, statues of 2013) requires the State Water Board to establish and implement a comprehensive regulatory groundwater monitoring and oversight program for well stimulation treatment activities (including hydraulic fracturing) in areas of oil and gas operations. The Legislature also required the State Water Board to develop model criteria for groundwater monitoring in order to assess potential effects of well stimulation treatments on California's groundwater resources. The Model Criteria was adopted by the State Water Board on July 7, 2015 (Resolution No. 2015-0047). It outlines groundwater monitoring requirements for area-specific monitoring conducted by oil and gas operators, as well as the approach the State Water Board will take to conduct the Regional Groundwater Monitoring Program.

The State Water Board directed staff to collaborate with stakeholders to develop performance measures for the evaluation of the Model Criteria. Performance Measures were presented to the State Water Board on March 1, 2016 and included goals, strategies, and plans for implementing the Model Criteria.

The Performance Measures identified five goals:

1. Provision of transparent and easy to access online information and documentation
2. Provision of clear milestones and timely deliverables
3. Understanding and mitigation of the impacts of well stimulation on water quality and public health
4. Providision of region-specific or localized flexibility where possible
5. Assessment of implementation costs

Appendix A includes information on the proposed implementation plans and current status for the Performance Measure goals.

2.0 AREA-SPECIFIC GROUNDWATER MONITORING

This section provides a summary of the area-specific groundwater monitoring plans submitted by oil and gas operators to the State Water Board and Central Valley Regional Water Quality Control Board (collectively Water Boards) during the reporting period. This section also includes a summary of groundwater monitoring plans that were approved by the during the period prior to the adoption of the Model Criteria (interim period).

A well stimulation treatment cannot be performed until the Water Boards have approved an operator-submitted area-specific groundwater monitoring plan (GWMP) or has issued a letter to the operator that groundwater monitoring is not required (exclusion from groundwater monitoring). The requirement for area-specific groundwater monitoring is limited to areas where "protected water" is present.

"Protected water" is defined as:

- Water with less than 10,000 milligrams per liter (mg/L) of total dissolved solids (TDS), and
- Located outside an exempt aquifer (meeting the criteria of Code of Federal Regulations, title 40, part 146.4).

2.1 Number and Location of Groundwater Monitoring Plans Submitted for Review

During the reporting period, six proposed GWMPs were uploaded by operators to the publicly-accessible State Water Board's GeoTracker information system (GeoTracker) for Water Boards staff review. The status of each GWMP is summarized in Table 1 and the project sites are shown on Figure B-1 in Appendix B. The GWMPs are located in two oil fields in Kern County, and two areas outside of an oilfield administrative boundary.

One GWMP has been approved for the Buena Vista Nose area in Kern County. Groundwater monitoring wells associated with the Buena Vista Nose GWMP have not been installed therefore no monitoring data has been collected.

2.2 Timelines for Reviewing Groundwater Monitoring Plans

The process flow chart for reviewing GWMPs is shown on Figure D-1 in Appendix D. After a GWMP has been uploaded to GeoTracker and has been accepted by State Water Boards staff as complete, the Water Boards begin their review. It is the State Water Boards staff's intention to respond to the operator with review comments within 45 calendar days from acceptance of the submittal. After review completion, additional information may be requested or the GWMP may be denied. A revised GWMP addressesing Water Board comments may need to be

submitted to GeoTracker. Approval of a GWMP cannot occur until the Axial Dimension Stimulation Area (ADSA)[1] has been approved by DOGGR and reviewed by the Water Boards.

For the Buena Vista Nose GWMP, Water Boards staff met several times with the operator after the GWMP was submitted for review. Written comments were provided to the operator within 105 days after the GWMP was accepted as complete. Based on Water Boards staff written comments, the operator submitted a revised GWMP within 90 days. The GWMP was approved 35 days after the Water Boards received and reviewed the final ADSA from DOGGR.

Additional time was required by Water Boards staff to review and respond to the operators because review procedures and standards consistent with the Model Criteria were being developed concurrently. In addition, time was required to develop procedures and standards for reviewing well-stimulation permit applications and ADSA analyses submitted by DOGGR. Also, staff resources were redirected to oil and gas aquifer exemption and underground injection control (UIC) project proposal reviews. Continued development of consistent procedures and standards for reviewing these requests will help Water Boards staff meet the target of 45 day response to operators.

Table 1. Groundwater Monitoring Plans Submitted (July 7, 2015 - December 31, 2016)

GeoTracker Global Identification	Oil Field or (Area)	Operator	Groundwater Monitoring Plan Received	ADSA Approved by DOGGR[1]	Status/Determination	Days Until Approval or Denial after Reciept of DOGGR Approved ADSA
GAOG10009209	(Buena Vista Nose)	California Resources Corporation	12/10/2015[2]	10/14/2016	Approved-11/18/2016	35 Days
GAOG10009277	South Belridge	Aera Energy LLC	8/23/2016	(1/9/2017 - 1/20/2017)	Sent Comments to Operator (12/19/2016)	Review In Progress
GAOG10009284	Lost Hills	Chevron	8/24/2016	Under Review	Sent Comments to Operator (3/17/2017)[3]	Review In Progress
GAOG10009406	Lost Hills	Aera Energy LLC	9/22/2016	11/15/2016	Review In Progress	Review In Progress
GAOG10009523	(Terrebonne)	California Resources Corporation	10/20/2016	12/21/2016	Sent Comments to Operator (3/9/2017)[3]	Review In Progress
GAOG10009958	South Belridge	Linn Energy LLC	11/30/2016	Under Review	Review In Progress	Review In Progress

[1] As defined in DOGGR's Well Stimulation Treatment Regulations (July 1, 2015), the ADSA is the estimated maximum length, width, height, and azimuth of the area(s) affected by a well stimulation treatment. DOGGR approves or denies the ADSA as part of the well stimulation permitting process. A well stimulation permit with an approved ADSA may be issued to an operator; however, stimulation cannot occur until the State Water Board has approved either a GWMP or request for exclusion from groundwater monitoring associated with the permitted well(s).

Notes:

1. ADSA approved by DOGGR for multiple wells to be stimulated during this time frame.
2. Water Boards responded back to operator with comments within 105 days. A revised GWMP was submitted by the operator on June 27, 2016.
3. Comments sent to the operator after this reporting period

2.3 Groundwater Monitoring Plans that Propose Alternative Methods

The Model Criteria allows Water Boards staff to consider proposed alternatives and modifications to the methods for area-specific monitoring based on factors such as site-specific conditions (e.g., terrain, geology, access), number and depth of aquifers containing protected water, potential pathways, and risk to receptors (e.g., groundwater resources). The Water Boards shall provide at least fifteen days public notice and an opportunity for comments on the proposal prior to approving a proposed alternative or modification.

Water Boards have not received any requests for consideration of alternative methods during the reporting period.

2.4 Interim Groundwater Monitoring Plans

Groundwater monitoring associated with well stimulation treatments was regulated under DOGGR's Interim Well Stimulation Treatment Regulations, prior to the State Water Board's adoption of the Model Criteria (interim period). The interim regulations required that prior to issuance of a well stimulation permit, operators needed to acquire a DOGGR-approved GWMP or a letter from the State Water Board concurring that groundwater monitoring was not required.

DOGGR, in collaboration with the Water Boards, approved 36 GWMPs during the interim period (interim GWMPs). For 21 of the approved interim GWMPs, well stimulation was not conducted at the project sites and therefore the interim GWMPs were not implemented. Fifteen of the approved interim GWMPs are associated with wells that were stimulated and groundwater monitoring has been implemented. Information on the implemented interim GWMPs is summarized in Table C-1 in Appendix C and the project sites (locations of area-specific GWMPs or requests for exclusions) are shown on Figures B-2 and B-3 in Appendix B. Thirteen project sites are located in Kern and Kings Counties, and two project sites are located in Orange and Ventura Counties.

Groundwater monitoring data associated with the implemented Interim GWMPs has been uploaded to GeoTracker and is publicly available. Water quality results have been reviewed and are being assessed along with Regional Monitoring Program water quality results to establish baseline water quality conditions. Preliminary review of the interim groundwater monitoring data does not indicate conclusive evidence of impacts from well stimulation activities.

3.0 REQUESTS FOR EXCLUSION FROM GROUNDWATER MONITORING

Area-specific groundwater monitoring is required unless an operator can clearly demonstrate that the wells to be stimulated do not penetrate protected water. If the Water Boards concur, an exclusion from groundwater monitoring requirements is granted to the operator.

This section provides a summary of requests for exclusion from groundwater monitoring requirements (requests for exclusion) submitted to the Water Boards during the reporting period. This section also includes a summary of requests for exclusion that were approved by the State Water Board during the interim period.

3.1 Number and Locations of Requests for Exclusion from Groundwater Monitoring Submitted for Review

Five requests for exclusion were uploaded by operators to GeoTracker for Water Boards staff review during the reporting period. These submittals are publicly available in GeoTracker. The status of the requests for exclusion are summarized in Table 2 and the project sites are shown on Figures B-4 and B-5 in Appendix B. Two requests for exclusion have been approved, one has been denied, and two were approved after this reporting period. The requests for exclusion project sites are located Ventura, Kern and Kings Counties.

Table 2. New Requests for Exclusion from Groundwater Monitoring (July 7, 2015 - December 31, 2016)

GeoTracker Global Identification	Oil Field	Operator	New Requests for Exclusion from Groundwater Monitoring Received	ADSA Approved by DOGGR	Status/Determination
GAOG10008765	Sespe	Seneca Resources	11/18/2015	Under Review	Denied- 3/14/2016
GAOG10008424	Buena Vista	California Resources Corporation	11/23/2015	Under Review	Approved- 2/16/2016
GAOG10008916	Lost Hills	Aera Energy LLC	5/12/2016	11/16/2016	Approved- 10/6/2016
GAOG10009914	South Belridge	Aera Energy LLC	12/21/2016	Under Review	Approved- 3/9/2017[1]
GAOG10009592	South Belridge	Aera Energy LLC	12/21/2016	2/17/2017	Approved- 3/9/2017[1]

Notes:

1. Approved after reporting period.

Operators have also requested an exclusion from groundwater monitoring for additional wells to be stimulated in areas previously granted exclusion during the interim period. The status of these requests are summarized in Table 3. All of the requests have been approved since they

are located in areas previously granted exclusion from groundwater monitoring. The project sites are all located in the South Belridge Oil Field.

Table 3. Requests for Exclusion from Groundwater Monitoring for Additional Wells in Areas where Water Boards have Previously Granted Exclusion (July 7, 2015 - December 31, 2016)

GeoTracker Global Identification	Oil Field	Operator	Request for Exclusion from Groundwater Monitoring Received	Number of Additional Wells During this Reporting Period	ADSA Approved by DOGGR	Status/Determination
GAOG10009503	South Belridge	Aera Energy LLC	10/18/2016	6 Wells	1/20/2017	Approved- 11/18/2016
GAOG10008892	South Belridge	Aera Energy LLC	11/16/2016	6 Wells	(1/20/2017 - 1/23/2017)[1]	Approved- 12/2/2016
GAOG10008913	South Belridge	Aera Energy LLC	11/18/2016	2 Wells	1/20/2017	Approved- 12/2/2016
GAOG10008915	South Belridge	Aera Energy LLC	11/18/2016	2 Wells	1/20/2017	Approved- 12/2/2016
GAOG10009503	South Belridge	Aera Energy LLC	11/22/2016	1 Well	1/23/2017	Approved- 12/2/2016
GAOG10008892	South Belridge	Aera Energy LLC	11/22/2016	1 Well	Under Review	Approved- 12/21/2016
GAOG10008892	South Belridge	Aera Energy LLC	11/22/2016	1 Well	1/23/2017	Approved- 11/29/2016
GAOG10008892	South Belridge	Aera Energy LLC	12/7/2016	1 Well	1/23/2017	Approved- 12/19/2016

Notes:

1. ADSA approved by DOGGR for multiple wells to be stimulated during this time frame.

3.2 Timelines for Reviewing Requests for Exclusion from Groundwater Monitoring

The process flow chart for reviewing requests for exclusion is shown on Figure D-2 in Appendix D. Water Boards begin their review after a request for exclusion has been uploaded to GeoTracker and has been accepted as complete. The State Water Board staff goal is to

respond to the operator with review comments within 45 calendar days from acceptance of the submittal. After Water Boards staff have completed their review, additional information may be requested or the request for exclusion may be denied. A revised request that addresses Water Boards comments may need to be submitted to GeoTracker. Approval of a request for exclusion is not dependent on an approved ADSA by DOGGR but is based solely on whether sufficient technical information has been submitted to indicate the absence of protected water.

Water Boards staff responded back to the operator an average of 112 days for requests for exclusion, and an average of 18 days of review for additional wells in existing areas of exclusion. Additional review time was needed for requests due to re-direction of staff resources to other oil and gas related work (aquifer exemption and UIC project proposal reviews). In addition, continued development of consistent procedures and standards for reviewing these requests will help Water Boards staff meet the goal of 45 day response to operators.

3.3 Interim Requests for Exclusion from Groundwater Monitoring

State Water Board staff approved 21 requests for exclusion during the interim period (January 1, 2014 to July 6, 2015). The approved submittals are publicly available in GeoTracker. Information for these approved requests is summarized in Table C-2 in Appendix C, and the project sites are shown on Figure 6 in Appendix B. All of the approved requests for exclusions are located in Kern and Kings Counties, with the majority of these exclusions located in the Elk Hills Oil Field. Information for requests for exclusions denied during the interim period is summarized in Table C-3 in Appendix C.

4.0 PROPERTY-OWNER REQUESTED WATER SAMPLING

Operators are required to hire an independent third party to notify property owners, or tenants of a property, located within 1,500 feet of the well to be stimulated or within 500 feet of the surface representation of the horizontal path of the area of stimulation. DOGGR is responsible for maintaining records regarding the third-party notification process. The third party sends the property owners or tenants a Well Stimulation Treatment Neighbor Notification Form (notifications), which includes information such as the earliest date the well may be stimulated and how the property owner may request water quality testing on an existing water well or surface water suitable for drinking. The number of notifications sent by operators during 2014, 2015, and 2016 are summarized in Table 4. There were fewer permits granted to operators in 2016 due to increased regulatory requirements and a longer time associated with DOGGR permitting stimulated wells, therefor fewer notifications were issued that year.

Table 4. Number of Neighbor Notifications Sent by Operators (Source: DOGGR)

Operator	2014	2015	2016
Aera Energy LLC	818	960	29
Breitburn Energy Co., LLC	18	-	-
Central Resources, Inc.	19	-	-
Chevron	35	6	-
Crimson Resource Management	194	-	-
DCOR	11	-	-
Occidental of Elk Hills, Inc.	57	36	-
Seneca Resources Corporation	19	4	-
Vintage Production California, LLC	108	-	-
California Resources Elk Hills, LLC	-	5	42
Linn Operating, Inc.	-	273	-
Salt Creek Oil LLC	-	-	2
Total	**1279**	**1284**	**73**

The State Water Board is required to designate qualified independent third-party contractors to perform property owner requested water quality sampling (designated contractor). A property owner that has received a notification can access a list of designated contractors on the Water Board's webpage. The designated contractor is to sample in accordance with the standards and protocols outlined in the State Water Board's Requirement for Designated Contractor Sampling and Testing, as detailed in the Model Criteria. Designated contractors are required to notify the State Water Board staff prior sampling and after sampling upload the results to GeoTracker.

In November 2014, the State Water Board conducted an audit to determine if any designated samplers or operators were contacted by a property owner. The results of the audit indicated that only one operator was contacted by a property owner. In that case, Rincon Consultants collected a surface water sample for this property owner in the Hopper Canyon Oil Field in 2014. Analytical results are publicly available in GeoTracker. A surface water sample was collected prior to the proposed well stimulation (pre-stimulation sampling); however, well stimulation never occurred, so additional samples were not collected (post-stimulation sampling).

In February 2017, the State Water Board conducted a second audit. The audit indicated that one designated contractor was contacted by a property owner; however, they did not have any existing water wells or surface water on their property, therefore sampling was not conducted. In addition, operators were not contacted by property owners to conduct water sampling and testing, or contacted by a designated third party contractor requesting compensation for the costs associated with water sampling and testing.

5.0 REGIONAL MONITORING PROGRAM

The goal of the Regional Monitoring Program is to evaluate potential impacts from oil field operations to protect all waters designated for any beneficial use, while prioritizing the monitoring of groundwater that is or has the potential to be a source of drinking water. Factors considered for the Regional Monitoring Program include well stimulation treatments, and other events or activities that have the potential to contaminate groundwater, such as a well failure or breach. The main components of the Regional Monitoring Program are to characterize and monitor groundwater risk zones, surface activity effects, and well integrity. Assessing potential water quality impacts related to these three components will help to systematically and comprehensively collect and interpret information that will support management and protection of waters designated for any beneficial use.

The Regional Monitoring Program is being conducted in a phased approach. Utilizing a phased approach allows State Water Board staff to work with the USGS to assess findings and develop future phases that will best allow us to assess potential impacts from well stimulation activities. The scope of work conducted through 2016 is described in the following sections.

5.1 Work Conducted September 2014 through December 2015

The first phase of the Regional Monitoring Program was initiated in 2015 and focused on prioritizing areas for regional monitoring and mapping of protected groundwater using existing data. Work also included exploratory groundwater sampling to identify chemical constituents to include in the program. Part of that effort systematically delineated aquifer zones containing less than 3,000 mg/L TDS, and 3,000 to 10,000 mg/L TDS, to create a tiered approach for the regional monitoring.

Analysis of the exploratory data is summarized in the USGS Open-File Report 2016-1100: “Preliminary results from exploratory sampling of wells for the California Oil, Gas, and Groundwater Program, 2014-15.” This report is publicly available on the State Water Board Oil and Gas website at: http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/regional_monitoring/index.shtml

5.2 Work Conducted in 2016

In 2016, the USGS conducted salinity mapping near high, priority oil fields in Kern County to evaluate groundwater quality by using water sample data, oil well borehole geophysical logs, and collecting airborne and surface geophysical surveys. Reconnaissance salinity mapping using water sample data has been completed in roughly 30 oil fields and 90 additional oil fields are in progress. Well depth and water chemistry data from many sources are also being compiled into numerical databases for use in the regional analyses; these compilations have been complete for the Fruitvale Oil Field and are nearing completion for several other oil fields in Kern County. The USGS conducted a collaborative effort with Water Boards staff, stakeholders, and local water agencies to determine a regional sampling design for the following

oil fields: Fruitvale, Lost Hills, South Belridge, and North Belridge. As part of the Regional Monitoring Program, the USGS sampled 14 supply water wells, and nine oil wells in the Fruitvale oil field. Sampling is in progress for 17 water supply wells and nine oil wells in the Lost Hills, South Belridge, and North Belridge oil fields.

5.3 Preliminary Results

Preliminary results indicate that there are large differences in the depth of protected water across the Central Valley in Kern County, reflecting changes in hydrogeologic conditions. In addition, techniques for automating salinity calculations from digitized oil well borehole geophysical logs show promise for improving the speed with which borehole salinity analysis can be conducted in the future. These tools are being developed through collaborative agreement with California State University, Sacramento. Preliminary analysis of airborne (helicopter-mounted) electromagnetic data indicate useful results for mapping salinity and subsurface clay layers in the western Central Valley in Kern County. These methods may prove valuable to apply in other groundwater areas adjacent to oil fields in the future to develop a more complete three-dimensional picture of the subsurface than can be done with well data alone.

Preliminary findings indicate that groundwater quality may have improved in the Fruitvale Oil Field since the 1950s, when groundwater quality was degraded by oil-field water disposal. This improvement may reflect historical changes in produced water management and high groundwater recharge rates along the Kern River, which has helped dilute and (or) replace historic contamination. This is an example of how hydrogeologic setting has a major effect on groundwater quality. Groundwater quality is generally poorer (higher TDS) on the west side of the valley, partially reflecting lower recharge rates.

5.4 Upcoming Work in 2017

In 2017, the USGS will be sampling groundwater in the following oil fields: Elk Hills (Kern County), Montebello (Los Angeles County), Oxnard (Ventura County), and Orcutt (Santa Barbara County). The USGS will be drilling and installing multiple monitoring well sites for monitoring fluid pressure and water-quality at different depths in groundwater systems near selected oil fields. The monitoring well sites will be selected to fill priority gaps in existing data and are planned for completion in 2017. The USGS plan to sample three oil wells in the weeks and months following well stimulation to identify chemical signatures that indicate how quickly well stimulation fluids are replaced with formation fluids in produced water discharge from oil wells. This reconnaissance study may indicate what constituents to monitor at stimulated wells in the future to demonstrate when water chemistry from these wells is indistinguishable from other oil wells.

6.0 EVALUATION OF COST OF COMPLIANCE

Performance Measure Goal #5 requires the State Water Board staff to "assess implementation costs associated with the Model Criteria." The estimated cost of compliance is summarized in the following section.

State Water Board staff, in cooperation with operators and representatives from the California Independent Petroleum Association (CIPA) and the Western States Petroleum Association (WSPA), developed a list of information needed to assess operator costs. CIPA, in collaboration with WSPA, used a third-party aggregator to collect and report operator costs associated with the implementation of the Model Criteria. The estimated operator costs are for the period between 2014 and 2016 (interim period and reporting period, combined).

Information regarding the estimated operator costs as reported by WSPA and CIPA is summarized in Table 5. According to this information, between 2014 and 2016 approximately $7.6 million was spent by operators on implementing groundwater monitoring. The groundwater monitoring was associated with 176 wells that underwent stimulation treatment. A total of 1,362,969 barrels of oil were produced from these 176 wells. Approximately $74,000 was spent on submitting requests for exclusion and is associated with 1,089 wells that underwent stimulation treatments. A total of 9,438,976 barrels of oil were produced from stimulated wells in areas that have approved requests for exclusion from the groundwater monitoring requirement.

Fourteen Water Boards staff positions have been dedicated to work on implementing the Model Criteria, with an approximate expenditure of $1.82 million dollars per year. The USGS is under a contract agreement with the Water Boards to implement the Regional Monitoring Program and is not to exceed $7.25 million dollars per year. Water Boards staff and contracting costs are payable from the Oil, Gas and Geothermal Administrative Fund.

Table 5. Estimated Operator Costs Associated with the Implementation of the Model Criteria (Source: WSPA and CIPA)

2014/2015 Interim Period through December 31, 2016[1]		
Groundwater Monitoring Plans	Number of Groundwater Monitoring Plans Developed	19
	Total Cost	$517,250.00
Monitoring Well Installation	Number of Wells Installed	19
	Total Cost	$5,806,232.00
Sampling and Reporting	Number of Samples Collected	105
	Number of Reports Submitted	28
	Total Cost	$990,000.00
Laboratory Testing	Number of Samples Analyzed	86
	Total Cost	$172,500.00
Well Stimulations Performed and Associated Production	Number of Well Stimulation Treatments Performed with Groundwater Monitoring	176
	Number of Well Stimulation Treatments Performed with Exclusion from Groundwater Monitoring	1,089
	Production from wells with Groundwater Monitoring (bbl)	1,362,969
	Production from wells Granted Approval for Exclusion from Groundwater Monitoring	9,438,976
Other Sub- Contractor and Consultant Fees		$111,969
Total Cost for Groundwater Monitoring (Capital + Opex)		$7,597,951.00
Numbers of Requests for Exclusion from Groundwater Monitoring (no protected water)		11
Total Cost of Exclusions from Groundwater Monitoring (no protected water)		$73,710.00

Notes:

1. Estimated total operator costs associated with assisting in implementing the Regional Monitoring program was $15,000.
2. Estimated cost of groundwater monitoring per sample collected was $72,361.44.
3. A total of 10,801,945 barrels of oil were produced from wells subject to Model Criteria requirements.
4. Estimated cost of groundwater monitoring per barrel of oil produced was $5.57.
5. The average cost of compliance per well was $43,170.18.

7.0 LESSONS LEARNED

Performance Measure Goal # 3 is to “understand and mitigate impacts of well stimulation on water quality and public health.” One of the proposed implementation strategies to meet this goal is to include a summary of significant findings and lessons learned in the annual Model Criteria performance reporting. Preliminary findings and lessons learned to date are summarized below:

- Review process: Continued Water Boards program development of consistent procedures, policies and standards for reviewing submittals will help to reduce response time to operators.
- Site-specific characteristics: Information from the Regional Monitoring Program indicates that the hydrogeological setting differences between the east and west sides of the San Joaquin Valley appear to make some groundwater more susceptible to oil and gas actvities. For example, groundwater quality is generally poorer (higher TDS) on the west side of the valley, partially reflecting lower recharge rates.
- Assessment techniques: A combination of analysis of historical water sample data from many sources, analysis of oil well borehole geophysical logs, and new airborne and surface geophysical data collection in areas adjacent to oil fields provides a three-dimensional regional picture of protected groundwater near oil fields. In particular, preliminary results of the geophysical analysis provide new insight on groundwater salinity distributions near the Lost Hills, North Belridge, and South Belridge oil fields.
- Data access: Greater access to digital records (e.g. borehole-geophysical logs, water sample analyses in numerical format) held by oil and gas operators would improve the efficiency of the regional monitoring.
- Sampling access: Access to water and oil wells for sampling is a rate-limiting step in collecting new regional monitoring data and impedes the implementation of the Regional Monitoring Program.
- Disparate data: Historical water-quality and well-depth data are widely scattered among several sources and formats, including data in scanned images rather than numerical formats. The process of compiling these data into numerical datasets suitable for analysis is laborious and slow.
- Incomplete data: Data on pressure gradients between groundwater and oil resources zones are often lacking or of questionable quality.

8.0 DATA AND INFORMATION SHARING

Performance Measure Goal # 1 is to provide “transparent and easy to access online information and documentation.” One of the proposed implementation strategies to meet this goal is to create a strategy to optimize data and information sharing between the Water Boards, DOGGR, and other agencies, as appropriate. The Water Boards, in collaboration with DOGGR, developed an Oil and Gas Data Communication and Data Sharing Plan for the State Water Resources Control Board and Division of Oil, Gas and Geothermal Resources (Data Sharing Plan, June 1, 2016).

The Data Sharing Plan outlines current Water Boards and DOGGR oil and gas data systems, existing communication and data sharing processes, and strategies for future data sharing between the agencies. Effective sharing of oilfield related data and information will help streamline regulatory efforts, avoid duplicity of collection and submittal requirements, facilitate data submittal processes for operators, and help provide the public easy access to the information.

The data sharing plan included proposed actions to work towards more effective data sharing. The proposed actions and status of each are provided below.

1. Action: Monthly meetings/conference calls will be held to better understand existing data systems and optimize data sharing.

   Status: In-person meetings and phone calls are conducted multiple times a month between Water Boards staff and DOGGR staff to discuss data and information sharing. Process flow charts and tracking tables have been shared between agencies to help ensure logical flow and consistency between data and information sharing.

2. Action: Over the next 6 months, Water Boards staff will initiate consolidating existing oil and gas data and information and begin to transfer that information into GeoTracker (e.g. produced water pond geolocations and associated monitoring data).

   Status: To date, approximately 60 percent of the produced water ponds have been geo-located in GeoTracker. Efforts to further consolidate existing oil and gas data and information into GeoTracker is ongoing.

3. Action: Over the next 6 months, Water Boards staff will work on developing new tools in GeoTracker to facilitate data and information sharing with DOGGR and operators (e.g. linking groundwater monitoring plans or exclusions from monitoring with DOGGR well stimulation permit numbers and 72-hour well stimulation treatment notifications).

   Status: New tools and processes have been developed in GeoTracker to facilitate data and information management and sharing as summarized below.
   - Developed a well stimulation table tool for each submittal that includes:
     - Submittal Status (Under Review, Approved ADSA, DOGGR Approved, 72-Hour Notice, Final)
     - DOGGR Permit Number
     - American Petroleum Institute Number
     - Well Number
     - Latitude/Longitude
     - Total Depth

   - Developed a tool to link documents to each submittal that includes the following document types:
     - State Water Board Submittal Approval/Denial Memo
     - DOGGR ADSA Narrative
     - DOGGR Permit
     - State Water Board Well Stimulation Permit Review Memo
     - DOGGR 72-Hour Notice

   - Developed a project status summary report by Regional Water Board Boundary and by County Boundary

- Received
- Under Review
- Review Complete – Approved
- Review Complete – Denied

9.0 PLAN TO EVALUATE EFFECTIVENESS OF MODEL CRITERIA

Performance Measure Goal # 3 states: "Understand and mitigate impacts of well stimulation on water quality and public health." One of the proposed implementation strategies to meet this goal is for the State Water Board staff to develop a plan to re-evaluate the effectiveness of the Model Criteria and to provide on-going program evaluation. In addition, the State Water Board directed staff to review and update the Model Criteria periodically as needed according to the added requirements by Senate Bill 4 to the Water Code, section 10783 and State Water Board Resolution No. 2015-0047. At this time there are no current plans to update or modify the Model Criteria.

The Model Criteria was developed to assess the potential impact of well stimulation treatments on groundwater resources and consists of two groundwater monitoring activities: Area-specific monitoring conducted by operators and the Regional Groundwater Monitoring Program. Water quality information collected as part of the approach defined in the Model Criteria will help evaluate groundwater and hydrogeological conditions, including establishing a baseline of water quality that will be used to assess future potential impacts. Due to the large scale associated with this monitoring program, it will take a considerable amount of time before an appropriate level of data is collected, the density of the groundwater monitoring well network is fully established, and a baseline of water quality is determined. State Water Board staff will consider USGS and oil and gas operator recommendations when assessing if information being collected is effective in understanding potential impacts to groundwater resources from well stimulation activities.

The proposed scope to evaluate each of the monitoring programs is summarized below:

1. Area-specific monitoring: Monitoring data collected for the area-specific monitoring program are uploaded into GeoTracker. These data will be analyzed to help establish a baseline of water quality conditions that will be used to assess future potential impacts. These data will also be evaluated to assess if the required list of analytes provided in the Model Criteria should be modified to include fewer analytes or additional analytes. In addition to collecting cost of compliance information on an annual basis, operators will also be asked to complete a survey and provide information on how the area-specific monitoring is working for them, lessons learned, and any additional feedback for suggested modifications to the Model Criteria requirements.

2. Regional Groundwater Monitoring: The USGS is tasked to report on analysis of the Regional Groundwater Monitoring data after three years of interpretive data collection. The USGS will include information collected as part of the area-specific monitoring as

well. Based on the result of the analysis, the USGS will make recommendations for potential revision(s) to the Model Criteria.

APPENDIX A- CURRENT STATUS OF PERFORMANCE MEASURE GOALS

Current Status of Performance Measure Goals

Goal #1: Transparency and availability of online information and documentation.

Strategy	Proposed Implementation	Status
1.1 Improve and expand upon available datasets and the ability to analyze and manipulate that data.	The State Water Board's GeoTracker information system (GeoTracker) will be used to provide online easy access to operator-submitted groundwater monitoring plans, requests for exclusion from monitoring, and associated data and reports. These data and information will be publicly available for export and analysis. GeoTracker will integrate capabilities for operators to easily upload information.	Groundwater monitoring plans, requests for exclusions, and data analysis is uploaded to GeoTracker and is publicly available.
	By April 15, 2016, a GeoTracker frequently asked questions (FAQs) will be available on the State Water Board Oil and Gas Monitoring webpage that will include information on how operators can upload data and how the public can access the data.	FAQs Posted on webpage on 4/13/2016 http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/geotracker/docs/upload_gw_mon_exclusion.pdf
1.2 Improve online user experience with simplified and clear messaging to make data easier to access.	By June 1, 2016, the Oil and Gas Monitoring webpage will be improved to provide better access to information such as schedules, FAQs, announcements, and reports.	The Oil and Gas Monitoring webpage has been improved; it is updated and being amended as needed. http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/index.shtml
1.3 Create data communication/ sharing strategy to optimize data and information sharing between the State Water Board, Regional Water Boards, DOGGR, and other agencies, as appropriate.	By June 1, 2016, State Water Board and DOGGR staff will develop a plan for data and information sharing.	Plan posted on webpage on 6/1/2016 http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/docs/data_sharing_plan_06012016.pdf

Goal #2: Provide clear milestones and timely deliverables.

Strategy	Proposed Implementation	Status
2.1 Make milestones and deliverables outlined in the Model Criteria and Senate Bill 4 (Chapter 313, Statutes of 2013, including Water Code section 10783), publicly available.	By April 15, 2016, a schedule of deliverables and milestones (including U.S. Geological Survey [USGS]) deliverables to the State Water Board) will be posted on the Oil and Gas Monitoring webpage.	Schedule posted on webpage on 4/13/2016 http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/docs/sb4_deliverable_schedule.pdf
2.2 Prepare review processes, flowcharts, and timelines for reviewing groundwater monitoring plans and requests for exclusion from groundwater monitoring, including interagency collaboration and program efficiencies.	By June 1, 2016, State Water Board staff will develop process flowcharts and estimated timelines for reviewing groundwater monitoring plans and requests for exclusion from groundwater monitoring. This information will be posted on Oil and Gas Monitoring webpage.	Flowcharts updated on webpage on 3/2/2017 http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/area_specific_monitoring/docs/flow_chart_area_specific_gwmps.pdf Flowcharts updated on webpage on 3/2/2017 http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/area_specific_monitoring/docs/flow_chart_exclusion_from_gwm.pdf
	Beginning in March of 2017, State Water Board staff will prepare and make publicly available an "Annual Model Criteria Performance Report". This report will include such information as the number of monitoring plans and requests for exclusion from monitoring submitted by operators, the number of submittals with proposed alternative approaches, timelines for review of the submittals, and the number of plans approved.	To be posted on completion of this report and subsequent reports.

Goal #3: Understand and mitigate impacts of well stimulation on water quality and public health.

Strategy	Proposed Implementation	Status
3.1 Provide regular assessments of monitoring data, including pilot study results and identification of any chemicals of concern.	Beginning in February of 2016, the USGS will provide technical briefings to stakeholders summarizing findings of the regional monitoring efforts (The first briefing was held on February 19, 2016).	Held on these dates: February 19, 2016, March 9, 2016, June 8, 2016, August 10, 2016, October 25, 2016, March 28, 2017. Upcoming stakeholder briefing scheduled for May 15, 2017.
3.2 Mitigate problems as they occur and share mitigation efforts with stakeholders.	If data demonstrates a potential water quality or public health concern, State Water Board and Regional Water Quality Control Board (collectively Water Boards) staff will develop a work plan to address the concerns and information will be made available to the public.	Preliminary data review cannot determine a connection between groundwater quality and oil and gas activities.
3.3 Develop a plan to re-evaluate the effectiveness of monitoring. Modify the scope of work and pproach based on evaluation of the data collected and evaluated.	By March 31, 2017, State Water Board staff will develop a plan to be used to re-evaluate the effectiveness of the Model Criteria and to provide on-going program evaluation based on the performance measures.	This plan is included in the Annual Model Criteria Performance Report.
3.4 Coordinate with other agencies to identify risk.	Beginning in March of 2017, State Water Board staff will include a summary of significant findings and lessons learned in the "Annual Model Criteria Performance Report".	To be posted on completion of this report and subsequent reports.

Goal #4: Provide region-specific or localized flexibility where possible.

Strategy	Proposed Implementation	Status
4.1 Consider local conditions when reviewing groundwater plans.	Beginning in March of 2017, State Water Board staff will report on the number of proposed alternative plans submitted, number of approved plans, and any observed regional geological trends associated with those plans in the "Annual Model Criteria Performance Report".	To be posted on completion of this report and subsequent reports.
4.2 Clearly communicate why region- specific activities are occurring.		
4.3 Use consistent flexibility criteria for monitoring.		

Goal #5: Assess implementation costs

Strategy	Proposed Implementation	Status
5.1 Assess implementation cost for the State Water Board and stakeholders.	By August 31, 2016, the State Water Board will develop a list of information needed to assess the cost associated with the implementation of the Model Criteria.	State Water Board, in cooperation with operators and representatives from the California Independent Petroleum Association and the Western States Petroleum Association, developed a list of information needed to assess these costs.
	Beginning October 1, 2016, the State Water Board will request operators to submit on an annual basis the required information for assessing the cost of implementation.	Information to assess the costs of implementation of the Model Criteria was submitted for the October 1, 2016 deadline and is included in this Annual Model Criteria Performance Report.
	Beginning in March of 2017, State Water Board staff will report on the cost of implementation of the Regional Monitoring Program and area-specific monitoring. The "Annual Model Criteria Performance Report" will include an evaluation of State Water Board costs and operator costs, including effectiveness of the collection, sharing, and management of data.	To be posted on completion of this report and subsequent reports.

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APPENDIX B- FIGURES

APPENDIX B: LIST OF FIGURES

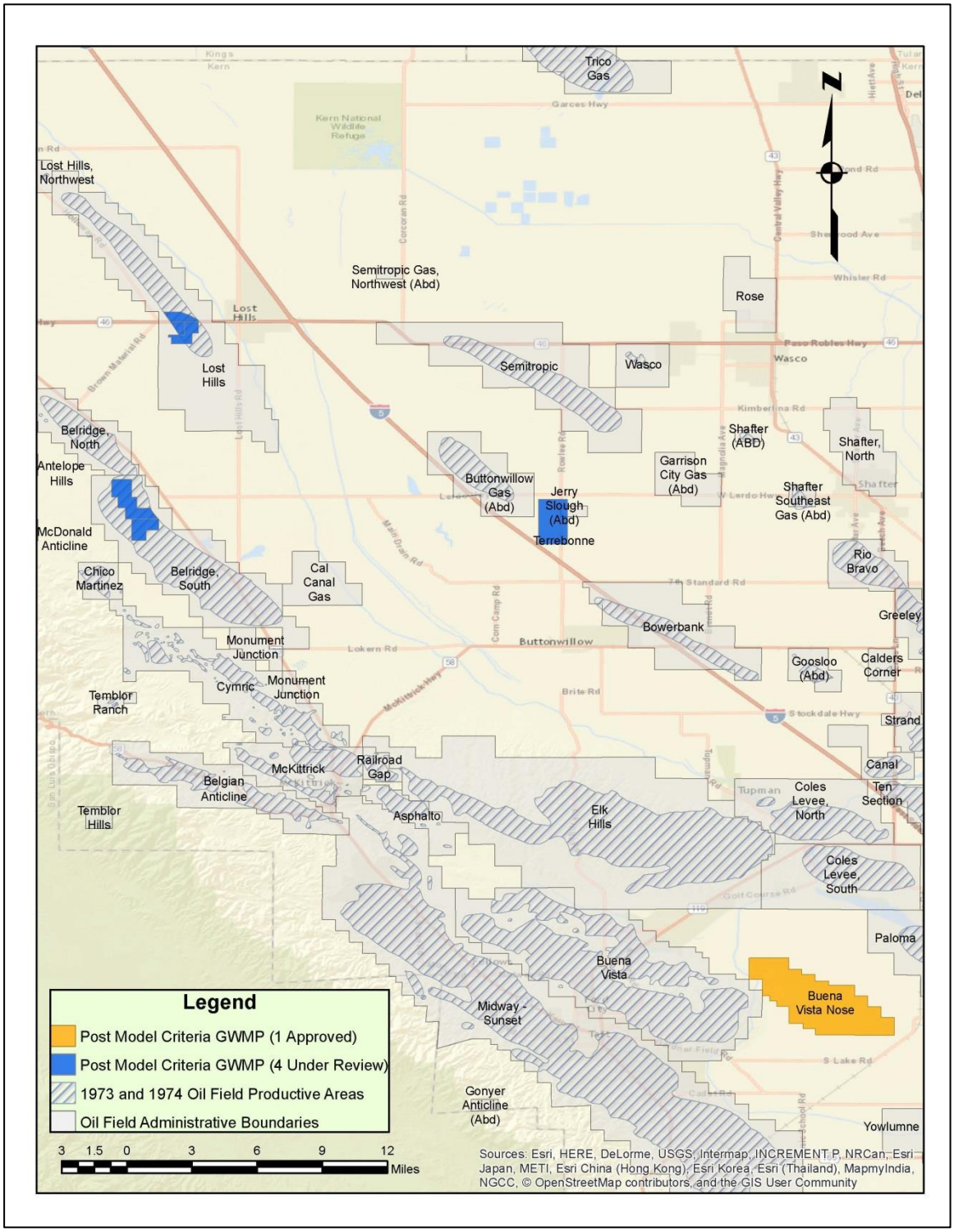

Figure B-1. Groundwater Monitoring Plans Submitted During the Reporting Period (July 7, 2015- December 31, 2016)

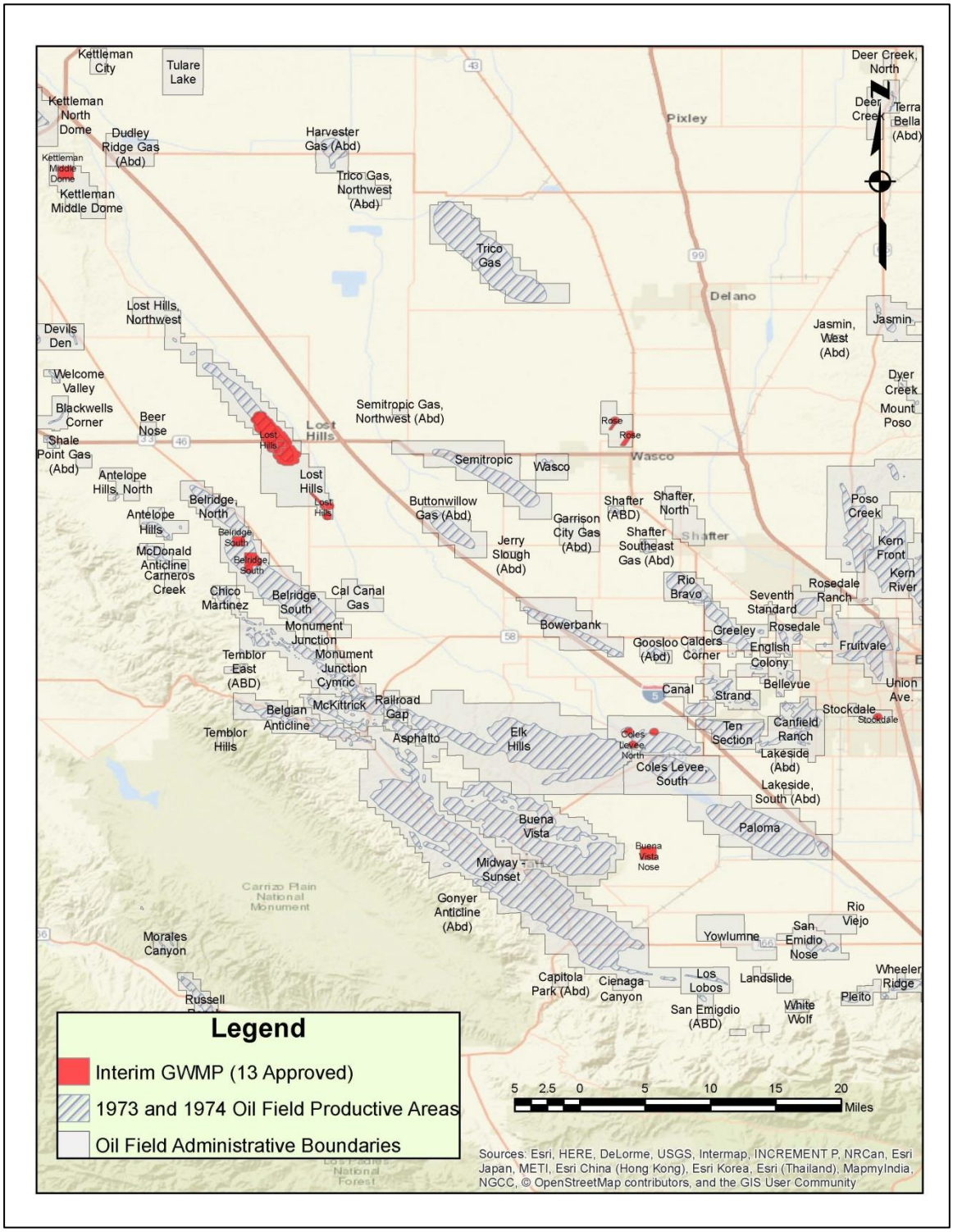

Figure B-2. Groundwater Monitoring Plans Approved by DOGGR During the Interim Period (January 1, 2014- July 6, 2015) in Kern and Kings Counties

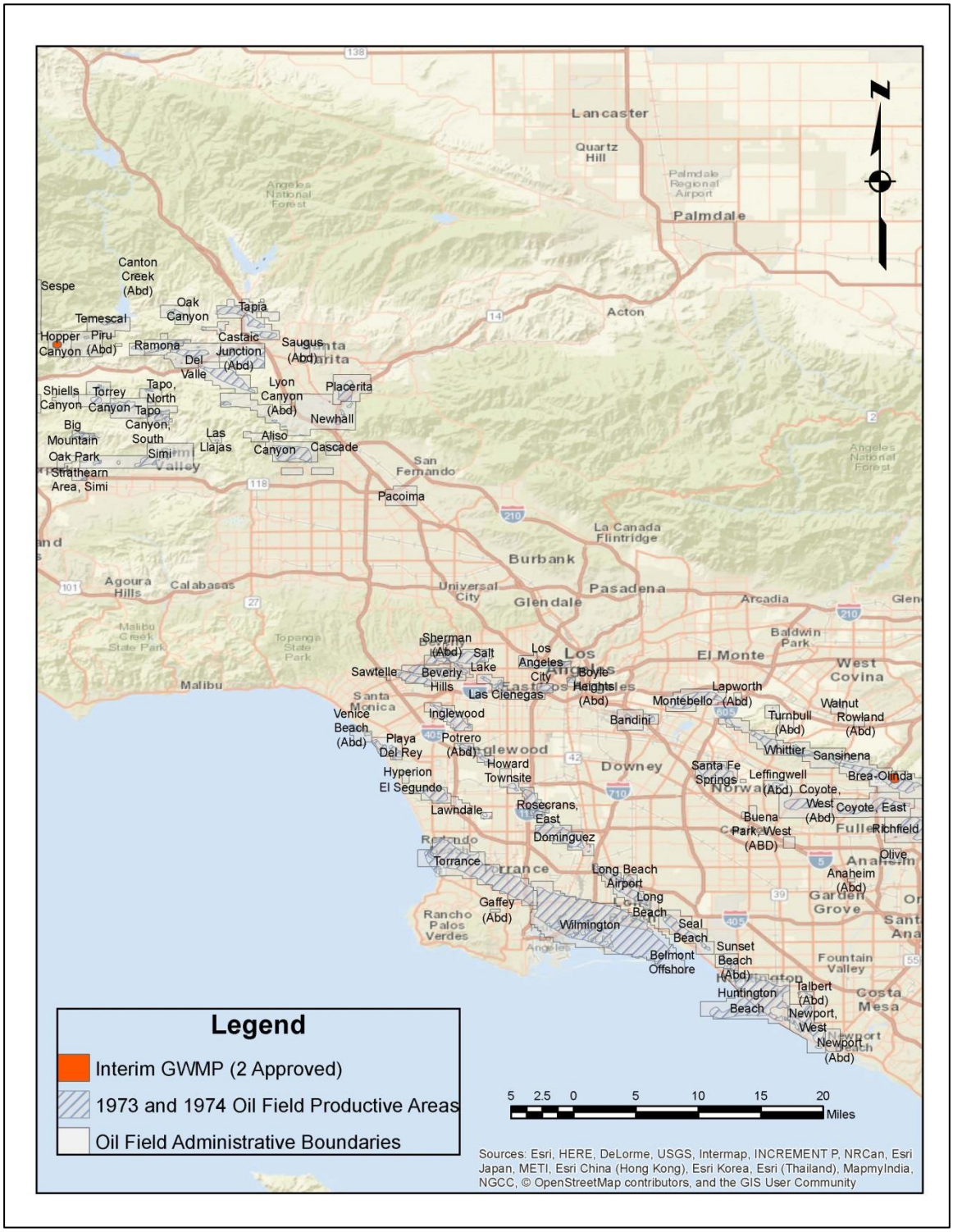

Figure B-3. Groundwater Monitoring Plans Approved by DOGGR During the Interim Period (January 1, 2014- July 6, 2015) in Orange and Ventura Counties

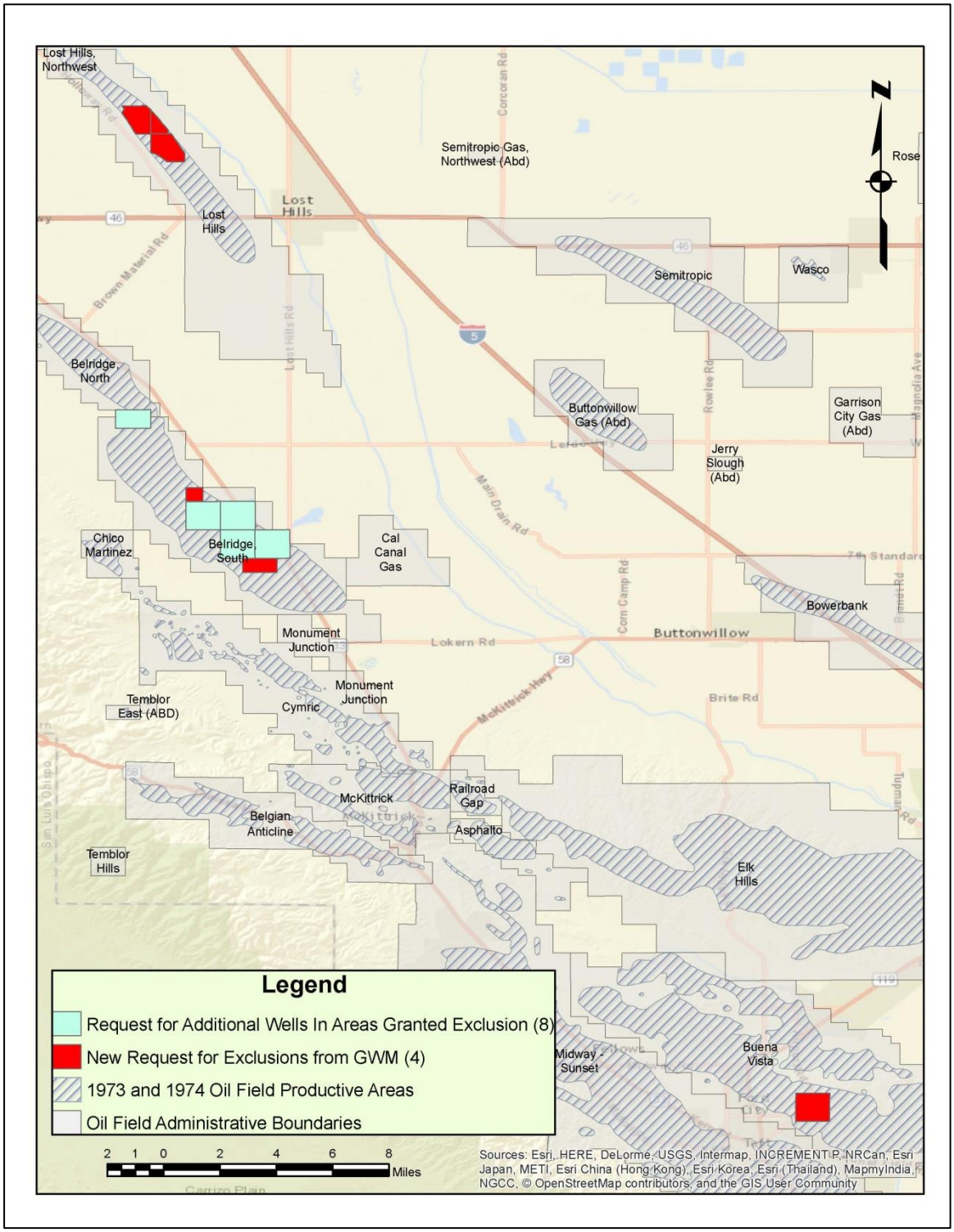

Figure B-4. Requests for Exclusion from Groundwater Monitoring Submitted During the Reporting Period (July 7, 2015- December 31, 2016) in Kern and Kings Counties

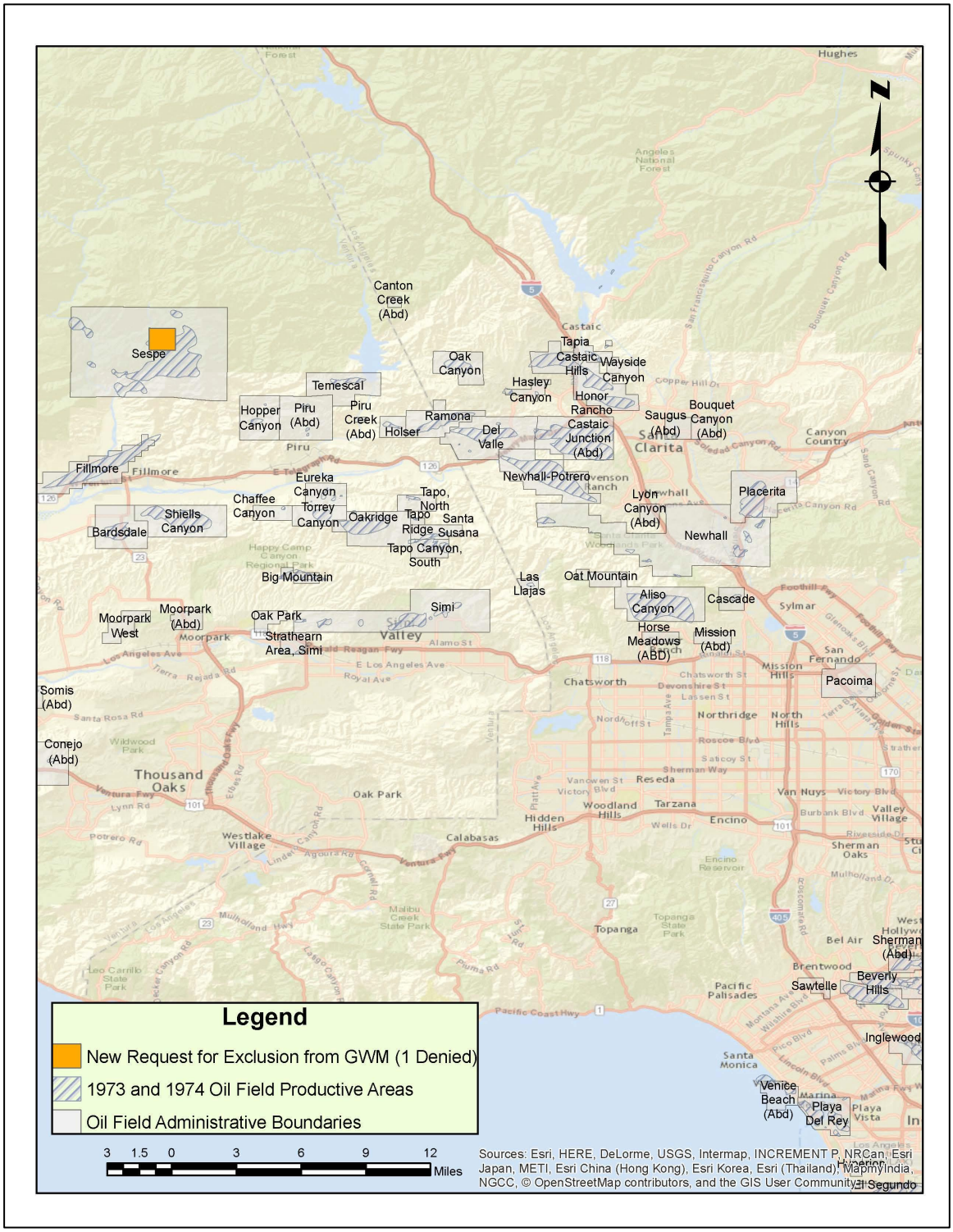

Figure B-5. Requests for Exclusion from Groundwater Monitoring Denied During the Reporting Period (July 7, 2015- December 31, 2016) in Ventura County

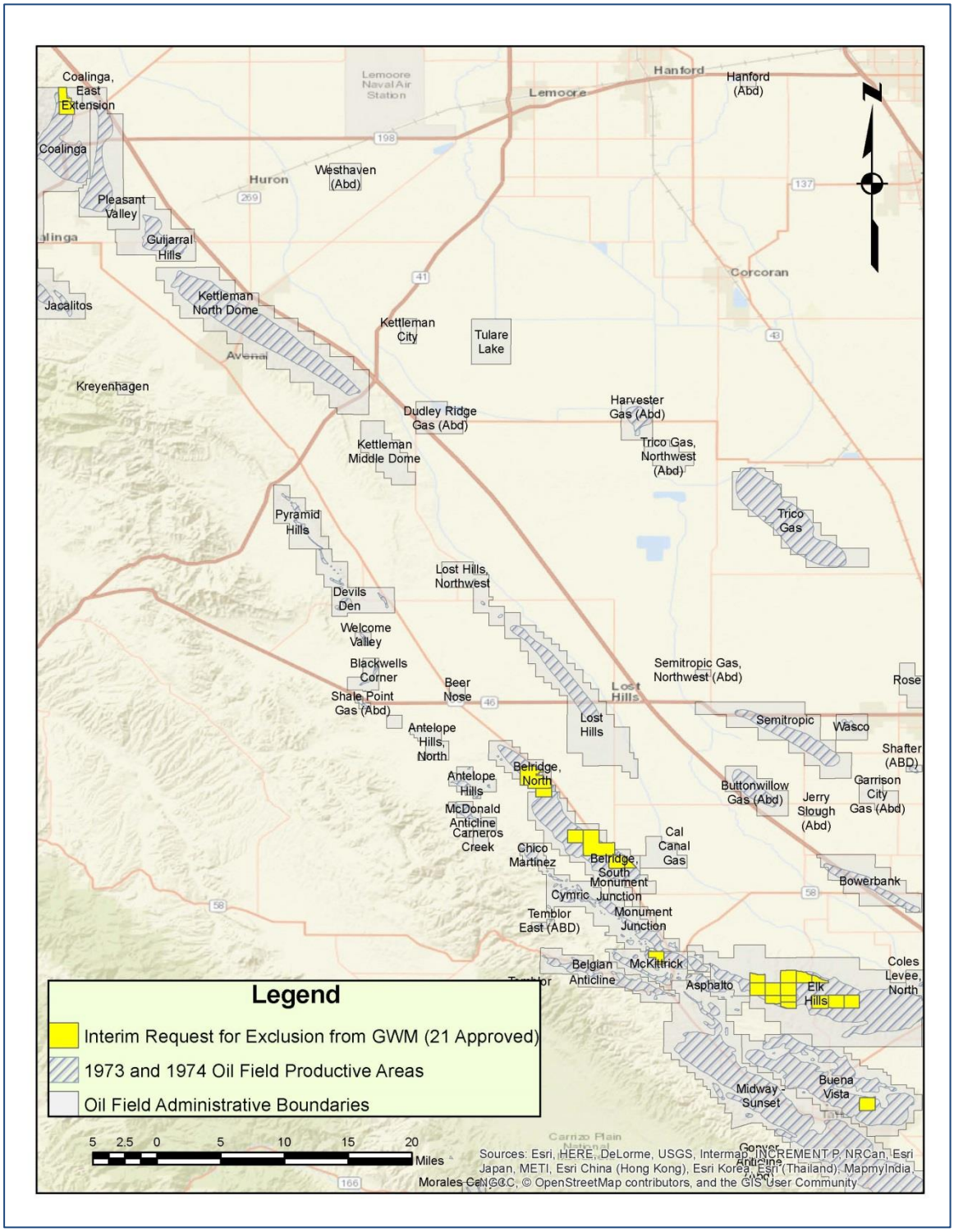

Figure B-6. Requests for Exclusion from Groundwater Monitoring Approved During the Interim Period (January 1, 2014- July 6, 2015) in Kern and Kings Counties

APPENDIX C- INTERIM PERIOD SUMMARY TABLES

APPENDIX C: LIST OF INTERIM PERIOD SUMMARY TABLES

Table C-1. Groundwater Monitoring Plans Approved by DOGGR During the Interim Period (January 1, 2014- July 6, 2015)

GeoTracker Global Identification	Oil Field or (Area)	Operator	Status/Determination
GAGW10000035	(Buena Vista Nose)	California Resources Corporation	Approved- 8/28/2014
GAGW10000040	Kettleman Middle Dome	KMD Operating Company	Approved- 8/25/2014
GAGW10000032	Rose	California Resources Corporation	Approved- 7/2/2014
GAGW10000031	Rose	California Resources Corporation	Approved- 7/2/2014
GAGW10000050	Brea Olinda	Linn Operating, Inc.	Approved- 6/29/2015
GAGW10000047	Lost Hills	Chevron	Approved- 2/6/2015
GAGW10000038	Lost Hills	Aera Energy LLC	Approved- 6/25/2014
GAGW10000039	Lost Hills	Seneca Resources Corporation	Approved- 8/26/2014
GAGW10007870	South Belridge	Aera Energy LLC	Approved- 6/30/2015
GAGW10000049	South Belridge	Aera Energy LLC	Approved- 6/16/2015
GAGW10007878	South Belridge	Linn Operating, Inc.	Approved- 6/29/2015
GAGW10000018	North Coles Levee	Central Resources Corporation	Approved- 1/12/2015
GAGW10007872	North Coles Levee	Central Resources Corporation	Approved- 12/23/2014
GAGW10000041	Stockdale	Crimson Resource Management	Approved- 9/12/2014
GAGW10000042	Hopper Canyon	DCOR LLC[1]	Approved- 8/20/2014

Notes:

1. DCOR LLC did not perform well stimulation in Hopper Canyon. Monitoring data was collected only pre-stimulation.

Table C-2. Requests for Exclusion from Groundwater Monitoring Approved During the Interim Period (January 1, 2014 - July 6, 2015)

GeoTracker Global Identification	Oil Field	Operator	Status/Determination
GW10007847	South Belridge	Aera Energy LLC	Approved- 3/4/2014
GW10007848	North Belridge	Aera Energy LLC	Approved- 5/14/2014
GAOG10008892	South Belridge	Aera Energy LLC	Approved- 6/6/2014
GW10007850	South Belridge	Aera Energy LLC	Approved- 11/25/2014
GW10007851	North Belridge & South Belridge	Breit Burn Operating L.P.	Approved- 5/2/2014
GW10007852	Elk Hills	California Resources Corporation	Approved- 4/24/2014
GW10007853	Elk Hills	California Resources Corporation	Approved- 5/14/2014
GW10007854	Elk Hills	California Resources Corporation	Approved- 6/26/2014
GW10007855	Elk Hills	California Resources Corporation	Approved- 7/31/2014
GW10007856	Elk Hills	California Resources Corporation	Approved- 7/31/2014
GW10007857	Elk Hills	California Resources Corporation	Approved- 7/31/2014
GW10007858	Elk Hills	California Resources Corporation	Approved- 9/14/2014
GW10007859	Elk Hills	California Resources Corporation	Approved- 9/16/2014
GW10007860	Elk Hills	California Resources Corporation	Approved- 9/16/2014
GW10007861	Elk Hills	California Resources Corporation	Approved- 9/24/2014
GW10007862	Elk Hills	California Resources Corporation	Approved- 10/21/2014
GW10007863	Elk Hills	California Resources Corporation	Approved- 10/21/2014
GW10007864	Elk Hills	California Resources Corporation	Approved- 1/22/2015
GW10007865	Buena Vista	California Resources Corporation	Approved- 4/2/2015
GW10007866	Coalinga	Seneca Resources Corporation	Approved- 5/27/2014
GW10007867	McKittrick	Chevron	Approved- 4/23/2015

Table C-3. Requests for Exclusion from Groundwater Monitoring Denied During the Interim Period (January 1, 2014 - July 6, 2015)

GeoTracker Global Identification	Oil Field	Operator	Status/Determination
n/a[1]	North Belridge & South Belridge	Aera Energy LLC	Denied
n/a	Lost Hills	Aera Energy LLC	Denied
n/a	Lost Hills	Aera Energy LLC	Denied
n/a	Brea- Olinda	Linn Operating, Inc.	Denied
n/a	Round Mountain	MacPherson Oil Company	Denied
n/a	Asphalto	California Resources Corporation	Denied
n/a	Lost Hills	Seneca Resources Corporation	Denied
n/a	Lost Hills	Seneca Resources Corporation	Denied
n/a	Wilmington	THUMS	Denied
n/a	Kettleman North Dome	California Resources Corporation	Denied
n/a	Buena Vista	California Resources Corporation	Denied

Notes:

1. Only approved requests for exclusion have been uploaded to GeoTracker (n/a- not applicable).

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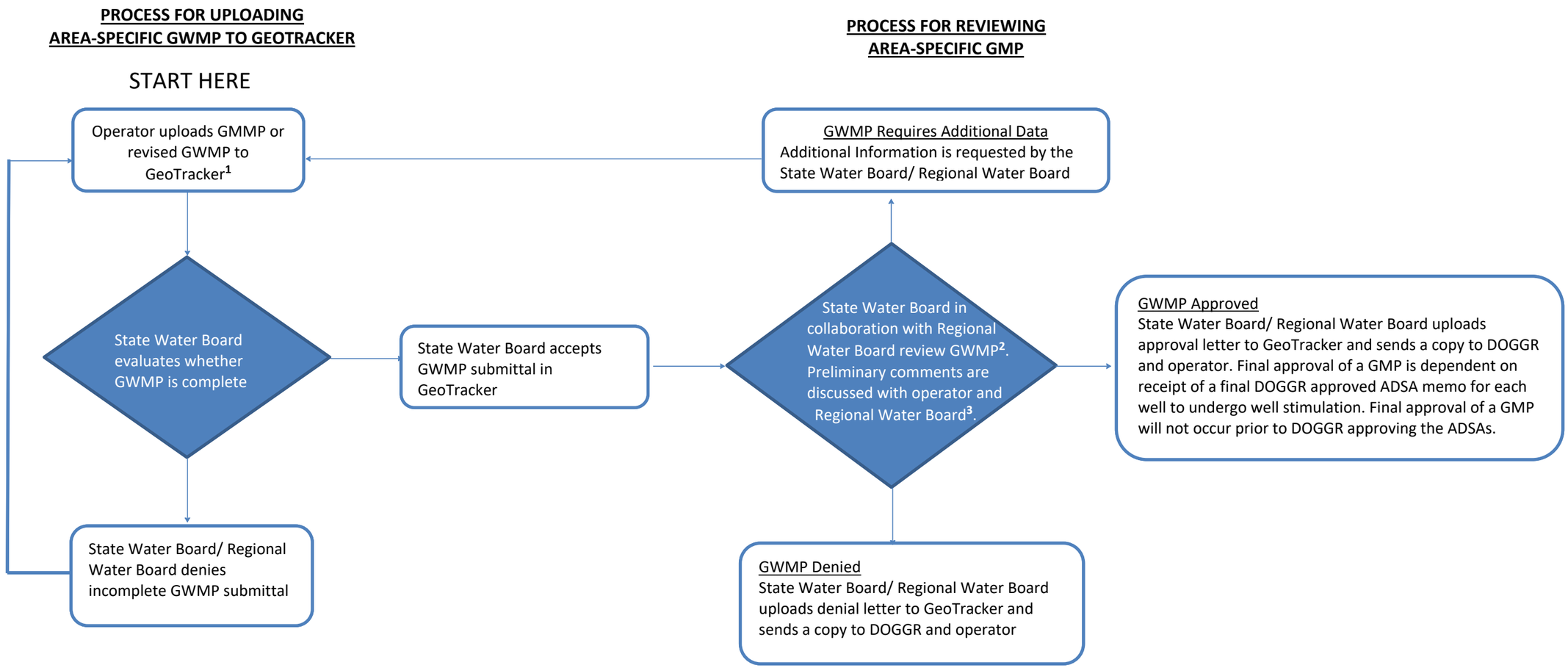
APPENDIX D- PROCESS FLOW CHARTS

APPENDIX D: LIST OF FLOW CHARTS

Figure D-1. Process Flow Chart For Uploading and Reviewing Area-Specific Groundwater Monitoring Plans

State Water Resources Control Board

Oil and Gas Monitoring Unit



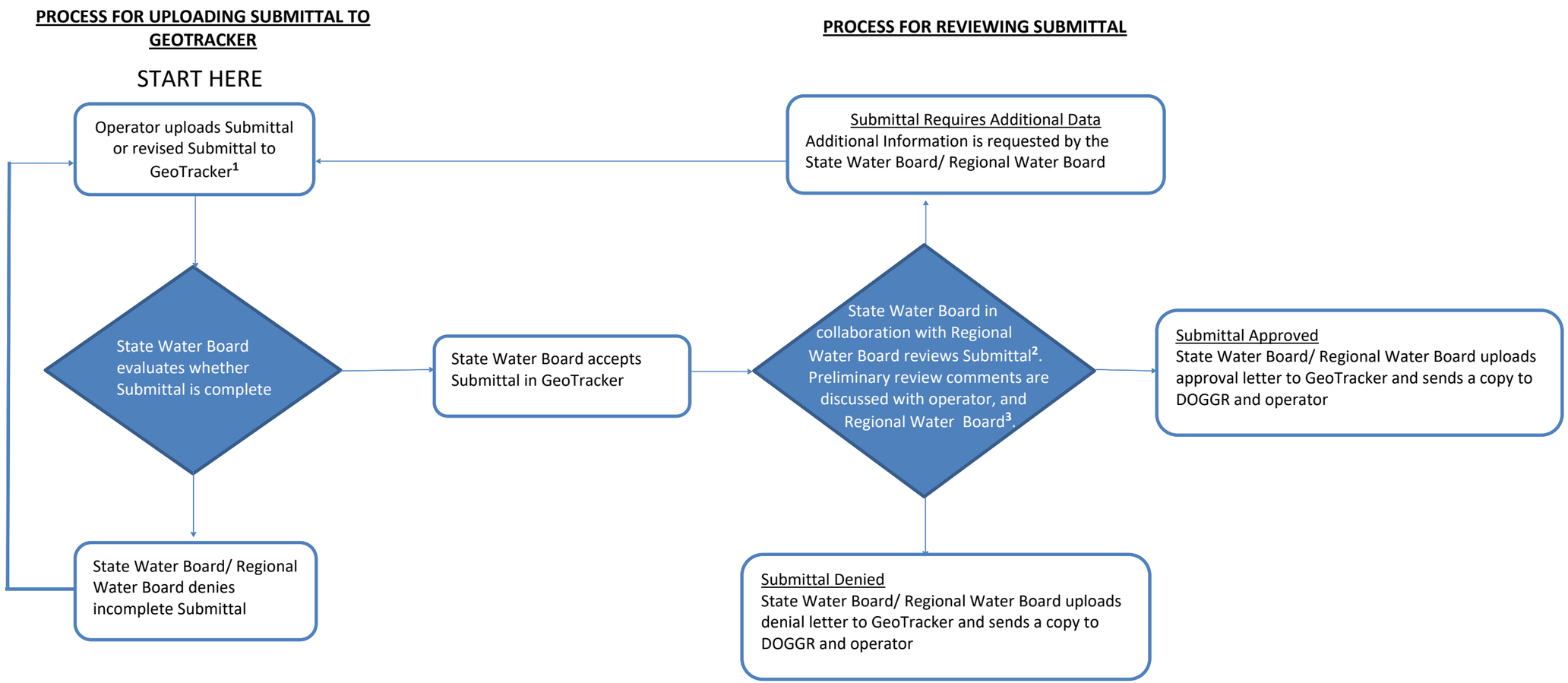
DEFINITIONS

GWMP = Groundwater Monitoring Plan
State Water Board = State Water Resources Control Board
Regional Water Board = Regional Water Quality Control Board
DOGGR = Division of Oil, Gas, and Geothermal Resources
ADSA = Axial Dimensional Stimulation Area

FOOTNOTES

1. New monitoring plans, or addendums to existing monitoring plans, submitted after July 7, 2015 must follow the requirements outlined in the Model Criteria for Groundwater Monitoring in areas of Oil and Gas Well Stimulation (Model Criteria).
2. Regional Water Board provides review comments to State Water Board within 30 calendar days.
3. State Water Board staff will respond to the operator in 45 calendar days from acceptance of a complete GWMP.

Figure D-2. Process Flow Chart For Reviewing
Request For Exclusion From Groundwater Monitoring
State Water Resources Control Board
Oil and Gas Monitoring



DEFINITIONS
Submittal = Request for Exclusion from Groundwater Monitoring
State Water Board = State Water Resources Control Board
Regional Water Board = Regional Water Quality Control Board
DOGGR = Division of Oil, Gas, and Geothermal Resources

FOOTNOTES
1. Requests for exclusion from groundwater monitoring submitted after July 7, 2015 must follow the requirements outlined in the Model Criteria for Groundwater Monitoring in areas of Oil and Gas Well Stimulation (Model Criteria). If future information indicates the potential presence of protected water in an area granted exclusion from groundwater monitoring, the State Water Board/ Regional Water Board will re-evaluate its determination.
2. Regional Water Board provides review comments to State Water Board within 30 calendar days.
3. State Water Board staff will respond to the operator in 45 calendar days from acceptance of complete submittal.